ELECTRONIC USTRIES LT

JUNE 1962REFERENCE ISSUE



ET The Reference Issue



The Electronic Industry



Tubes & Semiconductors



Materials & Hardware



Electronic Components



Electromechanical Components



Measurement & Test



Military Electronics



Data Processing & Automation



Microwave

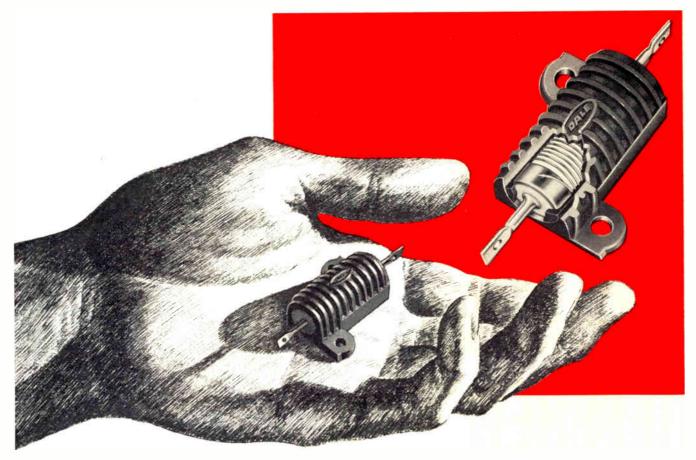


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ELECTRONIC INDUSTRIES

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1962-63 All Reference & Directory Issue

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ELECTRONIC INDUSTRIES

Vol. 21, No. 6

JUNE, 1962

The New Reference Issue

THIS fifth annual All-Reference Issue includes our twentieth edition of the ELECTRONIC INDUSTRIES Directory. You will note a major change in presentation which we believe will increase its usefulness.

How to organize and correlate the immense volume of information in these annual All-Reference issues has been a continuing problem over the years. In this issue, the subject matter has been divided into a dozen categories. Eight of these deal with specific types of products and the other four are concerned with general areas of electronic interest.

We have grouped the editorial pages at the start of each section and included a topical index on the title page. Appropriate advertising follows the editorial material. We have listed in each section catalogs and technical bulletins manufacturers have reported to us as being available. You may send for these by circling the item number on any one of the six product inquiry cards contained in this issue.

Section A, immediately following. provides complete editorial and advertising content information for this 532 page issue. The editorial material has been cross-referenced into a quick finding index appearing on page A-3. Advertising has also been cross-referenced by product, and these listings start on page A-4.

Section L contains the Directory of Electronic Manufacturers and provides name, address, and product information. The listings are a machine print-out of data contained in the master ELECTRONIC INDUSTRIES census card deck, which is also used to develop market research information. This directory is the most accurate summary of the industry available from any source. It includes verified information on 6136 manufacturing plants based on mail survey questionnaires, telephone calls, and personal plant interviews.

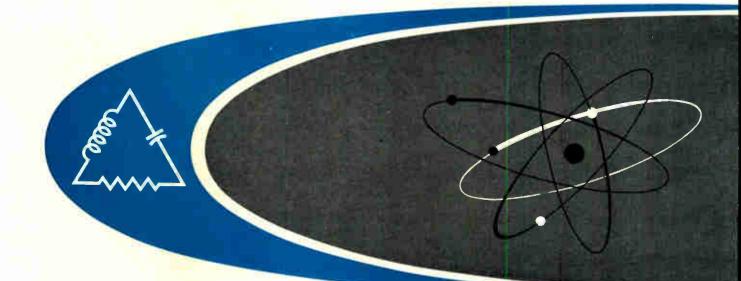
We hope you will like this issue and find it useful. Your comments and suggestions will be welcomed.



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THE FIRST



TWIN Universal POWER SUPPLY

TWO INDEPENDENT DC SOURCES EACH FURNISHING:

- CONSTANT VOLTAGE OUTPUT: 0-40 VDC, 0-0.5 A
- CONSTANT CURRENT OUTPUT: 25-500 MA, 40 Volts Max.
- REGULATION: .05% or 10 Millivolts (Voltage) .02% or 100 Microamps (Current)
- RIPPLE: 250 Microvolts RMS (Voltage) 20 Microamps RMS (Current)
- AUTOMATIC TRANSFER from Voltage to Current Regulation at Any Operating Point.
- AUTOMATIC TRANSFER from Current to Voltage Regulation at Any Operating Point.
- CONSTANT VOLTAGE OUTPUT With Continuously Adjustable Current Limiting
- CONSTANT CURRENT OUTPUT With Continuously Adjustable Voltage Limiting
- SERIES Operation or PARALLEL Operation
- REMOTE VOLTAGE and REMOTE CURRENT Programming

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The Electronic Industry



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ELECTRONIC INDUSTRIES

1962 Coming Events Calendar

Portraying important electronic events for the next 7 months

A listing of meetings, conferences, shows, etc., occurring during the last half of 1962 that are of special interest to electronic engineers. The events are listed chronologically and by the area—

East, Midwest, and West—in which they occur.

ONLY THE OPENING DAY OF EACH MEETING IS MARKED ON THE CALENDAR

JUNE

 EAST

 June 4-6: Lubrication Symp., ASME;

- Deauville Hotel, Miami Beach, Fla. June 4-6: Edison Electric Inst., An-
- nual Conv., Atlantic City, N. J. June 4-7: 1962 Int'l Atomic Expos. & 7th Annual Nuclear Congress,
- EJC; Coliseum, New York, N. Y. June 5-7: National Fuels Symp., ASME & Rutgers Univ.; Rutgers Univ., New Brunswick, N. J.
- June 6-8: Soc. of Tech. Writers & Publishers Annual Mtg.; Sheraton Hotel, Phila., Pa.
- tel, Phila., Pa. June 11-12: Illuminating Eng'g Soc. Northeastern Regional Mtg.; Hotel U. S. Thayer, West Point, N. Y.
- June 11-13: Brookhaven Nat'l. Lab., Molecular Beams Conf.; Brookhaven Nat'l. Lab., Upton, N. Y.
- June 11-15: Annual Tech. Writers' Inst.; Rensselaer Polytechnic Inst., Troy, N. Y.
- June 12: Mtg. of Ultrasonic Mfrs. Assoc.; Statler-Hilton Hotel, New York, N. Y.
- June 12: Reinforced Plastics, Eastern New Eng. Sec., SPE; Statler-Hilton Hotel, Boston, Mass.
- June 12-14: 16th Annual AFCEA Conv.; Sheraton-Park and Shoreham Hotels, Washington, D. C.
- June 18-20: American Nuclear Soc. Annual Mtg.; Statler-Hilton Hotel, Boston, Mass.
- June 18-22: Amer. Crystallographic Assoc. Annual Nat'l. Mtg.; Villanova Univ., Phila., Pa.
- June 24-28: Nat'l. Assoc. of Music Merchants Trade Show & Conv.; Hotel New Yorker and N. Y. Trade Show Bldg., New York, N. Y.

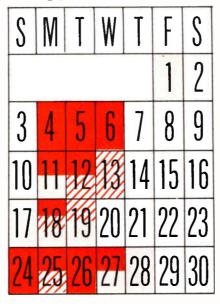
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West

- June 24-29: ASTM Annual Mtg.; Statler Hotel, New York, N. Y.
- June 24-29: Nat'l. Assoc. of Power Engineers Nat'l. Conv.; Statler-Hilton Hotel, Washington, D. C.
- June 25-27: 6th Nat'l. Conv. Military Electronics (MIL - E - CON), IRE, PGMIL; Shoreham Hotel, Washington, D. C.
- June 25-27: Annual Mtg., ASHR & ACE; Deauville Hotel, Miami Beach, Fla.
- June 26-28: Aviation Conf., ASME; Univ. of Maryland, College Park, Md.
- June 27-29: Joint Automatic Control Conf., IRE, AIEE, ISA; New York Univ., New York, N. Y.

MIDWEST

June 12: Regular AEP&EM Mtg.; Chicago, Ill.



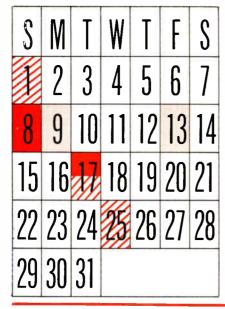
- June 13-16: Annual NSPE Mtg.; French Lick-Sheraton Hotel, French Lick, Ind.
- June 18-19: Chicago Spring Conf. on Broadcast & TV Receivers, IRE (PGBTR); O'Hare Inn, Chicago, Ill.
- Great Lakes Show; Cobo Hall, Detroit, Mich.
- June 19-21: Summer APS Mtg. in East; Evanston, Ill.
- June 25-27: Amer. Assoc. of Cost Engineers Annual Mtg.; Edgewater Beach Hotel, Chicago, Ill

WEST

- June 1-3: ARRL Southwestern Div. Conv.; Disneyland Hotel, Anaheim, Calif.
- June 11-22: Topics in Geophysics; AFOSR & Univ. of New Mexico, Cloudcroft, N. Mex.
- June 17-22: Summer Gen'l. Mtg., AIEE; Hotel Denver-Hilton, Denver, Colo.
- June 18-21: 4th U. S. Congress, Theoretical & Applied Mechanics, ASME; Univ. of Calif., Berkeley, Calif.
- June 18-22: Amer. Soc. for Eng'g. Education Annual Mtg.; Air Force Academy, Colo.
- June 19-21: 2nd Annual San Diego Bio-Medical Eng'g. Symp. & Exhib.; Stardust Motor Hotel, San Diego, Calif.
- June 19-22: Summer Mtg., IAS; Ambassador Hotel, Los Angeles, Calif.
- June 27-28: 9th Annual Symp. on Computers & Data Processing, Denver Research Inst., Univ. of Denver; Elkhorn Lodge, Estes Park, Colo.
- June 28-29: 4th Nat'l. Symp. on RF1, IRE, PGRF1; Dell Webb, Town House Hotel, San Francisco, Calif.

East

THE REFERENCE ISSUE



EAST

JULY

- July 8-14: Int'l. Congress on Glass, ACS; Sheraton-Park Hotel, Washington, D. C.
- July 17-18: Data Acquisition & Processing in Medicine & Biology, IRE (PGBME), AIEE, ISA; Whipple Audit., Strong Memorial Hosp., Rochester, N. Y.

MIDWEST

July 1-20: Telephone Eng. Conf.; Michigan State Univ., E. Lansing, Mich.

AUGUST

EAST

- Aug. 5: Industrial Research Conf., Columbia Univ.; Arden House, Harriman, N. Y.
- Aug. 27-29: Conf. on Metallurgy of Semiconductor Materials; Ben Franklin Hotel, Phila., Pa.

MIDWEST

- Aug. 30-Sept. 5: Annual Conv., APA; Chase-Park Plaza Hotels, St. Louis, Mo.
- Aug. 31-Sept. 9: 1st World's Fair of Music & Sound; McCormick Place, Chicago, Ill.

WEST

- Aug. 5-8: 5th Nat'l. Heat Transfer Conf. & Exhib., ASME, AIChE, Houston, Tex.
- Aug. 10-11: The Future of Manned Vehicles in Air & Space, IAS; Olympic Hotel, Seattle, Wash.
- Aug. 13-16: Pacific Energy Conver-

ABBREVIATIONS

- ACM-Association for Computing Machinery
- ACS-American Ceramic Society
- AEC-Atomic Energy Commission
- AEP&EM—Association of Electronic Parts and Equipment Manufacturers
- AES-American Electroplaters Society
- AES—Audio Engineering Society AES—Aircraft Electrical Society
- AFCEA—Armed Forces Communications & Electronics Association AFOSR—Air Force Office of Scientific Re-
- search
- AICE—American Institute of Consulting Engineers
- AIChE-American Institute of Chemical Engineers
- AIEE—American Institute of Electrical Enaineers
- AIME—American Institute of Mining, Metallurgical & Petroleum Engineers ANS—American Nuclear Society

- sion Conf., AIEE; Fairmont Hotel, San Francisco, Calif.
- Aug. 14-16: 1962 Int'l. Conf. on Precision Electromagnetic Measurements, IRE(PGI), NBS, AIEE; NBS Boulder Labs, Boulder, Colo.
- Aug. 14-16: Cryogenic Eng'g. Conf.; Univ. of Calif., Los Angeles, Calif. Aug. 15-17: 3rd Electronic Packaging
- Symp.; Univ. of Colorado, Boulder, Colo.
- Aug. 16-18: Joint Western Regional Aircraft & Missiles Conf., ASQC; Benjamin Franklin Hotel, Seattle, Wash.
- Aug. 21-24: Western Electronics Show & Conf. (WESCON), IRE, WEMA; Memorial Sports Arena & Statler-Hilton Hotel, Los Angeles, Calif.
- Aug. 23-24: AEEC Summer Mtg.; Hotel Benjamin Franklin, Seattle, Wash.
- Aug. 26-29: Nat'l. Mtg., AICE; Denver-Hilton Hotel, Denver, Colo.
- Aug. 27-29: Summer APS Mtg. in West; Seattle, Wash.
- Aug. 28-30: 4th EIA Conf. on Maintainability of Electronic Equip., EIA

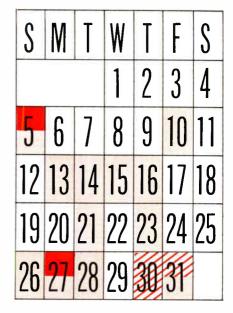
APS-American Physical Society

- ARF-Armour Research Foundation
- ARRL-American Radio Relay League
- ARS-American Rocket Society ASA-Acoustical Society of America
- ASA-American Standards Association
- ASCE—American Society of Civil Engineers
- ASHR&ACE—American Society of Heat-
- ing, Refrigerating and Air Conditioning Engineers
- ASME—American Society of Mechanical Engineers
- ASQC-American Society for Quality Con-
- ASTM-American Society for Testing And Materials
- ASTME-American Society of Tool and Manufacturing Engineers
- AWS-American Welding Society
- EIA-Electronic Industries Association
- IAS-Institute of Aeronautical Sciences IHFM—Institute of High Fidelity Manufacturers

- July 17-19: Lunar Mission Mtg., ARS; Pick-Carter & Statler-Hilton Hotels, Cleveland, Ohio.
- July 25-29: Int'l. Sound Fare, SORD, CMA, IHFM, ARMADA, MRIA;Cobo Hall, Detroit, Mich.



- July 9-13: 5th Annual Institute in Tech. & Industrial Communications; Colorado State Univ., Ft. Collins, Colo.
- July 13: Western Regional Conf., SAME; Seattle, Wash.



Dept. of Defense; Univ. of Colorado, Boulder, Colo.

Aug. 31-Sept. 3: ARRL Nat'l. Conv.; Portland-Sheraton Hotel & Memorial Coliseum, Portland, Ore.

- IRE—Institute of Radio Engineers ISA—Instrument Society of America
- MRIA-Magnetic Recording Industry Association
- NAB-National Association of Broadcasters NACE-National Association of Corrosion Engineers
- NASA-National Aeronautics & Space Administration
- NBS-National Bureau of Standards NSPE-National Society of Professional Engineers
- OSA—Optical Society of America
- ORSA-Operations Research Society of America
- SAE—Society of Automotive Engineers SAME-Society of American Military Enaineers
- SMPTE-Society of Motion Picture & TV Engineers
- SPE-Society of Plastic Engineers
- WEMA-Western Electric Manufacturers Association

COMING EVENTS CALENDAR

SEPTEMBER

EAST

- Sept. 4-7: 1962 ACM Nat'l. Conf. & Int'l. Data Processing Exhib; Assoc. for Computing Machinery; Hotel Syracuse & War Memorial Audit., Syracuse, N. Y.
- Sept. 4-8: Reaction Mech. Conf.; Brookhaven Nat'l. Lab., Upton, N. Y.
- Sept. 9-14: 142nd Mtg. of American Chemical Soc.; Atlantic City, N. J.
- Sept. 11-13: EIA Mtg.; Biltmore Hotel, New York, N. Y.
- Sept. 13-14: 6th Nat'l. Symp. on Eng'g. Writing & Speech, IRE(PGEWS); Mayflower Hotel, Washington, D. C.
- Sept. 16-20: Mtg. Electrochemical Soc.; Statler-Hilton Hotel, Boston, Mass.
- Sept. 17-18: Hydrofoil & Air Cushion Vehicles, IAS; Shoreham Hotel, Washington, D. C.
- Sept. 24-26: Nat'l. Power Conf., ASME, AIEE; Lord Baltimore Hotel, Baltimore, Md.
- Sept. 26-29: Materials & Equip. & White Wares Div. Fall Mtg., ACS; Bedford Springs Hotel, Bedford, Pa.
- Sept. 27: New Look at Thermosets, Binghamton Sec. SPE; Hotel Casey, Scranton, Pa.
- Sept. 28-29: 12th Annual Fall Symp., PGB; Willard Hotel, Washington, D. C.

MIDWEST

- Sept. 1-3: ARRL Delta Div. Conv.; Jung Hotel or Fountainbleu Motel, New Orleans, La.
- Sept. 9-14: Petroleum Industry Conf., AIEE, ISA; Carter Hotel, Cleveland, Ohio
- Sept. 9-14: Semi-Annual Mtg., ASP; Chase-Park Plaza Hotels, St. Louis, Mo.
- Sept. 12-15: Enamel Div. Fall Mtg., ACS; French Lick-Sheraton Hotel, French-Lick, Ind.
- Sept. 13-14: Joint Eng'g. Management Conf., ASME; Roosevelt Hotel, New Orleans, La.
- Sept. 18-19: 1962 Conf. on Rectifiers in Industry, AIEE; Deshler-Hilton Hotel, Columbus, Ohio
- Sept. 19-20: 11th Annual Industrial Electronics Symp., IRE, PGIE; Chicago, Ill.

WEST

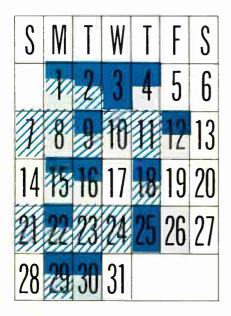
Sept. 9-14: Nat'l. Tech. Conf., IES; Statler-Hilton Hotel, Dallas, Tex.

Sept. 13-14: Nat'l. Topical Mtg. on Plutonium as a Power Reactor Fuel; Richland, Wash.

OCTOBER

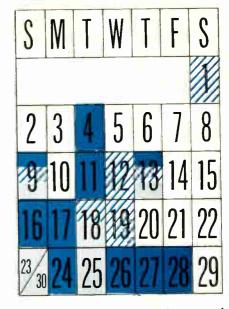
EAST

- Oct. 1-2: Annual Mtg., Engrs. Council for Professional Development; Bellevue Stratford Hotel, Phila., Pa.
- Oct. 1-3: 8th Nat'l. Communications Symp., IRE; Municipal Audit. & Hotel Utica, Utica, N. Y.



- Oct. 1-4: Northeast Region Conf., NACE; Hotel Sheraton Ten Eyck, Albany, N. Y.
- Oct. 2-4: Nat'l. Symp. on Space Electronics & Telemetry, IRE; Fontainebleau Hotel, Miami Beach, Fla.
- Oct. 3-6: Annual Mtg., OSA; Manger Hotel, Rochester, N. Y.
- Oct. 4-5: Fuels Conf., ASME, AIME; Penn Sheraton Hotel, Pittsburgh, Pa.
- Oct. 4-6: Refractories Div. Fall Mtg., ACS; Bedford Spring Hotel, Bedford, Pa.
- Oct. 9-12: Electronics Div. Fall Mtg., ACE; Statler-Hilton Hotel, Boston, Mass.
- Oct. 12-13: Photographic Electronic Symp., SPSE; Washington, D. C.
- Oct. 15-16: NAB Fall Conf.; Dinkler-Plaza, Atlanta, Ga.
- Oct. 15-17: Conf. on Electrical Insulation, Nat'l. Academy Science & Nat'l. Research Council; Hershey Hotel, Hershey, Pa.
- Oct. 15-19: 17th Int'l. Instrument-Automation Conf. & Exhib. & ISA Annual Mtg., ISA; New York Coliseum, New York, N. Y.
- Oct. 16-18: Lubrication Conf., ASME, ASLE; Pittsburgh Hilton Hotel, Pittsburgh, Pa.

Oct. 16-18: Nat'l. Conf. on Standards,



- Sept. 18-20: Ordnance Environmental Symp. (unclassified), R&D Div., Dept of the Army; Granada Hotel, San Antonio, Tex.
- Sept. 23-26: Peetroleum Mech. Eng'g. Conf., ASME; Sheraton - Dallas Hotel, Dallas, Tex.
- Sept. 25-28: Power Systems Conf., ARS; Miramar Hotel, Santa Monica, Calif.
- Sept. 30-Oct. 5: 4th Pacific Area Nat'l. Mtg.; Statler-Hilton Hotel, Los Angeles, Calif.

ASA; Biltmore Hotel, New York, N.Y.

- Oct. 18-19: Regional Conf., AIIE; Hotel Lafayette, Buffalo, N. Y.
- Oct. 18-19: NAB Fall Conf.; Biltmore Hotel, New York, N. Y.
- Oct. 22-24: East Coast Conf. on Aerospace & Navigational Electronics (ECCANE), IRE, PGANE; Baltimore, Md.
- Oct. 25-26: NAB Fall Conf.; Statler-Hilton Hotel, Washington, D. C.
- Oct. 25-27: 1962 Electron Devices Mtg., IRE, PGED; Sheraton Park Hotel, Washington, D. C.
- Oct. 29-31: Mtg. Soc. of Rheology; Johns Hopkins Univ., Baltimore, Md.
- Oct. 29-Nov. 2: World Metal Show & 44th Nat'l. Metal Cong., ASM; Coliseum, New York, N. Y.
- Oct. 29-Nov. 2: Annual Conv., Soc. for Nondestructive Testing: Hotel Commodore, New York, N. Y.
- Oct. 30: Annual Dinner, AICE; Waldorf-Astoria Hotel, New York, N. Y.

MIDWEST

- Oct. 1-4: Nat'l. Fall Mtg., AWS; Hotel Schroeder, Milwaukee, Wis.
- Oct. 2-4: 3rd Symp. on Advanced Propulsion Concepts, Cincinnati, Ohio

THE REFERENCE ISSUE

NOVEMBER

Oct.---Midwest (Cont.)

- Oct. 7-9: Basic Science Div. Fall Mtg., ACS; Battelle Memorial Inst., Columbus, Ohio Oct. 7-12: Fall General Mtg., AIEE;
- Pick-Congress Hotel, Chicago, Ill.
- Oct. 8-10: Nat'l. Electronics Conf., IRE, AIEE, EIA; McCormick Place, Chicago, Ill.
- Oct. 8-12: ASCE Annual Mtg. & Nat'l. Transp. Eng'g. Conf.; Statler Hotel, Detroit, Mich.
- Oct. 9-11: North Central Region Conf., NACE; Detroit, Mich.
- Oct. 10-11: Magnetohydrodynamics Conf.; Mich. State Univ., E. Lansing, Mich.
- Oct. 11-12: Southeast Regional Conf., NACE; Birmingham, Ala.
- Oct. 15-18: Symp. on Space Phenomena & Measurements, IRE, AEC, NASA; Detroit, Mich.
- Oct. 15-17: Materials Handling Conf., ASME; Cincinnati, Ohio
- Oct. 18-19: Nat'l. Conf. on Industrial Hydraulics; Sherman Hotel, Chicago, Ill.
- Oct. 21-26: Semi-Annual Conv. & Equip. Exhib., SMPTE; Drake Hotel, Chicago, Ill.
- Oct. 22-23: NAB Fall Conf.; Edgewater Beach Hotel, Chicago, Ill.
- Oct. 23-25: Symp. on Space Phenomena & Measurement, IRE; Chicago, Ill.
- Oct. 24-25: Computer Applications Symp., ARF; Morrison Hotel, Chicago, Ill.
- Oct. 24-26: Annual Mtg., Soc. for Experimental Stress Analysis; Schroeder Hotel, Milwaukee, Wis.
- Oct. 29-31: 15th Conf. on Electrical Techniques in Medicine & Biology, ISA, AIEE, IRE; Edgewater Beach Hotel, Chicago, Ill.

WEST

- Oct. 1-5: Semi-Annual Western Eng'g. Conf. & Tool Expos., ASTME; Pan Pacific Auditorium, Los Angeles, Calif.
- Oct. 4-5: Weapons Systems Technical Panorama, IAS; Dallas, Tex.
- Oct. 8-12: Nat'l. Aeronautic & Space Eng'g. Mtg., Mfg. Mtg. & Exhibit, SAE; Ambassador Hotel, Los Angeles, Calif.
- Oct. 10-12: 20th Annual Aerospace Electronic Expos. Report, AES; Pan-Pacific Audit., Los Angeles, Calif.
- Oct. 12-13: Regional Conf., AIIE; El Cortez Hotel, San Diego, Calif.
- Oct. 15-20: Pacific Coast Regional Mtg., ACS; Olympia Hotel, Seattle, Wash.
- Oct. 16-19: South Central Region Conf. & Exhib., NACE; Granada Hotel, San Antonio, Tex.
- Oct. 26-27: Midwest Quality Control Conf., ASQC; Statler-Hilton Hotel, Denver, Colo.
- Oct. 30-Nov. 1: Conf. on Eng'g. Techniques in Missile & Spaceborne Computers, IRE; Disneyland, Ana,heim, Calif.

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EAST

- Nov. 1-2: Regional Conf., AIIE; Deauville Hotel, Miami Beach, Fla. Nov. 1-3: Regional Conf. AIIE; Shoreham Hotel, Washington, D. C.
- Nov. 5-7: Northeast Res. & Eng'g. Mtg. (NEREM), IRE; Boston, Mass.
- Nov. 8-9: Extrusion Fundamentals as related to Polymer Structure, New-
- ark Sec. SPE; Hotel Essex House, Newark, N. J. Nov. 8-9: Nat'l. Mtg., ORSA; Shera-
- ton Hotel, Phila., Pa.
- Nov. 12-15: Magnetism & Magnetic Materials Conf. & Exhib., AIEE, AIP; Penn-Sheraton Hotel, Pittsburgh, Pa.
- Nov. 25-30: Winter Annual Mtg., ASME: Statler-Hilton Hotel, New York, N. Y.
- Nov. 26-28: Winter Mtg. & Atom Fair, ANS & AIF; Sheraton-Park & Shoreham Hotels, Washington, D. C.

MIDWEST

- Nov. 1-2: Annual Instrumentation Conf.; Louisiana Polytechnic Inst., Ruston, La.
- Nov. 4-7: Annual Conf. on Electronic Techniques in Medicine & Biology. IRE, AIEE, ISA; Conrad-Hilton Hotel, Chicago, Ill.
- Nov. 5-9: Fall Meeting, AIMM, PE, MS; Chicago, Ill.
- Nov. 10-25: World Economic Progress Assembly & Expos.; McCormick Place, Chicago, Ill.
- Nov. 12-13: NAB Fall Conf.; Muehlebach Hotel, Kansas City, Mo.
- Nov. 23-24: Thanksgiving Mtg. of APS; Cleveland, Ohio
- Nov. 26-28: Machine Tools Conf., AIEE: Statler-Hilton Hotel, Detroit, Mich.

DECEMBER





WEST

- Nov. 1-3: Fall Mtg., Nat'l. Soc. of Prof. Engrs.; Hotel Westward Ho, Phoenix, Ariz. Nov. 7-10: Fall Mtg., ASA; Olympia
- Hotel, Seattle, Wash.
- Nov. 8-9: NAB Fall Conf.; Sheraton Dallas Hotel, Dallas, Tex.
- Nov. 12-18: Annual Mtg. & Astronautical Expos., ARS; Pan Pacific Audit., Los Angeles, Calif. Nov. 14-16: Material Handling Inst.
- Southwest Show; Dallas, Tex.
- Nov. 15-16: NAB Fall Conf.; Brown Palace, Denver, Colo.
- Nov. 19-20: NAB Fall Conf.; Sheraton-Portland Hotel, Portland, Pre.
- Nov. 27-29: EIA Mtg.; Jack Tar Hotel, San Francisco, Calif.

EAST

- Dec. 4-6: Eastern Joint Computer Conf. (EJCC), IRE, (PGEC), AIEE, ACM; Bellevue - Stratford Hotel, Phila., Pa.
- Dec. 17: Wright Bros. Lecture; Washington, D. C.
- Dec. 26-31: Space Physics Conf., ARS; Phila., Pa.
- Dec. 26-31: Annual Nat'l. Mtg. & Expos. of Science & Industry, Amer. Assoc. for the Advancement of Science; Phila., Pa.

MIDWEST

- Dec. 2-6: Annual Mtg., AIChE; Conrad-Hilton Hotel, Chicago, Ill.
- Dec. 5-7: Electric Furnace Conf., AIMM, PE, MS; Netherland-Hilton Hotel, Cincinnati, Ohio
- Dec. 11-14: Winter Mtg., ASAE; Palmer House, Chicago, Ill.

WEST

Dec. 26-29: Winter APS Mtg.; Stanford, Calif.

1962 Roster of Associations Serving the Electronic Industries

A listing of the technical and fraternal organizations for the professionally employed in the electronic arts and sciences. Shown are the name of the organization; membership; mailing address; officers; date and location of the annual meeting, and objectives.

- AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.-84 Members . . . 610 Shoreham Bldg., Washington 5, D. C., DI 7-2315 . . . August C. Esenwein, Pres.; Samuel L. Wright, Sec.-Treas. . . Fall Meeting, Mid November, Phoenix, Ariz. . . . National trade association of the manufacturers of air craft, guided missiles, spacecraft, and accessories.
- AMERICAN ELECTROPLATERS' SOCIETY, INC.—9000 Members ... American Bldg., 443-445 Broad St., Newark, N. J., HU 2-3400 ... Chester G. Borlet, Pres ; John Nichols, Exec. Sec. ... 50th Annual Convention, June 24-27, 1963, Ambassador Hotel, Atlantic City, N. J. ... Advancement of the theory and practice of electroplating, metal finishing, and the allied arts.
- AMERICAN GEOPHYSICAL UNION—700 Members 1515 Massachusetts Ave., N. W., Washington, D. C., DU 7-0900. . . . Dr. Thomas F. Malone, Pres.; Waldo E. Smith, Exec. Secy. . . . 2nd Western Nat'l Meeting, late December 1962, Stanford Univ.; Eastern Nat'l Annual Meeting, April 1963, Washington, D. C. . . . To promote, coordinate and facilitate the study of problems concerned with the figure and physics of the Earth.
- AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS 60,000 Members ... 345 E. 47th St., New York 17, N. Y., PL 2-6800 Warren H. Chase, Pres.; Nelson S. Hibshman, Secy. ... Winter General Meeting Jan. 27-Feb. 1, 1963, New York, N. Y. ... To facilitate the exchange of technical information between the members of the Institute.
- AMERICAN RADIO RELAY LEAGUE, INC.—100,000 Members ... 38 LaSalle Rd., W. Hartford, Conn. (203)236-2535 ... Coodwin L Dosland, Pres ; A. L. Budlong, Secy. & Gen. Mgr. ... National Conv., Sept 1-3, 1962, Portland, Ore. ... To promote interest in amateur radio communication and experimentation.
- AMERICAN SOCIETY FOR METALS—34,000 Members . . . Metals Park, Ohio, (216)338-5151 . . . Carl E. Swartz, Pres.; Merrill A. Scheil, Secy -Trustee . . . World Metal Show and National Metal Conzress, Cct. 29-Nov. 2, 1962, New York Coliseum, New York, N. Y. . . . Non-profit educational society working for improved technology in every area of metalworking's materials and process engineering.
- AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGI-NEERS—42,000 Members . . . 10700 Puritan Ave., Detroit 38, Mich., UN 4-7300 . . . Wm Nordland, Pres.; Arthur Cervenka, Secy . . . Western Tool Expos. & Engineering Conf., Oct. 1-5, 1962, Pan Pacific Auditorium, Los Angeles, Calif. . . . To further research in creative manufacturing and to advance the scientific and educational progress of tool and manufacturing engineering.
- AMERICAN SOCIETY FOR TESTING AND MATERIALS—11,000 Members . . . 1916 Race St., Phila. 3, Pa , LO 3-5315 . . . T. A Marshall, Jr., Exec. Secy. . . , Meeting, Sept. 30-Oct. 5, 1962,

Statler Hilton Hotel, Los Angeles, Calif . . . Promotion of knowledge of the materials of engineering, and the standardization of specifications and the methods of testing.

- AMERICAN STANDARDS ASSOCIATION, INC. 2300 Members ... 10 E. 40th St., New York 6, N. Y., MU 3-3058 ... Frank H. Roby, Pres.; Roger E. Gay, Managing Dir. & Secy. ... 13th National Conf. on Standards, Feb. 18-20, 1963, Biltmore Hotel, New York, N. Y. ... Coordination and integration of voluntary national standards work to establish uniform national standards approved by ASA.
- AMERICAN VACUUM SOCIETY—1200 Members . . . P.O. Box 1282, Boston 4, Mass. . . Donald J. Santeler, Pres.; Wilfred G. Mathesin, Secy. . . . 9th Annual National Vacuum Symposium, Oct. 31-Nov. 2, 1962, Statler Hilton, Los Angeles, Calif. . . . To increase and diffuse the knowledge of vacuum science and engineering and to promote its practical applications.
- ARMED FORCES COMMUNICATIONS AND ELECTRONICS ASSO-CIATION—12,000 Members ... 1624 Eye St., N.W., Washington 6, D. C., EX 3-3033 ... Frank A. Gunther, Pres.; Col. W. J Baird, USA (Ret.), Gen. Mgr. ... Annual Conv., June 4-6, 1963, Sheraton-Park Hotel, Washington, D. C. ... A non-political, patriotic, non-profit organization whose main objective is to support national security through the cooperation of the military-industry team.
- ASSOCIATED PUBLIC-SAFETY COMMUNICATIONS OFFICERS, INC.—2000 Members ... 51 Government St., Mobile, Ala. ... Joseph T. Marshall, Pres; Howard P. Black, Secy.-Treas. ... Meeting, Aug. 8-11, 1962, Harrison Hotel, Clearwater, Fla. ... Betterment of public-safety communications locally, state-wide and nationally.
- ASSOCIATION FOR APPLIED SOLAR ENERCY—1650 Members Campus, Arizona State Univ., Temple, Ariz, WO 7-1411, Ext 397....H. Walmsle, Pres; Frank L. Snell, Secy.....To gather, compile and disseminate information relating to solar energy and its use.
- ASSOCIATION OF ELECTRONIC PARTS & EQUIPMENT MANU-FACTURERS, INC.—150 Members ... Suite 1710, 100 S. Wacker Dr., Chicago 6, III., FI 6-4800 ... Bruce Vinkemulder, Pres; Kenneth C. Prince, Exec Secy... To foster better understanding and business practices between the manufacturers and distributors of electronic parts, equipment and related items.
- AUDIO ENGINEERING SOCIETY—2315 Members P.O. Box 12, Old Chelsea Sta, New York 11, N. Y., OR 5-7820 H. H. Scott, Pres.; C. J. LeBel, Secy. ... Annual Fall Convention, Oct. 15-19, 1962, Barbizon-Plaza Hotel, New York, N.Y. The advancement of the theor, and practice of audio engineering and its closely related arts, and the dissemination of important information in this field.

World Radio History

ELECTRONIC REPRESENTATIVES ASSOCIATION—850 Members . . . 600 S. Michigan, Chicago 5, III., HA 7-0100 . . . Charles E Ault, Pres.; Harry Halinton, Secy -Treas. . . . Annual Convention and Management Conf., Jan. 20-24, 1963, Hotel Mark Hopkins, San Francisco, Calif . . . The improvement and advancement of electronic manufacturers representatives.

- FORESTRY, CONSERVATION COMMUNICATIONS ASSOCIATION —P.O Box 357, Columbia, S. C., 253-5321 . . . Raymond M. Littlejohn, Pres.; John Tomblin, Secy -Treas Nat'l Convention, July 17-20, 1962, Portland, Maine . . . To foster the development and progress of the art of Forestry, Conservation Communications
- INSTITUTE OF THE AEROSPACE SCIENCES, INC,—15,972 Members ... 2 E. 64th St., New York 21, N. Y., TE 8-3800 ... L Eugene Root, Pres.; Robert R Dexter, Secy Annual Meeting, Jan. 28-30, 1963, Hotel Astor, New York, N. Y. ... To advance the aerospace sciences by disseminating technical information covering the entire range of human and automated flight.
- INSTITUTE OF HIGH FIDELITY MFRS., INC.—77 Members 516 Fifth Ave., New York 36, N. Y., MU 2-5131 Raymond V. Pepe, Pres.; Wybo Semmelink, Secy. N Y. High Fidelity Music Show, Oct. 2-7, 1962, N. Y. Trade Show Bldg., New York, N. Y. ... Trade Association representing the component manufacturers of high fidelity equipment.
- INSTITUTE OF PRINTED CIRCUITS—60 Companies 27 E Monroe, Chicago 3, III., (312)RA 6-3727 R. G. Zens, Pres.; R. E. Pritchard, Exec. Secy. Annual Technical Session, Oct. 2-3, 1962, Congress Hotel, Chicago, III. Advance the interests of printed circuits manufacturers.
- THE INSTITUTE OF RADIO ENGINEERS, INC.—97,000 Members ... 1 E. 79th St., New York 21, N. Y., LE 5-5100 ... Patrick E. Haggerty, Pres ; Haraden Pratt, Secy. ... International Convention, March 24-28, 1963 ... Waldorf-Astoria Hotel & New York Coliseum, New York City ... Advancement of the theory and practice of electronics, radio, allied branches of engineering, and the related arts and sciences.
- **INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION** 2100 Members . . . 130 W. 42nd St., New York 36, N. Y., CH 4-4663 . . . Kenneth W. Smith, Pres.; Irvin Shulsinger, Secy . . . Annual Conf., Sept. 23-26, 1962, Montreal, Canada . . . To exchange technical information, to establish standards, to improve the art and practice of municipal signaling.
- THE JOINT TECHNICAL ADVISORY COMMITTEE (JTAC)—8 Members I. E. 79th St., New York 21, N. Y., LE 5-5100 Ralph L. Clark, Chairman; L. G. Cumming, Secy. To evaluate Information relating to the radio art for the purpose of advising Government bodies and other professional and industrial groups
- LONG ISLAND ELECTRONICS MANUFACTURERS COUNCIL—70 Members . . . P.O. Box 453, Mineola, N. Y., PY 6-0990 . . . Franklin Meyers, Pres.; John Cammarata, Secy. . . . Cooperative effort on mutual problems affecting the electronics industry on Long Island.
- METAL POWDER CORE ASSOCIATION—21 Members . . . 60 E. 42nd St., New York, N. Y., MU 7-2888 . . . Meeting, Sept. 27-30, 1962, Williamsburg Inn, Williamsburg, Va. . . . Kempton R. Roll, Exec. Secy. . . . Promotion, standards, statistics.
- NATIONAL ALLIANCE OF TELEVISION & ELECTRONIC SERVICE ASSOC. (NATESA)—150 Members ... 5908 S. Troy St., Chicago 29, III, GR 6-6363 ... Ralph Woertendyke, Pres. ... Meeting, Aug. 23-26, 1962, Pick-Congress Hotel, Chicago, III To upgrade the industry.
- NATIONAL APPLIANCE & RADIO-TV DEALERS ASSOCIATION— 5000 Members . . . 1141 Merchandise Mart, Chicago 54, III, MI 2-5505 . . . Meeting, Jan. 11-13, 1963, Pick-Congress Hotel, Chicago, III. . . . To build better dealers.
- NATIONAL ASSOCIATION OF BROADCASTERS—2700 Members 1771 N St, N.W., Washington 6, D.C., DE 2-9300 LeRoy Collins, Pres; Everett E. Revercomb, Secy.—Treas.... NAB Annual Convention, Mar. 31-Apr. 3, 1963, Chicago, III..... To foster and promote aural and visual broadcasting in all its forms.

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information and to promote the standardization of ratings, nomenclature, and testing.

- NATIONAL COMMUNITY TELEVISION ASSOCIATION, INC.— 550 Members . . . 535 Transportation Bldg., 17th & H Streets, N W, Washington, D C., DI 7-3440 . . . 12th Annual Convention, June, 1963, Seattle, Wash. . . . Representation of the community antenna television industry.
- NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS 57,000 Members . . . 2029 K St, N.W., Washington 6, D.C., FE 7-2211 Murray A Wilson, Pres. . . Annual Meeting, June 19-22, 1963, Sheraton-Cleveland Hotel, Cleveland, Ohio . . . Promote the social, professional, ethical, and economic aspects of engineering as a profession.
- MANUFACTURING CHEMISTS' ASSOCIATION, INC.—198 Members 1825 Connecticut Ave., N.W., Washington 9, D.C., 483-6126 John E. Hull, Pres.; M. F. Crass, Jr., Secy, J. Semi-annual Meeting, Nov. 20, 1962, New York, N. Y. J. To represent the chemical manufacturing industry of the United States and Canada.
- THE P.A.'s OF RADIO, TELEVISION, AND ELECTRONIC INDUSTRY —85 Members . . . Box 62, Rosedale 22, N. Y. . . . Milt Brody, Pres.; Abe Schneiderman, Treas. . . . To promote a better understanding among management, P.A., and industry.
- PHOTOGRAPH MANUFACTURERS ASSOCIATION, INC.—11 Members . . . 37 W. 53rd St., New York 19, N. Y., CI 6-2940 . . . Joseph Dworken, Pres.; A. D. Adams, Exec. Secy. . . . To foster better trade relations among prime photograph manufacturers and their suppliers, customers and consumers.
- PRECISION POTENTIOMETER MANUFACTURERS ASSOCIATION —26 Members . . . 27 E. Monroe St., Chicago 3, III., RA 6-3727 . . . Robert C. Chase, Pres.; Raymond E. Pritchard, Exec Secy. . . . Symposium on Precision Potentiometers, Aug. 20, 1962, Los Angeles, Calif. . . . To advance standardization.
- **RADIO AND TELEVISION EXECUTIVES SOCIETY**—1200 Members 444 Madison Ave., New York 22, N. Y., PL 8-2450 To create a lasting fraternity of persons professionally engaged in radio and television broadcasting and its allied fields.
- SC!ENTIFIC APPARATUS MAKERS ASSOCIATION—220 Members 20 N. Wacker Dr., Chicago 6, III., ST 2-0277 . . . Ray G Halvorsen, Pres.; Richard G. Hannan, Exec. Secy. . . . Pre-WESCON Panel Discussions, Aug. 20, 1962, Statler-Hilton, Los Angeles, Calif . . . To provide management information and environment for the interchange of this information leading to more efficient research, production and distribution.
- **SOCIETY OF PLASTICS ENGINEERS, INC.**—9500 Members . . . 65 Prospect St., Stamford, Conn., FI 8-7528 . . . James R. Lampman, Pres.; George P. Kovach, Secy. . . . To promote the development and dissemination of technical information relating to plastics materials and plastics products.
- SOCIETY OF VACUUM COATERS—205 Members . . P.O. Box 3095, Cleveland 17, Ohio, KE 1-5050, Ext 286 . . . B. C. Hineline, Pres; R. G. Lux, Secy.-Treas. . . . Vacuum Metallizing.
- **STANDARDS ENGINEERS SOCIETY** 1200 Members 170 Livingston Ave, New Providence, N. J., CR 3-0290 Kenneth W. Truhn, Pres.; Robert F. Franciose, Secy 110 Meeting Sept 10-12, 1962, Hotel Ambassador, Los Angeles, Calif. 110 further standardization as a means of enhancing general welfare.
- **ULTRASONIC MANUFACTURERS ASSOCIATION** 19 Members ... 271 North Ave., New Rochelle, N. Y., BE 5-4020 ... James R Fisher, Pres.; H. B. Foulkes, Jr., Secy. ... To promote the growth of the ultrasonic industry on a firm and lasting basis.
- WESTERN ELECTRONIC MANUFACTURERS ASSOCIATION—325 Companies . . . 1435 S. La Cienega Blvd., Los Angeles 35, Calif., OL 5-9640 . . William J. Miller, Pres.; William H Heflin, Secy. . . . Annual corporate meeting of WEMA members, Aug. 22, 1962, Statler Hilton, Los Angeles, Calif. . . . To encourage and promote the recognition and development of the electronics industry in the 11 Western states.

PROFESSIONAL ENGINEERING GROUPS OF THE INSTITUTE OF RADIO ENGINEERS

- **AEROSPACE AND NAVIGATIONAL ELECTRONICS**—3200 Members . . . George M. Kirkpatrick, Chairman . . . East Coast Conf. on Aerospace & Navigational Electronics, Oct. 22-24, 1962 Baltimore, Md. . . . The application of electronics to the operation and control of air and space craft and to the navigation of all craft.
- ANTENNAS & PROPACATION—3800 Members . . . Harry Fine, Chairman . . . Technical advances in antenna and wave propagation theory and the utilization of techniques or products of this field.
- AUDIO—4200 Members ... Cyril M. Harris, Chairman ... WESCON, Aug. 21-24, 1962, Sports Arena, Los Angeles, Calif. ... Technology of communication at audio frequencies and of the audio-frequency portion of radio-frequency systems, and the recordings and reproduction from recordings.
- AUTOMATIC CONTROL—100 Members ... John M. Salzer, Chairman ... Joint Automatic Control Conf., June 19-21, 1963, University of Texas, Austin, Tex. ... The theory and application of automatic control techniques including feedback control systems.
- BIO-MEDICAL ELECTRONICS—2700 Members ... George N. Webb, Chairman ... 15th Conf. on Electrical Techniques in Medicine & Biology, Nov. 5-7, 1962, Conrad Hilton Hotel, Chicago, III. The use of electronic theory and techniques in problems of medicine and biology.
- BROADCAST & TELEVISION RECEIVERS—1700 Members . . . John F. Bell, Chairman . . . Radio Fall Meeting, Nov. 12-14, 1962, King Edward Hotel, Toronto, Canada . . . The design and manufacture of broadcast and television receivers and components and activities related thereto.
- CIRCUIT THEORY—6800 Members . . . James H. Mulligan, Jr., Chairman . . . International Solid State Circuits Conf, Feb. 19-23, 1963, Univ. of Pa. & Sheraton Hotel, Phila., Pa. . . . Design and theory of operation of circuits for use in radio and electronic equipment.
- COMMUNICATIONS SYSTEMS—4000 Members . . . Ralph L. Marks, Chairman . . . 8th Nat'l Communications Symp., Oct. 1-3, 1962, Hotel Utica & Municipal Auditorium, Utica, N. Y. . . . Radio and wire telephone, telegraph and facsimile in marine, aeronautical, radio-relay, coaxial cable and fixed station services.
- **COMPONENT PARTS**—1800 Members . . . Floyd E. Wenger, Chairman . . . Electronic Components Conf., May 7-9, 1963, Marriott Twin Bridges Hotel, Washington, D. C. . . . Characteristics, limitation, applications, development, performance and reliability of component parts.
- ELECTRON DEVICES—5300 Members ... Willis A. Adcock, Chairman ... Electron Devices Meeting, Oct. 25-27, 1962, Sheraton Hotel, Washington, D. C. ... Electron devices including particularly electron tubes, solid state devices, integrated electronic devices and energy sources.
- ELECTRONIC COMPUTERS—9300 Members . . . Arnold A. Cohen, Chairman . . . Eastern Joint Computer Conf., Dec. 4-6, 1962, Bellevue Stratford Hotel, Phila., Pa. . . . Activities devoted to design and operation of electron computers.
- **ENGINEERING MANAGEMENT**—4300 Members . . . Theodore W. Jaramie, Chairman . . . 10th Annual Engineering Management Conf., Sept. 13-14, 1962, Hotel Roosevelt, New Orleans, La. . . Engineering management and administration as applied to technical, industrial and educational activities in the field of electronics.
- ENCINEERING WRITING & SPEECH—1800 Members . . . John M. Kinn, Jr., Chairman . . . Nat'l Symp. on Engineering Writing & Speech, Sept. 13-14, 1962, Mayflower Hotel, Washington, D. C.

. . . The study, development, improvement and promotion of the techniques for preparing, organizing for use, processing, editing, collecting, conserving and disseminating any form of information in the electronics and related fields by and to individuals and groups by any method of communication.

- GEOSCIENCE ELECTRONICS—Robert W. Olson, Acting Chairman . . . Research and development in electronic instrumentation for geophysics and geochemistry, especially gravity measurements, seismis measurements, magnetics, well-logging, space exploration, meteorology, oceanography.
- **HUMAN FACTORS IN ELECTRONICS**—700 Members . . . Robert R. Riesz, Chairman . . . Development and application of human factors knowledge germane to the design of electronic equipment.
- INDUSTRIAL ELECTRONICS—1800 Members ... J. E. Eiselein, Chairman ... 11th Annual Industrial Electronics Symp., Sept. 19-20, 1962, Chicago, III. ... Activities devoted to electronics pertaining to conctrol, treatment and measurement, specifically in industrial processes.
- **INFORMATION THEORY**—3500 Members . . . George L Turin, Chairman . . . Int'l Symp. on Information Theory, Sept. 3-7, 1962, Brussels, Belgium . . . Information theory and its application in radio circuitry and systems.
- INSTRUMENTATION—3700 Members . . . Harvey W. Lance, Chairman . . . Int'l Symp. on Precision Electro-magnetic Measurements, Aug. 14-16, 1962, Nat'l Bureau of Standards, Boulder, Colo. . . . Measurements and instrumentation utilizing electronic techniques.
- MICROWAVE THEORY & TECHNIQUES—5500 Members . . . Tore N. Anderson, Chairman . . . Nat'l Symp. on Microwave Theory & Techniques, May 20-22, 1963, Miramar Hotel, Los Angeles, Calif. . . . Activities devoted to microwave theory, microwave circuitry and techniques, microwave measurements and the generation and amplification of microwaves.
- MILITARY ELECTRONICS—4400 Members . . . Willie L. Doxey, Chairman . . . 4th Winter Conv. on Military Electronics, Jan. 30-Feb. 1, 1963 . . . Activities devoted to electronic sciences, systems, activities and services germane to the requirements of the military.
- NUCLEAR SCIENCE—1600 Members ... Louis Costrell, Chairman ..., Symp. on Space Phenomena & Measurements, Oct. 15-18, 1962, Statler Hilton Hotel, Detroit, Mich. ... Application of electronic techniques and devices to the nuclear field.
- PRODUCT ENGINEERING & PRODUCTION—1100 Members . . . Alfred R. Gray, Chairman . . . 6th Nat'l Symp. on Product Engineering & Production, Nov. 1-2, 1962, San Francisco, Calif. . . . New advances in methods, processes, materials and components in design and manufacture of electronic equipment.
- **RADIO FREQUENCY INTERFERENCE**—1000 Members . . . Harold E Dinger, Chairman . . . Origin, effect, control and measurement of radio frequency interference.
- **RELIABILITY & QUALITY CONTROL**Louis J. Paddison, Chairman ... 9th Nat'l Symp. on Reliability & Quality Control, Jan. 21-24, 1963, Sheraton Plaza Hotel, San Francisco, Calif. ... Techniques of determining and controlling the quality of electronic parts and equipment during their manufacture.
- SPACE ELECTRONICS & TELEMETRY-4000 Members ... Kenneth M. Uglow, Jr., Chairman ... Nat'l Symp. on Space Electronics & Telemetry, Oct. 2-4, 1962, Fountanebleau Hotel, Miami Beach, Fla. ... Space science and the measurement and recording of data from remote points by electromagnetic media.
- ULTRASONICS ENGINEERING-1000 Members . . . Vincent Salmon, Chairman . . . Ultrasonics Symp., Nov. 29-30, 1962, New York, N. Y. . . . Ultrasonic measurements and communications, including underwater sound, ultrasonic delay lines and various chemical and industrial ultrasonic devices.
- VEHICULAR COMMUNICATIONS—1700 Members . . . Richard P. Gifford, Chairman . . . Annual Vehicular Communications Conf., Dec. 6-7, 1962, Mayfair Hotel, Los Angeles, Calif. . . . Communications problems in the field of land and mobile radio services, including public safety, public utilities, railroads, commercial and transportation, etc.

THE REFERENCE ISSUE

New Electronic Standards

A listing of the electronic standards issued during the 12-month period, June 1961 to May 1962, by the American Society for Testing and Materials, the American Standards Association, the Electronic Industries Association, and the Institute of Radio Engineers are given. Copies of standards listed may be obtained by contacting the issuing group directly.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- D 257-61-Methods of Test for Electrical Resistance of Insulating Materials
- D 1674-61-Methods of Testing Polmericable Embedding Compounds Used for Electrical In-
- sulation D 1825-61 T—Recommended Practice for Etching and Cleaning Copper-Clad Thermosetting Laminates for Electrical Testing
- D 1867-61 T—Specifications for Copper-Clad Thermo-setting Laminates for Printed Wiring
- D 1930-61 T—Specification for Kraft Dielectric Tis-sue, Capacitor Grade F 23-62 T—Recommended Practice for Temperature
- Measurement of Thermionic Emitters
- F 128-61 T—Methods of Testing Sleeves and Tubing for Electron Tube Cathodes
- F 238-61 T-Recommended Practice for Cathode Melt Prove-in Testing
- F 239-62 T-Specification for Nickel Alloy Cathode Sleeves for Electronic Devices
- F 278-61 T-Test for Sublimation Characteristics of Metallic Materials by Electrical Resistance
- F 300-61 T-Methods of Measuring Cathode Interface Impedance Characteristics of Electron Tubes

7-61 T-Specification for Aluminum Oxide Powder

- F 652-61 T-Methods for Measuring Mica Stampings Used in Electronic Devices and Incandescent Lamps
- F 1-62 T-Specification for Clear Nickel-Clad and Nickel-Plated Steel Strip for Electron Tubes
- F 2-62 T—Specification for Aluminum-Clad Steel Strip and Nickel-Steel-Aluminum Com-
- F 4-62 T—Specification for Carbonized Nickel-Plated and Nickel-Clad Steel Strip for Electron Tubes
- F 20-62 T-Specification for High Conductivity Composite Aluminum-Steel-Copper for Electron Tubes
- F 16-61 T—Methods for Measuring Diameter or Thickness of Wire and Ribbon for Electronic Devices and Lamps
- F 288-61 T-Specification for Tungsten Wire for Electronic Devices and Lamps 290-62—Specification for Round Wire for Use as
- F Grid Lateral Winding Wire in Electron **Tube Grids**
- F 14-61 T-Recommended practice for Making and Testing Reference Glass - Metal - Band-Seal
- F 15-61 T-Specifications for Iron-Nickel-Cobalt Sealing Allov
- F 18-61 T-Method for Evaluation of Glass-to-Metal Headers for Electron Devices
- F 19-61 T—Method for Tension and Vacuum Testing Metallized Ceramic Seals
- F 21-62 T-Test for Hydrophobic Surface Films: The Atomizer Test

F 24-62 T-Method for Measuring and Counting Particulate Contamination on Surfaces of Small Electronic Components

AMERICAN STANDARDS ASSOCIATION (ASA)

- C16.13-1961—American Standard Methods of Testing Monochrome Television Broadcast Receivers
- C16.33-1962-Method of Measurement of Differential Gain and Differential Phase (60 IRE 23.S1)
- C83.22-1962—Polarized Dry Aluminum Electrolytic Capacitors for General Use (EIA RS-154-B)
- C16.5-1954 (F1961)--Volume Measurements of Electrical Speech and Program Waves C16.11-1949 (R1961)—Methods of Testing Antennas
- (48 IRE 2.S2)
- C16.12-1949 (R1961)—Methods of Testing Frequency-Modulation Broadcast Receivers (47 IRE 17.S1)
- C16.18-1951 (R1961)—Methods of Testing Vehicular Communications Receivers (49 IRE 16.-S1)
- C16.19-1951 (R1961)-Methods of Testing Amplitude-Modulation Broadcast Receivers (48 IRE 17.S1)
- C16.20-1951 (R1961)—Methods of Measurement of Television Signal Levels. Resolution, and Timing of Video Switching Systems
- C16.23-1954 (1961)-Methods of Measurement of Aspect Ratio and Geometric Distortion of Television Cameras and Picture Monitors (54 IRE 23.S1)
- C60.4-1950 (R1961)-Designation System for Metal Electron Tube Shells (RETMA ET-112; NEMA 508)
- C60.8-1952 (R1961)-Rating Values of Interelement Capacitances (RETMA ET-114; NEMA 510)
- C83.2-1949 (R1961)-Preferred Values for Components for Electronic Equipment (RETMA GEN 102)
- C83.3-1951 (R1961)—Terminology for Piezoelectric Crystals (49 IRE 14.S1)
- C83.6-1955 (R1961) Recommendations for Fixed Wire Wound Resistors (RETMA REC-117)
- C83.7-1955 (R1961)-Recommendations for Variable Control Resistors (RETMA REC-121-B)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

- RS-206-A-Recommended Practice for Preparation of Basing or Terminal Diagrams July 1961, \$.60
- RS-212-A-Numbering of Electrodes and Designation of Units in Electron Tubes, October 1961, \$.25
- RS-217-A—Wound Cut Cores, July 1961, \$.70 RS-235-A—Color Code for Traveling Wave Wired Leads, October 1961, \$.25 Tube

ELECTRONIC INDUSTRIES · June 1962

New Standards (Concluded)

- RS-241-Outlines for Semiconductor Devices, July 1961, \$.25
- RS-242-Definitions for Electromagnetic Delay Lines, June 1961, \$.40
- RS-243-Color Coding for Stereo Pick-up Leads, July 1961, \$.25
- RS-244-Character codes for Numerical Machine Tool Control Perforated Tape, July 1961, \$.50
- RS-245-Letter Symbols and Abbreviations for Semiconductor Data Sheets and Specifica-tions, July 1961, \$.80
- RS-246-Environmental Method of Life Testing Lead Mounted Semiconductor Power Rectifiers, July 1961, \$.25
- RS-247-Analog-to-Digital Conversion Equipment, October 1961, \$.25
- RS-248-Case Temperature Measurements by Manufacturers of Hex Base Silicon Rectifiers, October 1961, \$.25
- RS-249-Temperature Measurements by Users of Silicon Rectifiers, October, 1961, \$.25
- RS-250-Electrical Performance Standards for Television Relay Facilities, October 1961, \$1.10
- RS-251-Test to Determine Temperature Rise as a Function of Current in Printed Conductors, October 1961, \$.50
- RS-252-Baseband Characteristics of the Microwave Radio and Multiplex Equipment, October 1961, \$1.70
- RS-253-Temperatures for Electrical Measurement and Rating Specification Semiconductor Devices, December 1961, \$.25
- RS-254-Precision Reel for Instrumentation Use, De-
- cember 1961, \$.30 RS-255—Simulated Life Test Circuit for Semiconductor Rectifier Diodes, January 1962. \$.25
- RS-256-Deflecting Yokes for Cathode Ray Tubes. January 1962, \$.80
- RS-257—Mercury Warning Label, February 1962, \$.25 RS-258—Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 ohms, March 1962. \$.60
- RS-259-Rigid Coaxial Transmission Lines and Connectors, 75 ohms, March 1962, \$.60

INSTITUTE OF RADIO ENGINEERS (IRE)

- 61 IRE 14.S1—Piezoelectric Crystals: Measurements of Piezoelectric Ceramics 61 IRE 23.S1—Video Techniques: Definitions of
- Terms Relating to Television
- 61 IRE 23.S1-Solid State Devices: Definitions of Terms for Non-Linear Capacitors 61 IRE 28.S2—Solid State Devices: Measurement of
- Minority-Carrier Lifetime in Germanium and Silicon by the Method of Photoconductive Decay
- 61 IRE 27.S1—Radio Interference: Methods of Meas-urement of Conducted Interference Output to the Power Line from FM and Television Broadcast Receivers in the Range 300 KC to 25 MC
- 61 IRE 30.RP1-Recommended Practices on Audio and Electroacoustics: Loudspeaker Measurements
- 62 IRE 7.S1—Electron Tubes: Methods of Testing
- 62 IRE 28.S1-Solid State Devices: Definitions of Superconductive Electronics Terms
- 62 IRE 27.S1-Radio Interference: Measurement of Radio Noise, Generated by Motor Vehicles and Affecting Mobile Communications Receivers in the Frequency Range 25 to 1000 MC

Statistics

U. S. Domestic Exports of Electronic Products, 1959-1961

(Value in thousands of dollars)

COMMODITY	1959	1960	19611
Total	400,725	466,462	613,031
Consumer electronic products, total	76,394	71,382	81,384
Television receivers and chassis: Television receivers Television receiver chassis	17,631 2,901	14,713 3,968	16,809 11,468
Radio receivers and chassis: Automobile receivers Home-type receivers Radio receiver chassis	1,782 4,086 935	1,395 2,861 876	2,015 3,616 735
Radio-phonographs	916	515	726
Phonographs, parts, and accessories: Coin-operated Other Parts and accessories Phonograph records and blanks	13,164 3,108 6,864 10,704	12,419 2,346 5,838 10,682	12,409 2,055 5,146 8,176
Recorders, parts, and accessories	10,986	12,971	14,603
Other	3,317	2,798	3,626
Commercial, industrial, and military electronic equipment, total ²	210,860	252,328	362,687
Radio and television broadcast equipment Radio communication equipment	18,456	20,838	23,455
(airborne, shipborne, land) Detection and navigational equipmen Other	90,691 t 45,809 55,904	94,249 50,538 86,703	107,445 72,268 159,519
Components, total	113,471	142,752	168,960
Electron tubes and parts, total	49,326	64,091	66,019
Receiving Television picture Power and special purpose Tube parts, except blanks	14,671 13,757 15,911 4,987	14,382 21,304 21,609 6,796	16,400 21,320 22,028 6,271
Semiconductor devices	9,148	15,973	20,788
Other	54,997	62,688	82,153

¹ Preliminary.

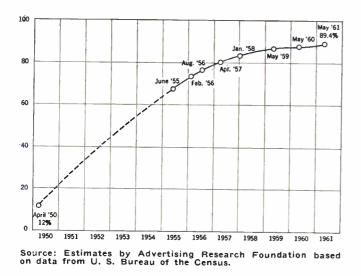
² Excluding exports to the U.S. armed forces and diplomatic missions abroad for their own use.

Source: Bureau of the Census: Report No. FT-410 and pre-liminary unpublished data.

of the Electronic Industries

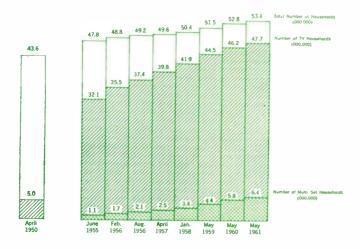
GROWTH in TELEVISION PENETRATION

Percentage of households having TV, 1950-1961



GROWTH in TELEVISION HOUSEHOLDS

Number of homes having TV, 1950-1961



Source: Estimates by Advertising Research Foundation based on data from U. S. Bureau of the Census.

Electronic Output in 1947 and 1950-62¹ (In millions of dollars)

Year	Consumer- type radio & TV receivers & related products ²	All other electronic equipment ^s	Electron tubes	Semi- conductor devices	Electronic components other than tubes and semi- conductors
1961	1,780 _b	4.900	850 ₀	580 _p	2,120 _p
1960	1,850	4,570	860	540	2.000
1959	1,790	4,000	865	395	1,750,
1958	1,350	3,250	790	210	1,340
1957	1,500	3,100	820	150	1,450
1956	1,470	2,800	790	90	1.360
1955	1,500	2,500	770	40	1,360
1954	1,420	2,470	690	25	1.275
1953	1,593	2,503	734	25	1.445
1952	1,340	2,330	690	20	1,110
1951	1,296	843	473	(4)	788
1950	1,687	473	443	(4)	697
1947	810	469	122	(4)	349

-Preliminary.

r—Revised.

¹ Data cover manufacturers' shipments. The totals represent the factory value of production or shipments (output) of electronic products, whether incorporated in other products or used in maintenance and repair of end equipment.

² Not including sales of phonograph records and magnetic tape. ³ Not including payments on research and development contracts or electronic services.

⁴ Data for years prior to 1952 are included in "Electronic components other than tubes and semiconductors."

Source: Bureau of the Census; Electronic Industries Association Marketing Data Department; Electronic Division, BDSA; and other sources.

Financial obligations for basic research, by selected agency, fiscal years 1960, 1961, and 1962

Agency	Actual	Estimates			
	1960	1961	1962		
Total (millions of dollars)	\$741	\$969	\$1,416		
	Perce	nt distribution			
National Aeronautics and Space Administration	29	34	48		
Department of Defense Atomic Energy Commission Department of Health, Education,	24 14	19 13	15 10		
and Welfare National Science Foundation	14	14	12		
All other agencies	9 10	8 12	87		

Note: Detail may not add to totals because of rounding.

Electronics Manufacturing Occupations

Military Equipment Represents Almost One-Half of Total Electronics Output

ELECTRONIC INDUSTRIES

STATISTICS (Continued)

Imports of Electronic Products, Total, 1959-1961

(Value in thousands of dollars)

(rence in measures e		,	
COMMODITY	1959	1960	1961 ²
Photocells and electron tubes and parts,			
except television, X-ray and radio	1,358	2,394	3,816
Television apparatus and parts, total.	1,302	3,502	5,817
Cameras and parts	227	1,092	484
Tubes and parts ³ Other	387 688	464 1,946	1,428 3,905
Radio apparatus and parts, total	72,724	92,653	111,188
Portable radios (except transistor)	n.s.s.	2,512	1,78
Transistor radios. Other radios (except radio-	n.s.s.	55,849	66,68
phonographs)	n.s.s.	9,303	13,42
Radio tubes	n.s.s. n.s.s.	10,099 14,890	12,52
Phonographs, gramophones, grapho- phones, and similar articles, n.s.p.f.	1,813	1,329	64
Parts, n.e.s., for phonographs, etc.	963	573 3,714	37 4,11
Records for phonographs, etc.	3,551	3,714	4,11
Subtotal	81,711	104,165	125,96
New classes established January 1,			
1960: ⁴ Electrical or electronic testing, re-			
cording, checking, analysing or			
automatically controlling instru- ments, apparatus and parts		8.767	6,87
Radar equipment		4,434	10,56
Sound equipment or devices and parts:			
Loudspeakers ⁵		1,747	2,32
Radio-phonographs (complete units)		8,643	12.94
Record players and parts (includ-		-,	,
ing record changers, turntables, pick up cartridges, motor as-			
semblies and other parts, except		0 707	14.01
loudspeakers) Other articles and parts utilizing	_	9,787	14,21
an electronic transducer device			
(including microphones, ampli- fiers, megaphones, hi-fi equip-			
ment, etc., n.e.s.		4,842	6,38
Subtotal	n.a.	38,220	53,30
TOTAL	n.a.	142,385	179,20
		_	

¹Items which can be separately identified in the U.S. import statistics; certain electronic products are reported in hetero-geneous groups according to the material from which they are made and hence excluded, e.g. television picture tubes and semi-conductors conductors.

² Pr<mark>elimi</mark>nary.

³ Excluding tube blanks and television picture tubes.

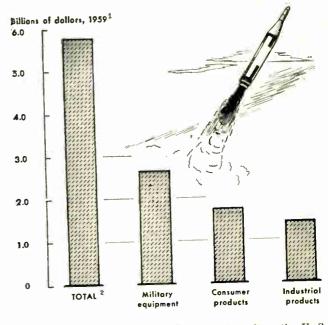
⁴ Prior to 1960, these items were included in "basket classi-fications" not solely electronic products.

⁵ Not including loudspeakers designated as and imported as parts of television and radio receivers.

n.e.s.-Not elesewhere specified. n.s.p.f.-Not specially provided for.

n.s.s.-No separate statistics.

Source: U. S. Bureau of the Census. Report No. FT-110 and preliminary unpublished data.

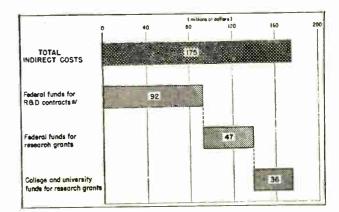


Estimates of value of output based on data from the U.S. Department of Commerce. Business and Defense Services Administration.

² Excludes research and development expenditures, and sales of phonograph records and magnetic tape.

Military spending continues to dominate spending for electronic products, as it did in the recent year shown above. Since consumer products, as it did in the recent year shown above. Since consumer and industrial spending for electronic products has continued to grow also, job opportunities in the electronics field should keep on increasing. The U. S. Department of Labor estimates job opportunities will be particularly good until 1970 for scientists, engineers, tech-nicians and skilled craftsmen (1961 Occupational Outlook Report Series, Bulletin No. 1300-35, "Employment Outlook in Electronics Magnifications") Manufacturing Occupations").

Federal Research—Indirect Costs



Source: U. S. Bureau of the Budget.

^a Generally, the indirect costs of R&D contracts are completely covered by Federal funds, except that slight variations may occur due to negotiation of individual contracts.

Graph shows indirect costs of federally sponsored research and de-velopment in colleges and universities, by source of support, fiscal year 1962. Indirect costs amount to about 30% of the direct costs of a project, according to Bureau of the Budget system for computing costs. Indirect costs are those which, because of their general or supporting nature, cannot be directly assigned to a particular service performed.



CONNECTORS, ENGINEERED FOR SPECIFIC RELIABILITY REQUIREMENTS.

TYKON EDGE CONNECTOR is what it's called.

TYKON is designed for double-sided .062" printed circuit boards.

TYKON is miniature in size. Contacts are spaced on .050" centers.

TYKON ribbon-type flexing action contacts <u>guarantee</u> a new plateau of reliability. (A <u>flat</u> surface yields more points of contact over an area than a <u>round</u> surface does on a line.)

TYKON is ideal for all high density connection jobs including: diodes on insulating substrates; memory planes (standard and thin film types); and almost any type of modular plug-in unit.

TYKON is furnished with conventional wiring tails. It can also be made available with tails for wire wrapping or dip soldering.

TYKON is available in various sizes with 6 to 25 contact positions.

For additional information on this connector, or any connector requirement, write us at our Chicago office or contact your local Cinch representative.

HERE IT IS! A NEW PLATEAU OF RELIABILITY FOR HIGH DENSITY CONNECTORS



This is a 25 contact position **TYKON** and a regular cigarette in actual size

FEATURES:

- CONTACT MATERIAL—PHOSPHOR BRONZE, FLAT RIBBON
- CONTACT FINISH-COPPER FLASH PLUS .00003 GOLD PLATE PER MIL-G-45204 TYPE II .
- INSULATOR MATERIAL-GLASS-FILLED ALKYD TYPE: MAI-30 PER MIL-M-14F

CINCH MANUFACTURING COMPANY

1026 South Homan Avenue, Chicago 24, Illinois Plants located at Chicago, Illinois; Shelbyville, Indiana: City of Industry, California; St. Louis, Missouri.

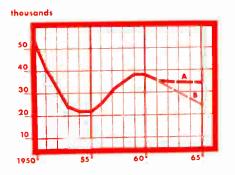
Circle 1 on Inquiry Card

DOT

A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

STATISTICS

FIRST ENGINEERING DEGREES



Source: Data obtained from Engineering Manpower Commission.

Above graph shows number of BS degrees awarded college engineering students since 1950 and projection to 1965 based on con-tinuation of present rate of decrease (A) or stabilization at present level (B).

RETENTION RATES

First degrees as a % of freshmen enrolled four years earlier

percent



Source: Data obtained from Engineering Manpower Commission.

Graph shows percentage of total freshman enrollment of all college engineering classes receiving BS degrees in their senior years since 1950. Projection is included to 1965, based on current retention rate decrease.

RESEARCH & DEVELOPMENT AGENCY OBLIGATIONS-FISCAL YEAR 1961

(millions of dollars)

Agency	Total Research	Basic Research	Develop- ment
TOTAL,			
ALL AGENCIES.	2,295	969	6.701
Dept. of Defense.	872	187	5,567
Dept. Health,			
Educ., Welf.	432	140	3
NASA.	392	327	398
AEC.	229	128	634
Dept. of Agric.	165	67	5
NSF.	77	77	-
	67	26	9
Dept. of Int	04	20	60
FAA			
Other	54	17	25

Includes \$0.2 billion for pay and allow-ance of military personnel in research and development which have not been al-located to research or development. Source: National Science Foundation.

EMPLOYMENT IN INDUSTRIES ENTIRELY ENGAGED IN PRODUCING ELECTRONIC PRODUCTS

(Thousands of employees)

		(mousands o	employeest		
Period	Total	Radio and TV receiving sets	Radio and TV communication equipment	Electron tubes	Electronic components n.e.c.
1000 Ιοπιιοπι	591.8	119.5	244.7	79.3	148.3
1960 January	586.9	116.2	243.9	78.0	148.8
February March	579.8	110.4	243.6	77.9	147.9
	579.8	104.1	242.0	77.4	147.2
April May	570.7	107.6	238.8	76.3	147.6
June	576.2	107.8	240.9	76.3	149.2
July	575.5	109.1	243.0	74.7	148.7
August	590.8	115.5	248.0	75.2	152.1
September	597.5	119.1	250.3	75.3	152.8
October	590.2	115.6	249.3	72.6	152.7
November	591.9	112.0	254.6	74.1	151.2
December	574.3	99.5	256.0	69.7	149.1
1961 January	578.0	102.9	253.1	72.5	149.5
February	578.6	103.4	251.9	72.0	151.3
March	575.2	100.3	250.1	71.8	153.0
April	574.1	98.5	249.7	71.5	154.4
May	580.5	104.2	249.5	71.6	155.2
June	584.9	107.9	251.2	71.4	154.4
July	583.1	111.7	248.5	70.8	152.1
August	599.0	120.6	251.5	71.3	155.6
September	609.3	125.8	254.9	71.6	157.0
October	619.2 _p	128.2	260.0 _p	72.0 _p	$159.0_{\rm p}$

-Preliminary.

Source: Bureau of Labor Statistics.

The largest part of the electronics workforce is concentrated in the four industries shown above, which only produce electronic products. However, large numbers of workers engaged in electronic production are employed in the ordnance, office equip-ment, electrical instruments, and other industries.

Percentage Radio Sets Per Household in U. S.

1960 Census Study

s Total number of radios per household, from intensive interview									
Total	None	1	2	3	4	5	6 or more		
100.0	6.3	43.1	27.8	12.8	6.1	2.1	1.8		
7.4 49.9	6.3	0.9 42.1	0.2	0.9	0.3	0.1			
25.6		_	21.1	3.4	0.8	0.2	0.1 0.2		
4.6			-	0.1	3.7	0.5	0.3		
1.3						1.1	0.2 1.1		
	Total 100.0 7.4 49.9 25.6 10.0 4.6 1.3	Total None 100.0 6.3 7.4 6.3 49.9 25.6 10.0 4.6 1.3	Total None 1 100.0 6.3 43.1 7.4 6.3 0.9 49.9 42.1 25.6 10.0 1.3	Total None 1 2 100.0 6.3 43.1 27.8 7.4 6.3 0.9 0.2 49.9 - 42.1 6.5 25.6 - 21.1 10.0 - 0.1 4.6 - - 1.3 - -	Total None 1 2 3 100.0 6.3 43.1 27.8 12.8 7.4 6.3 0.9 0.2 49.9 - 42.1 6.5 0.9 25.6 - 21.1 3.4 10.0 - 0.1 8.2 4.6 - - 0.1 1.3 - - -	Total None 1 2 3 4 100.0 6.3 43.1 27.8 12.8 6.1 7.4 6.3 0.9 0.2 0.9 0.3 49.9 - 42.1 6.5 0.9 0.3 25.6 - 21.1 3.4 0.8 10.0 - 0.1 8.2 1.2 4.6 - - 0.1 3.7 1.3 - - - - -	Total None 1 2 3 4 5 100.0 6.3 43.1 27.8 12.8 6.1 2.1 7.4 6.3 0.9 0.2 0.9 0.3 0.1 25.6 - 21.1 6.5 0.9 0.3 0.1 25.6 - 21.1 3.4 0.8 0.2 10.0 - 0.1 8.2 1.2 0.3 4.6 - - 0.1 3.7 0.5 1.3 - - - - 1.1		

Includes radios not in working order. Based on households for which both first responses and results of intensive interviews are available. Only standard household and portable radios included. Excludes car radios, sending-receiving sets, short-wave and crystal sets.

Federal Research and Development Indirect Costs

(Operating Costs)

	(Dollar an	nounts in th Amount	ousands)	Percent distribution			
Source of support	Total	Contracts	Grants	Total	Contracts	Grants	
Total	\$362,529	\$208,109	\$154,420	100.0	100.0	100.0	
Atomic Energy Commission Department of Defense	39,254 154,487	35,761 153,829	3,493 658	10.8 42.6	17.2 73.9	2.3 0.4	
Department of Health, Education, and Welfare National Science Foundation Other	114,536 35,864 18,388	3,920 188 14,411	110,616 35,676 3,977	31.6 9.9 5.1	1.9 0.1 6.9	71.6 23.1 2.6	

Compiled above are the operating expenses for separately budgeted research and development projects for 93 large colleges and universities, according to source of Fed-eral support, for fiscal year 1960. These operating expenses represent part of the indirect costs of running these projects, that is, the costs which cannot be charged against any particular service performed. They are expenses incurred for operating and maintain-ing the institutions' physical plants.



CONNECTORS, ENGINEERED FOR SPECIFIC RELIABILITY REQUIREMENTS

Multiple-contact and sub-miniature connectors and sockets...printed circuit board connectors and sockets ... transistor sockets ... tube sockets and shields . . . "Jones" plugs, sockets and barrier terminal strips . . . radio hardware.

HEAT DISSIPATING TUBE SHIELDS

Seven and nine pin miniature series for various applications. Designed to meet requirements of MIL-S-9372C (USAF); MIL-STD-242B (Ships); MIL-S-19786B (Navy); and SCL-6307/2 (Signal Corps.). Details furnished on request.



Under license arrangement with International Electronic Research Corporation.





TRANSISTOR SOCKETS

Cinch transistor sockets available include: miniature/subminiature types; power transistor sockets with integral mounting eyelets permitting easy assembly to chassis; universal types which accommodate .2" x .1" triangular bases and .048 x .192 three-contact in-line; and other types for various standard base configurations. Details furnished on request.



PRINTED CIRCUIT SOCKETS

Sockets accommodate these types of receiving tubes: Octal; miniature; sub-miniature, both flat press and button; transistor and numerous other types. Details furnished on request.

NUVISTOR TUBE SOCKETS

Designed for: low insertion force; contact protection; and minimum space. Tube cannot be inserted incorrectly, even by "feel." Socket saddle provides spring elements which by "feel." Socket saddle provides spring elements which effectively ground tube envelope to panel. Two types: rivetmounted or crimp-mounted to chassis, eliminating screws and/or rivets (crimp-mounted socket is polarized by placement of cutout, facilitating automatic assembly). Details furnished on request.





ALL-MOLDED OCTAL SOCKET

Standard octal socket molded in a single Bakelite cast-ing. Contacts are of brass, cadmium plated. Mica insulation with brass or phosphor bronze contacts can be made available. Choice of two contact layouts. Details furnished on request

CINCH HINGE CONNECTORS



Eliminate contact damage caused by high insertion and extraction forces encountered with conventional multi-contact connectors. Available with 20-100 contacts.

Ingenious hinge-and-latch principle is foolproof, provides added reliability. Positive contact is maintained because of the unique wiping action of the contacts. Various companion hoods also available. Details furnished on request.

CINCH GOLDEN "D"* MONOBLOCK CONNECTORS

Monoblock insulators, probe-proof closed-entry socket contacts, mates with standard "D", available in 9, 15, 25, 37 and 50 contacts sizes. In general, meets requirements of MIL-C-8384B. Mark I utilizes solder pot contacts and Mark II has crimp-type snap-in contacts. Mating hermetically sealed plugs also available. Details furnished on request.

*Under license arrangement with Cannon Electric Company.



TYKON EDGE CONNECTORS

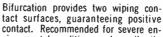
for high-density application Guaranteed high reliability. Designed for double-sided .062" printed circuit boards with contacts spaced on .050" centers. Flexing action ribbon-type contacts assure maximum contact. Ideal for memory planes and modular plug-in units. 6 to 25 contact positions. Details furnished on request.

BLUE Floor * AND BIBBON * CONNECTORS

These versatile reliability-proven connectors utilize double-sided, flexingaction, self-wiping contacts to assure positive contact of both mating members. Both rack-and-panel types and cable-to-chassis types are available. Size (no. contacts): Micro-Ribbon-14, 24, 36, 50; Blue Ribbon-8, 16, 24, 32. Details furnished on request.

*Registered trademarks of Amphenol-Borg Electronics Corporation.

BIFURCATED CONTACT EDGE CONNECTORS



vironmental conditions such as vibration; also overcomes effects of printed circuit board irregularities. Mounting hole styles; floating bushing, molded-in bushing and plain-hole types. Conventional wiring tail or dip solder termination in sizes from 6 to 25 contact positions, single or double row. Insulation is glass-filled diallyl phthalate. Meets applicable requirements of MIL-C-21097A. Polarizing keys available. Details furnished on reauest.

WRAPOST TERMINATION PRINTED CIRCUIT CONNECTORS

For 1/16" copper-clad laminated board. Similar in construction to bifurcated connector illustrated above except without bifurcation feature. Wiring tail consists of a long, rigid ribbon conditioned for wire-wrapping. Polarizing keys can be furnished as described above. Details furnished on request.

"JONES" PLUGS, SOCKETS, BARRIER TERMINAL STRIPS

"Jones" products have been an industry standard for over a generation. "300" series for light duty service, 2-33 contacts. "500" series for heavy duty to 5kv, 25 amps, 2-12 contacts. "2400" series designed for highest obtainable electrical and mechanical performance, 2-12 contacts. Also available: barrier terminal strips and fanning strips. Literature furnished on request or see your local electronic component distributor.

FOR FURTHER INFORMATION on above listings or any connector requirement, contact your nearest Cinch and Jones representa-tive or United-Carr sales office. Address requests for literature to the Advertising Manager at the Chicago address below. Please reference product interests as outlined in the heading or above listings. Standard Cinch and Jones products are handled by leading electronic component distributors throughout the U.S

CINCH MANUFACTURING COMPANY

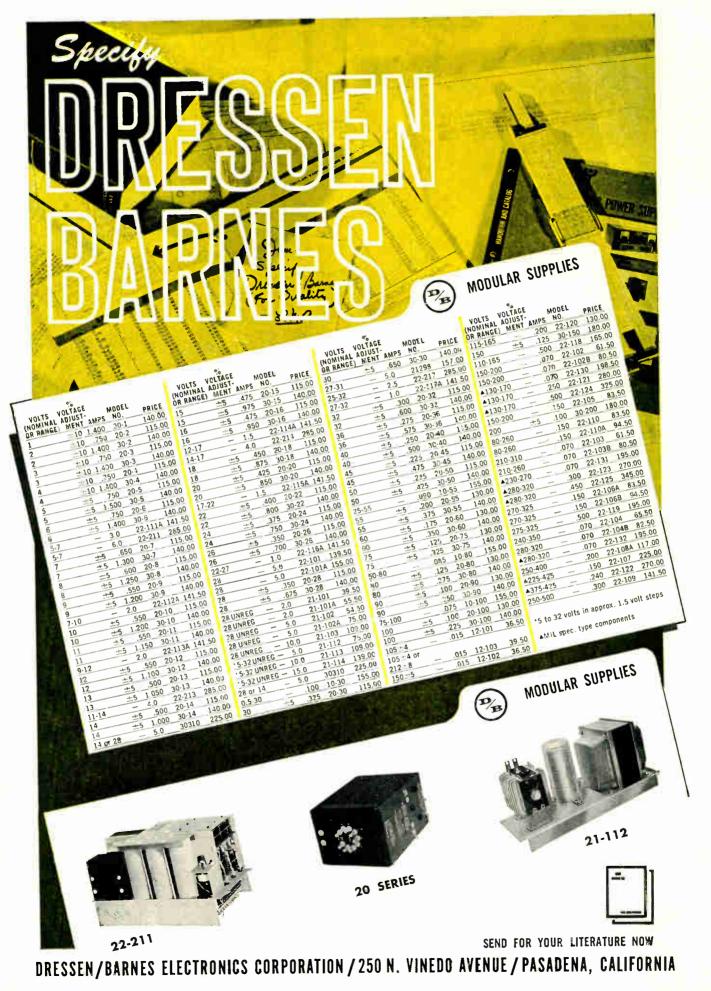
1026 South Homan Avenue, Chicago 24, Illinois Plants located at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.



World Radio History

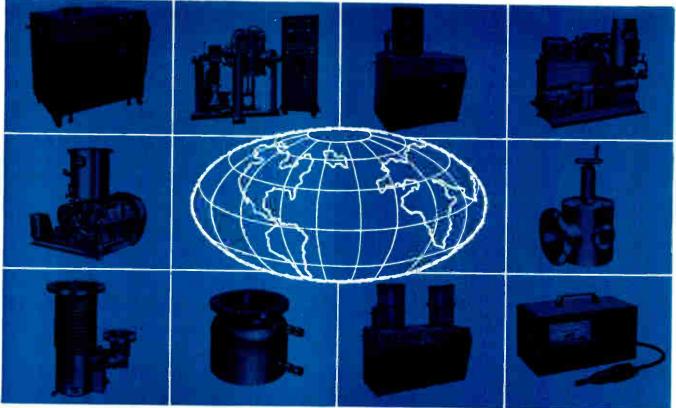
A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS





ELECTRONIC INDUSTRIES • June 1962

World Radio History



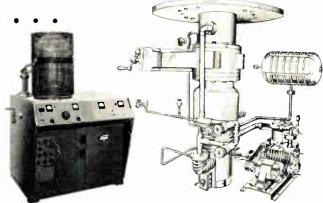
LEADERSHIP

with a forward look in the field of high vacuum equipment . . .

Kinney Vacuum, the accepted leader in the manufacture of vacuum pumps is acknowledged foremost in research and development in the high vacuum industry.

This leadership is carefully guarded by constant and extensive research and development that produces the ultimate in mechanical pumps, diffusion pumps, valves, baffles, gauges, vacuum furnaces, space chambers, and complete vacuum systems. The resources of the New York Air Brake Company and all of its divisions guarantee every Kinney Vacuum product to be efficient in operation, most modern in design, and constructed to give the maximum in service.

- PROVEN STABILITY
- EXTENSIVE RESOURCES
- DYNAMIC DEVELOPMENT



HIGH VACUUM EVAPORATORS ... KSE-6, KSE-6H This attractively packaged system delivers maximum performance, requires minimum floor space. Formica work surfaces, integral control panels with grouped controls for operating convenience. These units are built around flange connected components including new high speed oil diffusion pumps, water cooled baffle (also available with liquid nitrogen cooled baffle). Hydraulic bell jar hoist. Rapid evacuation to below 1×10^{-6} torr., ultimate pressure less than 5×10^{-7} torr. KSE-6H offers a pot-type base plate (Haas Chamber) to allow more freedom for location of monitoring devices and additional feed-throughs.

KINNEY VACUUM DIVISION THE NEW YORK AIR BRAKE COMPANY 3529 WASHINGTON STREET • BOSTON 30, MASS.

World Radio History

Circle 4 on Inquiry Card



If you're using flexible printed circuitry now or have tried in the past with little success, Schjeldahl's Schjel-Clad Copper Mylar lamination offers you the strongest bond and the purest finished product.

With Schiel-Clad Copper Mylar, all inherent characteristics of Mylar and copper are maintained. The "creep" factor is very low; circuits don't shift. The bond is uniform, eliminating air bubbles and "fish eyes" in the final product.

The bonding agent is Schjel-Clad, a special thermo-setting Schjeldahl adhesive which assures high purity and high bonding strength in the lamination. Low distortion of circuits etched on Schjel-Clad Copper Mylar is proof of its dimensional stability. It can be etched by the use of standard etching materials and also can be exposed to chlorinated cleaning solvents for short periods of time without damage.

AVAILABILITY

Schieldahl's Copper Mylar is available in various composites from 10 mil Mylar laminated to 5 oz. copper to 1/2 mil Mylar on 1 oz. copper.

*du Pont trademark for its polyester film

This material is available with copper on both sides of Mylar, or Mylar on both sides of copper. There are a number of circuit fabricators who are familiar with Schjel-Clad. A listing available on request. The applications listed below show a number of uses or proposed uses of Schjel-Clad:

Resulting in:

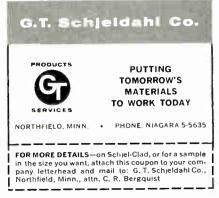
Strongest Bond

Stability

Extreme Flexibility

High Dimensional

Computers	Automobiles
Aircraft	Memory Systems
Television and Radio	Printed Wiring
Transformers	Circuitry
Business	Shielding
Machines Switchboards	Harnessing and Wiring
0	····· ·



Tech Data for Engineers

Contamination Control

A 4-page, 2-color brochure is available from Central Vacuum Corp., 3008 E. Olympic Blvd., Los Angeles 23, Calif., on micro vacuuming. This method developed by Central Vacuum is for: vacuuming personnel prior to entry into "White Rooms"; keep them dust-free; and insure immaculate assemblies. Information includes: inlets; hoses; suction control valves; shoe cleaners; dual systems for large installations; and general plant maintenance.

Circle 301 on Inquiry Card

Optical Terminology

The first in a series of continuing terminology glossaries, "Glossary of Optical Terminology," covers a wide range of technical terms from "aber-ations" to "surface reflection." Availations to "surface reflection." Avail-able from Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.

Circle 302 on Inquiry Card

Chromatography

A comprehensive bibliography en-titled, "Thin-Layer Chromatography" includes information on the technique of thin-layer chromatography, up-todate as of December 1961, with a total of 167 entries. Research Specialties Co., 200 S. Garrard Blvd., Richmond, Calif. Request the bibliography by writing under company letterhead.

Circle 303 on Inquiry Card

Clean Rooms

"Keeping 'Clean Rooms' Clean with Spencer Vacuum," 4 pages, 2 color, is available from Spencer Turbine Co., 486 New Park Ave., Hartford, Conn. Need for a central system is explained and illustrated; photographs, description and specs. provided on one operator, two operator and larger systems. Circle 304 on Inquiry Card

Photographic Emulsions

Tech. data is available on photographic emulsions, designed for use in studies in nuclear physics, called "Scientia NUC 3.07." This emulsion is particularly suitable for recording alpha particles, low-energy electrons and protons. Industrial Photo Prod-ucts Dept., The Gevaert Co. of America, Inc., 321 W. 54th St., New York 19, N. Y.

Circle 305 on Inquiry Card

Flutter

A 12-page booklet entitled "FLUT-TER: Its nature, cause, and avoidance" presents a study of the phenomenon of flutter and its associated disturbances: wow and drift. Basic theory is followed by a discussion of flutter measurement, causes, avoidance and anti-flutter maintenance. Amplifier Corp. of America, Broadway, New York 13. N. Y. 398 Circle 306 on Inquiry Card

Circle 5 on Inquiry Card



heat shrinkable **BOOTS...**

FOR MOISTURE-PROOFING CONNECTORS THERMOFIT



RAYCLAD TUBES

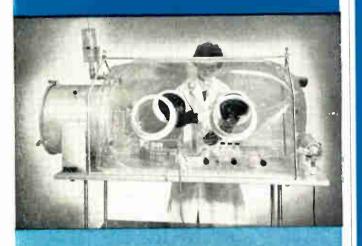
OAKBIGE AT NORTHBIGE

REOWODO CITY, CALIFORNIA

World Radio History

Heat-shrinkable Thermofit[®] boots used in conjunction with Rayclad adhesive provides a moisture-proof seal at the point where a coaxial cable enters the connector. This completely eliminates moisture wicking and consequent loss of insulation values and dielectric strength. Thermofit[®] boots are supplied in an expanded form which permits easy installation after the connector assembly is completed. Exposure for a few seconds to heat in excess of 250°F. then shrinks the boot tightly into ploce.

<u>This</u> is the PERFECT "Dust-free" Laboratory



AMSCO Flexible Film Laboratory Dry Box

This low-cost, transparent "self-contained laboratory" is designed for laboratory or production procedures demanding a controlled, isolated atmosphere... whether it be dust-free, moisture-free, toxic compound confining, inert gas atmosphere... an almost endless list.

Amsco's disposable Flexible Film Dry Box is ideal for delicate transistor and diode assembly, experimental metallurgy, missile sub-assembly work, instrument assembly . . . even Alpha radiation studies. The clear plastic canopy enables technicians to work comfortably and swiftly with no eye strain.

When not in use the "envelope" may be collapsed into a compact package for convenient storage. Upon completion of certain studies, the canopy may be disposed of and replaced quickly and economically. The chamber size is 48" long x 26" wide x 28" high and is provided with four "working" ports, a large interchange lock for introducing parts and several tubular ducts for service lines. Complete air filtration system is optional.

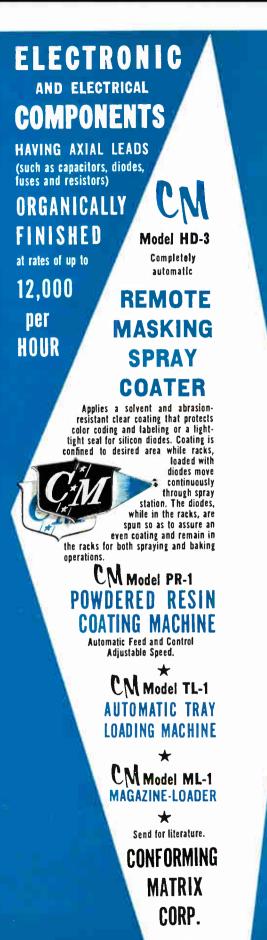
Won't this low-cost, disposable Dry Box fit into your laboratory or production plans? An Amsco man will be happy to discuss the matter in detail . . . or write for bulletin IC-607.

World's largest designer and manufacturer of Sterilizers, Surgical Tables, Lights and related technical equipment for hospitals, industry, research



E. PENNSYLVANIA

Circle 8 on Inquiry Card



839 NEW YORK AVENUE TOLEDO 11, OHIO

Circle 9 on Inquiry Card

ELECTRONIC INDUSTRIES



Tech Data

for Engineers

Antenna Test Site

"TACO Long Range Antenna Test Site" describes Technical Appliance Corp's antenna test site capabilities at their 2,870 ft. range located at Earlville, N. Y. Photographs and site layout included. Circle 319 on Inquiry Card

Transducers

This short form brochure gives information on a wide range of pres-sure operated instruments, rectilinear potentiometers and associated equipment. Servonic Instruments, Inc., 1644 Whittier Ave., Costa Mesa,

Circle 320 on Inquiry Card

PC Drilling

Tech data is available on the Panto-Duplicator which is designed for pro-duction drilling of printed circuit boards (or any other similar multi-ple-hole drilling operation) with speed, accuracy and efficiency. Photographs and specifications are includ-ed. Coleman Machine Co., Inc., 321 Snyder Ave., Berkeley Heights, N. J.

Circle 321 on Inquiry Card

Answering Industry Problems...



DIP-RAC, widely adjustable printed circuit dip soldering fixture. Eliminates tooling-up time, use of custom fixtures, welding clamps, tongs and other make-shift devices. Holds assemblies firmly, assuring higher quality,





For prototype panels or high production work, drill quickly and easily without specialized labor or expensive tooling. The Green D2 Pantograph Engraver with D2-201 Pneumatic Attachment provides manufacturers with a Printed Circuit Drill having unlimited application flexibility. Check these features:

drills

up to

- Spindle speeds to 26,000 R. P. M.
- Drill speeds and feeds independently adjustable
- May be used for profiling and engraving
- Boards can be stacked 4 deep for fast production
- holes/min. Operates on "In Plant" compressed air or tank air (very small volume required)

Whatever your requirements, the Model D2-201 is the answer-complete and ready to operate. Write or call today for full details.

GREEN INSTRUMENT COMPANY, INC.

Dept 59 • 295 Vassar Street Cambridge, Mass. • ELiot 4-2989

Circle 66 on Inquiry Card





Look What It Means:

- No apparel inventory or maintenance problems!
- Wide selection of lint-free apparel to meet every need!
- Garments designed for maximum coverage of body with free movement!
- Special laundering and packaging to keep particles out!

Look in the Yellow Pages under "Linen Supply''.

Write for information on how Linen Supply solves clean room apparel problems.



Circle 63 on Inquiry Card

Tech Data

for Engineers

Test Chambers

Information is available on environmental and climatic test chambers and testing facilities for research, test engineering, quality control, and production uses. Associated Testing Inc., 200 Route 46, Laboratories, Wayne, N. J. Circle 322 on Inquiry Card

Shaft Position Encoder

Mechanical and electrical design considerations in the selection of the proper shaft position encoder for the required application are discussed in bulletin 312-B. Also described are the various codes used and translation operations and equipment. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 323 on Inquiry Card

Flaw Detection

"Visible Penetrant Process — Pro-cedures and Techniques," 8-pages, de-scribes the use of the visible or dye penetrant inspection method for finding cracks and similar flaws. The Met-L-Chek Co., 11919 S. Western Ave., Los Angeles 47, Calif. Circle 324 on Inquiry Card

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607 MARKET ST. SUITE 201 SAN FRANCISCO 5, CALIF. GA 1-8145

9735 WILSHIRE BLVD. **SUITE 129** BEVERLY HILLS. CALIF. CR 5-5397

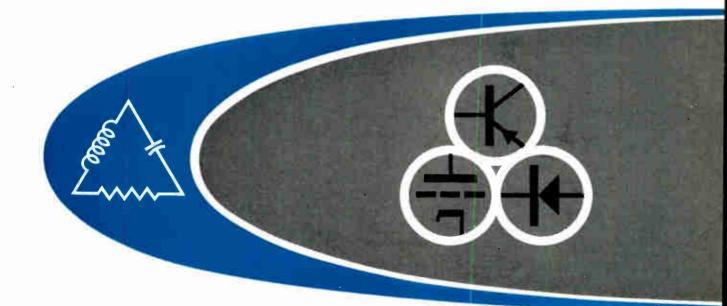
Circle 64 on Inquiry Card

EISLER PRESS TYPE VERTICAL EISLER Makes the largest assortment of Precision Press Type Resistance Spot —Wire Butt—Seam— Tweezer-Gun and Flash Welders. We also carry in stock Welding Tips, Holders and other Welding Accessories. OPERATED PRESS TYPE SPOT WELDER. NO. 250-VDAS WIRE BUTT WELDER WITH HYDROGEN JET No.95-LBSHI EISLER ENGINEERING CO., INC. 770 So. 13th St., NEWARK 3, N. J.

Circle 65 on Inquiry Card



Tubes & Semiconductors



PART ONE

High Frequency Semiconductors . . . C-2

New Semiconductors . . . C-8

-

*

High Frequency Semiconductors

---Technical specifications on the transistors, diodes and tunnel diodes available for operation above 100 megacycles.

The frequency spectrum is so crowded that there is only one direction to go for more room—and that's up! Nature's seeming paradox, however, is that while the upper microwave regions offer much more in spectrum space, bandwidth performance, smaller r-f component size and signal-beaming techniques they also pose severe problems in power generation, control of noise and reduction of transmission losses.

Until rather recently, worthwhile signal generation and amplification at Gc frequencies was confined almost entirely to the hot cathode tubes because of their high power handling capabilities and low noise performance. The need for lighter weight, reliable power sources in new communications systems, however, has spurred intensive experimental and developmental activity in the field of solid-state circuitry, and much progress has been made.

Semiconductor technology now has reached the stage where power levels of several hundred milliwatts are produced at X-band.

Transistors are available with gain-bandwidth products which exceed those obtainable with tubes. Noise figures have been reduced to as low as 4, for example, at 2 Gc. And while the power obtained from the semiconductor is still relatively low, efficiencies compare favorably at microwave frequencies with those of the best tubes.

This report, prepared by our staff, documents the results of a recent ELECTRONIC INDUSTRIES' survey of 30 semiconductor manufacturers to determine the performance characteristics of available transistors and diodes at frequencies of 100 megacycles and higher. Functions include oscillators, amplifiers, switchers, detectors, mixers, harmonic generator and special purpose devices. From the data supplied and within the space allotted, what are thought to be the most significant parameters have been selected for each category. The values given are typical unless otherwise noted, and are not necessarily obtained simultaneously in any one set of parameters.

100 MC OSCILLATOR, AMPLIFIER TRANSISTORS

Туре	App.	Freq. Gc	Gain db	P	N F db	Type	App.	Freq. Gc	Gain db	P mw	NF db
UDEDEV	000 D. K. A.		NV			NOTOPOL	Semiconduc	tor Prods (Continued)		
MPEREX,	, ZO DUNY AVE	., Hicksville, L.I.	20		6	2N741/A	ampi	.073	14	200	
ADT28	ampi	.2	20	832	0	2N1141	ampl	.15	125	300 ²	4
ADT28	osc	.7	14	1252	8	2N1141 2N1142	• .	.15		300	4.5
12084	ampl	.1	14	862	8		ampl	.15	105 85	300	5
1987	ampl	.1	14	2002	0	211143	ampl		125	300	Å
NDT35	ampl	.1		200-		2N1195	ampl	.15	126	1w ²	
EVITE	CORP., Waltha	m. Mass.				2N707	ampl	.16	12	3 w ²	
707	ampl	.1	126	300		2\1561	ampl	.073	11	3w2	
		LE des Semico	-ductore			2N1562	ampl	.0727	12	3w ²	
		uteaux (Seine) Fra				2N1692	ampl	.073 .0727	11	3w2	
7358	ample, r	.071	14	120	7	2N1693	ampi	.0727	*1	34	
T357	OSC	.071		120	•	NATIONAL	SEMICOND	JCTOR CORP	, Danbury, Con	n.	
T357P	mix	.081	6	120	10.5	NS731	ampl	.1	55 ^J		
	ampl	.031	20	120		N\$732	ampl	.1	1250		
1384	• .	.071	20	120		NS733	ampl	.1	1255 555		
11225	ampl	.071	20	1.0		N\$734	ampl	.1	125 ⁵		
	D SEMICONI			untain View, Cal		PACIFIC	ENICONDUC	TORS, INC.,	12955 Chadron A	ve., Hawthorne,	Calif.
918	ampl	.29	15	308	6	PT720	ampl	.1	15	.2w	
918	OSC	1.5	0	10 ⁸		2N707	ampl	.1	6	.2w	
917	ampl	,25	9	100		2N1338	ampi	.0715	10	.5w	
917	osc	1,1	35	122		2N1338	OSC	.0715	10	.55w	
1916	ampi	.14	35	1.2w2		2N1505	ampl	.12	7-10	lw	
1915	ampl	.14	2.5 ⁵ 25	1.2w ² .8 ²		2N1506	ampl	.12	9-12	lw	
957	ampl	.2				2N1300 2N1709	ampl	.0315	10	5w	
ENERAL	INSTRUME	NT SEMICOND		ouverneur St., Ne	ewark 4, N.J.	2N1709	OSC	.2	10		
499	ampl	.1	10	602		2N1703 2N1710	ampi	.0315	8	5w	
588	ampl	.1	8	602		2N1342	ampi	.071	13	.4w	
TACH1 presented	LTD., Tokyo, by International	Reporters, Inc.,	2242 S. Western /	Ave., Chicago 8,	101.	2N1342	osc	.25			
SA87	ampi	.1	35	80		T2351	amp	le, Div., Lansdal 2	6	10	10.5
688A	ampl	.1	18	80		T2351	OSC	3-5	•	.4	
A289	ampl	.1	20	80		T2028	ampl	.38	22	••	4.5
A288	ampl	.13	18	80		T2028	OSC	1.6			
A289	ampl	.15	20	80				.28	19		6.5
A 290	ampl	.18	21	80		T2029	m1X	.28	13	2.5	0.5
A234	ampl	.11	606	80		T2030	OSC		19	.5	5,5
A235	ampl	.12	806	80		2N1742	ampl	.26	19		5.5
		D1	via Aug. Nour	ut Reach Calif		2N1742	osc	1.3	10	15	10
	Semiconducto		rior Ave., Newpo 206	ni beach, cam.		2N1743	mix	.2	16	15	10
917	ampl	1,1	126	1.w ²		2N1743	ampl	.6			
917	ampl	.4				T2364	ampl	.0612	29	60	3
OTOROL	A Semicondu	ictor Prods., 5	005 E. Mc Dowel	I Rd., Phgenix, J	Ariz.	2N1158	OSC	.2		35	
700	алрі	.07-1	23	752	6	T2379	ampl	.1	21	60	5.5
700	OSC	.4		45		2N502A	ampi	.2	10		/
700A	ampl	.073	22	75	10	2N502A	OSC	.6			
				SYI	MBOLS, ABBREV	ATIONS AND NOT					
BV	Reverse break	dawn voltage				L _{in} Inse	rtion loss				
	Output capaci					NF Nois	e figure				
	put capacitanc					N Shot i	noise constant	,= 20 1 .R ., whe	re:lo=½lond	R _o ≭neg res€	151 p
- f	Resistive cuto	ff frequency				Q - Quality	y factor =	1, where	C=voltage vo	iable cap. in f	arods
(_ 0	in bandwidth	product: Freq. (at which $c = 1$	(with output sh	orted)		2 f	60	De contra con	in share	
· · · · ·	D	products a requi	l	(R Part	cp	s s ency = ratio of	DC lood v. to t	eak of input	
hFE **	Dc amplificat	ION TOCTOP	D								
hfe **	Ac amplificat	ion factor					s resistance				
I F	orward current					Z ··· Lo	od impedance				
_ I P	eak current										
I P	- Peak-to-vall	ey current ratio				NOTES: 1	. Min. 2. Ma	x• 3. ∜3Gc	4. @10Gc	5. հք 6. հբ	E

TUBES & SEMICONDUCTOR DEVICES

	Τ					PLIFIER TRANSIST	URS - (Co				
Гуре	App.	Freq. Gc	Gain db	P	NF db	Туре	App.	Freq. Gc	Gain db	P mw	
co c o	DRP. – (Conti	inued) .12	14	125				CO., North Ada		1	·
15	osc ampl	.032	28	120		X T200 X T200	ampi osc	.16-1	8	1w2	
68 44	ampi osc	.2 .036	28 33	2.5		2N502A	ampl	.26	9,5	75	
44 7 2	ampl	.1	15 10		5	2N502A XT400	osc ampi	.6 .166	12	752	
۴.	ampl	.1	10		5	XT400	0SC	.6	•-		
010 CO	RPORATION	OF AMERIC	A .			TEXAS INS	TRUMENTS	5, INC.			
491	ampl)iv., Somerville, 1 .1	1.85	.52 _w .5w ²		T1X2000	ral Expresswa ampl	y, P.O. Box 5012, 1-2	Dallas, Tex. 12.4	902	8
192 193	ampl ampl	.1	1.85 1.85	.5w2 .5w2		2N1405	ampl	1.1	105	752	
023	ampl	.1	189	1202		2N1406 2N1407	ampi ampi	$\frac{1.12}{1.12}$ $\frac{1.12}{1.12}$	105 7,55	752 752 752	
066 397	ampi ampi	.1	189 189	120 ² 120 ²		2N2363 2N1195	ampl		7.55 105 15.55	752 2252	5
177	ampl	.12	14			2N1141	ampt ampt	.5	13,55	2234	6
178 179	OSC mix	.12 .12	17			2N1142	ampl	.4	11.5		
						2N1143 2N2415	ampi ampi	.3 .2–.5	9,5 14*	752	2
		CO., Laureldale				2N2416 2N2413	ampi ampi	.25 .13	12,5* 14	752 1w ²	3
37 37	ampl osc	.072 .2	10	175 .75		2N2188	ampl	.15	35 3.75	1252	
094	ampi	.25	105	1502		2N2190 2N2191	amp1 amp1	.15 .15	3.75	125 ² 125 ²	
195 645	ampi ampi	.072 .25	105	300 ² 1.6 w ²		2N2412 2N2412	ampi ampi	1	35 25 25	3002 3002	
.992	ampl	.15	105	.35:v ²		• 3.5 Gc	4bu		6a -	000-	
		[T	T	CHING TRANSISTO	RS	T	1	1	
Гуре	V _{CB}	^h fe	fT Ge	С _{ов}	DISS mw	Туре	∨св	ĥFE	fT Gc	C _{ob}	Di
EVITE	CORP.,Walthan 25	n, Mass. 40	.400	5	5?					II Rd., Phoenix, A	
06B 08	25 40	40 151	,400	4.5	.5w ² .3w ²	2N705 2N710	15 15	40 25	.35 .6	5	150 150
14	40	301		6 6	.36w2 .36w2	2N 711 2N 695	12 15	30 40	.35	5 5	150 75
						2N828	15 15	40 40	.4		150
IRCHIL	D SEMICOND	UCTOR, 545 %	/hisman Rd., Mo .8	untain View, Cal 2.5	ıf. .3w	2N960 2N961	12	40	.46	3.5 42 42	150 150
2368	40	101	.65	2.5	.36w	2N962 2N964	12 15	40 70	.46	42 42	150 150
2369 708	40 40	201 15 ¹	.65 .45	2.5 62	.36w	2N965	12	70	. 46	42	150
706	25	201	.4	5	.36w .3w	2N966 2N963	12 12	70 20	.46 .3	42 5	150 150
914	40	55	.35	4.5	.36w	2N967	12	40	.3	5	150
						2N968 2N969	15 12	35 35	.32 .32	4	150 150
	ELECTRIC		Summer 1 at 5	1		2N970	12	35	.32	4	150
miconducto 1994	ir Prod s. Dept., E 15	Electronics Park, 75	Syracuse 1, N. Y	Y. F	200	2N971 2N972	7 15	35 75	.32 .32	4	150 150
914	40	30	.6	6	360	2N973	12	75	.32	4	150
705 710	15 15	25 25	.6 .5		150 150	2N974 2N975	12 7	75 75	.32 .32	4	150 150
711	12	30		5	150	2N706 / A	25	40	.4	5	.5w
711A 711B	15 18	401 401		62 62	150 150	2N 706B 2N 753	25 25	40 401	.4 .4	4.5 4.5	.3w .5w
725	15	201	.6		150	2N834	40	40	.5	4.5 42 42	.5w
781 782	15 12	45 40	.7 .6	62	150 150	2N835 2N2217	25 60	40 201	.45 .4	42	.5w .8w
828	15	45 201	.5	62 62 62 5	150	2N2218	60	401	.4	4	.8w
706/A 708	25 40	151	.4		300 360	2N2219 2N2220	60 60	1001 201	.4 .4	4	.8w .5w
753 834	25 40	401 251	.4		300 300	2N 2221	60	401	.4	4	.5w
834 960 961	40 15 12	201 201	.5 .4 .4	42	300 150 150	2N2222	60	1001	.4	4	.5w
962 964	12 12 15	201 401	.4	52 42 42 42 42 42 42	150 150 150	NS381	L SEMICON		.4	onn.	30
965	12	401	.4	42 42	150	NS382 2N834	40	120 40	.4 .4		30 30
966	12	401	.4	44	150	2N835 2N743		60	.4		30
NEDAL	INSTRUMEN	T SEMICONO		ouvement St., No	wark & N 1	2N744		120	.4		30 30
706/A	25 25	40	.4	5	1.2w ²	2N706/A 2N753	25	60 120	.3 .3		30
706B 753	25 25	40 401	.4	5 52	1.2w ² 1.2w ²	21/122	23	120	.3		30
834	40	251	.4	52 42	360				10055.01		
	25 20	201 201	.3 .35	42 52 52 62 62	360 360	PACIFIC 2N702		JCTORS, INC. 60		n Ave., Hawthorne	, Cal if. .6v
835	20	401	.35	52	360	2N703	25 25	100	.35 .35		.61
835 743 744	40	301 201	.35 .35	62 62	360 360	2N706 A 2N706B	25 25	60 60	.4	5 4.5	ly lv
35 43 44 14	40	151	.35	62	360	2N753	25	120	.35		1.4
835 743 744 914 2242	40 40					2N834 2N919	40 25	251 60	.35 .4		1w 1.1
835 743 744 914 2242						2N920 2N697	25 60	120 75	.4	12	1.3
835 743 744 914 2242 708 JGHES, 1	40 Semiconductor	r Div., 500 Supe		ion Beach, Calin		/0107/				17	
835 743 744 914 2242 708	40	r Div., 500 Supe 120 120	erior Ave., Newp .8 .4	ort Beach, Calif.		2N699	1201	401		••	Zw Dw
835 743 744 914 2242 708 JGHES, 5 709 708 708 744	40 Semiconductor 15 40 20	120 120 120	.8 .4 .4	ort Beach, Calif.		2 N69 9					Zw Dv
135 143 144 114 1242 108 16HES, 1 109 108	40 Semiconductor 15 40	120 120	.8	ort Beach, Calif.		2 N69 9	ORP., Lans	401 dale, Div., Lansd 80			
135 143 144 1242 08 16HES, 1 09 08 144 43	40 Semiconductor 15 40 20 20	120 120 120 60	.8 .4 .4 .4	5 5	1w ² 1w ²	2N699 PHILCO C		dale, Div., Lansd	ale, Pa. .9 1.2 .6	1.5 4	2w 25 10 15 10

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V

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HIGH f SWITCHING TRANSISTORS (Continued)

TYPE	∨св	hFE	fT Ge	C _{ob}	DISS mw	TYPE	v _{св}	h _{fe}	fT Gc	C _{ob} pf	DISS mw
	ORP. Lanst	ale, Div., Lansd	ale Pa.			SYLVANIA	, (Continued	,			
2N834	40	40	.35			2N783	40	08		3.5	300
T2425	40	20				2N784	30	251		3.5	300
2N779B	40	50	.32		150	2N828	15	251	.3	6	150
T2492	18	50	.25		150	2N 1962	40	80		3.5	400
12492	10	30	.23		130	2N 1963	30	251		3.5	400
RADIO CO	RPORATION	OF AMERIC	CA			2N2397	35	100	.3	2.5 62	300
		Div., Somerville				2N781	15	45	.7	62	150
2N955	12	60,	1	4	150	2N782	12	40	.6	62	150
2N828	15	25	.3 .	6	150	2N697	90	401		14	
2N834	40	251	.351	4	300	LINUST	50				
2N1708	25	251 201 201 401		6	300	TEXAS IN	STRUMENTS	13500 N. Cen. E	xpressway, P.O.	Box 5012, Dallas	, Tex.
2N 2205	25	201		â	300	TIX895	5	201	2.5	1.1	752
2N2205	25	401		ŝ	300	2N797	20	85	.6	3	1502
2N697	60	1202		20	600	2N743	20	101	.4	5	1w2
2N097 2N706/A	25	120 ² 20 ¹	.4	5	300	2N744	20	201	.4	5	1w2
	25 40	20-	1.4	5	360	2N2410	60	75	.3	9	2.52
2N708		151 251 251 251 201	c	6	150	2N726	20	15		5	1w2
2N705	15	25	.6	J E	150	2N706 A	25	201		5	1w2
2N710	15	25	.0	5		2N706B	25	201		52	1w2
2N711	12	20-	<i>c</i>	5	150 360	2N753	25	1202		3.5	1w2
2N914	40	120 ²	.6	ь	360	211/33	23	120-		0.0	***-
RAYTHE	ON CO., Lexin	igton 73, Mass,						RONIC CORP.	, Wakefield, Ma	s.	
2N705A	15	40		8		2N728	15	40		8	. 3H
2N710A	15	34		8	150	2N729	30	40		8	.3w
2N711	12	30	.3	7.5	150	2 N699	120	65		14	.6w
2N828	15	40	.3	3.5 62 62	150	2N697	60	75		20	. 6w
2N781	15	45	.7	62	150	2N706	25	35		4.5	.3w
2N782	12	40	.6	62	150	1					
								Laureidale Plan			100
SYLVANI	A, Semi conduct	or Div., 100 Sylv	van Rd., Woburn, I	Mass.		2N559	15	45	.44	5.2	150
2N706/A	25	20 1		5	300	2N1195	30	22	.55	2.6	300
2N706B	25	60	.4	5	300	2N1645	10	35	.6	11.9	6w
2N753	25	120	.3	5	300	2N1992	10	45	.43	3.9	.35w

MICROWAVE MIXER, DETECTOR DIODES

TYPE	Freq. Gc	L _c db	Z _{max} K - Ohms	NF db	R _E %	TYPE	Freq. Gc	L _c db	Z _{max} K - Ohms	NF db	R _E %
COMPAG	NIE GENERA	ALE des Semio	onducteurs			MICROWAY		ES, INC. (Co	ntinued)		
		Puteaux (Seine)Fr				1N160	7	6.5	.5	11.4	
SFD 117	.9-1	10.5	unco	147		MA451B	10	6.5	.6	11.4	
360.11		10.5		• •		MA451C	10	6	.47	9.8	
KEMTRO	N ELECTRO	N PRODS., IN	IC., Newburyport,	Mass.		MA451D	10	Š	.45	8.2	
IN21B	4	6.5	.8	107				6	.46	7.5	
IN21C	7	5.5	.8	8.37		MA451E	10	0		7.5	
	4		.45	7 27		MA451F	10		.46		
1N21D	4	5		7.3 ⁷ 7 ⁷		MA4133	10	6	. 47	9.8	
1N21E	4		.45			MA4125	10	6	.6	23	
1N21F	4		.45	67		MA4125A	10	6	.6	20	
1N21WE	4	5.5	.45	77		1N832	10	6	.47	10	
1N23B	10	8.5	.6	117		1N832A	10	-	. 45	7.5	
1N23C	10	6	.47	9.87		MA445	16	7.5	.62		
1N23D	10	5	.45	8.27		MA445A	16	7	. 56	9.8	
		J	.46	757				/		8.8	
1N23E	10			7.57		MA445B	16		.56		
1N23F	10		. 47	7.57		1N78C	16	6	.56	8.3	
1N23WE	10	6	.47	1.51		MA4124	16	7.5	. 62	27	
1N25	1	8	.4			MA4124A	16	7.5	.62	24	
1N25A	1	7	.3			1N26	24	8.5	.6		
1N25B	1	5.5	.3	87		1N53	35	8.5	.8	13.1	
K25A	1	6.5	.4	-		1N53A	35	8.5	.8	13.1	
K25B	i	5.5	.3	87		1N53B	35	6.5	.8	10.4	
	10	5.5	.47	8.37		10320	22	0.5	.0	20.7	
1N149				9.87		PHILCO C	ORP., Lansdal	e, Div., Lansdal	le, Pa		
1N 150	7	6	.5	5.0° 117		1N26	24	8.5			
1N 160	1	6.5	.5	11 ⁷ 7 ⁷			24	7.5			
1N831/A	4	5.5	. 45	"		1N26A		7.5		107	
1N832	10	6	. 45	107		1N26B,C	24	7.5		10.	
1N832A	10	6	. 45	8.57		1N78	16	7.5			
						1N78A	16	7			
MICROW	AVE, ASSOCI	IATES, INC., I	Burlington, Mass.			1N78B	16	6.5		-	
MA449B	4	6.5	.8	10		1N78C	16	6		9.57 8.87	
MA449C	4	5.5	.8	8.3		1N78D	16	5.7		8.87	
MA449D	4	5	.47	7.3		1N263	9.4	6		7.57 327	
		5.5	.45	7		1N1838	13.5			327	
MA449E	4	3.3	.45	6				13.5		177	
MA449F	4					1N2792	70	17.2		47.	
MA421A	4		.45	6.5		SEMI ELE	MENTS INC	Samphute RI	vd., Saxonburg, Pa.		
MA4127	4	5.5	.5	8.3			1	-, Janonous Di	101, 000000064 1 04		50*
MA4127A	4		.5	7		DC7	1		25		60*
MA4126	4	5.5	.8	18		DC7A	1		.25		70*
MA4126A	4	5.5	.8	15		DC7B	1		.25		
1N831	4	5.5	.45	-		DC7C	1				75*
1N831A		5.5	.45	7		DC7D	1				85*
	4	r	.5	9.8		• measured of	. 1Gc				
1N 150	7	6	•2	3.0		1					

MICROWAVE TUNNEL OSCILLATOR, AMPLIFIER DIODES

TYPE	f co Gc	l p mo	l _p ∕l _v	R _s ohms	N _s	TYPE	f _{co} Gc	1 p ma	l _{p∕l_v}	R _s ohms	Ns
	NIE GENERA					GENERAL	LELECTRIC	CO., (Contin	ued)		
	la Republique, P	uteaux (Seine) I	France			MTD2	2.5	2.2	.3(1v)		
SFD160	.1					MT D3	2.6	4.7	.6(Iv)	.5	
	L ELECTRIC		ark, Syracuse 1, N.	v		MT D4	2.3	10	1.3(Iv)	.3	
MTD1	2.3	1	.131v	1.5		TDI	2.3	1	, l(iv)	1.5	

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TUBES & SEMICONDUCTOR DEVICES

			MICRO	WAVE TUN	NEL OSCILLA	TOR, AMPLIFIE	R DIODES -	(Continued)			,
Туре	f _{co} Gc	l _p ma	L _{p/1}	R s ohms	N s	Туре	f co Gc	i p ma	T _{p/Tv}	R _s	Ns
GENERAL		Electronics Park	Suppose 1 N	······································		INTERNA	TIONAL MIC	ROWAVE CO	RP., - (Conti	nued)	1
TDIA	3.2	1	.](Iv)	1.		DGE 2010	20	1	5		
rD2	2.2	2,2	.3(Iv)	1.7 Í		DGE2012	20	1.2	5		
D2A	3	2.2	.2(1v)	1.1		DGE 2014	20	1.4	5		
D3	1.8	4,7	.6(Iv)	.5		DGE2016	20	1.6	5		
D3A	3,4	4.7	.5(Iv)	.52		DGE 2020	20	2	5		
D3A	1.6	10	1(Iv)	.3		D GE 3008	30	.8	5		
D4A	2.8	10	.1(lv)	.3		DGE 3010	30	1	5		
D4A D5	1.6	22	3(Iv)			DGE3012	30	1.2	5		
D5A	2,6			.2		DGE3014	30	1.4	5		
	2.0	22	2(1v)	.22		DGE 3016	30	1.6	5		
D310		4.7	.6(1v)	1.5		DGE 3020	30	2			
D310A	5.5	4.7	.6(Iv)	1.5							
D311	2.7	10	1.3(Iv)	1		MICRO S	TATE	TRONIÇS CO	RP., 152 Floral 16	Ave., Murray Hil	I, N. J.
N3218	2	1	.13(Iv)	1.5		WS233	2. 5 3.5	1	16	4	.95
N3218A N3219	3		.13(ly)	1.5		MS234	3.0	3	16	3	.85
		2.2	.28(Iv)	.7		MS235	4 5 61	3	20 20	3	.85 .85
13219A	3.4	2.2	.28(Iv)	.7		MS225	71	3.5	10	2	.00
						MS1100	10	3.5	10	3,5	
D5A	INSTRUME	NT SEMICON			ewark 4, N. J.	MS222	3.5	1.5	8	2	1.7
DSA D6A		20 10	8	.75		MS223	3.5	1.5	3	2	1.5
		* -		1		MS224	3.5	1.5	8	2	1.35
D7A		5	12	1		VS242	4.5	20	ă	1	1.00
D8A		1	8	2			1.5	20	0	*	
09A		20	12	.5							
D10A		10	12	.5		PHILCO	CORP., Lansda	le Div., Lansdal	le. Pa.		
DIIA		5	12	1		1N3560	1.3	1	5	1.5	
D12A		1	12	2		1N3561	1.3	1	8	1.5	
		_				1N3562	.85	5	6	.7	
ITERNAT GE1008	IONAL MIC	ROWAVE COP	RP., 1 Seneca P	face, Greenwich,	Conn.					-	
GE1000		.8	5			RADIO C	RPORATION	OF AMERIC	CA		
	10	1	5			Semiconouc	or and Materials				
GE1012	10	1.2	2			1N3128*	.1**	5	11	1.5	
GE1014	10	1.4	5			1N3129*	1	20	11	1.5	
GE1016	10	1.6	5			1N3130*		50	11	1.2	
GE1020	10	2	2 2			1N3138*	1**	50	20	2.6	
GE1508	15	.8	5			*Tunnel s	uitcling diod	es; **Pulse 1	epetition rate,	max.	
GE1510	15	1	2								
GE1512	15	1.2	5			TEXAS IN	ISTRUMENTS,	INC., 13500	N. Cen. Expressy 15	vay, P.O. Box 50	12. Dallas. 1
GE1514	15	1.4	5			XA650					
GE1516	15	1.6	5			XA651		10	10		
GE1520	15	2	5			XA652		5	5		
GE2008	20	.8	5			XA653		5	5		

MICROWAVE SWITCHING DIODES

							J				
Туре	Freq. Gc	L _{in} db	l o ma	C pf	P mw	Туре	Freq. Gc	L _{in} db	l _o ma	C pf	? mw
CONTINE	ENTAL DEVIC .52 .52 .52 .52 .52 .52 .52 .52	E CORD 125	15 Chadron Aug	Neudhama Cali		0.5.15.0.4				t	
CD6111		P 500 100	15 UNAURON AVE.,	Hawmome, Call	I. 250	GENERA	L ELECTRIC	CO (Cont		. 2	
000111	.32	ME= 206.100	/3	2	250	1N3605			75	22	250
CDPIIZ	.55		/5	2	250	1N3606			75	24	250
,IN914/A	.54		75	4	250	1N3608			75 75	-2	150
1N916/A	.54		75	2	250	1N3609			75	52	150
1N903	.54		10	2	250	1N3604			75 75	22	250
1N903A	52		20	1+	250	1N3607			75	222222222222222222222222222222222222222	250
1N904	52		10		250	143007			/ 3	-	150
1N904A	52		20	1.	250	1000 CC					
1N905	š2		10	2	250	HUGHES	, Semiconducto	r Div., 500 Su	perior Ave., New	port Beach, Calif.	
11005	52		20	1*	250	HD5000			5	12	75
11000	· 2		20	1	200	HD5001			5	12	75
11100CA	.3-		10	2.5	250	HD5002			2	12	75
ADUCINI	.32		20		250	H D5003			2	12	75
10907	.52		10	2.5"	250	HD5004			2	:2	75
IN90/A	.52		20	2.5*	250	1N914			51	11	
1N908	.52		10	2.5*	250	1N902			51 51	i 1	
1N908A	.52		20	2.5*	250	1N995			1001		
* @=6 volt	5					HD1800			100	12	
						HD1610			200-	52	
						HD1640			ai	34. 27	
FAIRCH	LD SEMICONE	NICTOR 545 V	Whisman Rd Mou	ntain View Cali	r	HD1640			1001 31 31 31 51	11 11 12 12 12 32 32 32 11	
FD192	LP VENICOINE		10	1		1\1837			3* r 1	<u>¥</u>	
FD100			10	22	25.02	1.4021			5*	11	
FD200			100	22 52 62 52	2502 2502	D100 CO	CODD I	1.01.1			
FD300			200	52	2502	PHILCO		ale Div., Lansda			
FD400			150	62	2002	1N3093	9	1.6	85		500
1N903					500 ²	1N3481	9	.75	60		10
			1002	1.2	250	1N3482	9	1	100		1.3w
1N904			1002	1.2	250						
1N907			1002	2.7	250	MICROSE	MICONDUCTO	R CORP., 1	1250 Plava Cour	t. Culver City. Ca	dif.
1N908			1002	2.7	250	MC303		-	10	1	300
1N914			.01	4	250	MC903A			20	1	300
1N914A			.02	4	250	MC904			10	ī	300
1N916			.01	2	250	MC904A			20	î	300
1N916A			.02	2	250	MC905			10	î	300
1N251	.1-1 RF@.1=60°	2 0	75	.8	125	MC905A			20	1	300
1N252			100	.8	150	MC906			10	2.5	300
1N811			40		150	MC906A			20	2.0	
IN812			60		150	MC907			10	2.5	300
1N813			75		150	MC907A				2.5	300
1N814			60		150	MC908			20	2.5	300
1N815			120						10	2.5	300
11013			120		150	MC908A			20	2.5	300
CENES		6 0				MC914			10	4	300
GENERA	L ELECTRIC	CO.,				MC914A			20	4	300
Semiconduc	tor Prods. Dept., E	lectronics Park,				MC916			10	2	300
MP1	R _F @.1Gc=45%		75	1	250	MC916A			20	2	300
MP2	C		75	1.5	250	MC001			10	2	300
MQ1 + MQ2 +	R _F @.1Gc=45%		75	1	250	MC001A			20	2	300
MQ2 '	1.Earria-12.0		75	1.5	250	MC002			100	5	300
										-	000

ELECTRONIC INDUSTRIES · June 1962

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				MICRO	WAVE SWITCHI	NG DIODES - (C	continued)				
Type	Freq. Gc	L _{in} db	1 ₀ mo	C pf	P	Туре	Freq. Gc	Lin db	1. ma	C pf	P
	CONDUCTOR	CORP /C	ontinue d		·	TRANSITR	ON, Wakefiel	d, Mass.			
3206			10	4	300	1N251			14	.8	125
13207			150	6	.300	1N252	1	RE@.1GC=60%	100	.8	150 150
						S4G	1		40 60	.8 .8	150
CROWAVE	E ASSOCIATE	S, INC., Burl	lington, Mass. 1002	1,2	250	\$5 G \$6 G	1		75	.8	150
903			1002	1.2	250	59G	1		60	.8	150
904			1002	2	250	\$10G	i		120	.8	150
4413			100-2	2	250	\$266G	-		20		50
4414 908			1002 1002 1002	2.7	250	1N914			10	42	250
907			1002	2.7	250	1N916			10	2% 42 42	250 ²
4121			30	.5		T MD50			20	42	100
914			.01	4	250	TMD914			20	22	100
914A			.02	4	250	TMD916			20	22	100
914B			.1	4	250	1					
916			.01	2	250				25.40 M. Oahar	Dd Dhooniy	A -1 -
916A			.02	2	250	U.S SEMIC	CONDUCTOR	R PRODS., INC.,	,5540 W. USDOT 20	72 n Ku., Phoenix,	AUT.
1916B			.03	2 2	250 500	GSC102 GSC052			20		
4245			.03	2 7.5	400	GSC052 GSC104			20	12	
920			.5	7.5	400	GSC054			20	42	
1921			.5 10	2	250	GSC108			20	82	
444]			20	2	250	GSC058			20	82	
44442 44443			50	2	250	GSB102			10	22	
A4444			100	2	250	GSB052			10	22	
44445			200	2	250	GSB104			10	42	
A4446			500	8	500	GSB054			10	42	
A4303			10	1.5	125	GTB052			10	12	
A 4304			10	1.5	200	GTB042			10	12	
A4305			10	1.5	125	GTB032			10	1- 2	
A 4306			10	1.5	200	GTB034			10	2.55	
A4307			30	2	125	GTB044			10 10	2.5-	
A4308			30	2	200	GTB054			20	2.3-	
		12500 8	N. Cen. Expressw	av P.O. Box 50	12 Dallas Ter	GTC052 GTC042			20	12	
EXAS INS	STRUMENTS,	INC., 13300 P	75	ay, 1.0. Dox 30.	250	GTC032			20	12	
N251 N914/ A ' B			75	4	250	GTC034			20	2.5 2	
N915			75	é	250	GT C044			20	2.52	
N916/A 'B			75	2	250	GT C054			20	2,52	
N917			75	2.5	250	GTB104			10	42	
1254			50	٤	100	GTB102			10 20	22	
1255			50	4	100	GTC104			20	42	
1256			50	2	100	GTC102			20 5	12	
1257			50	2	100	GPA044			5 5	22 4 4 8 8 2 2 4 4 2 2 2 2 2 2 2 2 2 2 2	
N3593			50	4	100	GPA044A GPB074			5 10	4°	
N659			100	2.7		GPB074 GPB124			10	42 42	
N660			100	2.7		GFB102			10	2	
N661			100	2,7 ,75		GFC102			20	72 22	
516				.75		GFC102 GFA010			5		
517				. 0		GFA020			5		
		Hace				GTA052			5	.8 2	
		mass.	80	.5	80	GTC064			30	2	
	R 4.1Gc=55%	mass.	80 20	.5	80 50 50	GTC064 1N251 1N252			20 5 10	2	

MICROWAVE HARMONIC GENERATOR, PARAMETRIC AMPLIFIER DIODES

Type	f _{co} Gc	ΒV,	Q	C pf	R s ohms
BOMAC L	ABS., INC., Sa	em Rd., Beverly.	Mass.	,	
BLV11	150	30		.5 ¹ ,	
BLV12	150	30		.551	
BLV13	150	30		.751	
BLV14	150	30		1,11 2 ¹ ,	
BLV15	150	30		21	
BLV16	150	30		3,51 6.8 ¹ .5 ¹ .551	
BL V17	150	30		6.81	
BL V21	150	60		.51	
BLV22	150	60		.551	
BLV23	150	60		.75	
BLV24	150	60		$\frac{1}{21}$	
BLV25	150	60		21	
BLV26	150	60		3.51	
BLV27	150	60		6.81	
BLV31	150	90		.51	
BLV32	150	90		.551	
BLV33	150	90		.751	
BLV34	150	90		1.11	
BLV35	150	90		21	
BLV36	150	90		3.51	
BLV37	150	90		6.81	
BLV41	150	120		.51	
BLV42	150	120		.551	
BLV43	150	120		.751	
BLV44	150	120		$\frac{1}{2^{1}}$	
BLV45	150	120			
BLV46	150	120		3.51 6.81	
BLV47	150	120			
	Semiconductor	Div., 500 Super	ior Ave., Newport 6 ¹ ,	Beach, Calif.	
1N950	130	399 369 309 239 209 209	61		
1N951	80	36	121		
1N952	60	30,5	201		
1N953	25	235	121 201 461 141 221 321		
1N954	25	20 20 20 20 20 20 20 20 20 20 20 20 20 2	141		
1N955	25	20 ³ 20 ⁹	221		
1N956	25	205	32*		

Type	f _{co} Gc	₿∨,	Q	C pf	R _s ohms
MICRO STA	TE ELECTR	ONICS COR	P., 152 Floral Av	e., Murray Hill,	N.J.
MS2501	80	6	b.'	1.1	.3
MS2502	105	6	84	1.1	.3•
MS2503	130	5	104	1.1	.3*
MS2504	160	6	124	1.1	.3 °
MS2505	200	ő	154	1.1	.3*
MS2602	40	30		1.1	15
MS2602	60	30		1.1	12
MS2604	10	30		1.1	10
	8	30		1.1	
MS2605	e E	30		1.1	5 5 25
MS2606		30 30		3-6	5
MS2620	10			3-6	, ×
MS2621	20	30		3-6	1.3
MS2622	40	30		3-6 3-6	
MS2623	60	30			1
MS2630	10	30		6-10	2.5
MS2631	20	30		6-10	1.3
MS2632	40	30		6-10	1
* m,h					
	E ASSOCIAT	FES , Burlingto	n, Mass.	14	28
MA4050A 😱		80		14	38
MA 4050B		80			
•20-watt UHF	varactor consis	ting of two junct	ions packaged in e	either a power ti	ansistor or po
diode case. D	Jual junction pe		pushpull operation	·	. 8
MA4321A		6		.8	68
MA4321B		6		1.6	3.5
MA4321C		6		3	2.3
MA4321D		6		6	1.7
MA4321E		Ğ		12	1.3
MA4321E MA4321F		6		25	1.2
		6		50	1.1
MA4321G		12		.8	6
MA4322A				1.6	3.5
MA4322B		12			2.3
MA4322C		12		3	
MA 4322D		12		6	1.7
MA4322E		12		12	1.3
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TUBES & SEMICONDUCTOR DEVICES

YPE	F _c Gc	BV _r	Q	C pf	R _s ohms	TYPE	f Ge	^{B∨} r	Q	C pf	R _s ohn
ROWAV		ES, (Continued)				PACIFIC		UCTORS INC.,	(C		
4322F		12		25	1.2	PC113	JEMICORD	80		22	
4322G		12		50	1.1	PC114		80	509 509	22 47	
A4323A A4323B		18 18		.8	6	PC115		100	1009	10	
A4323C		18		1.6 3	3.5 2.3	PC116 PC117		100 100	1009	22 47	
A4323D		18		6	1.7	PC122		100	1009 759	47	
A4323E		18		12	1.3	PC123		25	759 509	15	
A4323F		18		25	1.2	PC124		50	1259	15	
A4323G A4324A		18 24		50 .4	1.1 11	PC 125 PC 126		80	509	15	
A4324B		24		.8	6	PC126 PC127		100 25	1009 509	15 33	
A4324C		24		1.6	3.5	PC 128		50	1259	33	
A4324D		24		3	2.3	PC129		80	509	33	
A4324E A4324F		24 24		6 12	1.7 1.3	PC130 PC132		100	1009	33	
A4324G		24		25	1.2	PC133		25 25	502	10 22	
A4325A		48		.4	11	PC134		25	509 509 509	47	
A4325B		48 48		.8	6	PC135		50	150 ⁹	10	
Z4325C A4325D		48		1.6 3	3.5 2.3	PC136 PC137		50 50	1259	22	
A4325E		48		6	1.7	PC137		25	100 9 75 9	47 6.5	
A4325F		48		12	1.3	PC139		50	1509	6.5	
A4325G		48		25	1.2	PC140		80	759	6.5	
A4326A A4326B		60 60		.4 .8	11 6	PC141 V7		100	1259	6.5	
A4326C		60		1.6	3.5	V 10		25 25	189 189	7 10	
A4326D		60		3	2.3	V12		25	189	12	
A4326E		60		6	1.7	V15		25	189	15	
44326F 44326G		60 60		12 25	1.3 1.2	V20 V27		20 20	199 169	20	
A4327A		90		.2	21	V33		20	159	27 33	
A4327B		90		.4	11	V 39		20	149	39	
A4327C		90		.8	6	V47		20	139	47	
44327D 44327E		90 90		1.6 3	3.5 2.3	V56 V68		15 15	119 149	56	
A4337F		90		6	1.7	V82		15	139	68 82	
A4337G		90		12	1.3	V 100		15	119	100	
A4328A		120		.2	21	V7E		100	4.59	7	
A4328B A4328C		120 120		.4 .8	11 6	V10E V12E		100 100	5.59	10	
44328D		120		1.6	3.5	VISE		100	6.59 7.59	12 15	
A4338E		120		3	2.3	V20E		70	199	20	
4338F		120		6	1.7	V27E		65	169	27	
450AR 450BR	30 40	6 6		6 4		V33E V39E		60	159 159	33	
A450CR	50	6		3.6		V47E		55 50	169	39 47	
450DR	60	6		2.8		V56E		40	149	56	
450ER	70	6		2							
450 FR 450 GR	80 90	6 6		2		L4110	ORP., Lans	sdale, Div., Lansdal 80	e, Pa.		
450HR	100	6		2		L4111	60	40		1 .35	5
4297	120	5		2		L4112	100	20		.17	6 7
4259		5		8	4	TEVACIN					
4260		5 5			3 3	XD500	60 1	TS, 13500 N. Cen. 61	Expressway, P.U		
4298	150	Š		2	·	XD501	811	61	20 3 273	.51 .51	.7• .7•
4552	140	5.5		2		X D502	1081	61	363	.51	.7•
4553	120	5.5		2		XD503	144 1	61	483	.5	.7•
4554 4555	100 60	5.5 5.5		2		A600/610 A601/611		8 8	22 30	.7/.6 _7/.6	
4556	60	5.5		2.5		A602/612		8	30	.7/.6	
4557	40	5.5		4	***	*mµıh @ 9.4G	:	-		/ ••	
4280		30 30		.4	504 304	TO A ME	ALL P1				
1281 1282		30 30		.8 1.6	154	SC1	UN ELEC	TRONIC CORP.,	Wakefield, Mass	L	
4283		30		2	124	SC2		22	309	4.4 8	
4284		30		3	84	SC3		18	259	15	
4285		30		5	64	SC5		11	209	25	
4286		30 30		7 10	44 34	SC7 SC11		9	182	55	
4287		30 30		10	34 34	SC11 SC15		6 6	189 159 129	85	
4289		30		20	34	SCH51	5	10	1009	120	85
4290		30		25	34	SCH52	5	7	1009	.35 .8	43
1291		30 30		30	34 34	WEETERN	EL COTO:	e fa ula er			
292		30		35	37	IN3152	ELECTRIC 9	C, Laureldale Plant			_
CIFIC SE	MICONDUCT	ORS INC., 129	955 Chadron	Ave., Hawthome, Ca 6.5	uif.	1N3152 1N3153	9	6 6.8	3.1 3.1	4.7 4.7	1.5
D7		30	1509	6.5				V.V.	د بن ۱۰۰۰ ۱۰۰۰	1able only to agen	1.65

MICROWAVE SPECIAL PURPOSE DIODES

TYPE	APP	FREQ Gc	SENS. dbm	R _E %	Z _{max} Kohms	TYPE	APP	FREQ Gc	SENS. dbm	R _E %	Z _{ma} Koh
EMTRON	ELECTRON	PROD., Newb	uryport, Mass.			MICROWA		ATES, Burlingto	n Maee	.6	
1N32	video	3.3			22	1N32	video	-	,		2
1N32A	video	3.3			17			3.3			2
K408	video	9	-50v		3	MA452	video	9	- 50		3.
K408A	video	ő	-51v			MA4128	video	9	- 50	(for high radiation)	
		,			.3	1N830	det	.1		65	
K408B	video	9	-52 v		.3	MA4123	det	i i	- 45		1
1N31	video	9.4			24	1N833	det	10	-40		
1N31A	video	9.4			1/				-40		1
1N76/C		9.4				MA437	mon	.1-1			.: 1 10
1N79		10				MA4135	mon	16			1
	معاداته		40		10	MA424	mon	10			1
1N833	video	9,4	-40		18						
1N830/A		.1.		65							
K20	det	0-10									
1N82/A	det	.1									

ELECTRONIC INDUSTRIES . June 1962

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New Semiconductors

-Registered during the period May 1961 to May 1962

(From data supplied by Electronic Industries Assoc., Engineering Dept., 11 W. 42nd St., NYC.)

T	C 1	A	Outline	V	Power
Туре	Class	App.	Outsine	'CB	Dissipation
2N225	GPNP	S	T0-5	15v.	200mw.
2N315A	GPNP	S	T0-5	30v.	150mv/.
2N315B,	2N316A -	(Same as			
2N317A	GPNP	S	T0-5	25v.	150mw.
2N339A	SNPN	1F. RF	T0-11	60v.	.25w.
2N340A	SNPN	IF. RF	T0-11	85v.	.25w.
2N341A	SN P N	if, RF	T0-11	125 v.	.25.
2N356A	GPNP	S	T0-5	30v.	150mw.
2N357A,	2N358A -	(Same as	2N356A		
2N398A	GPNP	AFO	T0-5	105v.	150mw.
2N428A	GPNP	S	10-5	30v.	150m.
2N444A	GNPN	GP	T0-5	40v.	150 m.w.
2N445A	GNPN	GP	TO-5	30 v.	150mw.
2N446A.	2N447A -	(Ame as	2N445A ·		
2N447B	GNPN	Gp	T0-5	25v.	150m.v.
2N470	SNPN	AF	T0-5	15v.	200 nw.
2N471	SNPN	٩F	™ 0-5	30v.	200m.
2N472	SNPN	AF	T 0-5	45v.	200mw.
2N473	SN PN	٩F	T0-5	15v.	.2w
2N474	SN PN	AF	T0-5	30v.	.2
2N475	SNPN	٩F	T0-5	45v.	.2w.
2N476	SN PN	AF	T0-5	15v.	.2w.
2N477	SNPN	ΑF	TO-5	30 v.	.2w.
2N478	SNPN	IF, RF	T0-5	15v.	.2w.
2N479	SNPN	IF. RF	T0-5	30v.	.2%.
2N480	SNPN	IF, RF	T0-5	45v.	.2w.
2N489A	SPNP	OSC		65v.	450mw.
			2N493A, 2N4	94A -	
	(Same a	s 2N489A	J		
2N499A	GNPN	IF. RF	T0-1	30 v.	60mw.
2N502B		RE	TO-9	30v.	75mw.
2N519A	-	AFO	T0-5	25v.	150mw.
	. 2N521A.		(Same as 2	N519A	
2N523A		AFO	T0-5	20v.	150mw.
2N541A		AF	T0-5	15v.	.2w.
2N545	SNPN	AFO	T0-5	60v.	.6w
2N546	SNPN	AFO	T0-5	30v.	.6w.
2N547.	2N549, 2N	551 - (Sam	ne as 2N545)	
2N548	2N550, 2N	552 - (Sa	me as 2N546	5	
2N694	GPNP	IF. RF		30 v.	100mw.
2N698	SNPN	ну	T0-5	120	/. 0,8w.
	- (Same				
2N699E		HV	T0-5	120	v. 0,87 w.
2N7004		IF, RF	T0-17	25v	
21705/		S	10-18	15v	
2N708	SN PN	S,HF	TO-18		
211708		S, HF	T0-18		
2N709	SNPN	5. HE	TO-18		
2N710		S	T0-18		
2N7107 2N7117		as 2N710/			
2N711/ 2N711/			T0-18	18v	150mw.
2N711 2N721	SPNP	GP	T0-18		
2N721 2N721		GP	T0-18		
2N721	A SPNP SPNP	AFB	T0-18		
			T0-18		
2N728	SNPN	S S	T0-18		
2N729	SN PN		T0-18		
2N736		AF0			
2N741					
2N743			ТО-18 ТО-18		
2N743			10-1	J 401	. 1.ZW.
	- (Same a	S 2N/431	• •		
211743	A (Samo	50 7N //3	0.1		

TRANSISTORS

Type	Class	App.	Outline	v _{св}	Power Dissipation
2N754	SNPN	IF. RF	TO-18	60v.	.3w
2N755	SNPN	IF,RF	TO-18	100 v ,	
2N756A	SNPN	Γb	TO-18	60v.	500 mw.
2N757A.	2N759A, 2	N760A - C	Same as 2N	756A)	
2N779A	GPNP	S	TO-18	15v.	60mw.
2N779B	GPNP	S	TO-18	15v.	150mw.
2N780	SNPN	AFO	TO-18	18v.	300mw. 150mw.
2N781	GPNP	S	TO-18 TO-18	15v. 12v.	150mw.
2N782	GPN P SNPN	S S	-18	40v.	300mw.
2N783 2N784	SNPN	S	TO-18	30v.	300 mw.
2N785	GPNP	AFO	TO-23	12v.	50 m.w.
2N797	GNPN	S	TO-18	20v.	150mw.
2N828	GPNP	S	TO-18	15v.	150mw.
°N834	SNPN	S	T0-18	40v.	.3
2N835	SNPN	S	TO-18	25v.	.3w.
2N839	SNPN	IF, RF	TO-18	45v.	.3w.
2N840.	2N841 - (S	ame as 2N			
2N844	SNPN	IF. RF	TO-18	60 v.	
2N845	SNPN	IF. RF	TO-18	100	r3w.
2N849	- (Same a SNPN	S		25v.	.3w.
	(Same as				2
2N851	SNPN	S		20v.	.3w.
	 Same as SPNP 	GP	TO-18	25v.	.36w.
2N869 2N870	SNPN	GP	TO-18	100	-
	- I Same as		10 10	100	
2N909	SNPN	OSC	TO-18	60v	4w.
2N910	SNPN	AF	TO-18	100	v5w.
2N911	SN PN	GP	31-0T	100	v5w.
	- (Same as	2N910)			
2N914	SN PN	HF	T 018	40 v	
2N915	SNPN	HF	TO-18	70v	
2N916	SNPN	HF	TO-18	45v	
	- (Same a		10		26
2N919	SNPN	S	TO-18	25v	36w.
	- (Same as		TO-18	50v	
2N921	SNPN	S	10-10	264	30%.
2N922 2N929	 Same as SNPN 	AFO	T0-18	45v	
2N930	SNPN	AFO	T0-18		
2N956	SNPN	GP	T0-18		
2N960	GPNP	S	T0-18		
2N961	GPNP	S	T0-18		
	- (Same as				
2N963	GPNP		T0-18	3 7v.	150mw.
	-(Same as				
	2N966 - (N961)		
	- (Same a				
	- (Same a				
	, 2N970 - (MAPT)		
	- (Same a				
	(Same a		N9613		
	, 2N974 - 1		11201)		
2N975 2N976	- (Same a GPNP		T0-1	8 15	v. 100mw.
	- (Same a		10-1	- 13	
2,1977			T0-1	8 20	v. 60mw.
2N982			T0-1		
2N983			T0-1		
	- (Same a		10 1	- 0	
611004	(oamo a			_	

Туре	Class	App.	Outline	V _{CB}	Power Dissipation
21985	GPNP	S	TO-18	15v.	150mw.
2N988	SNPN	IF, RF	TO-18	20v.	.3w.
	(Same as				
21994	GPNP	S	TO-18	15v.	200mw.
2N995	SPNP	GP	T0-18	20v.	.36w.
2N1000	GNPN	S	T0-5	4 0v.	150mw,
		s 2N1000		80v.	lw,
2N1047B				120v	
2N1048B		LRF as 2N1047	D)	. 20 V	w.
		as 2N1048			
2N1050B	SNPN	RF, IF	T0-29	8v.	.5w.
211055	SNPN	AF0	T0-5	100v	
2N1060	SNPN	S	T0-28	40v.	250mw.
2N1065	GPNP	GP	T0-9	40v.	120mw.
2N1072	SNPN	P		75v.	12.5w.
2N1078	SNPN	S	T0-46	25v.	300mw.
2N1094	GPNP	RF, 1F	T 0-28	30v.	150mw.
2N1097	GPNP	AF	T0-5	16v.	175mw.
2N1098	– (Same a	s 2N1097)			
2N1116	SNPN	AFO	T0-5	60v.	.6w.
2N1117	— (Same a	is 2N116)			
2N11314		S	T0-5	60v.	.75mw.
		as 2N113		70	<i>c</i>
2N1132E		S	T0-5	70v.	
2N1139	SNPN	S	T0-5	15v. 35v.	
2N11417 2N11427		RF, IF AFO		30v.	
		as 2N114	20)	304	
2N1143/	GPNP		2.57	16v	. 175mw.
		as 2N1144)			
2N1173	GN PN		TO-29	35v.	
2N1174	-(Same a	s 2N1173)			
2N1185	GPNP	AFO	TO-5	45v	. 200mw.
2N1186	GPNP		то-5	60 v	, 200 mw.
2N1187	2N1188	- (Same as			
2N1194			T0-5	40v	
2N1196				70v	. 350mw.
		as 2N1196		~~	200-
2N1204			T0-9	20v	
2N1208				60 v	
2N1209				45v 60v	
2N1210 2N1211				80 v	
2N1211 2N1212				60 v	
		as 2N1208		001	
2N1254			, TO-5	30 v	275w.
		as 2N1254			
2N1255			T0-5	40 \	275w.
		as 2N1256			
2N1258	•		T0-5	30 \	
2N1259		S	T0-5	50	275w.
2N1389			T0-5	50 \	/. 300 m.w.
2N1391		N GP	T0-5	25	/. 150mw.
2N1392		PH 9		201	/. 50 m.w.
2N1393				201	v. 50mw.
2N 1394		PH 9		10	ν. 50 m.w.
2N1404			T0-5	25	r. 150m.w.
2N1405			T0-1		
		- (Same a			
2N1408			T0-5	50	v. 150 m.v.
				-	

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ABBREVIATIONS

GP - General Purpose GPNP - Germanium PNP HF - High Frequency VHF, UHF Amp. HV - High Voltage Applications IF - If Amp. LP - Low Power App. LRF - Low Frequency Amp. M - Mixer OSC - Oscillator P - Power Switch PH -- Phototronsistor RF -- Rf Amp. S -- Switch SNPN -- Silicon NPN SPNP -- Silicon PNP

2N744A - (Same as 2N743A)

AF - Audio Amplifier AFB - AF Amplifier, Closs B AFO - AF Power Amplifier

CD - Core Driver

GNPN - Germonium NPN

Type	Class	App.	Outline	v _{св}	Power Dissipation
1444 1494A 1495	SNPN GPNP GPNP	S S S	TO-29 TO-31 TO-9	60v. 20v. 40v.	500m.v. 400mw. 250mw.
11495A 11496	- (Same a: GPNP	s 2N1495) S	TO-31	40v.	500mw.
1561 1562 - 1566A	GPNP (Same as SNPN	1F, RF 2N1561) AFO	T0-5	25v. 80v.	3w. 600mw.
1613A 1613B	SN P N SN PN	GP GP	TO-5 TO-5	75v. 120v.	1.0w. 1.0w.
	SNPN (Same as	IF, RF 2N1210)	T0-5	100 v.	0.6w.
N 1616A N 1617 - N 1617A	SNPN (Same as SNPN	LRF 2N1211) LRF		60 v. 80 v.	85w. 85w.
N1618	SNPN	P		100v.	60w.
N1618A N1620	SNPN SNPN	LRF P	TO F	100v. 100v.	85w. 60w. 120mw.
N1622 N1647	GNPN Snpn	hv If, Rf	TO-5	90 v. 80 v.	40w.
	SNPN (Same as			120v.	40w.
N1650 - N1651 N1652	GPNP GPNP GPNP	AF0 AF0	TO-41 TO-41	60v. 100v.	100w. 100w.
N1653	GPNP SPNP	AF0 AF0	TO-41 TO-5	120v. 100v.	100 w. 250 mw.
N 1655 N1656 -	SPNP (Same as	A FO 2N1655)	TO-5	150v.	250mw.
N1672A	GNPN SPNP	HV AF	то-5 то-5	40v. 50v.	120mw. 250mw.
N1693 N1699	GPNP GPNP	IF,RF,HF IF, RF		25v. 40v.	350mw. 100mw.
N1700 N1701	SNPN SNPN	S P	TO-5 TO-8	60v. 60v.	5w. 25w.
N1702	SNPN SNPN	P P	TO-36	60v. 60v.	75w. 75w.
N1704 N1708A N1711A-	SNPN SNPN -(Same as	GP S 2N1613A)	TO-5 TO-46	45v. 40v.	500mw. 1w.
	-(Same as SNPN			90v.	0,8w.
	SNPN (Same as (Same as 2			150v.	0.8w.
N1718 N1719	SNPN SNPN	GP GP		90v. 150v.	2.0w. 2.0w.
N1719	SNPN (Same as	GP		150v.	2.0w. 2.0w.
N1721 - N1722	(Same as SNPN	2N1719) GP		120v.	3w.
N1724 - N1753	(Same as GPNP	2N1722) IF, RF	T0-1	30v.	30 mw.
N1755 N1756	GPNP GPNP	P P		40v. 60v.	28 w. 28 w.
N1757 N1758	GPNP GPNP	P P		80v. 100v.	28w. 28w.
N1759 - N1760 -	(Same as (Same as	2N1756)			
N1762 -	(Same as (Same as	2N1758)			
2N1768 2N1769	SNPN SNPN SNPN	P P P		60v. 100v. 50v.	40w. 40w. 250w.
N1809 N1810 N1811	SNPN SNPN SNPN	P P P	ŀ	50v. 100v. 150v.	250w. 250w. 250w.
N1812 N1813	SNPN SNPN	P P		200 v. 250 v.	250w. 250w.
N1814	SNPN	Р	me as 2N18	300 v.	250w,
1817, 2	2N1824, 2N	1831 - (Sa	ime as 2N18 ime as 2N18	10)	
			me as 2N18		2.0w.
N1886 N1889	SN PN SN PN	IF, RF GP	T05	60v. 100v.	40w. .8w.
N1893	(Same as SNPN	GP	T0-5	120v.	
N1907 N1908	GPNP GPNP	GP GP	TO-3 TO-3	100v. 130v.	150w. 150w.
N1917 N1918 -	SPNP (Same as)	AF 2N1917)	TO-5	25v.	250mw.
N1919 N1920 -	SPNP (Same as	AF 2N1919)	105	40v.	250mw.
N 1921 N 1922	SPNP SPNP	AF AF	TO-5 TO-5	50v. 80v.	250mw. 250mw.

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Туре	Class	App.	Outline	V _{CB}	Power Dissipation
2N1923 2N1924	SNPN GPNP	AFO AFO	T0-11 T0-5	85v. 60v.	.750w. 225mw.
		Same as 2M		60v.	600mw,
	(Same as 2	?N1958)			
2N1960 2N1961 2N1962	GPNP GPNP SNPN	S S S		15v. 12v. 40v.	150mw. 150mw. 400mw.
2N1963 2N1964	SNPN SNPN	s s		30v. 60v.	400mw.
2N1965	SNPN	S	TO 5	60v.	400mw.
2N1966 2N1969 2N1970	GPNPN GPNP GPNP	S S P	TO-5 TO-5 TO-36	35v. 30v. 100v.	120mv. 150mw. 93w.
2N1971	GPNP	P		80v.	37.5w.
2N1972 2N1973 2N1974	SNPN SNPN SNPN	OSC GP AF	ТО-5 ТО-5	60v. 100v. 100v.	0.6w. 0.8w. 0.8w.
2N1975 2N1978	SNPN SNPN	AF	T0-5	100 v. 100 v. 60 v.	0.8w. 30w.
2N1980 2N1981	GPNP GPNP	AFO AFO	T0-36 T0-36	50v. 70v.	
2N1982 2N1983	GPNP	AF0 GP	TO-36 TO-5	90v. 50v.	0.6w.
2N1984, 2	N 1985, 2N	1986, 2N19	87 - (Same	as 2N1	983)
2N1988 2N1989, 2 2N1991	SNPN 201990 - (SPNP	OSC Same as 2M GP	TO-5 1988) TO-5	100v. 30v.	0.6w.
2N1992 2N1993	SNPN GNPN	S S	TO-18 TO-5	15v. 30v.	330mw 150mw,
2N 1994 2N 1995	GN PN GN PN	S S	TO-5 TO-5	30v. 25v.	150mw. 150mw.
2N1996 2N1997	GNPN	S S	TO-5 TO-5	20v. 45v.	150mw. 250mw.
2N1998	GPNP	S	TO-5	35v. 30v.	250mw.
2N1999 2N2000 2N2001	GPNP GPNP GPNP	S S S	TO-5 TO-5 TO-5	30v. 50v. 30v.	250mw, 300mw, 300mw,
2N2004 2N2012	SPNP SNPN	S GP	TO-5 TO-5	50v. 120v.	250mw. 5w.
2N2017 2N2020	SNPN	GP P	TO-5	60v. 150v.	1w. 40w.
2N2021 2N2032	SNPN SNPN	P AFO		200 v. 45v.	40w. 85w.
2N2042	GPNP	AF0	TO-5 (Same as 2	105v.	200mw.
2N2048 2N2049	GPNP SNPN	P AF	TO-9 TO-5	20v. 75v.	150mw. 0.8w.
2N2059 2N2060	GPNP SNPN	S AF	T0-1	10v. 100v/s	60mw. .6w/sec.(both)
	GPNP 2N2079		(Same as 2	80v. N 2075)	170w.
2N2076	GPNP	LRF	(Same as 2	70v.	170w.
2N2077	GPNP	LRF	(Same as 2	50v.	170w.
2N2078	GPNP	LRF	(Same as 2	40v.	170w.
2N2085 2N2086	GNPN SNPN		T0-5 T0-5	33v. 120v.	150mw. .6w
2N 2087 ~ 2N 2101	(Same as SNPN	2N2086) AFO		60v.	75w.
2N2104	SPNP (Same as	S	T0-5	50v.	0.8w.
2N 2106	SNPN	AFO	TO~5	60 v.	lw.
2N2107, 2 2N2109 2N2110	2N2108 - (SNPN SNPN	Same as 2N P P	12100)	50v. 100v.	250w. 250w.
2N2111 2N2111 2N2112	SNPN	P P		150v. 200v.	250w. 250w. 250w.
2N2113	SNPN	P P		250v. 300v.	250w. 250w.
		2130 - (Sa	ame as 2N2 anne as 2N2	109)	730 M *
2N2118, 3	2N2125, 2N	12132 – (Sa	ame as 2N2	111)	
2N2137	GPNP	LRF	me as 2N2 TO-3 (Same as 2	30v.	62.5w.
2N2138	GPNP	LRF	TO-3 (Same as 2	45v.	62.5w.
2N2139	GPNP	LRF	T0-3	60v.	62.5w.
2N2140	GPNP	LRF	(Same as 2 TO-3	75v.	62.5w.
2N 21 40A 2N 21 41	, 2N2145, 2 GPNP	2N2145A - LRF	(Same as 2 TO-3	N2140 90v.	62.5w.

	Type	Class	App.	Outline	v _{св}	Power Dissipation
				·(Same as 2		130
	2N2152 2N2152A	GPNP GPNP	LRF LRF	TO-36	45v. 45v.	170w. 170w.
	2N2153	GPNP	LRF	10 00	60v.	170w.
	2N2153A	GPNP	LRF	TO-36	60v.	170w.
1	2N2154	GPNP	LRF		75v.	170w.
	2N2154A	GPNP	LRF	TO-36	75v.	170w.
	2N2155 2N2155A	GPNP		T0-36	90v. 90v.	170w.
		GPNP (Same as	LRF 2N2152)	10-36	304.	170w.
			s 2N2152A	0		
		· (Same as		~		
1			s 2N2153/	N)		
		(Same as				
			s 2N2154A	()		
		· (Same as	2N2155) s 2N2155A			
	2N2155A	GPNP	s znzioor S	то-9	20v.	60mw.
	2N2169	GPNP	S	TO-9	15v.	60mw.
	2N2170 -	·(Same as	2N2169)			
	2N2172	GPNP	S	T 0-5	10v.	200mw.
	2N2175	SPNP	AFO	TO-5	6v.	100mw.
	2N2176 2N2177 -	SPNP (Same a	AFO s 2N2175)	TO-18	6v.	100mw.
	2N2178 -					
	2N2180	GPNP	S	T0-24	15v.	50mw,
	2N2181	SPNP	S	T0-1	25v.	150mw.
	2N2182	SPNP	S	T0-1	25v.	150mw.
	2N2183 2N2184 -	SPN P (Same as	S 2N2183)	T0-1	15v.	150mw.
				70.10	20	150
	2N2185 2N2186, 2	SPNP 2N2187 -	S (Same as 2	TO-18 N2185)	30v.	150mw.
	2N2100, 7	SNPN	S S	TO-5	60v.	0.8w.
	2N2193	SNPN	HF	T0-5	80 v.	0.8w.
	2N2193A	, 2N2193E	- (Same a	is 2N2193)		
	2N2194	SNPN	HF	T0-5	60v.	0.8w.
	2N2194A, 2N2195	, 21N 21 94 B SNPN	– (Same a HF		45v.	0.6
			- (Same a	TO-5 s 2N2195)	437.	0.6w.
	2N2199	GPNP	OSC	T0-9	15v.	75mw.
	2N2200 -	(Same as	2N2199)			
	2N2208	GPNP	IF, RF	TO-44	40v.	120mw.
	2N2209 2N2210	GPNP GPNP	S P	TO-5	307.	150mw.
	2N2210	GPNP	GP	TO-41	190v. 120v.	70w. 60w.
	2N2216	SPNP	GP	T0-5	15Jv.	0.8w.
	2N2224	SNPN	S	T0-5	65v.	0.8w.
	2N2226	SNPN	AFO		50v.	150w.
	2N2227 2N2228	SNPN SNPN	AF O AF O		100v.	150w.
					150v.	150w.
	2N2229 2N2230 -	SNPN (Samo as	AF0		200 v.	150w.
	2N2230 -					
	2N2232 -	(Same as	2N2228)			
	2N2233 -	(Same as	2N2229)			
	2N2239	SNPN	AFO		60 v.	1w.
	2N2242 2N2243	SNPN SNPN	S S	TO-18	40v.	36mw.
	2N2243 2N2271	SPNPN	5 AF	TO-5 TO-5	120v. 20v.	0.8w. 250mw.
	2N2282	GPNP	AFO	TO-37	60v.	5w.
	2N2283	GPNP	AFO	T 0-37	100v.	5w.
	2N2284	GPNP	AFO	TO-37	200v.	5w.
	2N2285	GPNP	AFO	TO-3	60v.	100 w.
	2N2286 2N2287	GPNP GPNP	AFO AFO	TO-3 TO-3	100v. 120v.	100w. 100w.
	2N2288	GPNP	AFO	TO-3	40 v.	
	2N2289	GPNP	AFU	TO-3 TO-3	40 v. 80 v.	60 w. 60 w.
	2N 22 90	GPNP	AFO	TO-3	120v.	60w.
	2N2291 - 2N2292 -					
	2N2293 - 2N2294	(Same as GPNP	2N2290) P	T0-41	40v.	60w.
	2N2295	GPNP	P	TO-41 TO-41	40v. 80v.	60w.
	2N2296	GPNP	P	TO-41	120v.	60w.
	2N2330	SNPN *	S	T0-5	30v.	0.8w.
	2N2331	SNPN	S	TO-18	30v.	0.5w.
	2N2349 2N2374	SNPN SPNP	AFO GP	TO-5 TO-5	15v. 35v.	150mw. 250mw.
	2N2375, 2	N 2376 - (Same as 2	N2374)	-	
	3N47	GPNP	Р	TO-15	40v.	75w.
	3N48	GPNP	Р	TO-15	60 v.	75w.
	3N 49	GPNP	P	10-13	60 v.	/5w. 94w.
	3N50	GPNP	P		80v.	94w.
	3N51 3N52	GPNP GPNP	P P		40 v. 60 v.	94w. 94w.
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SILICON CONTROLLED RECTIFIERS

Type	Class	App.	Outline	Sine Wave Input Voltage	Average DC Output Current	Reverse or Forward Leokage Current	Power Dissipation °	Type	Class.	App.	Outline	Sine Wave Input Voltage	Àverage DC Autput Current	Reverse or Forward Leakage Current	
N1798 N1842 N1843 N1844 N1844	SPNPN SPNPN SPNPN SPNPN SPNPN	B B B B	TO-48 TO-48 TO-48 TO-48	400v. 25v. 50v. 100v. 150v.	70a. 10a. 10a. 10a. 10a.	4.0 ma. 22.5ma. 19.0ma. 12.5ma. 6.5ma.	0.5w.	2N685 2N686 2N687 2N688 2N689	SPNPN SPNPN SPNPN SPNPN SPNPN	8 8 8 8		200v. 250v. 300v. 400v. 500v.	16a. 16a. 16a. 16a. 16a.	6.0ma. 5.5ma. 5.0ma. 4.0ma. 3.0ma.	
2N1846 2N1847 2N1847 2N1848 2N1849 2N1850	SPNPN SPNPN SPNPN SPNPN SPNPN	B B B B B	TO-48 TO-48 TO-48 TO-48 TO-48 TO-48	200v. 250v. 300v. 400v. 500v.	10a. 10a. 10a. 10a. 10a.	6.0ma. 5.5ma. 5.0ma. 4.0ma. 3.0 ma.		2N1596	SPNPN - (Same as 2N SPNPN - (Same as 2i- SPNPN	A	TO-5 TO-5 TO-5	50v. 100v. 200v.	1a. 1a. 1a.		
2N1869 2N1869A - 2N1870	SPNPN - (Same as 2N1) SPNPN - (Same as 2N1) SPNPN	C 869) C	TO-9 TO-9 TO-9		1.25a. 1.25a. 1.25a.			2N1598	- (Same as 2N SPNPN - (Same as 2N SPNPN - (Same as 2N	11598) A	T0~5 T0-5	300v. 400 v.	la. la.		
2N1872 2N1872A - 2N1873	- (Same as 2N1 SPNPN - (Same as 2N1 SPNPN - (Same as 2N18	C 872) C	TO-9 TO-9		1.25a. 1.25a.			2N1600 2N1601 2N1602 2N1603 2N1604	SPNPN SPNPN SPNPN SPNPN SPNPN	Λ Α Α Α		50v. 100v. 200v. 300v. 400v.	3a. 3a. 3a. 3a. 3a. 3a.		
2N1874 2N1874A - 2N1909 2N1910 2N1911	SPNPN - (Same as 2N1 SPNPN SPNPN SPNPN	C 874) B B B	TO-9 TO-49 TO-49 TO-49	25v. 50v. 100v.	1.25a. 70a. 70a. 70a.			2N1765 2N1770A 2N1771A 2N1772A 2N1772A 2N1773A	SPNPN SPNPN SPNPN SPNPN SPNPN	C B B B	10-29	25v. 50v. 100v. 150v.	4.7a. 4.7a. 4.7a. 4.7a. 4.7a.	4.5ma. 4.5ma. 4.5ma. 4.0ma.	
2N1912 2N1913 2N1914 2N1915 2N1915 2N1916	SPNPN SPNPN SPNPN SPNPN SPNPN	B B B B B	TO-49 TO-49 TO-49 TO-49 TO-49 TO-49	150 v. 200 v. 250 v. 300 v. 400 v.	70a. 70a. 70a. 70a. 70a.			2N1774A 2N1775A 2N1776A 2N1777A 2N1777A 2N1792	SPNPN SPNPN SPNPN SPNPN SPNPN	8 8 8 8		200 v. 250 v. 300 v. 400 v. 50 v.	4.7a. 4.7a. 4.7a. 4.7a. 70a.	3.0ma. 2.5ma. 2.0ma. 1.0ma. 6.5ma.	(
2N 1929 2N 1930 2N 1931 2N 1932 2N 1932 2N 1933	SPNPN SPNPN SPNPN SPNPN SPNPN	8 8 8 8 8 8		25v. 50v. 100v. 150v. 200v.	550a. 550a. 550a. 550a. 550a.	2.0ma. 2.0ma. 1.0ma. .75ma. .55ma.		2N1793 2N1794 2N1795 2N1795 2N1796 2N1797	SPNPN SPNPN SPNPN SPNPN SPNPN	8 3 8 8 8		100v. 150v. 200v. 250v. 300v.	70a. 70a. 70a. 70a. 70a.	6.5ma. 6.5ma. 6.0ma. 5.5ma. 5.0ma.	
2N1934 2N1935 2N2023 2N2024	SPNPN SPNPN SPNPN SPNPN	B B B B	T0-49 T0-49	250 v. 300 v. 25 v. 50 v.	550a. 550a. 70a. 70a.	.5ma. .45ma.		2N2025 2N2026 2N2027 2N2027 2N2028	SPNPN SPNPN SPNPN SPNPN	B B B B	TO-49 TO-49 TO-49 TO-49	100 v. 150 v. 200 v. 250 v.	70a. 70a. 70a. 70a.		
2N681 2N682 2N683 2N684	SPNPN SPNPN SPNPN SPNPN	B B B		25v. 50v. 100v. 150v.	16a. 16a. 16a. 16a.	6.5ma. 6.5ma. 6.5ma. 6.5ma.		2N2029 2N2030 2N2031	SPNPN Spnpn Spnpn	8 8 8	TO-49 TO-49 TO-49	300v. 400v. 50v.	70a. 70a. 70a.		

CODE: A - Rectifier + Phase Control, B - Power Control + Switching, C - Pulse Applications, SPNPN - Silicon PNPN

SEMICONDUCTOR DIODES

Type	Class	App.	Outline	Continuous Average Forward Current	Maximium Reverse Current	Sine Wave Input Voltage	Pcak Reverse Voltage	Power Dissipation	Type	Class	App.	Outline	Continuous Average Forward Current	Maximium Reverse Current	Sine Wave Input Voltage	Peak Reverse Voltage	Pawer Dissipation
1N96A	GO	GP		70ma.				80mis.	1N813	S0	\$	00-7	75ma.			15v. 40v.	150mw.
1N98A 1N100A -	GO (Same as 1*	GP (98A)		70ma.				80mw.	1N814 1N815	SD SO	2	DO-7 DO-7	60ma. 120ma.			40v. 15v.	150mw. 150mw.
	(Same as 1*								1 \\ 816	SD	10	DO-7	150ma.			20v.	80mw.
1N695A	GD	GP	00-7	150ma.				80m	1N993	SO	5	DO-7					80m-v.
1N781	GO	S	00-7	60ma.				80m A.	1.1994	GD	2	00-7					80mw.
	(Same as 1)	781)							1:\\995	GD	S	00-7					80mw,
1N810	SO	S			يهم 1.0		50v.	0.19.	1N996	GD	S	00-7					
1N811	SD	S	00-7	40ma.			20v.	150 i.v.	1N1150A	SD	- 28					1500v.	
1N812	SO	2	DO-7	60ma.			30 v .	150 m v.	1N11998	SD	РQ	00-4	12a.		50v.		

GD - Germonium Diode GP - General Purpose LRF - Low Frequency Amplifier ABBREVIATIONS

MA – Microwove Amplifier OSC – Oscillotor PR – Power Rectifier S — Switch SD — Silicon Diade SUD — Silicon Unijunction Diade

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Power Dissipation	1.0w.		100mw, 0.1w, 250mw, 250mw, 250mw, 250mw, 250mw, 150mw,		
Peak Reverse Voltage	50v. 100v. 200v. 300v. 400v. 500v. 800v. 1000v. 1200v. 300v. 400v. 800v. 800v. 800v. 300v. 300v.		350 v. 20 v. 75 v. 30 v. 65 v. 200 v. 5.5 v. 5.5 v. 700 v.	800v. 900v. 1000v.	
Sine Wave Input Valtage	600 v. 800 v. 800 v. 1000 v. 1200 v. 1200 v. 500 v. 600 v.	200 v. 400 v. 600 v. 300 v. 1600 v. 100 v. 200 v. 200 v. 500 v. 400 v. 500 v. 400 v. 500 v. 100 v		200 v. 400v. 600 v. 200 v. 400 v. 600 v. 800 v. 50 v.	100 v. 200 v. 300 v. 400 v. 100 v. 200 v. 400 v. 600 v. 800 v. 1000 v. 1200 v.
Maximum Reverse Current	3,10 10,12 5,12 10,12 5,12 3,12 3,12 3,12 3,12 3,12 3,12 3,12 3		. 012:2а. 2,2-2 16та.	16ma. 16ma. 16ma.	2.4ma. 1.1ma. 250 Ja. 250 Ja. 250 Ja. 250 Ja. 250 Ja. 250 Ja. 250 Ja.
Continuous Average Forward Current	3a. 3a. 3a. 3a. 3a. 0.3a. 0.3a. 0.3a.	.750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a. .750a.	240a.	240a. 240a. 240a. 1.0a. 1.0a. .75a. .75a. 0.5a. 0.5a. 15a.	15a. 15a. 15a. 15a.
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Power Dissipation		1.0w.			
Peak Reverse Voltage		200v. 400v. 600v. 120v.			
Sine Wave Input Voltage	100 v. 150 v. 200 v. 300 v. 500 v. 500 v. 500 v. 500 v. 200 v. 300 v. 500 v. 300 v. 500 v. 600 v. 500 v. 500 v. 500 v. 600 v. 500 v. 500 v. 600 v. 500 v.	600 v. 100 v. 200 v. 300 v. 400 v. 500 v. 600 v. 200 v. 300 v. 400 v. 500 v. 600 v.	500 v. 600 v. 800 v. 1000 v. 1200 v. 50 v. 50 v. 200 v. 300 v. 300 v.	400 v. 400 v. 500 v. 500 v. 600 v. 600 v. 800 v. 800 v. 1000 v. 1200 v. 1200 v. 50 v.	50V. 50V. 100V. 200V. 200V. 300V. 300V. 400V. 400V. 500V. 500V.
Maximum Reverse Current		1.0 ma.	3.0 µа. 3.0 µа. 3.0 µа. 3.0 µа. 3.0 µа. 3.0 µа. 3.0 µа. 3.0 µа. 3.0 µа. 3.0 µа.	3.0 معبر ۵.8 3.0 معبر ۵.8	5,02 3,02 5,02 3,02 3,02 5,02 3,02 5,02 5,02 5,02 5,02 5,02 5,02 5,02
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Type	Class	App.	Outline	Continuous Average Foward Current	Maximum Reverse Current	Sine Wave Input Valtage	Peak Reverse Voltage	Power Dissipation	Type	Class	App.	Oùtline	Continuous Average Forward Current	Maximum Reverse Current	Sine Wave Input Voltage	Peak Reverse Voltage	Power Dissipation
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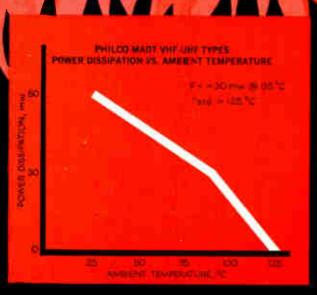
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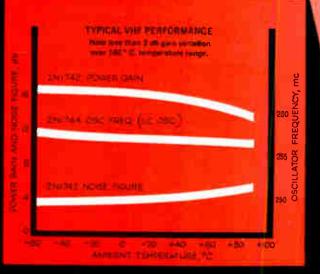
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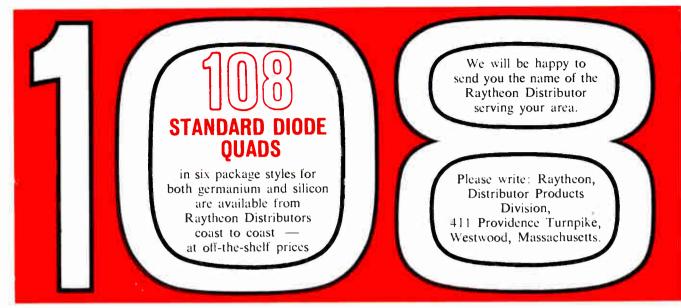
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ELECTRICAL DATA GERMANIUM QUADS

$T = 25 \degree C$ Each diode		
lo—Average Rectified Current	65	mA
Peak Rectified Current	150	mΑ
Surge Current for 1 Second	500	mΑ
Ambient Temperature Range -60 to	+90	°C
Power Dissipation	80	mW
Maximum Forward Voltage @ 100 mA	1	V

Electrical Rating Code (ordering)	Degree of Forward Match @ 4 mA	PIV each Diode	Maximum Inverse Current @ - 10 V
1	1%	35 V	20 µa
2	1%	75 V	10 µa
3	1%	100 V	1 0 µa
4	2.5%	35 V	20 µa
5	2.5%	75 V	10 µa
6	2.5%	100 V	10 µa
7	5%	35 V	20 µa
8	5%	75 V	10 µa
9	5%	100 V	10 µa

HOW TO ORDER: C707 T T RATING CODE

ELECTRICAL DATA SILICON QUADS

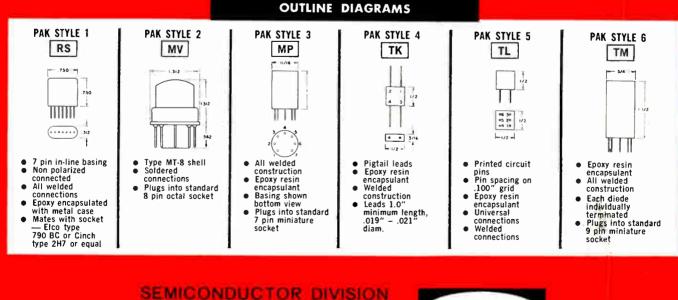
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lo — Avera	ige Recti	fied Curren	it	200	mΑ
Surge Cui	rent for	1 Second		1.5	Α
Ambient 1	Temperati	ure Range	— 60 to –	- 150	°C
Power Dis	sipation			250	mΨ
Maximum	Forward	Voltage @	100 mA	1	٧
Maximum	Reverse	Current @	PIV	.025	μa
Maximum	Reverse	Current @	PIV (150°C) 5.0	μa

Electrical Rating Code (ordering)	Degree of Forward Match @ 4 mA	PIV each Diode		
1	.5%	25 V		
2	.5%	125 V		
3	.5%	180 V		
4	1.0%	25 V		
5	1.0%	125 V		
6	1.0%	180 V		
7	2.5%	25 V		
8	2.5%	125 ∀		
9	2.5%	180 V		

HOW TO ORDER: C708 PAK STYLE

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in the standard TO-5 package types 2N2217, 2N2218 and 2N2219

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silicon epitaxial Star* planar transistors

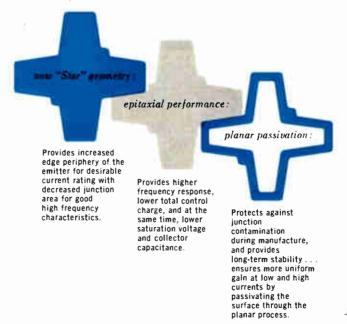
Since the introduction of Motorola's silicon epitaxial Star planar transistor series, many users have commented on its performance. One company is using this new transistor "... because of its outstanding gain at only 2.5 microamperes."

At the other end of the current spectrum, another manufacturer reports the highest gain at high current levels of any type he has previously tried. Both firms made note of the Star planar's unusually high frequency response.

To still another firm the overall broad-range performance of the Star has meant being able to reduce the number of different devices required in their equipment from 7 types to 1 type.

Now for your new circuit designs you can plug in "performance" previously unavailable in any device at any price. And these new Motorola units are priced competitively with older type devices . . . with prices as low as \$3.90 each in quantity.

Determine for yourself what a difference a Motorola Star planar can make in your circuit designs. Check the specifications, and if you have a bona fide application for any of these remarkable new transistors, contact your nearest Motorola District Office. A sales engineer will advise you how you may obtain free samples.



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2N2221 2N2222

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400% HIGHER GAIN BANDWIDTH PRODUCT The "Star" geometry's smaller emitter area and Motorola's advanced diffusion techniques combine to improve high frequency performance.

ONE-FIFTH THE OUTPUT CAPACITANCE The reduced area of the "Star," plus the high resistivity epitaxial layer combine to substantially lower collector capacitance.

ONE-SEVENTH THE SATURATION VOLTAGE With the low substrate resistance of the epitaxial process. collector saturation voltage is greatly reduced.

EXTENDED BETA RANGE — 10 μ A to .5 AMPS Passivated to stabilize characteristics and eliminate surface recombination effects, the Motorola "Star Planar" provides more uniform gain at low and high current.



World Radio History



ton torr 20-60

40-120

1.6

8 picofarads (maximum)— All Types

250 mc (minimum) - All Types

12 nsec (typical) - All Types

26 nsec (typical)—All Types 68 nsec (typical)—All Types

100-300

1.6

Semiconductor Products Inc.

 A SUBSIDIARY OF MOTOROLA. INC.
 1968

 5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

@ Ic = 150 mA

V_{CE(1+1)} volts (max) Is = 500 mA Is = 50 mA

 $I_E = 0, V_{CB} = 10 V$

 $I_C = \frac{f_T}{20}$ mA, $V_{Ct} = 20$ V

Switching Time (total) non-saturated

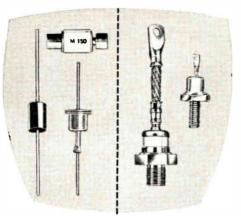
Switching Time saturated

ELECTRONIC INDUSTRIES · June 1962

Circle 20 on Inquiry Card

Low Current Silicon Rectifiers

22 types, with ratings from 0.15 amps to 1.50 amps; 100 to 2800 piv. Send for Bulletin 62CC4.



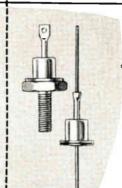
Hermetically Sealed Silicon Rectifiers

Ratings from 2 amps to 250 amps; 50 to 600 piv; choice of positive or negative base polarity in most styles. Send for Bulletin 62CC4.

Controlled Silicon Rectifiers

Two series, 3 and 5 amps; 25 to 400 piv. Stud mounted and hermetically sealed. Send for Bulletin 62SCR5.



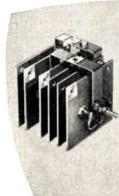


Silicon Voltage Regulators

Regular series: 93 types in 1/4, 1, and 10-watt classifications; 5.6 to 100 volts breakdown. Special series: 17 types in 1-watt, 6 to 105 volts breakdown. Excellent performance at low cost. Ask for Bulletin 61VR11.

Silicon Rectifier Assemblies

336 types, ratings from 5 amps to 1250 amps; 50 to 500 piv. Configurations include single-phase bridge and center-tap, and three-phase halfwave, bridge, and full-wave center tap. Ask for Bulletin 62SA3.





Tube Replacement Silicon Rectifiers

Long life, cool-operating, compact units replace 95% of all popular vacuum tube rectifiers. Ratings from 1600 to 10,400 piv; 250 to 750 ma dc output current. Send for Bulletin 62TR5.

7 invitations

to invention in circuit design... seven lines of Tarzian semiconductor products offering dependable performance at realistic prices, plus interested and informed application engineering service and production and development facilities to help you solve special problems or meet special requirements. Tell us your need or send for our newest catalogs, or both.

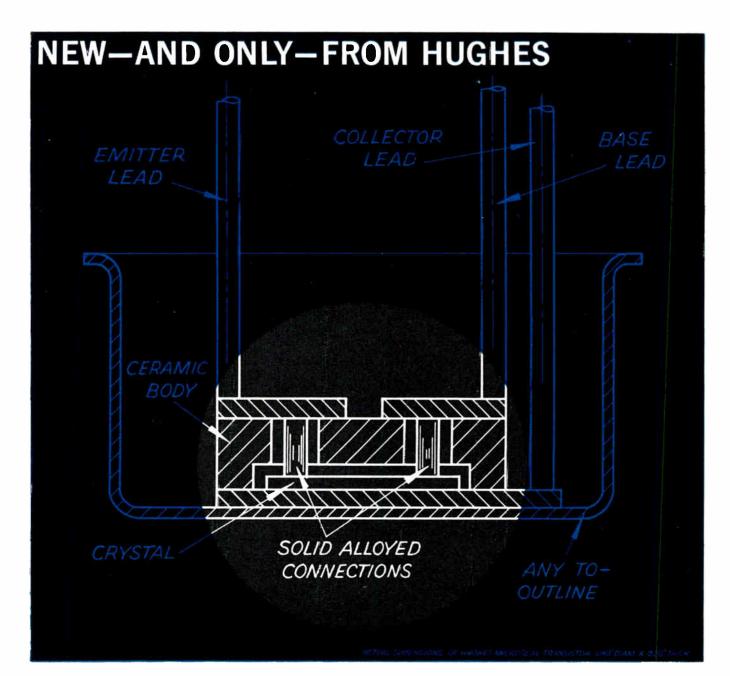


klipvolt-Surge Suppressors

136 types, polarized, single phase and three-phase non-polarized; maximum discharge currents from 0.25 to 33 amps. Ask for Bulletin 61KV10.



Circle 34 on Inquiry Card



SOLID ALLOYED CONNECTIONS-NO BONDED WIRES-IN NEW HUGHES MICROSEAL* STANDARD PACKAGE TRANSISTOR

NEW DESIGN CONCEPT Solid alloyed connections —no bonded wires—mean a tremendous increase in environmental reliability, especially where a high degree of resistance to shock, acceleration and vibration is a critical factor. Hughes pre-selected MICROSEAL transistors—hermetica!ly sealed—are now available in any industry standard package.

YOU DESIGN THE CIRCUITS Hughes MICROSEAL transistors are compatible with all known micro concepts. When your specifications call for a reduction in size, Hughes can supply transistors in just about any size package you want (TO-5, TO-18, TO-46, TO-51 and MICROSEAL packages).

HIGHER POWER RATINGS Regardless of transistor type and package, power ratings and currenthangling capabilities are vastly superior to the standard transistors you are now using. *Trade mark, Hughes Aircraft Company **RELIABILITY PLUS** Stringent life and environmental tests are performed on MICROSEAL transistors prior to re-packaging.

ONE-WEEK DELIVERY Hughes can supply most transistor types in any industry standard package one week from the time your order is received. Types such as 2N706, 2N706A, 2N706B, 2N707, 2N726, 2N753, 2N708, 2N869, 2N1131, 2N1132, 2N1254, 2N1255, 2N1256, 2N1257, 2N1258, and 2N1259.

NO ADDITIONAL COST No additional cost to you for Hughes transistors with MICROSEAL elements, regardless of the package type ordered.

For further information, call your nearest Hughes representative; or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California. For export, write Hughes International, Culver City, California.

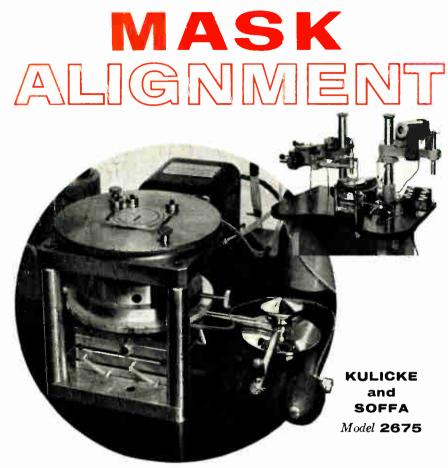


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ELECTRONIC INDUSTRIES · June 1962

FOR FAST, ACCURATE



MASK ALIGNMENT SYSTEM

The K&S Mask Alignment System is a fast, accurate production tool for the precise positioning of mask and wafer for the manufacture of semiconductors and microcircuits. It is the only such tool that meets all the essential requirements:

 The accuracy of alignment is limited only by the resolving power of the optical system.

• There is no side motion when the mask is lowered against the wafer after alignment.

• The wafer chuck is self-aligning, compensating for any varying or nonuniform wafer thickness.

• A mask frame supports and protects mask edge and geometry; simplifies handling.

 Both[®] wafer and mask are held securely by vacuum chucks.

• The vertical distance between mask and wafer is adjustable.

• The pressure between the wafer and the mask can be controlled for optimum resolution.

Aligning motions are in the X and Y plane and there are both coarse and fine rotary wafer motions.

• The scanning microscope has a range covering the full mask geometry, traveling X and Y between adjustable limit stops: after these stops are set, any inspection point on the mask can be easily reached.

Chuck motion is smooth and accurate with no play or backlash.

 Its use is simple; requires a minimum of training.

World Radio History

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Designers and Builders of Research and Production Equipment 401 NORTH BROAD STREET PHILADELPHIA 8, PA. 215-WALNUT 5-4270

Tech Data

for Engineers

Transistors & Components

Texas Instruments Incorporated, P.O. Box 5012, Dallas 22, Tex., is of-fering a 32-page brochure, with complete specs, on their germanium transistors, silicon transistors, diodes and rectifiers, solid tantalum capacitors, materials and sensors, resistors, and semiconductor networks.

Circle 307 on Inquiry Card

Semiconductors

Monsanto Chemical Co., Inorganic Chemicals Div., 800 N. Lindberg Blvd., St. Louis 66, Mo., is offering a revised manual for the evaluation of III-V intermetallic semiconductors. The four main sections include methods for preparing crystals for evalua-tion; crystal orientation by X-rays; Hall coefficient and resistivity measurements; and dislocation density measurement. An additional 3 sec-tions cover methods for crystal orientation optically; epitaxial layer thickness measurement by cross section staining; and epitaxial layer thickness measurement by infrared interference.

Circle 308 on Inquiry Card

Semiconductor Catalog

This 18-page condensed catalog in-cludes more than 2500 separate semi-conductor devices covering transis-tors, zener diodes, rectifiers, high-fre-quency silicon planar and mesa transistors. It also includes mechani-cal characteristics and outline draw-ings on all semiconductor devices ings on all semiconductor devices. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 309 on Inquiry Card

Silicon Rectifiers

Complete tech. information is contained in a 6-page short form data folder on Bradley, JEDEC Type Sili-con Rectifiers. Also included are di-mensional drawings. Bradley Semi-conductor Corp., 275 Welton St., New Haven 11, Conn. Circle 310 on Inquiry Card

Photoconductors

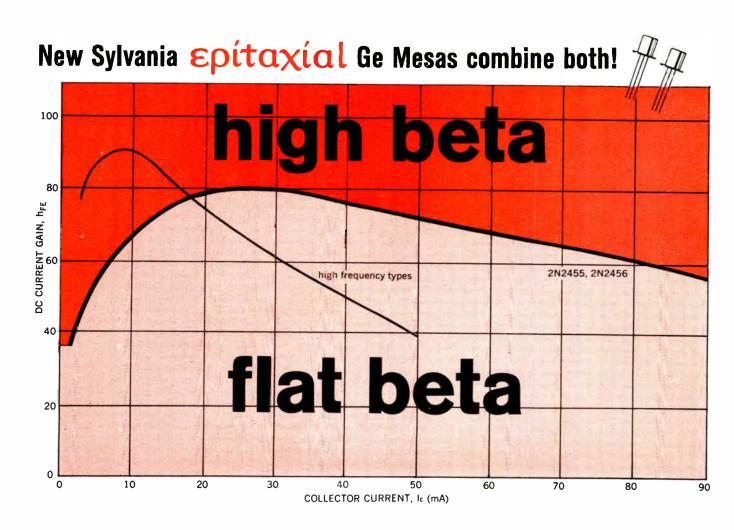
"Sylvania Photoconductor Devices" outlines photoconductor character-istics and some of the techniques used to manufacture the devices. The pamphlet places special emphasis on the Sylvania 8100, a device whose spectral response approximates that of the human eye. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y

Circle 311 on Inquiry Card

Transistor Brochure

An 8-page brochure on silicon planar epitaxial transistors is available from General Instrument Corp., Semiconductor Div., 65 Gouverneur St., Newark 4, N. J. Bulletin PE-15 includes characteristics. performance curves, test results and storage life reliability tests.

Circle 312 on Inquiry Card



...offer superior GBW (2N2456 typically 1200MC)

New 2N2455, 2N2456 provide high beta at low current and exhibit virtually linear beta over a *wide current range*. In this respect, as well as in current gain characteristics and GBW product, they far surpass performance of popular high-frequency types.

Packaged in TO-18, the 2N2455 and 2N2456 offer optimum performance in both PNP switching and amplifier applications. Both combine the well-known reliability and dissipation capabilities of the mesa structure with the reduced storage time, low saturation voltage and extraordinary uniformity inherent in Sylvania epitaxial process.

The full range coverage of Sylvania high beta typesat low current (2N2455, 2N2456)-at medium current (2N960 series)-and at high current (2N705, 2N781) offers wide design flexibility at optimum current levels. Your Sylvania Sales Engineer or Sylvania Franchised Semiconductor Distributor can give you full details. Ask him. Or, write for tech data to Semiconductor Division, Sylvania Electric Products Inc., Woburn, Massachusetts.

ABSOLUTE MAXIMUM RATINGS AT 25°C

ADJULUTE MIAAT	MOM NATH	AUS MI 1	23 6		
Collector To Base Voltage, VCB					15 volts
Collector To Emitter Voltage, Vcr					
Collector Current, Ic			0.5		200 1112
Storage Temperature, T _{stg}					
Junction Temperature, T _J					+100°C
Power Dissipation, P _J					150 mw
ELECTRICAL CHARACTERISTICS	AT 25°C	Min.	Typ.	Max.	Unit
Current Gain, h _{EF}		20	52	100	
$I_{\rm C} = 2.0 \text{ ma}, V_{\rm CE} =20 \text{ V}$		20	02	100	
Current Gain, h _{EF}		40	76		
$I_{\rm C} = 30 \text{ ma}, V_{\rm CF} =40 \text{ V}$		40	70	_	—
Gain Bandwidth Product, f_{T}					
	2112455	COO	000		
$V_{C} = 10 \text{ ma}, V_{CE} = -60 \text{ V}$	2N2455	600	820		mc
	2N2456	1000	1200		mc
Output Capacitance, Cob					
$I_{E} = 0, V_{CB} = -6 V, f = 1 mc$	2N2455			3.5	pf
	2N2456		_	3.0	pf
Input Capacitance, C _{te}		_		4.0	pf
$I_{c} = 0$, $V_{EB} = -1.0$ V, f = 1.0 m	nc				
Rise Time, t,	2N2455		11	30	nsec
	2N2456	_	8.0	15	nsec
Off Time, t _{off}	2N2455	_	45	65	пѕес
	2N2456		37	65	nsec
Storage Charge Factor, K		_	30	60	nsec
01010D0 01101 D0 1001011 115			00	~~	11300



cuts the air gap to 0.002"

Beckman introduces the first in an entirely new generation of Hall voltage generators-the 'Hallefex' Model 335. To increase the efficiency of magnetic circuits, Beckman reduces the effective magnetic air gap to under 0.002". That's 10 times smaller than the gap required by most Hall generators. Beckman does it with a special manufacturing technique that sandwiches an indium antimonide film only 7 microns thick between two ferrite slabs. This same process sends input impedance up to 100-600 ohms; voltage output sensitivity up to 2.0 volts/amp.-Kilogauss, minimum; and drops outside dimensions to $0.25^{"} \ge 0.25^{"} \ge 0.04"$.



What kind of job can this new member of the fastgrowing Beckman 'Hallefex' line do-more efficiently, less expensively-for you? Get some ideas and complete specs by writing Beckman for Model 335 data file.

FOR APPLICATIONS ASSISTANCE OR AIR-MAILED EVALUATION UNITS... write, wire or phone: Sales Manager, Special Products, Helipot Division. Phone: TRojan 1-4848. Teletype: FULLERTON CAL 5210. Complete 'Hallefex' application assistance is yours for the asking. Model 335 evaluation units in quantities of 1 through 9 are \$35.00 each.

Beckman®

HELIPOT DIVISION Fullerton, California

INSTRUMENTS, INC.

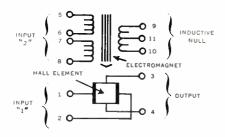
*IRADEMARK BULL

HALLEFEX

HALL EFFECT PACKAGES GO TRULY COMPATIBLE

... now possible with new-generation Beckman 'HALLEFEX'* generators!

Meet the Hall generator evaluating package that's 10 times more sensitive than ever before possible. Beckman combines the 'Hallefex' Voltage Generator and magnetic circuitry to come up with the 'Hallefex' Model 700 Magnetic Hall Package. It's a sure winner-and not hard to see why. Beckman doesn't use conventional polishing techniques on brittle generator element material. A special process evaporates this semi-conductor material to vacuum deposit a film only 7 microns thick. The result? Input impedance jumps to 100-600 ohms, produces output sensitivity of 2.0 volts/amp. Kilogauss, minimum.



Here are a few think pieces. The Model 700's magnetic circuit has split windings for series or parallel connection for use at 60 cycles. An additional winding is included for inductive nulling. The control current input operates from DC into the megacycle frequencies. Custom units

are available for use with carrier frequencies up to 2,000 cycles. Some typical Model 700 applications: analog multipliers, power measurement devices, choppers, inverters, gyrators, modulators, mixers.

ALSO-REAL POWER WATTS TRANS-DUCER AND WATTMETER...two more Beckman 'Hallefex' packages that boast unheard of sensitivities. The 'Hallefex' Model 701 Real Power Watts Transducer gives instantaneous real power measurements in a wide variety of power system applications. It has a 0.500 watts range and covers line frequencies of 50.500 cycles/second. And for those who want to see what's going on, Beckman adds a 4" x 6" panel meter to the Model 701 and calls it the 'Hallefex' Model 080.6570.0 Real Power Wattmeter.

HALL EFFECT APPLICATIONS GROUP AT

YOUR SERVICE... ready with experience to assist you on known applications, and ready with imagination to assist you in developing new applications. To discuss either (or just exchange Hall effect ideas), simply write, wire or phone Sales Manager for Special Products, Helipot Division. Telephone: TRojan 1.4848. Teletype: FULLERTON CAL 5210.



INSTRUMENTS, INC. HELIPOT DIVISION Fullerton, California

POTS : MOTORS : METERS



Circle 26 on Inquiry Card

ELECTRONIC INDUSTRIES · June 1962

Tech Data

for Engineers

Silicon Rectifiers

Tech. data on silicon power rectifiers rated at 3, 5, 6 and 12a is available from The Bendix Corp., Semiconductor Div., Holmdel, N. J. Dimensional drawings and complete specs. are included.

Circle 313 on Inquiry Card

Silicon Slide Rule

This slide rule, for use with silicon and silicon dopants, contains scales for: fractional inch, millimeters, and decimal in. dia.; sq. millimeters and sq. in. areas; slice thickness; weight in grams; a table of silicon proper-ties; and scales for figuring dopant concentration and resistivity. Available upon request under company let-terhead. Hyper-Pure Silicon Div., Dow Corning Corp., Midland, Mich. Circle 314 on Inquiry Card

Semiconductor Catalog

Semiconductor Div., Microwave As-sociates, Inc., Dept. HE, South Ave., Burlington, Mass., has available a 12page short-form catalog describing it's complete line of microwave semiconductor products. Electrical and mechanical specs. plus outline draw-ings with dimensions cover varactor diodes, diodes, microwave mixer microwave r-f video detector diodes, an r-f power monitoring diodes. Circle 315 on Inquiry Card

Rectifier Catalog

This 44-page, 2-color catalog de-scribes standard silicon power recti-fiers and rectifier stacks. The catalog is a composite of 12 data bulletins describing 8 basic silicon power recti-fiers and their corresponding standard rectifier stack assemblies. Illustrations include complete tabulations of electrical data, characteristic curves and dimensional diagrams. Silicon rectifiers range from 6 to 240a, with max, PRV ranging from 50 to 600v. Ratings for the stacks are from 12 to 370a., 1ϕ , and from 18 to 520a., 3phase. Available from Rectifier-Ca-pacitor Div., Fansteel Metallurgical Corp., N. Chicago, Ill.

Circle 316 on Inquiry Card

Semiconductor Catalog

North American Electronics, Inc., 71 Linden St., W. Lynn, Mass., is offering a 12-page semiconductor catalog covering their complete line. Information includes type specs., dimensions, and operating characteristics. Circle 317 on Inquiry Card

Semiconductor Products

A short form catalog #120B, 12 pages, 2 colors, describes a line of semiconductor products including solid-state modular power packs, laboratory power supplies. magnetic components, transistor test equipment, inverters, converters, and frequency changers. Electrical and physical data, specs, and prices are included. Electronic Research Associates, Inc.. 67 Factory Place, Cedar Grove, N. J.

Circle 318 on Inquiry Card

C23

FOR We had golf pro Bud H Holscher take his best • shots at a standard Hoffman 1N429 zener. Then we hooked the very same zener into a 6-volt DC circuit. It worked perfectly, of course. And, no wonder. This straight-from-the-bin unit is built to take many times the impact required by current military specifications. It's the same device that has achieved a 99.49% per 1000 hours Survival Rate Factor after two million component operating hours of testing. Our 1N429 stands

up in every way, like all Hoffman semiconductor devices.

We specialize in devices for control, regulation and power. You can buy them with confidence that they'll work and keep on working. Confidence that they'll be available when and where needed. That's why so many of the most successful electronics designers keep coming back to Hoffman-again and again and again. Chances are you'll do the same. Try us. Call your nearest Hoffman distributor or sales office today.



ELECTRONICS CORPORATION Semiconductor Division

Circle 27 on Inquiry Card World Radio History

MORE HIGH POWER TRANSISTORS FROM BENDIX



71 NEW TYPES Now Available

The greatly expanded line of Bendix High Power Transistors offers power switching capabilities up to 25 amps. Characteristics of typical types are listed in the table below. Together with improved design and increased ratings, you get higher gain and flatter beta curves. These high power transistors are categorized in gain and voltage breakdown to provide optimum matching, as well as to eliminate burn-out. They are capable of switching up to 1000 watts. Every Bendix Transistor is 'Dynamically Tested,' an exclusive Bendix quality control process to assure uniformity and maximum reliability. High power transistors also available with lugs. For complete data on the expanded line of Bendix Power Transistors and Power Rectifiers, write us in Holmdel, N. J.

	MAXIMU	M RATIN	CURRENT	GAIN	
Type Number	VCES	'c	Рc	^h FE [€]	^j ^l c
	Vdc	Adc	W		Adc
2N511-2,A,B	40-60	10-15	80	20-60	10-15
2N513-4,A,B	40-60	20-25	80	20-60	20-25
2N627-2N630	30-75	10	90	10-30	10
2N677,A,B,C	30-80	15	90	20-60	10
2N673,A,B,C	30-80	15	90	50-100	10
2N1031,A,B,C	30-80	15	· 90	20-60	10
2N1032,A,B,C	30-80	15	90	50-100	10
2N1120*	70	15	45	20-50	10
2N1146-7 A,B,C	30-75	15	87	30	15
2N1549-55,A	30-75	15	90	10-60	10
2N1557-60,A	30-75	15	90	50-100	10

*Also available per MIL-T-19500/68 (SigC)

Bendix Semiconductor Division



Main Office: South St., Holmdel, N.J. – Ph: SH 7-5400 • New England Office: 114 Waltham, Lexington, Mass. – Ph: VO 2-7650 • Detroit Office: 12950 W. 8 Mile Rd., Detroit 37, Mich. – Ph: JO 6-1420 • Midwest Office: 1915 N. Harlem Ave., Chicago, III. – Ph: 637-6929 • West Coast Office: 117 E. Providencia Ave., Burbank, Calif. – Ph: VI 9-3961 • Canadian Affiliate: Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ont. • Export Office: Bendix International, 205 E. 42nd Street, New York 17, N.Y. Stocking Distributors: Contact nearest sales office for name of local distributor.



SOLID REASONS WHY... For more information on any of Motorola's more than 2.700 industrial and military type semiconductor devices and the exclusive Motorola "Meg-A-Life" program of certified reliability —contact your local Motorola Semiconductor Distributor or District Sales Office Or, call or write: Motorola Semiconductor Products Inc. Technical Information Department. 5005 East McDowell Road, Phoenix 8, Arizona.

MOST CIRCUIT DESIGNERS SPECIFY

MOTOROLA POWER TRANSISTORS

HIGHEST POWER RATINGS

Motorola power transistors are available with power dissipation ratings up to 170 watts, and with collector voltages up to 120 volts...provide practical operation far beyond the operating limits of ordinary power transistors.

HIGHEST CURRENT RATINGS

In addition to the highest current ratings in the industry—up to 60 Amps—Motorola offers the most complete line of "diamond" (T0-3) and "doorknob" (T0-36) packages \ldots 3, 5, 10; 15, 25, 30, and 60-Amp ratings.

BEST TECHNICAL LITERATURE

Typical of its leadership in power transistor technology, Motorola's Power Transistor Handbook is the accepted industry reference for theory, design, and applications information ... Motorola data sheets are unsurpassed in format and content, clearly spelling out details on device voltages and other typical product traits such as temperature vs. g_{FE} , h_{FE} , and l_{CBO} ... also included are definitive curves showing safe operating areas as well as power derating characteristics.

BEST LOCAL SERVICE AND PRODUCT AVAILABILITY

Immediate customer service is available from 15 strategically located field offices, and Motorola devices are available from stock in sample or volume quantities (up to 999) from twentyeight of the top semiconductor component distributors in the United States.



NEW CONDENSED

For a concise reference to Motorola's complete line of quality semiconductor products, ask your Motorola distributor for a free copy of the new "Motorola Semiconductors, Condensed Catalog, March 1962."



If you don't have this valuable reference book yet, copies are still available from your Motorola Distributor for only \$2.00.



5005 EAST MCDOWELL ROAD . PHOENIX 8, ARIZONA

BEFORE YOU BUY ANY MORE TRANSISTORS,



MAKE SURE THEY HAVE CERAMETERM* BASES. CERAMIC SEALS WILL SOLVE 3 TOUGH PROBLEMS

1 Soldering heat that causes ordinary glass to crack. 2 The problem of glass insulation cracking through shock or impact. 3 The problem of leakage due to glass insulation failure when bending or adjusting pins. Cerameterm terminals were specially developed for super reliability on severe high-performance applications for transistor bases, diodes, rectifiers, relays, and capacitors. Exceed Mil-Specs. Can take 11,000 psi shearing stress without failure. PROVE TO YOUR OWN SATISFACTION that Cerameterm terminals are everything users say they are. Take advantage of our free sample offer. Eatontown, New Jersey.

*Trademark for Bendix' practically indestructible, alumina-insulated, ceramic-metal terminal assembly.		Red Bank Division
F	REE	SAMPLE
Electron Tubes Department B4 Red Bank Division The Bendix Corporation Eatontown, New Jersey	NAME	TITLE
Gentlemen: Please send me a sample of your new CERAME- TERM HEADER. I understand this places me under no obliga- tion.	ADDRESS	ZONESTATE

World Radio History

ELECTRONIC INDUSTRIES · June 1962

Circle 30 on Inquiry Card

Now—1000-volt rating with 240-amp current!

6

197

4

1.65



Westinghouse high-power silicon rectifier series-proved in use since 1958-now in industry's highest rating!

Westinghouse high-power silicon rectifiers are available in 1N 3161 series, 50-600 volts; 1N 3171A series, 700, 800, 900, and 1000 volts. Proven Westinghouse design and construction features include: 1. Ceramic-to-metal bond and welded case-provide lifetime hermetic seal. 2. Hard-soldered joints-eliminate thermal fatigue. 3. Alloy junction-prevents internal corona. 4. "Rock-Top" ceramic case-provides maximum creepage distance. 5. Flexible internal lead-absorbs mechanical stress. 6. Exclusive silver tungsten base-provides matched expansion coefficient and high thermal conductivity.

Depend on extra reliability, ruggedness, long life, proved by millions of performance hours in power supplies for aluminum pot lines . . . coal mines . . . railway traction equipment . . . resistance and arc welding . . . telephone systems . . . and many other applications.

For complete information, call your nearest Westinghouse representative or semiconductor distributor. Or write: Westinghouse Electric Corp., Semiconductor Division, Youngwood, Penna. You can be sure . . . if it's Westinghouse. SC-1074



For immediate "off-the-shelf" delivery, order from these Westinghouse Distributors : EASTERN

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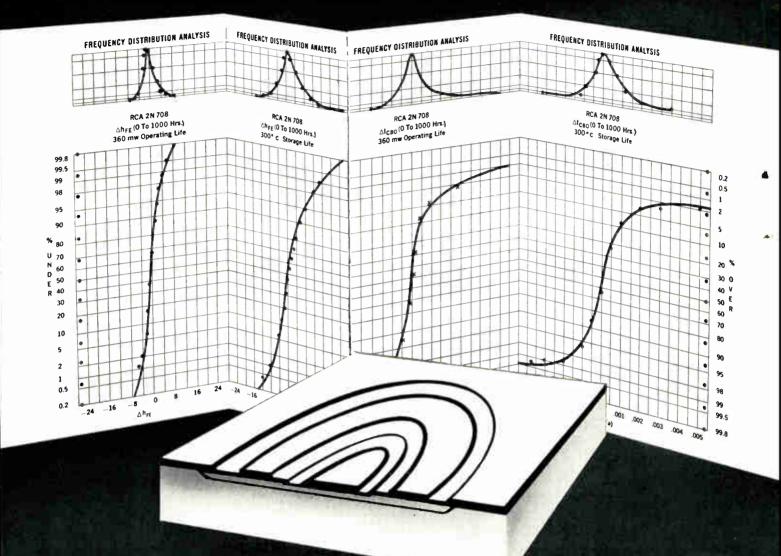
WESTERN

ALMAC ELECTRONICS CORP. Seattle, Wash./PA 3-7310 ELMAR ELECTRONICS

ELMAR ELECTRONICS Oakland, Calif./TE 4-3311 HAMILTON ELECTRO SALES Los Angeles, Calif./BR 2-9154 Paio Alto, Calif./OA 1-7541 Phoenix, Ariz./272-2601 NEWARK ELECTRONICS CO. Inglewood, Calif./OR 4-8440 DENNY-HAMILTON ELECTRONICS San Oiego, Calif./AC 4-3451

CANADA CANADIAN WESTINGHOUSE CO., LTO, Hamilton, Ontario/JA 8-8811





BRING NEW SILICON PLANAR STABILITY TO YOUR COMPUTER DESIGNS WITH THE RCA 2N708 TRANSISTOR FAMILY

All RCA 2N708, 2N706 and 2N706A silicon transistors—now in planar construction to assure a new degree of stability and reliability for your high-speed switching applications

Here's proof of the outstanding stability you get from RCA's 2N708 family. Check these curves which summarize the results of RCA production lot acceptance tests—a dramatic presentation of the actual production lot stability of the RCA 2N708.

In addition, here are some of the other outstanding advantages these high-speed silicon planar computer transistors will bring to your designs:

- Reduced collector cutoff current...by as much as 20 to 1 over mesa types.
- Uniform Beta over a wide current range.
- Storage temperatures up to 300°C.

RCA 2N708: Proved high-reliability for very-high-speed saturated switching and high frequency amplifier applications in military and industrial equipment—designed to offer the full advantages of planar construction in low I_{CBO} and in beta stability.

RCA 2N706: Very high speed silicon planar switching transistor designed to meet MIL Specifications, field proved in a wide range of switching applications and backed by a long history of life data.

RCA 2N706A: Improved version of 2N706 for more stringent high speed applications requiring lower collector capacitance and storage time.

Call your RCA Representative today for complete reliability information on RCA 2N708 silicon planar transistors. For additional technical information write RCA Semiconductor and Materials Division, Commercial Engineering, Section F-50-NN, Somerville, N. J.



The Most Trusted Name in Electronics

Circle 32 on Inquiry Card World Radio History

Now All RCA Silicon Computer Transistors Go Planar Epitaxial—Triple-Diffused—Double-Diffused

RCA expands line of silicon planar and planar-epitaxial switching transistors to meet the stringent reliability and performance requirements of today's computers

RCA SILICON DIFFUSED-JUNCTION PLANAR TRANSISTORS

In addition to the popular 2N708 family, here is a lineup of the many other high-speed silicon planar transistors now available from RCA, incorporating all the advantages of surface protection inherent in planar technology:

RCA 2N696... Specially designed and processed to assure stability of characteristics and reliable performance under conditions of severe thermal and mechanical stress. High switching speeds at high current makes RCA 2N696 especially suitable for core driving and other high current applications.

RCA 2N697... High Beta version of RCA 2N696.

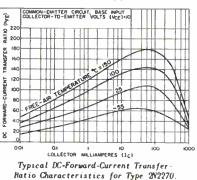
RCA "Universal" 2N2102 ... First silicon n-p-n triple-diffused planar transistor specifically designed for widest possible application in military and industrial equipment. It features high switching speed, high pulsed beta $(h_{\rm FE})$ at $I_{\rm C}=1$ amp, and controlled beta over 5 decades of I_c. It has high breakdown-voltage ratings, high dissipation ratings, low saturation voltages, and low output capacitance.

RCA 2N699...New triple-diffused-junction silicon n-p-n planar transistor especially useful for vhf and video applications. Triple-diffused-junction design makes possible lower saturation voltages, higher sustaining voltages and lower output capacitance.

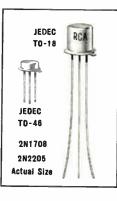
RCA 2N1613...Four-step beta control-specifically designed for wide application in military and industrial equipment. It features low noise and low leakage characteristics. Beta 40 min., BV_{CBO} 75 v min., I_{CBO} at 25°C equals 0.01 μ a max.

RCA 2N2270... New economy version of the RCA "universal" triple-diffused silicon planar transistor for applications in

military and industrial equipment. It features high breakdown voltages, low V_{CE} (Sat), low leakage characteristics, very low output capacitance. Minimum gainbandwidth product =60 Mc, in applications from de to 20 Me.



RCA SILICON PLANAR-EPITAXIAL TRANSISTORS



RCA combines two of today's most advanced technologies, planar construction and the epitaxial process. to bring you silicon transistors with excellent stability, high reliability, low saturation voltage and improved 'switching times.

RCA 2N1708.... First silicon planarepitaxial computer transistor in the TO-46 miniature package offers a V_{CE} (sat) of 0.22y max., Beta(h_{FE}) 20 min., t_s 25 nsec max., $BV_{CBO} =$ $25v \text{ min., I}_{CBO} = 0.025 \ \mu a \text{ max. It is}$

especially designed for use in very-high-speed applications in military and industrial equipment requiring high reliability and high packaging densities. See chart for beta stability versus current and temperature.

RCA 2N2205... Electrically identical to the 2N1708, but in the JEDEC TO-18 package. Like the 2N1708, its epitaxial structure insures low collector saturation voltage at high collector current. Planar construction insures low collector cutoff current (I_{CBO}) and exceptional stability throughout life.

RCA 2N2206...High-beta version of RCA 2N1708 in the TO-46 package. Minimum beta 40, Short storage time, 35 nsec. max.

RCA PACKAGING...Whatever your packaging requirements, from transistors and multiple devices in standard JEDEC packages, to special configurations or RCA Minimodules and RCA Micromodules, RCA Semiconductor and Materials Division packaging specialists are ready to work with you to meet your design requirements.

CALL YOUR RCA REPRESENTATIVE TODAY FOR COMPLETE INFORMATION ON RCA'S BROAD LINE OF SILICON PLANAR TRANSISTORS. For additional technical information, write RCA Semiconductor and Materials Division, Commercial Engineering, Section F-50-NN, Somerville, N.J.

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FROM DCT





World Radio History

TRANSISTON



For Technical Data and prices, contact:

SILICON TRANSISTOR CORPORATION

CARLE PLACE, LONG ISLAND, NEW YORK Planeer 2-4100

Sixteen Different PNP Types:

11/16" hex ... 85 watts ... STC5550 through STC5555 Square package ... 85 watts ... 2P389, 2P389A, 2P424, 2P424A TO-3... 75 watts ... STC5080 through STC5085 Characteristics: hFE 10 to 30 @ 2 amps... RcE (sat) 0.5 ohms @ 2 amps...Vct 80 volts...Ic max 5 amps NPN Complements: 11/16" hex 85 watts . . . STC1550 through STC1555 Square package 85 watts . . . 2N389, 2N389A, 2N424, 2N424A TO-3 75 watts ... STC1080 through STC1085

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Fused hemisphere front contoct in the glass subminioture packoge provides unusuolly good mechanicol protection agoinst shock ond vibrotion. There are no loose parts to couse intermittent operation.

GENERAL ELECTRIC PLANAR PLANAR EPITAXIAL PASSIVATED DIODES FEATURE CONTROLLED CONDUCTANCE

General Electric PEP silicon diodes bring you a unique design combination that allows ultra-fast switching speed combined with extremely tightly controlled conductance over a wide current range.

Gaseous *planar* diffused junction means high breakdown voltage with low capacitance.

Thin *epitaxial* layer on low resistivity substrate gives negligible body drop and increased uniformity from diode to diode.

Surface *passivation* is applied before the junction is formed for maximum protection against contamination.

	ACTERIS				
1N3605 1N3606		3608 3609		1N3605 1N3608	1N3606 1N3609
lf (ma)	VF (mil	livolts)	Breakdown Voltage		
	Min.	Max.	$(I_R = 5 \mu omps)$	40 V min.	75 V min.
0.1	485	555		50 yamps max.	50 yamps max.
0.250	525	595	Leakage Current (25° <mark>C</mark>)	$@V_{R} = 30V$	$@V_R = 50V$
1.0	580	680	Leakage Current (150°C)	50 µomps max.	50 µomps mox.
2.0	625	725		@ $V_{R} = 30V$	$@V_R = 50V$
10.0	710	840	1N3605 AND 1N3606	ARE IN THE GLASS	SUBMINIATUR
20.0	750	900	PACKAGE ILLUSTRATE	D. 1N3608 AND 11	N3609 ARE IN

If your application does not require controlled conductance and exceptionally tight specifications, G-E also has available 1N3063. For complete details, call your Semiconductor District Sales Manager. Or write Semiconductor Products Department, Section 13F118, General Electric Company, Electronics Park, Syracuse, N.Y. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 159 Madison Ave., New York, N.Y.

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15



New Tech Data

for Engineers

Power Rectifiers

Standard Rectifier Corp., 620 E. Dyer Rd., Santa Ana, Calif., is offer-ing Catalog No. 661-2, 46 pages, which contains outline drawings, characteristics charts, and complete specs. on their line of double diffused silicon top hats, silicon power rectifiers, varistack, and 250w. zener power regulator. Information includes descriptions, current ratings, peak inverse voltage, reverse current, junction temp. ratings and data on assemblies.

Circle 325 on Inquiry Card

Power Transistor

A 12-page technical data bulletin on 30a silicon power transistors is avail-able from the Westinghouse Electric Corp., Semiconductor Dept., Young-wood, Pa. The booklet, illustrated with over 30 charts and graphs, describes the electric characteristics, test cir-cuits, and peak pulse power capabilities. Bulletin 54-662.

Circle 326 on Inquiry Card

Power Transistors

Tech data is available on 3 series of pnp germanium power transistors of pnp germanium power transitions packaged in the new, low-outline TO-36 package. Series 2N1518 thru 2N-1523 feature P_T of 150w, I_c of 25 to 50a. Series 2N2075 thru 2N2082 fea-ture P_T of 170w, I_c of 15a. Series 2N2152 thru 2N2159 feature a P_T of 170w. I of 20c Serie onice Inc. 4 170w, Ic of 30a. Semi-onics, Inc., 4 Broadway, Lowell, Mass.

Circle 327 on Inquiry Card

Transistor Bases

Tech data is available on both compression and strain-free types of transistor bases. Photographs, dimensional drawings and complete specs, are included. Electrical Industries, div. of Philips Electronics & Pharmaceutical Industries Corp., Murray Hill, N. J.

Circle 328 on Inquiry Card

Power Transistors

A tech, bulletin is available covering 6 silicon power transistor types; 2N1210, 2N1211, 2N1620, 2N1616, 2N1617 and 2N1618. These transistors are diffused junction, npn high power units suitable for use in power con-verters, power supply regulators, re-lay replacements and controls, and dc and servo amplifiers. Bulletin No. Carle Place, N. Y. Circle 329 on Inquiry Card Corp.,

Silicon Diodes

A brochure listing the characteristics of 86 conventional glass silicon diodes is available from Computer Diode Corp., 250 Garibaldi Ave., Lodi, N. J. Catalog D-100 contains information on hermetically encapsulate diodes now in stock. They comprise 35 general purpose silicon types and 51 silicon computer diode types.

Circle 330 on Inquiry Card

Transistor Noise

Technical Application Bulletin No. 2110, 12 pages, describes several methods of evaluating transistor low freg. noise characteristics. Complete with curves and formula derivations, covering applications for low noise amplifying devices which fall into the less than 100cPs portion of the freq. band, the brochure is available from Sperry Semiconductor, Norwalk, Conn. Circle 331 on Inquiry Card

Instructional Films

Information is available on 16mm instructional films on printed circuits and semiconductors. These films can be purchased or rented. Titles in-"Semi-Conductors, Part II." Bray Studios, Inc., 729 7th Ave., New York 19, N. Y.

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Call on Semi-Elements for your . . . LASER and SINGLE CRYSTAL NEEDS Potassium Iodide (Thalium Activated) Rubidium Bromide Rubidium Chloride Rubidium Iodide Silicen Silver Bromide Sodium Chloride Sodium Ghloride Sodium Ghloride Sodium Ghloride Sodium Iodide (Thalium Activated) Strontium Chloride Thalium Bromide Thalium Bromide Thalium Bromide Thalium Bromide Thalium Bromide LAJER Allur Aluminum Aluminum Oxide Barium Titanate Barium Titanate (IronDoped) Bisnuth Cadmium Sulphide Cadmium Sulphide Cadmium Teluride Calcium Fluoride doped with Rare Earths Cesium Bromide & CSBR (Thallium Activated) Cesium Chloride Cesium Chloride Cesium Chloride Cesium Chloride Cesium Chloride Cesium Chloride Gadolinium Iron Garnets Germanium Gardanium Tho Garless Germanium Lead Lithium Chloride Lithium Fluorida Magnesium Dxide (Chromium Dozed) Magnesium Dxide (Copper Doxide (Copper Dxide (Copper Dxide Magnesium Dxide with Ran Earths Magnesium Oxide (Titanium Doped) Potassium Bromide Potassium Chloride Potassium Fluoride Potassium Fluoride Potassium Fluoride Na, Rare Earth Metals & U COMPLETE LINE OF LASER, OPTICAL, INFRARED SCIN-TILLATION, SEMI-CONDUCTOR THERMOELECTRIC ETC. SINGLE CRYSTALS AND Zino Zino Sulphide MATERIALS Ultra Pure Chemicals and Metals, Rare Earth Metals & Oxides, Neutron Diffraction Plates CRYSTALS GROWN TO CUSTOMER SPECIFICATIONS DIAL 412-352-1548 0 SINGLE CRYSTAL DIVISION SEMI-ELEMENTS, INC. SAXONBURG BOULEVARD, SAXONBURG, PA. USA Circle 41 on Inquiry Card



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Advanced research and development efforts, and many months of

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produced Hall effect devices of high reliability and accuracy for

immediate applications in field measurement, magnetic circuits,

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cludes ultra-thin and miniature

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formance requirements.

When you think of mag-netic field measurement — think of Bell!

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ELECTRONIC INDUSTRIES June 1962

Now from Fairchild...

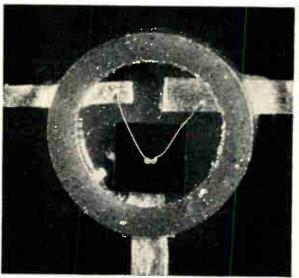
PLANAR FIELD EFFECT TRANSISTOR

high input impedance low capacitance low noise figure low leakage current TO-51 glass package[®]

Fairchild's new 2N2458 Field Effect Transistor features the ruggedness and stability of Fairchild Planar construction. Planar total surface passivation with patented metal-over-oxide techniques produces a device which is mechanically large enough for normal, reliable lead bonding techniques but at the same time electrically compact. Results: lower pinch-off voltage (V_p), lower leakage, and lower capacitance than any other field effect transistor. Complete specification sheet available on request.

*The Field Effect Transistor is also available in a standard TO-5 outline, designated the N2457.

CHARACTERISTIC	M1N.	TYP.	MAX	. UNITS	TEST CONDITIONS
Drain to gate breakdown voltage	30	_	_	Volts	I==1.0µA, Is=0
Drain to gate leakage current	_		0.1	mμA	Vog = 5.0V, Is= 0
Drain to gate leakage current			0.1	μA	Vpg=5.0V, 1s=0
Saturation current	200	500	600	μA	Vos= 5.0V, Vos=0
Transconductance (f=1 kc)	125	200		μmhos	Vos- 5.0V, Vos=0
†Noise figure		0.4		db	Vps= 5.0V, Vg= 0
Pinch-off voltage	_	3.0	4.0	Volts	l _p = 0.1mμA
Total gate capacitance	_	0.7	1.0	pf	Vpgs-5.0V
Input impedance (f=1 kc)		100		MΩ	$V_{DG} = 5.0V, V_G = 0$
	Drain to gate breakdown voltage Drain to gate leakage current Drain to gate leakage current Saturation current Transconductance (f==1 kc) †Noise figure Pinch-off voltage Total gate capacitance	Drain to gate breakdown voltage 30 Drain to gate leakage current Drain to gate leakage current 200 Transconductance (f=1 kc) 125 †Noise figure Pinch-off voltage Total gate capacitance	Drain to gate breakdown voltage30Drain to gate leakage currentDrain to gate leakage currentSaturation current200500Transconductance (f=1 kc)125200†Noise figure0.4Pinch-off voltage3.0Total gate capacitance0.7	Drain to gate breakdown voltage 30 Drain to gate leakage current 0.1 Drain to gate leakage current 0.1 Saturation current 200 500 600 Transconductance (f=1 kc) 125 200 †Noise figure 0.4 Pinch-off voltage 3.0 4.0 Total gate capacitance 0.7 1.0	Drain to gate breakdown voltage30VoltsDrain to gate leakage current0.1 $m\mu A$ Drain to gate leakage current0.1 μA Saturation current200500600 μA Transconductance if=1 kc)125200 $\mu mhos$ †Noise figure0.4dbPinch-off voltage3.04.0VoltsTotal gate capacitance0.71.0pf



MAGNIFIED 15 TIMES

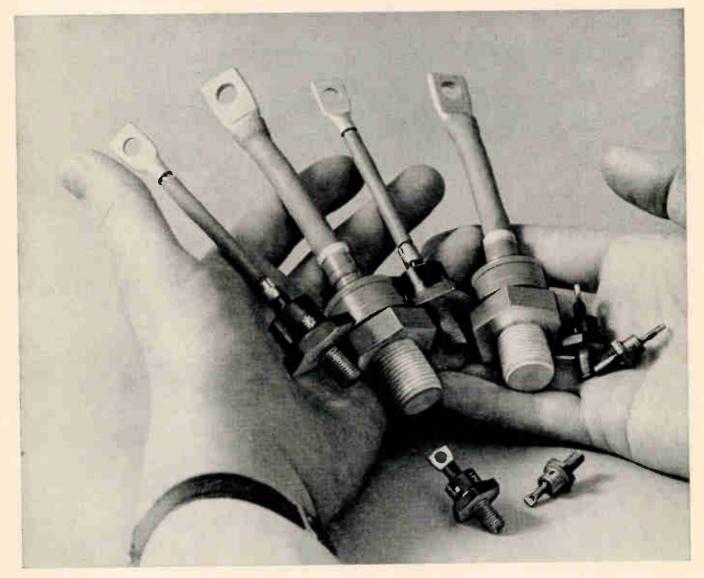


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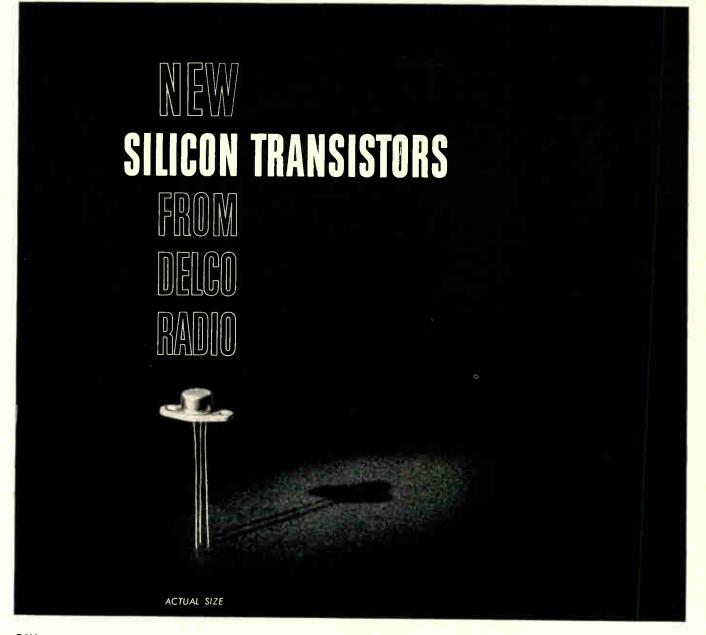
Fansteel silicon diodes: high-rated for rocket support gear



In recent evaluation tests for rocket ground support equipment, Fansteel silicon rectifier diodes were rated near perfect for their extremely high qualifying percentage. On applications demanding long shelf life, high reliability and close performance ratings, Fansteel silicon rectifiers consistently produce top results. What makes the difference? Attention. Attention to design, materials, packaging—to extreme caution in whiteroom procedures, and to a unique testing program that is uncannily accurate. Fansteel silicon stacks and Zener diodes get the same care. Silicon diodes are rated from 6 to 240 amps.; Stacks from 6 amps. up; Zeners available in 1- and 10-watt ratings. For specification data, write the Rectifier-Capacitor Division, Fansteel Metallurgical Corporation, North Chicago, Illinois.



Additional data on Fansteel silicon rectifier diodes is presented in Re-Cap, a bi-monthly publication. To receive, write the Publications Department.



Silicon power transistors in a TO-37 package

Delco's unique new family of silicon NPN power transistors combines the benefits of miniaturization (TO-37) and light weight with the ability to withstand continuous junction temperatures of up to 175°C while operating at these absolute maximum ratings: collector diode voltage Vcb 100 volts; emitter diode voltage Vebo, 4 volts; collector current, 1 amp.; base current, .2 amp. This entire 2N2340 family is particularly useful where moderate power handling capabilities are required in a miniature package. The units have just two mounting holes and may be mounted with leads up, down or sideways on either side of the heat sink. Available in either single or matched units, they're characterized by low saturation voltage and high switching speeds. The transistors in this family are especially well suited for military or industrial applications in regulated power supplies, square wave oscillators, servo amplifiers and core driver circuitry. For complete engineering data, or applications assistance, write or call our nearest Sales Office or your nearest Delco Radio Semiconductor Distributor.

Number	IC Max.	Vcbo	Vceo	Sat. V @ IC Max.	Gain Min.—Max. @ IC	fae @ 250 ma IC (typical)
2N2340	1A	50V	40V	4V @ .75A	10- 40 @ .75A	900 kc
2N2341	1A	50V	40V	4V @ .75A	40-100 @ .75A	550 kc
2N2342	1A	100V	60V	3V @ .75A	10- 40 @ .75A	900 kc
2N2343	1A	100V	40V	2.5V @ .75A	40-100 @ .75A	550 kc

Thermal resistance of 8°C/watt max. Typical Alpha cutoff of 15 Mc

Rise Time of .2 μ seconds – .75A, 1B = 40 ma (Vce = 12V), Fall Time of .5 μ seconds (1C = 0 Veb = 2 ν Reb = 37 Ω)

Union, New Jersey 324 Chestnut Street MUrdock 7-3770 Detroit, Michigan 57 Harper Avenue TRinity 3-6560

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Tube Cutting Lead Beading Crystal Growing Crystal Refining Crystal Mounting **Body Forming** Welding Final Sealing

TRANSISTORS

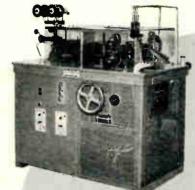
Header Forming Crystal Mounting Welding Exhausting Sealing

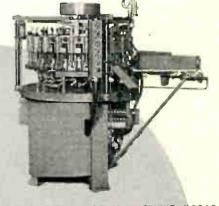
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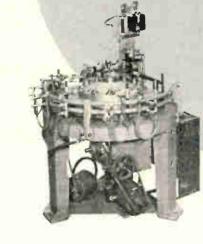


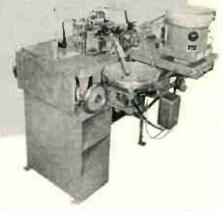


AUTOMATIC DIODE FINAL SEAL MACHINE #3383

AUTOMATIC EQUIPMENT & METHODS FOR MANUFACTURING TRANSISTORS

AUTOMATIC LEAD-BEADING MACHINE #3808





AUTOMATIC CAT-WHISKER WELDER #3711

SERVICES ENCOMPASS THE COMPLETE RESPONSIBILITY FOR SPECIAL MACHINE PROJECTS NAL-HATE FROM DESIGN & DEVELOPMENT TO FINAL TESTING. FOR 30 YEARS, MODIFIED HAS DESIGNED AND BUILT RELIABLE, EFFICIENT PRODUCTION MACHINES FOR MANUFACTURING A WIDE VARIETY OF PRODUCTS. SHOWN HERE, ARE SOME RECENT EXAMPLES OF KANNING AUTOMATIC PRODUCTION EQUIPMENT

DESIGNERS AND BUILDERS OF PRODUCTION MACHINERY

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TO-18 CASE

"NON-UNIVERSAL" SWITCH!

Specifically designed to meet your challenging ultra-high-speed needs for "next generation" computers!

No need to compromise on any key parameters!

• Combines the best of diffused collector and electro-chemical technology in one superlative logic device!

Compare the XT-300 with Present-day Selected "Bests"...

CHARACTERISTICS	2N779A	2N964	XT-300
$BV_{CES} @ I_{C} = 100 \ \mu A$	15 V min.	15 V min.	25 V min.
$BV_{CEO} @ I_{C} = 1mA$	12 V min.	6 V min.	12 V min.
$I_{CBO} @ V_{CB} = \delta V$	3 μA max.	3 μA max.	3 μA max.
$h_{FE} @ I_C = 50 mA, V_{CE} = 1V$	40 min.	40 min.	40 min.
V_{CE} (SAT) @ I _C = 50 mA, I _B = 5 mA	.18 V min.	.35 V min.	.18 V min.
$V_{BE} @ I_{C} = 50 \text{ mA}, I_{B} = 5 \text{ mA}$.6 V max.	.75 V max.	.6 V max.
$f_{T} @ I_{C} = 20 \text{ mA}, V_{CE} = 1 \text{ V}$	200 mc min.	300 mc min.	300 mc min.
t (on) (a) $I_{C} = 10 \text{ mA}, R_{L} = 300 \text{ ohms}$ $I_{B_{L}} = 1 \text{ mA}, V_{BE} \text{ (off)} = 1.25 \text{ V}$	60 nsec max.	50 nsec max.	50 nsec max.
t (off) @ $l_{C} = 10 \text{ mA}, R_{L} = 300 \text{ ohms}$ $l_{B_{1}} = 1 \text{ mA}, l_{B_{2}} = .25 \text{ mA}$	120 nsec max.	85 nsec max.	85 nsec max.

For complete information, write Product Marketing Section, Transistor Division, Sprague Electric Company, Concord, New Hampshire.

SPRAGUE COMPONENTS

TRANSISTORS CAPACITORS MAGNETIC COMPONENTS RESISTORS MICROCIRCUITS

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INTERFERENCE FILTERS PULSE TRANSFORMERS PIEZOELECTRIC CERAMICS PULSE-FORMING NETWORKS TOROIDAL INDUCTORS HIGH TEMPERATURE MAGNET WIRE CERAMIC-BASE PRINTED NETWORKS PACKAGED COMPONENT ASSEMBLIES FUNCTIONAL DIGITAL CIRCUITS ELECTRIC WAVE FILTERS

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A **NEW** TWIST

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SEMICONDUCTOR

DIVISION OF SPERRY RAND CORPORATION NORWALK, CONNECTICUT

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NPN OR PNP SMALL SIGNAL SILICON PLANAR TRANSISTORS IN TO-46 AND TO-18 CASE STYLES

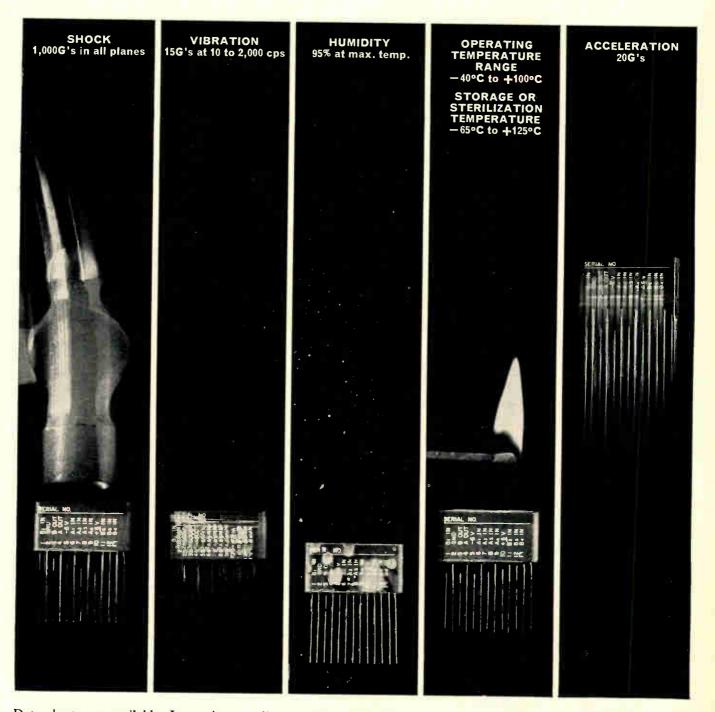
A practical achievement available today for use in complementary circuits - enables use of single polarity power supplies in direct-coupled amplifier designs - maintains original signal phase with fewer amplifier stages for transistor economy - and simplifies design of differential amplifiers. They're reliability proven - life tested at 300°C storage life and 500MW operating life - plus an extra margin of safety which provides true design flexibility. Write for complete technical data and specifications.

SPECIFICATIONS FOR SMALL SIGNAL SILICON PLANAR TRANSISTORS

- Tight beta spreads with controlled design centers
- High F_{r} : > 100 mc
- High BV_{CEP}: > 80 volts
- Low I_{cto}: < 2nA for NPN < 25nA for PNP
- Low Capacitance: 5pf @ 10 volts

SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*). ALLOY SILICON TRANSISTORS AND DIODES SALES OFFICES: CHICAGO, ILLINOIS: LOS ANGELES, CALIFORNIA: OAKLAND, NEW JERSEY; MEDFORD, MASSACHUSETTS: SYKESVILLE, MARYLAND; BETHPAGE, L. I. NEW YORK SEMICONDUCTOR OPPORTUNITIES *Trade Mark, Sperry Rand Corporation

ENVIRONMENTALLY PROVED... AVAILABLE NOW! Delco Radio's new silicon digital modules operate on less than 4 mw. of power per logic stage. They are rugged enough to withstand extreme environmental conditions and are small and lightweight. Encapsulated in light foamy epoxy, each module weighs less than 12 grams and occupies less than one-half cubic inch. The basic set of modules includes a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator. From these basic units larger computer subassemblies can be assembled, such as shift registers, adders, binary counters, decimal counters and timing devices. A range of applications—from small scale switching circuits to large computers can be satisfied with these modules. Environmentally proved to:



Data sheets are available. Just write or call our Military Sales Department. Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics. PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS Division of General Motors • Kokomo, Indiana

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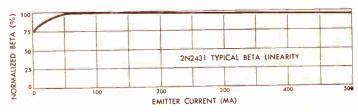
who cares about audio transistors today?

As a cost conscious, quality-hungry designer of audio equipment you know that for nearly a decade—despite spectacular advances in other design areas—little has changed with audio transistors. You know because your design possibilities and the quality of your end products have been severely limited by the absence of improved audio types.

Yes, you care! And because you care, Amperex cares.

Indeed, Amperex cared enough to develop an entirely new process, the Uniform Low Frequency Technique, for manufacturing quality audio frequency transistors. The advantages of this technique—measured in terms of beta linearity and exceptional uniformity without a corresponding increase in price—could scarcely be more impressive.

To take but one example from among the first five U.L.T. types available in production quantities: The 2N2431, a PNP medium power transistor designed for Class A and B audio output stages, is capable of up to 2 waits power output per pair. It is available in a TO-1 case, as are all five U.L.T. transistors. The exceptional linearity of its beta is dramatically shown in the curve reproduced at right where beta remains substantially constant up to the maximum rated current of 500 ma. Further, the 2N2431 offers high gain with a beta of 50 to 180, 550 mw maximum dissipation and a collector-to-emitter breakdown voltage of 32 volts.



Here, then, are five great new transistors—as economical as they are excellent—to open new doors for you in the design of • Portable Radios • AM-FM Receivers • Car Radio Audio Drivers • Audio applications in communications systems • Slowspeed switching in computer applications.

ULT Transistor Type No.	Cose	Application	plication Breakdown Voltages		Peak Current	Collector Dissipation	
2N2428 PNP	To-1	Preomps, drivers ond low wottoge output devices	-32 volts	80-160	100 mo	165 mw	
2N2429 PNP	To-1	Preomps, drivers ond low wottoge output devices	-32 volts	130-300	100 mo	165 mw	
2N2430 NPN	To-1	Preomps, drivers ond low wottage output devices	-15 volts	65-190	100 mo	165 mw	
AC127/132 NPN PNP	To-1	Motched poir, NFN-PNP for 200 mw output stoge using complemen- tory-symmetry circuits.	15 volts	65-190	100 mo	165 mw	
2N2431 PNP	To-1	Closs A & B oudio output stoges up to 2 wotts.	-32 volts	50-180	500 mc	550 mw	

Write for complete data on the U.L.T. types that will make the big difference in your particular audio frequency application. Amperex Electronic Corporation, 230 Duffy Avenue, Hicksville, L. 1., N. Y. IN CANADA: PHILIPS ELECTRON DEVICES LTD., 316 VANOC RHOOF AVENUE, TORONTO 16, ONTARIO



World Radio History

who carries Amperex audio transistors

The ULT line is now available from these and other leading industrial electronic distributors

CALIFORNIA R. V. WEATHERFORD COMPANY Glendale 1, Calif, BRILL SEMICONDUCTOR CORP. Oakland 6, Calif, ELMAR ELECTRONICS INC. Oakland 7, Calif. COLORADO INTERSTATE RADIO & SUPPLY Denver 4, Colarado CONNECTICUT CRAMER ELECTRONICS, INC., Hamden, Conn. ELECTRONIC WHOLESALERS, INC. Washington 1, D. C. FLORIDA THUROW ELECTRONICS, INC. Cocoa, Fla. • Jacksonville, Fla. • Miami, Fla. Orlando, Fla. • Pensacola, Fla. • Tampa, Fla. ILLINOIS NEWARK ELECTRONICS CORP. Chicago, III. INDIANA RADIO DISTRIBUTING COMPANY Indianapolis 6, Indiana MASSACHUSETTS RADIO SHACK CORP., Boston, Moss. MICHIGAN RADIO SPECIALTIES COMPANY Detroit, Michigan MISSOURI INTERSTATE INDUSTRIAL ELECTRONICS St. Louis 32, Missouri BURSTEIN-APPLEBEE COMPANY Kansas City, Missouri **NEW YORK** MILO ELECTRONICS, New York, N.Y. ROME ELECTRONICS, Rome, N. Y. OHIO UNITED RADIO, INC., Cincinnati, Ohio OKLAHOMA OIL CAPITOL INDUSTRIAL ELECTRONIC DISTRIBUTORS, Tulsa, Oklahoma OREGON UNITED RADIO SUPPLY, INC. Portland 9, Oregon PENNSYLVANIA RADIO ELECTRIC SERVICE CO. Philadelphia, Pa. TEXAS ADLETA COMPANY Dallas 1, Texas + Fort Worth, Texas BUSACKER ELECTRONIC EQUIPMENT CO., INC. Houston 19, Texas WASHINGTON ROBERT E. PRIEBE COMPANY Seattle 1, Washington Ask Amperex

Tech Data

for Engineers

Germanium Diode

Nanosecond Germanium Diode Types CGD-1092 and 1093 are de-Scribed in tech. data available from Clevite Transistor Products, 200 Smith St., Waltham, Mass. Tech. Smith St., Waltham, Mass. Tech. rating for the 1092 include a reverse recovery time of 8.0nsec. max.; max. capacitance of 1.5pf @ 3.0v; and an average power dissipation of 80mw. Specs on the 1093 include a reverse recovery time of 3.0nsec. max.; max. capacitance of 2.0pf @ 3.0v; and istness for 1 sec. of 150ma.

Circle 333 on Inquiry Card

Activation Analysis

A bulletin for the semiconductor industry explains the activation analysis technique, and listing applications including research and quality control is available from General Atomic Div., General Dynamics Corp., P. O. Box 608, San Diego 12, Calif. This ultra-sensitive analytical technique can be used to determined the amounts of phosphorus, antimony, arsenic. indium. gold and gallium in semiconductor components.

Circle 334 on Inquiry Card

Rectifier Assemblies

Bulletin 106 describes a line of high voltage rectifier assemblies which are single junction silicon diodes with PIV ratings in excess of 100v. The typical reverse leakage ratings of these devices are 10na at 1000v and 25°C. Also available is Bulletin 107 which contains information on pas-sivated silicon dice that will not degrade when subjected to Mil-S-19500 testing. Microsemiconductor Corp., 11250 Playa Court, Culver City, Calif. Circle 335 on Inquiry Card

Microwave Diode Guide

Containing electrical characteristics and performance ratings of a wide range of microwave mixer, detector, varactor, tunnel and switching-diodes, this 26-page illustrated brochure is available from Sylvania Electric Products Inc., Semiconductor Div., 100 Syl-van Rd., Woburn, Mass. Also featured is a 4-page replacement guide insert, complete listing of mechanical and environmental test procedures, and more than 6 pages, of microwave diode applications notes. Circle 336 on Inquiry Card

Silicon Diodes

Tech. data describing a line of Silicon Double Diffused Alloy Diodes for use in core driving, clamping, gating and similar circuits in high speed digital computers, is available from National Transistor Mfg., Inc., 500 Broadway, Lawrence, Mass. Catalog B-101 lists conductances of the order of 500ma at 1.0v and switching speeds of 500ma at 15nsec. typical. Circle 613 on Inquiry Card

World Radio History



lems. We maintain a sales force of qualified engineers who can make recommendations on circuit techniques and components. Also, we have available a complete set of application notes from various manufacturers and maintain laboratory test equipment to help solve your breadboard problems.

CLEVITE FAIRCHILD MOTOROLA PHILCO SHOCKLEY WESTINGHOUSE **GENERAL ELECTRIC** TANTALYTIC® CAPACITORS Semiconductor Specialists INC DISTRIBUTOR

S700 WEST NORTH AVENUE CHICAGO 39, ILLINOIS TELEPHONE NATIONAL 2-8860 Circle 62 on Inquiry Card

A Saratoga Thoroughbred

250 MW SILICON ZENER DIODE

Reliability — assured by 100% load testing and burn-in. All units meet the requirements of MIL-E-1 and MIL-S-19500C. Availability — from stock in the 1N713-1N745 series. (400 MW 1N960-1N992 series also available from stock)

Zener Voltages — from 9.1 to 200 Volts (5%, 10%, 20% tolerances)

Military Types (Sig. C.): 1N716, 1N718, 1N720, and 1N722 --- per MIL-E-1/1238 (Sig. C.).

For additional information on Saratoga's complete line (standard and special) of silicon diodes, write:



Saratoga Semiconductor

A Division of Espey Mfg. & Electronics Corp. Saratoga Springs, N. Y.
Phone 4100 Circle 61 on Inquiry Card

New Tech Data

UHF Power Oscillator

Maxson Instruments Div., Maxson Electronics Corp., 475 Tenth Ave., New York 18, N. Y., is offering tech data on their uhf wide range power oscillator and power supply. Features are power at 40 w.; stability of a precision coaxial cavity and a range of 200 to 2500 mc, continuously variable in 2 bands.

Circle 337 on Inquiry Card

Silicon Rectifiers

Semtech Corp., 652 Mitchell Rd., Newbury Park, Calif., is offering tech data on their Subminiature High Voltage Silicon Rectifiers, SC series including the 15, 20, 25, 30, 40, 50. 75, and 100 units. The P1V respectively is 1500, 2000, 2500, 3000, 4000. 5000, 7500 and 10,000v. Body dimensions including end seals from 15 to 30 types is 0.140 in dia. x 0.310 in. long and from 40 to 100 types is 0.140 in dia. x 0.410 long. Operating temp. is -65 to $+175^{\circ}$ C.

Circle 338 on Inquiry Card

Power Tubes

A summary catalog of power tubes and accessories is available from Penta Laboratories, Inc., 312 N. Nopal St., Santa Barbara, Calif. Information includes specs. and prices for the Penta line of beam pentodes, power tetrodes, power triodes, highvoltage rectifiers and vacuum switches.

Circle 339 on Inquiry Card

Semiconductor Wire

Secon Metals Corp., 9 Intervale St., White Plains, N. Y., is offering a revised edition of its comprehensive semiconductor wire catalog. Included are newly developed wires of pure metals, alloys, and coatings for the semiconductor industry. Other sections of the catalog include information on a variety of doped gold, silver and aluminum alloys, pure metals including platinum, titanium and aluminum as well as the more commonly used metals.

Circle 340 on Inquiry Card

Solid State Inverters

Electrosolids Corp., 12740 San Fernando Rd., North, Sylmar, Calif., is offering tech data on ZERO to ZERO power factor solid state inverters. The new design is available either as an inverter or coupled with a transformer rectifier for freq. and/or voltage conversion.

Circle 341 on Inquiry Card

for Engineers

Rectifiers

Bulletin 101, 8 pages, describes selenium rectifiers covering ranges from microamps to kiloamps and voltages from millivolts to kilovolts. Edal Industries, Inc., 4 Short Beach Rd., East Haven, Conn.

Circle 342 on Inquiry Card

Sweeping Oscillators

Tech data is available on the Kay all electronic Wide-Sweep Video through UHF Sweeping Oscillator, with a sweep width variable to 300-MC plus and a freq. range of 0.025 to 1050MC. Also included is information on a de to 500MC coaxial electronic switch and de to 1000MC, 10db switched attenuator pads. Kay Electric Co., Maple Ave., Pinebrook, N. J. Circle 343 on Inquiry Card

Microwave Tube Catalog

Raytheon Co., Microwave & Power Tube Div., Waltham 54, Mass., is offering a 70-page microwave tube catalog. The catalog lists 201 active, unclassified microwave tubes of all types, as well as ferrite devices, magnetic components, high power test modulators and infrared detectors. The catalog is color-tabbed, with descriptive 'spees,' for sections including magnetrons, klystrons, amplitrons and stabilotrons, BWOS, TWTS, crossed field amplifiers and associated components.

Circle 344 on Inquiry Card

Electron Tube Catalog

Litton Industries, Electron Tube Div., San Carlos, Calif., is offering their Electron Tube Condensed Catalog for 1962. The catalog contains information on Pulse Magnetrons, CW Magnetrons, M-Type BWOs, Crossed Field Forward Wave Amplifiers, BARRATRON® Transmitting Tubes, Klystrons, TWTs, Switch Tubes, Millimeter Wave Tubes, Display Devices, Equipment and Accessories, and a Tube Cross Reference. Included are photographs and tables of specs.

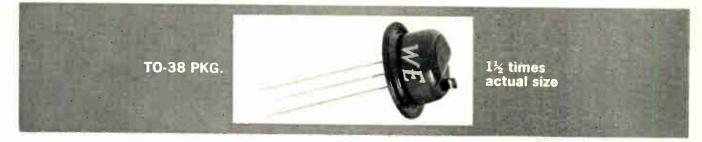
Circle 345 on Inquiry Card

Transistor Devices

This short-form catalog of transistor devices contains spec. of power supplies, audio amplifiers, i-f amplifiers, transformers and converters. Ferrotran Electronics Co., Inc., 693 Broadway, New York 12, N. Y. Circle 346 on Inquiry Card

World Radio History

HIGH CURRENT SWITCHING TRANSISTOR 2N1072



12.5 WATTS, 75 VOLTS, 2 AMPERES

Western Electric's 2N1072 is an NPN diffused silicon mesa transistor, designed by Bell Telephone Laboratories for high current switching and core driver applications. Typical turn-on time is 80 nanoseconds. Typical turn-off time is 200 nanoseconds. One ampere may be switched at rise and fall times of 50 nanoseconds. The maximum power dissipation at a case temperature of 100°C is 5 W.

ABSOLUTE MAXIMUM RATINGS (T_C=25°C)

PC	VCES	V _{EBO}	VCBO	IC &-IE
12.5 W	75 Vdc	6.0 Vdc	75 Vdc	2.0 A

ELECTRICAL CHARACTERISTICS

	hFE	V _{CE} (sat)	V _{BE} (sat)	t _d +t _r	$t_s + t_f$	
	(V _{CE} =5 Vdc)	(I _C =750 mAdc)	(IC=750 mAdc)	(V _{CC} =20 Vdc)	(R _C =25 ohms)	
	(I _C =750 mAdc)	(I _B =75 mAdc)	(I _B =75 mAdc)	(1 <mark>8 (1</mark>)	=7 <mark>5</mark> ma)	
				(V _{BE(0)} =0)	(I _{B(2)} =–75 ma)	
Min.	20	_	0.70 Vdc	—	_	
Max,	-	2.0 Vdc	1.8 Vdc	100 nsec	300 nsec	

The 2N1072 transistor may be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, address your request to Sales Department, Room 105, Western Electric Company, Incorporated, Laureldale, Pa. Telephone – Area Code 215 – 929-5811.

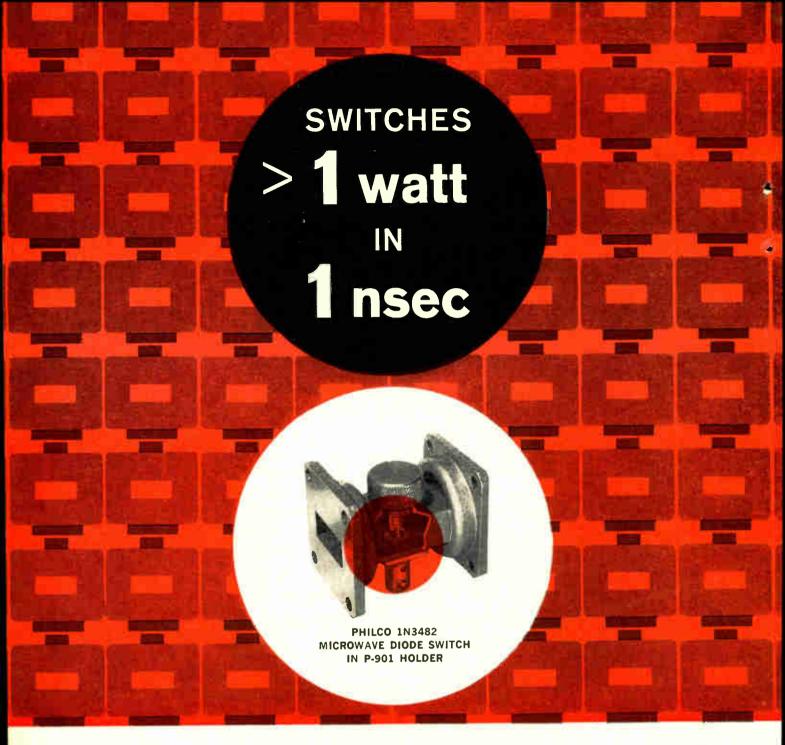
World Radio History



Western	Electric
MANUFACTURING AND SUPPLY	UNIT OF THE BELL SYSTEM

ELECTRONIC INDUSTRIES . June 1962

Circle 33 on Inquiry Card



Now you can design faster microwave switching, higher frequency modulation, and pinpoint-output pulsing—in smaller, more reliable packages. The Philco 1N3482 microwave diode switch—world's fastest—can modulate an X-Band wave or produce an extremely narrow RF output pulse.

The Philco 1N3482, as a result of the Philco microetch process, has many unusual capabilities Only 100 mw turns on this 1.25W switch Typically maintains 22 db isolation at 1.25W, with isolation values as high as 30 db attainable Dissipation life tests show the device meets advertised performance even after 1600 hours Requires no tuning or adjustment Philco simplified holder design enables you to replace diodes in the same holder Availability is excellent For complete data on the Philco family of solid state microwave switches, circle reader service card.



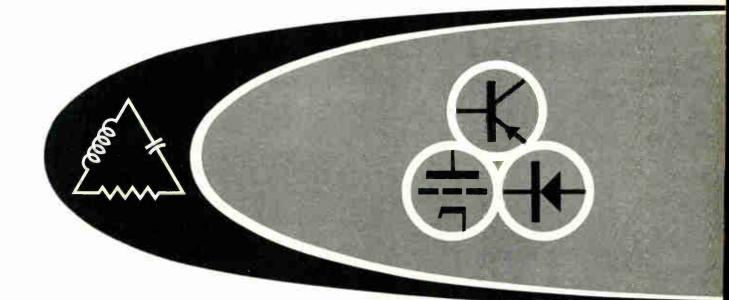
For special report, "Theory of Operation of Solid State Diodes as Microwave Switches," write on your letterhead to Dept. El662S.







Tubes & Semiconductors



PART TWO

New Receiving Tubes & Special Purpose Tubes . . . C48

Electron Tube Interchangeability Chart . . . C54

New Receiving Tubes & Special Purpose Tubes

—registered during the Period May 1961 to May 1962

(From data supplied by Engineering Dept., Electronic Industries Assoc., 11 W. 42nd St., N.Y.C.)

Tube	Sponsor	Operating Band	Туре	Power Output	Remarks
6249A	Raytheon	8500 - 9600 Mcs.	Internal Magnet	240 kw.	Forced Air Cooled
6517	Raytheon	1250 - 1350 Mcs.		1.3 meg. w.	Forced Air Cooled
6841	Raytheon	16500 Mcs.		50 kw.	Forced Air Cooled
6959	Raytheon	9330 - 9420 Mcs.		500 kw.	Forced Air Cooled
7156	Raytheon	5450 - 5825 Mcs.	Internal Magnet	250 kw.	
7208B	Western Electric	15500 - 17500 Mcs.		130 kw.	Unilaterally Interchangeable With 7208
7444	Bomac Labs	5400 - 5900 Mcs.		1 kw.	Air Cooled
7452	Raytheon	15840 - 16160 Mcs.		70 kw.	
7521	Raytheon	8900 - 9400 Mcs.			
7541	Westinghouse	8500 - 9600 Mcs.			Forced Air Cooled
7547	Raytheon	406 - 450 Mcs.	Internal Magnet	2.0 meg. w.	Liquid Cooled
7578	Raytheon	5400 - 5900 Mcs.		800 – 1200 w.	
7589	Western Electric	8500 - 9600 Mcs.		425 kw.	Air Cooled
7619	Sylvania	Ka Band			Ruggedized Version of 5789
7630	Raytheon	15840-16160 Mcs.		70 kw.	
7692	Sylvania	9200 - 9550 Mcs.	_	220 kw.	Forced Air Cooled
7692A	Sylvania	8550 - 9650 Mcs.		220 kw.	
7718	Raytheon	Fixed		1 meg. w.	Liquid Cooled
7794	Westinghouse	4200 - 4400 Mcs.	CW	10 w.	Air Cooled
7795	Sylvania	C-Band	CW	5 w.	
7796	Sylvania	4200 - 4400 Mcs.		1.5 w.	
7950	Western Electric	8500 - 9600 Mcs.		265 kw.	Air Cooled
7976	Western Electric	13600 - 15600 Mcs.		1 <mark>35 kw.</mark>	Forced Air Cooled
8079	Western Electric	17400 - 19500 Mcs.		135 kw.	Forced Air Cooled

MULTIPLIER PHOTOTUBES

ETRONIC

Tube	Sponsor	Const.	Application	Max. Re'sponse	Remarks
8049	Tung - Sol	Cesium - Antimony Head-On		4000 ± 500 A	Spectral Response: S-4
8054	RCA	10-Stage Head-On – 3" Dia. Face	Scintillation Counter	3000 - 6500 A	
8062	A.B. Dumont Labs	10-Stage - Flat End Window	Infrared Spectroscopy		Luminous Sensitivity — 19-µa./lumen
8100	Sylvania	Cadmium Sulfide		6100 Å	
8142	Sylvania	Cadmium Sulfide	Relays	6100 Å	
8143	Sylvania		Same as Type 8142		
8053	RCA	10-Stage - Head-On	Scintillation Counter	4400 Å	Spectral Response: S-11
8055	RCA	10-Stage - Head-On - 5" Dia. Face	Scintillation Counter	4400 ± 500 Å	Spectral Response: S-11

SPECIAL PURPOSE TUBES

THYRATRONS

-

Tube	Sponsor	Anode Voltage Drop	Peak Anode Voltage	Construction	Application	Remarks
6901	Tung-Sol	10 v.	1250 v.	7–Pin Octal		Inert Gas & Mercury Vapor Filled
8043	Westinghouse			3-Electrode	Power Supplies	Negative Control Characteristics
8063	Mullard, Ltd.	10 v.	1500 v.		Power Control	Inert Gas Filled

TRAVELING WAVE TUBES

Tube	Sponsor	Heater Ratings	Power Output	Range	Application	Construction	Remarks
6698	Sylvania	6.3 v./2.7 a.	1 kw.	2.0-4.0 Gcs.	Airborne Amplifier		
6752	Sylvania	6.3 v./1.5 a.	2 w.	1.0 – 2.0 Gcs.	CW or Pulsed Amplifier (Airborne)		
6753	Sylvania	6.3 v./0.96 a.	15 m.w.	1.0 - 2.0 Gcs.	Broadband Amplifier		
7393	G.E.		5 m.w.	4000-8000 Mcs.	Microwave Relay Systems	Metal & Ceramic	
7394	G.E.		5 m.w.	8000-12000 Mcs.	Microwave Relay Systems	Metal & Ceramic	
7642	M-O Valve Co. Ltd.		18 w.	1700 - 2300 Mcs.	Telecommunications		
7847	ITT	6.3 v. /2.2 a.	10 w.	5000 - 6000 Mcs.	CW Operation		Air or Water Cooled
8154	G.E.			7000 - 11000 Mcs.	Military Systems		

RECTIFIERS

Tube	Sponsor	Туре	Heater Ratings	PIV	D.C. Output Current	Construction	Application
2AH2	G.E.	Heater-Cathode Diode	2.5 v./0.3 a.	24 kv.	1.5 ma.		H.V. – T.V. Rectifier
5AZ3	C.B.S.	Full-Wave	5.0 v./3.0 a.	1700 v.	1.0 a.	High Vacuum	Power Rectifier
5BC3	R.C.A.	Full-Wave	5 v./3 a.	1700 v.			Power Supplies
6AY3	R.C.A.	Half-Wave		5000 v.	1.1 a.	9-Pin Min.	Damper Diode for T.V.
6BH3	R.C.A.	Half-Wave		5500 v.	1.1 a.	9-Pin Min.	Damper Diode for T.V.

12AY3 & 17AY3 Same as 6AY3

25DK4	G.E.	Half-Wave	25 v./0.15±.01 a.	330 v.	100 ma.	7-Pin Min.	
6982	Electrons, Inc.	Full-Wave	2.5 v./11.5 ± 1 a.	725 v.		Lug-Type Base	
6983	Electrons, Inc.	Half-Wave	2.5 v./21 a.	920 v.		Lug-Type Base	
6984	Electrons, Inc.	Grid Control	2.5 v./17 ± 2 a.	1700 v.			
6985 & 6	986 Same as 6984						
6987	Electrons, Inc.	Grid Control	2.5 v./24 ± 2a.	4000 v.			
6988	Electrons, Inc.	Grid Control	2.5 v./21 ± 2 a.	1250 v.			
6989	Same as 6988						
7631	Brimar	Duo-Diode		360 v.		7-Pin Min.	Pulse Shaping
7789	Tung-Sol	Half-Wave	5.25 v./9.3 a.	15 kv.		Hydrogen-Filled	High Voltage Rectifier
7792	Tung-Sol	Half-Wave	12.0 v./10.5 a.	25 k v .		Hydrogen-Filled	High Voltage Rectifier
7869	UTT		15.0 v./36 a.				
8034	ITT		7.5 v./51 a.				
8065 & 8	066 Same as 6984						
8094	Machiett Labs			110 kv.		High Vacuum	Pulse Circuits

TUBE	SPONSOR	TYPE	CONSTRUCTION	APPLICATION	Sect Ep(v)	p(ma)
698	Machlett Labs	Planar Triode		R-FOsc., R-FPwr. Amp.		
815	Machlett Labs	Planar Triade		R-F Osc., R-F Pwr. Amp.		
081	G.E.	Planar Triode	Metal – Ceramic	A-F Amp.		
082	G.E.	Planar Triode	Metal – Ceramic	VHF, UHF Osc.		
3083	G.E.	Planar Triode	Metai - Ceramic	R-F Amp.		
FS5	G.E.	Pentode	Same as 6FS5 E	xc. Heater Ratings (2.9 v./0.45	a.)	
HS8	G.E.		Same as 6HS8 E	xc. Heater Ratings (3.15 v./0.6	a.)	
FS7	Mullard, Ltd.	Triode-Pentode	9-Pin Min.	Freq. Changer	125	14
IGK5	Sylvania	Triode	Same as 4GK5 E	xc. Heater Ratings		
HS8	Tung-Sol	Twin Pentode	Same as 6HS8 E	Same as 6HS8 Exc. Heater Ratings (4.2 v./0.45 a.)		
AG11	G.E.	Duo-Diode-Twin Triade		F.M Stereo Multiplex		
SAR11	G.E.	Twin Pentode		I-F Amp.		
6AV11	G.E.	Triple Triode		General Purpose		
6BF8	G.E.	Sextuple-Diade	9-Pin Min.	Shunt Detector		11
6DR4	C.B.S.	Triode	7-Pin Min.	Voltage Amp., Phase Inverter		
				R-F Amp.		
6DS4	RCA	Triode	9-Pin Min.	K-F Amp.	250	
6EL7	Siemens Edison Swan, Ltd.	Pentode Dua Taiada	Zer in Min.	Vert. Osc & Amp.	330	
6FR7	Sylvania	Duo-Triode	9-Pin Min.	T.V. Receivers	330	12
6FV8A	Westinghouse	Triode-Pentode	7-r in Min.	TV Output	275	440
6GB5	Amperex	Pentode			213	
6GE5	G.E.	Pentode		Horiz, Amp.		
6GF5	G.E.	Pentode		Horiz, Amp.		
6G11	G.E.	Duo-Pentode		FM Detector, A-F Amp.		
6GJ5	RCA	Beam-Power		Horiz. Amp.		
6GM5	Sylvania	Pentode		Power Output	500	1.
6GM8	Rogers	Duo-Triode	9-Pin Min,	R-F Amp., Self Osc. Mixer	-	
6GT5	RCA	Begm-Power		Horiz. Amp.		
6GW8	Amperex	Triode-Pentode	7-Pin Min.	Sound Output	300	
		Pentode	7-Pin Min.	FM Detector	300	
6GX6 6HB6	RCA Raytheon	Pentode	9-Pin Min.	Vert. Amp.	350	
			7-Pin Min.	I-F Amp.	+	15
6HQ6	Radio Valve Co., Ltd.	Pentode			300	13
6HU8	Standord Elektrik Lorenz	Pentode	9-Pin Min.	General Purpose	300	30
<mark>6H₩8</mark>	G.E.	Sheet-Beom	9-Pin Min.		200	3.5
6HZ8	Philco	Triode-Pentode	0.01	Voltoge Amp. & Video Amp.	200	4.5
6JE8	Philco	Triode-Pentode	9-Pin Min.	Voltage Amp.	-	
6JH9	G.E.	Sheet-Beam	9-Pin Min.	Color TV I-F Amp.	330	
6J11	G.E.	Twin Pentode	0.01.14			
6JK8	Sylvania	Duo-Triode	9-Pin Min.	FM Tuners	250	
7EK7	Siemens Edison Swan, Ltd.	Twin Triode	9-Pin Min.	R-F Amp.		
8HG8	Mullard, Ltd.	Triode-Pentode	Some as 6HG8	Exc. Heater Ratings (8.0 v./0.3	0.)	
8JE8	Philco	Triode-Pentode		Exc. Heater Rotings (8.2 v./600	mo.)	
8JK8	Sylvania	Duo-Triode	9-Pin Min.	FM Tuners		
10FR7	Sylvania	Duo-Triode		Vert. Osc. & Amp.	1.	· ·
10 GN8	Tung-Sol	Triode-Pentode	Same as 6GN8 8	8GN8 Exc. Heater Ratings (10	⊃v./.45 0	0 0.)
11JE8	Philco	Triode-Pentode		Exc. Heater Rotings (10.9 v./45		+
12AX3	G.E.	Diode		Exc. Heoter Ratings (12.6 v./0.		
12DJ8	Sylvania	Duo-Triode	Some as 6DJ8	Exc. Heoter Ratings (12,6 v./180) ma.)	
12FV7	RCA	Twin-Triode	9-Pin Min.	TV Tuners		
12GE5	G.E.	Beom Pentode	Some as 6GE5	Exc. Heoter Ratings (12.6 v./0.	5 a.)	
12GJ5	RCA	Beam-Power		Horiz. Amp.		
12410	Standord Elektrik Lorenz	Pentode	9-Pin Min.	General Purpose	300	
12HU8		Duo-Triode		Vert. Osc. & Amp.	330	
13FR7	Sylvania	Duo-Diode-Triode		Voltage Amp.	330	2
14JG8	G.E.		Same as ACKA	Exc. Heater Ratings (16.0 v./30		
16GK6	Sylvania	Pentode Triada Tatada	9-Pin Min.	Level House Rennings (1010 49/00	250	
16GK8	Siemen's Edison Swan, Ltd.	Triode-Tetrode Beam Power	2-6 10 M10*	Horiz, Amp.		
17GK5	RCA					-
17GT5	RCA	Beom Power	0.01-111	Horiz, Amp.		
17JK8	Sylvania	Duo-Triode	9-Pin Min.	FM Tuners	15 1	
17W6GT	Westinghouse	Pentode		Exc. Heater Ratings (16.8 v./		
19HV8	G.E.	Triode-Pentode	9-Pin Min.	Radio Receivers	330	
19JN8	G.E.	Triode-Pentode	9-Pin Min.	 & 28GB5 Exc. Heater Ratings (1	1
17 JINO						

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Heoter Ratings	Gm	Amp. Factar	R p (Ω)		lp(ma)	Gm	Amp. Factar	R p (Ω)	REMARKS	TUB
6.3 v./1.3 a. 5.0 v./1.0 a.	$30000 \ \mu$ Mhos 2500 μ Mhos	80 100						1317	Conduction & Convection Cooled Conduction & Convection Cooled	7698 7815
5.3 v./0.22 a.		ļ			1				Plate Dissipation - 0.85 w.	8081
5.3 v./0.24 o.		-							Plate Dissipation - 1.0 w.	8082
5.3 v./0.24 a.									Plate Dissipation -1.1 w.	8083
4.6 v.∕600 ma.	5500µ Mhos			250	10	12000 µ Mhos			Plate Dissipation—T-15 w., P-2 w.	3 F 55 3 H 58 4 F 57 4 G K 5 4 H 58
0.3 v.∕0.75 œ.	7800 μ Mhos	66	8.5 K.						Plate Dissipation - 2.0 w.	6AG
5.3 v./0.8 a.	10500 # Mhos		.2 meg.						Plate Dissipation - 3.1 w.	6AR
5.3 v./0.6 a.	2200µ Mhos	17	7.7 K.						Plate Dissipation – 2.75 w.	6AV
5.3 v./0.45 c.										6BF
5.3 v./0.15 a.	1600µ Mhos	100	62.5 K.						Plate Dissipation - 1.2 w.	6DR
5.3 v./0.135 a.	9000μ Mhos	62	6.9 k.						Plate Dissipation - 1 w.	6DS
5.3 v./0.3 a.	9200 µ Mhos	64							Plate Dissipation – 3 w.	6EL
6.3 v./925 ma.	1600 µ Mhos	68	40 k.	330	10	7200µ Mhos	5.4	750	Plate Dissipation-#1-1.5w., #2-10w	6FR
5.3 v./0.45 a. 5.3 v./1.38 a.	8000µ Mhos	45	5.6 k.	330	12	6500μ Mhos		2 meg.	Plate Dissipation - T-2.0 w., P-2.3w	6 F V 6 G B
5.3 v./1.2 a.	4700	4.1	20 k.						Plate Dissipation - 17.5 w.	6GE
5.3 v./1.2 a.	4700 µ Mhos	4.2	260 k. 10 k.			1000			Plate Dissipation -9.0 w.	6GF
5.3 v./1.2 a.	7500 µ Mhos 7100 µ Mhos	4.4	10 k. 15 k.			1000µ Mhos		.5 meg.	Plate Dissipation-#1+6.5w., #2-1.7w Plate Dissipation - 17.5 w.	
5.3 v./0.8 a.	10200 µ Mhos	4.4	29 k.						Plate Dissipation - 17.5 w. Plate Dissipation - 19 w.	6GJ
5,3 v./330 ma.	2600µ Mhos	14			-				Plate Dissipation - 0.6 w.	6GM
5.3 v./1.2 a.		4.4				7100µ Mhos		15 k.	·	6GT
5.3 v./700 ma.	10000µMhos	100		300		1600 μ Mhos	21		Plate Dissipation - T-0.5 w., P-9 w	6GW
5.3 v./0.45 ±6%a			.14 meg.						Sharp Cutoff	6GX
5.3 v./760 ma.	20000 / Mhos	33	24 k.						Plate Dissipation - 10 w.	6HB
6.3 v./300 ma.	10500 µ Mhos		,22 meg.						Semi-Remote Cutoff	6HQ
5.3 v./0.55 a. 5.3 v./0.3a	6000μ Mhos		.08 meg.					1	Plate Dissipation – 12 w.	6HU
6.3 v./1.125 a.	4000µ Mhos	70		250	29	12600 µ Mho s		.14 meg.	Plate Dissipation - 2.0 w.	6HW
5.3 v./780 ma.	4200μ Mhos	70		250	22	12000 <u>µ</u> Mhos		.14 meg.	1	6HZ
5.3 v./0.3 a.									Plate Dissipation - 3.0 w.	6JH9
5.3 v./0.8 a.	13000μ Mhos		.2 meg.						Plate Dissipation – 3.1 w.	6111
5.3 v./400 ma.	6800µ Mhos	55	8 k.			1300μ Mhos	70	5.4 k.		6JK8
7.0 v./0.3 a.	9000 μ Mhos	26							Plate Dissipation - 2.0 w.	7EK
										8HG
3.4 v./300 ma.	6800 <i>µ</i> Mhos	55	0 1			1200	70	5.41		8JE8
9.7 v./600 ma.	1600μ Mhos	68	8 k. 40 k.			1300 µ Mhos 7200 µ Mhos	70 5.4	5.4 k. 750		81K8
··· •·· •·· •·· •·· •·· •·· •··	1000 μ milos	00	40 K.			1200 µ Mhos	5.4	7 30	Plate Dissipation #1-1.5w.,#2-10w.	10 F F
										1111
										12A)
12 6 / 45	0400	21.5	2.05.1							12D.
12.6 v./.45 a.	9600µMhos	21.5	2.25 k.							12F\ 12GE
12.6 v./0.6 a.	7100μ Mhos	4.4	15 k.						Plate Dissipation – 17.5 w.	12G
	6000µ Mho s		.08 meg.						Plate Dissipation - 12 w.	12HI
13.0 v./450 ma.	1600 µ Mhos	68	40 k.	330		7200μ Mhos	5.4	750	Plate Dissipation.#1-1.5w,#2-10w.	13FF
4 v./.15±.009 a.	2200 µ Mhos	90	41 k.	330	2	2200μ Mhos		41 k.	Plate Dissipation - 1.1 w.	14GJ
	2.00	10								16GK
16.0 v./0.3 p. 16.8 v./0.45 c.	3400μ Mhos 7100μ Mhos	18 4.4	15 k.						Plate Dissipation - Tr-1.0w., Te-7w. Plate Dissipation - 17.5 w.	16GK 17GK
	,	4.4				7100 (1 146		161		
16.8 v./150 ma.	6800 µ Mhos	4.4 55	8 k.			7100µ Mhos 1300µ Mhos	70	15 k. 5 <mark>.</mark> 4 k.		176G
	- soopt mild's		V K.			. soop milos	10	J.4 K.		17JK 17W6
0.0 /0.154.000	1300 µ Mhas	70	54 k.	330		6500 µ Mhos	1	200 k.	Plate Dissipation - T55w.,P-3.0w.	17 WC
18.9 v/ U.15 1.009a										וחיו
	7500 / Mhos		200 k.			8500 µ Mhos	46	5.4 k.	Sharp Cutoff Pentode	19JN

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TUBE	SPONSOR	TYPE	CONSTRUCTION	APPLICATION	Ep(v)	ion 1 Ip(ma)
28GB5	Amperex	Pentode	Same as 6GB5 &	27GB5 Exc. Heater Ratings (28	v./300 r	na.)
4GD5A	RCA	Beam-Power	7-Pin Min.	Audio Output Amp.		
5NF5	Campagnie Industrielle Francais	Pentode	Same as 6FN5 E	xc. Heater Ratings (35 v./0.3 a.)		
0HC6	G.E.	Pwr. Pentode	7-Pin Min.	A-F Power	150	
0 HK6	G.E.	Pwr. Pentode	7-Pin Min.	Audio Power Amp.		
146A	Sylvania	Beam Pentode				2
159 A	Sylvania	Beam Pentode			n 11	
263A	RCA	Triode	Unilaterally Inter	changeable With 6263		
398	ITT	Pwr. Triode		R-F Amp. or Osc.		
872	Raytheon	Pentode			165	_
883A	Sylvania	Beam Pentode				
079	Raytheon	Twin-Triode		UHF Amp. & Osc.		
083	Raytheon	Pentode		VHF Amp.		
246	Raytheon	Triode	Filament Type	VHF-UHF Amp., Class C Osc.	150	
328A	Westinghouse	Triode		A-F Amp.		
					220	1.5
489	Brimar	Duo-Triode	9-Pin Min.	A-F & Control Amp.	330	14.5
490	Brimar	Duo-Triode	9-Pin Min.	A-F Control, DC Amp.	300	8.5
492	Brimar	Duo-Triode	9-Pin Min.	R.F. & Computer	380	3.2
494	Standard Telephones & Cables	Duo-Triode	9-Pin Min.	A-F & Control	330	1.75
495	Standard Telephones & Cables	Tetrode	9-Pin Min.	VHF Amp.	300	57
496	Brimor	Pentode	7-Pin Min.	R-F, I-F Amp.	330	13.5
498	Brimar	Pentode	7-Pin Min.	R-F, I-F Amp.	300	12.2
7499	Brimar	Pentode	9-Pin Min.	Video Amp.	300	50
	-	Tetrode	9-Pin Min.	A-F Power	350	7.5
7500	Stondard Telephones & Cables				330	4.1
502	Standard Telephones & Cables	Heptode	7-Pin Min.	Freq. Changer	330	4.1
7527	Amperex	Tetrode		VHF Amp, Osc., or Mod.		
7548	CBS	Hexode	9-Pin Min.	Pulse Amp.	1000	1
7581A	G.E.	Beam Pentode	Unilaterally Inter	changeable With 7581 & 6L6GC		
7587	RCA	Tetrode		R-F, I-F Video Amp. & Mixer	250	11.5
7604	Westinghouse	Triode		General Purpose		
7767		D D	0.01	Mish Valass	3000	
7757	Bendix	Beam Power	9-Pin Min.	High Voltage	330	
7763	G.E.	Sheet Beam	9-Pin Min.	I-F Amp.	330	
7768	G.E.	Triade		R-F Amp.	0.50	[
7788	Amperex	Pentode	9-Pin Min.	Broad-Band Amp.	250	
7800	Amperex	Triode	Ex. Plate	R-F, I-F Amp. & Osc.		-
7802	Tung-Sol	Duo-Triode		Power Supplies		
7837	ITT	Triode		R-F Amp & Osc., Class B Mod.		
7838	ITT	Triode		R-F Amp. & Osc., Class B Mod		
7839	ITT	Triode		R-F Amp. & Osc., Class B. Mo	d.	
7851	Tung-Sol.	Tetrode	7-Pin Min.		12	16
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7855	Machlett Labs	Triode	0.01.14	Osc., Freq. Multiplier		
7868	RCA	Pwr. Pentode	9-Pin Min.	Audio Output Amp.		
7861	G.E.	Duo-Triode	Same as 5670 E	xc. Heater Ratings		
7892	Tung-Sol	Duo-Triode		Pulse Amp. & Osc.	175	
7899	Amperex	Triode		Pulsed R-F Amp.		
7900	Amperex	Triode		TV Transmitter		
7962	Sylvania	Duo-Triode		UHF Amp.	100	15
7963	Sylvania Sylvania	Duo-Triode		UHF Amp.	165	22
7979	-	Triode	Neon Filled	Grid Control Device	118	11
79 83	Raytheon Amperex	Duo-Tetrode	9-Pin Min.	Output Amp., Driver, Freq. Mul		
_						
7994	Raytheon	Triode		Wide-Band Amp.	100	15
7995	Raytheon	Pentode		R-F, I-F Amp.	150	8.0
BO 32	CBS	Beam Power	Same as 6883 E	xc. Heater Ratings (13.5±10% v	./.625 a	•)
8042	Amperex	Beam Tetrode		R-F Amp. & Osc.		1
8044	Westinghouse	Triode		Modulator		
80 58	RCA	Triode				
8064	Suluania	Pentode		R-F, I-F Amp.	165	1
	Sylvania				105	
8068	G.E.	Beam		Series Regulator		
8070	Sylvania	Triode	0.01	R-F Amp.		
8077	RCA	Pentode	9-Pin Min.	Mobile Communications		
8078 8136	Assoc. Electrical Ind. G.E.	Triode Pentode	7-Pin Min.	R-F Transmitting I-F Amp.		

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Heater Ratings	Gm	Amp. Factor	R _P (Ω)		ian 2 Ip(ma)	Gm	Amp. Factar	R p (Ω)	REMARKS	TUBE
3.4 v./0.1 a.	5700 µ Mhos		13 k.						Plate Dissipation – 5 w.	28GB5 34GD5 35NF5
50 v./0.15±.009a 50 v./0.15 a.	14600µ Mhos 7500µ Mhos		11 k. 10 k.						Plate Dissipation ~ 5.5 w. Plate Dissipation ~ 5.5 w.	50HC6 50HK6
	7000 µ Mho s 7000 µ Mho s	4.5 4,5							Plate Dissipation - 25 w. Plate Dissipation - 25 w.	6146A 6159A
15.5 v./420 a. 6.9 v./217 ma.	4800µ Mhos	21	.34 meg.						Water Cooled Plate Dissipation - 1.1 w.	6263A 6398 6872
	7000 µ Mhos 5000 _µ Mhos	4.5	4 k.					_	Plate Dissipation - 25 w.	6883A 7079
	5000 µ Mhos	22	340 k.						Plote Dissipation ~ 1.1 w. Plate Dissipation ~ 0.7 w.	7083 7246
.0 v./245 a.									Forced Air Cooled	7328A
	2650 μ Mhos 3000 μ Mhos 6500 μ Mhos 9000 μ Mhos	18.5 37 70 175 20		330 300 380 330	14.5 8.5 3.2 1.75	2650 μ Mhos 3000 μ Mhos 6500 μ Mhos	18.5 37 70 175		Plate Dissipation – 3.0 w. Plate Dissipation – 5.0 w. Plate Dissipation – 2.8 w. Plate Dissipation – 1.1 w.	7489 7490 7492 7494
5.3 v./0.3 g.	5200μ Mhos	32		+	+				Plote Dissipation - 12 w.	7495
5.3 v./0.3 o. 5.3 v./0.75 a. 5.3/0.45 o.	9250μ Mhos 13500μ Mhos 5200μ Mhos 9000μ Mhos	89 32 25							Plate Dissipation – 3.3 w. Plote Dissipation – 3.0 w. Plote Dissipation – 12 w. Plate Dissipation – 13.2 w. Plate Dissipation – 1.1 w.	7496 7498 7499 7500 7502
5 v./14.1 a. 5.3 v./700 ma.	4000μ Mhos 26000μ Mhos	5.1							Air Cooled Plate Dissipation - 3.5 w.	7527 7548
5.3 v./0.15 a. 5.0 v./8.0 a.	12200µ Mhos	20							Sharp Cutoff Forced Air Cooled	7581A 7587 7604
.3 v./0.6 o. .3±0.6v/0.3 a. .3 v./0.4 a.									Plote Dissipation – 14 w. Plate Dissipation – 0.75 w.	7757 7763 7768
5.3v±5%v/340 ma 8 v./130 a.	5000 µ Mhos	58							Plate Dissipation - 5 w. Forced Air Cooled	7788 7800
5.3 v./2.5 a.	200000µ Mhos	9				20000 µ Mhos			Water Cooled	7802 7837
2.5 v=/.200 a,	40µ Mhos	5	1.7 μ						Forced Air Cooled Forced Air Cooled	7838 7839 7851
0.0 v./1.0 a.	10 200 μ Mho s		29 k.						Forced Air Cooled Plate Dissipation ~ 19 w.	7855
5.3±.3v/450 ma. 3 v./130 o.				175					Plate Dissipation ~ 7.5 w. Forced Air Cooled	7861 7892 7899
2.6 v./32 a. .3 v./235 ma.	15000μ Mhos 9500μ Mhos	32 20							Forced Air Cooled Plate Dissipation - 0.8 w.	7900 7962
.3 v./350 ma. .25±5%v/250 mo 3.15 v./1.65 a.	13000	40							Plate Dissipation - 1.1 w.	7963 7979
	18000 µ Mhos	43	25 k.		-				Radiation & Convection Cooled	7983
.3 v./0.3 a.	13000 µ Mhos		.1 meg.						Sharp Cutoff	7994 7995 8032
.6./3.2 a. v./185 a. .3 v./0.135 a.	7000µ Mhos 125µ Mhos	4.5 20 70	5.6 k.						Plate Dissipation - 25 w. Forced Air Cooled High-Mu Nuvistor	8042 8044 8058
6.5 v./45 ma. .3 v./.9 a.	4500µ Mhos 5200µ Mhos		54.5 k.						Plate Dissipation ~ 1.1 w. Plate Dissipation ~ 35 w.	8064 8068
5.3 v/125 ma. 3.5 v./0.275 a. 5.0 v./32.5 a.	11000μ Mhos 11500μ Mhos	58	.1 meg.						Plate Dissipation – 1.0 w. Plate Dissipation – 5 w. Forced Air Cooled	8070 8077 8078

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ELECTRON TUBE INTERCHANGEABILITY CHART

By C. P. MARSDEN, W. J. KEERY, and J. K. MOFFITT

National Bureau of Standards Washington 25, D. C.

Part Three A:

Domestic to Foreign Foreign to Domestic

As part of the function of the Electron Devices Data Service of the National Bureau of Standards, these tables were prepared as a service to the engineers, procurement and service personnel engaged in the field of electronics. All information was taken from manufacturer's published specifications and every effort has been made to assure accuracy and completion. However, the Bureau cannot assume responsibility for omissions nor for results obtained with these data.

No degree of interchangeability is indicated, as in most cases the geometrical shape or method of mechanical attachment vary considerably between manufacturers. In general, these types are stated as being similar to, a frequency variant of or a prototype of a given type. However, in most cases, a minor modification of the voltages, electrical connections and/or mechanical attach-ment will permit direct substitution of the similar type. Furthermore, old and developmental type numbers which have been assigned a new type number by the manufacturer are included.

CODE

The following alphabetical code is used to describe the Kind and Type:

A-Argon gas and Mercury AHG-Argon gas and Mercury

BEA-Beam Pentode

DIO-Diode

GAS-Gas-filled

H-Hydrogen-filled

HG-Mercury vapor

- IGN-Ignitron
- PND-Pentode
- SIN-Single e.g., single triode
- TET----Tetrode
- THY-Thyratron
- TRI-Triode
- TWN—Twin with separate cathodes e.g., twin triode

XE-Xenon gas-filled

To indicate the country of manufacture, the following letters are used. They are preceded by the symbol "@" to eliminate confusion as to whether the letter is a postfix on the type number G-Germany H-Holland l—Italy J—Japan E---England F-France

Finally, the following symbols are used ta indicate: * Type number registered with EIA by a foreign manufacture. # Equivalent type, usually a direct replacement

Domestic vs. Foreign Microwave Tubes

10.	Type/Similar to or Interchangeable With	No.	Type/Similar to or Interchangeable With
	DIO GAS #150C2 @E+G+ #051207 #E+ #5TV150/30 #G	*2 J2	DIO SIN U26 . 2. 2
A2		•2L2	D10 SIN U25 +E. 2L2 +E
_	DA2 #E.F.G.H. CV1832 D10 GAS #KD21 #E. #051205 #E. 0575/40 #E. CV3796	344	PND SIN #DL93 PE+H+G+ 344 PF+G+J+ CV807
A 3		345	TRI TWN #DCC90 PE.G.H. 345 PJ. CV808
A4G	TR1 GAS #PL1267 @G.H. 23001 @G.H. #1267 @G CV752	384	8EA SIN #DL98 @E. 384 @E.F.J. CV2240
82	010 GAS #108C1 0E.G. #STV108/30 0G. #051208 0E.	#3C4	PND SIN #DL96 #E.G.H. IPI #E. 3C4 #E.G.H
	052 #E.F.G.H. CV1833	304	PND SIN #DL95 PE.G.H. 304 PE.F.G.H.J. CV818
63	DIO GAS 90C1 @E.G.H. EEVR90 @E. #M8206 @E.	305GT	BEA SIN #DL33 DE.G.H. #N16 DE. 305GT DE. CV819
	M8207 PE, CV3799	354	PND 51N #1910 PE. #PL92 PE.G.H. #N17 PE.
C3	DIO GAS #K024 @E, #051206 @E, M8098 @E, M8142 @E,		354 PC.E.F.J
	DC3 #E.F. #VR105/30 #E. CV686	3V4	PND SIN #N19 @E. #DL94 @E.G.H. #IP11 #E. 3V4 @E.J.
03	D10 GAS #KD25 @E+ #150C3 @E+ #05150/40 @E+ 0D3 @E+		CV2983
	#VR150/30 4E, CV216	#4CM4	TRI SIN #PC86 @G.H. 4CM4 @G
E 3	D10 GAS #85A1 #E.G.H. 0E3 #G.H	+5AR4	DIO TWN GZ34 RE.G.H. SAR4 C.G.H
53	DIO GAS #85A2 PE+G+H, 0583/3 PE+ #STV85/10 @G+	514	DIO TWN U52 0E. GZ34 0E.G.H. CV1846
	CV449	5U4G	DIO TWN GZ34 ØE+G+H+ #U52 ØE+ SU4G @E+[+J
A 3	DIO SIN #DA90 #E.G.H. #1D13 #E. 1A3 #E.F.G.J.	5V4G	DIO TWN #6232 0E.F.G. 6234 0E.G.H. 5V46 0E.F. CV725
	Cv753	5×4G	DIO TWN GZ34 9E.G.H. 5X45 9E.I. CV1851
A5GT	PND SIN DL35 PE+ CV756	5V3G	DIO TWN #U50 @E. 5V3G @E. CV1854
A7GT	PTG SIN DK32 PE+ 147GT RE+ CV1800	5Z4GT	D10 TWN #GZ30 #E. GZ34 #E.G.H. 524GT #E.
A86	PTG SIN #DK96 #E.G.H 1AB6 #E.G.H.	6A8GT	PTG SIN EK32 PE. 648GT PE. CV579
AC6	PTG SIN #DK92 @E.F.G. X18 .E. #1C2 .E. 1AC6 .E.F.G	6484	TRI SIN #EC92 #F.F.G.H. KABA #F
AD4	PND SIN #DF62 @E+G+H+ 1AD4 @F+G+H+ CV2237	+6AB8	TRI PND #ECL80 #E+F+G+H+ 6488 #E+F+G+H+
AF 4	PND SIN DF92 PE+G+H	+6AFB	TRI HEX #X79 ME. CAER MA
AH5	DIO PND #DAF96 @E+G+ 1FD1 @E+ 1AH5 @E+G+H	+6AF 7G	TRI IND EM34 PE.G.F. 6AF7G PF
۵٫۹	PND SIN #DF96 PE.G. 1F1 PE. #W25 PE. 1AJ4 PE.G.H.	6AG7	PND SIN EF55 PE+G+H+ CV1882
83	D10 51N #U41 @E, E2004 @E, 183 @1.J. 163 @1.J.	6AH6	PND SIN EB3F #E.G.H. CV2521
	CV2115	•6AJ8	TRI PTG WECHBI #E.F.G.H. 6AJB #E.F.I.J. #6C12 BE
C3	TRI SIN #DC90 #E+G+H+ 1C3 #E	6AK5	PND SIN #EF95 #E.G.H. #M8100 #E. 64K5 PF.J.S.
CSGT	PND SIN #0L35 PE, IC5GT PE, CV1805	1	CV4010
E3	TRI SIN DC70 #E+G+H+ 1E3 #G+H	6AK6	PND SIN EL91 PE.G.H. 64K6 PE.F. CV1762
63	DIO SIN U41 #E. E2004 #E. 183 #1.J. 163 #1.J	+6AK8	TRD TRI #EABCBO #E.F.G.H. #6LD12 #E DH719 #E
HSGT	DIO TRI #DAC32 PE+ 1H5GT PE+ CV1818	1	6AKR PE.F.G.H
LA	PND SIN #DF92 #E.G.H. 1L4 @F.G.J. IF2 #E	6AL5	DIO TWN #077 #E. #006 #E. #602 #E. #E891 #E.F.G.H.
1 M 3	TRI IND #DM70 PE+F+G+H+ 1M3 PG+H+I+ DM71 PE+F+G+H	one o	WEAA9015 PG. WEAA91 PG.H
	TRI IND #DM71 #E+F+G+H+ IN3 #C+G+H+J+ DM70 #E+F+G+H	+6AM5	PND SIN #709 PE, WEL91 PE.G.H. 64M5 PC.E.
1N3	PND SIN #0F33 #E. 1856T #E. #214 #E. CV1823	+6 AM6	PND SIN #803 PE, #PM07 PF, #6F12 PE, #277 PE,F
INSGT		-0,4/40	#EF91 @E.G.H. 64M6 @E.F
105GT	BEA SIN #DL36 #E, 105GT #E, CV1826 PTG SIN #DK91 #E,G,H, X17 #E, #1C1 #G, 1R5 #C,E,FJ	+6A04	TRI SIN #EC91 #E.G.H. 6L34 #E. 64M6 #E.F
185		6AQ5	BEA SIN WELSO DE FIGHH N727 DE, 6495 DE FIGHIS
1524	D10 SIN DV86 @G, 152A @C+G+H 010 PND #DAF91 @E+G+H+ #ZD17 @E+ #1FD9 @E+ 155 @C+	8405	CV1862
155		#6A08	TRI TWN #ECC85 #E.G.H. #8719 #E. 6L12 #E. 6408 #C.
	E+1+J+ CV784	-0-08	EIGHIJ
1 T 2	010 SIN U37 #E4 172 #E	6457G	TRI SIN 41834 #E+ CV2523
174	PND SIN #DF91 #E+G+H+ #W17 #E+ 1F3 #E+ 1T4+ #E+F+J	6AT6	OWD TRI MDH77 PE, MERCOD PE, 6AT6 C.F.J
1.04	PND SIN #DF904 @G. 104 @J. CV2507	6AU6	PND SIN #EF94 0F+G+ 6AU6 #C+E+G+H+1+J+5+ CV2524
105	010 PND #DAF92 #E+ 105 4E+ J+ CV3912		DIO TWN #EBC91 #E+F+G+ 6AV6 #C+F+G+H+1+J+ CV2524
1 X2 A	DIO SIN #0480 46, 0486 46, 045032	6AV6	PND SIN #EF93 #E+F+G+H+ ##727 #E+ 68A6 #C+E+F+1+J+
2051	TRI TWN 2051L #5. CV2831	6846	
2021	TET GAS #PL2D21 @G.H. #PL21 #G. #EN91 #E.G.H.	6866	PTG SIN #EK90 PE.F.G.H. #X727 PE. 68E6 9E.F.1.J.S
	2021 @E+F+G+H+J+ CV797	*68E7	PTG SIN #EQ80 eE.G.H. 68E7 eG.H

Domestic vs. Foreign Microwave Tubes (Continued)

No.	Type/Similar to or Interchangeable With	
68H6	PND SIN #E90F @G.H	
*68J5	PND SIN #N78 PF. 68J5 44	- T
68,J6 *68K8	PND SIN #E99F @G.H PND SIN EF86 @E.G.H. 2729 @A.E	
*6BL8	TRI PND #ECF80 @E.G.H. #6015 @E. 68L5 @C.G.H	
*68M8	TR! PND #ECL82 @E.G.H. 6PL12 @E. 68M8 PND SIN #EL85 @E.G.H. 6BN5 @G.H. CV3526	
*68N5 *68Q5	PND SIN #6P15 @E. #EL84 @E.F.G.H. #N709 @E.	
	6805 @C.E.F.G.H.I.J	
6807A *68R5	TRI TWN ECC84 @E.G.H. 68Q7A @E.F.I.J TRI IND #EM80 @E.G.H. Y119 @E. 68R5 3C.G.H	
#68R7	PND S1N #805 0E, 68R7 0E, CV2137	
6814	DIO TWN EZ40 @E.F.G. 6874 @G.H	
₽68¥7 #68X6	PND SIN EF80 @E.F.G. 68%7 @E PND SIN #EF80 @E.F.G.H. #2719 @E. 65X6 @F.E.G.M	
*68Y7	PND SIN #6F19 @E. #EF85 2E.G.H. #W719 @E. 6BY7 @E.GVH	
6C4 #6CA4	TRI SIN #177 \$E. #EC90 @E.G.H. 6C4 @E.J. CV2842 D10 twn #E281 @E.G.H. #UU12 @E. 6CA4 @C.G.H.J	1
#6CA7	PND SIN #EL34 @E.G.H. 6CA7 @G.H	
6086	PND SIN EF91 PE.G.H. 6CB6 PC.E.F.I.J	
#6CD7 #6CH6	TRI SIN #EM34 @E.F.G.H. 6CD7 @C.G.H PND SIN #EL821 @F. #7010 @E. 6CH6 @E	- 1-
*6CJ5	PND SIN 6F16 . FF41 . S.H. 6CJ5 .G.H	
#6CJ6 #6CK5	PND SIN #EL81 @E.F.G.H. 6CJ6 @E.F.G.H. PND SIN EL41 @E.F.G.H. 6CK5 @G.H	
#6CK6	PND SIN #EL83 @F.G.H. EL803 @G. 6CK6 @F.G.H.	
	Cv2726	- 11
#6CM4 #6CM5	TRI SIN #EC86 @E.G.H. 6CM4 @G PND SIN #EL36 #E.G.H. 6CM5 @C	
#6CN6	BEA SIN WEL38 PE.G.H. 6CN6 PE	
*6CQ6	PND SIN #6F21 @E, 906 @E, 177 @E, EF92 @E,G,H, 6006 @E,F	
*6CR4	6006 ME.F TRI SIN #42521 ME. EC88 0G.H. 6CR4 ME	
6056	PTG SIN NEH90 DE G.H	
#6CT7 #6CU7	DIO PND #EAF42 @E.F.G.H. 6C17 @G.H TRI MEX #ECH42 @E.G.H. 6C10 @E. 6CU7 @G.H	
#6CV7	DWD TRI EBC41 @E.F.G.M. 6LD3 @E. 6CV7 @G.H	
*6C¥5 6D4	PND SIN EL86 @E.G.H. 6CW5 @C.G.H TR1 GAS AFX212 @E. 6D4 @E. CV1949	
+6DA5	TRI IND #EMBI #E.G.H. Y119 @E. 6045 @C.G.H.	
*6DA6	PND SIN #EF89 #E.G.H. 6046 @E.G.H.	- Ł.
*60CB 60E6	DWD PND #EBF89 @E+G+H+ #6FD12 @E+ 6DC8 @C PND SIN EF91 @E+G+H	0
*6DJ8	TRI TWN WECC88 @E.G.H. E88CC @E.G.H. 6DJ8 9C.G.H	
*6DL 5 *6DR8	PND SIN WEL95 #G.H. 6DL5 @C DWD PND E8F83 #E.G.H. 6DR8 #C	
#6058	TRI PTG ECH83 @E+G+H+ 6DS8 @C	
6DT8	TRI TWN ECC85 @E.G.H. 6DT8 @J	
#6DX8 #6EC7	TRI PND #ECL84 @G.H. 6DX8 @C.G.H PND SIN #6F18 @E. EF89 @E.G.H. 6EC7 3E	
6EH7	PND SIN #EF183 @E.G.H. 6F29 @EX 6EH7 @C.G.H	
*6EJ7 6EL7	PND SIN #EF184 @E.G.M. 6F30 @E. 6EJ7 @C.G.M PND SIN 6F23 @E. 6EL7 @E	
6556	PND SIN EF97 PE.G.H. 6ES6 PC	
*6E58	TRI TWN #ECC189 @E.G.H. 6ES8 @C.G.H	11
*6ET6 6EU7	PND SIN #EF98 @E.G.H. 6ET6 @C TRI TWN ECC83 @E.F.G.H	
6E¥6	PND SIN EF184 #E+G+H+ 6EW6 #E+J	
6F6 #6FC7	PND SIN #KT63 @E.J. CV1912	
#6FG6	TRI TWN #ECC89 @E+ 6FC7 @E TRI IND #EM84 @E+G+H+ EM84A @G+ 6FG6 @C+G+H	
*6GAB	TRI TWN #6/30L2 @E 6GAB @E	
6GK6 *6GM8	PND SIN EL84 @E.F.G.M Tri twn #Ecc86 @E.G.M. 6gm8 @C.G.M	
6GW8	TRI PND #ECL86 @E+G+H+ 6GW8 #G+H	
#6HG8 #6HU8	TRI PHD #ECF86 @E+ 6HG8 @E Phd twn #Ell80 @G+ 6HU8 @G	13
6J5GT	TRI SIN #L63 @C+E+ 6J5GT @E+J	
6J6GT	TRI TWN ECC91 @E+G+H+ M8081 @E+ 6J6GT @E+F+I+S	
6J7GT 6L6G	PND SIN Z63 @E, KTZ63 @E, EF37A @E,G, 6J7GT @E BEA SIN EL37 @E, KT66 @E, 6L6G @E,1+J	
*6N8	DWD PND #EBF80 @E+F+G+H+ 6N8 @E+F+G+H	
*6Q4 6Q7GT	TRI SIN #EC80 @G.H. 6Q4 @G.H. CV1886 DWD TRI EBC33 @E. DH63 @E. 6Q7G @E	
#6R3	DIO SIN EY81 @E.F.G.H. 6R3 @C	
*6R4 *652	TRI SIN #EC81 #G+H+ 6R4 #G+H+ CV1865	
*652 65L7GT	DIO SIN WEY86 PE+G+H+ 652 PC TRI TWN ECC35 PE+ 65L7GT PE+J+ CV1985	
6SN7GT	TRI TWN ECC33 @E. #865 @E. 65N7GT @C.E.J	
*6U3 6U5	DIO SIN #EYBO @G.H. 6U3 @G.H. TRI IND #Y63 @E	
608	TRI PND #ECF82 @E. ECF80 @E.G.H. 608 @E.I.J.	
*6V4	CV5065 DIO TWN #E280 @E.F.G.M. 6V4 @E.F.G.M	
6x2	DIO SIN #EY51 @E.F.G.H. 6x2 @E.F.G.H	
6X4 6X5GT	DIO SIN #U78 0E+ #EZ90 0E+G+H+ 6X4 0E+F+J+H DIO TWN #EZ35 0E+G+H+ 6X5GT 0I	
#7AN7	TRI TWN #PCC84 @E+G+H+ B319 @E+ 30L1 @E+ 7AN7 @C+	
#70J8 #7ED7	TRI T₩N #PCC88 @E.G.H. 7DJ8 @C PND SIN #30F5 @E. 7ED7 @E	•
#7EK7	TRI TWN JOL15 . 7EK7 PE	
*7ES8 ●7FC7	TRI TWN PCC189 @G+H+ 7E58 @C TRI TWN PCC89 @E+ 7FC7 @E	**
#7HG8	TRI PND #PCF86 #E+G+H+ 7HG8 #E	
*9A8	TRI PND #30C1 @E. #PCF80 @E.G.H. #LZ329 @E. LN329	
#94K8	EE. 9AB EC.E.G.H TRD TRI #PABCBO EE.G.H. 9AKB €C	
#9AQ8	TRI TWN #PCC85 @E.G. 9AQ8 @C	Ľ
#9EN7	TRI PND #30C15 0E. 9EN7 0E	
#9688 #908	TRI BEA #30FL1 @E+ 9688 @E TRI PND #PCF82 @E+6+ 948 @E	+0
#12AC5	PND SIN #UF41 @E.F.G.H. 12AC5 @G.H	*6
12AJ8 12AT6	TRI PTG ECH81 @E.F.G.H. 12AJ8 @F.I DWD TRI #H8C90 @E. 12AT6 @C.E.J.S	**
12410	TRI TWN #ECC81 @ <mark>E</mark> .F.G.H. #B152 @E. B309 @E.	
12406	12AT7 @E'F'G'H''I'J PND SIN #HF94 @E'12AU6 @C'F'I'J'S' CV1961	1:
12408	TRI TWN #ECC82 @E.F.G.M. ECC8025 @G. 12AU7 @E.	1.6
	G.H.J	1 + 4

cr	owave inc			
	No.	lype		ilar to or Interchangeable With
	12AV6 12AX7			#HBC91 @G. 12AV6 @C.F.J.S #6L13 @E. #ECC83 @E.F.G.H. 8339 @E.
	15947	191		#ECC8035 @G+ 12AX7 @E+F+G+H+1+J
	128A6 128E6			WHE93 @E. 12846 @C.F.F.1.J.S
	12660	TET	SIN	#HK90 @E. 12886 @E.F.1.J.S #30P12 @E. 12885 @E
	#12HU8	PND	TWN	#PLL80 @G. 12HU8 @G
	12SN7GT #13EC7			#836 @E, 125N7GT @1, CV925 10F18 @E, UF89 @E,G,M, 13EC7 @E
	#13GC8	TRI	TET	#30PL1 @E. 13GC8 @E
	#14K7 #14L7	TRI	HEX	AUCH42 @E+F+G+H
	#15A6			#10LD3 @E. #UBC41 @G.H. 14L7 @G.H #PL83 @E.F.G.H. #N309 @E. 15A6 @E.F.G.H
	15CW5			#30P18 . N379 @E. PL84 @E.G.H. 15CW5 @C
	*15008 *1645			15008 @C, PCL84 @E.G.H. 15008 *C #PL82 @E.F.G.H. #N329 @E. #30P16 %E, 16A5
				ØE.F.G.H
	*16A8 *16GK8			#PCL82 @E.G.H. 30PL12 @E. 16A8 @C #30PL13 @E. 16GK8 @E
	±17C8	DWD	PND	UBF80 @E.G.H. 17C8 @C
	#17Z3 #19AQ5	DID	S1N	#PY81 @E+F+G+H+ 1723 @E+F+G+H
	#19CS4			#HL90 @E. 19AQ5 @E #U191 @E. 19C54 @E
	+19D8	TRI	PTG	#UCH81 @E.G.H. #10C14 @E. 19D8 @C
	1978 #19X3			HARC80 @E. 1978 @1.J #PY80 @E.G.H. 19x3 @G.H
	#19Y3			#PY82 @E.F.G.H. #U192 @E. #U319 @E. 19Y3
	+2565	PND	SIN	@E+F+G+H ₩PL36 @E+G+H+ 25E5 @C+E
	+25GF6	BEA	SIN	#30P4 @E: 25GF6 @E
	28GR5 +30A5			PL500 @G #HL94 @G.H. 30A5 ⊜C.J
	3505	BE A	SIN	HF94 @G. 35C5 9J.S
	35¥4	D:0	SIN	HY90 @E. 35W4 @E.F.I.J.S
	3525GT #38A3	D10	SIN	U74 @E, 3525GT @E.J. CV568 #U381 @E. UY85 @E.G.H. 38A3 @C
	#45A5	PND	SIN	#UL41 @E.F.G.H. 4545 @G.H
	#4585 #508M8	BEA	SIN	UL84 @E.G.H. 10P18 @E. 4585 @C.G.H #10PL12 @E. 508M8 @E.J. #UCL82 @E.G.H
	5005	BEA	SIN	#HL92 @E. 50C5 @E.J. CV1959
	50L6GT 417A			50L6GT @E.J. CV571 #E2754 @E. 417A @E.S. 5842 @E.G.M.S. CV2642
	CK512AX			#DF66 @E.G.H. CV2107
	1267	TRI	GAS	#Z300T @E.G.H. #PL1267 @G.H. CV1992
	5636 5641	DIO	SIN	#EF730 @E+ 5636 @E+F+G+ EY70 @E+ CV5211
	5642	0:0	SIN	DY70 RE.G.H
	5643 5647	TET	GAS	#EN70 @E. 5643 @F. CV5079 EA76 @E.G. CV469
	5651			85A2 #E+G+H+ QS83/3 #E+ #QS1209 #E+ 5651
	5654	PND	SIN	@C.E.G.H.J. CV2573 #E95F @E. 5654 @E.F.G.H.J. CV4010
	5672	PND	SIN	#DL620 @E+ 5672 @E+F+G+H+J
	5676 5678	TR I	SIN	XFR3 0E. DL68 0G.H. 5676 0E.F.G.J
	5676	FIND	214	XFR2 @E, XFR5 @E, #DF60 @E, 5678 @E,F,G,H CV2254
	5687 5696	TRI	TWN	E182CC @E.G.H. 5687 @F. CV5188
	5718			#EN92 @E+ 3696 @G+ CV3512 EC70 @E+ 5718 @E+F+G+H+ CV468
	5725			5725 @F.J. CV4011
	5726	010	TWN	#EAA91 @G.H. #D77 @E. #6D2 @E. #EAA901 @G EB91 @E.F.G.M. 5726 @E.F.G.M.J. CV5189
	5727			#M8204 0E. 5727 0E.G.H. CV4018
	5749			#EF93 @E.F.G.H, ##727 @E. 5749 @E.F.J x727 @E. EK90 @E.F.G.H. 5750 @E.J
	5751			E283CC @G. 5751 @F.J. CV4017
	5783 5800			#M8190 @E+ 5783 @C+F
				ME1402 DE. ME1401 DE
	5814			#ECC186 @G.H. CV5146
	5823			Z50T @G+H+ #Z900T @E, QT1251 @E 5823 @E,G+H+J
	5840	PND	SIN	#EF72 @E+ 5840 @E+F+G+ CV3929
	5842 5847	PND	SIN	#F7004 eF, 5842 eE.G.H.S. CV3789 5847 eG.H.S. CV3905
	5879	PND	51N	EF86 @E.G. 2729 @A.E. CV2901
	5881 5889	BEA	SIN	EL37 @E. KT66 @E. CV2796 ME1403 @E. 4068 @G. CV2348
	5899	PND	SIN	#EF71 #E. 5899 #E.F.G.
	5915 5916			#EH9005 @G.
	5920			EF730 @E #E90CC @E+G+H+ #ECC960 @G+ 5920 @G+H+
	5932 6007	BEA	SIN	EL37 @E; KT66 @E; CV3899 #DL67 @G;H; 6007 @G;H
ч	6008	PND	SIN	#DE67 @G.H
	*6067			#ECC186 @G.H. ECC8025 @G. #ECC82 @E.F.G.
ч	6073	010	GAS	6067 @E #0A2WA @E.F.G.H. #150C2 @E.G. QS1207 @E.
				STV150/30 @G+ 6073 #F+ CV2963
	6074	010	GAS	#108C1 @E+G+ STV108/30 @G+ #Q51208 @E+ 6074 @F
	*6084			#E80F @E+ 6084 @G+H
11	#6085 #6086			ECC40 @E+F+G+H+ #E80CC @E+G+H, 6085 @G+H #18042 @G+H+ 6086 @G+H
	#6132	PND	SIN	#EL821 #E+ CV4055
	6186 6189			E99F 8G+H
	6201	TRI	TWN	#ECC802S @G. ECC186 @G.H ECC85 @E.G.H. #ECC801S @G. 6201 @G.H.J
				CV3508
	6205 *6218	REA	SIN	EF732 #E+G+ 6205 #E+ CV3929 #E80T #G+ 6218 #C+G+H+
	*6227	PNO	214	#EBOL #E+G+H+ 6227 #C+G+H+
	*6267 *6354	PND D10	SIN SIN	EF86 @E.G.H. Z729 @A.E. EF8065 @G. 6267 @C #15082 @E.G.H. #M8163 @E. 6354 @E.G.H.
				CV2225
	#6373 #6374			DL70 @E. 6373 @E. CV2105 EY84 @E.G.H. 6374 @E. CV2235
	*6375	TRI	SIN	#DC70 @E.G.H. 6375 @E.G.H
	6386 *6487			2C51L #S #EF70 #E
1				

Domestic vs. Foreign Microwave Tubes (Continued)

No.	Type/Similar to or Interchangeable With	No.	Type/Similar to or Interchangeable With
+6488	PND SIN EF73 RE. CV466	6977	TRI IND #DM160 @G.H# 6977 @G.H
+6489	D10 SIN EA76 . E+G+ CV469	+7001	BEA SIN #F7001 #E
6550	PND SIN EL34 PE . G. H. KT88 PE	7059	TRI PND ECF82 .E
+6574	TET GAS EN32 . 6574 . 6574 . CV2253	*7062	TRI TWN #E180CC #E+G+H+ 7062 #C
6511	PND SIN DE61 ME.G	#7119	TRI TWN #E182CC @E.G.H. 7119 @C
6626	DIO GAS 150C2 #E.G. #051207 #E. #STV150/30 #G	7 308	TRI TWN #E188CC #G.H. 7308 #G.H
6627	DID GAS #108C1 @E.G. #STV108/30 @G. #QS1208 @E	7316	TRI TWN #ECC186 @G+H+ 7316 @G+H
6561	PND SIN #E90F #G+H	+7320	PND SIN #E84L @G. 7320 @F
6662	PND SIN #E99F #G.H	7534	PND SIN #E130L #G+ 7534 #G+H
6680	TRI TWN MECCOO25 @G"	7643	TR1 PND #E80CF @E+G+H+ 7643 #G+H+
6681	TRI TWN #ECC8035 @G	7693	PND SIN #E90F @G.H. 7693 @G.H
6686	PND SIN #EBIL #E.G.H. 6686 @C	7694	PND SIN #E99F #G.H. 7694 @G.H.
6587	PTG SIN #EH91H @E+G+H+ EH9005 @G+ 6687 @C+G+H	7721	PND SIN D34 .G
6688	PND SIN #E180F #E.G.H. 6688 #C.E.G.H. CV3998	7722	PND SIN #E280F @G
66689	PND SIN #E83F #E+G+H+ 6689 #C+G+H	7737	PND SIN E186F . OG+H
6778	TRI SIN #EC70	7788	PND SIN #E810F #E+G+H+ 7788 #G+H+
+6779	DIO GAS #2803U +E+G+H+ 6779 +E	*7971	BEA SIN #SILE12 DE. 12E1 DE. 7971 CE
5569	TRI TWN #ECC88 0E.G.H. #E88CC 0E.G.H. 6922 0C.G.H	+7972	864 SIN #1361 #6+ 7972 #6
+6923	DIO SIN #EA52 @E+H+G+ 6923 @C	+7973	BEA SIN #S2P20 0E. 7973 0E

Foreign vs. Domestic Microwave Tubes

No. Ty	pe/Similar to or Interchangeable With		Type/Similar to or Interchangeable With
_			DID TWN #5V4G
	PTG SIN #1R5	GZ32 DF33	PND SIN #1N5GT
	PTG SIN #1AC6	DL33	BEA SIN #305GT
	DIO SIN #1A3 PND SIN 1AJ4	EBC33	DWD TRI 607GT
152	PND SIN 1L4	ECC33	TRI TWN 65N7GT
153	PND SIN 1T4	EL34	PND SIN #6CA7+ 6550
1501	DID PND 1AH5	EM34 GZ34	TRI IND #6CD7+ 6AF7G DIO TWN 5AR4+ 504G+ 5T4+ 5V4G+ 5X4G+ 5Z4GT
1509	DIO PND #155 PND SIN 3C4	0135	PND SIN 145GT+ 105GT
191	PND SIN #354	ECC35	TRI TWN 65L7GT
1211	PND SIN #3V4	EZ35	DIO TWN #6X5GT
PL 2021	TET GAS #2021	836	TRI TWN #12SN7GT
52P20	BEA SIN #7973	DL36	BEA SIN #105GT
XFR2	PND SIN 5678	EL 36	PND SIN #6CM5 PND SIN #25E5
2051L	TRI TWN 2051+ 6386	PL36	PND SIN #2525
D3A XFR3	PND SIN 7721 TRI SIN 5676	EL 37	BEA SIN 6L66, 5881, 5932
XFR5	PND SIN 5678	U37	DID SIN 172
006	DID TWN #6AL5	EL38	BEA SIN #6CN6
6010	TRI HEX 6CU7	ECC40	TRI TWN 6085
6012	TRI PTG #6AJ8	EZ40	DIO TWN 68T4 Dwd TRI 6CV7
6016	TR! PND #68L8	EBC41 EF41	PND SIN 6CJ5
602	DID TWN #64L5+ #5726	EL41	PND SIN 6CK5
6F12 6F16	PND SIN #6AM6 PND SIN 6CJ5	U41	DID SIN #183+ 163
6-18	PND SIN #6EC7	UBC41	DWD TRI #14L7
6519	PND SIN #68Y7	UF41	PND SIN #12AC5
6F21	PND SIN #6CQ6	UL41	PND SIN #4545
6F23	PND SIN GELT	EAF42	DID PND #6CT7
6529	PND SIN 6EH7	ECH42 UCH42	TRI HEX #6CU7 TRI HEX #14K7
6F 30	PND SIN 6EJ7	00442	DIO TWN #5Y3G
6F012	DWD PND #6DCB TRI TWN 6AQ8	Z50T	TRI 645 5823
6L12 6L13	TRI TWN #12AX7	EY51	DIO SIN #6X2
6134	TRI SIN 64Q4	EA52	DID SIN #6923
6L03	DWD TRI 6CV7	052	DID TWN ST4. 5U4G
6LD12	TRD TRI #64K8	EF55	PND SIN 6AG7 PND SIN #5678
6P15	PND SIN #6805	DF 60 DF 61	PND SIN 6611
6PL12	TRI PND 68M8 TRI TWN #6GA8	DF 62	PND SIN #1AD4
5/30L2	PND SIN #6AM6	DH63	DWD TRI 607GT
709	PND SIN #6AM5	KT63	PND SIN #6F6
7010	PND SIN #6CH6	KTZ63	PND SIN 6J7GT
803	PND SIN #6AM6	L63	TRI SIN #6J5GT TRI IND #6U5
805	PND SIN #68R7	763 Z63	PND SIN 6J7GT
906	PND SIN 6C06	865	TRI TWN #6SN7GT
10C14 10F18	TRI PTG #1908 PND SIN 13EC7	DF66	PND SIN #CKSIZAX
10003	DWD TRI #14L7	KT66	BEA SIN 666, 5932, 5881
10218	BEA SIN 4585	DF67	PND SIN #6008
10PL12	TRI PND #508M8	DL67	PND SIN #6007
SI1E12	BEA SIN #7971	0168	TRI SIN 5676 TRI SIN 1E3, #6375
0012	DID TWN #6CA4	0170	PND SIN 6373
1251	8EA SIN 7971 BEA SIN #7972	DM70	TRI IND #1M3+ IN3
13E1 Z14	PND SIN #1NSGT	DY70	DIO SIN 5642
N16	BEA SIN #305GT	EC70	TRI SIN 5718 #6778
NI7	PND 51N #354	EF70	PND 51N #6487
W17	PND SIN #1T4	EN70 EY70	TET GAS #5643 DID SIN 5641
×17	PTG SIN 185 DID PND #155	DM71	TRI IND WIN3
ZD17 ×18	PTG SIN 14C6	EF 71	PND SIN #5899
N19	PND SIN #3V4	EF 72	PND SIN #5840
K021	DID GAS #DA3	EF 73	PND SIN 6488
PL21	TET GAS #2D21	U74	D10 SIN 3525GT
K D24	DIO GAS WOC3	Q575/40 EA76	DIO GAS DA3 DID SIN 5647+ 6489
KD25	DIO GAS #DD3	D77	DID SIN 3047: 0489 DID TWN #6AL5: #5726
U25	DIO SIN 2L2 PND SIN #1AJ4	0477	DWD TRI #6AT6
W25 U26	DID SIN ZJ2	L77	TRI SIN #6C4
GZ30	DID TWN #5Z4GT	w77	PND SIN 6CQ6
3001	TRI PND #948	277	PND SIN #6AM6
30015	TRI PND #9EN7	N78	PND SIN #68J5
30F5	PND SIN #7ED7	U78	DIO SIN #6X4 TRI HEX #6AEB
30FL1	TRI BEA #9688	279 DY80	DIO SIN #1x2A
3011	TRI TWN 7AN7	EBDCC	TRI TWN #6085
30115	TRI TWN 7EK7 BEA SIN #25GF6	EBOCF	TRI PND #7643
30P4 30P12	TET SIN #12F85	EBOF	PND SIN #6084
30P16	PND SIN #16A5	EBOL	PND SIN #6227
30P18	PND SIN #15CW5	EBOT	BEA SIN #6218
30PL 1	TRI TET #13GC8	EABCBO	TRD TRI #64K8 Dwd PND #6N8
30PL12	TRI PND 16A8	EC80	TRI SIN #604
30PL13	TR1 8EA #166K8 D10 TR1 #1456T	ECF80	TRI PND #68L8+ 6U8
DAC32 DK32	DIO TRI WINSGT PTG SIN 1A7GT	ECL80	TRI PND #6ABB
EK32	PTG SIN 6A8GT	EF80	PND SIN 68W7, #68X6
EN32	TET GAS 6574	ELLBO	PND TWN #6HU8

No.	Type/Similar to or Interchangeable With	omestic Mic	No.	i <mark>bes (Continued)</mark> Type/Similar to or Interchangeable With	
EM80 E080	TRI IND #68R5 PTG SIN #68E7		EF93	PND SIN #6846. #5749	
EYBO	DIO SIN #603		HF93 DL94	PND SIN #12846 PND SIN #344	
EZ80 HABC80	DIO TWN #6V4 TRD TRI 19T8		EF94 MF94	PND SIN #6AU6	
PABC80	TRD TRI #94K8		HL94	PND SIN #12406. 3505 PND SIN 3045	
PCF80 PLL80	TRI PND #948 PND TWN #12HUB		DL95	PND SIN #394	
PY80	D10 S1N #19x3		E95F EF95	PND SIN #5654 PND SIN #6445	
UBF80 E81L	DWD PND 17C8 PND SIN #6686		EL95	PND SIN #60L5	
ECBI	TRI SIN #6R4		DAF96 DF96	DIO PNO #14H5 PND SIN #14J4	
ECC81 ECH81	TRI TWN #12AT7 TRI PTG #6AJ8+ 12AJ8		DK96	PTG SIN #1486	
EL81	PND'SIN #6CJ6		DL96 EF97	PND SIN #3CA PND SIN 6ES6	
EM81 EY81	TRI IND #6DA5 DIO SIN 6R3		DL98	BEA SIN #384	
EZBI	DIO TWN #6CA4		EF98 E99F	PND SIN #6ET6 PND SIN #68J6+ 6186+ 6662+ #7694	
UCH81	DIO SIN #1723 TRI PTG #1908		VR105/30	DIO GAS #OC3	
ECC82	TRI TWN #12AU7. #6067		STV108/30 109C1	010 GAS #082. 6074 010 GAS #082. #6074	
ECF82 ECL82	TRI PND #6U8+ 7059 TRI PND #68M8		Y119	TRI IND 68P5+ 6DA5	
PCF82	TR1 PND #908		E130L 05150/40	PND SIN #7534	
PCL82	TRI PND #1648		STV150/30	D10 GAS #DA2 . 6073 . #6626	
PL82 PY82	PND SIN #1645 DIO SIN #1973		VR150/30 15082	DIO GAS #0D3 DIO SIN #6354	
UCL82 E83F	TRI PND #508M8		15002	DIO GAS #042, #6073, 6626	
E8F83	PND SIN 6446, #6689 DWD PND 6088		8152	DID GAS #0D3 TRI TWN #12AT7	
ECC83	TRI TWN 6EU7. 12AX7 TRI PTG 6D58		DM160	TRI IND #6977	
ECH83 EL83	TRI PTG 6D\$8 PND SIN #6CK6		E180CC E180F	TRI TWN #7062 PND SIN #6688	
PL83	PND SIN #15A6		E 182CC	TRI TWN 5687, #7119	
Q583/3 E84L	DIO GAS 0G3, 5651 PND SIN #7320		EF183 EF184	PND SIN #6EH7 PND SIN #6EJ7+ 6EW6	
ECC84	TRI TWN 6807A		E186F	PND SIN 7737	
ECL84 EL84	TRI PND #6DX8 PND SIN #6BQ5+6GK6		ECC186 E188CC	TRI TWN #5814, #6067, 6189, #7316 TRI TWN #7308	
EM84 EM84A	TRI IND #6FG6		ECC189	TRI TWN #6ES8	
EMB4A EY84	TRI IND #6FG6 Dio sin 6374		PCC 189	TRI TWN 7ESB DID SIN #19054	
PCC84	TRI TWN #7AN7		0192	DID SIN #1973	
PCL84 PL84	TRI PND 15008 PND SIN 15CW5		AFX212 E28CF	TRI GAS 604 PND SIN #7722	
UL84	864 SIN 4585		E283CC	TRJ TWN 5751	
ECC85 EF85	TRI TWN #6408. 6018. 6201 PND SIN #68Y7		2300T 8309	TRI GAS DA4G. #1267 TRI TWN 12AT7	
EL85	PND SIN #68N5		N309	PND SIN #1546	
PCC85	TRI TWN #9AQ8 Dio Sin 38A3		8319	TRI TWN 7AN7 DIO SIN #1973	
85A1	DID GAS WOES		LN329	TRI PND 948	
8542 STV85/10	DIO GAS 0G3, 5651 DIO GAS #0G3		LZ 329 N329	TRI PND #948 PND SIN #1645	
DY86	DID SIN 1524+ 1824		R339	TRI TWN 12AX7	
EC86 ECC86	TRI SIN #6CM4 TRI TWN #6GM8		N379 U381	PND SIN 15CW5 DID SIN #38A3	
ECF86	TRI PND #6HG8		PL 500	BEA SIN 28G85	
ECL86 EF86	TRI PND #66#8 PND SIN 68K8: 5879: 6267		DL620 N709	PND SIN #5672 PND SIN #6805	
EL86 EY86	PND SIN #6CW5		8719	TRI TWN #6ADB	
PC86	DID SIN #6S2 TRI SIN #4CM4		DH719 ¥719	TRD TRI 64K8 PND SIN #68Y7	
PCF86 E88CC	TRI PND #7HG8 Tri TWN 6Dj8+ #6922		Z719	PND SIN #68x6	
EC88	TRI SIN 6CR4		N727 W727	8EA SIN 6405 PND SIN #6886+ #5749	
ECC88 KT88	TRI TWN #6DJ8+#6922 PND SIN 6550		×727	PTG SIN #6864 5750	
PCC88	TRI TWN #70J8		Z 729 EF 730	PND SIN 68K8+ 5879+ 6267 PND SIN #5636+ 5916	
ECC89 EBF89	TRI TWN #6FC7 DWD PND #6DC8		EF732	PND SIN 6205	
EF89	PND SIN #60A6+ 6EC7+ #6ET6		ECC8015 ECC8025	TRI TWN #6201 TRI TWN 12AU7: 6067: #6189: #6680	
PCC89 UF89	TRI TWN 7FC7 PND SIN 13EC7		ECC8035	TRI TWN #12AX7, #6681	
DA90	DIO SIN WIA3		EL803 Z803U	PND SIN 6CK6 DID GAS #6779	
DC90 DCC90	TRI SIN #1C3 TRI TWN #3A5		EF 806S	PND SIN 6267	
EPOCC	TRI TWN #5920		E810F	PND S1N #7788 PND S1N #6CH6+ #6132	
E90F EBC90	PND SIN #68H6+ #6661+ #7693 DWD TRI #6AT6		EH900S	PTG SIN #5915, 6687	
EC90	TRI SIN #6C4		Z900T EAA901	TRI GAS #5823 Dio TWN #5726	
EEVR90 EH9D	DIO GAS 083 PTG SIN #6CS6		EAA901S	DID TWN #6ALS	
EK90	PTG SIN #6866. 5750		DF904 ECC960	PND SIN #104 TRI TWN #5920	
EL90 E290	BEA SIN #6AQ5 DID SIN #6X4		QS1205	DIO GAS #0A3	
HBC90	DWD TRI #12AT6		051206 051207	DIO GAS #0C3 DID GAS #DA2+ #6073+ #6626	
HK90 HL90	PTG SIN #12866 BEA SIN #19805		QS1208	D1D GAS #D82+ #6074+ #6627	
HY90	DID SIN 35W4		Q51209 QT1251	D10 GAS #5651 TRI GAS 5823	
9DC1 DAF91	D1D GAS 083 D1D PND #155		PL1267	TRI GAS #044G. #1267	
DF91	PND SIN #1T4		1267 ME1401	TRI GAS #044G TRI SIN 5802	
DK91	PTG SIN #185		ME1402	TET SIN 5800	
E891	DID TWN #6AL5+ #5726 DID TWN #6AL5+ 5726		ME1403 41834	PND SIN 5889 TRI SIN 6457G	
E8C91	DID TWN #6AV6		E2004	DIO SIN 183, 163	
EC91 ECC91	TRI SIN #6AQ4 TRI TWN 6J6GT		A2521 E2754	TRI SIN #6CR4 TRI SIN #417A	
EF91	PND SIN #6AM6+ 6CB6+ 6DE6		4068	PND 51N 5889	
EH91H EL91	PTG SIN #6687 PND SIN 64K6+ #64M5		F 7001 F 7004	BEA SIN #7001 TRI SIN #5842	
EN91 HBC91	TET GAS #2021		M8081	TRI TWN 6J6GT	
DAF92	DWD TRI #12AV6 DID PND #1U5		M8098 M8100	DIO GAS OC3 PND SIN #6AK5	
DF92	PND SIN 1AF4. #1L4		MB142	DIO GAS OC3	
DK92	PTG SIN #1AC6 PND SIN #354		M8163 M8190	DID SIN #6354 DID GAS #5783	
EC92 EF92	TRI SIN #6484 PND SIN 6C06		M8204	TET GAS #5727	
EN92	TET GAS #5696		M8206 M8207	D10 GAS #083 D10 GAS 083	
HL92 DL93	BEA SIN #50C5 PND SIN #344		18042	PND SIN #6086	
0293	FIG SIN ROAS			D ON PAGE C-64)	

ELECTRONIC INDUSTRIES . June 1962

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New Tech Data

for Engineers

Display Storage Tubes

Complete information including photographs, schematics, and operations data on the Iatron Display Storage Tubes is available from the Industrial Laboratories Div., International Telephone and Telegraph Corp., 3700 E. Pontiac St., Ft. Wayne, Ind.

Circle 347 on Inquiry Card

L-F Oscillators

The Electronics Div., of Bulova Watch Co., Inc., 61-10 Woodside Ave., Woodside, N. Y., is offering tech data on a number of low freq. crystal controlled oscillators for use as high stability freq. sources of high accuracy timer references. The oscillators range from 1CPS to 20 κ C, stabilities from 2pp 10° to 1pp 10° for an hour's operation.

Circle 348 on Inquiry Card

DC Power Modules

Technical Bulletin TP-660 describes ACDC's TP Series of 'Transistor Power Modules.' These compact, plug-in, dc power supplies are available in 8 models ranging from 5 to 41v and up to 3.5 amperes output. Regulation is 0.01% and ripple does not exceed $500\mu v$. ACDC Electrons. Inc., 2979 N. Ontario St., Burbank. Calif.

Circle 349 on Inquiry Card

Solid State Time Delay

Shockley Transistor unit of Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif., has tech. data available describing simple, variable time delay circuits, using a small number of components which can be designed with the Shockley 4-layer diode as the active element.

Circle 350 on Inquiry Card

Thermoelectric Devices

A 6-page catalog illustrating and describing a new line of single, 2 and 3 stage thermoelectric cooling/heating devices and a Peltier chamber, which operate on up to 90% less current than other thermoelectric devices is available from Jepson Thermoelectrics. Inc., 139 Nevada St., El Segundo, Calif.

Circle 351 on Inquiry Card

Thermistors

Victory Engineering Corp., 124-28 Springfield Ave., Springfield, N. J., is offering their 11th Edition Catalog V 680. Included is information on high quality thermistors and varistors, with full specs., outline drawings, and characteristic curves.

Circle 352 on Inquiry Card

Subcarrier Oscillator

Model MVO-20, silicon transistorized, low level subcarrier oscillator features high temp. stability, high input impedance and low power consumption. Standard IRIG channels are available with $\pm 7.5\%$ deviation with signals of ± 10 mv or 0 to +20mv input. Linearity is better than 0.5%of design bandwidth from best straight line. Dorsett Electronics, Inc., 119 W. Boyd, Norman, Okla.

Circle 353 on Inquiry Card

Tube Handbook

A 40-page reference handbook describing the English Electric Valve line of communication and microwave tubes is available from Calvert Electronics, Inc., 220 E. 23rd St., New York 10, N. Y. The book lists complete information on more than 350 EEV tubes as well as interchangeability data on comparable American and European tube types. Available by writing under company letterhead.

Solar Heat

"Solar Heat Simulation," 6 pages, discusses problems encountered in simulating the heating effects of solar radiation on satellites and other space vehicles. Typical space-environment chambers and infrared heat sources are described with emphasis on the use of programmed controls in reproducing flight path conditions. Research Inc., Box 6164, Minneapolis 24, Minn.

Circle 355 on Inquiry Card

Transistorized Chopper

Tech data is available from Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif., describing its Model 65 Plug-in Chopper. The unit has a transformer-coupled isolated drive network so that it can, for example, be driven from a 400CPS power line or from a drive source that is common to the dc voltage being chopped.

Circle 356 on Inquiry Card

Klystrons

Microwave klystron tubes are presented in a 4-page Quick Selector booklet. The booklet lists 18 tube types in 3 groups: fixed frequency, tixed frequency trimmable, and tunable. In addition to freq. range and power output information, the booklet lists similar tube types for each of the klystrons described. A copy of Reflex Klystron Quick Selector booklet ET-1309 can be obtained from the Westinghouse Electronic Tube Div., Box 284, Elmira, N. Y.

Circle 357 on Inquiry Card

World Radio History

Transistor Nomograph

A transistor transformer load impedance and dissipation nomograph for use in design of Class A and Class B transformer coupled transistor audio and servo amplifiers, is included in Catalog 621 "Miniaturized Transformers" available from Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y. The 35-page catalog also contains information on audio, converter, driver, interstage, isolation 400CPS, pico-miniature, subminiature audio, transistor-output interstage, and veri-miniature audio transformers. Also included is a dbm vs power level chart, Mil-T-27A information, photographs, and spec. tables. -

Circle 358 on Inqury Card

Constant Firing Diode

Engineering Data Release Issue No. 37, entitled, "Constant Firing Regulating Diode" contains information on the Bendix® TD-36A, a miniature cold cathode inert gas filled diode. It is designed for use as a constant firing diode in overvoltage protection circuits, RC timing circuits and energy transfer circuits. Photographs, schematics, characteristics, charts, and a typical oscilloscope trace are included. The Bendix Corp., Red Bank Div., Eatontown, N. J.

Circle 359 on Inquiry Card

Ceramic Tubes

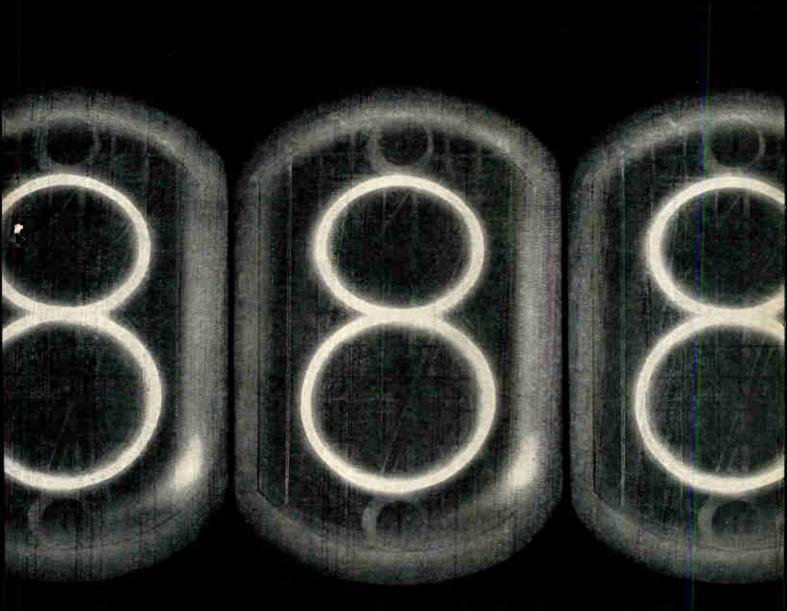
Complete compilation of information on ceramic receiving tubes is contained in 2 new volumes from General Electric's Receiving Tube Dept.. Owensboro, Ky. Bulletin ETD-2713. 213 pages, contains full tech. data on G-E's entire line of 20 registered and 15 developmental ceramic tube types. Graphs, diagrams, illustrations, a tube selection chart and typical socket data are included. Bulletin ETD-2134. 52 pages, contains extensive application information as well as data on design, materials, manufacturing UHF-VHF performance, and reliability. of small ceramic receiving tubes.

Crcle 360 on Inquiry Card

Indicator Tube Catalog

Burroughs Corp., Electronic Components Div., P. O. Box 1226, Plainfield, N. J., is offering a new NIXIE Indicator Tube Catalog, describing the new Wide Viewing Angle Series of NIXIE tubes. The Catalog covers circuit design criteria and contains detailed suggested circuits for using NIXIES in various types of electromechanical and electronic systems.

Circle 361 on Inquiry Card



the new rectangular NIXIE[®] tube

There's a new addition to the Nixie Tube Line . . . the Rectangular Nixie Indicator Tube. This latest advance in Nixie Tube design provides a major reduction in the over-all width and depth of the readout, but the same character size is maintained.

To the design engineer this means: Greater freedom for equipment miniaturization • Design flexibility, including the use of smaller drive circuits • The ability to add features without increasing space.

And the new Rectangular Tube retains all of the advantages which have made Nixie Tubes industry's most popular readout . . . longest life, lowest cost, smallest size (now smaller than ever!), and greatest readability. Write today for complete technical information on the entire line of Nixie Indicator Tubes . . . including the new Rectangular Nixie Tube.





NEW RECTANGULAR





optical systems and

components

FOR VISIBLE, ULTRAVIOLET AND INFRARED RADIATION

ASTRON ☐ OPTICS Division can supply custom designed optical systems and components to meet the most rigid specifications.

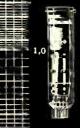
Components are available in any material including all known optical glasses, synthetics, germanium, silicon, and beryllium.

Systems and components assembly is performed in strict clean-room environment.

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GEC vidicon camera tubes

GEC offers the highest sensitivity image pick-up tubes having the widest coverage of the spectrum.

Available are a variety of Ubicons, Ebicons, Vidicons, and far infrared imaging tubes.

A wide choice of other tube parameters including slow scan characteristics, magnetic focus and deflection, electrostatic focus and deflection, electrostatic focus and magnetic deflection and return beam multiplication is available from GEC.



GEC scan conversion systems

Transistorized with printed circuit modular components, GEC Scan Conversion Units incorporate the most advanced technological developments available for controlled conversion from one scanning mode to any other.

Conversion of PPI to TV, TV standards conversion, storage and integration of video information, time-coordinate transformation, digital to analog, TV conversion, and conversion of slow scan narrow band systems to standard TV or vice versa are available.

Information on GEC Monoscope Video Signal Generators, monitoring systems and slow scan TV cameras for use with GEC Scan Converters is available on request.

For integrated systems employing either optics, sensors or processing electronics, or any combination to meet your requirements, write or call



GENERAL ELECTRODYNAMICS CORPORATION 4430 FOREST LANE • GARLAND, TEXAS • BROADWAY 6-1161

Circle 55 on Inquiry Card



EXTRA PERFORMANCE AT LOWER COST

GAZ

Specify Raytheon Reliable Receiving Tube Types

Raytheon's exclusive design features can improve the performance of your radio, television receiver and high fidelity designs. To illustrate:

Video Pentode 6HB6, 15HB6 — A unique Raytheon grid winding makes possible twice as much sensitivity as conventional tubes and increased voltage output. This tube with transconductance in excess of 20,000 μ mhos is ideal as a luminescence amplifier in color TV; video amplifier in single-rectifier b&w receivers. New Pentode-Diode 6GA7 — A horizontal amplifier and damping rectifier, the 6GA7 utilizes a 12-pin integral all-glass base. It delivers performance equivalent to separate 6DQ6B and 6AX4B tubes along with space, socket, and other savings.

Horizontal Amplifiers 6GE5, 12GE5, 17GE5 — New 12-pin integral all-glass base types are equivalents of "-DQ6B" types with greater reliability and uniformity, plus exceptional performance on low-to-high line voltage variations.

For special engineering assistance on your specific application as well as technical data on these tube types, please contact: Raytheon Company, Receiving Tube Operation, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

For small order and prototype requirements see your local franchised Raytheon Distributor.

INDUSTRIAL COMPONENTS DIVISION RAYTHEON

NEWTON 58, MASSACHUSETTS

Circle 56 pro inquiry Card



Tung-Sol's "High Environmental" transmitting, series regulator and modulator tubes —including hard-glass miniature—are designed and built to withstand the toughest extremes of shock, vibration and temperature with highest standards of performance and reliability.



HYDROGEN DIODES

Tung-Sol has expanded its hydrogen diode family to include tubes with ratings up to 2 amperes average at 25KV peak inverse voltage. These tubes, the 7789, 7790, 7791 and 7792 serve as charging diodes or clippers in radar modulators and as general-purpose, high voltage rectifiers.

NEW 5000-VOLT

SILICON RECTIFIER

This uniquely designed 5000-volt unit

features a special double-seal to as-

sure maximum reliability in the toughest high-voltage industrial and military applications. These rectifiers are smaller than competitive devices and less expensive. They are furnished with

clip-mounting terminals for ease of

installation.

PHOTOTUBES



Tung-Sol's new series of experimental photo-emissive and photo-conducting devices offer reliable full-spectrum coverage from infra-red to far ultra-violet in any of countless control applications.

Now greatly expanded, the Tung-Sol line of rugged subminiatures is designed to highest performance standards, including MIL specs, for exacting industrial and military uses. Included are pentodes, triodes, diodes, VR tubes, reference tubes and thyratrons.

CERAMIC HYDROGEN THYRATRONS



This new Tung-Sol family of ceramic hydrogen thyratrons includes the 8191, 8192, and 8036 which deliver peak output powers of 135 KW., 450 KW., and 6.5 MW., respectively. All are flange-mounted, with flying leads, to permit easy installation and good electrical connections, consistent with minimum tube size as demanded by airborne radar and other highly compact applications.

COMPACTRONS



Tung-Sol compactrons offer definite advantages, both engineering and economic, to equipment manufacturers. Basic design considerations include careful attention to tube usage from a functional standpoint. The 12-pin configuration provides the versatility necessary to produce multi-purpose, multiple structure tubes.

PRESS-FIT DIODES AND ASSEMBLIES



Tung-Sol premium-quality press-fit diodes offer electrical characteristics that are equal to or exceed those delivered by the stud-mounted 1N2154-1N2160 series. These economical units make practical the use of a single device for applications requiring from 1 to 30 amperes. Also available: a wide line of standardized rectifier modular assemblies in a variety of voltage ratings. The assemblies are the smallest made today for the 2 to 50 ampere range.

SUBMINIATURE LAMPS



Tung-Sol subminiature incandescent lamps are produced in many combinations of bases and filaments and are designed to operate over a broad range of voltages. Life expectancies range from 500 to more than 5000 hours. The Tung-Sol T 1¾ unit, the newest addition to the line, is intended for indicator service in aircraft, military and commercial applications.

NO. 4 READ-OUT LAMP



The No. 4 Tung-Sol lamp is a highintensity miniature light source particularly well suited for photoelectric read-through applications. It may readily be adapted to a wide variety of uses where an intense, small spot of light is required.



TRANSFORMER-RECTIFIERS



Nine of every ten transformerrectifiers supplying airborne power to the nation's newest commercial, military and experimental aircraft were designed, developed and manufactured by Tung-Sol's Chatham Division. Chatham manufactures more than thirty different transformer-rectifiers with ratings from 5 amps through 200 amps.





Tung-Sol germanium Cold-Weld power transistors feature ultra-low K-factors, maximum junction temperatures of 110C°, low saturation voltage, and high breakdown voltages which contribute to the superior performance of these peakpower devices. Copper-tocopper Cold Welds eliminate heat-produced contamination.

World Radio History

DYNAQUAD,

Tung-Sol's new 4-layer PNPN bistable transistor slashes component requirements and offers substantial circuit simplification. One example of this component advantage: a 10-bit shift register designed with Dynaquad requires 1/3 the printed circuit board area as that in a conventional transistor circuit.

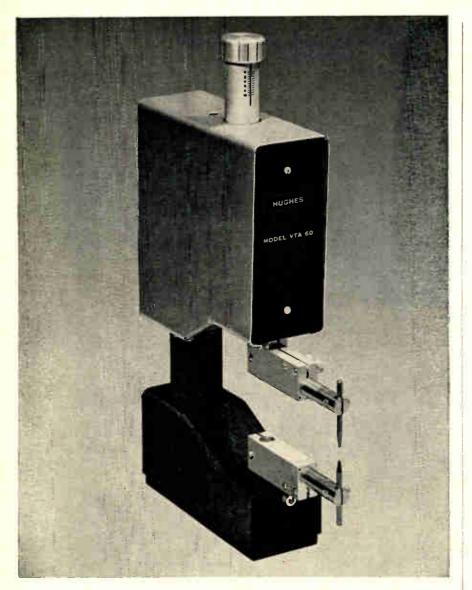


REGULATED POWER SUPPLIES



This new hand-carry 100 ampere regulated d-c power supply, Model R2432-100 is the first of a series to be introduced by Tung-Sol's Chatham Division. Weighing less than 100 pounds, 50% lighter than comparable competitive units, the R2432-100 features solid-state reference and control circuits in addition to complete internal radio noise suppression. More detailed information and technical assistance are promptly available from Tung-Sol Electric Inc., Newark 4, New Jersey, or through sales offices in the following cities: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N.J.; Melrose Park, Ill.; Newark, N.J.; Philadelphia, Pa.; Seattle, Wash. CANADA: Toronto, Ont. TWX:NK193

C63



HUGHES NEW MODULE WELD HEAD

The rugged, all-new Hughes VTA-60 Weld Head gives you many advantages. Look at the list... **Down-stroke stop**—adjustable to allow only an additional .1 lb. weld force beyond firing force regardless of foot pedal pressure applied.

Up-stroke stop—can be used to limit electrode travel without changing electrode horns.

Force range 3/4 to 20 lbs.—exact preset weld force must be reached before weld energy is released.

Low inertia—only 3-3/4 ounces of moving weight. Throat depth—5-1/4 inches standard.

Mechanical advantage of 2.5 to 1 provides maximum operator "feel" with minimum effort.

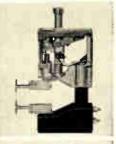
Both upper and lower electrode arms can be rotated a full 180° to accomplish an endless variety of weld setups.

Head casting swivels 360° (see photo at right). Only 1-1/2 inches wide—permits work pieces to pass by the weld head when using offset electrodes:

Hardened steel ball bushings and roller bearings throughout for exceptional rigidity and durability. Electrode arm alignment blocks—make possible complete change of electrodes at the weld station in less than 30 seconds—with any preset angle regained within ± 1 degree!

For full information on the VTA-60 and Hughes full line of electronic welding equipment, write or wire: HUGHES WELDERS, 2020 Short Street, Oceanside, California.

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Creating a new world with ELECTRONICS

HUGHES

VACUUM TUBE PRODUCTS

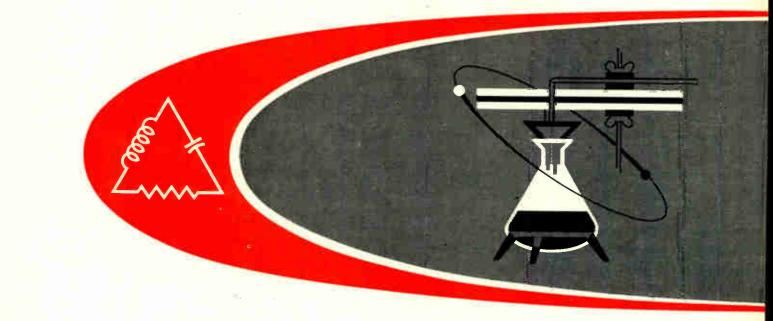
Foreign vs. Domestic Microwave Tubes (Continued)

No. Type/Si	milar to or Interchangeable Wit
CV216	D10 GAS 003
CV449 CV466	DIO GAS OG3 PND SIN 6488
CV568	D10 SIN 3525GT
CV571	BEA SIN SOLOGT
CV579 CV686	PTG SIN 648GT DIO GAS 0C3
CV 729	DIO TWN SV4G
CV752	TRI GAS DA4G
CV753	DIO SIN 143
CV756 CV784	PND SIN 145GT DID PND 155
CV797	TET GAS 2021
CV807	PND SIN 344
CV808 CV818	TRI TWN 345 PND SIN 304
CV819	BEA SIN 305GT
CV925	TRI TWN 125N7GT
CV1 762	PND SIN 64K6
CV1800 CV1805	PND SIN 1C5GT
CV1818	DIO TRI INSGT
CV1823	PNO SIN INSGT
CV1826 CV1830	BEA SIN 105GT DIO SIN 183
CV1832	DIO GAS OA2
CV1833	D10 GAS 082
CV1846 CV1851	DIO TWN 574 DIO TWN 5X4G
CV1854	DIO TWN SY3G
CV1862	BEA SIN 6405
CV1865	TRI SIN #6R4 PND SIN 6AG7
CV1882 CV1886	TRI SIN 604
CV1912	PND SIN 6F6
CV1949	TRI GAS 6D4
CV1959 CV1961	BEA SIN 50C5 PND SIN 12AU6
CV1985	TRI TWN 65L7GT
CV1992	TRI GAS 1267
CV2105 CV2107	PND SIN 6373 PND SIN CK512AX
CV2115	010 SIN 183
CV2137	PND SIN 6887
CV2225 CV2235	DIO SIN 6354 DIO SIN 6374
Cv2237	PND SIN 1AD4
CV2240	BEA SIN 384
CV2253 CV2254	TET GAS 6574 PND 51N 5678
CV2348	PND SIN 5889
CV2507	PND SIN 104
CV2523	PND SIN 6AH6 TRI SIN 6AS7G
Cv2524	PND SIN 6AU6
CV2526	DIO TWN 6AV6
CV2573	DIO GAS 5651 TRI SIN 4174
CV2642 CV2726	PND SIN ACK6
CV2796	BEA SIN 5881
CV2831	TRI TWN 2051 TRI SIN 604
CV2842 CV2901	PND SIN 5879
CV2963	D10 GAS 6073
CV2983	PND 51N 3V4 TR1 TWN 6201
CV3508 CV3512	TR1 TWN 6201 TET GAS 5696
CV3526	PND SIN 68N5
CV3789	TRI SIN 5842
CV3798	DIO GAS 043 DIO GAS 083
CV3899	8EA SIN 5932
CV3905	PND SIN 5847
CV3912 CV3929	DIO PND 105 PND SIN 5840+ 6205
CV3930	TRI SIN 5718
CV3998	PND SIN 6688
CV4010 CV4011	PND SIN 5654, 64K5 PND SIN 5725
CV4017	TRI TWN 5751
CV4018	TET GAS 5727
CV4020	DIO SIN OA2WA
CV4028 CV4055	PND SIN 6132
CV5032	DIO SIN 1X24
CV5065	TRI PND 608
CV5079 CV5146	TET GAS 5643 TRI TWN 5814
CV5188	TRI TWN 5687
CV5189	D10 TWN 5726
CV5211	DIO SIN 5641

World Radio History



Materials & Hardware



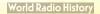
Magnetic	Materials	Selection	Charts		D2	

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Magnetic Materials Selection Charts

SEE CHART

в

D

Е

MAGNETIC materials, in one form or another, are

relays, solenoids, filters, computer cores, motors, syn-

INDEX OF

steel

nickel alloys

nickel alloys

pieces

chros. etc.

frequencies

frequencies

force

High permeability

IF YOUR PRIMARY CONSIDERATION IS

Core loss at low or intermediate

Core loss at low or intermediate

Low retentivity or low coercive

High frequency operation

used in such varied components as transformers,

CHARTS

AND YOUR

Lominated or wound cores of silicon

Material for relay cores or pole

Powder, wound, or laminoted cores

Laminoted or wound cores of

Laminoted or wound cores of

By J. E. MITCH Chief Electrical Eng The Arnold Engineering Co P. O. Box C Marengo, III



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There are many types of magnetic materials, each of them generally having certain specific applications. The materials come in various forms-laminated, tape wound, rolled, or pressed powder, and they are available in shapes to suit various applications.

The charts presented here list magnetic materials that are of a non-permanent magnet nature. An index chart is given to aid in rapidly finding the "lettered" chart that contains the particular application of interest. The "lettered" charts list the application, recommended material and the necessary properties of the material. Also included is a summary chart that lists the major types of material and their properties, both physical and de magnetic.

CHART	А

Grade General Applications		AISI Type M-43	AISI Type M-36	AISI Type M-27	Super Dynamo	Al SI Type M-22	AISI Type M-19	AISI Type M-6	AISI Type M-7
		Intermittent duty rotating machines, pole pieces, relays	Rotating machines, including ac-dc motors	nes, efficiency requiri ing motors, improv Ic small low den		Designs requiring improved ow density ermeability Stators of induction motors and high efficiency rotating equipment		Power and distribution transformers, large turbogenerators, small power and audio transformers	
Nominal conter percer Cold r	nt, nt	.50	1.75	3.00	3.00	3.00	3.00	3.25	3.25
Core los	s, WPP								
	ax (.014 in.	1.30	1.17	1.01	.95	.82	.72		
. 1	.014 in. .0185 in.	-	1.35	1.14	1.08	.94	.83		
00 ch2	.0185 Inc	1.98	1.70	1.30	1.25	1.10	.97		
15.0008	(.014 in.		3.00	2.46	2.35	2.00	1.75	.66	.73
-	.0185 in.		3.20	2.66	2.54	2.20	2.00		
00 CP3	.025 in.		3.85	3.05	2.93	2.60	2.35		
Saturati induc gauss	on tion (B _s)	20 500	20 000	19 000	19 000	19 000	19 000	19 700	19 700
Specific gravi		7.75	7.75	7.65	7.65	7.65	7.65	7.65	7.65
Electrical resistivity microhm-cm		28	37	47	47	47	47	50	50

A brief comprehensive description of magnetic materials is given here to aid designers in their selection. The material is presented in an easy-to-follow tabular form.

-

			C	CHART I	В			
Grade	AISI Type M.7 Wound Core, .012 in.	AISI Type M-7 Strip, .014 in.	AISI Type M-7 E-1 Lamina- tions, 1x1 interleaved	Mumetai .014 in.	50% Nickel Iron, .014 in (non- oriented)	4-79 Moly- Permalloy, .014 in.	Oriented 50% Nickel Iron, .005 in.	Non- Oriented cold-rolled silicon steel,.007 i
General Applications	Distribu- tion trans- formers	Power trans . formers	Power and audio trans- formers	Shields, audio trans- formers and filters	Audio trans- formers and filters	Audio trans- formers and filters	Magnetic amplifiers	High frequency rotating machinery
Nominal composition, percent								
Silicon	3.25	3.25	3.25			_		3.25
Nickel				77.00	48.00	79 .00	50.00	0.20
Core loss, WPP								
10,000B 60 cps	.30 max	.32	.40	.033	.20	.026	.20	.50
400 cps	6.00 max	6.50	7.30	1.00	5.50	.90	1.20	8.00 max
15,000B 60 cps	.71 max	.73	.90		.50			
400 cps	13.00 max	16.00	19.00		13.00-			_
Saturation induction (B _s) gausses	19 700	19 700	1 9 700	7 500	15 500	8 000	16 000	19 700
Specific gravity	7.65	7.65	7.65	8.50	8.20	8.74	8.25	7.65
Electrical resistivity microhm-cm	50	50	50	60	50	<u>55</u>	45	50

CHART C

Grade	AISI Type M-7 Wound Cores, .012 in.	Silectron Laminations .014 in.	Mumetal .014 in.	Molybdenum Permalloy .014 in.	4750 .014 in.	Oriented 50% Nickel- Iron, .002in.	Supermalloy .004in.
General Applications	Power distribution transformers	Power and audio Low induction trans- filters and audio formers transformers		Servo and synchro motors, audio transformers	Magnetic amplifiers	Magnetic amplifiers, specialty transformers	
Nominal composition, percent					in an stormers		
Molybdenum			_	4.00			5.00
Silicon	3.25	3.25	-				
Nickel			77.0	79 .00	48.00	50.00	79 .00
DC permeability							
μ max	50 000		100 000	200 000	80 000	100 000	700 000
B at μ max	8 000		2 500	3 000	5 000	12 000	3 000
μat 40B	4 000		25 000	30 000	8 000	500	75 000
μ at 100 B	6 500		30 000	45 000	12 000	2 000	80 000
AC permeability 60 cps							
μat 40B	3 500		20 000	26 000*	8 000*	500	70 000
μat 2008	6 500	_	30 000	32 000*	13 500*	1 000	9 0 000
μ at 2,000B	15 000		40 000	54 000*	30 000*	20 000	160 000
Saturation Induction (B ₈) gausses	19 700	1 9 70 0	7 500	8 000	15 500	16 000	7 800
Specific Gravity	7.65	7.65	8.5	8.74	8.20	8.25	8.77
Electrical resistivity microhm-cm	50	50	60	55	45	45	65

ELECTRONIC INDUSTRIES . June 1962

Magnetic Materials Selection Charts (Continued)

Grade	Similar To AlSI Type M-36	Similar To AISI Type M-37	4750	Mumetal	Stainless Steels 400 Series	2V Permendur; 2V, 49Co, 49Fe
General Applications	Relays	, armatures, s <mark>ole</mark>	noids, magne	tic clutches, po	le pieces	47/6
Nominal compo- sition, percent Silicon	1.25	2.50			_	
Nickel			4 <mark>8.00</mark>	77.00		-
Chromium			—	1.50	12.00-18.00	
Molybdenum				-		
Cobalt		_				49.00
DC Hysteresis						
B _{max} (gousses)	10 <mark>000</mark>	10 <mark>000</mark>	10 000	5 000	10 000	20 000
B _r (gausses)	6 000	6 000	8 000	3 000		15 000
H _c (oersteds)	.7	.5	.03	.015	3.0	1.0
Saturation induction (B _s) gausses	20 500	19 500	1 <u>5</u> 500	7 500	15 500 to 17 500	23 000
Specific gravity	7.75	7.65	8.20	8.50	7.65	8.15
Electrical resistivity microhm-cm	25	40	50	60	<u>55-120</u>	38

CHART D

CHART E

							Ultra T	hin Nickel	-Irons
Grade		Permalloy		Oriented Silicon- Steel 4 Mil	Oriented Silicon - Steel 2 Mil	Oriented Silicon- Steel 1 Mil	Square Permalloy	Oriented 50% Nickel Iron	Super- mallo
G <mark>ene</mark> ral Applications	Pulse trans- formers, high frequency trans- formers	Load- ing coils, filters	High frenquency rotating machinery	high fre	se transform quency trans gnetic ompli	formers,	•	netic ampli mputer cor	
Nominal compo- sition, percent									
Nickel	47.00	81.00	I		—	-	79.00	50.00	79.00
Silicon	- I	-	3.25	3.25	3.25	3.25	-		
Molybdenum	3.00	2.00		-			4.00		5.00
Nominal frequency range	Audio range	Audio to low R.F.	400 cps 800 cps	400 cps Audio range	Pulse .5 to 10 microsec	Pulse under .50 microsec	Pulse at repetition rates up to 1 megacy		
Specific gravity	8.25		7.65	7.65	7.65	7.65	8.74	8.25	8.77
Saturation induction (B _s) gausses	14 500	7 800	19 7 00	<mark>19 70</mark> 0	19 700	19 700	8 000	16 000	8 000
Electrical resistivity microhm-cm	65 min	high	50	50	50	50	55	45	65

AP. L. J. Lawrence

MATERIALS & HARDWARE

Magnetic Material	S <mark>p</mark> ecific Gravity	Resistivity microhm- cm	Saturation Induction (B ₈), gausses	Initial Permeability #0	Permeability at 200 gausses	Maximum Permeability ^µ m	Induction at $\mu_{\rm m}$ gausses	Coercive Force (He) oersteds
AISI Type M-43	7.75	28	20 500	280	500	3 000	8 000	.90
AISI Type M- <mark>3</mark> 6	7.75	37	20 000	280	900	5 000	6 000	.80
AISI Type M-27	7.65	47	19 000	290	1 100	7 000	8 000	.70
Super Dynamo	7.65	47	19 000	290	1 100	7 000	8 000	.70
AISI Type M-22	7.65	47	19 000	290	1 100	9 0 <mark>0</mark> 0	7 000	.60
AISI Type M-19	7.65	47	19 000	300	1 500	10 000	7 000	.20 —.50
AISI Type M-6	7.65	50	19 700	350	8 000	50 000	9 000	.08 —.12
AISI Type M-7, 4 mil	7.65	50	19 700	1 000	3 500	20 000	10 000	.40 —.60
AISI Type M-7, 2mil	7.65	50	19 700	1 000	2 200	15 000	9 000	.50 —.70
AISI Type M-7, 1 mil	7.65	50	19 700					.60 —.80
AISI Type M-36	7.75	25	20 500			5 000	8 500	.5090
AISI Type M-37	7.65	40	19 500			9 500	7 500	.20 —.60
2V Permendur	8.15	40	23 000	800		4 900	13 500	.40 -1.20
Туре 406	7.41	120	15 500					2.005.00
Type 416	7.65	57	17 500			900	10 000	2.00
4750	8.20	50	15 500	3 500	15 000	40 000- 130 000	5 000	.02 —.10
Monimax	8.2 <u>5</u>	65 min	14 500	3 500	10 0 <mark>0</mark> 0	40 000 100 000	5 000	.02 —.10
Oriented 50% Nickel-Iron	8.25	45	16 0 00	5 <mark>0</mark> 0	3 000	100 000- 200 000	14 000	.04 —.16
Mumetal	8.50	60	7 500	20 000	5 0 000	70 000– 300 000	3 000	.0103
4-79 Molybdenum Permaliey	8.74	55	8 000	25 000	60 000	100 000-	3 000	.0103
Supermalloy	8.77	65	7 800	60 000	95 000	3 00 000- 900 000	3 500	.003009

TYPICAL PHYSICAL AND DC MAGNETIC PROPERTIES

Permeability values were measured on samples cut parallel to the rolling direction except for Rotosil where the sample was cut half parallel and half at right angle to the rolling direction.

STANDARD MAGNETIC TEST SYMBOLS

a	Cross sectional area of B coil (mean area	H _{c1}	Intrinsic coercive force
	of turns in square centimeters)	Her	Relaxation coercive force
$-\Lambda$	Cross sectional area of specimen in	H _{cs}	Coercivity
	square centimeters	H	Demagnetizing force
	Magnetic induction	Н	Incremental magnetizing force
В	Normal induction	Hm	Maximum magnetizing force in a hyster-
	Magnetic flux density	1 m	esis loop
$\mathbf{B}_{\mathbf{b}}$	Biased induction	\mathbf{I}_{c}	
B _d	Remanent induction; values of induction		In-phase component of exciting current
	on the demagnetization curve	Iq	Quadrature component of exciting cur-
В,	Intrinsic induction		rent
Bm	Maximum induction in a hysteresis loop	L	Self inductance
Br	Residual induction	L _m	Mutual inductance
B _{cs}	Retentivity	1	Mean length of magnetic circuit
B _s	Saturation induction	N	Total number of turns
B_{Δ}	Incremental induction	n	Turns per centimeter
B	Demagnetizing coefficient	P	Electrical resistivity
	(Magnetomotive force	30	Permeance
F	Magnetic potential difference	P _a	Apparent core loss
f	Frequency	P_c	Core loss
ß	Form factor	Pe	Eddy current loss
н	Magnetizing force	P 81	Specific core loss
n	Magnetic intensity	P _h	Hysteresis loss
$\mathbf{H}_{\mathbf{b}}$	Biasing magnetizing force	P _g	Reactive power
H	Coercive force	P _A	Incremental core loss

- R Reluctance
- S Lamination factor
- T_e Curie temperature
- {Permeability μ.
- Normal permeability (DC) Differential permeability Ha
- μ_1 Intrinsic permeability
- μ_I,
 - Alternating current permeability based on comparison of the magnetic material to a capacitor or inductor in a bridge circuit
- Maximum permeability μ_m Initial permeability
- 140 $\mu_{\rm p}$
 - Alternating current permeability based on peak exciting current
- Reversible permeability μ_r
- Space permeability μ_v
- Alternating current permeability based μ, on the rms exciting current
- Incremental permeability μs
- ν Reluctivity
- ø Magnetic flux Ĵ Flux linkage

MATERIALS & HARDWARE

Fuel cells and their potential are being investigated by more than 60 governmental and industrial projects in the U.S. alone. What are fuel cells? Why this interest in them? What progress has been made? These and other questions pertaining to this "power source of the future," are answered.

FUEL CELLS—A Status Report

By SMEDLEY B. RUTH

Assistant Editor Electronic Industries

WELL over a century ago, an Englishman, Sir William Grove, demonstrated a fuel cell using hydrogen and oxygen. Until fairly recently little was done to develop fuel cells further. Why was this true? There are several answers to this question—sources of energy have been both plentiful and relatively cheap; present power systems have been able to fill the population's demands; and, means and materials to perfect the fuel cell were not available.

How and why has the picture changed in the last fifteen years? We have come to realize that our fossil fuel supply is not unlimited. The possibility of an exhausted fuel supply has been accentuated by the current population explosion. Also, we have found electrical energy useful for an increasing number of applications. Availability of improved materials has contributed to current fuel cell activity, but the greatest impetus has no doubt come from military and space agencies. The fuel cell has advantages over conventional power systems which are of special interest to the military.

Even though governmental contracts have spurred interest in fuel cell R&D, industry is also contributing. Company-funded R&D, in 1961, was estimated at \$15 million. This attests to the tremendous possibilities of the fuel cell.

Advantages

Some fuel cell power advantages should make obvious the reason for the increasing attention being afforded this device.



Fig. 1. Dr. B. Agruss, electrochemist at the Allison Div. of General Motors, is shown with regenerative liquid metal fuel cell he invented. Lab model is encased in small furnace in the foreground.

ELECTRONIC INDUSTRIES . June 1962

DA

Radio History

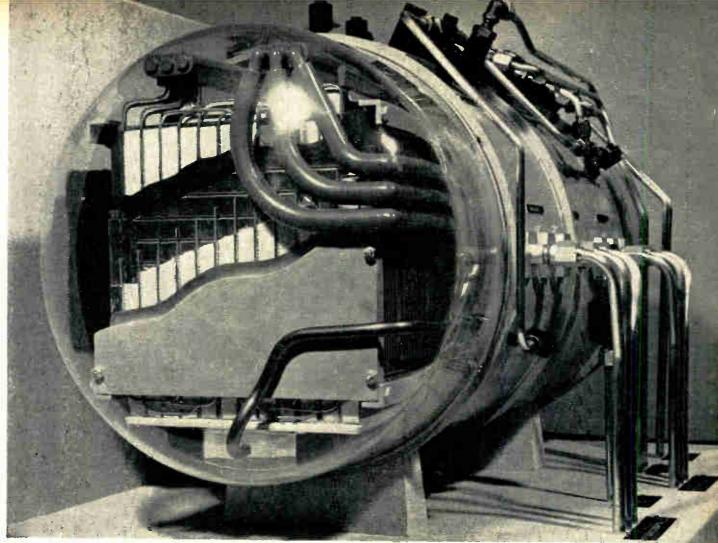


Fig. 2. Cut-away mockup of G.E. fuel cell that will be used as primary power sources in Gemini spacecraft being developed by

Estimates of attainable fuel cell efficiencies up to 90%—in theory and 70% in practice—have been made. When compared to the 25-35% efficiencies of gasoline and diesel engines or the 40% efficiencies of steam equipment, the advantage of the fuel cell is apparent. Fuel cells have no moving parts except for control. They do not produce obnoxious fumes, are silent, operate at ambient temperatures, and can (in theory) be built in any size and capacity. Low manufacturing costs are promised for some cells since precise tolerances are not necessary.

They are rugged, require a minimum of maintenance, and are efficient in all sizes. They use common fuels. Electrochemical action in some cells yields water which may be used for drinking (most desirable for space applications). The power pack need not be placed in one location, thus, more design flexibility. High power-to-weight and power-to-volume ratios are possible. When a load is not connected, no energy is consumed. Within material limitations, they can be run continuously without replacement or recharging.

Not all systems will include all of these advantages. Some will apply to certain types and some to others. Needs of the user will dictate which system must be selected.

Disadvantages

Fuel cells (at this time) cannot be used to generate large amount of power. Some systems require a large

McDonnell Aircraft. Cell will deliver a peak load of almost 2 kw of dc. It will also provide drinking water as a by-product of operation.

amount of auxiliary equipment for operation. Power output is limited to direct current. Conversion equipment is needed to obtain alternating current. Cost of present systems is prohibitive except for special industrial or military applications.

What is it?

The fuel cell may be defined as an electrochemical device that converts chemical energy directly into electrical energy. It is a primary battery in which the fuel and oxidizer are stored outside the battery and are fed to it on demand. A major difference between a fuel cell and a battery is that a fuel cell's electrodes are not consumed, as are a battery's.

The thermal cycle is eliminated, which is the secret

Main	Industrial	U.	S.	Fuel	Cell	Investigators
------	------------	----	----	------	------	---------------

ALLIS CHALMERS CHRYSLER CORP. CONSOLIDATION COAL	LEESONA MOOS LABS. LOCKHEED MSA RESEARCH CORP.
ELECTRIC AUTO LITE ESSO RESEARCH	R.C.A. STANDARD INDIANA
EXIDE	STUDEBAKER
FORD	UNION CARBIDE
GENERAL ELECTRIC	UNITED AIRCRAFT
GENERAL MOTORS	WESTINGHOUSE

Fuel Cells (Continued)

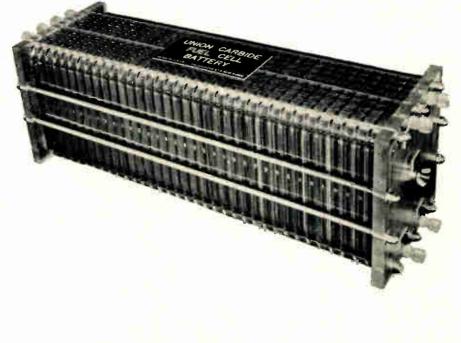
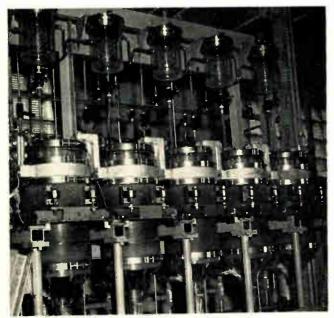


Fig. 3. Union Carbide multicell, flat-plate cell battery is designed to deliver up to 600 watts at good voltage levels. It consists of 36 hydrogen cells in series. This battery is particularly effective where operation at atmospheric pressure and utilization of atmospheric oxygen in place of processed oxygen supplies are important.

of the high efficiencies obtainable by fuel cells. Fuel cells are not subject to the Carnot Limitation as are heat engines. The basic law of thermodynamics dictates that only a fraction of the heat can be converted into mechanical or electrical energy at technically feasible temperatures. About twice as much useful work may be extracted from a pound of fuel when it is consumed in a fuel cell as when it is burned in the most efficient heat engines in operation today. Fuel cells contain, in addition to the fuels, two electrodes, one positive, one negative, and an electrolyte which

Fig. 4. Fuel cell pilot power plant being developed by The M. W. Kellogg Co. for the U.S. Navy Bureau of Ships. Plant consists of five cells in series, each cell having approximately 10.4 sq. ft. of effective area. It uses sodium amalgam and oxygen as the reactants.



serves as the electrochemical connection between the electrodes. Catalysts are used to promote the reaction.

The electrodes act as mechanical devices for bringing the reactants in contact with the electrolyte in a controlled way. They act as catalysts or as catalyst carriers and serve to carry the current generated by the reaction to the load.

Some of the electrode materials used are silver, nickel, palladium, mercury, platinum, carbon, rhodium, and treated forms of carbon.

The anode is the electrode at which the fuel gives up electrons for delivery to the external circuit.

The cathode is the electrode which gives up electrons to the oxidizer.

The electrolyte, in addition to providing the medium for ionic conduction and electron insulation, prevents transfer of the fuel gases away from their respective electrodes where the formation of explosive mixtures can occur.

Some electrolytes in use are potassium hydroxide, sea water, fused mixture of alkali carbonates, phosphates and zirconates, alkali halides and ion-exchange membranes.

At least two fuels are necessary for operation of a cell. One is known as an oxidant, the other as a reductant. They are classified on the basis of the electron donor and electron acceptor characteristics of the reactants in any given system. Some oxidants in use or proposed are oxygen, air, chlorine, and bromine. Some reductants are hydrogen, carbon monoxide, natural gas, methane, ethane, coal, formaldehyde, alcohol, zinc, magnesium, sodium, lithium and ammonia.

In order for practical outputs to be obtained, it will be necessary to connect a number of cells in series and/or parallel. This necessitates the use of additional equipment. This equipment is needed for fuel storage, supply and distribution, temperature and pressure regulation; and reactions product renewal. Fuels cells may be classified as hydrogen-oxygen, molten salt electrolyte, redox (reduction-oxidation). regenerative, consumable electrode and special types. These categories are subject to change as technological advances are made. No attempt will be made to explain the operation of the various types. However, as the major portion of fuel cell research has been concentrated on the hydrogen-oxygen type, its operation will be discussed for purposes of illustration.

How it Works

15 %

The least complicated of all fuel cells typically employs hydrogen and oxygen as fuels, concentrated alkaline solution as an electrolyte, and electrodes made of such materials as treated nickel and carbon.

Oxygen is fed in at the cathode. It is activated there by the proper catalyst and combines with water and an electron from the external circuit to form hydroxyl ions.

These ions move across the electrolyte to the anode. Hydrogen is fed in at the anode where it is activated by the proper catalyst. The hydrogen reacts with hydroxyl ions in the electrolyte to produce water and an electron. The electron is released to the external circuit. In order for the chemical reaction to proceed, a load must be connected to the cell. Thus when the load is not connected, chemical energy is not consumed.

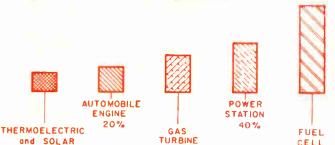
The electrochemical reaction which takes place may be written as:

 $\begin{array}{l} \text{Cathode} = \mathbf{O}_2 + 2\mathbf{H}_2\mathbf{O} + 4\mathbf{e} \longrightarrow 40\mathbf{H} \\ \text{Anode} = 2\mathbf{H}_2 + 40\mathbf{H}^- \longrightarrow 4\mathbf{H}_2\mathbf{O} + 4\mathbf{e} \\ \text{Overall cell reaction} = 2\mathbf{H}_2 + \mathbf{O}_2 \longrightarrow 2\mathbf{H}_2\mathbf{O} \end{array}$

Developments

Chrysler Corporation's present program is aimed at seeking new knowledge and principles. Although Chrysler's work on fuel cells has been with basic research, they have built several very efficient units of





MATERIALS & HARDWARE

Fig. 6. In this comparison of the achievable efficiency of energy conversion systems, the fuel cell is considered a power plant. Its efficiency advantage over other power plants is clearly shown.

30%

70%

the hydrogen-oxygen type. Other types are planned, as hydrogen and oxygen can be a dangerous mixture making them undesirable as a power source for a car. Other hydrocarbons are not so explosive and are widely available. Air would be used to create the required mixture.

Engineers at the corporation's research laboratories are using a ten-inch long engineless car to demonstrate fuel cells in action. They visualize the growth of the tiny car into a full size model powered by fuel cells.

A feature of fuel cell power for autos is that a power plant can be contained within the very framework of the vehicles. It is not difficult to visualize them contained in the door, side panels, in the floor or even in the roof.

Leesona Moos Laboratories (LML) are currently doing research and development work on fuel cell systems which operate at temperatures below 450° F.

Fundamental research is being conducted on fuel cells that use hydrocarbon fuels directly.

They have under development fuel cell systems using impure hydrogen/air (the hydrogen being obtained by refining of natural gas, kerosene, or methanol); methanol wood alcohol/air fuels; and ammonia/air fuel cells. The only oxidizer being considered at this time is air.

Both the Carbox (R) (hydrocarbon-air) and Hydrox (R) (hydrogen-oxygen) fuel cells are developments of LML.

Leesona has licensing agreements with United Aircraft Corp. (Pratt & Whitney Aircraft Div.). Under the agreements, United Aircraft is licensed to use LML patents in its own work with fuel cells. Both organizations are working simultaneously in this field, with United Aircraft's Activity being centered in application engineering and hardware design and development work. LML is concentrating on fundamental research to advance the state-of-the-art. Current areas of interest include basic studies of electrode-reaction mechanisms, solid state and catalysis, fundamental properties of electrolytes, electrode kinetics, surface chemistry and heterogeneous catalysis.

Electro-Optical Systems, Inc. is developing a simple, compact, sealed rechargeable hydrogen-oxygen fuel cell requiring no external controls. Energy to charge the cell would come from plugging it into regular house current. When used in space applications, it

Fig. 5. General Electric fuel cell battery undergoes below-freezing test. The 30 watt fuel cell battery is being evaluated by Army Quartermaster Corps as a potential power source for arctic clothing.

Fuel Cells (Continued)

would be charged by the solar energy system. The cell will provide 15-75 w hrs./lb. In comparison, current nickel cadmium batteries yield less than 5 hrs./lb after thousands of cycles.

The M. W. Kellogg Co. is currently engaged in the development of a fuel cell pilot power plant for the U. S. Navy Bureau of Ships. It uses sodium amalgam and oxygen as the reactants.

The pilot power plant consists of five cells in series, each cell having approximately 10.4 sq ft of effective electrode area. Open circuit voltage of the plant is slightly over 10 volts, and the maximum power output is approximately 16 kw.

Ionics, Inc. have conducted studies on an alkaline cell containing two anion membranes with a strong potassium hydroxide solution between them. This cell is operable at 60°C, with reasonable discharge characteristics, at which temperature water vapor may be removed and condensed elsewhere.

Another cell which has been investigated is the Fuelox cell, which combines the characteristics of a good hydrogen electrode with the equally good discharge characteristics of the bromine-bromide reaction. The bromine solution in the regenerative Fuelox cell is in a closed system.

Two types of Fuelox cells have been investigated with regard to discharge characteristics. The first one contains a "thick" sulfonic ion exchange membrane of about 10 ohm/cm² resistance, and the second, a "thin" sulphonic membrane, of only 5.8 ohm/cm² resistance.

Fuel cell research at *Allis-Chalmers* dates back to 1953. The company has investigated both high temperature, high pressure systems and ion exchange membrane systems. They predict a low pressure, low temperature system, which can be used for mobile power applications.

The first Allis-Chalmers hydrogen-oxygen fuel cell was displayed in 1958. The power volume was 0.1 kw/cu ft and it produced 30 w.

In 1959 a fuel cell power plant was used to drive a farm tractor. One thousand and eight cells, in modules of nine parallel connected cells, produced 15 kw. The tractor, constructed for research purposes only, was operated over a period of six months. It was later donated to the Smithsonian Institution where it is now on display.

Allis-Chalmers research efforts since 1959 have been aimed at increasing the power to volume ratios and the power to weight ratios of the fuel cell. They have also conducted life tests and corrosion studies.

The company's best results has been achieved with hydrogen-oxygen, alcohol-oxygen, alcohol-hydrogen peroxide and ammonia-oxygen. The hydrogen-oxygen cell is by far the most advanced.

Allis-Chalmers is one of several companies sponsoring work at the Electrochemical Eng. Div. of the Battelle Memorial Institute.

North American has announced that the Apollo will use fuel cell batteries. This fuel cell will be used to furnish both electric current and drinking water for the long journey to the moon and back. North American has picked two manufacturers to design competitive versions of an Apollo fuel cell. One is the Pratt and Whitney division of the United Aircraft Corp. The other is the Tapco division of Thompson-Kamo-Wooldridge, Inc. Both fuel cells are to be of the hydrogen-oxygen type.

Exide is conducting evaluating tests on hydrogenoxygen type fuel cells. Work is being done on trying to find cheap sources of hydrogen. Their cells are close to feasible for highly specialized markets, such as military, and possibly industrial.

General Motors Corp., Allison Div. has under development a thermally regenerative liquid metal fuel cell. It will provide a means of converting heat energy directly into electrical energy to supply electrical power for instruments aboard satellites and space vehicles.

Esso Research and Engineering Co. is under contract to the U. S. Army Signal R&D Lab to do fuel cell research. It will investigate carbon-based liquid fuels that are water soluble. Examples of these are methanol, isopropanol, and ethylene glycol. These



Fig. 7. General Electric power supply has demonstrated its ability to power field radar equipment. Air breathing hydrogen-oxygen bat-

tery consists of 40 fuel cells in series (r). Chemical generator supplies hydrogen, and is easily replaced when charge is expended.



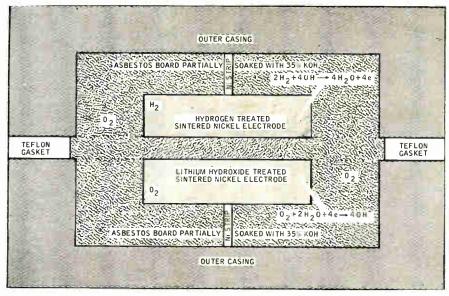


Fig. 8. Above illustration shows a cross section of a hydrogen-exygen regenerative fuel cell made by Electro-Optical Systems, Inc. Disassembled fuel cell (right) shows outer casing, asbestos bed and electrode contact. Also shown are the nickel electrode.

fuels are relatively inexpensive, easily transported, and easily stored when compared to fuels used in other experimental cells.

Esso has more than five years' experience studying fuel cells, especially those using hydrocarbon fuels.

Consolidation Coal Co.'s main interest has been the type of cells that would be capable of using coal as fuel. In this type of cell, coal would be gasified by means of steam or carbon dioxide. This would produce a carbon monoxide rich gas, suitable for use in fuel cells.

Although not active experimentally in years, this company has done considerable work on high temperature fuel cells.

Surface Processes R&D Corp. has worked on low temperature fuel cells using ethane, propane and isobutane as fuels.

The fuel cell that *Monsanto Research Corp.* is considering uses hydrazine fuel in a strong NaOH electrolyte, with a nitric acid oxidant and platinized-platinum electrode.

Most of the activity of Hoffman Electronics Corp. was first related to sodium amalgam-bromine and sodium amalgam-chlorine fuel cells. Using high surface area carbon electrodes, with a proper pore structure may result in fuel cells that could maintain at least 2v. and possibly 2.5v. at current densities of 200 to 250 ma/cm².

Electrochemical couple of their Smatko cell is made of sodium as sodium amalgam for fuel (or any other alkali metal), and a halogen as the oxidizer. For convenience, bromine was selected as the oxidizer. It is highly soluble in sodium bromide solutions and easy to handle.

Armour Research Foundation has developed a fuel cell which can directly convert heat to electricity at efficiencies exceeding 50%. The Foundation principle consists of essentially three parts. First the heat converts the chemicals for the generation of electricity. In the second step, electrical power is taken off while the chemical is cooling. Then, in the third step, portions of the spent chemicals are regenerated by the heat source and are again available for the generation of electricity. Taking off electricity at one point and regenerating materials at another results in a constant conversion of the heat energy to electricity. The heat energy could come from the sun, or possibly the tremendous amounts of heat given off by nuclear reactors could be utilized.

The Foundation is active in fuel cell research on cells with ion-exchange membrane electrolytes. It has also aided the Institute of Gas Technology in their work on natural gas fuel cells.

The Institute of Gas Technology is active in research and development work on high-temperature methane fuel cells. Tests on molten carbonate and solid oxide cells are being conducted.

MSA Research Corp, inventors of the lithiumlithium fuel cell have constructed and operated both calcium-hydrogen and lithium-hydrogen cells. Current loads as high as 420 a/sq ft. on the hydrogen electrode at approximately $\frac{1}{2}$ the open circuit voltage have been obtained.

Work at Union Carbide covers a wide range of topics in the fuel cell field. This includes temperatures from below zero to over 1000°C.; pressures from ambient to several hundred lbs/sq in.; neutral. acid and alkaline electrolytes (aqueous and fused salt); porous carbon and porous metal electrode

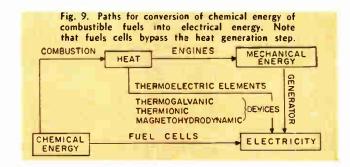




Fig. 10. One thousand and eight Allis-Chalmers fuel cells were used to drive this farm tractor in an experiment conducted in October of 1959.

Fuel Cells (Continued)

types; "redox" systems; and a broad group of fuels and oxidants.

Direct utilization of organic fuels in cells operating at low (less than 100°C.) temperature has been researched with many cells and batteries of this type having been tested.

The Union Carbide Fuel Cell (Hydrogen-Oxygen) is readily operated at temperatures of 70°F.-150°F. and at pressures ranging from atmospheric to a few atmospheres.

In 1957, a hydrogen-oxygen fuel cell battery was demonstrated to the U. S. Signal Corps for use on its portable "Silent Sentry" radar sets. Another demonstration of the fuel cell was made in 1958 at the World's Fair in Brussels, Belgium.

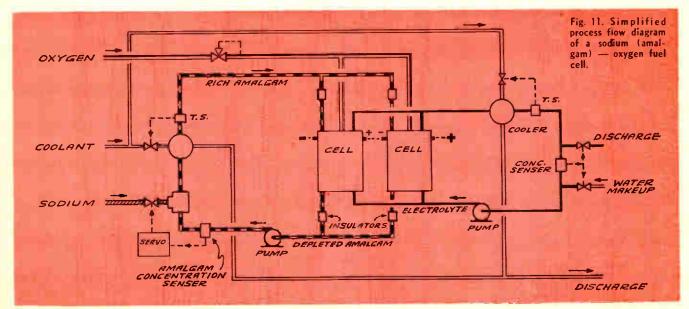
At present, Union Carbide makes batteries only on special orders, but models for the general market are anticipated for the near future.

General Electric's new Direct Energy Conversion Operation in Lynn, Mass., is currently studying ways of getting a fuel cell to operate directly on common fuels such as gasoline, propane or natural gas. The company's Aircraft Accessory Turbine Dept. has built a portable 200 w air breathing power source that has demonstrated its ability to power portable radar and radio equipment. They have also produced a 30 w fuel cell power source that has been demonstrated successfully under below-freezing conditions as a potential power source for arctic clothing. They are investigating the application of fuel cells to remote operating devices such as sonobuoys and navigation buoys, as small power sources, for unattended emergency standby power applications, and for submarine propulsion.

The laboratory in Lynn is doing fundamental work in electrochemistry, and electrode systems. Other engineering studies cover wick systems for water transport and storage, heat transfer, compact lightweight construction, feasibility studies of new fuel cell types using liquid electrolytes and general cost reduction.

Efficient use of conventional hydrocarbons in low temperature fuel cells is the primary aim of hydrocarbon fuel cell research carried on at the research laboratory in Schenectady, N. Y.

MSVD at Valley Forge, Pa., is conducting a program leading to development of a 500 w cell for the U. S. Army Signal Corps.



A small ion-membrane fuel cell battery mounted in a re-entry vehicle has been lofted 600 miles high and recovered after approximately 30 minutes. It performed successfully under conditions approaching those expected to be encountered in an orbital flight. The principle of the hydrogen-oxygen fuel cell with the ion-exchange membrane was conceived and improved by G.E. scientists.

General Electric, under contract with McDonnell Aircraft Corp. will develop a fuel cell battery to supply the primary for the two-man Gemini spacecraft. It will be the first time that conventional batteries or mechanical power units have been displaced by fuel cells as the primary electrical power source in space flight. This hydrogen-oxygen type fuel cell will deliver a peak load of almost 2 kw.

2

Potential Uses

Fuel cells will assume increasing influence and a multitude of new uses will undoubtedly be found for them as their development progresses.

A large potential market for fuel cell power supplies would be for one capable of supplying the necessary power and heat for the home. Initial cost of such a unit would have to be low. Long operating life and reliability would be other necessary features. It would also require a simple method of converting the direct current output of the cell to alternating current.

It is expected that fuel cells will someday be in competition with the internal combustion engine, either gasoline or diesel. It should also enter into competition with the power generating steam station or the diesel energy conversion system. Once again the emphasis would be on long life and reliability.

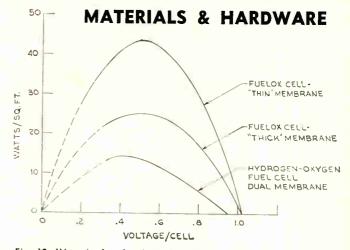
Fuel cells will no doubt find useful application for propulsion purposes. These cells may one day be used for power in switching engines, tractors, trucks, autos, in-plant vehicles, golf carts, etc.

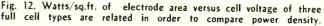
The fuel cell has been suggested for a power source in remote installations or for emergency standby power. In fact, the fuel cell could be the answer any place where independence of power line connections is of prime importance. Boats and other mobile equipment could use fuel cells for power. A sodium-oxygen cell is under development as a power plant for submarine applications, and lead acid batteries may one day be replaced with zinc electrode-oxygen fuel cells.

Work now in progress indicates that the carbonaceous fuel cell can be used as a chemical reactor, in dehydrogenation, and reforming reactor oxidation reactions capable of producing chemicals and power.

The use of fuel cells for military and space applications, industrial plants, household appliances and electrochemical refining plants can be anticipated.

It would be safe to assume that the fuel cell will eventually become a major power source, replacing other systems in some applications. The many improvements and technological advances which have been made in the last few years offer proof of this. However, for the present, fuel cell applications will probably be restricted to those in which fuel efficiency, silence, freedom from fumes, and simplicity of design and operation are important requirements.





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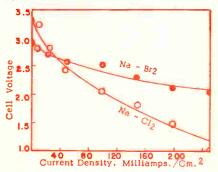
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Mass. 19. "Union Carbide Fuel Cell." Booklet published by Union Carbide Consumer Products Co., New York, N. Y. 20. Young, G. J. (Ed.), "Fuel Cells," Reinhold Publishing Corp., New York, N. Y., 1960.

Fig. 13. Discharge curves for Sodium Amalgam - Chlorine and Sodium Amalgam -Bromine Fuel cells.





1

Transistor Mounting

Information about mounting, replacing, soldering, sockets, and heat sinks for the major types of transistors is given in an easy-to-follow tabular form.

TO obtain optimum performance from a transistor, it is as important to use proper mounting, socketing and soldering procedures as it is to operate the unit within maximum electrical ratings.

T0-40

TO-9

T0-45

T0-1

TO-44

T0-7

T0-5

(A)

(B)

 \bigcirc

 \bigcirc

(E)

(7)

6

(H)

This guide describes the important procedures that should be observed when mounting or replacing most commercially available transistors. In addition, it gives information on sockets, mounting hardware, and heat sinks intended for use with these transistors.

The table is a key to the paragraphs which apply to each type of transistor. The procedures, precautions, and the socketing and heat sink information are given in the numbered paragraphs. The guide is used by locating the photograph of the transistor of interest and then checking the pertinent column (mounting, replacement, soldering, sockets, heat sinks) to obtain the numbers of the paragraphs that apply. The JEDEC number is the transistor outline number assigned by the Joint Electron Devices Engineering Council.

Mounting

1. Shield Lead: Some high-frequency, drift-field transistors of the type shown are provided with a shield lead that is either internally or externally connected to the case. To minimize interlead capacitance and coupling to adjacent circuit components, the shield lead should be connected to the chassis ground.

2. Heat Sink: To ensure adequate transfer of heat from the transistor, the mounting flange should be securely fastened to a heat sink. It is recommended that Silicone lubricant be applied between the base of the transistor and the heat dissipator.

3. Electrical Insulation Between Collector and Chassis: In an n-p-n transistor application where the chassis is connected to the negative terminal of the battery, or in a p-n-p transistor application where the positive terminal of the battery is connected to the chassis, an electrical insulator is needed between the mounting flange and the chassis. Satisfactory insulators include an anodized aluminum washer that de-

This guide includes components known to the author at this time. It is not intended to be limiting or restrictive, Suitable components may be available from manufacturers other than the examples listed here.



By JERRY EIMBINDER

Semiconductor & Materials Div. Radio Corp. of America Somerville, N. J.

1

and Application Guide

pends upon a thin oxide film coating for electrical insulation and various other washers of approximately 0.002 to 0.003 inch in thickness.

The aluminum washer should be about $\frac{1}{8}$ in. thick and should be drilled or punched to provide clearance holes for the emitter and base pins, and for the mounting hardware. To prevent accidental short circuits, the washer should be carefully deburred before anodizing, and all burrs should be removed from the chassis before mounting. T0-8

T0-3

T0-33

TO-18

TO-II

T0.36

1

0

R

(M)

(N)

P

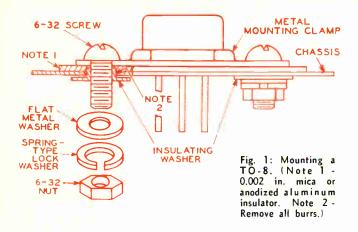
a. Suitable mica insulators manufactured by the Reliance Mica Co., Inc., 341-351 39th St., Brooklyn 32, N. Y., are part no. 712 for TO-3 outline and 2N301-type transistors, and part no. 732 for transistors conforming to the TO-36 outline.

TRANSISTOR MOUNTING AND APPLICATION TABLE

Photo	Typical	For Description, See Indicated Paragraph									
Identifications and JEDEC Types	Transistor Type	Mounting	Replace- ment	Soldering	Sockets	Heat Sinks					
JEDEC TO-40 (Fig. A) JEDEC TO-9 (Fig. B) JEDEC TO-45 (Fig. C) JEDEC TO-1 (Fig. D)	2N140 2N580 2N1180 2N220	3, 3b 1	1, 4 1, 4 1 1, 4	6 1 to 4 6 1 to 4	4 2 3	8 3 4 1					
JEDEC TO-44 (Fig. E) (Fig. F) JEDEC TO-7 (Fig. G) JEDEC TO-5 (Fig. H)	2N384 2N270 2N370 2N585	1 1 3, 3b	1, 4 1 1 1, 4	1 to 4 1 to 4 1 to 4 1 to 4	3 3 2	1 4 4 3					
JEDEC TO-8 (Fig. I) JEDEC TO-3 (Fig. J) (Fig. K) JEDEC TO-33 (Fig. L)	2N1485 2N1490 2N301 2N1395	4 2, 3, 3a, 5 2, 3, 3a, 5 1, 3, 3b	1 1, 3 1 to 4 1	6 5 5 1 to 4	1 1	5 2 2 3					
JEDEC TO-18 (Fig. M) JEDEC TO-11 (Fig. N) JEDEC TO-36 (Fig. O) (Fig. P)	2N706 2N1384 2N1511 2N1768	3, 3b 6 7	1 1, 4 1 to 3	1 to 4 1 to 4 6 6	2	6 3 7					

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Mounting Guide (Continued)

b. Suitable mylar^{*}, silicon-fiber glass, and nylon insulating washers manufactured by the Reliance Mica Co., Inc., are part no. 1 and part no. 8 for 2N301-type transistors and transistors having the TO-3 outline; and part no. 3 and part no. 4 for transistors having TO-5, TO-9, TO-11, and TO-33 outlines.

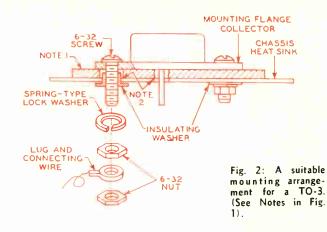
4. Suggested Mounting Arrangement for 2N1485 and Similar Transistors: Fig. 1 illustrates a mounting arrangement suitable for transistors conforming with JEDEC outline No. TO-8. The mounting clamp is usually supplied by the transistor manufacturer.

5. Suggested Mounting Arrangement for 2N1490 and Similar Transistors: Fig. 2 illustrates a mounting arrangement suitable for transistors conforming with JEDEC outline TO-3. A mounting hardware kit is manufactured by Delco, part no. 7274775.

6. Suggested Mounting Arrangements for 2N1511 and Similar Transistors: Fig. 3 illustrates a mounting arrangement suitable for transistors conforming with JEDEC outline No. TO-36. A mounting hardware kit is manufactured by Delco, part no. 7274633.

7. Suggested Mounting Arrangement for 2N1768 and Similar Transistors: Fig. 4 illustrates a mounting arrangement suitable for outlines similar to that of the 2N1768.

* Dupont registered trademark.



Replacement

1. Removal or Installation of Transistor: The power should be turned off before inserting or removing a transistor. Failure to turn off the power may result in transient currents that will damage the transistor.

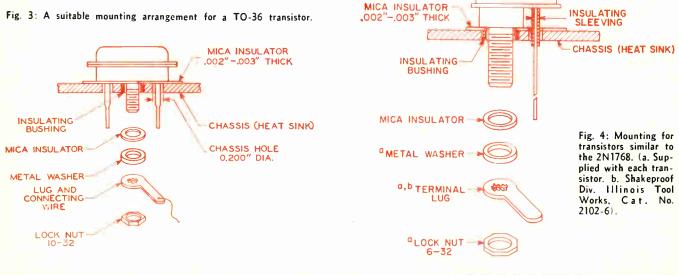
2. Bias Adjustment: After replacing audio-frequency power transistors, such as these used in the output stages of automobile radio receivers, the bias potentiometer should be readjusted for optimum performance.

3. Shock Hazard: The metal shell of the transistor may operate at a voltage appreciably above or below ground potential. Reasonable care should be exercised when servicing.

4. Lead or Pin Identification: Several methods are used to identify the leads or pins of these transistors. Some manufacturers place a color mark near the collector or a colored band around the collector lead; others place an index tab adjacent to the emitter lead. When in doubt, consult the manufacturer's literature.

Soldering

1. Lead Soldering: Leads may be soldered close to the glass seal if care is taken to conduct excessive heat away. A pair of long-nose pliers used to hold the lead while soldering or unsoldering is effective in reducing the amount of heat carried to the seal.



2. Soldering Iron: A low-wattage (25 or 30 watts) soldering iron, such as the pencil types intended for printed-circuit work or fine soldering, should be used. Higher-wattage irons (35 to 50 watts) should be used with caution.

3. Dip Soldering: These transistors may usually be dip soldered in the assembly of printed circuits provided that: (1) the temperature of the solder does not exceed that specified (255° C. for some types); (2) the immersion period does not exceed 10 seconds; and (3) the leads or pins are soldered at no closer than 1/32 in. from the transistor case.

4. Short-Circuit Prevention: When double-sided printed-circuit boards or printed circuit boards with eyelets are used, an insulating washer or similar standoff device, made of good dielectric material. may be used to keep the solder from shorting the leads to each other or to the board.

5. Mounting Flange: The mounting flange of a power transistor should not be soldered to a heat sink. The heat of the soldering operation could permanently damage the transistor.

6. Pins: Solder connections may be made directly to the pins of the transistors if care is taken to conduct the heat away from the pin seals. Failure to do so could result in cracking the glass seal.

Sockets

1. Manufacturers of Power-Transistor Sockets with 2-hole Mounting Arrangement: Cinch Mfg. Corp., 1026 Homan Ave., Chicago 24, Ill.: socket type numbers 14T24324, 54T24246. Loranger Mfg. Corp., Warren, Pa.: socket type number 2149.

2. Manufacturers of Sockets for Transistors with JEDEC Outlines TO-5, TO-9, TO-11, and TO-33: Elco Corp., M St., Philadelphia 24, Pa.: socket type numbers 3301, 3303, 3304, 3305, 3306, 3307, and 3308. Grayhill, Inc., 561 Millgrove Ave., LaGrange, Ill.: socket type number 22-11.

3. Manufacturers of Sockets for Transistors with JEDEC outline TO-7 (when the transistor leads are suitably out) and TO-45: Cinch Mfg. Corp., 1026 Homan Ave., Chicago 24, Ill.: socket type number 46A20967.

4. Manufacturers of Sockets for Linotetrar 3-Pin Bases: Elco Corp., M St., Philadelphia 24, Pa.: socket type numbers 799BC, 803BC, 3301, 3303, 3304, 3305, 3309, 3310, 3311, 3312, 3313. Eby Sales Co., 130 Lafayette St., New York 13, N. Y.: socket type number SM3. Cinch Mfg. Corp., 1026 Homan Ave., Chicago 24, Ill.: socket type numbers 46A20782, 46A20928, 46A22648, 46A22455, 46A24052, 46T20248, 46T22825.

When ordering heat sinks it may be necessary to specify finish (unfinished aluminum, black anodized aluminum, etc.) length, TO-outline, and hardware (if desired). The list below is representative. Equivalent types produced by other manufacturers are also available.

1. Manufacturers of Heat Sinks for Transistors with JEDEC Outlines TO-1 and TO-44: Birtcher Corp., 745 S. Monterey Pass Rd., Monterey Park, Calif., part numbers 3AL-635, 3AL-669, 3AL-680.

2. Manufacturers of Heat Sinks Intended for Use with 2-Pin Power Transistors (TO-3 Outline types and 2N301-case types): Accel Electronic Products Co., Box 467, Monterey Park, Calif., part number SR-23. Astro Dynamics, Inc., Second Ave., Northwest Industrial Park, Burling, Mass., part numbers 2503, 2501, 2505, 2506, 2501-B. Augat Brothers Inc., 33 Perry Ave., Attleboro, Mass., part numbers 8038-1G1, 8038-1G2, 8038-1G3, 9004-1G1, 9006-1G1, 9006-1G2. Birtcher Corp., part numbers 3B-663, 3AL-672, 3B-693, 3AL-704, 4AL series. Delta Division, Wakefield Engineering, Inc., Wakefield, Mass., NC-401A, NC-403A, NC-421A, NC-423-A, FC-501. International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif., part numbers TO3P-174-100, TO3P-174-125, TO3P-174-150, TO3P-174-200, TO3P-174-250, TO3P-174-300, TO3P-174-350, TO3-250-050, TO3-250-100, TO3-250-150, TO3-250-200, TO3-250-250, TO3-250-300, UP-TO3, UP-TO3B. National Beryllia Corp., First & Haskell Ave., Haskell, N. J., part number BTO-3. Vermaline Products Co., Franklin Lakes, N. J., part numbers HS6030-3A3, HS6030-3F3, HS7030-3A3, HS7030-3F3, HS8030-3A3, HS8030-3F3, HS6071-3A3, HS6071-3F3, HS6029-3A3, HS6029-3F3,

3. Manufacturers of Heat Sinks for Transistors with JEDEC Outlines TO-5, TO-9, TO-11, and TO-33: Astro Dynamics, Inc., part numbers 2701, 2702, 2703, and 2704-B. Birtcher Corp., part numbers 3AL-635, 3AL-669, 3AL-680, 3AL-681, 3AL-682, 3AL-683, 3AL-711, 3AL-716. International Electronic Research Corp., part numbers TXBP-032-029B, TXBP-032-037, TXBP-032-037B. National Beryllia Corp., part numbers BTO-5, BTO-9, BTO-11, BTO-33. Thermolloy Co., 2130 Irving Blvd., Box 4341, Dallas 8, Tex., part numbers 1101, 1101A, 2208, 2209.

4. Manufacturers of Heat Sinks for Transistors with JEDEC Outlines TO-7 and TO-45: Birtcher Corp., part numbers 3AL-675, 3AL-681, 3AL-683.

5. Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-8: Birtcher Corporation. part number 3AL-705. International Electronic Research Corporation, TXB-050-037B, TXB-050-037B. National Beryllia Corporation, part number BTO-8.

6. Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-18: Birtcher Corp., part numbers 3AL-635, 3AL-680, 3AL-702, 3AL-715. International Electronic Research Corp., part numbers TXBP-018-028B, TXB-018-028B. National Beryllia Corp., part number BTO-18. Thermolloy Corp., part numbers 1106, 1107.

7. Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-36: Accel, part number SR-26. Astro Dynamics, Inc., part numbers 2501-B, 2503, 2504, 2505, 2506. Augat Brothers Inc., part numbers 9004-1G2, 9009-1G1. Birtcher Corp., part numbers 3B-645, 3B-684, 3B-688, 4AL series. Delta, part numbers NC-401B, NC-403B, NC-4C1B, NC-423B, FC-502. International Electronic Research Corp., UP-TO36, UP-TO-36B. National Beryllia Corp., part number BTO-36. National Beryllia Corp., part numbers HS6030-3B3, HS7030-3B3, HS8030-3B3, HS6071-3B3, HS6029-3B3.

8. Manufacturers of Heat Sinks for Transistors with JEDEC Outline TO-40: Birtcher Corp., part numbers 3AL-635, 3AL-680.

Heat Sinks

		Platinum (Pt)									
		Mechanical Grade	Thermopure	Palladium (Pd)	lridium (lr)	Rhodium (Rh)	Ruthenium (Ru)	Osmium (Os)	Gold (Au)	Silver (Ag)	
Atomic weight		19	5.23	106.7	193.1	102.91	102.91 101.7		197.2	107.88	
Specific gravity		21.45		12.02	22.5	12.44	12.2	22.5	1 <mark>9.3</mark> 2	10.49	
Density, Ib/cu. in	n. (a 68° F		775	.434	.813	.449	.441	.813	.698	.379	
Melting point, °F °C		3216 1769		2826 1552	4449 2454	3571 1966	4530 ± 180 2500 ± 100	4900 ± 360 2700 ± 200	1945.4 1063.0	1761.4 960.8	
Thermal conduc Btu/ft ² /in./°F/ (32–212° F)		4	180	493	406	<mark>6</mark> 18			2031	2902	
Coefficient of ex in./in./°F x 10 (32–212° F)	pansion, 6	4	.94	6.50	3.61	4.6	5.33	3.33	8.0	10.93	
Specific heat, Btu/lb/°F	@ 32° F @ 212° F		0315 0325	0.0584	0.0307 (68°F)	0.058	0.057	0.03C9 0.0314	0.0312 (64°F)	0.0559 0.0568	
Resistivity, ohms/cir mil ft	@ 32° F @ 68° F @ 212° F	F 58.86 F 63.60		60.0 64.8		30.1 	47 84 —	54 57.1	13.1 14.1 —	9.56 8.84 	
Mean temperatu coefficient of per °C, 0–100 (32–212° F)	resistance		. 00392	.0037	.00392	. 00457	-	.0042	.0034	.0041	
Tensile strength, psi	annealed 50% RA		17-19,000 34,000	28,000 47,000	21,000	80,000 360,000			19,000 32,000	18,000 50,000	
Modulus of elasticity, psi	annealed 50% RA		3 x 10 ⁶ 6 x 10 ⁶	13.8 x 10 ⁶ 17.5 x 10 ⁶	74.7 x 10 ⁶	42.5 x 10 ⁶ —		_			
Vickers hardness (similar to Brinell— 10 mm ball, 3000 kg load	cast annealed 50% RA	45 i 42		49 46 118	183 189 351	147 144 401	231 310	362 381	25 66	26 90	

PRECIOUS METALS APPLICATIONS CHART

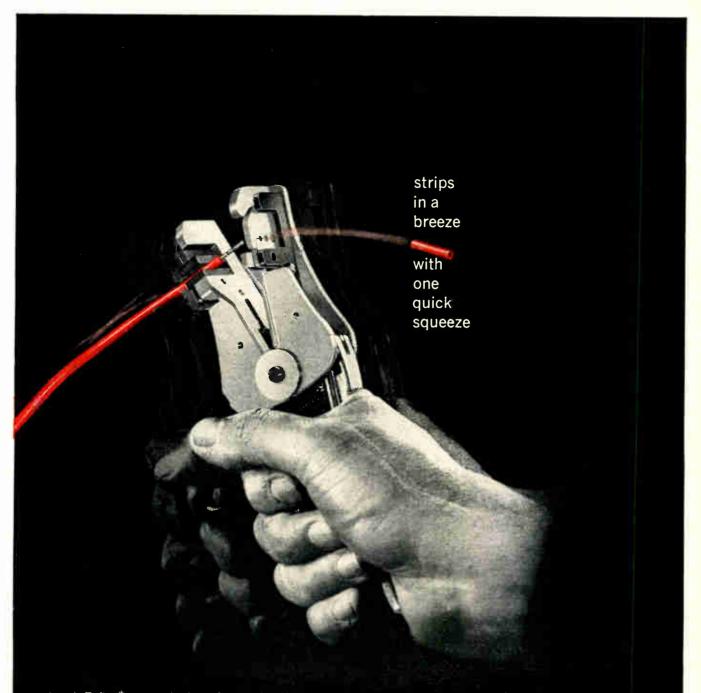
USES IN THE ELECTRONIC AND ELECTRICAL INDUSTRIES

METAL and ALLOYS	FORM	END USES
Rh Plating	Plated Contacts Plated Discs	Coaxial radio frequency circuits.
Pt, Pt-Rh, Pd-Au, Ir. Ir-Rh	Thermocouple Wire Tubing	High Temperature measurement elements and Sheats.
Rh Plating, Ir, Pd-Ag, Pt-Ru, Au, Pd-Ru, Au, Ag, Pd-Cu, Pt-Ir, Pt-Pd-Ru, Pt-Rh	Contacts Plated Contacts Strip	Relays, switches, telephone relays, telegraph transmitters, printed circults, multi- position switches in automatic telephone and telegraph exchange equipment alarm systems, radio frequency circuits, temperature controllers, spark plugs Magnets, Sensitive Relays, Voice Relays, Heating pads, Railway Signals.
Pt-Rh, Pt	Wire, Sheet	Electronic equipment, brushes, sliprings.
Pt, Pt-Rh	Wire	Furnaces
Pt, Pt Alloys	Wire	Thermionic valves.
Pt, Pt-Ir	Contacts and Discs	Electromatic Road traffic control equipment.
Pd-Au, Au	Wire	Thermal Fuses.
Pt, Pd-Al	Wire, Gauze	Exothermic Fuses—Detonating devices.
Pt-Ir	Wire	Miniature moving coil relays.
Pt-Rh, Ru-Pt, Pt-Rh-Ru, Pt-Ir	Wire	Potentiometers.
Pt, Pt-Bh	Thermocouple Wire	Resistors.
Pt, Pt-Rh	Wire, Shest	High Temperature Xray Diffraction.
Pt-Cobalt	All Forms	Permanent Magnets (Hearing Aids, Electric Watches).
Pt Alloys	Foil	Radio Tuners.
Pt Alloys	Wire, Tape	Cat Whiskers.
Pt, Pd, Pd-Au	Chemicals, Sponge, Powders	Fuel Cells.

• Material provided by J. Bishop & Co. Platinum Works, Malvern, Pa.

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even tough Teflon* covered wire... for precise electronic production required to pass high-confidence level inspections

TEFLON: REG, TRADE MARK OF DUPONT



(DEAL) CUSTOM Tripmaster

Strip solid or stranded wire easily — with no wire nicks, insulation scratches — no waste or rejects. Unique matched blades, drilled to exact wire size on watchmaker's equipment, plus colleting action. *help you meet high-confidence standards even on toughest insulation*. Three models — for Type E Teflon, Type EE Teflon and general purpose plastic and fibre-glass insulation. Sizes for 10 to 14, 16 to 26, or 26 to 30 wire. Optional transparent wire stop adjusts to strip exact insulation length. Send coupon for full information.

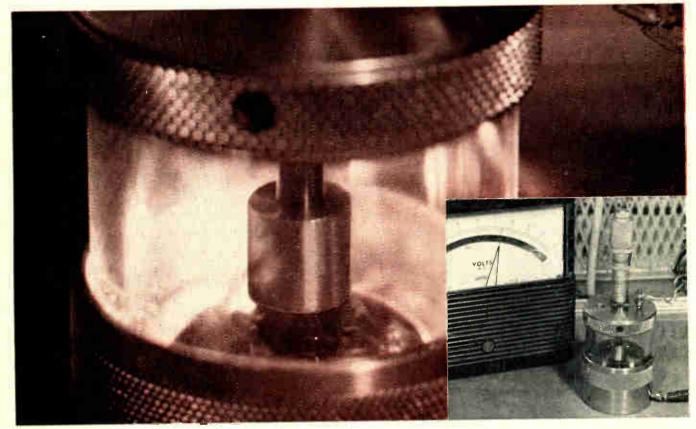
IDEAL INDUSTRIES, Inc. 4307-G Park Ave., Sycamore, III. Flease send me my free copy of Production Wire Strippers Catalog SOLD THRU AMERICA'S LEADING DISTRIBUTORS In Canada: Irving Smith, Ltd., Montreal

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Company		 -
Address		

Circle 218 on Inquiry Card World Radio History

SILICONE NEWS from Dow Corning

Improve product quality



Silicone fluids ... proved by test, by performance

A part of proving silicones in the laboratory for performance in your product is the development of realistic evaluation equipment like the ball test cell shown. Developed by Dow Corning, it is used in one of the stringent quality control tests for electrical grade fluids... available in viscosities of 20, 50, 100, 200, 350, 500, and 1,000 centistokes.

Dow Corning silicone fluids have proved themselves outstanding performers as: 1. dielectric coolants . . . 2. surface coatings . . . 3. filling and impregnating materials for electronic components and assemblies.

As an impregnant for paper capacitors, silicone fluid decreases dielectric losses, increases permissible operating temperatures, assures uniform capacitance over a wide temperature range. In this and other filling and impregnating applications, silicone fluids add to reliability . . . often eliminate costly compensating circuits.

As dielectric coolants, Dow Corning silicone fluids can be pumped at high speed without breakdown due to shear. They maintain consistency over a range of -65 to 250 C, will not oxidize or corrode metals.

TYPICAL PROPERTIES OF DOW CORNING 200 FLUID ELECTRICAL GRADE - 100 CENTISTOKES

Aummal Variation at 25 C, percent max. 5 Flash Point, degrees Fahrenheit, min. 575 Electric Strength, volts mil, min. 350 Diclectric Constant, maximum 350 at 23 C, 100 cps 2.75 at 150 C, 100 cps 2.45 Dissipation Factor, maximum 0.00008 at 23 C, 10° cps 0.00002 at 23 C, 10° cps 0.0001 Volume Resistivity, ohm-cm, minimum 1.0 x 10 ¹⁴ at 150 C, 500 volts d-c 0.1 x 10 ¹⁴ Specific Gravity 25 C 0.968 Refractive Index 25 C 1.403 Pour Point, degrees Fahrenheit 60 Thermal Conductivity [‡] 0.00037 Volume at 150 C gm-cal		
Viscosity Variation at 25 C. percent max. 5 Flash Point. degrees Fahrenheit, min. 575 Electric Strength. volts mil, min. 350 Dielectric Constant, maximum at 23 C. 10° cps at 23 C. 10° cps 2.75 at 150 C. 100 cps 2.45 Dissipation Factor, maximum 0.00008 at 23 C. 10° cps 0.00008 at 23 C. 10° cps 0.00002 at 150 C, 100 cps 0.00002 at 150 C, 100 cps 0.00002 at 150 C, 100 cps 0.0001 Volume Resistivity, ohm-cm, minimum at 23 C-500 volts d-c at 150 C, 500 volts d-c 0.1 x 10" at 150 C-500 volts d-c 0.968 Refractive Index 25 C 1.403 Pour Point, degrees Fahrenheit -60 Thermal Conductivity‡ 0.00037 Volume at 150 C gm-cal	Nominal Viscosity at 25 C. centistokes	100
Flash Point, degrees Fahrenheit, min 575 Electric Strength, volts mil, min 350 Dielectric Constant, maximum 350 at 23 C. 100 cps 2.75 at 150 C. 100 cps 2.75 bissipation Factor, maximum 2.45 Dissipation Factor, maximum 0.00008 at 23 C. 100 cps 0.00002 at 150 C, 100 cps 0.00002 at 150 C, 100 cps 0.0001 Volume Resistivity, ohm-cm, minimum 1.0 x 10 ³⁴ at 23 C -500 volts d-c 0.1 x 10 ¹⁴ Specific Gravity 25 C 0.968 Refractive Index 25 C 1.403 Pour Point, degrees Fahrenheit	Viscosity Variation at 25 C, percent max.	5
Electric Strength, volts mil, min350 Dielectrie Constant, maximum at 23 C. 100 cps2.75 at 150 C. 100 cps2.45 Dissipation Factor, maximum at 23 C. 100 cps2.45 Dissipation Factor, maximum at 23 C. 100 cps0.00008 at 23 C. 100 cps0.00002 at 150 C, 100 cps0.00002 at 150 C, 100 cps0.0001 Volume Resistivity, ohm-cm, minimum at 23 C-500 volts d-c1.0 x 10 ⁴⁴ at 150 C color volts d-c1.0 x 10 ⁴⁴ Specific Gravity 25 C	Flash Point degrees Fahrenheit, min	575
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Specific Gravity 25 C 0.968 Refractive Index 25 C 1.403 Pour Point, degrees Fahrenheit 60 Thermal Expansion Ratio† 1.12 Thermal Conductivity‡ 0.00037 Volume at 150 C gm-cal	at 23 C500 volts 0-C	
Refractive Index 25 C 1.403 Pour Point, degrees Fahrenheit -60 Thermal Expansion Ratio† 1.12 Thermal Conductivity‡ 0.00037 Volume at 150 C gm-cal		0.1 X 10
Pour Point, degrees Fahrenheit60 Thermal Expansion Ratio† 1.12 Thermal Conductivity‡ 0.00037 Volume at 150 C gm-eal		
Thermal Expansion Ratio† 1.12 Thermal Conductivity‡ 0.00037 Volume at 150 C gm-eal	Refractive Index 25 C	1.403
Thermal Expansion Ratio† 1.12 Thermal Conductivity‡ 0.00037 Volume at 150 C gm-cal	Pour Point degrees Fahrenheit	-60
Thermal Conductivity [‡] 0,00037		1.12
Volume at 150 C + gm-cal		
Volume at 150 C Volume at 25 C	Thermal Conductivity4	0.00057
Volume at 25 C deg C cm sec	Volume at 150 C gm-ca	l
	Volume at 25 C deg C cm	SEC

ASTM D877, D924, and D1169 tests procedures used to obtain values where applicable.

CIRCLE 21 ON READER-SERVICE CARD

Dow Corning is your best source of a broad line of silicone fluids, gels, elastomers and rigid forms for potting, filling, embedding and encapsulating.



... with these silicones

Molding compound for 700 F

A new mineral-filled silicone molding compound developed by Dow Corning in cooperation with Amphenol-Borg Electronics Corporation's research personnel, is designed for: long-term stability at 700 F: excellent thermal shock resistance: low dissipation factor and arc resistance. Used by Amphenol to make military-type connector inserts, this compound has withstood temperatures of 700 F for several hundred hours. Other promising uses include fuses, coil forms, relay parts, tube bases, contactors, arc barriers and switch parts. This compound can be molded by compression or transfer techniques.

CIRCLE 22 ON READER-SERVICE CARD

Sure fire potting of electron gun

This traveling wave tube made by Huggins Laboratories, Inc., is a broad band receiving and transmitting tube used in communications, radar, missile checkout . . . other complex electronic gear. It provides: power amplification greater than 10,000 over a two-to-one frequency range: operating band widths to 7,000 megacycles. To assure this performance, precise positioning of the electron gun is vital and must be maintained under all operating conditions. Silastic[®] RTV, the Dow Corning liquid silicone rubber that cures at room temperature, is used to bond and cushion the gun in position within the capsule. Quick set-up time of Silastic RTV speeds production, while high dielectric strength helps assure performance.

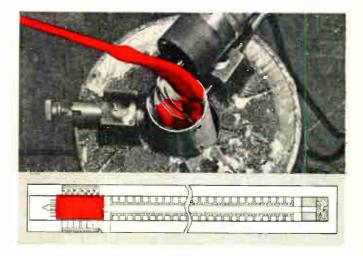
CIRCLE 23 ON READER-SERVICE CARD

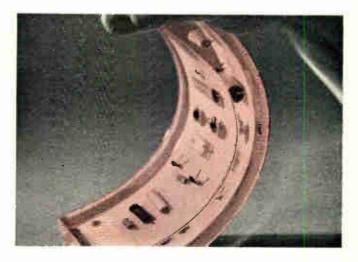
New transparent embedding resin

Tough, flexible, transparent and repairable, Sylgard[®] 182 is easy to process . . . provides excellent environmental protection. This solventless silicone casting resin cures in 4 hours at 65 C, 15 minutes at 150 C . . . cushions against shock from -70 to 225 C . . . assures constant dielectric strength . . . resists the effects of ozone, voltage stress, heat aging and thermal cycling. Faulty components can be exposed, replaced and the repair area filled with new resin. Sylgard 182 and its curing agent are not toxic to the skin, nor do they give off toxic fumes or exothermic heat during blending or cure.

CIRCLE 24 ON READER-SERVICE CARD







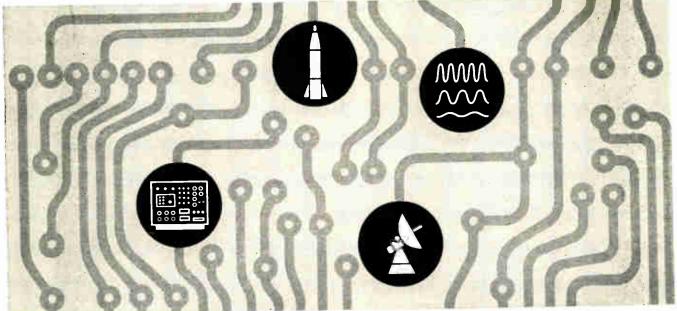
Free 12-page manual, "Silicones for the Electronic Engineer". Write Dept. 3606, Dow Corning Corporation, Midland, Michigan.

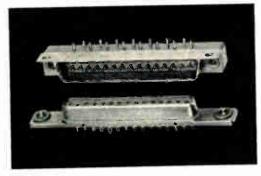
prime source for printed circuits, too

More and more products are using printed circuits; more and more printed circuits are using Lionel-Anton connectors, including edge board, plug-in, and dip solder types. **Together,** these components are working wonders in electronic assemblies. **Particularly where there can be no compromise of reliability**...and where design dictates stinginess in terms of size and weight. **Although your attention may be focused primarily on printed circuit connectors, we suggest you keep in mind that we also make micro-miniature, sub-miniature, and miniature units, in both rack and panel models, and in any size or configuration. Your Lionel-Anton sales engineer is available to discuss specific application requirements with you**.

WHERE IMPORTANT CIRCUITS MEET...

LIONEL-ANTON CONNECTORS





Lionel-Anton Series 320 Printed Circuit Connector for use in automated machines, avionics, communications, computers, controls, instrumentation, missiles, portable equipment, test apparatus, or wherever printed circuits are used. Features include die-cast, aluminum alloy shells for strength, protection, and polarization, and the use of angles on shells to assure correct alignment. Float bushings make for ease of mounting; asbestos filled, one-piece Diallyl Phthalate moldings eliminate moisture pockets. Phosphor bronze sockets and brass contact pins, with gold over silver, effect low contact resistance, and prevent corrosion. 5 sizes: 7. 11, 15, 19, and 23 contacts. Meets National Aircraft Standards, and applicable paragraphs of MIL-3-8384, and MIL-C-21097. Materials and specifications can be modified to meet specific needs. Immediate delivery.

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MANUFACTURERS OF CONNECTORS • RADIATION MEASURING DEVICES • DETECTORS: ALPHA, BETA, GAMMA, AND NEUTRON

VERSATILE RELIABLE ECONOMICAL

Glass-to-Metal



Including semi-conductor seals, individual terminals and multiple headers are available in hundreds of standardized types that reflect the economies of mass production methods. Offer a time and money-saving solution to all but the most unusual sealing problems.



E-I engineers will design "specials" or produce seals to your exact specifications. Custom threaded types, color coding or unusual terminal arrangements can be supplied quickly in reasonable quantities.

Custom Sealing Service

Complete facilities available for sealing assemblies of your own manufacture. Please supply sample or drawings for estimates on your sealing requirements, or ask to have a field engineer make recommendations on specific seal applications. Literature on request.





World Radio History

Special Seals



RESILIENCY THAT STAYS AND STAYS AND STAYS AND STAYS AND STAYS...

CHR Silicone Sponge Rubber sheet is low in compression set and keeps its resiliency because: \blacksquare It is flexible from minus 100 degrees to plus 500 degrees. \blacksquare It is immune to aging. \blacksquare It is non-absorbing. \blacksquare It is a uniform closed cell structure. \blacksquare For gasketing, vibration dampening and pressure applications, where you want a material that can take it and keep taking it, use CHR Silicone



Sponge Rubber. ■ Stocked by distributors across the country in thicknesses from ¼₆ to ½ inch in ¼₆ increments. Check Thomas Register for your local CHR cistributor.

CONNECTICUT HARD RUBBER CO., NEW HAVEN, CONN.

Circle 69 on Inquiry Card

Tech Data

for Engineers

Bobbin Cores

Bobbin Cores, which have the retentive properties characterized by a rectangular hysteresis loop and are made of very tiny tapes reducing the time delay effects caused by eddy currents, designed for digital data processing systems are described in tech data available from G-L Electronics, 300 Harvard Ave., Westville, N. J. Included are dimensional drawings and size tables on ceramic and stainless steel types.

Circle 362 on Inquiry Card

Bearing Analysis

"Ball and Roller Bearing Analysis Through Electronics." 6-pages, describes a high speed measuring instrument for evaluating the internal working surfaces of 97% of all bearings. Bearing Inspection, Inc., 3311 E. Gage Ave., Huntington Park, Calif.

Circle 363 on Inquiry Card

Metals

Tech data, 8 - pages, is available from Riverside-Alloy Metal Div., H. K. Porter Co., Inc., 19 Washington St., E. Orange, N. J., on electrical and electronic industry metals. Included are photographs and descriptions on nickel group, monel group. inconel group, nickel silvers, stainless steel, and nickel-clad copper wire metals.

Circle 364 on Inquiry Card

Ceramic Material

CarBerlox, a lossy dielectric ceramic material offers high ability to absorb and transmit heat, which gives high high-freq. energy absorption without thermal damage. This hardfired ceramic is dimensionally stable to temps. approaching 3500°F and has high mechanical strength and thermal shock resistance. Included are characteristic curves. National Beryllia Corp., First and Haskell Aves.. Haskell, N. J.

Circle 365 on Inquiry Card

Precious Metals

This 22-page, 2-color brochure describes the abilities and capabilities of Engelhard Industries, Inc., in the field of precious metals for use in such industries as the electrical, electronic, electroplating, delay line, semiconductor, nuclear, optics, missile, radar, radio, and aircraft. Information is also included on research in electrochemical techniques, ceramics, fuel cells, metal physics and metallurgy. Engelhard Industries, Inc., 113 Astor St., Newark 2, N. J.

Circle 366 on Inquiry Card

Tech Data

for Engineers

Vinyl

Additional test data, processing information and suggested uses for hitemp Geon vinyl are contained in a 12-page booklet entitled "Hi-Temp Geon" available from B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio. Hi-temp Geon vinyl can be extruded, molded, calendered, formed or stamped on conventional thermoplastic processing equipment.

Circle 396 on Inquiry Card

Resins

A 24-page technical manual-catalog giving complete electrical, physical and chemical properties of "Teflon" TFE and 100 FEP resins is available from Tri-Point Industries, Inc., 175 I.U. Willets Rd., Albertson, L. I., N. Y. Specs. for a wide variety of basic extruded and molded forms, including rod, tube, tape, film, sheet, plate and spaghetti in virgin resin, as well as special filled and reinforced resin compounds are included.

Circle 397 on Inquiry Card

Lithium Metal

Products list available from the Foote Mineral Co., Rt. 100, Exton, Pa., lists lithium chemicals, metal and minerals, electrolytic manganese, zirconium, welding grade products, and steel addition agents for use in the chemical, metallurgical, ceramic electronic, nuclear and astronautic industries.

Circle 398 on Inquiry Card

Glass-to-Metal Terminals

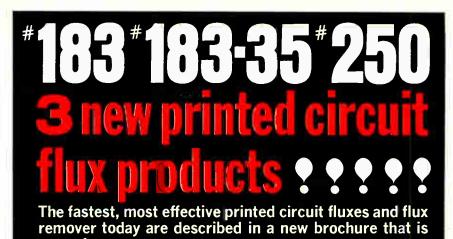
This 25-page multi-colored catalog describes specifications on glass-tometal hermetic terminals. Divided into 5 sections, summary information is provided on hermetic terminals, for design engineers and purchasing agents. The 5 major sections detail single electrode terminals, multiple electrode terminals, solid glass headers, miniature relay headers, and diode and transistor headers. The Fusite Corp., 6000 Fernview Ave., Cincinnati 13. Ohio.

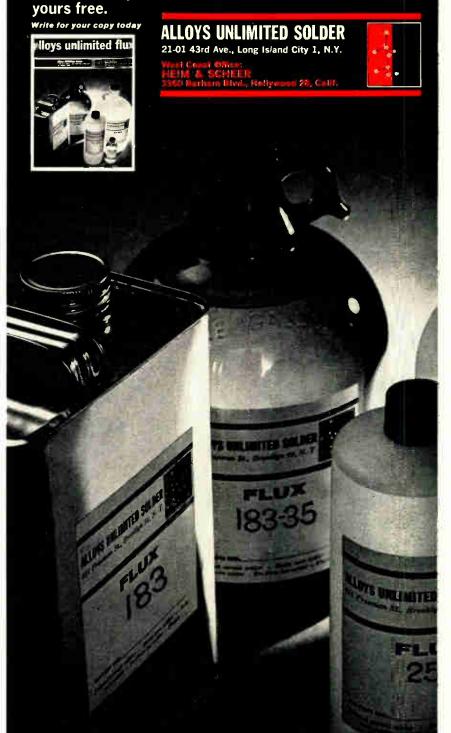
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Caulking Compounds

Tech. data is available on relatively low-cost, highly conductive putty-like caulking compounds designed for both the hermetical and electrical sealing of r-f enclosures. Two plastic types are offered. One is a non-setting paste and the other is solvent based and sets to a semi-rigid condition, giving moderate bonding. They are compatible with all types of metals and can be used over a temp. range of -85 to 100° C. Chomerics, Inc., 341 Vassar St., Cambridge 39, Mass. Circle 400 on Inquiry Card

ELECTRONIC INDUSTRIES · June 1962







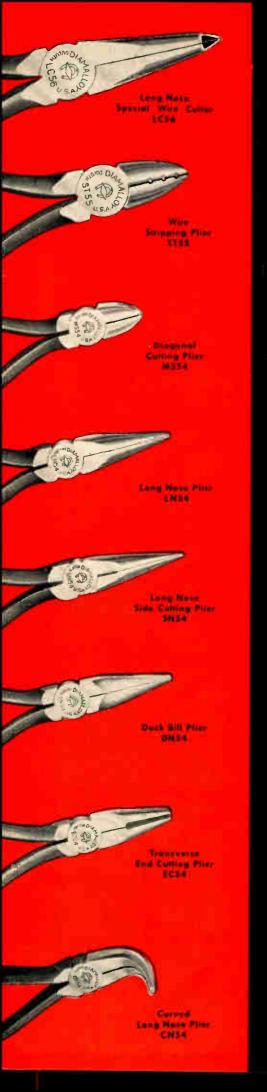
Take the Monkey Business Out of Connector Assembly with the Rugged MDR

No need to monkey around with delicate inserts found in so many electrical connectors today now that the new Deutsch Rigid is available. This rugged design with its solid plastic insert makes multiple contact connector assembly easy as falling out of a tree. And look at all the features the MDR has inherited from its space age relatives: crimp-type contacts that snap in and stay in, a reliable Deutsch ball-lock coupling mechanism that just needs an easy push to connect and gentle pull to disconnect, plus interchangeability with other Deutsch connector series. But for complete facts on this little beauty, contact your local Deutschman today or write for Data File U-**6**.

DEUTSCH

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ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS



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A variety of precision pliers built to stand up under the continuous use of production workers.

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Light weight

... shaped to fit the hand

Ask your favorite electronic distributor for Diamalloy Pliers.



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ON THE SHELF-ARNOLD CORES IN WAREHOUSE STOCK FOR IMMEDIATE DELIVERY

Let us handle your inventory problems and save you time and money on your magnetic core requirements.

Extensive stocks of four types of Arnold cores in the most popular sizes have been set up in our Marengo, Illinois and Fullerton, Calif. plants. Subject of course to temporary exhaustion of stock by prior sales, these cores will be shipped *the same day* on orders received at the warehouse by 12:00 noon. When cores are out of stock at the nearest plant, we may be able to ship within 24 hours from the other.

Arnold core products covered by this warehouse stock program include: 1) Silectron C, E and O cores in 2, 4 and 12-mil tape. 2) Type 6T aluminum-cased cores of Deltamax, Square Permalloy and Supermalloy, in 1, 2 and 4-mil tape. 3) Mo-Permalloy powder cores, both temperature-stabilized and unstabilized types, ranging down to 0.260" diameter. 4) Iron powder toroids, threaded cores and insert cores.

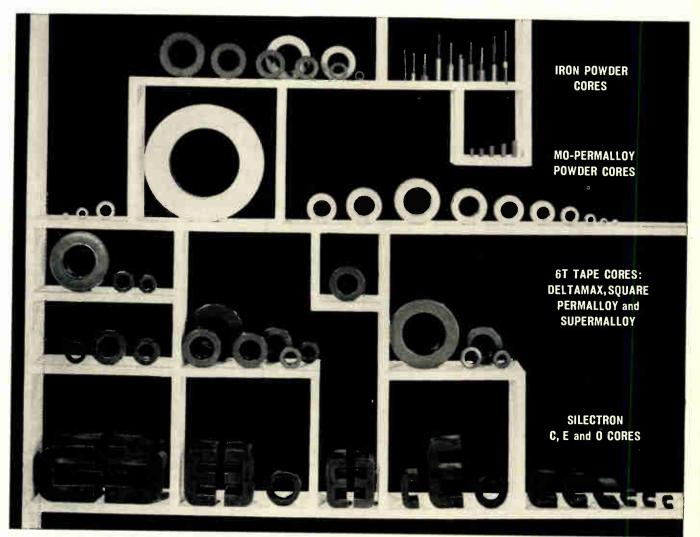
All four products are available

in a wide range of selection, for your convenience and economy in ordering either prototype design lots or regular production quantities. • Stock lists, bulletins, etc. are available write for information. The Arnold Engineering Company, Marengo, Ill.

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World Radio History

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AMP PRODUCT PERFORMANCE PROVES IT!

Gold over nickel plating . . . the standard AMP choice for printed circuit connector contacts! Not optional . . . but standard! And with good reason.

No haphazard choice dictated the metallic fraction that makes plating an important feature of the AMPin·cert* Printed Circuit Connector line. The decision to make gold over nickel standard plating came only after exhaustive tests involving a whole wide range of metals in various thicknesses and combinations.

Plating thicknesses, porosity, contact forces—all these were thoroughly tested. Exposure to heat, cold, corrosion and humidity...series after series of tests ran the gamut of extreme environmental conditions for every plating metal considered. Results, tabulated over a period of years, pointed to one fact—gold over nickel was vastly superior in every way.

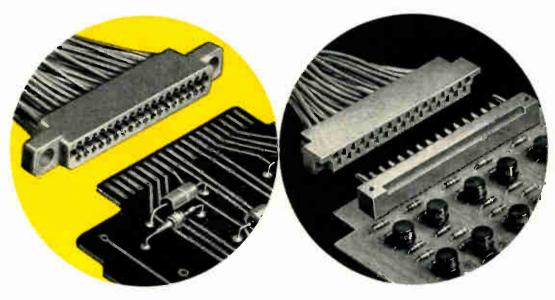
These AMPin-cert Printed Circuit Connectors can be loaded to accommodate only those circuits actually needed. There are no pre-loaded, unused contacts!

Crimp, snap-in type contacts are plated with .000030" gold over .000030" nickel (min.). There is no metal "creep". No debilitating oxide insulation buildup. Contact pressures are engineered to avoid excessive or quick plating wear. Consequently, AMPin-cert connectors last longer, give maximum performance and assured reliability.

Research findings on plating and facts on the AMP gold over nickel standard are available in reprints of papers published by AMP Research. Write for your copy today.



AMP-LEAF* and AMP-BLADE* Connectors . . . are part of the AMPIn-cert line which includes Pin and Socket, Printed Circuit, Coaxial, and General Duty types



AMP·LEAF

AMP-BLADE

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

Special Pliers for the **Highly Specialized Electronics Field**

When the early transmission lines were strung in this country a century ago, it was Klein Pliers in the hands of linemen that helped do the job.

Klein has kept pace with the development of the electrical field, meeting each new challenge with tools specially designed to do the wiring job better ... more economically.

Shown here are a few of the many highly specialized Klein Pliers carried in stock to meet the needs of electrical and electronics manufacturers

You will find your assemblies go together more smoothly and wiring is done more rapidly when the right Klein Plier is used.

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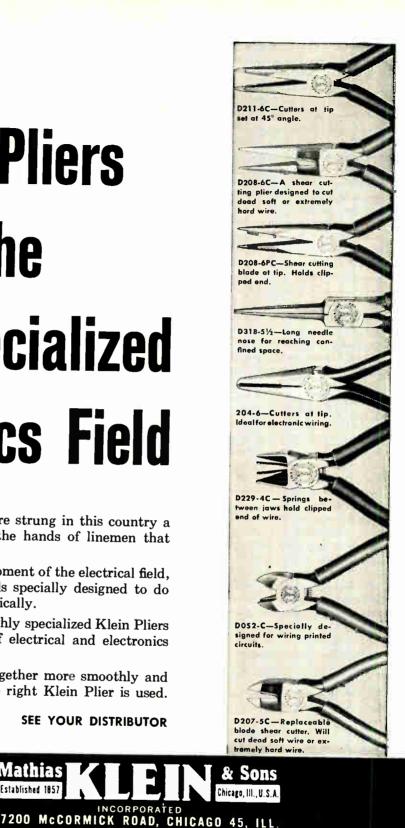
Mathias Klein & Sons, Inc. 7200 McCormick Road, Chicago 45, III, Please send me the Klein Plier Catalog and information.

Mathia

Established 185

Name Title_ Company Address City_

World Radio History



Source Contractions	
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Check your requirements against General Chemical's extensive line of B&A[®] "Electronic Grade" chemicals. Principal products are listed here—and there are many others too! You'll find that "B&A"—America's leading line of "Electronic Grade" chemicals—is your best single source for *all* your high purity chemical needs!

As America's foremost producer of laboratory and custom chemicals, General Chemical has the wide range of products, the versatile production facilities, and the specialized experience to meet virtually every electronic chemical need! Write today for our free information folder, "B&A Electronic Chemicals." Gives specifications plus other valuable information.



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Baker & Adamson[®] "Electronic Grade" Chemicals

PRODUCTION OF SEMICONDUCTORS: For Etching:

- Acetic Acid-Reagent, A.C.S.
- Ammonium Bifluoride—Technical
- Ammonium Fluoride-Reagent
- Bromine—Reagent, A.C.S.
- □ Glycerin—Reagent, A.C.S.
- □ Hydrochloric Acid—Reagent, A.C.S.
- □ Hydrofluoric Acid—Electronic Grade
- □ Hydrogen Peroxide (Stab.)—Electronic Grade
- □ Nitric Acid—Reagent, A.C.S.
- □ Phosphoric Acid—Reagent, A.C.S.
- Potassium Hydroxide Pellets and Solution— Electronic Grade
- □ Sodium Carbonate—Electronic Grade
- □ Sodium Hypophosphite—Reagent
- Sodium Hydroxide Pellets and Solution— Electronic Grade
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- Acetone-Electronic Grade
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- Carbon Tetrachloride-Electronic Grade
- Ether-Electronic Grade
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- □ Indium Fluoborate—Technical
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- □ Nickle Chloride—Reagent, A.C.S.
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Germanium Products:

- Germanium Dioxide-Electronic Grade
- □ Germanium Metal—Electronic Grades
- For Post Treatment of Semiconductors:

PRODUCTION OF TV TUBES:

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- 🔲 Barium Nitrate—Electronic Grade
- Calcium Nitrate—Electronic Grade
- Strontium Nitrate-Reagent, A.C.S.
- Aluminum Nitrate—Electronic Grade

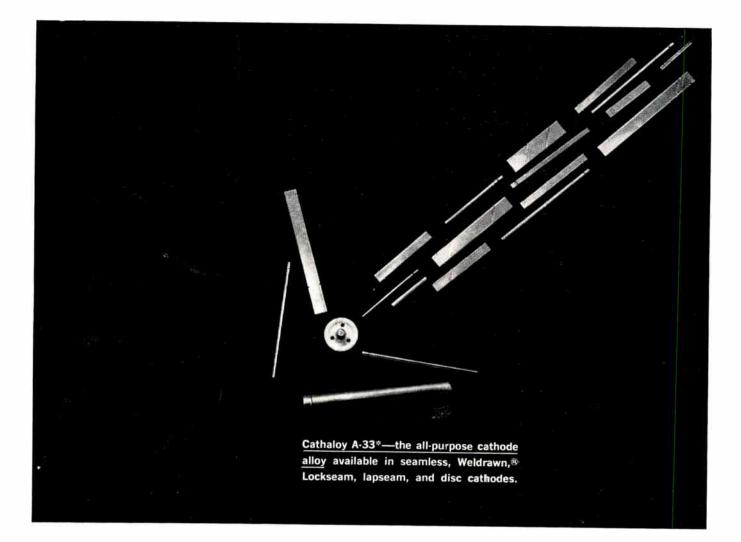
PRODUCTION OF CAPACITORS:

- □ Ammonium Hydroxide-Reagent, A.C.S.
- Boric Acid—Reagent, A.C.S.
- □ Manganous Nitrate—Reagent, A.C.S., Electronic Grade
- □ Oxalic Acid—Reagent, A.C.S.
- □ Sulfuric Acid—Reagent, A.C.S.

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NEW, SUPERIOR CATHALOY NAMED A-33 - PROVED IN USE FOR 21/2 YEARS

Cathaloy A-33 was designed by Superior Tube to be free of the problems of interface impedance and sublimation associated with active cathode alloys and yet easier to activate than the passive cathode alloys. Laboratory tests of this tungsten-zirconium-nickel alloy proved the composition did all that was expected of it. But more evidence was wanted. So the cathode alloy was labeled experimental —X-3012. That was back in April, 1959. Since then tubemakers have tried it, confirmed the laboratory findings, and started using it in production.

Now this alloy is named Cathaloy® A-33 and is a member of Superior's family of individually controlled cathode alloys. Every heat of each Cathaloy material is tested by Superior for electron tube performance before being fabricated into cathodes for customers. Tests include activation rate, emission level, life and sublimation.

Get the complete facts on Cathaloy A-33. Write Superior Tube Co., 2502 Germantown Ave., Norristown, Pa.

*U.S. Patent No. 2,833,647 (Superior Tube Company)

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Characteristics of Cathaloy A-33

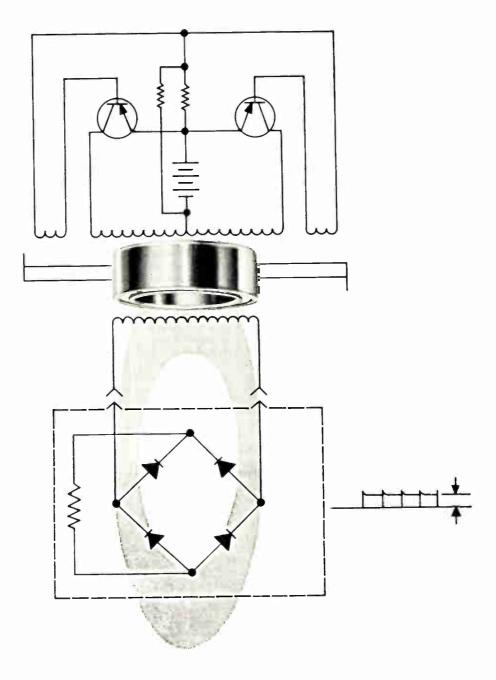
- 1. Combines the high-emission capacity of active alloys and the long life of passive alloys.
- 2. Sublimation and interface impedance reduced practically to zero.
- 3. Twice the hot strength of ordinary nickel alloys.
- 4. Sustained life under high current and overvoltage abuses.



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Johnson & Hoffman Mfg. Corp., Mineola, N.Y. — an affiliated company making precision metal stampings and deep-drawn parts

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How to design a static converter/inverter

Basically a magnetic coupled multivibrator, the square wave output of this static converter/inverter can be delivered as a-c directly to a load. Or, it can be rectified (full wave) to supply d-c voltages higher or lower than battery supply voltage. Ideal for highly portable equipment, the circuit has all the advantages of solid state devices. And, because transistors are the switches, replacing mechanical vibrators, potential maintenance problems are eliminated.

A Magnetics Inc. tape wound core is the *key* to perfect switching operation. The rapid change in core impedance in going from the unsaturated to saturated state forces the transistor switching. Thus, *a properly selected core* and the number of turns of wire on it become important, since this determines the operating frequency of the inverter.

Core material is important, too. For example, Magnetics Inc. Orthonol,® is ideal for most power applications where a given voltage and frequency are required. Where the design calls for a high voltage at low power levels, such as a d-c supply for photo tubes, Geiger tubes, or where high efficiencies are required under light loads, Magnetics Inc. Permalloy 80 should be selected.

Since power requirements, wire size, and frequency influence core size, Magnetics Inc. has a complete range of sizes and alloys available for complete design freedom.

To help you choose the core you need ... and for more details on this circuit, write for bulletin "Designing d-c to d-c Converters" to Magnetics Inc., Butler, Pa.



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MAPICO

IRON OXIDE REAGENTS



Pure Synthetic Iron Oxides for the Magnetics Industries

Calumbian has had well over 50 years experience in the business of manufacturing Pure Synthetic Iron Oxides. They can be produced by several practical procedures to give a variety of characteristic particle shapes and particlesize ranges. The methods by which MAPICO® Pure Iron Oxides are manufactured were chosen because they enable careful control of preselected characteristics.

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- (a) are strictly uniform from shipment to shipment (b) are reactive at the high temperatures customarily used in the ceramic industry
- (c) are available in three different particle shapes any of which may be had in several ranges of particle size
- (d) are of high purity and free from harmful impurities
- (e) give controlled shrinkage
- (f) give controlled electronic characteristics
- (g) are produced in ample supply by a large, modern, technically staffed plant

	z		NI ZE		Арр	arent	5	w		TYPIC	AL CHEN	ICAL A	NALYSIS			
DATA) MAPICO	COMPOSITION	PARTICLE SHAPE	PREDOMINANT PARTICLE SIZE (Microns)	SURFACE	De	nsity	% PURITY	MOISTURI (Loss of 105° C)	IGNITION	% WATER SOLUBLE SALTS	% SiO.	% TiO	% SO3	% Al <u>-</u> 03	% Cu	%Ma
PRODUCTS			A A	m ² /s	S.V.++ Gms./CN	Tapi Gms./	Min. Max.	Min. Max.	Min. Max.	Min.	Min.	Min. Max.	Min. Max.	Min. Max.	Min. Max.	Min. Max.
Yellow Ligh Lemon 100	ferric oxide hydrate	acicular	0.4-0.8	22.4	.14	.35	98.8 99.2	.30 .50	11.5	.04	.05	.002	.20	.001	.03 .05	.015
EG-1*	magnesium ferrite	acicular	0.4-1.2	4.7	.18	.40	99.3 99.6	.10	.05	.35	.05	.002	.10	.001	.02	.015
EG-2**	zinc ferrite	acicular	0.4-1.2	3.5	.27	.59	99.5 99.7	.10 .20	.05.10	.05.10	.10	.002	.02	.001	.02	.010
EG-3	gamma ferric oxide	cubical	0.3-1.2	8.7	.39	.71	98.0 99.0	.10 .20	.80	.10	.03	.02	.15	.002	.002	.10
Red 110-2	alpha ferric oxide	cubical	0.3-1.2	5.4	.33	.67	99.1 99.4	.05 .10	.25	.10		.02	.10	002	.002	.08
EG-60	alpha ferric oxide	cubical	2.0-4.0	2.8	.45	1.00	99.3 99.6	.05	.20 .30	.10		.02	.10	.002	.002	.06
Red H.P.	alpha ferric oxide	cubical	2.0-4.0	2.8	.45	1.00	99.7 99.8	.02 .05	.07	.02	.03	.005	.03	.002	.004 .002 .004	.04
EG-80	alpha ferric oxide	cubical	3.8-5.9	1.3	.85	1.74	99.4 99.7	.05	.10	.10	.03	.02	.05	.003 .002 .005	.002	.06
Red 297	alpha ferric oxide	spheroidal	0.3-0.8	8.4	.30	.59	99.3 99.6	.05	.30	.08	.05	.001	.05	.01	.004	.10
Red 347	alpha ferric oxide	spheroidal	0.3-0.9	7.4	.32	.61	99.4 99.7	.05	.20 .50	.05	.05	.003 .001 .003	.05	.02	.003	.01
Red 387	alpha ferric oxide	spheroidal	0.3-1.1	6.5	.33	.69	99.4 99.7	.05	.20 .50	.05	.05	.003 .001 .003	.05	.02	.003	.02
Red 477	alpha ferric oxide	spheroidal	0.4-2.0	5.9	.36	.74	99.5 99.8	.05	.15 .45	.04	.05	.003 .001 .003	.15	.02	.003	.03
Red 567	alpha ferric oxide	spheroidal	0.4-2.6	4.9	.37	.74	99.5 99.8	.05	.15 .45	.04	.05	.001	.10	.03	.003	.04 .03
Red 617	alpha ferric oxide	spheroidal	0.4-3.7	3.9	.39	.74	99.5 99.8	.05	.15 .35	.04	.15	.003	.10	.03	.003	.06 .03
Red 516-M	alpha ferric oxide	acicular	0.3-1.0	26.4	.14	.32	97.0 98.3	.10	.35 1.0 2.2	.10	.15	.003 .002	.10		.003	.015
Black†	synthetic magnetite	cubical	0.2-0.8	6.7	.34	.71		.05	.70	.05 .10	.03 .06	.004 .02 .04	.03 .06	.002 .002 .004	.002 .004	.025 .20 .25

*MgO (as MgO.FezO3); 18.7-19.2%—U.S. Patent 2,502,130 **ZnO (as ZnO.FezO3) 32.6-32.8%—U.S. Patent 2,904,395

***As determined by nitrogen adsorption

†FeO (as FeO·FezO3) 21-22%. ††Scott Volumeter

Samples are available on request and our trained technicians who are continually conducting ferrite research concerned with the use of Mapico Iron Oxides are at your service whenever desired.

COLUMBIAN CARBON COMPANY MAPICO IRON OXIDES UNIT

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news about solders, fluxes, preforms special alloys, lead and tin products

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VACULOY® USERS REPORT 90% LESS REJECTS AND REWORK PLUS 10% SAVINGS ON SOLDER

In a recent value analysis study by a major electronic product manufacturer, Alpha Vaculoy bar solder reduced rejects by 90%, produced higher quality joints, and provided 10% more joints per pound with less maintenance or critical control. The direct dollar saving is estimated to be nine times the extra cost of Vaculoy . . . and this figure does not include the intangibles anticipated from reduced field failures or the added value of increased reliability.

Alpha Vaculoy bar solder conforms to federa! specifications QQS-571 and applicable ASTM standards. It is substantially freer from oxide forming elements than other solders, because it is produced by a unique processing method which affects physical properties without disturbing metallurgical balance. Other cases in point

A radio manufacturer had to pre-tin transistor leads prior toprinted circuit assembly when using conventional 60/40 solder. A switch to Vaculoy 60/40 solder eliminated the need for pretinning.

A large manufacturer of resistors and capacitors uses an automatic dip machine to pre-tin leads. Thermal precautions limit the depth of the immersion. Pre-tinning of leads without heat damage is mandatory. Hence, rejects were high. A switch to Vaculoy process solder in the same alloy gave more complete tinning in less time, cutting down rejects.

Laboratory and production runs prove Vaculoy solder offers superior quality, reduces rejects and cuts solder costs. All Alpha alloys are

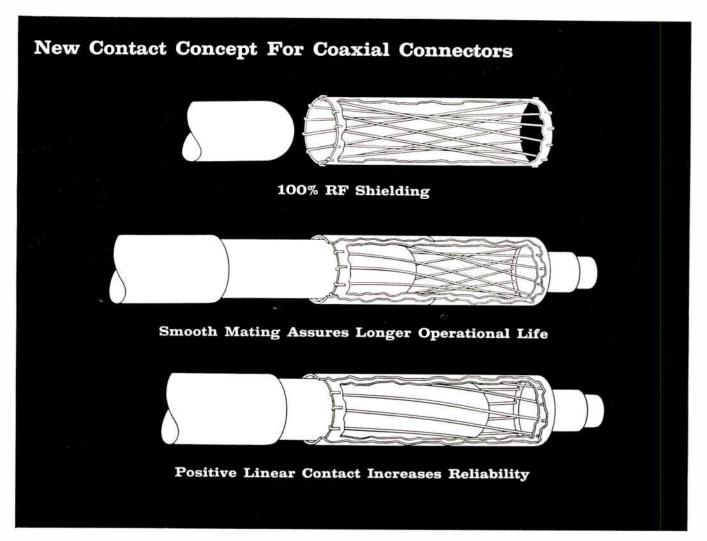
vailable "Vaculoy processed."

all or write for full information today.

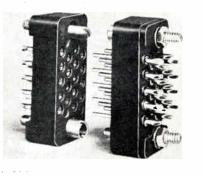
assed solder specimens — unretoucher

CA.

alpha







Ideal for all coaxial applications, CURTAC Connector design can also be applied to a variety of multiple rack and panel arrangements.

Operational Reliability That Lasts ... Even After 100,000 Insertion Cycles

CURTAC Connectors are completely new — in concept, design and construction — to give you reliable and consistent electrical and mechanical performance.

In life tests, CURTAC contacts functioned to specifications after 100,000 insertions. Elastic wrapping action of each contact wire, under tension, gives positive linear contact that withstands 50g shock, 20g vibration and temperatures ranging from 125° C to -65° C without physical damage or contact chatter. Multi-point contact provides normal operation after long static periods.

Contact design, plus wire wrapping action, assures 100% RF shielding — provides dependable contact pressure, low voltage drop and high current rating. Smooth mating of the CURTAC contact and solid pin make manual insertion of multiple coaxial contact arrangements easy and smooth. Meet or exceed all applicable Mil. Spees.



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in-stock cable shipped within 24 HOURS

Times can supply you with any RG coaxial cable you need—when you need it. This exclusive customer service is possible because Times produces and stocks the world's most complete line of polyethylene and teflon RG cables... including special and standard cables in an extensive variety of multiconductor configurations.

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In addition to being a major supplier of RG cable, Times also produces and stocks Teflon Hook-up Wire, Mil-Spec. 16878D.

Times publishes a *weekly* stock list indicating which cables are in stock and the amount available. For further information on this service and other Times' capabilities, write on your letterhead to Sales Manager, Dept. 600.



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IN ACCORDANCE WITH NEW GOVERNMENT SPECIFICATION MIL-T-55164

GEN-PRO SOLID BLOCK TERMINAL BOARDS Available for Immediate Delivery

New coordinated Government specification MIL-T-55164 requires that terminal boards with solid backs and molded-in inserts be used for all terminal board applications in equipment manufactured for the Department of Defense.

Gen-Pro Terminal Boards — manufactured by General Products Corporation — are in complete accordance with the requirements of new specification MIL-T-55164 and are available for immediate delivery.

SOLID BACKS save cost of insulating strips, resist moisture and breakage.

"MOLDED-IN" CONDUCTORS

assure greater capacity and permanent retention, reinforce mounting holes, eliminate separate saddle plates.

GEN-PRO solid block terminal boards are molded from Compound GDI-30F glass-filled diallyl phthalate flame resistant per MIL-M-19833 as required by this new coordinated government terminal board specification.



Write today for illustrated brochure to Military Marketing Manager

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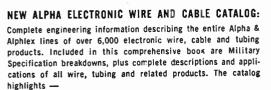
OVER 25 YEARS OF QUALITY MOLDING

AUTHORITATIVE REFERENCE DATA:

HOW TO SPECIFY ELECTRONIC WIRE, CABLE **& INSULATING** MATERIALS...

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 Shrinkable Irradiated Polyolefin Tubing
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 Alpha-Brady Wire Markers . Lacing Cords and Tapes

A complete section describes Alpha's special facilities such as Striping, Cutting, Stripping, Tinning, Coloring of Cable Jackets and Short Run Cables.



ALPHLEX SHRINKABLE TUBING complete "He are included.

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ALPHLEX ZIPPER TUBING An irradiated polyolefin tubing The most up-to-date and com-featuring controlled shrinkage. plete engineering brochure on Forms a tight mechanical bond the Alphlex line of Zipper Tub-seconds after heat is applied. ing. Featured is complete infor-Sizes, physical properties and a mation on all 5 types of Zipper complete "How to Use" section Tubing. Dimensions and physical properties account of the application of the applicatio ing. Featured is complete infor-mation on all 5 types of Zipper Tubing. Dimensions and physical properties are completely properi charted.

> Complete Data Sheets on New Alpha Products and Services. Cable Coloring Process

- Packaged Shrinkable Tubing Assortments
- Comprehensive Price Sheet on Cut Tubing, marked and unmarked

ALPHA-BRADY WIRE MARKERS Featuring the new vinyl B-400 line of miniature markers. The first wire marker specifically designed for Electronic Wire and Cable. Full data on the B-500, standard line of wire markers is also listed. Includes complete application instructions and ordering information.

4

BRADY WIRE

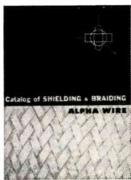
MARKERS

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ALPHA-TEMPIL TEMPERATURE INDICATORS

INDICATURS For positive indication of criti-cal temperatures. All electronic components can be temperature checked to $\pm 1\%$ accuracy with-out expensive and complex thermocouples. Available in liquid (Tempilag) or solid (Tem-pilstik) form. Catalog contains typical applications, characteris-tics, listings of more than 100 available temperature ranges and information on new Alpha Temperature Indicating Kits.



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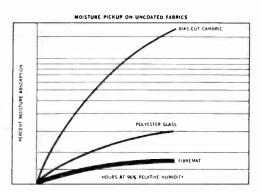
SHIELDING AND BRAIDING Applications, descriptions and all engineering data on Alpha Shielding and Braiding. Specifi-cations on the 3 different types, Flat Braid, Oval Commercial Braid and Tubular Braid to mili-tary spec QQ-B 575 are provided. A special glossary is included.

SEE OUR COMPLETE PRODUCT LISTING IN "RADIO MASTER" OR WRITE TODAY FOR YOUR COPY OF ANY OR ALL ALPHA WIRE CATALOGS.

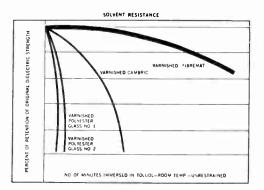
> ALPHA siacht WIRE ALPHA WIRE CORPORATION Subsidiary of LORAL Electronics Corporation 200 Varick Street, New York 14, N.Y. Pacific Division: 11844 Mississippi Ave., Los Angeles 25, Calif.

FOUR COMPARISON TESTS SHOW WHY YOU GET GREATER DEPENDABILITY WITH

NEW Fibremat Electrical Insulations

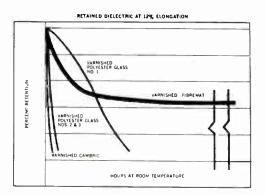


MOISTURE ABSORPTION – UNCOATED FABRICS – There's no pre-baking to drive out moisture when you use "Fibremat." The non-hygroscopic base fabric resists moisture. When exposed to 96 percent relative-humidity for 45 hours bias-cut cambric showed a moisture absorption of 25 percent, polyester-glass showed a moisture absorption of 2 percent, while "Fibremat" showed a moisture absorption of less than .7 of one percent. Proof of the superior moisture-resistance of "Fibremat" Insulation.



SOLVENT RESISTANCE – COATED INSULATIONS – "Fibremat" offers outstanding resistance to solvents used in dipping or impregnating operations. Conventional woven insulations leave relatively large unsupported areas of varnish film between the filaments. This unsupported film, when exposed to solvent, tends to swell and flake away from the base fabric and cause electrical failure. The uniform dispersion of fibers in "Fibremat" however, provides equal support for all areas of the varnish film and prevents this solvent-caused breakdown. PORER FACTOR VS. HUMIDITY

MOISTURE ABSORPTION – COATED INSULATIONS – In moist or humid environments "Fibremat" outperforms varnished cambric or polyester-glass materials. Continuous filaments in woven fabrics wick up moisture and offer a direct path for moisture to follow. The non-woven construction of "Fibremat" prevents wicking and moisture absorption. The power factor of varnished "Fibremat" remains relatively stable while the power factor of the other insulations zoom upward under increased humidity conditions.



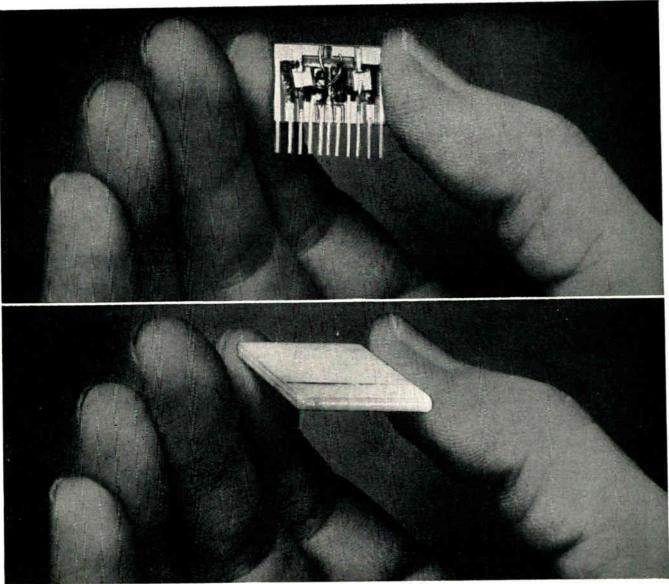
RETAINED DIELECTRIC AT 12% ELONGATION-COATED INSULATIONS—At 12% elongation varnished "Fibremat" retains a significantly greater percentage of its original electric strength than either varnished cambric or varnished polyester-glass materials. Woven insulation, when stretched, creates points of stress where filaments cross each other. Elongation produces a scissor-like action that weakens the structure, tends to tear the varnish film and rupture the insulation coating. Non-woven "Fibremat" has built-in stretch, doesn't "scissor", supports the entire film.

FIBREMAT** IS A REGISTERED TRADEMARK OF 3M CO.

"Fibremat" is no ordinary insulation. It's formed from a non-woven web of polyester fibers without the use of adhesives or any other bonding agent. This unique nonwoven construction gives "Fibremat" flexibility to conform snugly to irregular shapes without gapping or voiding. Helps it retain electric strength under elongation so fewer layers are needed to attain the same

electrical performance achieved with many layers of ordinary insulating materials. Use "Fibremat" for wrapping form wound coils, layer and phase insulation, slot liners, and high voltage cable. For more information, write: 3M Company, Irvington Division, St. Paul 6, Minn., or phone and ask for "Fibremat" at your nearest branch office listed below.

ATLANTA, 451-1661; BOSTON, HI 9-0300; BUFFALO, TX 4-5214; CHICAGO, GL 8-2200; CINCINNATI, EL 1-2313; CLEVELAND, CL 2-4300; DALLAS, DA 7-7311; DETROIT, 875-7111; LOS ANGELES, RA 3-6641; PHILADELPHIA, PI 2-0200; NEW YORK, OX 5-5520; ST. LOUIS, WY 1-1320; ST. PAUL, PR 6-8511; SAN FRANCISCO, PL 6-0800; SEATTLE, MU 2-5550.



Micro-electronic welds to nickel-plated ceramic substrate (top) and two edge-welded aluminum oxide ceramic wafers (bottom) show versatility of Hamilton-Zeiss Welders.

ELECTRON BEAM WELDING ... a new world of design at your fingertips

Hamilton-Zeiss Electron Beam Welders produce ultraprecise microminiature welds which set new standards of connection reliability. They also permit fabrication with difficult-to-join materials such as ceramics, refractories, and titanium. The Hamilton-Zeiss process allows designers of micro-electronic circuits and components to achieve optimum packaging density, reduced weight, and increased reliability.

The three exclusive Hamilton-Zeiss features which make these advantages possible are:

• Small beam diameter with high power density (371/2 million watts per square inch).

Circle 86 on Inquiry Card

- Optical viewing system which shows exact position of the beam on the workpiece at all times (40 mag.).
- Precise, repeatable control of beam energy, position, and penetration.

The process also permits component encapsulation and contamination-free joints of high structural integrity because the work is performed in a vacuum.

For full technical data on Hamilton-Zeiss Electron Beam Welder, write or wire: Electron Beam Systems, Hamilton Standard Division, United Aircraft Corporation, Windsor Locks, Connecticut.

Hamilton Standard DEVISION OF UNITED AIRCRAFT CORPORATION



Homemade small precision parts...



are just like Torrington

precision parts...

except they cost more

If you make your own small precision metal parts-or buy them-send Torrington a print or sketch-and sample if available. We will send you a prompt quotation that may amaze you. You see, our plants produce small parts like these daily by the millions in the temper, hardness and microfinishes Torrington is famous for. More than 90 years of precision metalworking experience assures you of quality and economy. As we said, send us a print or sample. We'll make the part faster, better and for less. Whenever you need small precision parts in volume, write: Specialties Division.

PROGRESS THROUGH PRECISION THE TORRINGTON COMPANY TORRINGTON, CONNECTICUT

Serving industry throughout the world with metal specialties, all basic types of antifriction bearings, rotary swaging machines.

ELECTRONIC INDUSTRIES . June 1962

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SHOCK IT, DROP IT Shake IT Even Drill IT

NETIC AND CO-NETIC MAGNETIC SHIELDINGS PERMANENTLY PROTECT YOUR COMPONENTS

Never require rejuvenation ... have negligible residual magnetism

Netic and Co-Netic magnetic shields make your sensitive components impervious to outside magnetic disturbances. Because of their proven reliability, both are widely used in satellites and missiles as well as on the ground to protect recording tapes, components and systems. The proprietary characteristics of these alloys enable you to design compactly, and improve overall performance.

Down time or replacement costs are eliminated because no time-wasting periodic annealing is required.

The magnetic shields have numerous military, scientific and laboratory applications as well as commercial uses where permanent component protection is demanded.



MAGNETIC SHIELDS CAN BE CUSTOM-FABRICATED TO ANY SIZE OR SHAPE. From micromodules to mobile shielded rooms, pick your shielding problem and let us help solve it! The Magnetic Shield Division offers you the widest range of production facilities.

PHONE YOUR NEAREST SALES OFFICE TODAY:

MERIOEN, CONNECTICUT, BEverly 7-9232 UNION CITY, NEW JERSEY, UNION 4-9577 BALTIMORE, MARYLANO, HOpkins 7-3766 GREENSBORO, NORTH CAROLINA, 272-6149 DECATUR, GEORGIA, 378-7516 CORAL GABLES, FLORIOA, Highland 3-7439 MAITLAND, FLORIOA, MIdway 7-7830 ST. PETERSBURG, FLORIDA, WAverly 1-9735 DALLAS, TEXAS, FLeetwood 1-1615 HOUSTON, TEXAS, HOmestead 5-7780

ALBUQUERQUE, NEW MEXICO, AMherst 8-6797 PHOENIX, ARIZONA, AMhurst 4-4934 SAN OIEGO, CALIFORNIA, BRowning 8-6230 LOS ANGELES, CALIFORNIA, WEbster 1-1041 PALO ALTO, CALIFORNIA, DAvenport 1-5064 SALT LAKE CITY, UTAH, CR 8-9023 SEATTLE, WASHINGTON, EA 3-8545 MONTREAL, QUEBEC, WEIlington 7-1167 WINNIPEG, MANITOBA, SPruce 4-1991 mestead 5-7780



Perfection Mica Company / EVerglade 4-2122

1322 N. ELSTON AVENUE, CHICAGO 22, ILLINOIS ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDS

Tech Data for Engineers

Soldering Fixture

DIP-RAC is an adjustable universal printed circuit dip soldering fixture. It eliminates the necessity of building custom fixtures for different sizes and types of boards. Defiance Printed Circuit Corp., Malden, Mass. Circle 367 on Inquiry Card

Soldering Irons

Tech data is available on 80 different models in 7 distinct types of soldering irons. Information is also included on a featherweight solder gun, and pencil irons. Hexacon Electric Co., Roselle Park, N. J.

Circle 368 on Inquiry Card

Thin Films

Optical Coating Laboratory, Inc., 2789 Giffen Ave., Santa Rosa, Calif. is offering a brochure on their capabilities and abilities in the field of thin films. Information is also included on an 8 micron long wavelength pass filter, a blue-red reflector, the "HEA" high efficiency anti-reflection coating; and a cold mirror.

Circle 369 on Inquiry Card

Laminates

Tech data is available on Genclad[®] F copper-clad Teflon[®]-Glass printed circuit laminates. Features include low dielectric loss under extreme temp. conditions, and low deformation under heat and pressure. General Plastics Corp., 55 La France Ave., Bloomfield, N. J.

Circle 370 on Inquiry Card

Component Clips

Transistor retainers of beryllium copper are fully described, including dimensional drawings and size tables, for a wide variety of transistors now on the market. Information is also included on capacitor retainers, and fuse clips. Braun Tool & Instrument Co., Inc., 140 Fifth Ave., Hawthorne, N. J. Two-colors, 11-pages Bulletin E-108.

Circle 371 on Inquiry Card

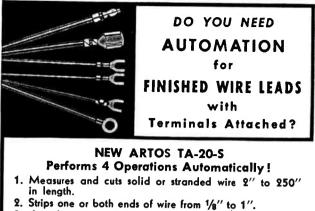
Technical Ceramics

This 4-page brochure on technical ceramics features a chart of some typical properties of special compositions which include a family of 5 grades of high purity aluminum oxides, steatite, zirconia, magnesia and cordierite. Technical Ceramics Div., Gladding, McBean & Co., 2901 Feliz Blvd., Los Angeles 39, Calif.

Circle 372 on Inquiry Card

World Radio History

ELECTRONIC INDUSTRIES · June 1962



- 3. Attaches any prefabricated terminal in strip form to one end of wire. (Model CS-9-AT attaches terminals to BOTH ENDS OF WIRE simultaneously.)
- 4. Marks finished wire leads with code numbers and letters (optional attachment).

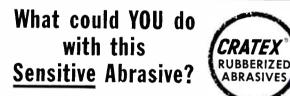
UP TO 3,000 finished pieces per hour. Can be operated by unskilled labor. Easily set up and adjusted to different lengths of wire and stripping. ENGINEERING consultation without obligation. Machines for all types of wire lead finishing.

AGENTS THROUGHOUT THE WORLD



GNEEDING 2753 South 28th Street Milwaukee 46, Wisconsin

Circle 89 on Inquiry Card



Without significantly changing dimensions of the workpiece, CRATEX® deburrs, smooths, cleans and polishes easy and hard-to-reach surfaces.

The unusual performance of Cratex results from its cush-ioned chemical rubber base. It is slightly compressible; shaped in a variety of forms, including Wheels, Points, Blocks, Sticks and Cones. First quality Silicon Carbide abrasive particles are evenly distributed throughout the base and each Cratex shape is available in 4 grit textures: (C) coarse; (M) medium; (F) fine; (XF) extra fine.

Typical Cratex applications include:

precision finishing without relieving stress loss of tolerances.

concentration, radiusing,

cleaning out and finishing intricate designs,

removing surface blemishes.

You can count on CRATEX® to do the same dependable job, time after time.

A comprehensive Cratex catalog and price list is available on request, without charge. Product and performance data provided may suggest how Cratex will benefit you in terms of time-saving cost reduction and quality improvement.



1600 ROLLINS ROAD BURLINGAME, CALIF.

Cratex is sold through leading industrial distributors.

Circle 90 on Inquiry Card



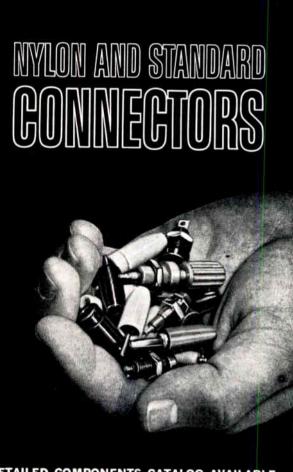
Time after time engineers specify Johnson connectors!

Whatever the choice ... sub-miniature nylon connectors for printed circuit use-or Johnson's patented "Six-Way" Binding Post . . . time and time again design and development engineers specify Johnson connectors!

A complete line of nylon and standard connectors are readily available to meet most military and commercial applications-nylon types include: subminiatures for printed circuit applications; insulated solderless tip and banana plugs; tip and banana jacks; tip jack and sleeve assemblies; metal-clad and "rapid-mount" tip jacks; dual banana plugs and a unique, "6-way" binding post. Available in 13 colors for coded applications, nylon connectors are designed to operate throughout an extremely wide temperature range and under conditions of high relative humidity -voltage breakdowns available up to 11,000 volts on some types! For detailed information on the complete Johnson connector line and other Johnson electronic components-write today for our newest components catalog!

E. F. JOHNSON COMPANY

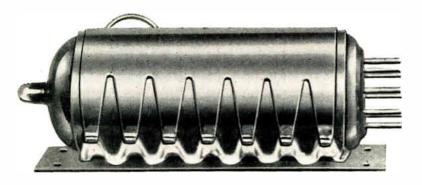
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DETAILED COMPONENTS CATALOG AVAILABLE -Write today on company letterhead!

• CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS .INSULATORS .KNOBS AND DIALS .INDUCTORS .HARDWARE

Circle 91 on Inquiry Card





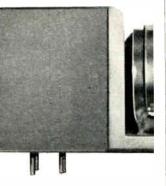
VERSATILE

TUBE RETAINERS

FOR OPTIMUM

THERMAL

DESIGN!

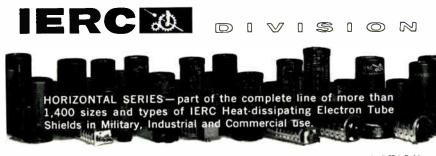




IERC Horizontal Hardmount Series for all Miniature and Subminiature tubes give you Maximum Control and Isolation of tube-generated heat!

Separate hot tubes from associated components thermally link tubes to a heat sink or cold plate with IERC horizontal mounting tube shields for the most efficient removal of tube-generated heat!

Compatability with a wide variety of design and mounting techniques plus complete availability for all miniature and subminiature tube sizes provides you with new, versatile and effective answers for improved thermal design. Efficient tube cooling and vibration protection gained with the Hardmount Series extends tube life and reliability – cuts costs!



INTERNATIONAL ELECTRONIC RESEARCH CORPORATION 135 West Magnolia Boulevard, Burbank, California • Victoria 9-2481 Foreign Manufacturers: Europelec, Paris, France. Garrard Mfg. & Eng. Co., Ltd., Swindon, England

Circle 92 on Inquiry Card

Tech Data

for Engineers

Epoxies

Tech data is available on CONAP 1610, which is a 2-component epoxy for potting and encapsulation. It features flexibility and maintains good electrical properties at temps. of 130° C and above. Other features include reasonable pot life, low viscosity and short cure for production efficiency. CONAP Inc., 184 E. Union St., Allegany, N. Y. Bulletin 1610.

Circle 373 on Inquiry Card

Heatsinks

Tech data is available on a line of heatsinks in all types and sizes. Vemaline Products Co., Franklin Lakes, N. J.

Circle 374 on Inquiry Card

Copper Alloy

This 4-page, 2-color, folder (D-29) lists the applications and physical properties of Amzirc—a heat-treatable, oxygen-free zirconium copper alloy. The alloy may be used for semiconductor bases, incandescent lamp filament supports, resistance welding electrodes and wheels, and commutators and slip rings. Chase Brass & Copper Co., Waterbury, Conn.

Circle 375 on Inquiry Card

Electronic Alloys

"Huntington Alloys for Electronic Uses" gives data on nickel and highnickel alloys for electronic component parts. Chemical compositions, general characteristics, typical uses and availability of mill products are included. Huntington Alloy Products Div., The International Nickel Co., Inc., Huntington 17, W. Va.

Circle 376 on Inquiry Card

Glass-to-Metal Units

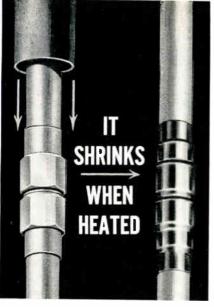
Information is available from Electron Technology, Inc., 626 Schuyler Ave., Kearny, N. J., on their abilities and capabilities for manufacturing stems and glass-to-metal assemblies, cathode-ray tubes, multiplier phototubes, ionization gauges, and special purpose tubes.

Circle 377 on Inquiry Card

Springs

Tech data is available on a line of beryllium copper compression springs, flat springs, strip springs, finger contact strips, and long contact strips. Instrument Specialties Co., Inc., Little Falls, N. J. This 19-page brochure also includes sections on properties, ductility, hardness, grain direction, tolerances, design recommendations, and endurance.

Circle 378 on Inquiry Card







Anaconda's Hyshrink tubing and sleeving gives you custom-fitting, insulating sheath on connectors, multi-pin connectors, cables, terminals, capacitors, pigtails and many other similar applications.

HERE'S HOW IT WORKS

1) Cut a section of Hyshrink tubing the length you want. Slip it on.

2) Apply 275°F heat for a few seconds.

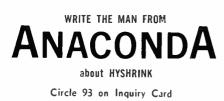
3) Hyshrink shrinks to form a protective sheath the exact shape of the area covered.

RESILLT

You get a custom-molded mechanical bond with these outstanding features.

- · CONTROLLED SHRINKAGE Hyshrink is an irradiated polyolefin material. The molecular cross-links control the shrinking-giving you the dimensions you require.
- EXCELLENT TEMPERATURE CHARACTERISTICS -minus 67°F to 275°F. Tubing will not run, flow, melt, harden, crack or blister.
- HIGH DIELECTRIC AND MECHANICAL STRENGTH Hyshrink is an excellent insulating material.
- MOISTURE AND CHEMICAL RESISTANCE Hyshrink protects against weathering. Is unaffected by most chemicals.

All of these features make Anaconga's Hyshrink the most versatile tubing and sleeving yet developed. Fcr complete information, just write Anaconda Wire and Cable Co., 2201 Bay Road, Redwood City, California, Dept. JEB-2.



THE BIG PLUS BEHIND **GREMAR'S** NEW RIGID LINE CONNECTORS

Another new advance in Connectronics[®] combines excellent cable retention, high torque resistance, consistently low VSWR and 100% effective weatherproofing!

TRUST GREMAR to produce a brand new connector to solve problems long plaguing the rigid cable field! Here's a complete series for Foamflex, Styroflex, Styrofoam, Spirafil-T, Coaxitube and other rigid cable applications that deliver exceptional electrical and mechanical performance.

It wrenches up to a lock-grip that gives unequalled stability in service, despite the most severe torque, vibration, thermal cycling and environmental attack. It can be assembled and taken apart repeatedly without need to replace parts or redress cable sheath . . . does not require special tools or fixtures.

TRUST GREMAR to develop unique weatherproofing: successive coatings of copper, electroless nickel, silver and rhodium, plus silicone gasket sealing that defeats any climate.

TRUST GREMAR for any R F connector requirement. Standards can be shipped in hours from our stock of 3200 types . . . 750,000 assembled

units...8,000,000 parts! If custom adapting to your CREMAN spec's is required, we'll handle it with speed and efficiency unmatched in the industry. If it's a new design, our Model Shop handles prototypes fast!

World Radio History



ELECTRONIC INDUSTRIES - June 1962

Circle 94 on Inquiry Card

Mary or Capitor of Marine Stations of



for Engineers

Semiconductor Cans

Tech data is available on cans for relays, crystals, and semiconductors made of nickel-silver, brass, copper, mu-metal, cold roll steel, cupro-nickel and stainless steel. Hudson Tool & Die Co., Inc., 18-38 Malvern St., New-ark 5, N. J.

Circle 379 on Inquiry Card

Filters

Tech data is available on filters, variable r-f attenuators, transformers, and wire wound resistors. Resistant ranges are from 0.1Ω to 5 megohms; wattage range from 0.1w to 2w and standard T.C. is ± 5 ppm above 100 Ω . Ortho Industries Inc., 7 Paterson St., Paterson 1, N. J.

Circle 380 on Inquiry Card

Current Regulators

Tech data is available on a line of constant current sources and regulators which feature a high ac impedance in addition to high dc resistance. They are suited for use in testing diodes or saturation effects of chokes. Leighner Mfg. Co., 1510 N. Neil St., Champaign, Ill.

Circle 381 on Inquiry Card

Flat Flexible Cable

IRC Polystrip® is ultra-thin, flat, flexible cable containing multiple conductors protected between tough plastic sheets. The 7-page brochure in-cludes photographs, ordering information, information on testing, inspection, quality control, an insulation parameter table, and characteristics curves and dimension tables. International Resistance Co., Plastic Prod-ucts Div., 401 N. Broad St., Phila. 8, Pa.

Circle 401 on Inquiry Card

Wire Markers

Bulletin 729 describes self-sticking B-400 Wire Markers designed specifically for wires in electronic equipment, parts and assemblies. The markers are designed to withstand continuous heat up to 250°F without change, and are resistant to oil, solvents, fuels, dirt and abrasions. W. H. Brady Co., 726 W. Glendale Ave., Milwaukee 9, Wis. Circle 402 on Inquiry Card w.

Ground Stud

Jan Engineering, 2018 Pico Blvd., Santa Monica, Calif., has tech. data available on their ground stud, P/N 5008. Designed for circuits requiring up to #14 AWG wire and for estab-ishing a true reference for single point ground to eliminate the possi-bility of ground loops and noise pickup. Information includes spec. sheets and outline drawings.

Circle 403 on Inquiry Card

Impulse Counters

SODECO Impulse Counters for totalizing, predetermining, printing and transmitting are described in tech data available from Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.

Circle 382 on Inquiry Card

Transformers

Dura-Clad[®] Transformers feature hybrid balance and longitudinal balance as high as 60 db and reflected impedance held to \pm 5% over the freq. range of 300CPS to 30MC. They are for data processing, automatic control, multiplex telephone and tel-emetry equipment. Aladdin Electronics, Dept. 2-M, Nashville 10, Tenn.

Circle 383 on Inquiry Card

Semiconductor Tips

"25 Tips on How to Buy Semiconductors" covers: rating suppliers; the use of distributors; the influence of pricing; reliability; use of standard specs.; use of drawings; buying in quantity; and other pertinent items. Transitron Electronic Corp., 168 Albion St., Wakefield, Mass. Circle 384 on Inquiry Card

Multiplex Equipment

"CT-42 Solid State Tone Multiplex Equipment," 16-pages, gives detailed data on equipment applications, freq. allocations, component diagrams, transmitter and receiver options and complete system specs. The CT-42 can be used with existing microwave, carrier or wireline circuits to give AM or freq. shift data transmission, teletype, telemetering, remote control and signaling functions. RCA, Micro-wave Dept., Bldg. 15-4, Camden 2, N. J.

Circle 404 on Inquiry Card

Magnetic Materials

Lodex^{T.M.} is a permanent magnet material based on highly elongated single domain particles. Four distinct magnetic grades are available for commercial use. Lodex 31, 32, 41, 42, are all iron-cobalt particles in a lead matrix. The four types differ in their manner of processing. Included are specs. and characteristic diagrams. General Electric Co., Magnetic Material Section, Edmore, Michigan. Circle 405 on Inquiry Card

Tapping Screws

This tech. bulletin on Type "K" Kaptiv screws is available from Parker-Kalon, a div. of General American Transportation Corp., Clif-ton, N. J. The P-K Kaptiv taps and stakes itself in a single operation. Bulletin 1C/4.

Circle 406 on Inquiry Card

for electronic assembly and service work

tool chest

IN VOU

Shockproof (UL), breakproof, plastic handles with clips

ROUND BLADE SCREWDRIVERS $\frac{2}{32}^{\prime\prime\prime}$ and $\frac{1}{6}^{\prime\prime\prime}$ x 2", 3", and 4" blades

PHILLIPS SCREWDRIVER Point size #0, 2" blade

BERYLLIUM-COPPER SCREWDRIVER Non-magnetic, non-sparking 1/8" x 2" blade

NUTDRIVERS

10 Hex sizes from 3/2" to 3/6". 1¼" blades Color coded handles

TERMINAL WRENCHES

Fit $\frac{1}{4}$ " and $\frac{1}{4}$ " O.D. spanner nuts on external antenna and phone jacks of transistor radios





PROFESSIONAL POCKET 1 8

XCELITE, INC. • ORCHARD PARK, N. Y. Canada: Charles W. Pointon, Ltd., Toronto, Ont. Circle 95 on Inquiry Card

and get these HIGHER DIELECTRIC RETENTION GREATER FLEXIBILITY MORE HEAT RESISTANCE AVAILABLE IN COILS

> CAN BE AFTER-TREATED Even under the most severe operating conditions, Varfil

AVAILABLE IN FOLLOWING NEMA CLASSES CLASS B-A-1 7000 VOLTS AVIRADE CLASS B-B-1 4000 VOLTS AVIRADE CLASS B-C-1 R300 VOLTS AVIRADE CLASS B-C-2

CORPORATION

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dielectric strength. Twist it, tie it, bend it, wrap it, knot it. Remains just as pliable as when you started. Won't crack, peel or suffer dielectric loss. Heat Varfil 2000 hours at 110° C.—1,000 hours at 125° C. —and even for extensive periods at 150° C. It won't brok down Can be often C. It won't break down. Can be aftertreated in baking and varnishing opera-tions. Reacts better than other oleoresinous Nons. Reacts better than other oleoresinous materials and synthetic coated tubings. Available in handy coils so you can cut the exact lengths you need . . . no waste. Standard colors. Wide range of sizes, Ex-ceeds or meets all A.S.T.M. specifications,

Sleeving and Tubing retains its average

NOW-Specify VARFIL

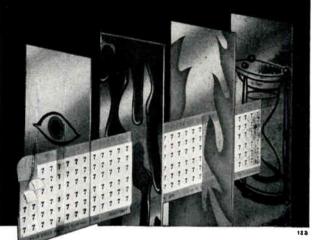
VA

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SEND TODAY VARFLEX Corporation, 308 N. Court St., Rome, N. Y. Circle 96 on Inquiry Card

NEW! for ELECTRONIC WIRES BRADY B-400 wire markers



A genuinely new wire identification product. Made of self-sticking B-400 Reinforced Plastic. Combines superior legibility, oil resistance, heat resistance and permanence . . . PLUS adhesive compatibility with all types of wire, even Teflon — or wires coated with silicones, oil, or containing plasticizers. Dispenser Card Mounted for fast application. Over 1100 standard legends in stock in four sizes.

Write for sample and fact-filled bulletin.

W. H. BRADY CO., 750 W. Glendale Ave., Milwaukee 9, Wis.

Manufacturers of Quality Pressure-Sensitive Industrial Tape Products, Self-Bonding Nameplates, Automatic Machines for Dispensing Labels, Nameplates, Masks and Tape.

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ELECTRONIC INDUSTRIES · June 1962

Madkasse



Nylon for high temperature ond other severe service conditions.



of economical Ethyl-Cellulose for maximum service at minimum cost. Non-circular shapes also available. Immediate delivery from on-hand stocks.

CABLE CLAMPS

A STYLE AND

REQUIREMENT

Weckesser Cable Clamps

offer superior insulating

properties, high strength,

light weight . . . with no rust

SIZE FOR EVERY CABLE FASTENING

WRITE TODAY FOR FREE SAMPLES AND PRICE SHEET



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or corrosion.



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448 ELM ST. . SYCAMORE, ILLINOIS

WIRE CONNECTORS

Immediate delivery. improved quality, new, low prices on

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beryllium

oxide diode and

transistor bases. BeO

electrically insulates

like a ceramic,

conducts heat like

a metal. It

also reduces

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collector to ground

capacitance.

Write

now

stating

requirements. Full

information and

specs available from



THE BRUSH BERYLLIUM COMPANY

5209 Euclid Avenue Cleveland 3, Ohio

Circle 101 on Inquiry Card

New Tech Data

Consoles

"Consoles & Cabinets Human Engineered" contains photographs and descriptions on a line of radar. computer, test and control consoles. Information is also included on a line of rack cabinets. Falstrom Co., 186 Falstrom Court, Passaic, N. J. Circle 385 on Inquiry Card

Temperature Testing

Tech data is available on Thermochrom Crayons and DetectoTemp Paints which are designed for mea-suring surface temperatures. When certain temperatures are reached, these indicating materials completely change color to a completely different color. Princeton Div., a div. of Cur-tiss-Wright Corp., Princeton, N. J.

Circle 386 on Inquiry Card

Delay Lines

Mechanical and electrical proper-ties and features of fixed length and tapped microwave delay lines are described in a 6-page bulletin available from the MicroDelay Div., Franklin Technical Corp., Kulpsville, Pa. At-tenuation, input vswr vs. freq., and internal reflections are discussed and full tech. specs are given. Bulletin 201.

Circle 387 on Inquiry Card

Silicon Rectifiers

Bulletin No. 62-SA-3, 8 pages, describes single-phase bridge and center tap, and 3-phase half-wave, bridge, and full-wave center tap assemblies. Also included are applications, circuit design factors, and typical rectifier circuit drawings. Sarkes Tarzian, Inc., 415 N. College, Bloomington, Ind.

Circle 407 on Inquiry Card

Shock Mounting

Technical Specialties Co., Inc., 415 Concord Ave., New York 55, N. Y., is offering a catalog of technical data on many types of rubber parts available with pressure sensitive, high-tack adhesive backing. The mate-rials are suited for waterproofing, insulating, shock mounting, weather-stripping, protecting and skid-proof-ing electronic and electrical components and assemblies.

Circle 408 on Inquiry Card

Turret Terminals

Components Catalog No. 61 describes and illustrates, with fully dimensioned drawings, over 500 stock turret terminals including single-end. double-end, tubular, slabbed, slotted, taper-pin, and insulated. Also in-cluded is data on swaging tools, terminal-boards, and other electronic hardware. This 48 page catalog is avail-able from Precision Metal Products Co., 41 Elm St., Stoneham, Mass. Circle 409 on Inquiry Card

for Engineers

Clean Rooms

Tech data is available on transparent atmosphere enclosures for operations requiring control of dust, fumes, moisture and inert gases in micro parts assembly, inspection, research and microscopic studies. Affiliated Manufacturers Inc., Box 105, Oldwick, N. J.

Circle 388 on Inquiry Card

Chromatography

This 4-page bulletin describes a full line of gas chromatography instrumentation available from F & M Scientific Corp., Rt. 41 and Starr Rd., Avondale, Pa. Data is included on a dual column temp, programmed gas, and automatic preparative gas chromatographs, and a power proportioning temp. programmer. Circle 389 on Inquiry Card

Antenna Testing

Rohde & Schwarz, 111 Lexington Ave., Passaic, N. J., is offering tech data on their "Reflectromat" which is a unit for the automatic plotting of reflection coefficients over the freq. range of from 30 to 400MC. Features included are dynamic range of 60 (80) db and a reflection coefficient range of 0.1% to 100%. Also included are photographs, tests setup, and

Circle 390 on Inquiry Card

Fused Synthetic Silica

Thermal American Fused Quartz Co., Rt. 202 & Change Bridge Rd., Montville, N. J., is offering a 2-color, 4-page bulletin on Spectrosil, a syn-thetic fused silica. Chemical and physical properties are shown in de-tail. Applications and specifications are also included. Circle 410 on Inquiry Card

Circle 410 on Inquiry Card

Tubing

J. Bishop & Co., Platinum Works, Malvern, Pa., is offering Bulletin No. 13, 20 pages, which gives the sizes, specs, finished, tolerances, chemistry, and suitable uses for small diameter stainless steel, nickel alloy, and re-fractory tubing. The line includes tubing up to 1 in. O.D. Circle 411 on Inquiry Card

Transfer Molding

A technical paper entitled, "Trans-fer Molding—Past, Present and Fu-ture" is available from Hull Corp., Hatboro, Pa. Circle 412 on Inquiry Card

Pre-printed Symbols

A money and time saving item. STANPAT tri-acetate sheets are coated with a water-clear adhesive and are pre-printed with repetitive symbols. Tech data describes the line of stock symbols and the custom printed service offered. Custom symbols of any type and detail are possi-ble. STANPAT Co., Whitestone 57, N. Y.

Circle 413 on Inquiry Card



These performance characteristics were confirmed in a recent evaluation of leading fluxes used in the fields of printed wiring and etched circuitry.

No one flux is best for all purposes. TEST HYDRAZINE FLUX AND CORE SOLDER FOR YOURSELF. The liquid permits pre-fluxing, is useful for soft-soldering a wide range of copper and copper-based alloys. The core solder flows at an ideal rate, leaves a minimum of soldering residues. Write for samples of either, or technical literature.

*U.S. Potent No. 2,612,459 and others

Available only from Fairmount and its sales agents.

Circle 80 on Inquiry Card





Valuable Literature! New Linen Thread Company catalog, "Lacing Cords and Tapes for Electronics," can help you save money, eliminate hazards. It tells you how to save up to 500% with LTCo X-Type Nylon Lacing Cord, gives data you need on other Specification Lacing Cords and Tapes made by LTCo in Nylon, Linen, Teflon, Cotton, Dacron.



Write Dept. 15F for your copy ELINEN THREAD CO., I

Blue Mountain, Alabama • Est. 1784

Circle 104 on Inquiry Card

at wm. a. force ENGRAVING IS OUR BUSINESS

Fairmount

CHEMICAL CO., INC.

136 Liberty St., N. Y. 6, N. Y.

Since 1875, whenever engraved parts are specified, the call goes out for the Force representative. Force manufactures engraved components to your particular requirements, such as numbering units, wheels, type, etc.—from the most complex assembly in elec-

tronic scanning to a single part. For many firms, engraved components by Force specialists has meant increased production rates, fewer rejects, all reflected in savings. Force products are turned out by the latest, automatic high-speed machines.



Tell us your needs and we will be happy to send you further information.



World Radio History

First and only tower of its kind

Are ordinary towers giving you antenna siting headaches? Facing this problem, Alberta Government Telephones directed Stainless, Inc., and their Canadian subsidiary, Walcan, Ltd., to muster all their engineering skills to lick it. They did just that.

The result is the unique guyed structure you see above—the first and only of its kind—one of several now in and working on a multi-hop TD-2 system in northwestern Canada! The two platforms will support up to six horn antennas per tower at any height from 25 feet to 500. Orientation of horns is a full 360°. Normal cost of tower materials, installation and maintenance is reduced one-third.

So when you need special towers—for microwave, radio or scatter transmission—call upon Stainless. Their experienced staff can handle the whole job from planning to installation.



Ask today for your free booklet describing mony Stainless installations.



Circle 106 on Inquiry Card

New Tech Data

for Engineers

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Light Detectors

Farrand Optical Co., Inc., Bronx Blvd. & E. 238th St., New York 70, N. Y., is offering a brochure describing ultra-violet, infra-red and visible light range-finders and detectors; navigation systems; servo-mechanisms; optical tooling, optical and electro-optical systems; electronic circuits, analog to digital converters and computers; and mechanical devices. In total, the brochure covers more than 100 subjects.

Circle 391 on Inquiry Card

Calibration Standard

Tech data is available on Model 1900 Semi-Automatic DC Instrument Calibration Standard which is a servo-type, wide-range, stable source of dc voltage and current for calibrating dc voltmeters and ammeters to within 0.05% of reading. Included are specs., features and photographs. Radio Frequency Laboratories, Inc., Boonton, N. J.

Circle 392 on Inquiry Card

Indicator Lamps

Signalite Inc., 1833 Heck Ave., Neptune, N. J., is offering tech. data on its complete line of Glow Lamps. Signalite Glow Lamps are used as indicators and as circuit components. Circle 393 on Inquiry Card Glass/Ceramic Reference

"How to Define Your Glass and Ceramic Requirements," 21 pages, is available from the Product Development Dept., Electrical Products Div., Corning Glass Works, Corning, N. Y. The reference material covers electrical, thermal, chemical, optical and mechanical properties of glassy materials. These include volume resistivity, dielectric constant, loss tangent, upper operating temps., thermal conductivity, ultraviolet and infrared transmittance, and photosensitivity. The illustrated booklet is available upon request under company letterhead.

Molding Compounds

A booklet describing, in detail, the physical chemical, and electrical properties of molding compounds based on diallyl phthalate, epoxy, and alkyd resins is available from Mesa Plastics Co., 12270 Nebraska Ave., Los Angeles 25, Calif. The 96-page booklet contains special sections dealing with important advantages of each type of compound and how to choose between them for a given use. Also included is a general reference data section with information ranging from tempand time conversion tables to listed percentages of thread for various materials.

Circle 395 on Inquiry Card



Circle 107 on Inquiry Card

Tech Data

for Engineers

Infrared Heating

Fostoria Corp., Dept. 109, 1200 N. Main St., Fostoria, Ohio, is offering tech data on radiant heat. Brochure describes Fostoria's equipment for use of electric infrared radiant heating processes and pictures some of the many and varied applications.

Circle 586 on Inquiry Card

Encapsulation

Encapsulation of resistors and ca-pacitors in a heat shrinkable Thermofit sleeve is described in a new bul-letin by Rayclad Tubes, Inc., Redwood City, Calif. The technique is suited for low cost automated production. Circle 587 on Inquiry Card

Refractory Metals

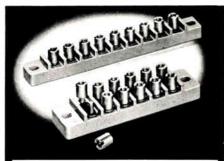
Tech. data is available on high pressure cast refractory metals. Informa-tion is included on HPC Molybdenum, Tungsten and tungsten - molybdenum alloys for electronic applications. Oregon Metallurgical Corp., Albany, Ore. Circle 588 on Inquiry Card

Ceramic-to-Metals Seals

A 32-page catalog covering over 40 standard types of high-alumina terminals, all of which remain highvacuum-tight during continuous op-eration 350°C in air is available from Ceramseal, Inc., New Lebanon Center, N.Y.

Circle 589 on Inquiry Card

TERMINAL BOARDS



Designed by Bureau of Ships According to MIL-T-16784B. Made to BUSHIPS 9000-\$6505-73214 drawings, with latest revisions, and BUORD \$64101.

Available as Single Row, Double Row, or thru-connected units; molded of Type MAI-60 glass-filled alkyd resin according to latest revision of M-14 specs.



ELECTRONIC INDUSTRIES · June 1962

Fasteners

"What You Should Know About Stand-off Fasteners," is available from Western Sky Industries, 21301 Cloud Way, Hayward, Calif. Sections covered include, Advantages and Disadvantages of each Type, Causes of Failure of Stand-off Fasteners, How to Compare Cost of Fasteners, and How to Select Stand-off-Fasteners. Circle 590 on Inquiry Card

RFI Shielding

A 4-page reprinted article, "Shielded Rooms for Electronic Equipment," describes the techniques and materials used to protect sensitive electronic equipment from RFI. Ace Engineer-ing and Machine Co., Tomlinson Rd., Huntington Valley, Pa.

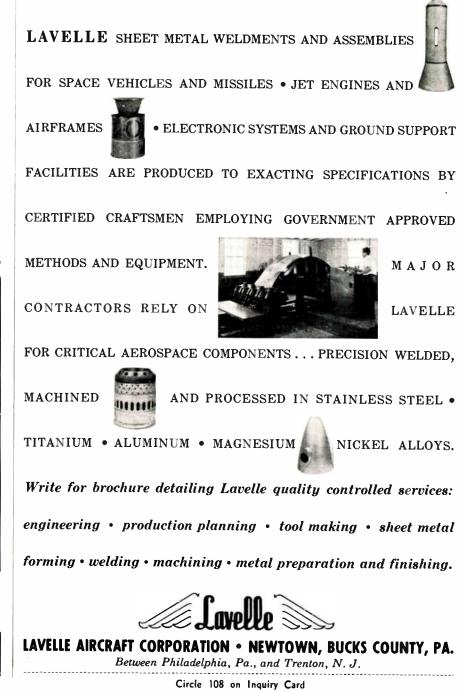
Circle 591 on Inquiry Card

Breadbording

Circuit Structures Lab., P. O. Box 36, Laguna Beach, Calif., will send data on their circuit builder which is designed for breadboarding and training; it eliminates soldering; gives quick circuit change; and is for vacuum tube or solid state circuits vacuum tube or solid state circuits. Circle 592 on Inquiry Card

ADS OF INTEREST IN OTHER SECTIONS . . . dealing with "Materials & Hardware"

Aiden Pro	ducts	Co.			p.	1-17
Centralab	, The	Elect	ronics	Div.	of	
Globe-l	Inion	Inc.			p.	F32
Sealectro	Corp.		· · · · · ·		p.	1-12



World Radio History

New Tech Data

for Engineers

Molding Material

Commercial Resins Corp., 1250 W. 7th St., St. Paul 2, Minn., is offering tech. data on "Premix Molding." This is a relatively simple compression molding material prepared by the molder from a special polyester resin, chopped glass fiber and inexpensive fillers.

Circle 270 on Inquiry Card

Coaxial Connectors

A 10-page catalog completely describing a new line of subminiature coaxial connectors is available from The Deutsch Co., Electronic Compo-nents Div., Municipal Airport, Banning, Calif. Information includes specs., performance characteristics and availability data on these all crimp terminated r-f connectors. Circle 271 on Inquiry Card

Microwave Amplifier

Broadband Microwave Amplifier, Model MWA-1, accommodates any one of 4PPM focused traveling wave of 4FFM focused traveling wave tubes, to provide a noise figure of 10db and a gain of 30db over the 1-2.6, 2.3-4.45, 4.3-7.35, and 7.05-10.75GC freq. bands. Applied Tech-nology, Inc., 930 Industrial Ave., Palo Alto, Calif.

Circle 272 on Inquiry Card

Eyelets

Prepared especially for designers and manufacturers of printed cir-cuitry and other electronic devices, this is 4-page, 3-color bulletin gives complete details on the line of elec-tronic eyelets. Bulletin E-107, "United Electronic Eyelets" is available from Fastener Div., United Shoe Machin-ery Corp., Shelton, Conn.

Circle 273 on Inquiry Card

Induction Heating

"High Frequency Heating Review" available from Lepel High Frequency Laboratories, Inc., 55th St. & 37th Ave., Woodside 77, N. Y., features an article on "Induction Heating in Vacuum and Controlled Atmosphere" as well as shop hints, new equipment and typical induction heating applications.

Circle 274 on Inquiry Card

Alumina Ceramics

Bulletin 621 "AlsiMag[®] Alumina Ceramics" contains a property chart which includes information on 3 dense and 3 porous AlSiMag Alumina Ce-ramics. Also included are photographs on different shapes available and production information. American Lava Corp., Chattanooga 5, Tenn. Circle 275 on Inquiry Card

Tantalum Pentachlorides

An 8-page, 2-color booklet on the properties, uses and handling of co. lumbium and tantalum pentachlorides is available from Stauffer Chemical Co., 380 Madison Ave., New York, N. Y. It discusses the use of these materials to prepare pure columbium and tantalum metals, and vapor deposition coating of other materials with columbium and tantalum.

Circle 276 on Inquiry Card

Solder Cataloa

This illustrated tech. catalog on solders, fluxes, preforms, special al-loys, lead and tin products and ultra high purity metals for semiconductor Metals, Inc., 56 Water St., Jersey City 4, N. J. Bulletin A-103 also contains characteristic charts on is available from Alpha solder alloys and fluxes.

Circle 277 on Inquiry Card

Control Equipment

Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa., is offering a 6-page control equipment brochure illustrating and giving brief descriptions of high-performance feedback control hardware. Included in the brochure are operational amplifiers, freq. response test equipment, pressure transmitters and receivers, actuators, and programmers.

Circle 278 on Inquiry Card

Notching Units

Unipunch catalog FTB fully illustrates and describes the complete line of Unipunch Series FTB hole punching and notching units. The units provide unobstructed feeding of the work and hole locations over the entire area of large work pieces. Punch Products Corp., 370 Babcock St., Buffalo 6, N. Y.

Circle 279 on Inquiry Cord

Connectors

Tech. data is available on Micro-Miniature Connectors Series 220 and 221, which give positive low resistance contacts even after 1,000 cycles of in-sertion and withdrawal. Photographs, outline drawings, and specs. are included. Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill. Circle 280 on Inquiry Card

Heating & Cooling

Tech Data Bulletin 356 from Dean Products, Inc., 1042 Dean St., Brook-lyn 38, N. Y., contains information on heating, cooling, heat transfer, an instantaneous LMTD chart, how to figure heating load, how to select heating surface and pressure drop short cuts, and uses of their Panelcoil®.

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Circle 281 on Inquiry Card

Connectors

The Ucinite Co., a div. of United-Carr Fastener Corp., Newtonville 60, Mass., is offering a 4-page, 2-color illustrated bulletin #7010, describing its line of TELERITE communica-tions products. The line consists of a series of Mil-spec and commercial telephone jacks and plugs, miniature and subminiature jacks and plugs, a number of hybrid and standard jack-andswitch, and jack-and-plug assemblies. Circle 282 on Inquiry Card

Chromium Oxide

Tech. data is available on single crystals of chromium oxide which are available in limited quantities. The chromium oxide single crystals are both undoped and doped with 1, 3, 6, and 10% additions of $A1_20_3$, most of which is retained in the as-grown crystal. Crystal Products Dept., Linde Co., 4120 Kennedy Ave., E. Chicago, Ind.

Circle 283 on Inquiry Card

Recording Device

Series 3440 Dataplotter is described a 12-page illustrated brochure in available from Electronic Associates, Inc., Long Branch, N. J. The 3440 Dataplotter is a 30 x 30 in. X-Y recording device for automatically plotting digital information from magnetic tape, punched tape, punched cards or manual keyboard. Bulletin DP 6188-1.

Circle 284 on Inquiry Card

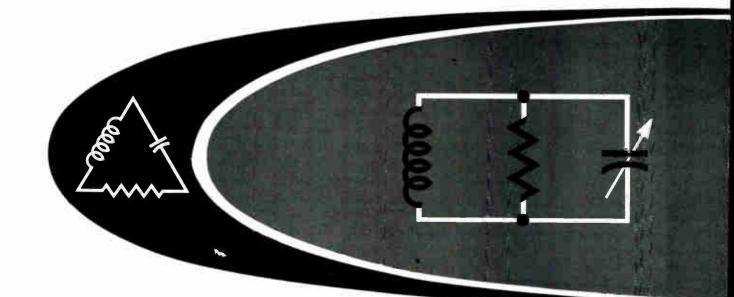
Microwave Components

Diamond Antenna & Microwave Corp., 35 River St., Winchester, Mass., is offering a catalog covering their line of antenna systems, rotary joints, microwave components, microwave test equipment, and microwave accessories. Specs, descriptions and photographs plus outline drawings are included. Also included is a section of custom components.

Circle 285 on Inquiry Card



Electronic Components



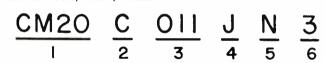
- Ordering Mil Spec Components . . . E2
- For Microsystem Designers . . . Stray Capacitance in Thin Films . . . E4
 - Reviewing Magnetic Law . . . E8
 - A New Look at Magnetic Amplifiers . . . E10
 - Resistor Application Guide . . . E18
 - Selecting the Right Capacitor . . . E19
 - Manufacturers' Data Currently Available . . . E34

Ordering Mil Spec Components

There is no mystery to properly ordering components. However, there are some points that you should know to facilitate your buying.

ORDERING components and materials for military use requires a knowledge of the military specifications involved. Generally, a component cannot be ordered by the Mil Spec number alone. Each specification has it own set of code designations that should

Example No. 1: MIL-C-5B CAPACITORS, MICA, FIXED



1. Mil type, style and case size.

2. Characteristic

Symbol		Temp. Coefficient Parts/Million/°C	Cap. Drift		
	B	not specified	not specified		
	Č	-200 to +200	$\pm 0.5\%$		
	D	-100 to $+100$	$\pm 0.3\%$		
	E	-20 to $+100$	= (0.1% 0.1pf)		
	F	0 to +70	± (0.05% ± 0.1pf)		

3. Capacitance. First two digits are first two figures of capacitance value in pf and third digit is the number of zeros which follow.

4. Capacitance Tolerance

$$G = \pm 2\%$$

 $J = \pm 5\%$
 $K = \pm 10\%$

Symbol	Oper. Temp. Range
M	-55 to +70°C
N	-55 to +85°C
O	-55 to +125°C
P	-55 to +150°C



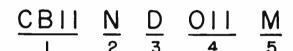
Grade	Condition			
1	10 to 55 cps			
3	10 to 2,000 cps			

....

be used to order a specific value or size of component. See Example 1. .

Often a capacitor is purchased from a local parts supplier by an electronic serviceman. A serviceman usually tells the parts supplier he wants a "5%, 100

Example No. 2: MIL-C-10950B



1. Mil type, specifies shape and case size.

2. Terminal Assembly

	Designation	Terminal
-		single L-rod eyelet single L single U double L double U offset rod
3. Characteristic	-	100
Symbol	Temp. Coefficient Parts/Million/°C	Cap. Drift
B D	not specified -100 to +100	not specified 0.3% or 0.3pf
E	-20 to $+100$	(whichever is greater) =0.1% +0.1pf

4. Capacitance. First two digits are first two figures of capacitance value in pf, and third digit is the number of zeros which follow.

5. Capacitance Tolerance

G	=	2%
J	=	5%
ĸ	=	10%
Μ	=	20%

micromike mica at 600 volts." Under the Mil Specs you do the same thing, but with a set of code numbers as illustrated in Example 1 or 2. Also, your order is more specific than the serviceman's order. By the use of letters and numbers you specify the type, size and shape of the item, ratings, temperature characteristics, tolerances, voltage ratings, electronic values, etc.

Note from Example 1, that the letters and numbers designate exactly what is ordered. These designations do not always mean the same thing for all specifications. The letter N in Example 1 does not have the same meaning as the N in Example 2, even though both specifications are for capacitors.

To properly order a component the purchaser, as well as the supplier, must have access to the necessary Mil Specs. These should be kept readily available for quick reference, and where necessary, the specifier of parts should be very familiar with the applicable Mil Specs. If in doubt as to where to purchase parts, a Qualified Products List (QPL) can be consulted. Such lists are available from the military department contracting officer or from the Departments of the Army, Navy, or the Air Force, depending on which service issued the contract. Before ordering parts, in addition to the above, the following should be known:

a. Determine if government inspection is required.

The following are some of the more common Mil Specs available from the Armed Services Electro-Standards Agency (ASESA). These were Abstracted from ASESA List 100-56. A complete List 100-56, as well as the specifications listed here may be obtained Inspection can be conducted at the supplier's plant or at the customer's plant, or the parts can come from bonded stock. The point of inspection should be given.

- b. If the contract requires Government Source Inspection (GSI) at the supplier's plant or from bonded stock, the purchase order must specify in writing that GSI is necessary and give the government contract number and priority rating. A copy of this should also go to the government inspector concerned.
- c. A Certificate of Compliance can be supplied (when required) to a Mil Spec or commercial specification. The Certificate is usually signed by two or more witnesses and may be notarized.
- d. Be sure that the supplier is on the Qualified Prodduct Lists for the required part when ordering Mil Spec components that require GSI.
- e. Watch for changes in Mil Spec and QPL suppliers. These change periodically.

Below and on the following pages we have selected the more common specifications that are available from the Armed Services Electro-Standards Agency (ASESA). Copies of these specifications and others can be obtained from ASESA.

MILITARY SPECIFICATIONS

from ASESA, Fort Monmouth, N. J. The specifications listed here are common to the three military departments. Adapter, Coaxial, to Waveguide MIL-A-22641 Adapters, Connector, Coaxial, Radio Frequency, MIL-A-27434 Between Series, General Specification For Attenuators, Fixed (Coaxial-Line and Waveguide) MIL-A-3933 **Batteries**, Dry MIL-B-18C Batteries, Dry MIL-B-13136A Cable Assemblies and Cord Assemblies, Electrical MIL-C-3885A (For use in Electronic, Communication, and Associated Electrical Equipment) Cables, Radio-Frequency; Coaxial, Dual Coaxial, MIL-C-17C Twin Conductor, and Twin Lead Cable and Wire, Electrical (Power and Control); MIL-C-3432B Flexible and Extra Flexible, 300 and 600 volts Capacitors, Variable, Air-Dielectric, (Trimmer) MIL-C-92A Capacitors, By-Pass, Radio-Interference Reduc- MIL-C-12889A tion, Paper Dielectric, AC & DC, (Hermetically Sealed in Metallic Cases) Capacitors, Feed Through, Radio-Interference MIL-C-11693B Reduction, Paper Dielectric. A.C. and D.C. (Hermetically Sealed) Capacitors, Fixed, Ceramic-Dielectric (General MIL-C-11015B Purpose) Capacitors, Fixed, Ceramic-Dielectric (Tempera- MIL-C-20D ture Compensating) Capacitors, Fixed, Electrolytic (A.C., Dry-Elec- MIL-C-387) trolytic, Nonpolarized) Capacitors, Fixed, Electrolytic (DC, Aluminum, Dry MIL-C-628 Electrolytic, Polarized) Capacitors, Fixed, Electrolytic (Tantalum) MIL-C-3965B Capacitors, Fixed, Solid Electrolyte, Tantalum MIL-C-26655A Capacitors, Fixed Glass-Dielectric MIL-C-11272B Capacitor, Fixed Mica-Dielectric MIL-C-5B Capacitors, Fixed, Mica-Dielectric, Button Styles MIL-C-10950B Capacitors, Fixed, Paper-Dielectric, Direct-Cur-MIL-C-25C rent (Hermetically Sealed in Metallic Cases) Capacitors, Fixed, Paper-Dielectric (Non-metallic MIL-C-91A Cases)

Capacitors, Fixed, Paper (Or Paper-Plastic) Di- electric, Direct-Current, High Reliability, Her- metically Sealed in Metallic Cases	MIL-C-14157B
Capacitors, Variable, Ceramic Dielectric	MIL-C-81A
Capacitors, Variable (Piston Type, Tubular Trim- mer)	MIL-C-14409A
Coils, Radio Frequency; and Transformers, Inter- mediate and Radio Frequency	MIL-C-15305B
Connectors, Coaxial, Radio Frequency, Series BNC, and Associated Fittings	MIL-C-3608A
Connectors Coaxial RF Series C and Associated Fittings	MIL-C-3989A
Connectors, Electrical, (Power, Bladed Type)	MIL-C-3767A
Connectors, "HN", for Radio Frequency Cables	MIL-C-3643A
Connectors, Coaxial, Radiofrequency, Series LC	MIL-C-3650A
Connectors, "N" for Radio Frequency Cable	MIL-C-71A
Connectors, Pulse, for Radio Frequency Cables	MIL-C-3607A
Connectors, Twin, for Radio Frequency Cables	MIL-C-3655A
Connectors, Plug and Receptacle, Electrical (Molded Body); and Accessories	MIL-C-8384B
Connectors, Plug and Receptacle (Electrical Wa- terproof); and Accessories	MIL-C-12520B
Couplers, Directional (Coaxial and Waveguide)	MIL-C-15370A
Dynamotors	MIL-D-24B
Electron Tubes and Crystal Rectifiers	MIL-E-ID
Filters, Radio Interference	MIL-F-15733D
Filters: High Pass, Low Pass, Band Pass, Band Suppression and Dual Functioning	MIL-F-18327A
Flanges, Waveguide, General Purpose	MIL-F-3922A
Fuseholders, Block & Plug Type, and Associated Electrical Clips	MIL-F-21346
Insulators, Glass-Bonded-Mica, Radio	JAN-I-7
	JAN-I-9
Insulating and Jacketing Compounds, Electrical (For Cable, Cord, and Wire)	MIL-I-3930A
Insulating Materials, Electrical Ceramic, Class L	MIL-I-IOA
Insulator, Pin (Lime-Glass)	MIL-1-3676A
Insulators, Porcelain, Radio	JAN-I-21
Insulators, Steatite, Radio	JAN-I-8
Knobs, Control (For use with Electronic, Com- munications, and Allied Equipment)	MIL-K-3926
(Continued on page E-7)	

By WILLIAM W. HAPP

Microsystems Electronics Dept. Lockheed Missiles & Space Co. Sunnyvale, Calif.

For Microsystem Designers . . .

Stray Capacitance in Thin Films

The interelectrode capacitance becomes critical as dimensions decrease and as substrates of high dielectric constant are developed. Here are some useful design charts and engineering approximations for evaluating its effect.

WHEN making thin film functional assemblies, high dielectrics are used to realize a large capacitance per unit area.¹⁻⁶ Fig. 1 shows a resistive film of thickness a and resistivity ρ deposited on a substratum of dielectric constant ε and thickness t; the resistance R and capacitance C can then be computed in terms of length l and width w of the film, if a

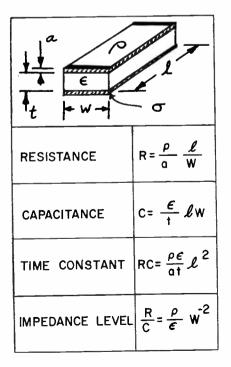


Fig. 1 (left): The circuit parameters for thin film capacitance.

Fig. 2 (right): The dielectric materials for thin film circuits.

perfect conductor σ is assumed for the opposite capacitor plate.

It is convenient to replace ε by $\varepsilon_o K$, and to express the capacitance per unit length as

$$C' = C/l = 0.225 \ K W/t \dots$$
 picofarad/inch

All formulas for interelectrode capacitance are based on this basic relationship.

Range of Dielectric Materials

In selecting dielectric substratum, these factors must be considered:

Dielectric Constant. The range of K is shown in Fig. 2 for several materials.

Dielectric Breakdown. Corresponding values are shown on Fig. 2.

Bulk Leakage Current. Associated with a high dielectric constant is often a relatively low resistivity, Fig. 3.

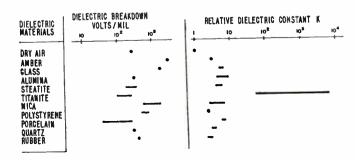


TABLE 1. CALCULATED VALUES OF CIRCUIT PARAMETERS

	ρ/a		t	ł	w	$\mathbf{R} = \boldsymbol{\rho} \mathbf{I} / (\mathbf{aw})$	C =.225 Ιw ε/t	RC		ED VALUES
Component	ohms per square		inches	inches	inches	K ohm	pf	μ Sec	Capacitance	Picofarad
RC ₁	200	1800	0.020	0.74	0.49	3.0	7400	22	C'1	11
RC ₂	200	1800	0.020	0.38	0.13	5.9	1000	5.9	C'2	11
RC ₃	200	. 1800	0.020	0.51	0.10	10.0	1600	16	C'a	2
	ري. مانيان	<u> </u>		_					C'	15
	#*								C's	15
• ·	ρ/a		I	w	R	$= \rho \mathbf{I}/(\mathbf{aw})$			C′6	2.5
Component	ohms per	square	inches	inch	es	K ohm			C'7	2.5
R₄	725		0.10	0.1	3	0.56	In the	first case	the effective size	of the plate
R₅	725		0.28	0.1	-	1.9			thickness of the s	

Temperature Characteristics. The refractory oxides, Fig. 3, are examples of substrate with high melting points and often particularly desirable temperature characteristics.

Other factors include: compatibility of expansion coefficient of substratum and of deposited film, mechanical stability, chemical stability, surface characteristics, producibility, and reproducibility, to name only a few. With these and other factors in mind, there appears to be a clear trend toward high K substrates.

The capacitance range in microsystem structures is shown in Fig. 4; here, the shaded regions C and D reflect the range of dielectric constants. The shaded regions A and B reflect area limits due to wafer size and resolution of the deposition process. Given the range in area and dielectric constant, Fig. 4, the product C^* of capacitance and substratum thickness, in picofarad-inches, is useful in assessing when the effect of stray capacitance must be considered. The enclosed region, Fig. 4, gives a range of values readily realizable with present technologies, the shaded region hints at possibilities.

Stray capacitance found in many uses is in the range of 1 to 10 pf; and, the dielectric substratum thickness is usually in the range of 0.010 to 0.100 in. Much of the available region, Fig. 4, becomes subject to limitations imposed by stray capacitances. With the increasing use of high K materials and smaller dimensions, the limitations become significant.

Useful Approximations

In Fig. 5, the interelectrode capacitance between two strips of width w, separated by a distance d is to be calculated. The substratum is of thickness t and dielectric constant K. It is advantageous to compare the resultant capacitance per unit length C' to that of an equivalent capacitance of a parallel plate capacitor, Fig. 5,

$C' = 0.225 \ K \ t_{o}/d_{o}$

Two useful approximations are obtained by assuming $d = d_o$

$$ext{if } d >> t \qquad ext{then } t_o = t \\ ext{if } d << t \qquad ext{then } t_o = u \\ ext{}$$

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World Radio History

TABLE 2

s are determined by the thickness of the substratum. They are independent of the electrode width. In the second case, the electrode width is alone the relevant factor in determining the effective capacitance.

When these asymptotic approximations are plotted a design graph, Fig. 6, results. This graph is fairly accurate provided d exceeds w; but, as w increases, an increasing error in C' results. This error can be assessed from the following:

The chart reads high in C' if d < < t, since the effective separation d_o will exceed d.

The chart reads low in C' if d >> t, since the effect of large electrodes can no longer be neglected.

The order of magnitude of the resultant error can often be estimated, thereby extending the validity of Fig. 6 to values of w comparable to d.

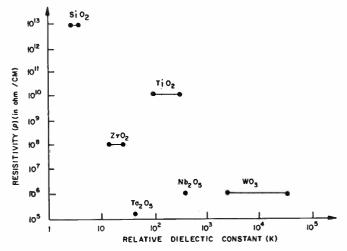
Intermediate values can be obtained by a more sophisticated analytical approach.

Exact Solution

By conformal transformations, an exact relationship between $t_o d_o$ in terms of w, t, and d can be calculated.^{7.8} The Schwarz-Christoffel transform yields a solution in terms of elliptic integrals.^{9, 10} Numerical values of these integrals F are available from standard reference tables.

$$\begin{aligned} & d_o' = 2F(\cos \theta, \pi/2) & \text{with } d_o' = \pi \, d_o/(4t) \\ & t_o' = F(\sin \theta, \pi/2) & \text{with } t_o' = \pi \, t_o/(4t) \end{aligned}$$

Fig. 3: The characteristics for some refractory oxide materials.

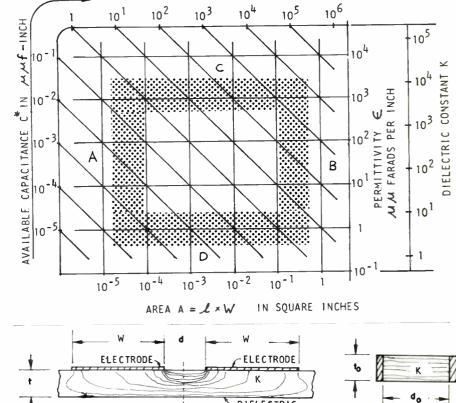


ELECTRONIC COMPONENTS

Thin Films (Continued)

Fig. 4: Limit of film-type capacitance due to stray capacitance, area, high & low K, with specified dielectric thickness.





and

 $\cos \theta = \tanh d' / \tanh (2w' + d')$ with $w' = \pi w/(4t)$ and $d' = \pi d/(4t)$

These exact formulas serve to verify the above approximations and permit computation of values of C'in the range where t is comparable to d. Comparison of computed and experimental values show excellent agreement,⁸ thus establishing the useful design chart, Fig. 7.

Amplifier Design Considerations

Harmful effects on circuit performance may result from undesirable stray capacitances when the size of stray capacitance between various conductive layers is no longer negligible compared with circuit components. It is, therefore, necessary to estimate these stray capacitances and to include their effects in the circuit design.

-DIELECTRIC

Fig. 8 shows the schematic diagram of an i-f 455 KC amplifier. The corresponding resistive and conductive patterns, front and back, for a wafer approximately 1.25 x 0.75 in. are shown in Fig. 9. The appropriate values of circuit parameters are presented in Table 1. Interelectrode capacitances were calculated from the above design charts and are summarized in Table 2. The stray capacitances shown in the layout correspond to the circuit diagram. The dielectric substratum was BiTaO₂ with a dielectric constant of approximately 1700.

Recommendations

In the design, example stray capacitances were sufficiently significant to require consideration in evalu-

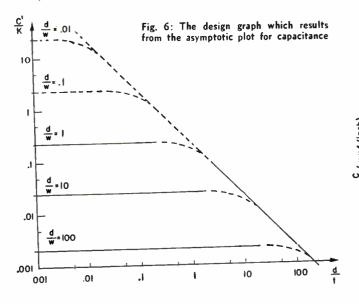
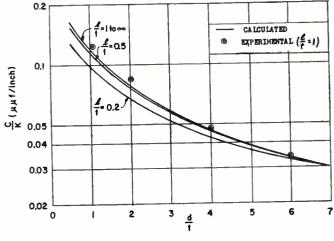
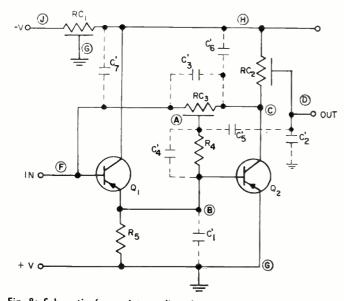
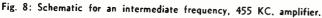


Fig. 7: Experimental values for interelectrode capacitance.







ating and interpreting amplifier performance, but presented no design limitation. However, if the dimensions of the wafer are to be reduced by a factor of 5 or more, or if the electrodes are spaced more closely, stray capacitance may present a serious constraint, particularly for high frequency characteristics.

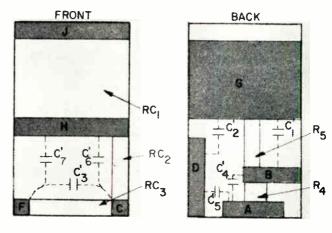
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Happ, W. W. and Castro, P. S., "Distributed Parameter Circuit Design Techniques," NEC Proceedings, Vol. 17, pp. 44-70, 1961.
 Happ, W. W. and Fuller, W. D., "Design Procedures for Film-Type Distributed Parameter Circuits," NEC Proceedings, Vol. 17, pp. 597-610, 1961.

Mil Spec Components

(Continued from page E-3)

Lampholders; Lights, Indicator; Indicator-Light Housings; and Lenses, Indicator Light, General Specification for TD-LC20 (Holders and Hous- ings) LCIIBD (Lenses)	MIL-L-3661 A
Plastic-Material, Molding; Rigid Thermoplastic, Aniline Formaldehyde; for use in Electronic, Communication, and Allied Electrical Equipment	MIL-P-3408
Plastic-Material, Molding; Rigid Thermoplastic, Polydichlorostyrene; for use in Electronic, Com- munication, and Allied Electrical Equipment	
Plastic Material, Molding; Rigid Thermoplastic, Polyvinyl Chloride and Copolymers Thereof, for use in Electronic, Communications, and Allied Equipment	MIL-P-3410
Plastic-Material, Molding; Rigid Thermoplastic, Vinylidene Chloride; for use in Electronic, Com- munications, and Allied Electrical Equipment	MIL-P-3411
Plastic-Sheet, and Plastic Rod, Thermosetting, Cast	MIL-P-77C
Plastic-Sheet, Acrylic Base, Antielectrostatic, Trans- parent (For Indicating Instrument Windows)	MIL-P-80B
Plastic Sheet, Filled Phenolic, Uncured	MIL-P-13436A
Plastic Sheet, FEP-Fluorocarbon (Unfilled), Cop- per Clad (For Printed Wiring)	MIL-P-27538
Plastic Sheet, Laminated, Copper-Clad Paper Base Phenolic	MIL-P-13949B
Rectifiers, Metallic, Selenium	MIL-R-11050A
Relays, (Electrical, Excluding Thermal), for Elec-	MIL-R-5757D
tronic and Communication Type Equipment	MIC-R-5757D
Resistors, Adjustable, Wirewound, Power	MIL-R-19365C
Resistors, Fixed Meter Multiplier, External (High	MIL-R-29A
voitage, rerrule lerminal lype)	
Resistors, Fixed, Composition (Insulated)	MIL-R-IID
Resistors, Fixed (Composition Film, Very High Frequency)	MIL-R-10683A
ELECTRONIC INDUSTRIES · June 1962	



RESISTIVE CONDUCTIVE

Fig. 9. Resistive and conductive patterns for amplifier of Fig. 8.

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 Fuller, W. D. and Castro, P. S., "A Microsystem Bandpass Amplifier," NEC Proceedings, Vol. 16, pp. 139-151, 1960.
 Happ, W. W. and Riddle, G. C., "Limitations of Film-Type Circuits Consisting of Resistive and Capacitive Layers," Proc. National IRE Conference. New York.
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 Kaiser, H. R. and Castro, P. S., "Capacitance between thin film conductors deposited on high-dielectric-constant substrate," Lockheed Tech. Rept. 6-59-61-2, June, 1961.
 Korn, G. A. and Korn, T. M., Mathematical Handbook for Scientists and Engineers. Sect. 7.9-4, McGraw-Hill, 1961.
 Jonke, F. and Emdle, F., Tables of Functions with Formulae and Curves. Dover, New York, 1945.

Resistors, Fixed Film (High Stability)	MIL-R-10509D
Resistors, Fixed, Film (Power Type)	MIL-R-11804D
Resistors, Fixed, High-Megohm (Hermetically Sealed	MIL-R-14293A
Resistors, Fixed, Wirewound (Accurate)	MIL-R-93C
Resistors, Fixed, Wire-Wound (Low-Power) TD: RU4A100K	JAN- R -184
Resistors, Fixed, Wirewound (Power Type)	MIL-R-26C
Resistors, Fixed, Wirewound, (Power Type, Chassis Mounted)	MIL-R-18546C
Resistors, Variable, Composition	MIL-R-94B
Resistors, Variable, Wirewound, {Low Operating Temperature}	MIL-R-19A
Resistors, Variable (Wirewound, Power Type)	M1L-R-22A
Resistors, Variable, Wirewound, Precision	MIL-R-12934B
Semiconductor Devices	MIL-S-19500B
Sockets, Electron Tube; and Accessories	JAN-S-28A
Sockets, for Plug-in Electronic Components; and Accessories	MIL-S-12883A
Switches (Coaxial) Radio Frequency Transmission Line	MIL-S-3928A
Switches, Rotary (Circuit Selector, Low Current Capacity)	MIL-S-3786A
Switches, Sensitive	JAN-S-63
Switches, Toggle	MIL-S-3950A
Transformers and Inductors (Audio, Power, and Pulse)	MIL-T-27A
Vibrators, Interrupter and Self-Rectifying	MIL-V-95A
Waveguide Assemblies, Flexible	MIL-W-287B
Waveguide Assemblies, Rigid	MIL-W-3970
Waveguide, Rigid, Circular	MIL-W-23066
Waveguides, Rigid, Rectangular	MIL-W-85C
Wire and Cable, Hook-Up, Electrical, Insulated	MIL-W-76B
Wire, Magnet, Electrical	MIL-W-583B

Electrical Engineer Space Technology Laboratories, Inc. 8433 Fallbrook Avenue Canoga Park, Calif.

Here's a quick refresher on the parameters of magnetomotive force. It should be useful in designing magnetic components.

Reviewing Magnetic Law

I N designing magnetic components, we must define and understand the magnetic law relating to the parameters of magnetomotive force. This law is a counterpart to Ohm's law for electromotive forces. If E = IR in Ohm's law, then $F = \phi R$ in the magnetic law,

j,

where,

- E = electromotive force (emf) is analogous to magnetomotive force (mmf), F
- I = electrical current is analogous to magnetic flux, ϕ
- R = electrical resistance is analogous to magnetic reluctance, R

The two laws are related since an emf is required to establish the mmf necessary to produce core flux.

Several systems are in use for defining the magnetic parameters; however, the following definitions will be limited to the more frequently used cgs (centimetergram-second) units. These units, which are also referred to as the irrational cgs electromagnetic units, are compared in Table 2 with similar units used in other systems. Magnetomotive force: Abbreviated "mmf" this quantity relates magnetic potential to the product of ampere turns. It is force which produces lines of flux in a magnetic material. The unit of force is the gilbert, and one gilbert = $.4\pi NI$, where NI is one ampere turn.

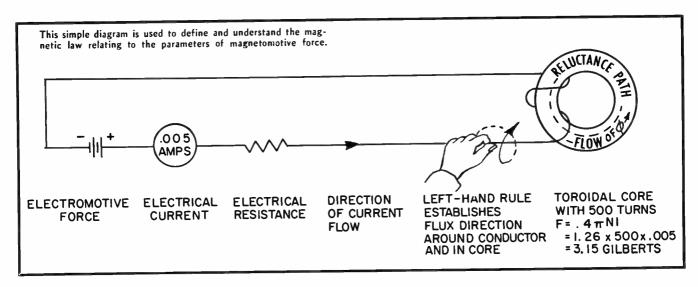
$$F = .4\pi NI = R\phi = BAR = Hl, I = \frac{F}{.4\pi N}, N = \frac{F}{.4\pi I}$$

Magnetic flux: This is equal to the total number of magnetic lines of force. Its dimensions are measured by lines or maxwells; one line = one maxwell. Flux in a magnetic circuit is proportional to ampere turns and inversely proportional to the reluctance of the magnetic path.

$$\phi = \frac{F}{R} = BA = \mu IIA$$

Flux density: This quantity is measured in gauss and refers to the total amount of flux distributed over a given core area. One gauss = one maxwell/ cm^2 .

$$B = \frac{\phi}{A} = \frac{Hl}{AR} = \mu H$$



World Radio History



 TABLE 2

 Conversion of Magnetic Units

Units of	To Convert	Into	Multiply By	Conversely Multiply By
φ	Maxwells	Lines	1	1
φ	Maxwells	Webers	10-8	108
φ	Webers	Volt-Seconds	1	1
В	Maxwells/CM. ²	Gauss	1	1
B	Lines/Inch ²	Gauss	. 1550	$1 \\ 6.452$
В	Webers/Meter ²	Gauss	104	10-4
H	Gilberts/CM.	Oersteds		
H	Ampere-Turns/Inch	Oersteds	495	0.00
H	Ampere-Turns/Meter	Oersteds	.01257	$\frac{2.02}{70.58}$
H	Ampere-Turns/CM.	Oersteds	1.257	$79.58 \\ .7958$
H	Ampere-Turns/CM.	Ampere-Turns/Inch	2.540	.3937
F	Ampere-Turns	Gilberts	1.257	.7958
μ	Henrys/Meter	Gauss/Oersted	7.958 x 10 ⁵	1.257 x 10 ⁻⁶
R	Ampere-Turn/Weber	Gilberts/Maxwell	1.257 x 10 ⁻⁸	7.958 x 10 ⁷
P	Webers/Ampere-Turn	Maxwells /Gilbert	7.958 x 10 ⁷	1.257 x 10 ⁻⁸

Magnetizing force: This parameter is often referred to as field strength and magnetic intensity. With units of oersteds, it is a measure of the magnetic potential

J	A	R	L	Ľ,	1	

		IADEL I	
Symbol	Dimensions	Definition	Useful Formulas
N	Turns	Turns through core	$N = \frac{Hl}{.4\pi I}$
1	Amperes	Average current	$l = \frac{Hl}{.4\pi N}$
NI	Ampere-Turns	Current times turns	$NI = \frac{III}{.4\pi}$
A	Square Centimeters	Effective core cross section area	$A = \frac{\phi}{B} = \frac{Hl}{BR} = \frac{\phi}{\mu H}$
В	Gauss	Flux density	$B = \frac{\phi}{A}$
H	Oersteds	Mag netizing force	$II = \frac{4\pi NI}{l}$
1	Centimeters	Means magnetic path length	$l = \frac{.4\pi NI}{H} = \frac{BAR}{H}$
μ	None	Permeability	$\mu = \frac{B}{H} = \frac{1}{V}$
φ	Lines or Maxwells	Total flux	$\phi = BA$
F	Gilberts	Magneto- motive force	$I' = .4\pi NI$
R	Nane	Reluctance	$R = \frac{l}{\mu A} = \frac{-1}{P}$
P	None	Permeance	$P = \frac{\mu A}{l} = \frac{1}{R}$
V	None	Reluctivity	$V = \frac{1}{\mu}$

drop per unit core length. When a mmf of one gilbert is distributed across 1 cm. of core length, the magnetic drop is one oersted.

$$II = \frac{F}{l} = \frac{.4\pi NI}{l} = \frac{B}{\mu} = \frac{BAR}{l} = \frac{\phi}{\mu A}$$

Permeability: Measures ease with which flux can pass through a magnetic material with reference to air. If the number of lines of flux in an air core coil were increased by 5000 when inserting a magnetic material into it, the permeability of the material would be 5000. One oersted of magnetizing force will produce one gauss of flux density when the permeability is one.

$$\mu = \frac{B}{H} = \frac{l}{RA} = \frac{\phi}{HA} = \frac{\text{gauss}}{\text{oersteds}}$$

Reluctance: This magnetic resistance quantity is a measure of the oppostion offered to lines of flux in the magnetic path of a core. Its value is dependent upon the physical dimensions and permeability of the core. The electrical counterpart of reluctance is resistance; however, reluctance has an additional characteristic in that it changes with permeability. Since permeability changes with flux density in most magnetic materials (certain powder cores bring exceptions), the reluctance becomes inversely proportional to permeability.

$$R = \frac{l}{\mu A} = \frac{l}{\left(\frac{B}{H}\right)A} = \frac{Hl}{BA} = \frac{F}{\phi} = \frac{F}{BA} = \frac{1}{P} = \frac{\text{gilberts}}{\text{maxwells}}$$

Permeance: The permeance of a magnetic material defines its ability to pass flux. Since permeance is the reciprocal of reluctance, any of the reluctance formulas may be used to find permeance by interchanging the denominator with the numerator.

Reluctivity: This unit is the reciprocal of permeability. Any of the permeability formulas with the denominator and numerator inverted may be used to find reluctivity.

* *



Fig. 1: Compact magnetic amplifier plugin modules provide highly reliable building blocks for complex control or logic systems. Each module is comprised of toroidally wound magnetic cores and silicon rectifiers.

Courtesy of The Siegler Corp., Magnetic Amplifiers Div.

THE magnetic amplifier uses an input signal to control the flux density in a special ferromagnetic core. Controlling this flux density controls the impedance of a reactor in series with the load and thus controls the power delivered to the load. The devices are amplifiers because a relatively small input signal can control a large output.

The saturable reactor was the first—and is still the simplest—form of the magnetic amplifier. The modern magnetic amplifier is built around the saturable reactor; rectifiers and other electronic components are added to produce outputs entirely different from the saturable reactor.

Interest in these devices waned a few years ago as other amplifying techniques appeared. For example, magnetic amplifiers were used in the early days of radio, but these amplifiers do not reproduce the input signal waveshape, and vacuum-tube amplifiers early preempted this field. But, recent developments in the field of high permeability magnetics have produced new core materials, and new rectifiers have been de-

TO

LOAD

A New Look at

veloped which have ideal characteristics for this application.

As an example of the tremendous improvements being made, one company (Acromag, Inc.) reports since 1952—an 80% reduction in size, a 75% reduction in space, a six-fold improvement in stability plus added improvement in packaging and reliability in their control system amplifiers.

The widespread use of magnetic amplifiers really began during the 1950's. An engineering highlight of this decade was the increased use of automatic control loops both in military and in industrial systems. These were complex new systems which demanded components with exacting standards of reliability and exceptional resistance to extremes of environments. The newly developed magnetic amplifier circuits proved remarkably well suited to these new systems. They were rugged and reliable; they could be miniaturized; and they were capable of high performance under adverse conditions.

There is renewed interest in these devices, because

Fig. 2: The basic saturable reactor. The control coil determines when during the positive half-cycle of line voltage the core will become saturated. At saturation, the impedance of the coil in series with the load drops abruptly.

From "Magnetic Amplifier Engineering," G. M. Attura, McGraw-Hill Book Company Inc., 1559, pp 48-

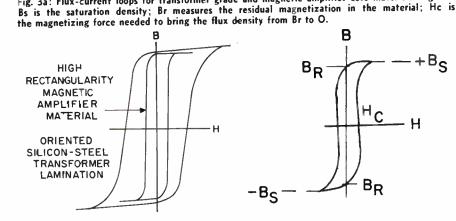


Fig. 3a: Flux-current loops for transformer grade and magnetic amplifier core materials. Fig. 3b:

World Radio History

a

CONTROL

INPUT

Engineers are taking a new look at a relatively old device the magnetic amplifier.

New core materials and new rectifiers have been developed which are ideal for magnetic amplifier applications. Standard "lines" have been developed and new manufacturing techniques have reduced prices. A wide variety of magnetic amplifiers is available.

Magnetic Amplifiers

they can be used in combination with vacuum-tube and transistor amplifiers; each amplifying technique serving its own unique application. Combinations of different types of amplifiers, using the best features of each amplifier, are rather common. The magnetic amplifier is often used as the output stage in these "hybrid" circuits, because it can easily handle large blocks of power; vacuum-tube and/or transistor circuits are often used to drive the output stage.

Fig. 10 shows a high precision power supply system built by Airpax Electronics, Inc., Fort Lauderdale, Fla., for RCA's new 601 computer. The power supply uses transistor-driven magnetic amplifiers to regulate ix critical voltage levels for the computer. Regulation is to within 34 of 1% of rated output even under severe variations of line voltage (plus or minus 15%) and output loads (80 amps as a step function with a rise time of 50 microseconds).

The power supply system is in two racks and weighs 2,500 lbs. It can handle a total load of 13 kw with precise regulation of each power level. The magnetic amplifiers in the power section are in bridge-type circuits operating from 208 v, three phase. The ripple freuency in the power supply output is 360 CPs filtered y a conventional LC filter.

Modern magnetic amplifiers have many advantages. d hey can be operated directly from line voltage; no warm-up time is needed (no-tubes); they use longlife components; many signals can easily be mixed; complete isolation between control and load is possible; and the units can be hermetically sealed. They provide dependable service under severe operating conditions of shock, vibration, moisture, and overload.

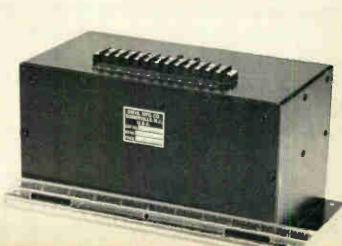
One feature—becoming more important every day —is their resistance to nuclear radiation. The Marquardt Corp., Van Nuys, Calif., recently successfully tested a 4800 cycle magnetic amplifier (developed for Project Pluto) to 10¹⁶ NVT fast neutrons at Convair's Ft. Worth reactor. This particular amplifier has an operating temp. range from 0 to 200°F. It is part of a line being developed by the company for high-gain thermocouple error amplifiers, integrators, logarithmic amplifiers, servo-valve drive amplifiers, and operational type amplifiers. The line will be used in airborne control systems for space power generators and nuclear propulsion systems.

Magnetic amplifiers can be used for fast-response switching and for all principal logic functions such as "and," "or," "not," memory, and time delay. Fig. 1 illustrates one unit in a line of plug-in modules built by the Magnetic Amplifiers Div., The Siegler Corp., 632 Tinton Ave., New York 55, N. Y., as reliable building blocks for complex control or logic systems.

(Continued on following page)

Fig. 4: Solid-state servo amplifier, XA-500, eliminates the need for constantly energizing a reference phase. Using the high-gain ac input (input impedance of 20K) full torque is obtained at the motor shaft with a signal input of 20 mv. Using the high-gain dc input (input impedance of 45K), full torque is obtained at the motor shaft with an input of approximately 120 mv.

Courtesy of Diebl Manufacturing Co.



World Radio History

Magnetic Amplifiers (Continued)

The Saturable Reactor

The saturable reactor is the "heart" of all magnetic amplifiers, and by itself is still widely used as a power amplifier and controller. This section describes rather simply how these devices work. Fig. 2 illustrates the principle of operation.

Two coils are wound upon a single core made of a special ferro-magnetic material. One winding is energized by the ac line and is in series with the load. The second coil is fed from a dc signal source; this is the control coil. The key to the circuit action is in the magnetic properties of the core.

The core differs from standard transformer core materials by having a B-H characteristic which is extremely rectangular. (The B-H characteristic is a plot of flux density "B" versus magnetizing force "H".) Fig. 3a illustrates the difference between the characteristics of transformer core materials and magnetic amplifier core materials.

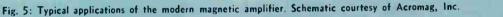
In the linear inductor, a rather simple mathematical

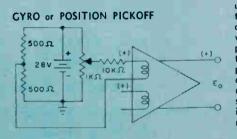
relationship describes "B" and "H" $(B/H = \mu)$.¹ No such relationship obtains with modern magnetic amplifier core materials—the relationship must be obtained experimentally. Several points on the curve in Fig. 3B are of interest; B_s is the maximum flux density or saturation density. B_r is the retentivity or the level the flux will decay to from B_s when the magnetizing force "H" is reduced to zero. H_c is the magnetizing force needed to reduce the flux density to zero from B_r .

The ratio of B_r to B_s is the "Rectangularity." For magnetic amplifiers, this value should be as close to unity as possible. The materials should also have a low value of H_c .

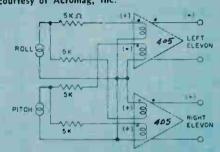
The saturable reactor is designed so that as long as the current in the control winding is zero, the flux density in the core produced by the line volt-second, remains less than the saturated value. When the flux density is less than saturation, the load coil is a high impedance in the ac line. However, with control current flowing, during the positive half-cycle of line voltage, the magnetizing forces of both line and control combine to drive the core to saturation. When the core saturates, the reactor is a low impedance in the

$$^{1}\mu = \text{permeability}.$$





Magnetic amplifier used to solve isolation problems frequently encountered with gyros or other position feedback transducers using dc potentiometer pickoffs. Circuit eliminates extra power supply and inconvenient grounding arrangement.

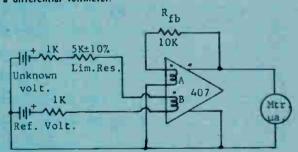


"ELEVON" CONTROL SYSTEM

Signal mixing technique used in guided missiles. System combines "roll" and "pitch" information in the missile's automatic pilot computer.

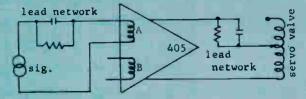
ACCURATE VOLTAGE COMPARATOR

For measuring the voltage difference between a standard voltage and an unknown voltage. The isolated input winding permits its use as a differential voltmeter.



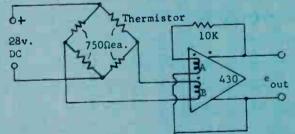
ELECTRO-HYDRAULIC VALVE DRIVE

This application requires a stable and linear dc to dc amplifier for proper operation. Fast time response is needed for good phase margins. This circuit has been tested with several commercially available valves and has given excellent results.



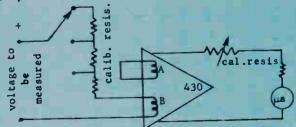


Magnetic amplifiers make excellent dc preamplifiers for thermist signals. This circuit is a typical temperature regulating application for stable gyro platforms, accurate temperature baths, and similar uses



DC VOLTMETER CIRCUIT

A computing magnetic amplifier makes a good voltmeter circuit. The extra control winding can be used to offset the zero for zero center scale operation, and a simple DPDT toggle switch can be used to reverse the meter signal to measure negative voltages without opening the input circuit.



circuit, and power is delivered to the load.

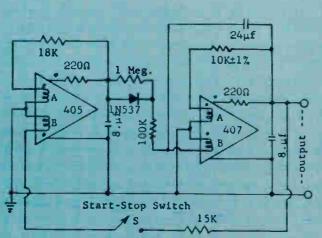
By controlling the dc in the control coil, we can control the firing point of the reactor. The firing point is the point on the positive half-cycle at which the reactor saturates. This controls the length of time that power is delivered to the load. Low dc inputs to the control coil mean later firing and less load power; high dc inputs mean earlier firing and more power output.

During the negative half-cycle of line voltage, the flux moves away from saturation. But, power is reflected into the load from the control winding by transformer action, and the output of the saturable reactor is ac with no dc component.

The familiar equal-ampere-turns law $(IN_{control} = IN_{load})$ governs in the saturable reactor. This means that for more output power, more input power must be supplied.

Other Saturable Reactor Configurations

To minimize the coupling effects of the two windings, a high impedance can be inserted in the control circuit, or two reactors can be connected so that the load coils are in series aiding and the control windings in series opposition. Another variation has the control windings in series opposition and the load

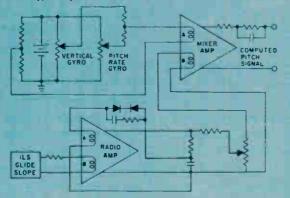


MAGNETIC SWEEP GENERATOR

This sweep generator is used to test precision magnetic amplifiers.

AUTOMATIC PILOT PITCH CONTROLLER

The computer combines signals from the Instrument Landing System, Radio Receiver, the Gyro Vertical, and the Pitch Rate Gyro. The complete computer weighs less than 1.3 lbs., operates on approximately 4 watts of 115 v, 400 CPS power, and can be packaged in a module 3.5 x 1.75 x 4 in. Compare this to a conventional vacuum tube chopper stabilized type amplifier.



windings in parallel.

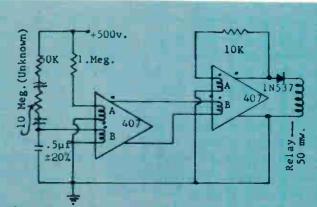
The outputs of both of these circuits are ac. With load rectifiers, the output is single polarity dc.

The major advantages of the saturable reactor amplifier are simplicity and reliability. The only active element is the coil, and if conservative ratings are used, the life of a saturable reactor is practically unlimited. The gain is not exceptional because of the equal-ampere-turns law, but this relationship is used to good advantage where a dc-dc transformation is needed.

The saturable reactor is still very much used for lighting control, electric furnace control, temperature sensing, two-phase servomotor drives, and other applications where rather large blocks of power must be controlled. The saturable reactor is also used to measure current safely at a high potential above ground.

Fig. 4 is a solid state servo amplifier recently introduced by the Diehl Manufacturing Co.'s Small Motors Division, Somerville, New Jersey. This amplifier will drive both phases of 115/115 volt, 60 cycle, servo motors with outputs from 25 to 100 watts. The unit uses silicon controlled rectifiers in conjunction with saturable reactors. Four inputs, two ac and two dc, are provided; they may be used in any combination.

(Continued on following page)



INSULATION RESISTANCE TESTER

This circuit was designed to check a wiring harness for electrical leakage. The magnetic amplifier is used as an accurate current comparator and accepts the harness if the resistance exceeds 10 megohms. The circuit resolves to an accuracy of better than ½ of 1%. Accuracy is not affected by minor changes in the 500 supply.

VELOCITY SERVO CIRCUIT

This arrangement gives good results in stabilizing the speed of helicopter rotors and in stabilizing the speed of precision film drives in aerial cameras. Positive feedback can be applied to increase the low frequency gain and enhance the accuracy of the system. These systems have produced speed accuracies of 0.1% under favorable circumstances.

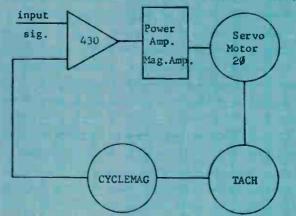




Fig. 6: This magnetic amplifier reactor assembly has no moving parts no tubes. For motor speed control of 200 hp motors, it is rated at 173 kva, 240 v, 60 CPS. Courtesy of Magnetics, Inc.

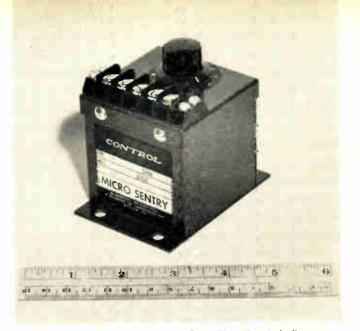


Fig. 7: This amplifier (the "Micro Sentry") will switch five watts on input of only 2.5 x 10^{-9} watts, or 0.5 mv at 5 μ a. Input is adjustable.

Courtesy of Magnetics, Inc.

Magnetic Amplifiers (Continued)

The Reactor-Rectifier Combination

Adding a rectifier to the load circuit of the saturable reactor completely changes its output characteristics.

When the line voltage is in the negative half-cycle, the rectifier in the load circuit effectively opens the circuit. The reactor is isolated from the line voltage allowing the control circuit to be fully effective in controlling the flux level in the core.

During the control half of the line cycle, the control windings move the flux away from the saturated value " B_s " to a point on the B-H curve called " B_o ". B_o is called the initial flux density. The value of B_o determines the point during the positive half-cycle at which the reactor fires. If B_o is very near the value of B_s , the reactor will fire early in the positive half-cycle, and nearly maximum power will be delivered to the load. If the control moves the flux to a value of B_o considerably below the B_s value, the reactor will fire later in the half-cycle and less power will be delivered to the load. The further away B_o is from the saturated value, the longer it will take the line volt-seconds to saturate the core.

Ideally, with no control current, the core will remain at B_s and the reactor will fire at the beginning of the positive half-cycle and deliver maximum power. But, if the B-H loop is not perfectly rectangular, the flux density will move away from saturation to B_r (see Fig. 3B) even with no control current. This means that on each cycle, the line volt-seconds must supply enough additional flux to drive the core from B_r to B_s and the reactor can never fire at the beginning of the positive swing. To compensate for this condition, a bias winding may be added. The bias current provides enough flux to maintain the flux density at B_s with no control current flowing.

The important feature of the reactor-rectifier combination is that the load action and the control action take place separately. The gain is much improved over the saturable reactor amplifier and so is the response. The output of the amplifier is limited only by heating, and the input is determined by the characteristics of the core.

As many as 20 different signals can be combined in the control circuits of magnetic amplifiers. These signals can be combined electrically using a summing point, or they can be combined using ampere-turn mixing within the amplifier's core.

This combination of saturable reactor and rectifier is the basic modern magnetic amplifier circuit. The output of the single section just described is halfwave rectified and the power output is determined by the length of time the core is saturated during the positive half-cycle of the line.

Combinations of these basic amplifiers may be used in conjunction with other electronic components to produce almost any output from the most basic to the most sophisticated imaginable.

Full-Wave DC Output

Two of the half-wave reactor-rectifier units described above can be combined for a full-wave rectified output. The load circuit is arranged so that current flows in the same direction regardless of which reactor is firing. One of the sections fires on the positive swing of the line, and the other section fires on the negative swing of the line. The units are designed so that each

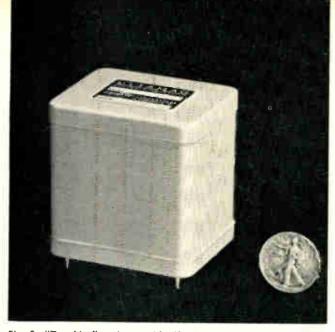


Fig. 8: "Ten Line" series provide 43 db gain at control levels less than 5 microwatts. Powered from 115 v, the units deliver 7.5 v across 1K with zero errors below 1% for input signals in the microamp region. Overloads of 1,000% can be withstood and the unit can be operated into a dead short without damage.

Courtesy of Military and Computer Electronics Corp

reactor fires at the same point in their respective halfcycles.

For the same power output as the half-wave circuit, this configuration has lower dissipation and lower load heating. Efficiency is high, and the circuit can handle large blocks of power.

Full-Wave AC Output

The basic reactor-rectifier units can also be combined to give a full-wave ac output with little or no dc component such as is obtained from the series connected saturable reactor.

Two half-wave sections are combined in a circuit. Each unit acts as a controlled rectifier feeding power to the load on alternate half cycles. The first rectifier fires on the positive half-cycle of line voltage and contributes a positive segment to the load. The second unit fires on the negative half-cycle of line voltage and contributes a negative segment to the load.

When reactor-rectifier units are combined there may be interactions between the units which affect their performance. For example, when one section fires, its ac impedance drops and it could effectively short out the other section. This affects the control circuit action of the second section. It also means that changes in control are reflected back and forth between the two units.

Reversible Circuits

Magnetic amplifiers are quite often used to drive reversible loads which means, of course, that the magnetic amplifier must have a reversible output.

Several unidirectional magnetic amplifiers can be arranged in a circuit so that as the output of one increases the output of the other decreases. The net output and direction depends on the difference between the two. The output can be fed to two separate control



Fig. 9. "One Hundred" line provide up to 43 db polarity reversible gain with zero stability better than 1%. Overload capacity is 1,000% and the units arc highly resistant to radiation. Operating Temperatures are from -10 to 180° F. Units measure 4.31 in. High x 2.53 in. dia.

Courtesy of Military and Computer Electronics Corp.

circuits or be compared differentially in a single circuit.

One undesirable feature of reversible output circuits is that considerable power is dissipated at low outputs. This is because two currents or voltages are being compared—the power must be dissipated either in the amplifier itself or in the load.

Some Problems

The magnetic amplifier, like any other device, has both advantages and disadvantages.

One disadvantage of these devices is that they do not reproduce the waveshape of the input. Because of this feature, these devices are not widely used in communications work.

The output of the magnetic amplifier is neither a clean sinusoid nor pure dc, and the effect of the distorted waveshape on the load should be carefully analyzed.

Matching the load to the magnetic amplifier can also be a problem, because the output impedance of the magnetic amplifier is generally high, and for maximum power transfer, the load impedance must be high.

Since magnetic amplifiers are used in automatic control systems, their transient response and time delays are important. Although the response depends a lot on the circuit used, the minimum delay is between one-half and one and one-half cycles of the line frequency since control and load action occur in alternate half-cycles. When two or more units are connected in a circuit, the firing of one can effect the firing of the others. A change in control can be reflected back and forth between the several units increasing the time constant. Large impedances can be inserted in the circuits to counteract this effect, but this impairs the circuit efficiency.

(Continued on following page)

Magnetic Amplifiers (Concluded)

In designing a magnetic amplifier drive, not only must the effect of the output wave shape on the load be considered, but also the induced electrical effects of the load on the magnetic circuit.

Some Applications

There are so many possible applications for these versatile devices that it would be impractical to list each of them. We suggest that the design engineer, interested in the possibilities of these devices, contact the manufacturers listed at the end of this article or listed in the Directory section of ELECTRONIC INDUSTRIES' June issue.

A few typical circuits are shown in Fig. 5. These circuits (from Engineering Bulletin 403-A, published by Acromag. Inc., 15360 Telegraph Road, Detroit, Mich.) illustrate the wide range of applications possible.

Fig. 6 shows a magnetic amplifier reactor assembly rated at 173 kva, 240 v supply. 60 CPS, designed for speed control of 200 hp motors. This unit is made by Magnetics, Inc., Butler, Penna. Magnetics, Inc., uses a sensitive, high-gain magnetic amplifier to trigger a silicon-controlled rectifier in their "Micro Sentry" (see Fig. 7). The device is designed to replace sensitive meter relays in such applications as reverse current protection, over-temperature control, and overspeed control.

The Micro Sentry will operate on a signal as low as 0.5 mv at 5 μ a. The output of 5 w is enough to drive static power amplifiers or pick up auxiliary relays. Two types of units are available: one operates from 15 v at 60 CPS: the other operates from 120 v at 60 CPS. Rated load of either unit is 30 ohms or greater, and maximum input is 15 ma. By using the magnetic core, the input and outputs are completely isolated—another attractive feature of magnetic amplifiers.

One of the main reasons for the renewed interest in magnetic amplifiers is that standardized "lines" are now being offered by companies in this field. Just a few years ago, most magnetic amplifiers were strictly "custom-made" for each application. With standard units available (the building block concept) design engineers now have excellent flexibility and adaptability in selecting the magnetic amplifier that is perfect for their job.

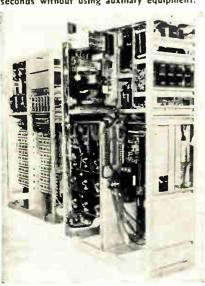
For example. General Electric Company's Specialty Transformer Dept. in Ft. Wayne Ind. makes a line of magnetic amplifiers (called Amplistats) for amplifying signals from relatively low impedance sources (up to several thousand ohms). The line includes ac and dc output units, static control power amplistats, and general purpose units. Input signals may come from thermocouples, strain gauges, thermistors, photocells, phototube amplifiers, and transistor amplifiers. Typical controlled devices include relays, solenoids, motor armatures and fields, lamps and heating elements. (For more information on this line, write for the Company's publication, GEA-6930.)

Fig. 8 and 9 illustrate two lines of magnetic amplifiers available from Military and Computer Electronics Corp., 900 N. E. 13th St., Ft. Lauderdale, Fla. Fig. 8 illustrates the "Ten Line" used for instrumentation and Control, servo systems, operational amplifiers, and other dc to dc amplification. Fig. 9 illustrates the "One Hundred Line" for instrumentation, control, servo system drive, and control, differentiating, mixing, integration, summing, all types of dc to dc amplification. Null detection, meter drive, and preamplification.

Another company offering a line of magnetic amplifiers and saturable reactors is the Freed Transformer

Fig. 10a. Power supply for RCA's new 601 computer fits into two $46 \times 20 \times 76$ in. racks. Three voltage levels are controlled to within $\frac{3}{4}$ of 1% of rated value; three others to within 1 and $\frac{1}{2}\%$. All voltages can be brought up in precise ratios from zero to full power in 15 seconds without using auxiliary equipment.

Fig. 10b. Simplified block diagram of the power supply. The transistor driven magnetic amplifiers are used to regulate voltage levels. Courtesy Airpax Electronics



TO TR P ANPLIFICE 44 V DO CONTROL 208 V TO TRUP 426 V DC DUPLICATE THREE PHASE 5 K VA 413 V DC TRIP DUPLICATE CIRCUI THREE DHASE -13 V DC DUPLICATE C DHASP BORN - 48 V 0C DUPLICATE CIRCUIT PHASE -SV DC DUPLICATE CIRCUIT CONTAL PONER THREE PHASE SETPOINT SIGNALS PHASE

Co., Inc., 1718 Weirfield St., Brooklyn 27, N. Y. (Write for catalog no. 5930.) The line includes units ranging from saturable transformers to half-wave type, fast response servo amplifiers. The units are designed for continuous operation in an ambient temperature range of -55 to 75° C. If high impedance inputs are required, the company offers a line of vacuum tube and transistor preamplifiers.

Fig. 11 shows just one of the magnetic amplifiers made by the Kearfott Div., General Precision, Inc. It is used in many applications requiring dc control. For example, it is used for temperature control of critical components, in conjunction with heaters and a temperature sensitive element.

Acknowledgments

Information for this article was solicited from many individuals and companies in the magnetic amplifier field.

Mr. Christopher M. Celent, Radio Corp. of America, Camden, N. J. has been particularly helpful in assembling this article.

We suggest if you are interested in finding out more about these devices—that you write to these companies.

The following books are excellent engineering texts on magnetic amplifiers. a.

"Magnetic Amplifier Engineering," George M. Attura, McGraw-Hill Book Co., Inc. "Magnetic Amplifier Analysis." David L. LaFuze, John Wiley b.

& Sons, Inc. The following company bulletins, design data sheets, catalogs, etc. were also used:

Design Manual, Bulletin 403-A, Acromag, Inc., 15360
 Telegraph Rd., Detroit, Mich.
 "How to Reduce Magnetic Circuit Size and Response Time."
 Magnetics, Inc., Butler, Penna.

3. Amplistats and Amplistat Reactors for Industrial Applica-tions, Bulletin GEA-6930, General Electric Co., Specialty Trans-former Dept., Fort Wayne, Ind.

4. "Magnetic Amplifier Circuit Applications," Blaz Mazzeo, Airpax Electronics, Inc., Seminole Div., Fort Lauderdale, Florida. Blaz Mazzeo. Fig. 11: This magnetic amplifier, the A5150, provides extremely high power gain. It is a singleended, single stage circuit. with selfcontained fixed bias. **Input** control current is from -0.4 to +0.8 ma dc; output ranges from 0.5 to 85 rms.



Courtesy of Kearfott Div., General Precision, Inc.

Magnetic Amplifier Manufacturers

1. General Precision, Inc., Kearfott Div., 1150 McBride Ave., Little Falls, N. J. (Catalog data sheets).

2. Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich. General Electric Co., Specialty Transformer Dept., Fort Wayne, Ind.

4. Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn
27, N. Y. (Catalog No. 5930.)
5. Industrial Control Co., Central Ave. at Pinelawn Farmingdale, L. I., N. Y. (Catalog.)

6. Magnetico, Inc., 6 Richter Court, East Northport, L. I., N. Y. 7. Varo, Inc., Magne Texas. (Catalog Sheets.) Magnetics Div., 2201 Walnut St., Garland,

8. The Marquardt Corp., Van Nuys, Calif.

9. Airpax Electronics, Inc., Seminole Div., Fort Lauderdale, Fla

10. Magnetics, Inc., Butler, Penna.

11. Cedar Engineering Div., Control Data Corp., 5806 West 36th St., Minneapolis 16, Minn.

MAGNETIC AMPLIFIER DEFINITIONS*

(Courtesy of General Electric Co.)

BIAS WINDINGS—The bias windings of a saturable reactor are those control windings by means of which the operating condition is translated by an arbitrary amount.

CONTROL WINDINGS - The control windings of a saturable reactor are those windings by means of which control magnetomotive forces are applied to the core.

FEEDBACK—Feedback (in a magnetic amplifier) is a circuit connection by means of which an additional magnetomotive force, which is a function of the output quantity, is used to influence t e operating condition.

MAGNETIC AMPLIFIER - A magnetic amplifier is a device using saturable reactors either alone or in combination with other circuit elements to secure amplification or control.

OUTPUT WINDINGS-The output windings of a saturable reactor are those windings other than feedback associated with the load and through which power is delivered to the load.

SATURABLE REACTOR—A saturable reactor is an electromagnetic device, employing one or more nonlinear magnetic cores, which is used in a.c. circuits to secure amplification or control, commonly by means of a d.c. signal which influences the nonlinearity.

SELF-SATURATION-Self-saturation in a magnetic amplifier refers to the connection of half-wave rectifying circuit elements in series with the output windings of the saturable reactors.

SIGNAL WINDINGS—The signal (input) windings of a saturable reactor are those control windings to which the independent variables (signals) are applied.

CONTROL AMPERE-TURNS --- Control ampere-turns expresses the magnitude and polarity of the control magnetomotive force required for operation of a magnetic amplifier at a specified output.

CONTROL CHARACTERISTIC --- The control characteristic of a magnetic amplifier is a curve of the output quantity versus control quantity under specified conditions, both expressed in suitable units.

FIRING-Firing in a magnetic amplifier is the transition from the unsaturated to the saturated state of the saturable reactor during the conducting or gating alternation. Firing is also used as an adjective modifying phase or time to designate when firing (n) occurs.

RECTIFIER, COMPLEMENTARY --- Complementary rectifiers are those half-wave rectifying circuit elements in the output circuit of a magnetic amplifier which are not self-saturating rectifiers. RECTIFIER, SELF-SATURATING-Selfsaturating rectifiers are those half-wave rectifying circuit elements connected in series with output windings of a saturable reactor in the self-saturating magnetic amplifier circuit.

RESPONSE TIME—The respone time of a magnetic amplifier is that period of time required for a given change of the output quantity following a step change of the input quantity. This change of the output quantity shall be 63% of the total change unless otherwise spe-cified. The "Response Time" specified shall be the maximum which exists for any condition within the rating (e.g. such effects as growth or decay, time phase of signal application, temperature)

ENVIRONMENTAL SENSITIVITY-Environmental sensitivity in a magnetic amplifier is the change in the control characteristic due to specified changes in environmental conditions. These include changes in ambient temperature, supply voltage, supply frequency, and other specified changes.

• Proposed Standard Terms and Defini-tions for Magnetic Ampliflers—AIEE Defi-nitions Sub-committee of the AIEE Mag-netic Amplifier Committee.

An application chart for both -the practical engineer, and -the marketing analyst.

Resistor **Application** Guide

THE material presented in chart form on the following page is designed to serve two purposesengineering and marketing.

Engineering

The engineering purpose of this chart is to show where the engineering emphasis should be placed. It is apparent that where reliability is not a major problem, e. g., the consumer market, the inexpensive carbon composition resistor, a worthy component of long standing, has been sufficiently developed. But, the military market is a different story. Here, a relatively new, and expensive type, the metal film, has the bulk of the market. Emphasis must be placed on improving an already reliable device and reducing the cost.

Marketing

This ties in very closely with the engineering considerations. However, a manufacturer must decide on what types he is able to produce engineering-wise and manufacturing cost-wise-and then attack the markets he is able to satisfy. The breakdown within each market should make his job a little easier.

RESISTOR APPLICATION CHART RESISTOR TYPE

Market	Application	Car <mark>bon</mark> Composition	Deposited Carbon	Metal Film	Glaze/ Cermet	Power Wirewound	Precision Wirewound
Consumer	Television Home Radio Portable Radio Auto Radio	XXXX XXXX XXXX XXXX	x			XXXX XXX XX XXXX	
Estimated Percentage of Market	Hearing Aids & Misc.	XXX 90	XX 4	X < 1	XX < 1	> 3	< 1
Estimated Percentage of Unit Usage		30	35	> <mark>1</mark> 9	50	15	< 1
Industrial	Computer Communication Power Supply & Instrumentation	XXX XXX XXX	XXX XXX XX	XX XX XXX	XXX XXXX XXXX	XXX XXXX XXXX	XXXX XXX XXXX
Estimated Percentage of Market	Automotive & Misc.	XXXX 50	XXX 20	XX 5	XXX 5	xxxx 5	X 15
Estimated Percentage of Unit Usage		50	5	< 1	20	5 <mark>5</mark>	>49
Military	Ground-Based Computer Ground-Based Communication	XX XX	XXXX XXXX	XXX XXX	XXX XXX	XX XXX	xx xxx
	Manned Aircraft Missile & Space Power Supply &	x x	XXX XXX XXXX	XXXX XXXX XXX	XX XX XXX	XXX X XXX	XX X XXX
Estimated Percentage of Market	Instrumentation	30	20	15	10	10	15
Estimated Percentage of Unit Usage		20	60	80	30	30	50

1. The extent of use in each end equipment is indicated by the number of X's. Thus, XXXX for metal film resistors in the Military Missile and Space category indicates that more metal film resistors are used in those applications than any other kind of resistor.

2. The Estimated Percentage of Market indicates that portion of the total of a specific market, e.g., Consumer, Industrial, or

Military, which is held by a specific type of resistor, e.g., Carbon, Metal Film, etc.

3. The Estimated Percentage of Unit Usage indicates that portion of the total produced of a specific type of resistor, e.g., Carbon, Metal Film, Precision Wirewound, which is used in a specific market, e.g., Consumer, Military, etc.

-Courtesy of International Resistance Co.

ELECTRONIC COMPONENTS

With so many types of capacitors available, capacitor selection is not always easy. The factors to be considered include size, shape, voltage, capacitance, cost, stability, and environmental capabilities.

Selecting the Right Capacitor

FROM the capacitor selection chart and graphs on the following pages, it will be seen that many types of capacitors are available. This large selection is both a blessing and a problem. The large number of types gives the designer a wide latitude, but also makes it difficult to select the most suitable one quickly. Generally, no one type meets a designer's requirements 100%.

To select the best type of capacitor for a given application, the designer must predetermine what type of configuration is needed for packaging, how much space is available, the circuit requirements, and the environment in which the equipment will operate. These facts, plus a few others, are necessary for an intelligent selection. Over specification should be avoided, as well as under-specification, because the tighter the capacitor requirements, the higher the cost.

Capacitor manufacturers say that money can be saved and capacitor selection aided by calling them in during the design stages. They ask that they at least be consulted about a selection before the capacitor is ordered, if only to check the designer's selection.

Understanding the Chart

Now, let's take a look at the Capacitor Selection Chart for fixed capacitors. The first thing that will be noticed is the color coding on the chart. The coding indicates the outstanding, normal, and limiting characteristics of each capacitor. The color coding will help you spot the needed desirable features of a capacitor for your application, as well as the limiting factors. Across the top of the chart are listed the various types of dielectrics used in capacitors. The characteristic of each capacitor is listed down the columns under each dielectric type. The legend for the characteristics is shown at the top of the chart.

Applicable Military Specification numbers are listed across the bottom of the chart. The latest revision designations (usually a letter following the number) have been deliberately left off because of the changes that are constantly taking place.

Reading across the chart for the Temperature characteristics, you will find notes saying "See graph . . .". These graphs are on the page following the chart. Graph 1 is a plot of paper capacitors with various impregnants and Graph 2 shows capacitors using other dielectrics or combinations with paper. Reference point is 25°C. A close examination of Graph 1 will show that the most stable paper capacitor is #8, with #9 second. The first thought would probably be that you would always use a paper capacitor impregnated with #8s impregnant. However, before you jump to this conclusion, remember your design requirements and cost-perhaps #1 or #5 will meet your temperature needs. They may be much cheaper to buy if they will do the job within the operating and environmental temperature limits of your equipment at the required voltage and capacity. Graph 2 should be used with the same selection thoughts in mind as those just mentioned for paper.

Another point that must be kept in mind is the capacitance and voltage requirements. The best dielectric material temperature-wise may not be available in either the voltage or capacitance rating required. This is also true for other characteristics such as stability or physical size.

Chart A, General Basic use of Various Dielectrics Over the Frequency Spectrum, will be useful as an aid in selecting a capacitor type where ac operation or ac characteristics are important considerations. From this Chart the optimum frequency ranges for each dielectric can be seen.

The charts and other information on the following pages were supplied by Cornell-Dubilier Electronics, Division of Federal Pacific Electric Company, Newark, N. J.

CAPACITOR SELECTION

Values and ranges shown herein are generally typical or average for fixed capacitors. However, actual

.

CI	CAPACITOR HARACTERISTICS	ELECTROLYTIC Aluminum	TANTALUM Wet Anode & Foil	TANTALUM Dry Anode	PAPER	MYLAR*	PAPER-MYLAR (Comb.)	POLYSTYRENE MYLAR (Con b.)	PAPER
	CAPACITANCE Range – Mfd.	.5-150,000	.2-1250	.25-330	.001-200	.01-20	.01–30	.001-1	.01 –20
AP.	TOLERANCE Standard %	+50, +100, +150 -10	+10, +20, +75	±20	±20	±20	±20	±10	±20
	TOLERANCE Minimum %	±25	±15	±5	±2	±1	±2	±1	±5
	DC OPERATING	2.4-500	3-150	6-35	50-200,000	50-1000	100-15,000	50-1000	50-600
	AC 60 CPS. OPERATING	40-320 Insernations Duty	1144411	1 Beginger	50-75,000	Seldom usea	Seldom used	Seldom used	25-250
	DISSIPATION FACTOR	dist bepund	WAR Cas' I BES, POUL	Keeper	.25	.3	.3	.I	.46
0. F.	% at 50 CPS. % at 1000 CPS.	THE REPORTER	Kanes win C and P	-	.25	.5	.5	.2	.68
	% at IMC Low Capacitance Values	-	-	-	Higher; varies with type	Relatively High	Relatively High	.75	Relatively High
-	INSULATION RESISTANCE	Leakage current (ma.) .006 x vCV	Leakage at 25°C	Leakage at 25 °C	300-20,000	50,000	20,000	>50,000	609-1200
. R.	Megohm/Mfd. at 25°C INSULATION RESISTANCE at 85°C compared to 25°C	Leakage current 4 x 25 °C value	.02 µa/mfd./volt Leakage current 4 x 25°C value	.02 ,a/mfd./volt Leakage current 10 x 25 °C value	116411	125	<u>1</u> 40	120	100
						_			
	OPERATING RANGE °C	-40 +85	-55 +125	-55 +125	She graphi	-55 +150	55 +125	-55 +125	-55 +125
ТЕМР.	OPERATING RANGE °C Coefficient TC in % or PPM	-40 +85	-55 +125	-55 +125	Sue y Don't	-55 +150 Sed phaph 2	-55 +125 See graph 2	-55 +125 See graph 2	-55 +125 See graph 2
	Coefficient TC in % or PPM	Relatively	Laige	Kan brobe 12h	She glaph	-55 +150			
STABILITY	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging	Sab drops han Sabar at a s	12-20 x 20-25	154 200 AS	.6- 3, depend-	Sed phaps 1	See graph 2	See graph 2	See graph 2
STABILITY	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging	Relatively Large	Large ±25	Medium ±10		Sed check	See graph 2 Medium	See graph 2 Medium	See graph 2 Medium
TABILITY	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging	Relatively Large	Large ±25	Medium ±10	.6- 3, depend-	Sed check	See graph 2 Medium	See graph 2 Medium	See graph 2 Medium
TABILITY	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent	Relatively Large	Large ±25	Medium ±10	.6 3, depend- ing on impreg.	See ends	See graph 2 Medium .9	See graph 2 Medium .3–.5	See graph 2 Medium
STABILITY D. A.	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as	Relatively Large - CV approx. Very small Small for	Large ±25 - CV approx. Very small Small for	Medium ±10 - CV approx. Very small Small for	.6– 3, depend- ing on impreg.	Nedium .5 CV ²	See graph 2 Medium .9 CV ² Nedium	See graph 2 Medium .3–.5 CV ²	See graph 2 Medium CV ²
STABILITY D. A.	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating	Relatively Large – CV approx. Very small	Large ±25 – CV approx. Very small	Medium ±10 - CV approx. Very small	.6-3, depend- ing on impreg. CV ² Mesikma Small	Nedium .5 CV ² Small	See graph 2 Medium .9 CV ² Medium Small	See graph 2 Medium .35 CV ² Lange	See graph 2 Medium - CV ² Small
TEMP. STABILITY D. A.	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating Per KVA 60 CPS. Per KVA 1MC	Relatively Large – CV approx. Very small Small for intermittent duty Not used	Large ±25 – CV approx. Very small Small for intermittent duty Not used	Medium ±10 - CV approx. Very small Small for intermittent duty Not used	CV ² Medium Small Not used	Nedium .5 CV ² Small Seldom used Not used	See graph 2 Medium .9 CV ² Medium Smith Seldom used Not used	See graph 2 Medium .35 CV ² Lange Seldom used Not used	See graph / Medium - CV ² Small Not used Not used
STABILITY D. A.	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating Per KVA 60 CPS. Per KVA 1MC Relative Cost for Equiv. CV Rating	Relatively Large - CV approx. Very small Small for intermittent duty Not used Very low	Large 125 – CV approx. Very small Small for intermittent duty Not used Moderate	Medium ±10 - CV approx. Very small Small for intermittent duty Not used	CV2 Medium Small Not used	Nedium .5 CV ² Small Seldom used Not used Moderately High	See graph 2 Medium .9 CV ² Hedium Smith Seldom used Not used Moderately High	See graph 2 Medium .3–.5 CV ² Lange Seldom used Not used Not used	See graph / Medium – CV ² Small Not used Not used Modecately High
STABILITY D. A.	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating Per KVA 60 CPS. Per KVA 1MC Relative Cost for Equiv. CV Rating Relative Cost per KVA 60 CPS.	Relatively Large – CV approx. Very small Small for intermittent duty Not used	Large ±25 – CV approx. Very small Small for intermittent duty Not used	Medium ±10 - CV approx. Very small Small for intermittent duty Not used	CV ² Medium Small Not used	Nedium .5 CV ² Small Seldom used Not used	See graph 2 Medium .9 CV ² Medium Smith Seldom used Not used	See graph 2 Medium .35 CV ² Lange Seldom used Not used	See graph / Medium - CV ² Small Not used Not used
STABILITY D. A. SIZE	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating Per KVA 60 CPS. Per KVA 60 CPS. Per KVA 1MC Relative Cost for Equiv. CV Rating Relative Cost per	Relatively Large - CV approx. Very small Small for intermittent duty Not used Very low Low for intermittent duty	Large ±25 - CV approx. Very small Small for intermittent duty Not used Moderate Not used.	Medium ±10 - CV approx. Very small Small for intermittent duty Not used Moderate Not used	CV ² Medium Small Not used Low Low	Nedium .5 CV ² Smail Seldom used Not used Moderately High Seldom used	See graph 2 Medium .9 CV2 Medium Small Seldom used Not used Moderately High Seldom used	See graph 2 Medium .35 CV2 Lange Seldom used Moderately High Seldom used	See graph A Medium - CV 2 Small Not used Not used Moderated High Not used
STABILITY D. A. SIZE	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating Per KVA 60 CPS. Per KVA 1MC Relative Cost for Equiv. CV Rating Relative Cost per KVA 60 CPS.	Relatively Large - CV approx. Very small Small for intermittent duty Not used Very low Low for intermittent duty	Large ±25 - CV approx. Very small Small for intermittent duty Not used Moderate Not used.	Medium ±10 - CV approx. Very small Small for intermittent duty Not used Moderate Not used	CV ² Medium Small Not used Low Low	Nedium .5 CV ² Smail Seldom used Not used Moderately High Seldom used	See graph 2 Medium .9 CV2 Medium Small Seldom used Not used Moderately High Seldom used	See graph 2 Medium .35 CV2 Lange Seldom used Moderately High Seldom used	See graph 1 Medium - CV 2 Small Not used Not used Moderable High Not used
STABILITY D. A. SIZE COST	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating Per KVA 60 CPS. Per KVA 60 CPS. Per KVA 1MC Relative Cost for Equiv. CV Rating Relative Cost per KVA 60 CPS. Relative Cost per KVA 40 CPS.	Relatively Large – CV approx. Very small Small for intermittent duty Not used Very low Low for intermittent duty Not used	Large 125 – CV approx. Very small Small for intermittent duty Not used Moderate Not used. Not used	Medium ±10 - CV approx. Very small Small for intermittent duty Not used Moderate Not used	CV2 CV2 Medium Small Not used Low Not used	Nedium .5 CV ² Smail Seldom used Not used High Seldom used Not used	See graph 2 Medium .3 CV2 Medium Seldom used Not used Moderately High Selaom used Not used	See graph 2 Medium .35 CV ² Seldom used Not used Moderately High Seldom used Not used	See graph / Medium CV 2 Small Not used Moderatel High Not used Not used
STABILITY D. A. SIZE	Coefficient TC in % or PPM CAPACITANCE CHANGE with Temp. Aging % Dielectric Absorption at 25 °C Varies as For Equivalent CV Rating Per KVA 60 CPS. Per KVA 60 CPS. Per KVA 1MC Relative Cost for Equiv. CV Rating Relative Cost per KVA 60 CPS. Relative Cost per KVA 60 CPS. Relative Cost per KVA 1MC	Relatively Large - CV approx. Very small Small for intermittent duty Not used Very low Low for intermittent duty Not used 62	Large 125 – CV approx. Very small Small for intermittent duty Not used Moderate Not used. Not used	Medium ±10 - CV approx. Very small Small for intermittent duty Not used Moderate Not used	CV ² Medium Small Not used Low Low Not used	Networks and the set of the set o	See graph 2 Medium .9 CV2 Medium Seldom used Not used Not used Not used Not used	See graph 2 Medium .35 CV ² Seldom used Not used Moderately High Seldom used Not used	See graph Medium CV 2 Small Not used Not used Not used Not used Not used

Du Pont Trademark.

OUTSTANDING CHARACTERISTIC

NORMAL CHARACTERISTIC



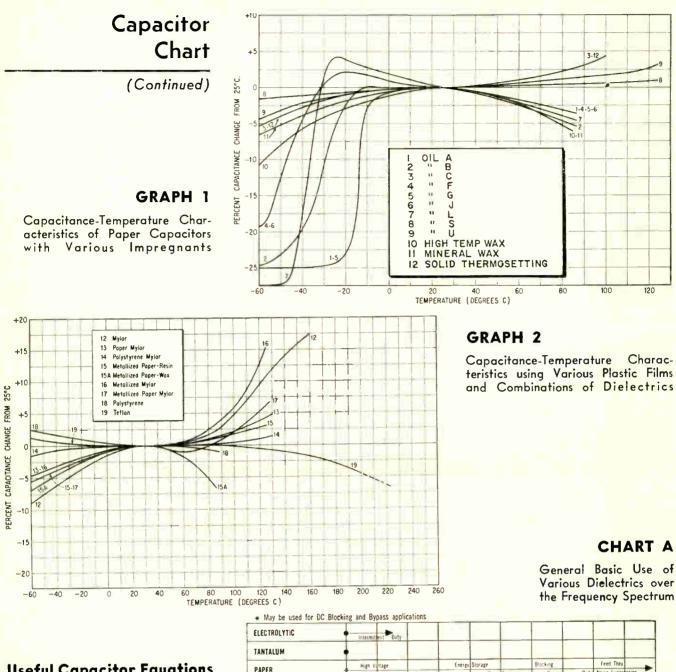
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limits in practice, may be considerably more (or less) depending on the specific application or requirements.

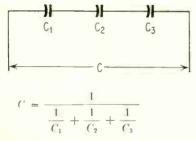
METALLIZED MYLAR	METALLIZED PAPER-MYLAR (Comb.)	Low-Voltage CERAMIC	General-Purpose CERAMIC	Temperature Compensated CERAMIC	POLYSTYRENE	TEFLON	MICA RECEIVING		RECONSTITUTE
01-20	.01-12	.005-2.2	.00000102	.0000010025	.01-10	.01-4	.00000105	.00001-1.0	.01-4
±20	±20	±20 to GMV	±5 to GMV	±5 to ±20	±10	±10	±10	15	±20
+2	+5	±20	±5	±.25 mmf.	±l	±2	±l	±l	±\$
58-600	200-600	3-50	500-5000	5005000	100-2000	50-1000	50-2500	200-50,000	200-15 000
25-250	Seldom used	Not used	Seldom used	Seloom used	50-350	Seldoni used	Seldom used	R-F voitage ones th curr nt & freq.	103-7500
.23	.46	_	- 1	-	<.1	<,1	Seldom used	Seldom usea	Seldom used
.45	.68	11254	2-2.5		.0205	.0205	<.1	.0407	.5
Relatively High	Relatively High	-	-	.052	.051	.0407	<1	.0306	193111
5900-50,000	2000	Variable with Voltage	>30,000 meg./unit	>50,000 meg'unit	>100,000	>100,000	20,000-50,000 meg. unit	15,000 meg./unit	10,000
40		<u>1</u> 20	<u> </u>	<u> </u>	15	1	1 5	$\frac{1}{7}$	1
-55 +125	rr .10r	-55 +85	-55 +125		nun				-55 +200-
				-55 +125		-55 +250	-55 +150	-55 +70	-33 2001
-30 TI23	-55 +125 See graph 2	State CC-	Vakiaki I	NPO-N4700 PPM °C	See graph 2	See graph 2	0 to +70 Normal PPM controllable	-20 to +100 PPM controllable	-55 +315 +500 PPM -350 PPM
Medium		-JJ TOJ	Variable Small to	NPO-N4700	See graph 2 Small		0 to +70 Normal PPM controllable Very Small;	-20 to +100 PPM controllable Very Small;	-350 PPM-
ien pram /	See graph 2	Kati ang Kat Kati ang Kati	kan apis	NPO-N4700 PPM/°C		See graph 2	0 to +70 Normal PPM controllable	-20 to +100 PPM controllable	-55 +315- +500 PPM -350 PPM- Good
Necium	See graph 2 Medium	V (ay day (a) Medium	Vanjable Smali to Medrum	NPO-N4700 PPM/°C Small	Small	See graph 2 Medium	0 to +70 Normal PPM controllable Very Small; Excellent	-20 to +100 PPM controllable Very Smail; Excellent	-500 PPM- -350 PPM- Good
Necium	See graph 2 Medium	V (avj da) (a) Medium	Vanjable Smali to Medrum	NPO-N4700 PPM/°C Small	Small	See graph 2 Medium	0 to +70 Normal PPM controllable Very Small; Excellent	-20 to +100 PPM controllable Very Smail; Excellent	-500 PPM- -350 PPM- Good
Medium	See graph 2 Medium	Medium	Vävävé Smali to Medrum -	NPO-N4700 PPM/°C Small	Small .0205	See graph 2 Medium .0205	0 to +70 Normal PPM controllable Very Smail; Excellent .3-	-20 to +100 PPM controllable Very Small; Excellent .3-	-500 PPM- -350 PPM- Good
Nedium - CV ²	See graph 2 Medium – CV ²	Vavanda Medium - CV2 & K	Váti dalé Smali to Medium – CV ² & K	NPO-N4700 PPM.°C Small - CV ² & K	Sməll .0205 CV2	See graph 2 Medium .0205	0 to +70 Normal PPM controllable Very Smail; Excellent .3-	-20 to +100 PPM controllable Very Small; Excellent .3-	-500 PPM- -350 PPM- Good
Nedium 	See graph 2 Medium - CV ² Smałł	Vagaala Medium – CV2 & K Very small	Vávávé Smali to Medrum – CV ² & K Small	NPO-N4700 PPM °C Small - CV ² & K Small	Small .0205 CV ² Medium Latge	See graph 2 Medium .0205 CV ² K 3428	0 to +70 Normal PPM controllable Very Small; Excellent .3- CV ²	-20 to +100 PPM controllable Very Small; Excellent .3- CV ² Kara	- CV ²
Nedium 	See graph 2 Medium - CV ² Small Not used Not used Not used	Vavaula Medium – CV2 & K Very small Not used	Vári ákié Small to Medium – CV ² & K Small Not used	NPO-N4700 PPM.*°C Small - CV ² & K Small Not used Not used	Small .0205 CV ² Medium Large Medium Large Small	See graph 2 Medium .0205 CV2 K %2A Seldom used	0 to +70 Normal PPM controllable Very Smail; Excelient .3- CV ² CV ² Seloom used	-20 to +100 PPM controllable Very Smail; Excellent .3- CV ² Varea Seldom used	-500 PPMJ -350 PPM- Gosd - CV ² Seldom used
Nedium CV2 Small Not used Not used	See graph 2 Medium - CV ² Small Not used Not used	Variaula Medium – CV2 & K Very small Not used Not used	Váti delé Smali to Medrum – CV ² & K Small Not used Not used Not used	NPO-N4700 PPM.*C Small - CV ² & K Small Not used Not used Not used	Small .0205 CV ² Medium Latge Medium Latge Small Moderately High	See graph 2 Medium .0205 CV2 Large Seldon used Small	0 to +70 Normal PPM controllable Very Smail; Excellent 	-20 to +100 PPM controllable Very Smail; Excellent .3- CV ² CV ² Seldom used Small	-500 PPM- -350 PPM- Good - CV2 CV2 CV2 Seldom used Not used
Nedium CV2 Small Not used Not used Not used	See graph 2 Medium - CV ² Small Not used Not used Moderately High	Vayaya Medium - CV2 & K Very small Not used Not used	Vări delê Smali to Medrum – CV ² & K Small Not used Not used	NPO-N4700 PPM.*°C Small - CV ² & K Small Not used Not used	Small .0205 CV ² Medium Large Medium Large Small	See graph 2 Medium .0205 CV2 K %2A Seldom used	0 to +70 Normal PPM controllable Very Smail; Excelient .3- CV ² CV ² Seloom used	-20 to +100 PPM controllable Very Smail; Excellent .3- CV ² Varea Seldom used	-500 PPM- -350 PPM- Good - CV ² Seldom used
Nedium 	See graph 2 Medium - CV ² Small Not used Not used Moderately High Not used	Varianda Medium 	Variable Small to Medrum – CV ² & K Small Not used Not used Low Not used	NPO-N4700 PPM.**C Small - CV2 & K Small Not used Not used Low Not useo	Small .0205 CV ² Medium Large Medium Large Small Moderately High Moderately High	See graph 2 Medium .0205 CV2 Vaceb Seldon used Small Vev WP4 Seldon used	0 to +70 Normal PPM controllable Very Small; Excellent 3- CV 2 Seldom used Small Nga Seldom used	-20 to +100 PPM controllable Very Smail; Excellent 3- CV ² Cv ² Seldom used Small Cheo Seldom useo	-500 PPM- -350 PPM- Good - CV ² Varb Seldom used Not used
Nedium 	See graph 2 Medium - CV ² Small Not used Not used Moderately High Not used	Varianda Medium 	Variable Small to Medrum – CV ² & K Small Not used Not used Low Not used	NPO-N4700 PPM.**C Small - CV2 & K Small Not used Not used Low Not useo	Small .0205 CV ² Medium Large Medium Large Small Moderately High Moderately High	See graph 2 Medium .0205 CV2 Vaceb Seldon used Small Vev WP4 Seldon used	0 to +70 Normal PPM controllable Very Small; Excellent 3- CV 2 Seldom used Small Nga Seldom used	-20 to +100 PPM controllable Very Smail; Excellent 3- CV ² Cv ² Seldom used Small Cheo Seldom useo	-500 PPM- -350 PPM- Good - CV ² Varb Seldom used Not used
Nedium CV2 Small Not used Not used Not used Not used Not used Not used	See graph 2 Medium - CV ² Small Not used Not used Moderately High Not used Not used Not used	Varianda Medium — CV2 & K Very small Not used Not used Low Not used Not used	Variable Small to Medium – CV ² & K Small Not used Not used Low Not used Not used	NPO-N4700 PPM.*C Small - CV2 & K Small Not used Not used Low Not used Not used	Small .0205 CV ² Medium Large Medium Large Small Moderately High Moderately High Low	See graph 2 Medium .0205 CV2 Vace Seldon used Small Seldon used Low	0 to +70 Normal PPM controllable Very Small; Excellent 3- CV 2 Seldom used Small Nga Seldom used Low	-20 to +100 PPM controllable Very Smail; Excellent 3- CV ² Cv ² Cv ² Seldom used Small Seldom useo Low	-500 PPM-1 -350 PPM- Good - CV ² V 202 Seldom used Not used Not used

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Useful Capacitor Equations

Capacitance C in Microfarads (mfd.) $Q = CV10^6$ Coulombs. Energy = $\frac{QV}{2} = \frac{C(KV)^2}{2}$ Wattseconds or Joules $0.225 \times Area \operatorname{sq. in.} \times \operatorname{Dielectric} \operatorname{Con.}$ C =Dielectric Thickness in Mils \times 10³



(Continued on page E34)

PAPER Radio Noise Suppression MYLAR PAPER-MYLAR • POLYSTYRENE-MYLAR RC Filters . METALLIZED PAPER Feed Thru Rad-0 use Suoi • Feed METALLIZED MYLAR Radio IDISP SUDD 1513 . METALLIZED PAPER-MYLAR Radio se Supp Feed • CERAMIC, LOW-VOLTAGE 4 . CERAMIC, GEN. PURPOSE 4 CERAMIC, TEMP, COMP. -POLYSTYRENE TEFLON MICA RECEIVING MICA TRANSMITTING RECONSTITUTED MICA -10,000 10 100 1000 10 cps 10.000 DC 100 1000 1 .1 cps cps cps mc -mc ៣០ πc រាល ភាព FREQUENCY

NEW.. Space-Saving Replacement for MIL-C-25C



Mylar-Foil Construction

> Hermetically Sealed

Available with or without insulating sieeve

ΤΥΡΕ

Superior Performance in a SMALLER Package Ideally Suited For Transistor Circuitry Proven Reliability — Excellent Stability

GOOD ALI

WRITE FOR TECHNICAL LITERATURE

SPECIFICATIONS

 TEMPERATURE RANGE
 Full rated to 85° C; to -125° C with 50% derating.

 ENVIRONMENTAL PROPERTIES
 Exceeds all requirements of MIL-C-25C

 CASE STYLES
 Available in all tubular MIL-C-25C versions

 Type 682 Extended foil; 1 lead grounded
 Type 683 Extended foil; both leads insulated

 Type 684 Tab Construction; 1 lead grounded
 Type 685 Tab Const., both leads insulated

 TOLERANCES
 Available in ±20% ±10%, ±5% and ±1%

FOR HIGH RELIABILITY REQUIREMENTS -

These designs are capable of being produced on a special project basis, to high reliability specifications comparable to MIL-C-14157 and MIL-C-26244 (USAF)

Co	mpar	ati	ve D	imen	sia	ns	Capacilance Change vs. Tempetature
	682		CP08			\$ +20 +15 +10	
CAP. MFDS.	100 0	0 V	L	100 O	VO	LTS L	
.001	.173	х	233	.175	x	22	3 _10
.0022	.173	×	7232	.175	x	3.4	🖌 -0 -05 ° +77 - 50 +11 + 50 -114
.0047	.173	×	23.72	.175.	x	2.2	Insulation Resistance vs. Temperature
.01	,173	14	22.52	.235	x	2.4	Degroes Control ado
.022	.233	×	23,32	.312	×	34	÷ 50 000
.047	,313	×	33.32	.312	×	24	3 10 000
.1	.313	×	23/32	.400	×	7.	
.22	.400	×	1%.	,400	×	136	500
.47	.500	×	1314	.562	x	186	
1,00	.560	×	3132	.670	×	134	

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Authorized Industrial Distributors

GOOD-ALL ELECTRIC MFG. CO.

OGALLALA, NEBRASKA / A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

World Radio History

$\frac{22}{\text{AT}}$ ways to get ohms

■ Like the proverbial iceberg, what shows here is only the smaller part of Ohmite's variety in MIL and commercial resistors. However, the 22 families illustrated do give some idea of scope, and incidentally, are a partial survey on the state of the art. As far as we know, Ohmite resistors form the largest selection available anywhere today—innumerable "specials", and thousands of standard units available from factory stock or distributors everywhere. This selection, combined with top engineering service, can provide unexcelled solutions to your procurement problems.

Write on Letterhead for Catalog and Engineering Manual 58



PRECISION, POWER: Wire-Wound; Vitreous Enameled; In Most Styles



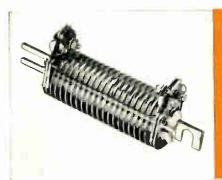
HIGH CURRENT: Corrib[®]; Low Resistance; Up to 1500 Watts



BROWN DEVIL®: Vitreous Enameled; Wire-Wound; 5, 10, 20 Watts



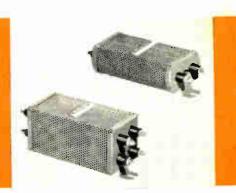
ADJUSTABLE HIGH CURRENT: Corrib[®]; Low Resistance



HIGH CURRENT: Powr-Rib[®]; Low Resistance; Up to 100 Amps



ADJUSTABLE HIGH CURRENT: Powr-Rib[®]; Low Resistance



IN CAGES: Terminal Type, Line Voltage Reducer Type, and Others



NON-INDUCTIVE: Vitreous Enameled; Wire-Wound; 10, 50, 100, 160 Watts



FERRULE MOUNTING: Four Styles; Up to 200 Watts



EDISON SCREW BASE: Up to 215 Watts

WORLD'S LARGEST SELECTION

RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS • TANTALUM CAPACITORS



LUG TYPE: Vitreous Enameled; Wire-Wound; 10, 25, 50, 100, 160, 200 Watts



THIN TYPE: Vitreous Enameled; Wire-Wound; 10, 20, 30, 40, 55 Watts



AXIAL LEAD: Vitreous Enameled; Wire-Wound; 1, 3, 5, 10 Watts



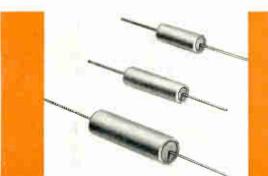
ADJUSTABLE: Dividohm®; Vitreous Enameled; Wire-Wound; 10, 25, 50, 75, 100, 160, 200 Watts



ADJUSTABLE THIN TYPE: Vitreous Enameled; Wire-Wound; 10, 20, 30, 40, 55 Watts



INSULATED: Wire-Wound; Molded; Precision Power; 1, 3, 5, 7, 10 Watts



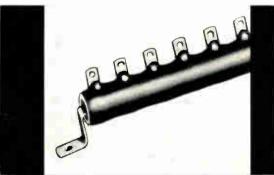
INSULATED: Tubeohm® Style; Wire-Wound in Sealed Ceramic Tube; 5, 10, 25 Watts



MIL-R-26C (FIXED); All Sizes; Tubular, Flat*, Axial Lead*, Insulated*, Ceramic Jacketed* *Not illustrated



MIL-R-19365C (ADJUSTABLE): Wire-Wound; Vitreous Enameled; All Eight MIL Sizes



TAPPED: Available in Any Terminal Style or Combination

ELECTRONIC INDUSTRIES · June 1962



TAP SWITCHES . RELAYS . R.F. CHOKES . GERMANIUM DIODES



NON-TURN: Notched or Fluted Cores Prevent Turning on Brackets; Fixed, Adjustable, Tapped

World Radio History



PUSH-ON CONNECTOR TERMINALS: For Lug Type Resistors Up to 10 Amps Current Rating





Circle 114 on Inquiry Card



Dale resistors-available in a wide selection of types, sizes and terminations-have established a solid reputation for inherent stability.

Dale's inherent stability has been established and maintained through advanced design and stringently controlled methods of manufacture-methods which constantly are reaching new levels of achievement as part of Dale's super - high reliability development program.

Wire Wound Resistors

Ultra-High Reliability Type ARS

Manufactured to have a failure rate of less than .001% per thousand hours of operation at 50% of rated power at 25° C. Environmental tests conducted on each production lot, and test data furnished with each order for more than 300 pieces. Resistance range from 0.1 ohm to 16K ohms, depending on type. Tolerance 1%. Three wattages-2, 5, 10; three sizes.



Ask for Bulletin R-66

TYPES RS and RLS; HS (High Temperature); NS and NLS (Non-Inductive) (Available with weldable leads)

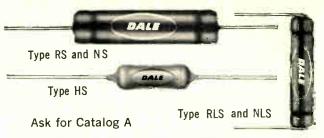
TYPES RS, RLS, HS resistance range from 0.05 ohm to 175K ohms, depending on type; TYPES NS, NLS from 1 ohm to 37K ohms. Tolerance range from 0.05% to 3%. TYPES RS, NS, NLS meet functional requirements of MIL-R-26C. TYPE RLS meets applicable paragraphs of MIL-R-26C, characteristic G. TYPE HS meets applicable paragraphs of MIL-R-26C, characteristic V.

TYPE RS with axial leads in eight wattages-0.5, 1, 2, 2.5, 3, 5, 7, 10; ten sizes.

TYPE RLS with radial leads in seven wattages-1, 2, 2.5, 3, 5, 7, 10; nine sizes.

TYPE HS with axial leads in eight wattages-1.25, 3, 3.25, 3.75, 4.25, 6.75, 9, 13; nine sizes. TYPE NS (axial leads) and NLS (radial leads) in

six wattages—2, 2.5, 3, 5, 7, 10; seven sizes.



Clip Mounted Type RSE (Available with weldable leads)

Complete insulation and protection afforded by suspending precision resistance unit in special shock absorbing material and then inserting in metal tube which can be clip mounted. Resistance range from 0.5 ohm to 175K ohms, depending on type; tolerance range 0.05% to 3%. Meets functional require-ments of MIL-R-26C. Five wattages-2, 3, 5, 7, 10; seven sizes.

Type RSE



TYPES RH, NH (Non-Inductive) RHM, PH

Resistance unit in TYPES RH, NH, PH silicone sealed and inserted in radiator finned housing; in TYPE RHM molded with high temperature material into radiator finned housing. Mount on or through chassis for maximum heat dissipation. TYPES RH and RHM meet all requirements of MIL-R-18546C; TYPE PH meets functional re-quirements of MIL-R-18546C.

TYPE RH resistance range from 0.1 ohm to 175K ohms, depending on type; tolerance range 0.05% to 3%; six wattages and sizes—5, 10, 25, 50, 100, 250. TYPE RHM resistance range from 0.1 ohm to 60K ohms, depending on type; tolerance range from 0.5% to 3%; two wattages and sizes-10, 25.

TYPE NH resistance range from 1 ohm to 37K ohms, depending on type; tolerance range 0.05% to 3%; five wattages and sizes-10, 25, 50, 100, 250. TYPE PH resistance range from 0.1 ohm to 60K ohms, depending on type; tolerance range 0.05% to 3%; three wattages and sizes-10, 25, 100.



Bobbin TYPE WW (Available with weldable leads) Non-inductive; encapsulated in material with very high dielectric strength. Unique Dale design and manufacture involving new winding and termination methods assure long-lasting stability. Meets requirements of MIL-R-93C, characteristic C. Resistance range from 10 ohms to 1.5 megohms, depending on type; standard tolerance 1%. Rated at 0.1 watt to 0.4 watt; eight sizes.



Deposited Carbon Resistors

(Available with weldable leads)

Designed for inherent stability, long load life and excellent protection against environmental factors in a wide range of applications. Made of pure crystalline carbon film bonded to selected ceramic cores. Excellent high frequency characteristics.

Type DC

Miniature size, protection against moisture at low cost. Resistance range from 1 ohm to 200 megohms; tolerance 1%. Seven wattages— $\frac{1}{10}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2 5; ten sizes.



Ask for Catalog A Types MC - DCF - DCH

(Insulated-Meet functional requirements of MIL-R-10509D)

TYPE MC is completely insulated and protected from environmental and mechanical damage by molded housing; resistance range from 1 ohm to 50 megohms. Available in five wattages— $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2; five sizes in standard tolerance of 1%.

TYPE DCF has a new coating material which provides a completely insulated resistor, yet maintains miniature size. Resistance range from 1 ohm to 50 megohms; six wattages— $\frac{1}{10}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2; nine sizes in standard tolerance of 1%.

TYPE DCH hermetically sealed in non-hygroscopic ceramic envelope. Resistance range from 1 ohm to 50 megohms; seven wattages— $\frac{1}{10}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 5; ten sizes in standard tolerance of 1%.



(Available with weldable leads) Type MF

Inherently good R.F. characteristics and low noise levels. Completely insulated and protected against moisture and other severe environmental factors. Resistance range from 100 ohms to 4 megohms, depending on size; tolerance 1%. Five wattages— $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2; five sizes. Temperature coefficient ± 50 and ± 100 P.P.M.





Series 1200 - 900 - 600 - 1500 - 5000

Produced under stringently controlled "white room" conditions to assure highest quality and reliability. Welded construction throughout; sealed to protect against moisture and potting compounds.

SERIES 1200—Humidity proof; three terminal configurations for standard or printed circuit mounting; 10 to 50K ohms; 5% tolerance; 1 watt.

SERIES 900—Humidity proof, three terminal configurations for standard or printed circuit mounting; 10 to 30K ohms; 5% tolerance; 1 watt.

SERIES 600—Humidity proof; eight terminal configurations for standard, panel or printed circuit mounting; 10 to 30K ohms; 5% tolerance; 1 watt. SERIES 1500—Humidity proof; nine terminal configurations for standard, panel or printed circuit mounting; 10 to 50K ohms; 5% tolerance, 1 watt. SERIES 5000—Humidity proof; space saving, square configuration; 100 to 50K ohms; 5% tolerance; 1 watt.



Ask for Catalog B Series 100 - 200 - 300 - 1100

Designed to give excellent performance for normal circuit problems where economy is of prime importance, yet dependable performance is a necessity.

SERIES 100—Five terminal configurations; 10 to 50K ohms; 5% tolerance; 0.8 watt.

SERIES 200—Five terminal configurations; 10 to 50K ohms; 10% tolerance; 0.5 watt.

SERIES 300—Two terminal configurations; 100 to 20K ohms; 15% tolerance; 0.25 watt.

SERIES 1100—High temperature; three terminal configurations for standard or printed circuit mounting; 10 to 50K ohms; 10% tolerance; 1 watt.

Ask for Catalog B



Special Problems?

When your requirements are for special resistance components and networks, please send us an outline of your problems.

Our standard line can be modified and special resistors can be produced to meet the toughest requirements.

Other products made by Dale are lightning arrestors; surge arrestors, RF and IF transformers; custom coils, chokes, torroidal inductors, ferrite antennas; precision potentiometers and tube shields.

DALE ELECTRONICS, INC.



World Radio History

1304 28th Ave., Columbus, Nebraska

A subsidiary of The Lionel Corp.

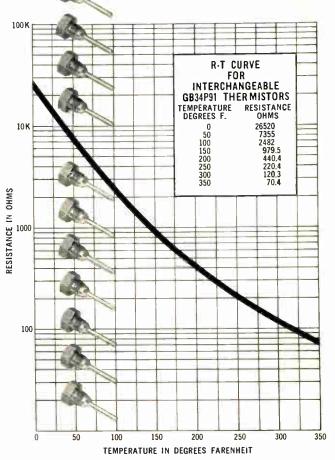
ELECTRONIC INDUSTRIES · June 1962

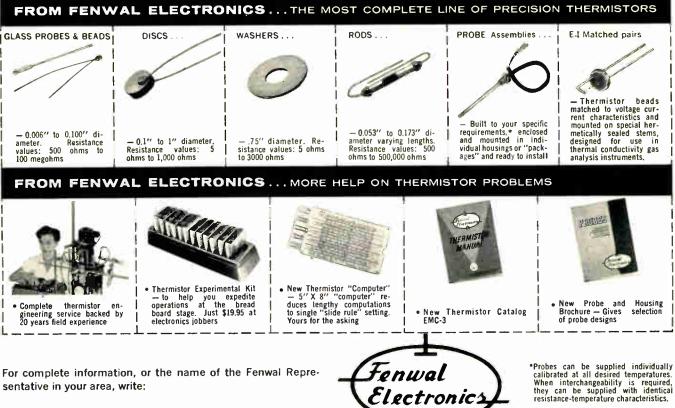
Circle 115 on Inquiry Card

BREAKTHROUGH! IN THERMISTOR DESIGN

Fenwal Electronics' new "identical" thermistors permit complete interchangeability! What do you need from a thermistor in the way of performance? Reliability? Extreme stability? High shock resistance? Long life? Fenwal Electronics can supply it. But Fenwal Electronics' thermistors provide an additional important characteristic all their own: they can be supplied with identical resistance temperature curves.

That means that now, for the first time, you can have complete interchangeability. It means you can rely absolutely on consistently accurate resistance changes versus temperature of Fenwal Electronics' thermistors. It means also you can now achieve accurate, multi-point temperature indication or control through a single system without having to calibrate out each individual sensor.





Circle 117 on Inquiry Card

33 MELLEN STREET FRAMINGHAM, MASSACHUSETTS

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World Radio History

New Long-Life 85°C Electrolytic Capacitors in Ultra-Miniature Sizes a Product of New Design and Manufacturing Techniques



Aluminum-cased units permit circuit applications previously impossible

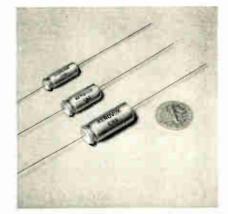
A new series of ultra-miniature tubular electrolytic capacitors is now available from Aerovox. A product of the continuing Aerovox program of advanced research and development, the greatly reduced sizes of these high-quality units have been made possible by the use of a revolutionary etching and formation process. All critical terminations are welded, thus eliminating the danger of open circuits with the passage of time in service. A unique, highefficiency seal has been produced by specially designed forming tools which were developed by Aerovox after months of intensive engineering effort to improve on conventional sealing methods.



High-Reliability Type QRE

Due to a totally new design concept, Aerovox has achieved a new industry high for capacitors of this type. Type QRE capacitors offer a useful life expectancy of more than 10 years when operated within ratings.

The combination of long life, ultraminiature size, and outstanding temperature characteristics now makes available an aluminum electrolytic capacitor which can be used in many circuit applications heretofore not considered possible with capacitors of this type. Design engineers in the computer and communications fields in particular can benefit from the extraordinary advantages offered by Type QRE. These units are manufactured in specially constructed super-clean "White Room" production areas where only the most experienced operators are employed. An exhaustive 100% testing program assures you high-reliability performance.

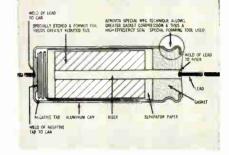


Commercial Type CRE

Type CRE ultra-miniature units are ideally suited for use in bypass, filter, and coupling applications in low voltage, compact, miniaturized equipments. This is especially true where assembly space is at a premium, such as personal radios, hearing aids, microphones, and wire receivers.

Availability

Aerovox Type QRE and CRE Ultra-Miniature 85°C Aluminum Cased Electrolytic Tubular Capacitors are available in prototype quantities for immediate delivery from the factory. See your Aerovox Representative for delivery information on production quantities.



Operating Tempera Capacitance Tolerand	PECIFICATIONS ture: -40° C to $+85^{\circ}$ C ce: standard capacitance 0% of rated capacitance.
DC Leakage Current : Volts DC 3 to 6 10 to 15 25 to 50 100 to 150	Current — Microamperes 1.0 2.5 5.0 15.0
Surge Voltage: Rated DC Working Voltage 5 6 10 12 15 25 50 100 150	Surge Voltage (Max.) 5 10 14 15 20 45 70 125 175
Operating Tempera Capacitance Toleran	PECIFICATIONS iture: -30°C to +85°C ce: standard capacitance i0% of rated capacitance.
DC Leakage Current: Volts DC 3 to 6 10 to 15 25 to 50 100 to 150	Current-Microamperes 1.0 2.5 5.0 15.0
Surge Voltage: Rated DC Working Voltage	Surge Voltage (Max.)
3 6 12 15 25 50 100 150	4 8 15 18 40 65 125 175

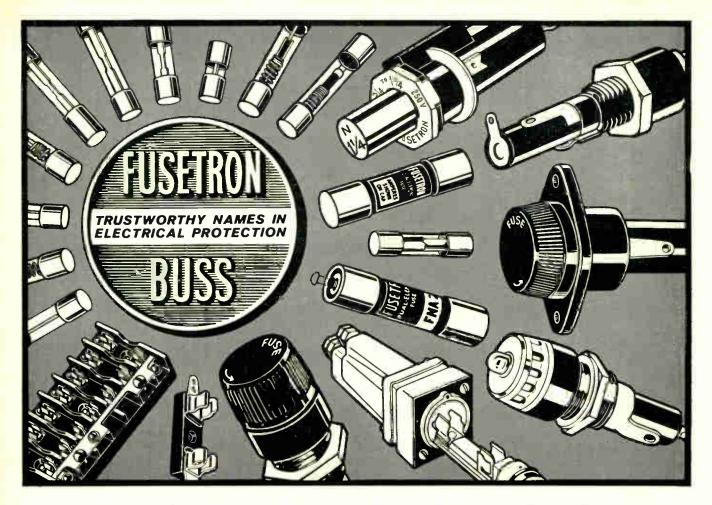
Complete Technical Data

Call your nearest Aerovox Field Representative or write today for a free copy of Bulletin 201B7 (Type QRE) and 201B6 (Type CRE).



ELECTRONIC INDUSTRIES · June 1962

Circle 118 on Inquiry Card



Save Time and Trouble by standardizing on BUSS Fuses—You'll find the right fuse every time...in the Complete BUSS Line!

By using BUSS as your source for fuses, you can quickly find the type and size fuse you need. The complete BUSS line of fuses includes: dual-element "slowblowing", single-element "quick-acting", and signal or visual indicating types... in sizes from 1/500 amp. up plus a companion line of fuse clips, blocks and holders.

BUSS Trademark Is Your Assurance Of Fuses Of Unquestioned High Quality

For almost half a century, millions upon millions of BUSS fuses have operated properly under all service conditions.

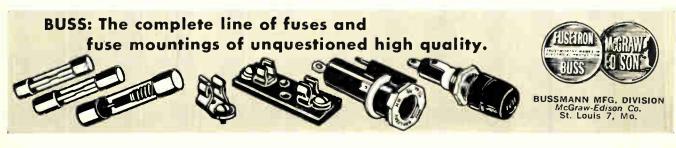
To make sure this high standard of dependability is maintained...BUSS fuses are tested in a sensitive

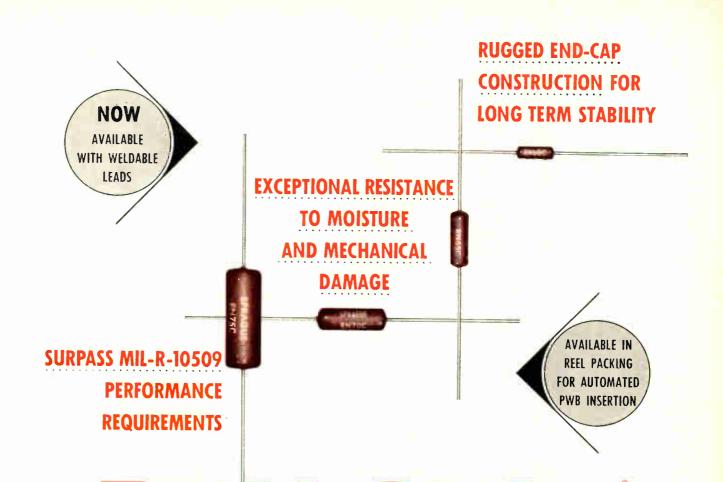
Circle 119 on Inquiry Card

electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

Should You Have A Special Problem In Electrical Protection . . . BUSS fuse engineers are at your service – and in many cases can save you engineering time by helping you choose the right fuse for the job. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be serviced easily.

For more information on the complete line of BUSS and FUSETRON Small Dimension Fuses and Fuseholders, write for BUSS bulletin SFB.





METAL FILM RESISTORS **OFFER 5 DISTINCT** Providing close accuracy, reliability and stability with low controlled temperature coefficients, these molded case metal-film resistors outperform precision wirewound and carbon film resistors. Prime characteristics include minimum **TEMPERATURE** inherent noise level, negligible voltage coefficient of resistance and excellent long-time stability under rated load as well as under severe conditions of humidity. Close tracking of resistance values of 2 or more resistors **COEFFICIENTS TO** over a wide temperature range is another key performance characteristic of molded-case Filmistor Metal Film Resistors. This is especially important where they are used to **MEET ALL CIRCUIT** make highly accurate ratio dividers. Filmistor Metal Film Resistors, in 1/8, 1/4, 1/2 and 1 watt ratings, surpass stringent performance requirements of MIL-R-10509D, Characteristics C and E. Write for Engineering Bulletin No. 7025 to: Technical Literature Sec-REQUIREMENTS tion, Sprague Electric Co., 233 Marshall Street, North

FLMSTO

Adams, Mass.

Circle 120 on Inquiry Card

For application engineering assistance write: Resistor Division, Sprague Electric Co., Nashua, New Hampshire. SPRAGUE COMPONENTS

RESISTORS CAPACITORS MAGNETIC COMPONENTS TRANSISTORS

INTERFERENCE FILTERS PULSE TRANSFORMERS PIEZOELECTRIC CERAMICS PULSE-FORMING NETWORKS HIGH TEMPERATURE MAGNET WIRE CERAMIC-BASE PRINTED NETWORKS PACKAGED COMPONENT ASSEMBLIES FUNCTIONAL DIGITAL CIRCUITS



^{&#}x27;Sprague' and '@' are registered trademarks of the Sprague Electric Co.

ELECTRONIC INDUSTRIES . June 1962

In PRECISION FILM RESISTORS if it's news, expect it first from IRC



Now... Evaporated Metal Film Reliability for as little as 9 cents

Re-evaluate your deposited carbon resistor requirements. You can now upgrade your circuitry with the premium performance of evaporated metal film resistors... at deposited carbon prices.

IRC-T-0 (tee-zero) evaporated metal film resistors are available molded or with exclusive moisture-resistant M-Coat.* They meet or exceed all MIL-R-10509 performance requirements except temperature coefficient for C and E characteristic.

Using T-0 resistors, you benefit by a design tolerance 5 times tighter than that of deposited carbon (MIL-R-10509 Characteristic B) resistors, and 20 times tighter than that of carbon composition (MIL-R-11) resistors.

Premium quality Metal Film Resistors are no longer too costly for your higher performance demands. Write for new T-0 Bulletin B-22. International Resistance Co., 401 N. Broad Street, Philadelphia 8, Pa. IRC Trademark

CAPSULE SPECIFICATIONS

Hardc	oat Meta	at <mark>Fi</mark> lm	Molded Metal Film					
MIL	IRC	125°C	MIL	IRC	125°C			
RN55	CEA	¼ W.	RN60	MEA	¹∕8 ₩.			
RN60	CEB	¼ W.	RN65	MEB	¼ ₩.			
RN20	CEC	¹∕₂ ₩.	RN70	MEC	½ ₩.			

MIL-R-10509: exceed all requirements characteristic B and D; G without hermetic sealing; C except for \pm 50 PPM T.C.; E except for \pm 25 PPM T.C.

RESISTANCE: 30 ohms to 1.5 megohms.

TOLERANCE: $\pm 0.5\%$ and $\pm 1\%$.



pacemaker in film resistors

ELECTRONIC INDUSTRIES . June 1962

MIL PARTS NOW AVAILABLE IN DEPTH FROM STOCK

PROTECTION

GUARANTEES EXCEPTIONAL CAPACITOR PERFORMANCE IN EXTREME ENVIRONMENTS



for complete assembly







.....Rugged pre-molded flameresistant outer case assures standard wall thickness, guaranteeing environmental immunity and absolute product uniformity. Square modular shape affords highest capacity per usable volume.

U.S. ARMY PHOTO

.....Epoxy potting solidly anchors, hermetically seals capacitor within case; increases mechanical strength and eliminates humidity leaks around leads.

-Resilient, moisture-proof plastic sheathing protects unit during assembly and absorbs thermal shock at extremes of temperature cycling.
-Uniformly exact dielectric margins around electrodes eliminate short circuiting and breakdown across edges under surge voltages through 400% of rating. Single standard 0.2" lead dimension for all values simplifies circuit design.

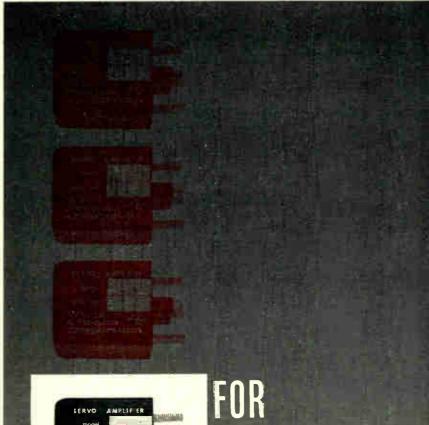


Box 544, Bridgeport 1, Conn.

B0.

encapsulation.

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SERVO AMPLIFIER



CRITICAL PERFORMANCE

Servo Amplifier, Model 500, provides 3.5 watt output, with voltage gains up to 2500 to drive size 11 or smaller Servo motors. Design eliminates need for external heat sinks.

- Gain Stability: \pm 2 db from -55° C. to + 125° C.
- Input Impedance: Up to 1 megohm.
- · Operating Life: In excess of 1000 hrs.
- Size (1 x 1 x 1% inches).

Performance features include: essentially zero dead band, negligible phase shift, balanced output.

Servo Amplifiers with 6 watts to 18 watts output are available.

World Radio History

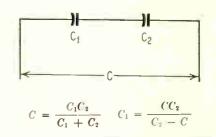
Write for complete information.

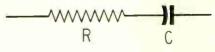
WHITE AVIONICS CORPORATION

Terminal Drive, Plainview, Long Island, New York

Useful Capacitor Equations

(Continued from page E16)





R =Equivalent Series Resistance

$$X = \text{Reactance} = \frac{10^6}{2\pi fC} \text{ Ohms}$$

When the Dissipation Factor (D) of a capacitor is less than 0.1 or 10% it is practically equal to the Power Factor Lose.

 $D = \frac{R}{X}$ with both D and R at same frequency f

 $D = R2\pi f C 10^{-6} \text{ with constant } D, R$ varies as $\frac{1}{f}$ $D \text{ at } 1000 \text{ CPS} = 0.00628RC \quad Q = \frac{1}{D}$

For a Damped Circuit: CR^2 is greater than 4L (L in Mierohenries) For a Critically Damped Circuit: $CR^2 = 4L$ For an Oscillatory Circuit: CR^2 is less than 4LFor Resonant Frequency in KC:

$$\kappa c = \sqrt{\frac{25330}{LC}}$$

L in Microhenries, C in Microfarads

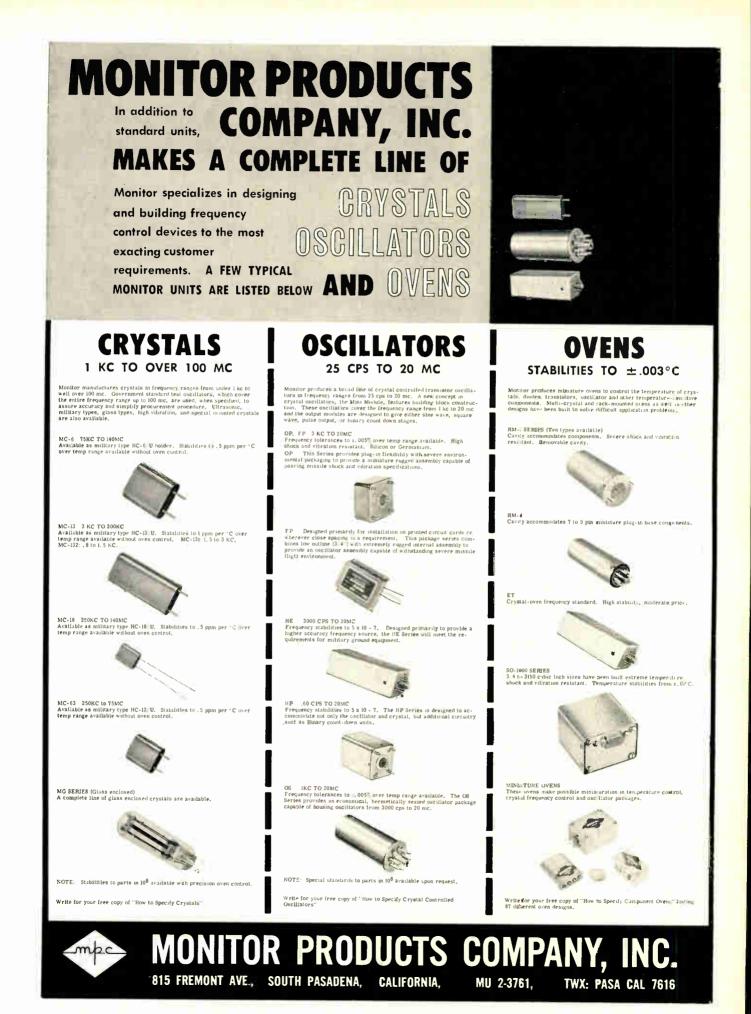
Reactance $X = \frac{10^6}{2\pi fC}$ Ohms 1 Mfd. at 60 crs = 2654 ohms 1 Mfd. at 400 crs = 398 ohms 1 Mfd. at 1000 crs = 159 ohms .001 Mfd. at 1 MC. = 159 ohms

 $EI_{RMS} = \frac{C (K V_{RMS})^2}{0.16}$ = VA Wattless Power Watt Loss = VA × Dissipation Factor

 $\% \text{ Duty} = \frac{\text{Time On} \times 100}{\text{Time On} + \text{Time Off}}$

Circle 123 on Inquiry Card

ELECTRONIC INDUSTR



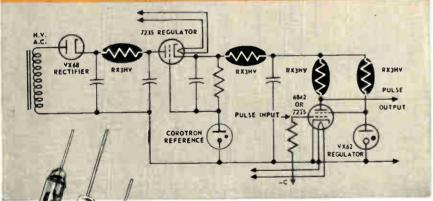
ELECTRONIC INDUSTRIES June 1962

<u>Worl</u>d Radio History

Circle 124 on Inquiry Card

Rx for ENTOMOPHOBIA*





The way to rid your circuits of "bugs" is to specify Victoreen glass-sealed resistors. Exceptionally accurate, they give long term stability, especially under extremes of temperature and humidity. You can get Victoreen resistors with voltages to 10 Kv... wattages to 10w in small, compact size... resistances up to 100,000,000 megohms. Don't get stung by untried components. Design your circuits for absolute reliability with Victoreen glass-sealed resistors. Give our Applications Engineering Department a call today they're ready and waiting to exterminate your circuit problems.

Fear of insects (also, sometimes, mellisophobia).

5806 HOUGH AVENUE • CLEVELAND 3, OHIO EXPORT: 3 WEST 61st STREET • NEW YORK 23, NEW YORK **Tech Data**

for Engineers

Over-Voltage Protection

Input/Output protectors, ENI Models 500 and 510 isolate electronic equipment input connections from voltage transients and other over-voltage conditions. For solid-state, circuitry these protectors clamp to a zero voltage level in less than 1 μ sec. any high-rise transients. Electro-Neutronics, Inc., 1401 Middle Harbor Rd., Oakland 20, Calif.

Circle 586 on Inquiry Card

Porcelain Capacitors

A brochure of 33 pages describes complete testing procedure and statistical analysis for porcelain capacitors. Specification is based on recommendations of the Ad HOC committee (Darnell) for Parts Specification Management for Reliability. High Reliability Specification S1002B. Vitramon, Inc., P.O. Box 544, Bridgeport, Conn.

Circle 587 on Inquiry Card

RIF Filters

Over 300 Genistron filters listed with important technical data are designed and manufactured according to Mil-F-15733D. The catalog, 56 pages, includes useful applications information on the Mil-F-15733D series including rectangular styles F1-51, 53, 56, 57, and cylindrical styles F1-52 and 24, covering a current range of 1 to 50a., both ac and dc. The Radio Interference Filter catalog is available for Genistron, Inc., 6320 W. Arizona Circle, Los Angeles 45, Calif. Photographs, dimension charts and characteristic charts are included.

Circle 588 on Inquiry Card

Tantalum Capacitors

"Parameters of Tantalum Capacitors" with physical, electrical, and chemical properties described, is available from Tansitor Electronics, Inc., Bennington, Vt. This 50-page booklet contains photographs, outline drawings, characteristics, charts, a partial list of type TS Solid Tantalum Capacitors. Information on: sintered anode type tantalum capacitors; ac and ripple considerations for polar vs non-polar; and case sizes is included.

Circle 589 on Inquiry Card

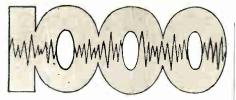
Battery Systems

A-6100A

World Radio History

A 20-page data book containing engineering design information on compact high-energy battery systems is available from Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y. The "Design Engineer's Energy Data Book," discusses the relationships of design parameters for integrated energy systems to the automatically-activated primary, manually-activated primary, and rechargeable battery systems. Characteristics of the silver-zinc and silver-cadmium battery systems are used. A glossary of battery terms is also included.

Circle 590 on Inquiry Card



ANSWERS TO YOUR SUB-MINIATURE CERAMIC CAPACITOR problem

MUCON THINLINE CAPACITORS

CAPACITANCE RANGE: 1 pF-150,000 pF VOLTAGES: 25 WVDC-500 WVDC

TEMP. CHARACTERISTICS: Any of 9 temperature-compensating and 4 general-purpose materials.

SIZES: Starting at .100" square max, by .090" thick max.

LEADS: Tinned copper, nickel or dumet. SHAPES: Square or rectangular, single or multiple-element.

APACITANCE RANGE: 10 pF-47,000 pF

MUCON MU-CAPS



of

of 25°C capacitance, between -55°C and +150°C. SIZES: 5 sizes from .200" sq. x .100" thick to .500" x .600" x .150" thick. LEADS: #22 tinned copper. Nickel or dumet also available.

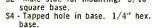
CAPACITANCE RANGE: 5 pF-10,000 pF

MUCON NARROW-CAPS



T

VOLTAGES: 10 WVDC-50 WVDC SIZES: .095" max. wide x 1/4" max. long x .095" max. thick thru 750 pF. Larger values 5/16" max. long. LEADS: #26 tinned copper. Nickel or dumet also available MUCON UHF CAPACITORS STANDOFFS: S1 - Tapped hole in base, 3/16", 5/16" and 7/16" square bases. S2 - Male stue for mounting. 3/16"



RIBBON-LEAD UNITS: RLA-axial ribbon leads RLR-radial ribbon leads

TEMP. CHARACTERISTICS: Any of 9 temperature-compensating and 4 general-purpose materials.

MUCON'S broad experience in manufacturing wide variety of constructions, ceramic bodies and leads will give you the one right capacitor for your electrical and physical requirements. Ask for Bulletin M-1 ar send us your requirements.



9 ST. FRANCIS ST., NEWARK 5, N. J. 201 Mitchell 2-1476-7-8

Circle 126 on Inquiry Card



Tech Data

for Engineers

R-F Amplifiers

This amplifier is designed for rug-ged military use, outdoors, under severe environments. It is watertight, pressurized, and has self-contained power supplies. Operating temps: -54° to $+71^{\circ}$ C. Gain is 26db, \pm 2db. Freq. range is 145 to 245MC. HRB-Singer, Inc., Science Park, P. O. Bay 60. State College Pa Box 60, State College, Pa.

Circle 591 on Inquiry Card

Catalog and Handbook

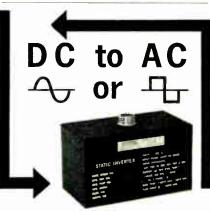
A new dc power supply handbook and catalog is now available to engineers in dc power design or procure-ment. This 24-page manual includes a step-by-step procedure, designed for engineers who wish to calculate packaging dimensions for multiple dc out-puts. The catalog details over 200 power supplies. Dressen-Barnes Electronics Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Circle 592 on Inquiry Card

Electrolytic Capacitors

Miniature electrolytic capacitors for low voltage dc transistor use are de-scribed in a 6-page, 2-color fold-out available from International Elec-tronic Industries, Inc., Box 9036, Nashville, Tenn. Features of these miniature units are ultra-small case sizes; high capacities with max, economy; and wide range of voltages and capacities.

Circle 593 on Inquiry Card



 Frequencies from 400 cps to 5 KC Output voltages from 5-500 VAC • 50, 100, 200 VA Standard

Designed to change low voltage DC power to sine or square power, these small-size, transistorized inverters can be supplied in a wide range of output voltages and frequencies. Units feature regulation to ½% for input 24 to 30 VDC, short circuit protection, and meet the environmental requirements of MIL-E-5272C. Prices range from \$185. to \$595. Delivery of most units from stock.

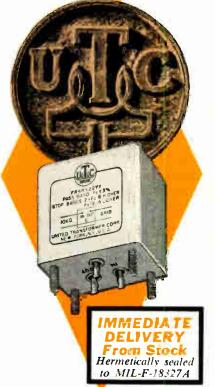
Send for complete 20-page catalog.

abbott transistor

LABORATORIES. INCORPORATEO 3055 Buckingham Rd. • Los Angeles 16 Direct Dial 213 • REpublic 1-9331

Circle 127 on Inquiry Card

STANDARD LINE & INTERSTAGE



UTC STANDARDIZED FILTERS have been developed to cover the more common mid-range frequency filter requirements with stock units. All are in compact drawn hermetically sealed cases shielded to reduce hum pick-up. They are divided into seven basic types.

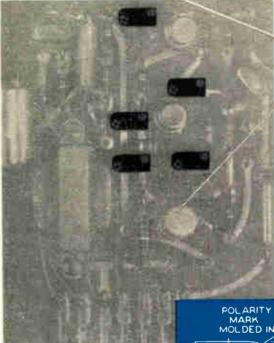
BMI filters are band pass interstage units designed to operate between a vacuum tube plate (or 10,000 ohms) and a grid. They provide a gain of 2 at center frequency BTI units are same as BMI, but 10,000 ohms output, for transistor application.

BML band pass filters, similarly, work into a grid, but have an input impedance of 500/600 ohms. They provide a gain of 9. HMI filters are high pass interstage units. LMI filters are low pass interstage units. HML filters are high pass with input and output impedance of 500/600 ohms. LML filters are low pass filters with input and output impedance of 500/600 ohms.

BMI, BTI, BML, HMI, and HML special filters can be obtained for any frequency from 60 to 12,000 cycles. LMI specials are available from 140 to 12,000 cycles. LML filters are available from 500 to 12,000 cycles.

UNITED TRANS**FO**RMER CORPORATION 150 Varick Street, New York 13, N.Y. PACIFIC MFG. DIVISION 3630 Eastham Drive, Culver City, Calif. EXPORT DIVISION 13 East 40th Street, New York 16, N. Y. WRITE FOR LATEST CATALOG Circle 128 on Inquiry Card

CRAMPED SPACES Now have a new dimension in Solid Tantalum Capacitors—



Actual size

CASE SIZE	H.	L.	W.				
X	.225	.290	.170				
Y	.325	.360	.170				
Z	.375	.600	.195				
Catalog Tolerance = ±.015"							

OTHER "KEMET" PRODUCTS For ELECTRONICS:

Solid Tantalum Capacitators—special H. Series available in 9 metal case sizes. Miniature hermetically sealed J-Series meets or exceeds MILC-26655A. N-Series for non-polar applications.

Barium Getters – a shape and a size for every type of electron tube.

Semiconductor Silicon—consistently uniform and pure to assure reproducible quality.

Silicon Monoxide—for a wide range of evaporation films in mechanical, chemical, optical, and electrical uses. Write for technical data



****KEMET''** P-SERIES

Provides Maximum Capacitance Per Unit of Chassis Area!

Reduce, minimize... pack more efficiency into smaller space. "Kemet" meets the need with its new P-Series polar solid tantalum capacitors!

Manufactured in a flat, rectangular shape, this high-density package consists of a tantalum anode encapsulated in a tough plastic case with an epoxy end seal. The parallel leads of solder-coated copper-clad iron are uniformly spaced 2/10" to conform with present printed circuit grid designs.

Capacitance values range from 1.5 to 220 microfarads, in $\pm 20\%$ and $\pm 10\%$ tolerances, and in working voltages of 6, 10, 15, 25, and 35. They are designed to operate continuously at 85° C without voltage derating. P-Series also available in 50 and 75-volt ratings on special request.

For full information on these new additions to Kemet's widely-specified J- and N-Series—the only full line ranging up to 75 volts—write to "The Specialist in Solid Tantalum Capacitators." Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

"Kemet" and "Union Carbide" are registered trade-marks for products of



CALL YOUR "KEMET" REPRESENTATIVE for all your needs in SOLID TANTALUM

NEW ENGLAND AND EAST COAST

NEW ENGLAND AND EAST COAST *Electrical Manufacturers Services, P. O. Box 489, Hempstead, N. Y. IVanhoe 5-4321; TWX: Hempstead 5777; Waltham 54, Mass., 680 Main St., TWinbrook 3-0100; New Haven 10, Conn., 265 Church St., UNi-versity 5-9104; Syracuse 6, N. Y., 3001 James St., HOward 3-4866; Derby, N. Y., 01d Lakeshore Rd., NA 7-2121; Poughkeepsie, N. Y., PO. Box 843; 7 New Market St.; Mountainside, N. J., 1476 Force Dr., PLainfield 6-1018; Camden, N. J., 26 Haddon Ave., WOodlawn 4-8014. In Boston, Buffalo, Rochester, and Utica, ask long distance for ENter-prise 4057; in Baltimore, ENterprise 9-4057; in Phil-adelphia, ENterprise 6057-all calls toll-free.

CAPACITORS

TENN., GA., FLA., S. C., MISS., ALA.

Roy Attaway Co., 2315 Bob Wallace Ave., S.W., Huntsville, Ala. Tel. 534-2811; TWX: HTVL ALA 8583; Orlando, Fla., 711 Magnolia Ave., GA 4-9983; TWX: OR FLA 7205

IND. (Except Lake County), MICH. (Lower Peninsula)

Warner, Kesler & Associates, P. O. Box 338, South Whitley, Ind. Tel. 723-5353

OHIO, Western PENN.

R. G. Sidnell & Co., 15120 Edgewater Dr., Cleveland 7, Ohio. ACademy 1-1313; Monroeville, Pa., 409 Hazelnut Dr.

MINN.

Stan Clothier Co., Inc., 12 West 58th St., Minne-apolis 19, Minn. TAylor 5-1234; TWX: MP 970

NEB., KAN., MO., Southern ILL. (Including Quincy)

Harris-Hanson Co., 2814 So. Brentwood Blvd., St. Louis 17, Mo. MIssion 7-4350; TWX: WEB 237; Kansas City 32, Mo., 7916 Paseo St., Highland 4-9494; TWX: KC 448

WIS. Northern ILL., IOWA, IND. (Lake County)

*D. Dolin Sales Co., (Nedco Electronics, Inc.) 3550 W. Peterson Ave., Chicago 45, III. JUniper 8-3738; TWX: CG 3373; Milwaukee 12, Wis., 811 East Vienna Ave., WOodruff 2-4270

TEX., OKLA., ARK., LA.

Ammon and Champion Co., 2714 Bomar St., Oallas, Tex. FLeetwood 7-3939; TWX: DL 210

COL., UTAH, NEW MEXICO, Southern IDAHO Barnhill Associates, 1170 So. Sheridan, Denver, Col., WEst 5-4646; TWX: DN 1022; Albuquerque, N. M., 319A Wyoming N.E., 2657766; Centerville, Utah, 300 S. Main, AXtel 5-6521; TWX: SU 236

CAL., ARIZ., NEV.

S. Marshall Co., 2065 Huntington Drive, °G. San Narino, Cal. MUrray 1-3292, SYcamore 5-4304; TWX: Pasa Cal 7797; Redwood City, Cal., 801 Woodside Rd., EMerson 6-8214; Scottsdale, Ariz., 30 Pima Piaza, 9464276; San Diego, Cal., 4410 Kearny Mesa Rd., BR 8-6350

WASH., ORE.

Samuel N. Stroum Co., Inc., 621 So. Michigan St., Seattle 8, Wash. PArkway 3-7310; TWX: SE 403

*Kemet Solid Tantalum Capacitors available for prompt delivery from complete stocks maintained at these locations.

If there is no representative in your area, please get in touch with us direct: P.O. Box 6087, Cleveland 1, Ohio, ACademy 6-3330; TWX CV 911

KEMET COMPANY

DIVISION OF UNION CARBIDE CORPORATION



New Tech Data

for Engineers

Ceramic Capacitors

Tech data is available on subminiature ceramic capacitors which in-clude thinline temperature-compensating, general purpose, UHF standoff, UHF ribbon, lead, and transistor-cir-cuit types. Mucon Corp., 9 St. Francis St., Newark 5, N. J.

Circle 414 on Inquiry Card

Oscillators

"How to Specify Low Frequency Oscillators," 4-pages, 2-color, gives a complete breakdown and analysis of the important parameters in the spec-ifying of low freq. oscillators. Accu-tronics, Inc., 12 So. Island, Batavia. 111.

Circle 415 on Inquiry Card

Trimmer Capacitors

JFD Electronics Corp., 6101 16th Ave., Bklyn. 4, N. Y., has a 32-page catalog, C-62, covering its complete line of variable trimmer piston capac-itors. The booklet covers complete electrical and physical data of JFD standard, split bushing, miniature, MAX-C, sealcap, split stator and dif-ferential trimmers in panel mount and printed circuit types.

Circle 416 on Inquiry Card

Potentiometers

Bourns, Inc., Trimpot Div., 1200 Columbia Ave., Riverside, Calif., is offering tech. data on their line of Trimpot[®] potentiometers. Included are dimensional drawings, specs., and photographs.

Circle 417 on Inquiry Card

Wideband Transformers

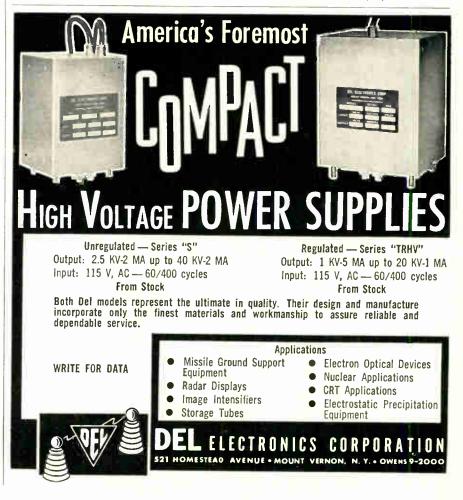
Type 0502 Wideband Transformer provides isolated coupling between 50 Ω to 200 Ω unbalanced over a freq. range of 200KC to 100MC. The inser-tion loss is less than 1db. Three case styles are offered. North Hills Electronics, Inc., Alexander Place, Glen Cove, L. I., N. Y.

Circle 418 on Inquiry Card

Magnetic Amplifiers

Tech data is available from MACE Corp., 900 N.E. 13th St., Ft. Lauder-dale, Fla. on Ultamag® harmonic type solid state magnetic amplifiers. Information covers three 60CPS units: signal level; high stability; and high sensitivity units. The units can with-stand 1000% overload and can be operated into dead short without damage.

Circle 419 on Inquiry Card



Circle 130 on Inquiry Card



Tech Data

for Engineers

Power Supplies

Complete data and selection guide for a line of modular power supplies designed specifically for microwave tubes is available from Micro-Power, tubes is available from Micro-Power, Inc., 20-31 Steinway St., Long Island City 5, N. Y. This data is presented in an 8-page catalog covering such microwave tubes as BWOs, voltage tunable magnetrons, klystrons, and TWT amplifiers. Specs., features, and TWT amplifiers are included and applications are included. Circle 420 on Inquiry Card

Resistors

Rheostats of 25-1000w and fixed, adjustable, and wire-wound resistors are described in tech data available from Harwick, Hindle, Inc., Newark, N. J. Included are photographs and specifications. Information also covers ferrule terminal types, 10 and 20w fixed, and axial lead type resistors.

Circle 421 on Inquiry Card

SCR Controller

The SILICOTRIG is a variable phase controller which provides the gating signal necessary to fully use the capabilities of silicon controlled rectifiers. Tech data includes photo-graphs, specifications and a number of schematics for high efficiency control systems. Bergen Laboratories Inc., 60 Spruce St., Paterson 1, N. J. Circle 422 on Inquiry Card

DC Power Supplies

Electro Products Laboratories, Inc., Electro Products Laboratories, Inc., Power Supply Div., 4500 N. Ravens-wood Ave., Chicago 30, Ill., is offer-ing Bulletin PS-562 covering their line of 18 low voltage, regulated, semi-regulated, and conventional dc power supplies. Information includes handy selection chart, characteristics and performance data.

Circle 423 on Inquiry Card

Variable Transformers

Product Guide, 12 pages, covers rat-ings and other essential tech. data on ings and other essential tech. data on Powerstat Variable Transformers, Stabiline Automatic Voltage Regula-tors, Slo-Syn Synchronous Motors and Translators, Supercon Electrical Con-nectors, and Varicell Adjustable AC/DC Power Supplies. The Superior Electric Co., Dept. PG. Bristol, Conn. Circle 424 on Inquiry Card

Resistors

This 28-page. 3-color, brochure available from General Resistance, Inc., 430 Southern Blvd., New York 55, N. Y., catalogs the company's complete line of resistors, networks, cans and shells, and instruments. Re-sistor section describes design per-formance, the specs, and Mil equivalents, and gives performance curves. The instrument section offers complete specs. on the company's line of Wheatstone bridges, transfer standards, decade voltage dividers and resistance boxes, and binary coded resistance modules.

Circle 425 on Inquiry Card

Circle 132 on Inquiry Card

World Radio History

ELECTRONIC INDUSTRIES . June 1962



Ready for immediate installation in your assembly

Applications :

Ice Making
 Water Cooling

Electronic

Standard

Component and System Cooling

Refrigeration

Environmental

Chambers

"Peltron" Model TU-6F





"Peltron" Model TU-6



MODULAR THERMO-ELECTRIC COOLING SYSTEMS

FOR INDUSTRIAL AND CONSUMER REFRIGERATING APPLICATIONS

"Peltron" thermoelectric cooling units, designed for low to medium capacity refrigeration applications, are available as standard, off-the-shelf models for direct application to users' equipment assemblies.

Ohio Semiconductors' new series of high-reliability coolers can be supplied as *modular* units for various cooling loads in industrial, commercial, and consumer refrigeration applications. Other accessory equipment is available depending on the users' needs. Your cooling problems are invited.



1205 Chesapeake Avenue Columbus 12, Ohio

SENICONDUCTORS HU 6-9561 Pioneer in the design, development and production of compound semiconductors, and

Pioneer in the design, development and production of compound semiconductors, and components and sub-systems, for electronic, thermoelectric and infrared applications.

ELECTRONIC INDUSTRIES · June 1962

Circle 133 on Inquiry Card World Radio History

JENNINGS VACUUM CAPACITORS



TO MEET HIGH VOLTAGE CIRCUIT DESIGN PROBLEMS

Of course this unusually large selection didn't just happen overnight. It represents the accumulation of twenty years experience in the manufacture of vacuum capacitors. During this time Jennings has developed exclusive vacuum processing techniques. Examine the representative types shown below, all of them proven successful in thousands of applications.

HIGH VOLTAGE

TypeVMMHHC
Capacitance Range
Peak Voltage 120 kv
RF Current 125 amps RMS
Length



HIGH CURRENT

Туре УММНСЖ
Capacitance Range
Peak Voltage
RF Current
Length

HIGH RATIO OF CAPACITANCE CHANGE

TypeUCSL
Capacitance Range
Peak Voltage 5 kv
RF Current
Length

SMALL SIZE

ТуреЕСЅ
Capacitance Range 3 to 30 mmfd
Peak Voltage
RF Current
Length 4½ inches

Our radio frequency laboratory with 12 functioning transmitters ranging from 17 KC to 600 MC and up to 100 KW CW power is at your service to test our products under your particular circuit conditions.

> Write for our special brochure describing our complete line of vacuum capacitors.

RELIABILITY MEANS VACUUM VACUUM MEANS

JENNINGS RADIO MFG. CORP., 970 McLAUGHLIN AVE., SAN JOSE 8, CALIF., PHONE CYpress 2-4025

Tech Data

for Engineers

DC Power Supplies

This 12-page. 2-color brochure contains information on dc power suptains information on de power sup-plies and is available from Sola Elec-tric Co., 1717 Busse Rd., Elk Grove Village, Ill. Information on a full line of regulated de supplies includes the following basic categories: CVDC, CVDR, and CVQ (brute force, me-dium and fine). Included are sche-matic diagrams, and a convenient glossary of power supply terms. Bro-chure GDC-100.

Circle 426 on Inquiry Card

Filters

Erie Resistor Corp., Erie Electron-ics Div., 644 W. 12th St., Erie, Pa., is offering tech bulletin 512 covering 6 styles of high frequency low pass filters with minimum attenuation of 45 to 50 db Corports 45 to 50 db. Capacitance of 1000 pf to 5000 pf and working voltage of 200 to 500 vdc. Circle 427 on Inquiry Card

Power Supplies

Pacific Electric Motor Co., 1009 66th Ave., Oakland 21, Calif., has tech. data available on their "Q" line transistorized solid state power supplies. Specs. include current regula-warm-up; and for low impedance type magnet load, approx. 0.5 to 10Ω. Units range from 5 to 500kw. Circle 428 on Inquiry Card

Trimmer Resistors

Bulletin 42-1216 is available from Centralab, The Electronics Div. of Globe - Union Inc., 900 East Keefe Ave., Milwaukee 1, Wis., containing detailed electrical and physical specs. on their line of PEC® miniature and microminiature trimmer resistors. Circle 429 on Inquiry Card

Trimming Potentiometers

Handy "Standard Selection Chart" simplifies specifying of more than 2000 standard models of Squaretrim® precision, subminiature, trimming potentiometers. They are used for adjustment of computer, control, tele-metering, missile, and other military and industrial electronic circuits. Included are actual curves showing power rating for 21 different series of Squaretrim potentiometers. Daystrom. Inc., Potentiometer Div., Arch-bald, Pa.

Circle 430 on Inquiry Card

Ceramic Capacitors

A 40-page, 2-color, catalog is avail-able from the Hi-Q Div., Aerovox Corp., Myrtle Beach, S. C., on their complete line of Ceramic Capacitors. The catalog contains detailed electrical and physical specs. on disc, plate, tubular, ceramic trimmers and eyelet feed-thru, feed-thru, stand-off, highvoltage, ring and square can capaci-tors. and R/C network plate assem-blies. Included are dimensional draw-ings, specs., tables, and operating curves.

Circle 431 on Inquiry Card

Circle 134 on Inquiry Card

ELECTRONIC INDUSTRIES · June 1962 Circle 135 on Inquiry Card

Design for Reliability and Superior Performance



with these Allen-Bradley AB quality electronic components

Mr. Design Engineer! When deciding upon components for your circuits, please remember that you can always be sure of obtaining maximum reliability with Allen-Bradley electronic components-and quality of production is consistent from one order to the nextand from one year to the next.

For example, Allen-Bradley fixed resistors—made by A-B's exclusive hot molding process-are famous for their conservative ratings, stable characteristics, and complete freedom from catastrophic failures.

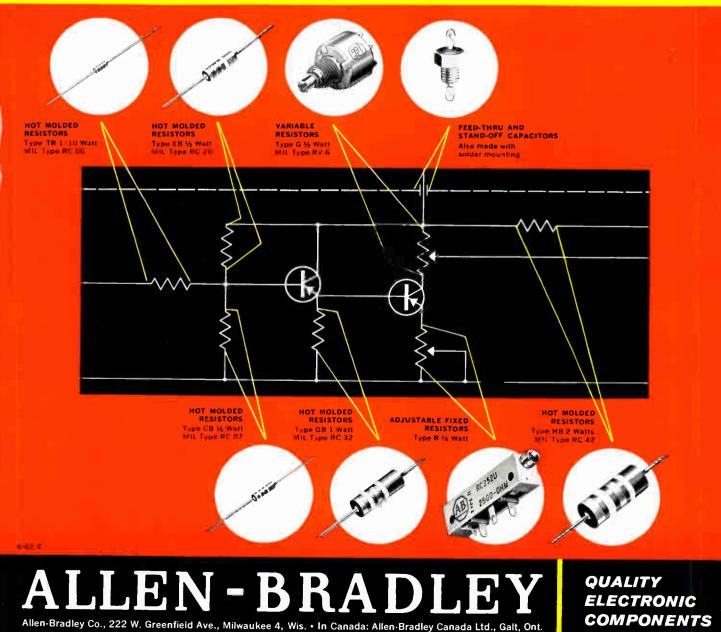
Then there are the miniature Type G potentiometers. They feature a solid, hot molded resistance element that gives exceptionally long life and quiet operation which even improves with use. Control is always smooth

-there are never any abrupt resistance changes during adjustment.

This same hot molding process is also used in making A-B's Type R adjustable fixed resistors, which provides "stepless" adjustment of resistance. In addition, the moving element is self-locking, resulting in absolutely stable settings.

Another "exclusive" is A-B's ceramic feed-thru and stand-off capacitors for use at VHF and UHF frequencies. With their unique discoidal design, all parallel resonance effects are eliminated at frequencies of 1000 mcps and less.

For details on the complete line of A-B quality electronic components, please send for Publication 6024.





Space Restricted? Application Severe?

Allen-Bradley Miniature Hot Molded Variable Resistors Provide Smooth Control Which Improves With Use!

> Type G or Type L Control enlarged 5 times

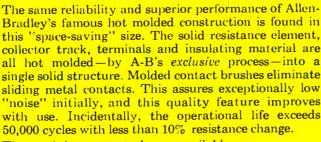
Diasweter











These miniature controls are available as:

Type G-For use over ambient temperature range from -55° C to $+120^{\circ}$ C. Rated 0.5 watt at $+70^{\circ}$ C.

Type L-For use over ambient temperature range from -55° C to $+150^{\circ}$ C. Rated 0.8 watt at $+70^{\circ}$ C.

Both furnished in maximum resistances from 100 ohms to 5 megohms. For full details on these *quality* controls, please write for Technical Bulletin B5201.



With line switch



For board mounting

ADDITIONAL A-B HOT MOLDED CONTROLS





The Type F controls are especially designed for printed board mounting. Terminals fit 0.1 inch spacing. Type F temperature range -55° C to $+120^{\circ}$ C, rated 0.25 watt at $+70^{\circ}$ C. Type O temperature range -55° C to $+150^{\circ}$ C, rated 0.4 watt at $+70^{\circ}$ C.

Type R adjustable fixed resistors allow stepless adjustment. Moving element is self-locking for absolutely stable settings. Watertight case permits encapsulation. For continuous use from -55° C to $+125^{\circ}$ C, rated 0.25 watt at $+70^{\circ}$ C.

Allen-Bradley Co., 222 West Greenfield Ave., Milwaukee 4 Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

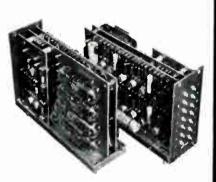
ALLEN - BRADLEY

QUALITY ELECTRONIC COMPONENTS



FREQUENCY STANDARDS

Highly reliable, ultra-stable standards with a basic frequency of 5 mc are available with circuitry for division to 100 kc and 1 mc and doubling up to 10 mc. Stability is up to 1 part in 10⁹ per day. Precision standards use crystals of our own manufacture and are packaged to your specifications.



PACKAGED OSCILLATORS

TRANSISTORIZED AND HARD TUBE TYPES of Reeves-Hoffman packaged oscillators are available in a frequency range from 100 cps to 100 mc. Stability is up to 1 part in 10⁹. Packaged to your specifications.

REEVES-HOFFMAN FREQUENCY SOURCES AND STANDARDS, CRYSTALS, OVENS, FILTERS

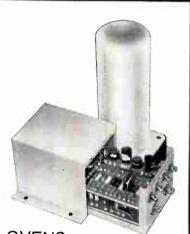


CRYSTALS

STANDARD TYPES of Reeves-Hoffman crystals, for all commercial and military applications, are available in a frequency range from 1 kc to 100 mc. Hermetically sealed in metal holders.

PRECISION TYPES of Reeves-Hoffman crystals, for use in high precision oscillators and secondary frequency standards, are available in a frequency range from 1 kc to 5 mc. Hermetically sealed in glass holders with standard radio tube bases.

World Radio History



OVENS

OVENS for precise temperature control are available in three types:

PROPORTIONAL CONTROLLED, for precise frequency standards, hold within 1/100th of 1°C at any fixed ambient.

THERMOSTATICALLY CONTROLLED, for high reliability requirements, hold within 1/10 of 1° C at any fixed ambient.

SNAP-ACTION CONTROLLED, for rugged military requirements, hold within 1° C at any fixed ambient.

FILTERS CRYSTAL FILTERS are available in a frequency range from audio to 30 mc.

Compact, rugged and highly reliable Reeves-Hoffman components are available in standard types or will be designed and manufactured to your specifications. Most units can be designed to withstand up to 10 g at 5 to 2000 cps. Write for complete details.



											_
		TRONI						temp, coeff.			
Components D	ivision • 6101 1	6th Arenue, Brookly capacitan	m, New Yori CP	 Phone DEwe 	dielectric	-NY25040	0 factor	PPM C	2		- 0
		range pr measured	per	DC	strength measured	insulation	at 1 mc.	-25 to 125 C -55° to -1		fron' of	page no.
model	type mount	JFD = 51 min	max	volts	at max. rated cap	500 VDC	per JFD 5178	for quarta	piston)	panell	
SEALCAP MINIATURE PANE	Prt. Ct.	PRINTED C	A.5	GLASS AN 750	D QUARTZ	2x10* Meg.	500	= 50	Glass - Invar	13,97	16
SC131*, 141 & 151 SC133*, 143 & 153	Prt. Ct.	0.8	8.5 12.0	1250	2500 VDC 2500 VDC	10x10 ⁴ Meg. 10x10 ⁴ Meg.	500 500	±50 ∴75	Glass - invar Glass - Invar	21 ₅₇ 7 7	16
SC134* SC144 & 154	Prt. Ct. Prt. Ct.	0.7 0.8	12.0	1250	2500 VDC	10x10* Meg.	500 500	- 75 - 100	Glass - Invar Glass - Invar	109 13 ₁₁ 7	16 16
SC136*, 146 & 156 SC139*	Prt. Ct. Prt. Ct.	0.8 1.0	18.0 30.0	1250	2500 VDC 2500 VDC	10x10* Meg. 10x10* Meg.	500	=100	Glass - Invar Glass - Invar	17.	15 16
SC149 & 159 QS171*, 181 & 191	Prt. Ct. Prt. Ct.	0.8 0.6	30.0 1.8	1250 750	2500 VDC 1500 VDC	10x10* Meg. 2x10* Meg.	500 1500	+25 ±25	Quartz - Invar	13 ₃₁ 7 21 ₁₁ 7	17 17
Q\$173*, 183 & 193 Q\$176*, 186 & 196	Prt. Ct. Prt. Ct.	0.6 0.6	5.5 9.5	1250 1250	2500 VDC 2500 VDC	10×10* Meg. 10×10* Meg.	1500 1500	→ 25 ±25 → 25 ±25	Quartz - Invar Quartz - Invar	1^{3} 177	17
Q\$179*, 189 & 199	Prt. Ct.	0.8	16.0	1250	2500 VDC	10×10 ⁴ Meg.	1500	⊤ 25 ≭ 25	Quartz - Invar	1'4 ⁷	
STANDARD SPLIT-STATOR		OUNT, GLAS (A) 0.5	5.0	500	1000 VDC	10º Meg.	700	≓ 50	Glass - Invar	¹¹ 1•	22
VC16G	Panel	(B) 0.8 (A) 0.6	2.5 8.5				700	±50	Glass - Invar	1'22	22
VC17G	Panel	(B) 1.1 (A) 0.7	4.5 14.0	500	1000 VDC	10º Meg.					22
VC18G	Panel	(B) 1.8 (A) 0.4	7.5 1.5	500	1000 VDC	10ª Meg.	700	±50	Glass - Invar	1"32	
VC80A	Panel	(B) 0.5	0.8	750	1500 VDC	104 Meg.	1000	- 25 · 25	Quartz - Invar	76	22
VC81A	Panel	(A) 0.55 (B) 0.75	1.3	750	1500 VDC	104 Meg.	1000	→ 25 == 25	Quartz - Invar	2.0	22
VC82A	Panel	(A) 0.65 (B) 0.95	5.0 2.5	750	1500 VDC	10' Meg.	1000	- 25 - 25	Quartz - Invar		22
VC83A	Panel	(A) 53 (B) 3.5	10.5 5.5	750	1500 VDC	104 Meg.	1000	→ 25 ··· 25	Quartz - Invar	11932	22
MINIATURE SPLIT-STATOR	SERIES	(A) 0.8	4.2								
SP86G*, 206G & 216G	Prt. Ct.	(B) 0.8	4.2 2.0 9.0	750	1500 VDC	10 ⁵ Meg.	500	≟5 0	Glass - Invar	1732	23
SP87G*, 207G & 217G	Prt. Ct.	(A) 0.8 (B) 1.5	4.5	750	1500 VDC	10 ⁵ Meg.	500	±100	Glass - Invar	1†	23
SP88G*, 208G & 218G	Prt. Ct.	(A) 1.0 (B) 2.0	14.0 7.0	750	1500 VDC	10 ⁵ Meg.	500	± 100	Glass - Invar	1"11	23
MINIATURE SPLIT-STATOR	SEALCAP	SERIES (A) 0.8	4.2							61 6n	24
SPS226G*, 236G & 246G	Prt. Ct.	(B) 0.8 (A) 0.8	2.0 9.0	750	1500 VDC	10 ⁵ Meg.	500	±50	Glass - Invar		24
SPS227G*, 237G & 247G	Prt. Ct.	(B) 1.5 (A) 1.0	4.5 14.0	750	1500 VDC	10 ⁵ Meg.	500	= 100	Glass - Invar	1,12,2	
SPS228G*, 238G & 248G	Prt. Ct.	(B) 2.0	7.0	750	1500 VDC	10 ⁵ Meg.	500	±100	Glass - Invar	1*5 _{8.1} †	2.4
DIFFERENTIAL SERIES, ST	ANDARD P	ANEL MOUN	т∗», мн	NIATURE T	YPES FOR	PANEL MOUNT	°, AND PI	RINTED CIRC	UIT TYPES		
	B .4. 64	(1) 0.7	3.0	500	1000 VDC	10° Meg.	500	±100	Glass - Invar	3.1	20
DC401**, 411* , 421 & 431		(2) 2.0 (1) 0.8	3.0 8.0		1000 VDC	10° Meg.	500	±100	Glass - Invar	35.41	20
DC403**, 413* , 423 & 433		(2) 2.5 (1) 0.8	+8.0 12.0	500		10° Meg.	500	±100	Glass - Invar	3.1	20
DC404**,414* ,424 & 434		(2) 3.0 (1) 0.9	12.0 16.0	500	1000 VDC		500	±100	Glass - Invar	15/11	
DC406**,416* ,426 & 436		(2) 3.5 (1) 1.5	16.0 28.0	500	1000 VDC	10* Meg.	500	±100	Glass - Invar	13147	20
DC409**, 419* , 429 & 439		(2) 5.0	28.0	500"	1000 VDC	104 Meg.			0.033		
MINIATURE DIFERENTIAL		SERIES (1) 0.7	3.0	500	1000 VDC	10ª Meg.	500	= 100	Glass Invar	?∕a‡	21
DS441*, 451 & 461	Prt. Ct.	(2) 2.0 (1) 0.8	3.0 8.0				500	±100	Glass - Invar	*3.4 1	21
DS443*, 453 & 463	Prt. Ct.	(2) 2.5 (1) 0.8	8.0 12.0	500	1000 VDC	104 Meg. 104 Meg.	500	±100	Glass - Invar	3.1	21
DS444*, 454 & 464	Prt. Ct.	(2) 3.0 (1) 0.9	12.0 16.0	500	1000 VDC		500	= 100	Glass - Invar	15.7	21
DS446*, 456 & 466	Prt. Ct.	(2) 3.5 (1) 1.5	16.0 28.0	500	1000 VDC	104 Meg.	500		Glass - Invar	1'10"	
DS449*, 459 & 469	Prt. Ct.	(2) 5.0	28.0	500	1000 VDC	104 Meg.					
MAX-C SEALCAP SERIES MC601*, 611 & 621	Prt. Ct.	1.0	14.0	1000	2000 VDC	104 Meg.	500	= 50 Glass	- Nickel Alloy Ste	el ²⁸ 41	18
MC603*, 613 & 623 MC604*, 614 & 624	Prt. Ct. Prt. Ct.	1.0	28.0 42.0	1000 1000	2000 VDC 2000 VDC	10* Meg. 10* Meg.	500 500	±50 Glass	- Nickel Alloy Ste - Nickel Alloy Ste	el "12	18
MC606*, 616 & 626 MC609*, 619 & 629	Prt. Ct. Prt. Ct.	1.0	60.0 90.0	1000	2000 VDC 2000 VDC	104 Meg. 104 Meg.	500 500	±50 Glass	- Nickel Alloy Ste -Nickel Alloy Ste	ei 1732'	18
PC SERIES PANEL MOU											
FC35H030	PANEL	0.5	3	500			nts meet 1			5	25 25
PC35H080 PC35H160	PANEL	1	8 16	50C 500		requirement	IS OF MIL-	°-1≈4034		1% 1%	25
PC35H300	PANEL	1	30	500	000	nnal	0	perating		ength	
LC TUNERS*		-resonating Juency (MC)		minal induct		itance		°C	(1	ront of panel)	
LC303* , 313 , 323 & 333	** 400 M	1NL 725 MAY	.0248 M	IN .0277 M	AX .54 MIN	6.56 MAX 170	0-200 55	to = 125	Glass - Invar Glass - Invar	437 64 577	
LC3044 ,314 ,324 & 334 LC3064 ,316 ,326 & 336	**, 275 M ** 200 M	INC BOO MANY	0507 M	IN 05.14 M	AX 86 MIN	11.66 MAX 150 20.19 MAX 135	5.1/0 5:	0 10 120	Glass - Invar	1°	
LC309* , 319 , 329 & 339 FOR JFD LC TUNE	** 125 M	IN 375 MAX	.0748 M	IIN .07 98 M	AX .88 MIN	24.49 MAX 14:	5-155 55) SEE CATAL	Glass - Invar .OG T172	14264	
+*Standard par				nel mount	Length Ap	plicable for Pa	anel Moun	t Types Only			_
EINED METALIZED IND	UCTORS	FOR PANEL	MOUN	T. (LEIP	PRINTED	CIRCUIT MOL	JNT (LEAW	SERIES), AF	RE ALSO AVAILA		
SERIES), OR PRINTED (AVAILABLE OFF THE SE GLASS DIAMETER. THEY					ETER TI	HESE RANGE	FROM .0	5 un to I U	UN, INCOL IC	OUR	
METALIZED INDUCTORS	FOR PANE	L MOUNT (L	F3P SEF	RES). UR							
TANK CIRCU	JITS, (SERI	ES LC371) A	VAILABL	E IN FIVE	MODELS CO	VERING FIVE	OVERLAPP	ING RANGES	ò		

TANK CIRCUITS, (SERIES LC371) AVAILABLE IN FIVE MODELS COVERING FIVE OVERLAPPING RANGES BETWEEN 170 Mc AND 1000 Mc ARE ALSO DESCRIBED IN JFD CATALOG T172

MORE ENGINEERS SPECIFY



VARIABLE TRIMMER PISTON CAPACITORS LC TUNERS AND METALIZED INDUCTORS

For complete data on LC Tuners and Metalized Inductors, refer to Catalog No. T172. For complete data on Delay Lines, refer to Catalog No. D82. For custom modifications please contact the JFD sales engineering office or JFD Sales Representative nearest you as listed on page 32

	LUIT				or JFD Sa	les Representative	nearest you	as listed on page	e 32		
	type	ranı meas	acitance ge pf wred per #5177	D.C. working	dielectric strength measured at max.	insulation resistance	Q factor measured at 1 mc.	temp. coeff. of capacitance P P M /*C	material	length (front	page no.
model	mount	min,	max.	volts	rated cap.	500 V D C.	per JFD .	+25° ta+125°C for -55° ta +125°C fo	glass (dielectric-	of panel)	
	PANEL MOUNT, GI	LASS AN	D QUARI	rz			- 51/6 -		a quartz constraint		
VC1G	Panel	0.7	9.0	1250	2500 VDC	10 ⁴ Meg. Min.	500	-60 to +10	Glass - Invar	21/2	7
VC4G	Panel	0.8	18.0	750	1500 VDC		500	•			7
VCSG	Panel	0.8	18.0	750	1500 VDC	0	500 500	+350 to +450 -20 to +40	Glass - Brass	1	
VC11G	Panel	0.6	14.0	750	1500 VDC	10 ⁴ Meg. Min.			Glass - Invar	1	7
VC11GRA	Panel	0.6	14.0	750	1500 VDC	10° Meg. Min. 10° Meg. Min.	500	-30 to $+40$	Glass - Invar	1	7
VC11GRB	Panel	0.6	14.0	750	1500 VDC 1500 VDC	10° Meg. Min. 10° Meg. Min.	500 500	-40 to $+50$	Glass - Invar	1	7
VCIIGRC	Panel	0.8	18.0	750	1500 VDC	10° Meg. Min. 10° Meg. Min.	500	+350 to $+450$	Glass - Brass	1	7
VC30G	Panel	0.8	30.0	750		_	500	+20 to +100	Glass - Invar	1	7
VC2	Panel	0.8	30.0 4.5	750	1500 VDC	10 ⁴ Meg. Min.	500	-10 to +50	Glass - Invar	1'%:	7
VC5	Panel	0.7	4.5 6.0	750	1500 VDC	10 ⁴ Meg. Min.	LARGELY	+25 ±25	Quartz - Invar	· · · •	7
VC11	Panel	0.6	10.0	750	1500 VDC	10 ⁴ Meg. Min.	IN	+25 ±25	Quartz - Invar	3/4	7
VC12	Panel	9.0	21.0	750	1500 VDC 1500 VDC	10º Meg. Min. 10º Meg. Min.	EXCESS	(-25 ± 25)	Quartz - Invar	1	7
VC99	Panel	0.8	10.0	2500	5000 VDC	10º Meg. Min.	0F 2000	$+25 \pm 25$ $\pm 25 \pm 25$	Quartz - Invar	**	
SPLIT BUSH	ING SERIES PA	NEL MOL	INT. PRI			S AND QUARTZ	1 2000	+25 ±25	Quartz - Invar	1%2	25
VC3G	Panel	0.7	9.0	1250	2500 VDC	10º Meg. Min.	650	1 200 4- 1	<u>-</u>		
VC3GI	Panel	0.7	9.0	1250	2500 VDC	10º Meg. Min.	650 650	+300 to +500	Glass - Brass	21/32	8
VCBCA	Panel	0.7	17.0	750	1500 VDC	10" Meg. Min.	750	+0 to $-150+400 to +600$	Glass - Invar	"5z	8 8
VC6GI VC7G	Panel	0.8	17.0	750	1500 VDC	10 ^e Meg. Min.	600	+400 to $+600-100$ to $+100$	Glass - Brass Glass - Invar	1%, 1%,	8
VC801GW	Panel	2.0	30.0	750	1500 VDC	10 ^e Meg. Min.	600	-100 to $+100$	Glass - Invar	1%	8
VC803GWA	Prt. Ct. Prt. Ct.		4.5 8.5	750 750	1500 VDC 1500 VDC	10* Meg.	500	±50	Glasș - Invar	1432	9
VC804GWA	Prt. Ct.	0.8	12.0	750	1500 VDC 1500 VDC	10* Meg. 10* Meg.	500 500	±50 ±75	Glass - Invar	1732	9 9
VC806GWA VC809GWA	Prt. Ct. Prt. Ct.	0.8 0.8	18.0 30.0	750 750	1500 VDC	10* Meg.	500	±100	Glass - Invar Glass - Invar	5. 1.52	9
VC811QWA	Prt. Ct.	0.6	1.8	750	1500 VDC 1500 VDC	10º Meg. 10º Meg.	500 2000	±100	Glass - Invar	14344	9
VC813QWA VC816QWA	Prt. Ct.	0.6	5.0	750	1500 VDC	104 Meg.	2000	+25 ±25 +25 ±25	Quartz - Invar Quartz - Invar	1352 1751	9 9
VC819QWA	Prt. Ct. Prt. Ct.	0.6 0.6	9.5 16.0	750 750	1500 VDC 1500 VDC	10º Meg. 10º Meg.	2000	+25 =25	Quartz - Invar	1364	9
DIRECT TRAV	ERSE, LOW COST,	HIGH Q	UALITY.		OUNT. PRIM	NTED CIRCUIT, GL.	2000	+25 ±25	Quartz - Invar	14%	9
VC13GB VC50CB	Panel					TO, MER' MILL'	ASS AND CI 500	+225 to +375	MERCIAL APPLIC	ATIONS	
VCS1CB	Panel Prt. Ct.	5.0 5.0	50.0 50.0	1250 1250	2500 VDC 2500 VDC	10 ^s Meg. Min. 10 ^s Meg. Min.	450	+250 to +450	Glass - Ph. Bron Ceram - Ph. Bron		10 10
WC52 WC53	Panel Prt. Ct.	1.0 1.0	12.0	750 750	1500 VDC 1500 VDC	10 ⁴ Meg. Min.	450 500	+250 to +450 +225 to +375	Ceram - Ph. Bron Glass - Ph. Bron	ize 11	10
SPLIT BUSH	NG, PANEL MOUN					10º Meg. Min.	500	+225 to +375	Glass - Ph. Bron	ze i 🦓	10
VL/6	Panel	0.5	7.0	500 500	1000 VDC		For				
VC77 VC78	Panel Panel	0.5	7.0 7.0	500	1000 VDC	10 ^e Meg. Min. 10 ^e Meg. Min.	500 500	±50 ±50	Glass - Invar Glass - Invar	1%	11 11
¥C79	Prt. Ct.	0.5	7.0	500 500	1000 VDC 1000 VDC	10 ⁴ Meg. Min. 10 ⁴ Meg. Min.	500 500	±50 ±50	Glass - Invar	1%2 1%2 1%2	11
					_				Glass - Invar	•%	11
		INTED CI	IRCUIT,	GLASS, "	WORLD'S SI	MALLET PISTON C	APACITOR"				
PT901 PT902	Panel Panel	0.5 0.5	2.0 3.0	500	1000 VDC	10 ⁴ Meg. Min.	500	– Glas	s-Nickel Alloy Ste	el 1/	12
PT903 PT904	Panel	0.5	5.0	500 500	1000 VDC	10º Meg. Min. 10º Meg. Min.	500 500	- Gias	is-Nickel Alloy Ste	el ¼	12 12
PT911	Panel Prt. Ct.	0.5 0.5	7.0 2.0	500 500	1000 VDC	10 ⁴ Meg. Min. 10 ⁴ Meg. Min.	500	- Glas	s-Nickel Alloy Ste s-Nickel Alloy Ste	el 1	12 12
PT912 PT913	Prt. Ct. Prt. Ct.	0.5	3.0 5.0	500	1000 VDC	104 Meg. Min.	500 500	Glas	s-Nickel Alloy Ste s-Nickel Alloy Ste	el 14	12 12
PT914	Prt. Ct.	0.5	7.0	500 500		10 ⁴ Meg. Min. 10 ⁴ Meg. Min.	500 500	— Glas	s-Nickel Alloy Ste	ei "‰	12
								Glas	s-Nickel Alloy Ste	el 1%µ	12,
SLIDING PIST	ON, SPLIT BUSHI	NG. PANI		NT. GLAS	5						_
VC481	Panel	0.8	4.5	750	3 1500	10 ⁴ Meg. Min.	500	+ 50		_	
VC483 VC484	Panel Panel	0.8 0.8	8.5 12.0	750 750	1500 1500	10° Meg. Min.	500	±50 ±50	Glass - Invar Glass - Invar	×. ×.	13 13
VC486 VC489	Panel Panel	0.8	18.0	750	1500	104 Meg. Min. 104 Meg. Min.	500 500	± 50 + 50	Glass - Invar Glass - Invar	142	13
		0.8	30.0	750	1500	10 ⁴ Meg. Min.	500	±50	Glass - Invar	1%	13 13
	ANEL MOUNT, PR					* Panel	Mount				
	96, VC9GW Prt. Ct. 96, VC10GW Prt. Ct.	0.8	8.5	750	1500 VDC	10 ⁴ Meg. Min.	500	±50	Glass - Invar	· %	14
VC21G+ VCI			4.5	750	1500 VDC	10 ⁴ Meg. Min,	500	:±50	Glass - Invar	316	14
	Panei G,VC32GW Prt. Ct.	0.7	12.0	750	1500 VDC	10 ^e Meg. Min.	500	±75	Glass - Invar	1144	14
VC23G* VL32 VC24G*		0.8	18.0	750	1500 VDC	10 ⁴ Meg. Min.	500	±100	Glass - Invar	- 1	14
VC31G, VC31G	Panel W Prt. Ct.	1.0 0.8	30.0 12.0	750 750	1500 VDC	10 ⁴ Meg. Min.	500	±100	Glass - Invar		14
VC42G & VC42					1500 VDC	10 ⁴ Meg. Min.	500	±75	Glass - Invar	2%1	14
VC42G & VC42 VC43G, VC43G		1.0	21.0	750 750	1500 VDC	10 ⁴ Meg. Min.	500	±100	Glass - Invar	15,,	14
MQ101*, 111 8		0.8	30.0	750 750	1500 VDC	10 ⁴ Meg. Min.	500	±100	Glass - Invar	154	14
MQ103*, 113 &		0.6	1.8	750 750	1500 VDC	10 ⁴ Meg. Min.	1500	+ 25 25	Quartz - Inva	r 314	15
		0.6	5.5	750	1500 VDC	10 ^e Meg. Min.	1500	: 25 25	Quartz - Inva	r %	15
MQ106*, 116 8		0.6	9.5	750 750	1500 VDC	10 ⁴ Meg. Min.	1500	25 25	Quartz - Inva	-	15
MQ109*, 119 8		0.8	16.0	750	1500 VDC	10 ⁴ Meg. Min.	1500	+ 25	Quartz - Inva	r: 1%	15
	JFC) Capaci	itors me	et or exi	ceed applic	able requiremen	ts of MIL-C	C+14409A.		_	_

PRECISION CAPACITORS-TOLERANCES TO 0.1%



EAI precision capacitors-fixed or adjustable-are available in tolerances of ±0.1% or better and with stability closer than ±.01% over operating temperature range. These unusually high standards result from EAI's specialized manufacturing know-how which includes the ability to measure capacity to accuracies of .005% and dielectric absorption to any circuit requirements.

Rectangular Fixed

TYPICAL SPECIFICATIONS: **PS521-Polystyrene Dielectric**

Capacitance Range: .001 mfd to 10 mfd. Tolerance: ±5% is standard, ±2%,

 $\pm 1\%$, and $\pm 0.1\%$ on request. Stability: Better than .01%.

Dielectric Absorption: Less than .01%.

Construction: Non-inductive. Temperature Range: -55°C. to +85°C. Insulation Resistance: 1012 ohm/mfd,

minimum.

Capacitance Change: 110 ppm/°c ±10 ppm/°c; ±5 ppm/°c, upon special request.



M521-Mylar Dielectric

Capacitance Range: .001 mfd to 10 mfd. Tolerance: $\pm 5\%$ is standard, $\pm 10\%$, $\pm 1\%$, $\pm 0.5\%$ or closer on request.

Construction: Non-inductive. Sealed under inert gas.

Temperature Range: -60°C to +150°C. Insulation Resistance: 1011 ohm/mfd, minimum.



EAI production facilities can provide capacitors of virtually any tolerance or stability in temperature ranges in excess of 200°C. Write describing your requirements. Additional data is available by writing to Components Department.



Circle 140 on Inquiry Card

New Tech Data

for Engineers

Inductors

Vari-L Co., Inc., P. O. Box 1433, Stamford, Conn., has available Cata-log 61 on their electrically-variable inductors. Information includes function of the variable inductor, principles of operation, special types, applications, explanation of tabular data, characteristic curves and dimen-sional drawings.

Circle 445 on Inquiry Card

General Purpose Relays

Branson Corp., 41 S. Jefferson Rd., Whippany, N. J., has tech. data available on their transistor sized general purpose relay Type JR. Specs., char-acteristics, capabilities and dimen-sional diagrams are included. The unit is 0.04 cu. in. and weighs 5 grams. Circle 446 on Inquiry Card

Voltage Regulator

Regohm[®] voltage regulators featuring an accuracy of regulation within for the combined effects of line, load, freq., and power factor variations are described in Condensed Catalog 5.17-1 available from Dept. VA, Electric Regulator Corp., Norwalk, Conn. The Regohm also features in-sensitivity to freq.: 54-66CPS model holds output to $\frac{1}{2}$ % and the 45-1000CPS model holds output to better than 2%.

Circle 447 on Inquiry Card

Toroidal Core Design

Connolly & Co., P.O. Box 295, Menlo Park, Calif., has available "Genalex Toroidal Core Design Handbook," containing basic design information tips and formulas. Included are temp. curves, analysis of core loss, dc resistance, eddy current loss re-sistance, hysteresis loss resistance and sistance, hysteresis loss resistance and self-capacitance.

Circle 448 on Inquiry Card

Resistors

New power metal film resistors which feature inherent stability and the ability to withstand severe environmental conditions are described in bulletin P-9 available from Interna-tional Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. The 3 and 4w. units were developed for most power resistor needs and are low available at wire wound prices.

Circle 449 on Inquiry Card

Resistors

The Daven Co., Livingston, N. J., has available a 17-page tech. brochure covering their precision wire wound resistors. Some of the resistors covered are encapsulated, sub-miniature axial lead types, lug types, high freg., card-type, complex networks, and in-formation on their reliability resistor program.

Circle 450 on Inquiry Card



Your AID is here ... AMPHENOL-BORG INDUSTRIAL DISTRIBUTORS

Amphenol-Borg Industrial Distributors (AID's) are staffed with technical personnel to assist you with your specific application. And each AID is prepared to ship from stock large quantities of many Amphenol-Borg components within their program franchise. The list of AID's below is keyed to the industrial programs for which each distributor is franchised. For fast service call your AID today.

ALABAMA	DISTRICT OF COLUMBIA	MASSACHUSETTS	LYNBROOK, LONG ISLAND	PENNSYLVANIA
BIRMINGHAM MG Electrical Equipment Co.	WASHINGTON Capital Padia Whatagalara	BOSTON DeMembre Redia Supelu Ce	Peerless Radio Dist. Inc.	HARRISBURG
203 S. 18th Street	Capitol Radio Wholesalers 2120-14th Street N. W.	DeMambro Radio Supply Co. 1095 Commonwealth Avenue	19 Wilbur Street LYnbrook 3-2121 P R&P RF	D & H Distributing Co. 2525 North 7th Street
FAirfax 2-6449 B	AD 2-6000 PR&PRF	ALgonquin 4-9000 P R&P RF	MINEOLA, LONG ISLAND	CEdar 6-8001 PR&PRF
ARIZONA	Electronic Wholesalers Inc.	Radio Shack Corp.	Adelphi Electronics	PHILADELPHIA
PHOENIX	2345 Sherman Avenue N. W.	730 Commonwealth Avenue	142 Mineola Blvd,	Almo Radio Co.
Moltronics of Arizona 2746 W. Palm Lane	HU 3-5200 PR&PRFB			913 Arch Street
2740 W. Faim Lane 278-5531 PR&PRF	FLORIDA MELBOURNE	CAMBRIDGE Electrical Supply Corp.	Arrow Electronics, Inc.	WAInut 2-5918 P R&P RF
CALIFORNIA	Electronic Wholesalers Inc.	205 Alewife Bk. Pkwy.	525 Jericho Turnpike Ploneer 6-8686 PR&PRFB	Herbach & Rademan, Inc. 1204 Arch Street
BURBANK	P.O. Drawer 1655	UNiversity 4-6300 PR&PRF	Schweber Electronics	LOcust 7-4309 B
R&C Electronics	1301 Hibiscus Blvd.	NEWTON	60 Herricks Road	Resco, Inc.
2625 West Olive Avenue	PArkway 3-1441 R&P RF	Cramer Electronics Inc. 320 Needham Street	Ploneer 6-6520 PR&PRF	701 Arch Street
Victoria 9-3341 PR&PRFB	WEST PALM BEACH Goddard Inc.	WOodward 9-7700 PR&PRFB	NEW YORK	WAInut 5-5840 PR&PRF
GARDENA Bell Electronic Corp.	P.O. Box 829	NORTH WILBRAHAM	Milo Electronics Corp. 530 Canal Street	PITTSBURGH Cameradio Co.
306 East Alondra Blvd.	1309-1311 N. Dixie	Industrial Components Corp.	BEekman 3-2980 PR&PRF	1121 Penn Avenue
FAculty 1-5802 P R&P RF	TEmple 3-5701 P R&P RF	2805 Boston Road LYric 6-3854 P	Progress Electronics Co.	(412) EX 1-4000 P R&P RF B
GLENDALE	GEORGIA ATLANTA	MICHIGAN	107 Franklin Street	SCRANTON
R. V. Weatherford Co.	Specialty Distributing Co., Inc.	ANN ARBOR	CAnal 6-5611 P R&P RF B	Fred Pursell Co. 1221 North Washington
6921 San Fernando Road Victoria 9-2471 R&P RF	763 Juniper Street N.E.	Wedemeyer Electronic Supply Co.	Sun Radio & Electronics Co. Inc. 650 Sixth Avenue	Dlamond 6-2011 PRF
INGLEWOOD	TRinity 3-2521 P R&P RF	215 North Fourth Avenue Normandy 2-4457 PR&PRF	ORegon 5-8600 PR&PRF	
Newark Electronics Co. Inc.	HAWAN Honolulu	NOrmandy 2-4457 PR&PRF DETROIT	Terminal-Hudson Electronics Inc.	TENNESSEE NASHVILLE
4747 West Century Blvd.	Industrial Electronics	Radio Specialties Co.	236 West 17th Street	Electra Distributing Co.
ORegon 8-0441 R&PRFB	P.O. Box 135 RF	12775 Lyndon	CHelsea 3-5200 P R&P RF B	1914 W. End Avenue
LOS ANGELES California Electronic Supply	ILLINOIS	BRoadway 2-4212 P R&P RF	POUGHKEEPSIE Victory Specialties Co. Inc.	ALpine 5-8444 PR&PRF
11201 W. Pico Blvd.	CHICAGO Allied Electronics Corp.	GRAND RAPIDS Industrial Electronics Supply	105 Dutchess Turnpike	TEXAS
BRadshaw 2-2126 B	100 North Western Avenue	704 Jefferson Avenue, S.E.	GRover 1-3511 R&P RF	ARLINGTON
Federated Purchaser, Inc.	TAylor 9-9100 PR&PRFB	CHerry 1-5695 PR&P	ROCHESTER	Adak Electric Co.
11820 West Olympic Blvd. BRadshaw 2-8771 R&PRF	Merquip Electronics Inc.	MINNESOTA	Rochester Radio Supply Co. Inc.	708 Avenue H East AN 4-1668 PR&PRFB
BRadshaw 2-8771 R&PRF Kierulff Electronics Inc.	4939 North Elston Avenue	MINNEAPOLIS Lew Bonn Co.	600 E. Main Street LOcust 2-0900 PR&PRF	DALLAS
820-830 West Olympic Blvd.	AVenue 2-5400 PR&PRF Newark Electronics Corp.	1211 LaSalle Street	SYRACUSE	Contact Electronics Inc.
Richmond 8-2444 R&P RF	223 West Madison Street	FEderal 9-6351 P R&P RF	Morris Electronics Inc.	2403 Farrington Street
Progress Electronics	STate 2-2944 PR&PRFB	Northwest Electronics Corp.	1153 West Fayette Street	RI 7-9831 P R & P R F
11924 Santa Monica Blvd. BRadshaw 2-0369 RF	OAK PARK	336 Hoover Street, N.E. FEderal 8-7551 PR&PRFB	GRanite 5-3191 P R&P RF	Engineering Supply Co. 6000 Denton Drive
LYNWOOD	Melvin Electronics	MISSOURI	Stewart Smith Inc. 325 Water Street	FL 7-6121 PR&PRF
Moulton Electronics	541 West Madison Street EStebrook 8-7741 PR&PRF	KANSAS CITY	HArrison 2-0323 B	
2909 East Imperial Highway	PEORIA	Burstein-Applebee Co.	YORKVILLE	Midland Specialty Co.
NEvada 6-0647 PR&PRFB	Klaus Radio & Electric Co.	1012 McGee St.	Valley Industrial Electronics, Inc.	500 West Paisano Drive
OAKLAND	403 East Lake Street	BAltimore 1-4266 RF B Walters Radio Supply Inc.	Truck Route 5A	KE 3-9555 R&P RF
Brill Electronics 610 East 10th Street	688-3401 PRF INDIANA	3635 Main Street	RE 6-3392 RF	HOUSTON Busacker Elect, Equip, Co,
TEmplebar 2-6100 RF	INDIANAPOLIS	VAlentine 1-1037 P R&P RF	NORTH CAROLINA WINSTON-SALEM	1216 W. Clay Street
PALO ALTO	Graham Electronic Supply Inc.	UNIVERSITY CITY	Electronic Wholesalers Inc.	JA 6-4661 PR&PRF
Pencor Electronics	122 South Senate Avenue	Olive Electronic Supply Corp. 6662 Olive Blvd.	938 Burke Street	Geophysical Supply Co.
410 Sherman St. DA 6-3366 PR&PRF	MEIrose 4-8486 PR&PRFB SOUTH BEND	Volunteer 3-4051 PR&PRF	PArk 5-8711 P R&P RF	1500 Crawford Street B
RIVERSIDE	Radio Distributing Co.	NEW JERSEY	OHIO	Harrison Equipment Co. Inc. Box 1505
Electronics Supply Riverside Inc.	1212 South High Street	CAMDEN	CINCINNATI Herrlinger Distributing Co.	1422 San Jacinto St.
2486 Third Street	ATlantic 8-4664 PR&PRFB	General Radio Supply Co. Inc.	112 East Liberty Street	CA 4-9131 P R&P
OVerbrook 3-8110 RF		600 Penn Street WOodlawn 4-8560 PR&PRF	GA 1-5282 P R&P RF	
SAN CARLOS Moulton Electronics	CEDAR RAPIDS Deeco, Inc.	Resco, Inc.	Schuster Electric Co.	SALT LAKE CITY
1058 Terminal Way	618 First Street, N.W.	513 Cooper Street	2410 Gilbert Avenue CA 1-6040 P R&P RF	Standard Supply Co. 225 East 6th Street
LYtell 3-7667 PR&PRFB	EMpire 5-7551 PRF	WOodlawn 4-2830 PR&PRF	CA 1-6040 PR&PRF CLEVELAND	Box 1047
SAN DIEGO	KANSAS	MOUNTAINSIDE Federated Purchaser Inc.	Pioneer Electronics Supply Co.	ELgine 5-2971 PR&PRFB
Radio Parts Co. Inc. 2060 India Street	WICHITA Interstate Electronic Supply	1021 U.S. Route 22	5403 Prospect Avenue	WASHINGTON
BEImont 2-8951 PR&PRF	230 Ida Street	ADams 2-8200 PR&PRFB	432-0010 PR&PRF	BELLEVUE
SAN FRANCISCO	HObart 4-6317 R&P P RF	PENNSAUKEN	Radio & Electronic Parts Corp.	Farwest Electronics Co. 12410 S.E. 32nd St.
Pacific Wholesale Co.	Radio Supply Co.	Alpha Electronics Services 5817 Roosevelt Ave.	3235 Prospect Avenue ST 1-6060 B	GLencourt 4-7905 PR&PRFB
1850 Mission Street UNderhill 1-3743 PR&PRF	115 Laura Street P.O. Box 1220 B	NOrmandy 2-1310 P R&P RF	DAYTON	WEST VIRGINIA
Zack Electronics	LOUISIANA	NEW MEXICO	Srepco, Inc.	CHARLESTON
1422 Market Street	NEW ORLEANS	ALBUQUERQUE Radio Specialties Co. Inc.	314 Leo Street	Chemcity Elect. Dist. 1637 Fourth Avenue
MArket 1-1424 RF	Electronic Parts Corp.	Radio Specialties Co., Inc. 6323 Acoma Road, S.E.	(513) 224-3871 P R&P RF B	1637 Fourth Avenue Dickens 2-8151 PR&PRFB
COLORADO DENVER	3622 Toulouse Street HU 6-3777 PR&PRF	AM 8-3901 PR&PRFB	OKLAHOMA Tulsa	WISCONSIN
Denver Electronic Supply Co.		NEW YORK	Radio, Inc.	MADISON
2170 South Grape	MARYLAND BALTIMORE	BINGHAMTON Federal Electronics Inc.	1000 South Main Street	Satterfield Electronics
SKyline 7-3351 BPR&PRF	Kann-Ellert Elect, Inc.	P. O. Box 208	LU 7-9124 P R & P R & P R F	1900 South Park Street
	2050 Rockrose Avenue	Ploneer 8-8211 PR&PRFB	OREGON	ALpine 7-4801 PR&P
NEW HAVEN Connector Corp.	TU 9-4242 P R&P RF B Westinghouse Electric Supply	BUFFALO	PORTLAND	MILWAUKEE
137 Hamilton Street	1710 Edison Highway	Genesee Radio & Parts Co. 2550 Delaware Avenue	Lou Johnson Co. Inc. 1506 N. W. Irving	Radio Parts Co., Inc. 1314 North 7th Street
SPruce 7-2513 P R&P RF	327-4300 PR&PRF	TR 3-9661 PR&PRFB	CApitol 2-9551 P R&P RF	BRoadway 6-4160 PR&PRF

- P-Primarily cylindrical Power Connectors such as AN/MS, MS-E, MS-R, 7, 48, 67, 89, 165, 172 and 182 Series Connectors. Also 115 Series rectangular Connectors and 294 Series Tools.
 B-Borg Micropot® Precision Potentiometers, Micro-pot® Trimmers, Microdial® Turn Counting Dials and Small Instrument and Control Motors.

R & P-All Amphenol Rack & Panel, Printed Circuit and Micro Miniature Connectors including Blue Ribbon®, Micro Ribbon®, Min-Rac 17®, Micro Mod@, Micro Min®, and Micro Edge®, 26, 57, 64, 74, 94, 96, 126, 133, 143 Series Connectors and Series 294 Tools.
 R F-All Amphenol and ipc RF Connectors, DK Coaxial Switches and Amphenol Teflon Coaxial Cable.

GENERAL LINE-In addition to Amphenol's Industrial Distributors there are more than 650 Amphenol General Line Distributors who handle Series 83 UHF Connectors, Tube Sockets and Shields, Coaxial Polyethylene and Polyfoam® Cable, Mili-tary and Commercial Tip Jacks, Microphone Connectors and 120/220 volt Plugs and Receptacles.

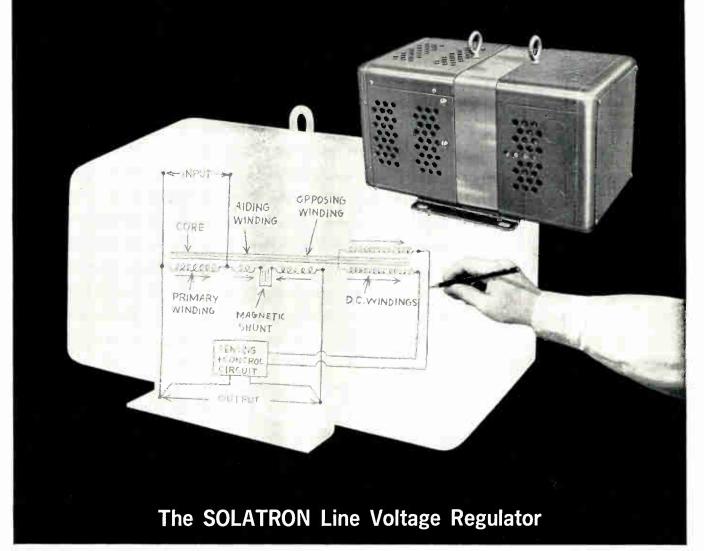
FNOL Distributor Division / Amphenol-Borg Electronics Corporation

2875 South 25th Avenue, Broodview, Illinois, COlumbus 1-2020, Area Code 312, or TWX: Moywood 1069

ELECTRONIC INDUSTRIES . June 1962

Circle 142 on Inquiry Card

A new concept in line voltage regulation in the KVA range...



Sola now has developed a new uncomplicated breed of line voltage regulators. Up to 10 times faster than mechanical regulators, the new SOLATRON Line Voltage Regulator features no moving parts, lower operating cost per KVA, and is maintenance free!

Designed to cover the 3-100 KVA range, the SOLATRON Line Voltage Regulator offers corrective action the instant output departs from nominal ... long before voltage even approaches boundaries of the regulation envelope! Output holds *stable* in the face of leading and lagging power factors. Efficiency -95% at full load.

For more information on the new SOLATRON Line Voltage Regulator, send requests, on company letterhead, direct to our factory address.

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• EXCELLENT REGULATION — $\pm 1\%$ from nominal, for any combination of line, load, and frequency change within specified parameters.

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ELECTRONIC INDUSTRIES · June 1962

Vacuum Tube Circuits for the Electronic Experimenter

By Julian M. Sienkiewicz. Published 1961 by Ziff-Davis Publishing Co., One Park Ave., New York 16, N. Y. 192 pages. Price \$4,95.

The experimenter can find in this book all the basic diagrams, schematics, and other vital information on vacuum tubes and their circuits to use in building a piece of electronic equipment.

Beginning with the Edison effect, the author leads the experimenter right up to the multi-element vacuum tubes used in everyday circuits. Vacuum-tube circuit design is described in clear, concise terms. Plate resistance, transconductance, gain load lines, characteristic curves, and the like are clarified as useful tools for experimenters.

Computer Programming Handbook: guide for beginners

By Robert Nathan & Elizabeth Hanes. Published 1961 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 214 pages. Price \$7.65.

Written especially for the beginner, this handbook provides a sound, practical approach to initial background knowledge in the field of computers. Specific machine operations of the major computers on the market are explained in clear, simple language.

The IBM 650 and 704, the Burroughs 220 and the Univac 1103A Scientific were selected as representative of the two major types of computers-binary and decimal. Fundamental principles of programming are related to each machine and the reader becomes familiar with the actual console, buttons, and commands of each type of computer. Only the most important features are stressed since anyone interested in more advanced programming and the use of computers may refer to the manuals issued by the individual companies.

Understanding Financial Statements and Corporate Annual Reports

By L. O. Foster. Published 1961 by Chilton Co., Book Div., Publishers, 56th & Chestnut Sts., Phila. 39, Pa. 135 pages. Price \$3.95.

Major investors and stockholders, both private and institutional, base their decisions to buy, sell or hold securities primarily on careful analyses of companies' financial statements. The small investor, on the other hand, has traditionally been guided by tips, hunches, brokers advice, and advertisements. Today, however, he is coming to realize that he cannot invest wisely without reading and understanding corporate financial state-ments. This is particularly true of members of the thousands of investment clubs functioning throughout the country. This book enables anyone, without previous training and with minimum effort, to interpret and understand the meaning of a financial report.

Modulation and Coding in Information Systems

Books

By Gordon M. Russell. Published 1962 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 260 pages. Price \$10.00.

Emphasis is placed on a logical development of the principles and general methods which apply to information processes of all kinds. The graduate engineer, seeking additional knowledge or in need of a refresher course in the electronic systems area, will find this text particularly appropriate for independent study.

1962 International Solid-State Circuits Conference Digest of Technical Papers

Published 1962 by Lewis Winner, 152 W. 42nd St., New York 36, N. Y. 112 pages. Priced at \$5.00 each, copies may be abtained from H. G. Sparks, The Moore School of Electrical Engineering, Univ. of Penna., 200 S. 33rd St., Phila. 4, Pa.

Forty-six papers were presented at the conference on subjects which included logic, microwave parametric circuits, new devices and device characterization, memory, high - speed switching, low - noise amplification, tunnel-diode applications, digital transmission, functional components, and design applications.

Fundamentals of Rockets, Missiles, and Spacecraft

By Marvin Hobbs. Published 1962 by John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y. 272 pages. Price \$8,95.

Book covers the theory and application of the basic elements of rockets, missiles and propulsion systems for space vehicles as well as both manned and unmanned spacecraft. Fundamentals of solid and liquid propellants, rocket engine components, basic rocket and missile elements, aerodynamic shapes of vehicles and nose cones, guidance and telemetry are covered prior to the treatment of missile and space rocket classes and types.

Statistical Analysis and Optimization of Systems

By E. L. Peterson. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 190 pages. Price \$9.75.

Book deals with a subject of paramount importance in the development of automatic control systems — the theory and methods underlying the analysis, synthesis, and optimization of systems in which statistical uncertainty is involved in the process dynamics. It clearly formulates the problems which the subject involves, and shows the great progress that has been made toward their solution through recent theoretical advances and the growth of computer technology.

Thermal Conduction in Semiconductors

By J. R. Drabble & H. J. Goldsmid. Published 1961 by Pergamon Press Itd., Headington Hill Hall, Oxford, England. 235 pages. Price \$10.00.

Recent developments in the field of thermoelectric devices have indicated a great need for a more fundamental understanding of thermal conduction processes in semiconductors, since these processes have a profound influence on all efficiency considerations. Because some of the materials concerned are available in highly pure and well ordered form, they are specially suitable for investigations of this kind. Present volume covers theoretical as well as practical aspects of these problems, including the techniques of measurement.

Satellite Tracking

By Stanley Macko. Published 1962 by John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y. 178 pages. Price \$5.50.

Book explains how and why satellites are launched, why they behave as they do, and how the orbital elements of any terrestrial satellite can be derived with a minimum of data. The information and calculations presented in this book may, for the most part, also be applied to the field of guided missiles, and thus will also provide the reader with an understanding of missile trajectories.

Coding Theorems of Information Theory

By J. Wolfowitz. Published 1962 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 125 pages. Price \$9.35.

This monograph describes and proves most of the known existence theorems of information theory. It begins from first principles and requires no prior knowledge of information theory.

Among channels discussed are: the discrete memoryless channel, compound channels, channels with stochastically determined states, channels with memory, semicontinuous and continuous channels.

Static Fields in

Electricity and Magnetism

By D. H. Trevena. Published 1961 by Butterworth Inc., 7235 Wisconsin Ave., Washington 14, D. C. 255 pages. Price \$6.50.

Book is concerned with the three main topics of electrostatics, magnetism and the magnetic fields of steady electric currents. Use of such concepts as the magnetic pole and the magnetic shell have been included. Problematic question of units, including M.K.S. units, is fully discussed and worked examples have been included throughout.

New Tech Data

Capacitors

A precision calibrated standard capacitor, hermetically sealed, compact size, with a tolerance $\pm 0.05\%$, is described in tech data available from Balco Capacitors, div. of Balco Re-search Laboratories, Inc., 49-53 Edi-son Place, Newark 2, N. J. The capacitor is for such uses as tuned circuits, filter networks, timing devices and computer applications.

Circle 613 on Inquiry Card

Terminals/Connectors

This 68-page catalog gives detailed information on a line of terminals and connectors including male and female quick-connect terminals in single and multiple styles; printedcircuit edge terminals; ring, space, taper, solder, and screw terminals; and a wide selection of adaptors to accommodate different terminal styles and circuits. Information is also included on terminal boards and on various automatic devices for attaching terminals. Ark-Les Switch Corp., 51 Water St., Watertown 72, Mass. Circle 614 on Inquiry Card

Tube Catalog

This 33-page, condensed tube catalog is available from Amperex Eleclog is available from Amperex Elec-tronic Corp., 230 Duffy Ave., Hicks-ville, L. I., N. Y. Tubes covered in-clude: cold cathode trigger; enter-tainment and audio; ignitrons; klys-trons; magnetrons; power; photo-multiplier; thyratrons; TWTS; mi-crowave triodes and UHF special purpose types Write for the catalog purpose types. Write for the catalog under company letterhead. Circle 615 on Inquiry Card

R-F Connectors

Tech. data. brochure SL-121, on the BRM and BRMM series of r-f con-nectors is available from the Scintilla Div. of the Bendix Corp., Sidney, N. Y. The max. VSWR of both connec-tors is 1.1:1 over the freq. range of 1 to 10GC. The BRM is 1/28 and the BRMM is 1/48 the size of the standard N type connectors. Circle 616 on Inquiry Card

Standoff Terminals

This 20-page illustrated catalog lists 350 molded, insulated standoff terminals and is available from Elec-tronic Molding Corp., 40 Church St., Pawtucket 10, R. I. Information on insulating materials, coding colors, selection of terminal and mounting platings, and specs. are included. Circle 617 on Inquiry Card

Microcircuits

Varo Inc., 2201 Walnut St., Gar-land, Tex., is offering a catalog on its microcircuitry devices, now avail-able as standard circuits. Featured in the catalog is data on digital, computer, control and audio freq. circuits. Photographs, complete specs. and prices are included.

Circle 618 on Inquiry Card

High Voltage Components

Components For Research, Inc., 979 Commercial St., Palo Alto, Calif., has a brochure available on High Volt-age Epoxy Resin Insulators, Feed-through Bushings, Very-High-Voltage Coax Terminations, and Hermetic-Seal Feed-through Bushings. Photographs, specs and line drawings are included.

Circle 619 on Inquiry Card

Bearings

Both flanged and sleeve bearings listed in bore ranges from 0.0469 to 0.3127 are contained in a catalog available from Northfield Precision available from Northfield Precision Instrument Corp., Island Park, L. I., N. Y. Bores, outside dia. and con-centricities are maintained to toler-ance of 0.0002 in. The information covers Northfield's complete line of miniature precision sintered bronze Microspin bearings. Catalog No. 461. Circle 620 on Inquiry Card

Printed Circuits

"Military Specifications on Printed Circuits" contains information on the early efforts by the Armed Forces to establish standards and specs. on printed circuit design and manufacture. Also included are the current of specifications covering: and definitions (Mil-STD-base materials (Mil-Pgroup terms 429A) 13949B), design standards (Mil-STD-275A), and manufacture and quality control (Mil-P-55110). This 12-page booklet is available from Arthur Ansley Mfg. Co., New Hope, Pa.

Circle 621 on Inquiry Card

AC/DC Power Supplies

A line of over 375 models of ac and de power supplies is described in short form catalog No. 1200 available from Behlman-Invar Electronics Corp., 1723 Cloverfield Blvd., Santa Monica, Calif. Information is included on a series of 54 modular supplies for data processing and ground support applications. Circle 622 on Inquiry Card

for Engineers

Capillary Tubes

A 4-page tech. bulletin on tungsten carbide semiconductor lead bonding capillary tubes is available from Tempress Research Co., Inc., 566 San Xavier Ave., Sunnyvale, Calif. In addition, a section is devoted to a discussion of the thermal compression "nail head" lead bonding process used in the manufacture of semiconductors. Circle 623 on Inquiry Card

Piezo Ceramics

Tech data on piezoelectric transducer elements, high alumina ceramics, 9-96-99% alumina vessels, metalized ceramics, and high alumina custom shapes, is available from Electro-Ceramics, Inc., 2645 So. 2nd West, Salt Lake City 15, Utah. Information includes:properties; photographs; uses; design suggestions and a list of terms and definitions.

Circle 624 on Inquiry Card

PC Connectors

This 36-page, 3-color catalog contains complete information on printed circuit connectors. Information includes outline drawings, electrical and mechanical specs., illustrations and uses. The product line covers microminiature, miniature and standard modating 1/32, 3/64, 1/16, 3/32, and % in. boards. Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y.

Circle 625 on Inquiry Card

Control Knobs

Tech. data including a complete control knob guide is available from National Radio Co., Components Div., Dept. P, Melrose 76, Mass. Data Sheet CO-9 gives full specifications, photos and diagrams on a complete line of knobs.

Circle 626 on Inquiry Card

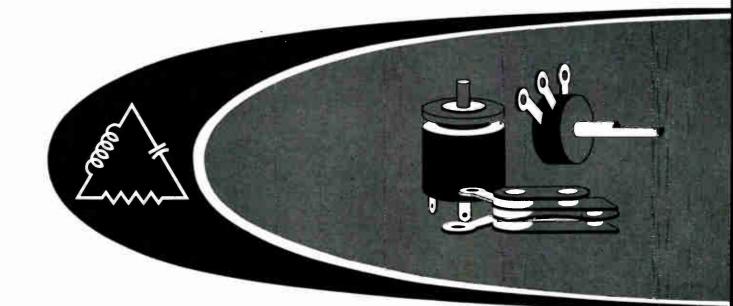
Zone Melting

Zone melting apparatus for precise control in solid state purification in zone refining, zone melting and crystal pulling is described in a Technical Review Vol. 2, No. 4 available from Research Specialties Co., 200 So Garrard Blvd., Richmond, Calif. Circle 627 on Inquiry Card

ADS OF INTEREST IN OTHER SECTIONS . . . dealing with "Electronic Components" Tung-Sol Electric Co.p. C62, C63



Electromechanical Components



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16

ELECTROMECHANICAL COMPONENTS

Specifying the Fractional



Fig. 1: Subminiature 400 CPS motor, the 25100 series, features almost instantaneous starting and stopping. Operating voltage is 115 v; current 20 ma. Power input is 3w max.; torque rating is 0.01 oz-in at 3000 RPM starting and running. Applications are in control systems in aircraft and guided missiles, in repeat cycle timers, time delay relays, and elapsed time indicators. Courtesy of A. W. Haydon Co.

E LECTRONIC engineers find many uses for small fractional-horsepower motors, ranging from fan drives for cooling electronic equipment to automatic control systems where the speed or angular position of a shaft must be accurately controlled.

The design engineer looking for a small motor can rely on the many reputable U. S. motor manufacturers¹ to supply him with a motor which will precisely fit his needs. Most manufacturers have a wide variety of models to choose from and can meet virtually any special combination of electrical and mechanical specifications.

Electric motor theory can be rather complicated, and the design of these motors should be left to those engineers who are experts in this field. But, the engineer who uses these motors should know the differences between the several types of motors and their advantages and limitations.

1. See the list of manufacturers at the end of this article or consult the "Directory" section of this issue of ELECTRONIC INDUSTRIES.



Fig. 2: Precision hysteresis synchronous motor. Motor-induced flutter will not exceed 0.1 rms at 1200 rpm or 0.15 rms at 360 rpm. They will withstand temperature ambients from -32 to 135 C. Applications include tape transports, turntable drives, missile instrumentation, and computer drum drives.

Courtesy of Hysyn Electromotive, Telecomputing Corp.

Types of Motors

The principle working parts of electric motors are the armature and field windings. Current—either ac or dc—is fed to, or induced into, both of these windings. These current carrying windings are in a rotating magnetic field, and since a mechanical force is exerted on a current carrying conductor in such a field, torque is produced.

There are three major classes of motors: synchronous and induction motors (both ac), and dc motors.

A synchronous motor is a motor whose speed is directly related to the powerline frequency and the number of field poles. For example, from a 60 CPS line, a two-pole motor will run at 3600 RPM, a four pole motor at 1800 RPM, and a six-pole motor at 1200 RPM.

If the line frequency is 400 CPS, the speeds for the above number of poles are 24,000, 12,000, and 8,000 RPM.

In the induction motor, ac is fed directly to the

The design engineer has a wide variety of motors to choose from. But one motor is best for his job. The user should be ready to answer questions on all details of how the motor will be used. Lack of detailed information may result in his getting a too-expensive motor or one that will fail under abnormal operating conditions.

Horsepower Motor



Fig. 3: Hysteresis synchronous motor provides high efficiency, noiseless operation. It operates at 14,400 rpm from a transistorized power supply, 30 v, 240 cps, 2-phase.

Courtesy of EMC Components Inc.

stationary (stator) windings and induced into the rotating (rotor) windings.

The third type of motor is the dc motor. Here dc is supplied to both windings. Lets take a quick look at each of these three classes of motor.

Induction Motors

In the induction motor, the power source is connected only to the stator windings. The current in the rotor is induced (transformer action). When a polyphase voltage is applied to the stator, a rotating magnetic field is produced, a voltage is induced in the rotor, and current flows in the rotor conductors. This condition: a current in a conductor in a rotating magnetic field, produce a force tending to move the conductor at right angles to the field and the current. These motors operate at a speed less than synchronous speed. The fraction by which the speed differs from synchronous speed is called the slip.

The rotor of this type of motor may have windings



Fig. 4: Gear motor uses a unique rectangular field stack coupled with toroidal field windings. The 1 and $\frac{1}{4}$ lb unit delivers 1/10 hp continuous duty $\frac{1}{4}$ hp intermittent duty. Unit illustrated incorporates a 3:1 gear reduction and delivers approx. 22 in-oz torque at 3 and $\frac{1}{2}$ a,27 vdc.

Courtesy of The Bendix Corp., Bendix-Pacific Div.

on it similar to the stator windings. This is called a wound-rotor. The rotor windings can either be closed on themselves or connected through slip rings and brushes to external resistances. These resistances may be varied to adjust the motor speed-torque-current characteristics.

A second type of rotor construction is the squirrelcage rotor. This type of rotor has slots punched on its laminations. Bare copper bars are secured in the slots and connected at the ends with copper rings. The bars are often slightly skewed to reduce hum. The extreme simplicity and economy of this construction has made it the most common type of rotor.

Most small induction motors are powered from a single-phase source. A single-phase motor does not develop a rotating magnetic field, so it has no starting torque, but once started, it will continue to run. The method used for starting is another way to classify these motors.

Common types of small, single-phase induction motors—based on their method of starting—are: the split-phase; capacitor-start; permanent-split-capacitor; two-valve-capacitor; and the shaded-pole motor. Fig. 5 shows the schematics for these motors.

The Split-Phase Motor

This is a single phase induction motor with two windings on the stator connected in parallel. One winding, the auxiliary winding, is displaced nearly 90 electrical degrees from the other. (a 90° difference is ideal but not easily obtained or necessary) The auxiliary winding has a higher resistance-to-reactance-ratio than the main winding. This is obtained by using fewer turns of smaller size wire. Splitting the field windings in this manner produces the phase difference noted above and results in a rotating magnetic field. With the rotating magnetic field, all conditions necessary to produce a starting torque are present.

The auxiliary winding is used only to start the motor. When the motor approaches synchronous speed, the auxiliary winding is not needed as the motor will develop good running torque. An automatic centrifugal switch is built into the motor to disconnect the auxiliary winding from the circuit when a high enough speed has been reached.

Both standard and special purpose types of splitphase motors are built. The standard type is used for applications requiring frequent starts and long operating periods. Special purpose types are designed for high starting torques. Standard types have lower operating costs but higher initial costs. They are quieter operating than the special purpose types.

The split-phase motor is generally built for nonreversing service because the auxiliary winding must be connected to give direction to the rotor. This means that the motor would have to decelerate until the centrifugal switch closed. They can easily be built to reverse from the stop position, and special switching arrangements have been designed to allow connecting

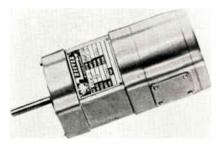


Fig. 6: Lightweight dc motor features 0.33 hp at 8400 rpm and 0.50 hp at 7700 rpm. It is a totally enclosed explosionproof motor designed to Mil-M-8609 and Mil-E-5272A.

> Courtesy of Hoover Electric Co.



Fig. 7: Universal motor, Model SMZ, develops 1/4 hp, 27.5 v, 11a, 4500 rpm at 30 oz-in. Starting torque is 36 oz-in. It is 4 and 1/8 in. in dia. and about 4 and 3/4 in. long.

> Courtesy of Small Motors, Inc.

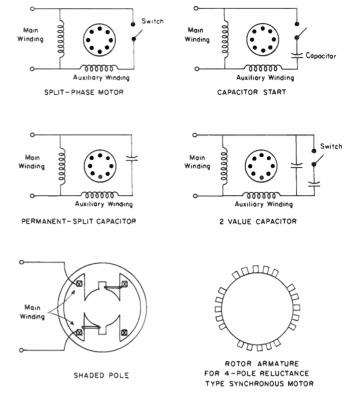


Fig. 5: Starting methods for single-phase fractional hp motors.

the auxiliary winding while the motor is running at full speed and thus permit reversing.

Figure 2 illustrates a split-phase motor built by the A. W. Haydon Co., Waterbury, Conn.

The Capacitor-Start Motor

The principle used to start this motor is the same as for the Split-Phase types, but the electrical displacement of the two stator windings is obtained by connecting a capacitor in the auxiliary winding. The phase difference using a capacitor can be made to approach 90° which makes the motor, essentially, two-phase.

Once the motor has been started, the capacitor is disconnected. A relatively inexpensive capacitor may be used, but precautions should be taken to insure that they are properly applied.

The running characteristics of capacitor-start motors are similar to those of the split-phase types but the starting torque is much higher than the starting torque of split-phase motors; the same restrictions apply as to reversing.

These motors are used where economy is wanted in a quiet operating motor with high starting and pull-in torque and low starting current.

The Permanent-Split-Capacitor Motor

Capacitor-start motors (See Fig. 11) can be simplified—and are less expensive—if the switches for disconnecting the capacitor at running speeds are eliminated. Leaving in the capacitor also improves the efficiency of the machine and makes it smoother and quieter running.

A more expensive capacitor must be used, however. The capacitor used is designed for good operation at normal running loads, and starting torque is reduced. The best features of both are combined in a motor

ELECTROMECHANICAL COMPONENTS

which uses two capacitors, one for starting (which is then disconnected) and one for running speeds.

This motor is fairly quiet and it can be reversed while running provided it is connected to a low inertia load.

If two capacitors are used, the reversing and starting characteristics are similar to the capacitor-start motor, and the running characteristics are similar to the two-phase motor.

The Shaded-Pole Motor

This type of motor generally has salient poles². One section of each pole is wound with a short-circuited turn called a shading coil. This winding is displaced magnetically from the main coil since the flux caused by the induced current in the shaded portion lags the flux generated by the main coils. The result is a rotating magnetic field—an imperfect rotating field but one sufficient to produce a starting torque. With the motor running, induced currents in the rotor maintain the field and running torque.

This type of motor is rather simple and is inexpensive to build but its efficiency is very low. They are generally not reversible and starting torque is low.

Synchronous Motors

These motors operate at a speed proportional to the frequency of the applied voltage. They are generally less efficient than induction-type motors. The two types of synchronous motor most often used in fractional-horsepower applications are the "reluctance" type and the hysteresis-type motor. (See Fig. 5).

The Reluctance Motor

Most fractional-horsepower induction motors can be made into synchronous reluctance motors. The motors are modified so that the reluctance of the magnetic circuit depends on the angular position of the rotor with respect to the stator coil axis. The rotor is built so that there are alternate high and low reluctance areas around the periphery of the motor. This, in effect, creates salient poles on the rotor. One way to do this is to remove some of the teeth and bars from a squirrel-cage rotor (leaving in the other bars and the end rings). Another way is to mill shallow grooves in the rotor.

The minimum value of reluctance is called the "direct-axis reluctance." The maximum value is called the "quadrature-axis reluctance." The applied excitation being ac, the flux in the air gap is alternating and the rotor will try to align itself in a position of minimum reluctance with respect to the flux wave.

The torque is developed only at synchronous speed, so the reluctance motors are not self-starting. This type of motor, however, is usually designed to start as an induction motor; when synchronous speed is

 2 In a salient pole machine, the poles are concentrated into confined arcs, and the windings are wrapped around these poles instead of being distributed in a series of slots around the machine.

Fig. 8: Breakdown torque for small single phase induction motors. NEMA standards.

Small power single phase induction motors shall be rated primarily on the basis of breakdown torque. The value of breakdown torque for the purpose of defining horsepower rating shall fall within the indicated range.

synchronous speed approx. full load, rpm	3600 3450	3000 2850	1800 1725	1500 1425	1200 1140	1000 950	900 850
brake hp rating	breakdown t	orque in ounce	feet				
1/20 1/12 1/8 1/6 1/4 1/3 1/2 3/4 1	$\begin{array}{c} 2.0-3.7\\ 3.7-6.0\\ 6.0-8.7\\ 8.7-11.5\\ 11.5-16.5\\ 16.5-21.5\\ 21.5-31.5\\ 31.5-44.0\\ 44.0-58.0\\ \end{array}$	$\begin{array}{c} 2.4-4.4\\ 4.4-7.2\\ 7.2-10.5\\ 10.5-13.8\\ 13.8-19.8\\ 19.8-25.8\\ 25.8-37.8\\ 37.8-53.0\\ 53.0-69.5\end{array}$	4.0-7.1 7.1-11.5 11.5-16.5 16.5-21.5 21.5-31.5 31.5-40.5 40.5-58.0 58.0-82.5	4.8-8.5 8.5-13.8 13.8-19.8 19.8-25.8 25.8-37.8 37.8-48.5 48.5-69.5 69.5-99.0	$\begin{array}{c} 6.0 - 10.4 \\ 10.4 - 16.5 \\ 16.5 - 24.1 \\ 24.1 - 31.5 \\ 31.5 - 44.0 \\ 44.0 - 58.0 \\ 58.0 - 82.5 \end{array}$	7.2-12.4 12.4-19.8 19.8-28.9 28.9-37.8 37.8-53.0 53.0-69.5 69.5-99.0	8.0-13.5 13.5-21.5 21.8-31.5 31.5-40.5 40.5-58.0 58.0-77.0

note: Breakdown torque range includes the higher figure, down to, but not including, the lower figure.

Courtesy of Westinghouse Electric Co.

Fig. 9: Effect of Variations in Voltage and Frequency: ac induction motors. NEMA standards.

This table shows the effect of variations of voltage and frequency when induction motors are operated under conditions different from their rated nameplate characteristics. Caution: These values are approximate and are not to be considered as guarantees.

		speed	full	percent	torque*	current		full	full	temp.	momen-	magnetic
tion		syn- chronous	load	slip	starting & maximum running	starting	full load load effi- ciency		load power service	rise	tary overload capacity	noise
frequency voltage	110%	no change	slight increase	decrease 17%	increase 21 <i>%</i>	increase 10%	decrease	slight increase	slight decrease	slight decrease	increase 21%	slight increase
	90 <i>%</i>	no change	slight decrease	increase 21 <i>%</i>	decrease 19%	decrease 10%	increase	slight decrease	slight increase	slight increase	decrease 19%	slight decrease
	105%	increase 5%	increase 5%	little change	slight decrease	slight decrease	slight increase	slight increase	slight increase	slight decrease	slight decrease	slight decrease
	95 <i>%</i>	decrease 5%	decrease 5%	little change	appreciable increase	slight increase	slight increase	slight increase	slight decrease	slight increase	slight increase	slight increase

The starting and maximum running torque will vary as the square of the voltage. The speed will vary directly with the frequency.

Courtesy of Westinghouse Electric Co.

reached, the rotor poles will line up with the field and the motor will continue to run. Very small motors of this type can be started by spinning the shaft; at synchronous speed, the motor will "pull into step" and continue to run. The motor can stall if an excessive overload is applied which drops the speed much below synchronous speed.

Efficiency is low compared to similar type induction motors and they may tend to vibrate.

The Hysteresis Motor

The simplest type of hysteresis motor has a smooth cylindrical rotor made of a hard magnetic material. There are no windings on the rotor; poles are created by the hysteresis effect. The windings of the stator are distributed-type windings and are designed to produce a sinusoidal rotating flux field. Any of the previously discussed methods of obtaining a rotating flux field can be used.

The hysteresis effect in the rotor causes its magnetization to lag the inducing magnetomotive force wave. A relatively large hysteresis loss occurs with a corresponding torque to supply the loss.

One advantage of the hysteresis motor is that it develops consistant torque from starting to synchronous speed and can synchronize any load which it can accelerate. It is a quiet and smoothly operating motor but it is not very efficient and can handle only relatively light loads.

The motor can be designed for reversing service. It can reverse either from the stopped position or while rotating. The motors are quieter and smoother operating than the reluctance synchronous motors just described.

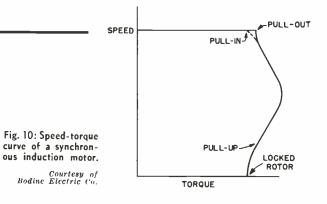
DC Motors

There are three general types of dc motors; the series-wound motor; the shunt-wound motor; and the compound-wound motor.

Advantages of dc motors include the wide range of load-voltage and load-speed characteristics which may be obtained and the ease with which dc motor speeds may be controlled. Quite often, ac is converted to dc so that a controllable dc motor may be used.



Fig. 11: Permanent-Split capacitor motor. Courtesy of Bodine Electric Co.



The Shunt-Wound Motor

In the shunt-wound motor, the rotating windings (usually the armature) and the stationary windings (usually the field) are connected in parallel.

These motors have fairly constant speeds which vary only slightly with a change in load (a small decrease in speed), and starting torque is moderate to high. The motors may be reversed either when rotating or when stopped by changing the input connections.

The speed of the motor can easily be controlled over a wide range. Either series or shunt resistors can be inserted in the armature circuit for speed control or a combination of series and shunt resistors may be used. Speed can also be controlled by inserting resistance in the field circuit but there is a limit to the speed variation because the armature current may become excessive.

The Series-Wound Motor

The field windings and the armature windings in this type of motor are connected in series. The starting torque is very high, starting current is medium, and there is a very large variation of speed with load (the lighter the load, the higher the speed).

The simplest way to control the speed is to insert a variable resistance in series with one of the leads. The no-load or light load speeds can be excessive and provisions should be made to control the motor under these conditions—a common practice is to use this type of motor in applications where the load is permanently connected to the motor.

Series wound motors can be built for reversing service, but the resulting motor is not as efficient as one built for rotation in one direction only.

Series motors can operate on ac or dc provided both stator and rotor cores are laminated but the speed and torque are greater when operated on dc. These "universal" motors are used where a light weight motor operating at very high speeds is wanted. The speed when used for ac service tends to be lower because of reactance-voltage drops in the field and the armature, but the difference can be minimized with compensating windings.

These motors are normally used for intermittent service applications because of the wear on the brushes and bearings at high speeds. They also tend to be rather noisy.

The Compound-Wound Motor

One of the windings in the compound-wound motor (usually the stator-or field winding) is in two sections. One of these section is connected in series with the armature and the other is connected in parallel with the armature.

The variation in speed with load depends on the relative strengths of the series and shunt fields. For example, if only a light shunt field is used, the motor characteristics are similar to a series-wound motor except that the shunt winding will limit the no-load speed to a controllable value.

These motors may be reversed by reversing the current through the armature. The reversing characteristics are better than those of a shunt wound motor

Other Motors

4520T.

In addition to the motors described in the preceding sections, wide use is made of special motors for special functions. Two of these are the "Servo Motor" and the "Torque Motor."

The Servo motor is a complete subject in itself, and space does not permit a detailed analysis of this motor. Basically, servo motors are characterized by their low rotor inertia, high speed response, and by having speeds proportional to the applied voltage.

Servo motors are usually two-phase induction motors. One phase is always energized, and when motion is required, a voltage is applied to the other phase (the control phase).

Torque motors (See Fig. 13) are used to supply torque either when stalled or turning at very low speeds. They are usually designed so that they may be stalled continuously. They can be designed for single-phase, poly-phase, or dc operation.

Standards

The horsepower rating alone of a fractional horse-

Fig. 13: Torque motor, model FBTis used in reel take-ups in data recording equipment. Courtesy of IMC Magnetics Corn.

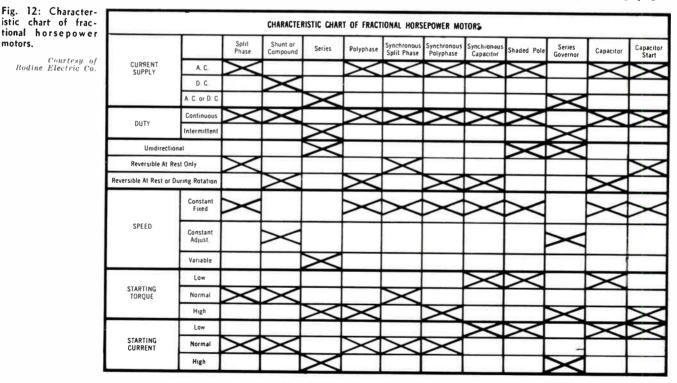
power motor will generally not completely describe its capabilities. Other indications of a motor's performance are: breakdown torque; locked-rotor torque; starting current; and service factor. The user should consult the appropriate NEMA (National Electrical Manufacturer's Association) standard to determine the range of values for standard motors.

Breakdown torque is the maximum torque a motor will develop without an abrupt decrease in speed. For different types of motors, NEMA divides breakdown torque into bands for the various horsepower ratings. Fig. 8 shows the adopted standards.

Locked-rotor torque (also called starting torque) is the torque developed by a motor at standstill. (See Fig. 10)

Service factor is a measure of the overload capabilities of the motor. The horsepower rating, multiplied by the service factor, determines the maximum continuous safe load of a motor. A factor which must be considered when operating a motor at overload conditions is the insulation life since the insulation is being subjected to higher operating temperatures.

Fig. 9, from Westinghouse Electric Co.'s, Brochure No. 2800, shows the effect on induction motors of variation in voltage and frequency from rated nameplate characteristics. (Continued on following page)



Motor Enclosures

The environment in which the motor will operate will determine which type of enclosure is needed.

If the motor is to be operated in a fairly clean and dry atmosphere free from explosive particles or gases, an *open-type* motor will generally be sufficient. This type of motor can be *self-ventilated* by building a fan on the rotor shaft. Another type of open motor is the *drip-proof* motor. This motor is built so that moisture or dirt striking the motor at an angle not greater than 15° from the vertical will not enter the motor.

If the motor is operating in an atmosphere where dust or other foreign particles can enter the motor, a *totally-enclosed* motor should be used. In this type of motor, no air is exchanged between the inside and the outside of the case, but it is not so completely sealed as to call it airtight.

Splash-proof motors are built to prevent liquids or solid particles striking the motor at an angle not greater than 100° from the vertical from entering the motor.

If the motor is to be used where explosive gases are present, an *explosion-proof* machine (See Fig. 14) must be used. These motors are designed to prevent sparks, flashes, explosions, etc. within the motor from igniting the external gasses. The motor is also designed to withstand an explosion of the gas or dust inside of the motor.

If the motors are to be operated in hazardous locations, the National Electric Code Classification (Article 500, sections 5002 and 5006) requires special motor construction and Underwriters Laboratories approval. Explosive atmospheres are defined as follows:

Class 1, group A—Atmospheres containing acetylene

Class 1, group B—Atmospheres containing hydrogen or gases or vapors of equivalent hazard such as manufactured gas.

Class 1, group C—Atmospheres containing ethylether vapor.

Class 1, group D—Atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors and natural gases.

Class 2, group E—Atmospheres containing metal dust such as magnesium, aluminum, etc.



Fig. 14: The M-15 motor is explosionproof. The 400 CPS motor conforms to MIL-M-7969A.Starting torque is 4.5 in-oz. For continuous or intermittent duty, ambient temperature is -65°F to +225°F.

Courtesy of General Controls Co. Fig. 15: Capacitorstart motor. Shafts are treated for corrosion resistance. They can be supplied with %" shaft dia. extension for special applications. Internal fan is used for ventilating the motor.



Courtesy of Emerson Electric Mfg. Co.

Class 2, group F-Atmospheres containing carbon black, coal or coke dust.

Class 2, group G—Atmospheres containing grain dust.

Class 3—locations which are hazardous because of the presence of easily ignitible fibers or flyers, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures.

The National Electrical Code further divides each of these three classes into two divisions—one of which covers the locations where the hazards exist continuously, intermittently or periodically under normal conditions, while the other covers the locations where the hazard is an abnormal condition. For complete information refer to article 500 of the "National Electrical Code."

Ordering the Motor

The motor manufacturer needs complete information on the motor's uses and working environment in order to supply the best motor for your job. He must know the load characteristics of the machine being driven so that he may match them closely with the characteristics of the motor. If full details are not provided a too large, or too expensive motor may be supplied. On the other hand, a less than adequate motor may be supplied which may fail under abnormal operating conditions.

Before ordering a motor, you should obtain answers to as many of the following questions as possible. (See Fig. 12)

1. What are the characteristics of the power supply? Is it ac or dc? If ac, what is the frequency and number of phases.

2. What power is required? What is the starting load, accelerating loads, normal running loads, over-loads, reversing loads, etc.? Is overload protection required?

3. What is the end use of the motor: e.g.: fan drive, pump drive, instrument drive, timing motor, stepping motor, teleprinter, etc.?

4. What is the "duty cycle"—The duty cycle describes how long the motor is running, how long it is stopped.

Is the duty intermittent or continuous—does the motor reach steady state temperature conditions?

5. What speeds are required and what speed variations will be allowed? Is the speed constant or variable? If the speed must be variable, how must it vary (Continued on page F39) I N the June 1961 issue of Electronic Industries, we published an article entitled "Potentiometers —Terms & Data" by John Arnold. In his article, Mr. Arnold defined most of the terms which have since appeared in the Precision Potentiometer Manufacturers Association standard entitled "Precision Potentiometer Terms and Definitions."

In the interest of standardization within the industry, we have reviewed this document; here we present any items which have been added or revised. They have been kept within the same general headings as those in Mr. Arnold's article.

General Terms

Shaft — The mechanical input element of the potentiometer.

Shaft Position — An indication of the relative position of the wiper to a reference point.

Input and Output

Output Ratio—The ratio of the output voltage e to the total applied voltage E, Fig. 1.

Total Variable Output—The difference between the maximum and minimum output ratios, Fig. 2.

Resistance

Minimum Resistance — The resistance measured between the wiper terminal and any terminal with the shaft positioned to give a minimum value.

End Resistance—The resistance measured between the wiper terminal and an end terminal with the shaft positioned to give a minimum resistance value.

Rotation and Travel

Direction of Rotation—Shaft rotation is defined as clockwise (CW) or counterclockwise (CCW) when viewing the specified mounting end of the potentiometer. The designation of the terminals in the figure corresponds to the direction of the shaft rotation, and is shown for reference only, Fig. 3.

Direction of Translation — Shaft translation is defined as "extending" or "retracting" when viewing the specified end of the potentiometer. (Applies to translatory potentiometers only.)

End Point and Tap

End Voltage—The voltage between

the wiper terminal and an end terminal when the shaft is positioned at the end point. It is usually expressed as a percentage of the total applied voltage.

Jump-off Voltage—The first measurable voltage change as the shaft moves the wiper from the overtravel region on to the actual electrical travel region. It is usually expressed as a percentage of the total applied voltage, Fig. 4.

Resolution

Travel Resolution—The maximum value of shaft travel in one direction per incremental voltage step in any specified portion of the resistance element.

Voltage Resolution—The maximum incremental change in output ratio with shaft travel in one direction in any specified portion of the resistance element, Fig. 5.

Conformity and Linearity

Function Characteristic—The relationship between the output ratio and the shaft position.

Mathematically

$$\frac{e}{E} = f(\theta)$$

(Continued on following page)

ELECTROMECHANICAL COMPONENTS

Since our last Reference Issue, the Precision Potentiometer Manufacturers Association has published a standard on Terms & Definitions. Here are the additions and revisions.

Potentiometers— Terms & Data

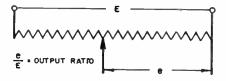


Fig. 1: Definition of the output ratio.

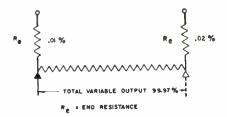
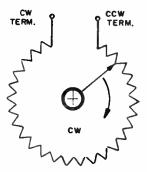


Fig. 2 (above): Illustrative voltage percentages for defining total variable output. Fig. 3 (below): Direction of rotation is determined from this view of potentiometer.



VIEW OF SHAFT AND ELEMENT FROM SPECIFIED MOUNTING END.

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Potentiometers (Continued)

Absolute Conformity — The maximum deviation expressed as a percent of the total applied voltage, of the actual function characteristic from a theoretical function characteristic extending between the specified output ratios which are separated by the theoretical electrical travel. An "index point" on the actual output is required, Fig. 6.

Mathematically

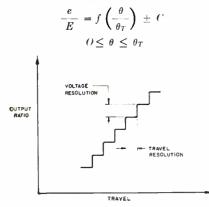
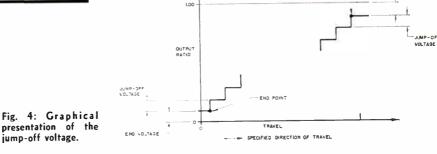


Fig. 5: Descriptive presentation of the definition of travel & voltage resolution. Terminal Based Linearity—The maximum deviation, expressed as a percent of the total applied voltage, of the actual function characteristic from a straight reference line drawn through the specified minimum and maximum output voltage ratios which are separated by the actual electrical travel. Unless otherwise specified, minimum and maximum output ratios are respec-



tively zero and 100% of total applied voltage, Fig. 7.

Mathematically

$$\frac{e}{E} = A \frac{\theta}{\theta_A} + B \pm C$$

where A is given slope

 $B \text{ is given intercept at } \theta = O$ Unless otherwise specified

.4 = 1

B = O

Tolerance Limits; Alternate Methods—There are three basic methods:

- 1. Constant Limits: Taken as a percentage of the total applied voltage.
- 2. Proportional Limits: Taken as a percentage of the theoretical output voltage ratio.
- 3. Modified Proportional Limits: Any combination of the first two methods.

All definitions in this document employ Method 1 for stating tolerance limits.

It should be noted that Proportional Limits may become impossibly restrictive in the vicinity of zero output, and should be modified in such cases to provide a practical tolerance in that region, Fig. 8.

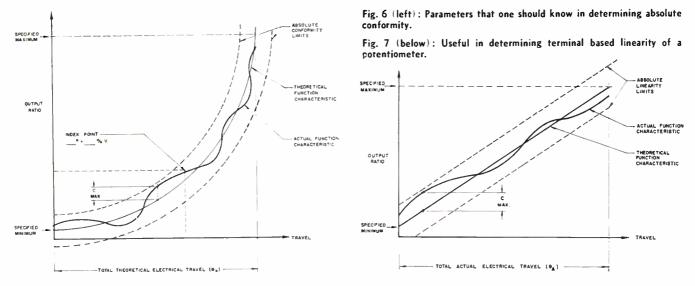
Mechanical Characteristics

Backlash—The maximum difference in shaft position that occurs when the shaft is moved to the same actual output ratio point from opposite directions. Resolution effects must be excluded from this measurement, Fig. 9.

NOTE: The definitions within the asterisks apply to rotary potentiometers only.

Shaft Runout—The eccentricity of the shaft diameter with respect to the rotational axis of the shaft, expressed in inches, and measured at a specified distance from the mounting face when the body of the potentiometer is held and the shaft rotated while a specified load is applied radially to the shaft.

Lateral Runout — The perpendicularity of the mounting surface with respect to the rotational axis of the shaft, expressed in inches and measured on the mounting surface at a specified distance from the axis of rotation when the shaft is held and the body of the potentiometer is rotated while specified loads are applied radially and axially to the body of the pot.



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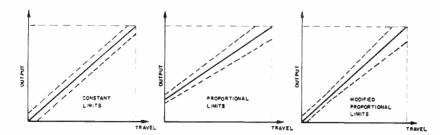


Fig. 8: The three basic methods of determining the tolerance limits of potentiometers.

Pilot Diameter Runout—The eccentricity of the pilot diameter with respect to the rotational axis of the shaft expressed in inches and measured on the piolt diameter when the shaft is held and the body of the potentiometer is rotated while a specified load is applied radially to the body of the pot.

Shaft Radial Play_The total radial excursion of the shaft, expressed in inches, and measured at a specified distance from the face of the unit, with a specified radial load applied alternately in opposite directions at a specified point.

Shaft End Play-The total axial excursion of the shaft, expressed in inches, and measured at the end of the shaft with a specified axial load applied alternately in opposite directions.

Starting Torque — The maximum moment in the clockwise and counterclockwise direction required to initiate shaft rotation anywhere in the total mechanical travel.

Running Torque --- The maximum moment in the clockwise and counterclockwise direction required to sustain shaft rotation at a specified speed throughout the total mechanical travel.

Moment of Inertia-The mass moment of inertia of the rotating element of the potentiometer about its rotational axis. (Includes shaft and connected rotating members.)

> * * * * * * *

Stop Strength.

Static Stop Strength-The maximum load that can be applied to the shaft at each stop without a permanent change of the stop position greater than specified. Dynamic Stop Strength—The inertia load, at a specified shaft velocity and a specified number of impacts, that can be applied to the shaft at each stop without a permanent change of the stop position greater than specified.

Electrical Characterisitcs

Life—The life expectancy of a potentiometer is the number of shaft revolutions or translations obtainable under specific operating conditions and within specified allowable degradations of specific characteristics.

Temperature Cofficient of Resistance-The unit change in resistance per degree centigrade change from a reference temperature, and expressed in parts per million per degree centigrade as follows:

$$T. C. = \frac{R_2 - R_1}{R_1 (T_2 - T_1)} \times 10^6$$

where,

- R_1 = Resistance at reference temperature in ohms.
- R_2 = Resistance at test temperature in ohms.
- T_1 = Reference temperature in degrees centigrade.
- T_2 = Test temperature in degrees centigrade.

Dielectric Strength - Ability to withstand a specified potential of a given characteristic between the terminals of each cup and the exposed conducting surfaces of the potentiometer, or between the terminals of each cup and the terminals of every other cup in the gang under prescribed conditions without exceeding a specified leakage current value.

Insulation Resistance-The resistance to a specified impressed dc voltage between the terminals of each cup and the exposed conducting surfaces of the potentiometer, or between the terminals of each cup and the terminals of every other cup in the gang under prescribed conditions.

Voltage Short-A segment of the resistance element over which the output ratio remains constant within specified limits as the wiper traverses the segment.

Resistance Short - A segment of the resistance element over which the resistance between the wiper and a specified terminal remains constant within specified limits as the wiper traverses the segment.

A. C. Characteristics

Total Input Impedance-The impedance between the two input terminals with open circuit between output terminals, and measured at a specified voltage and frequency with the shaft positioned to give a maximum value, Fig. 10.

Output Impedance-Maximum impedance between slider and either end terminal with the input shorted, and measured at a specified voltage and frequency, Fig. 11. Phase Shift-The maximum phase difference measured in degrees be-

tween the sinusoidal input and output voltages measured at a specified input voltage and frequency.

Quadrature Voltage - The maximum value of that portion of the output voltage which is $\pm 90^{\circ}$ out of time phase with the input voltage, expressed as volts per volt applied, measured at a specified input voltage and frequency. *

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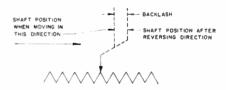


Fig. 9: Hore's how to Petermine backlash.

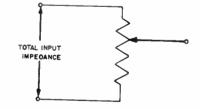
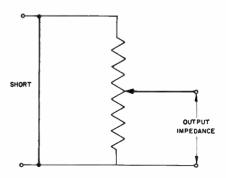


Fig. 10 (above): To determine total input impedance, measurements must be made at specified voltage and proper frequency.

Fig. 11 (below): Here's how to determine the output impedance of potentiometers.



Relay contacts which begin to show failures after a few thousand operations could give millions of operations with proper protection. With arcing adequately suppressed, contact erosion is limited to mechanical wear and current effects.

For Relay Circuits ...

How To Suppress The Arc

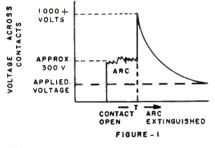


Fig. 1: Induced voltage may cause arcing as the contacts of the relay are opening.

LL electrical circuits in which A direct current flows are subject to an electrical inertia due to the inductance in the elements, wiring, etc. Just as mechanical inertia tends to maintain constant motion. inductance tends to maintain a constant current flow in the circuit. An instantaneous change in mechanical motion requires an infinite force, similarly an instantaneous change in inductive current is associated with an infinite voltage. Yet we normally expect a relay to instantly interrupt a current flow for millions of reliable operations.

Mathematically, the energy stored in an inductive field is $Li_2/2$ where L is the inductance of the

circuit and i is the steady state current. When the circuit is suddenly opened, this energy must be dissipated in the arc energy, circuit resistance, and eddy currents.

The contacts separating slightly attempt to instantly reduce the current to zero. The resulting induced voltage may exceed the breakdown voltage of the small air gap (approx. 300 volts) and an arc forms. Whether one attributes the resulting arc to the induced voltage, electrical "inertia" or energy dissipation, the results are the same. As the contacts continue to part, the arc becomes unstable and is extinguished. As the arc extinguishes, the current ceases abruptly and a voltage spike appears across the contacts. The arc heats and burns the contacts and the resulting voltage spike causes further damage by transferring molten material between the contact faces. With proper arc suppression, this damage can be virtually eliminated and the contact life extended by many times.

To eliminate arcing, some device or component must be provided which either: 1. Provides a temporary path in parallel with the opening contacts which will allow a gradual decay of current rather than an instantaneous interruption; or 2. Provides a path and source for accepting the energy stored in the inductive field. Regardless of which concept is considered, the effect is to provide a slower decay of inductive current. The induced voltage is directly dependent on the rate of change of current and corresponding magnetic flux. This implies that the decay of the magnetic flux is impeded; and, it follows that arc suppression tends to slow the release of a relay across whose coil it appears. (One exception is a capacitor of optimum value which may actually speed the release.)

An accurate analysis of arcs and arc suppression is quite complex due to such variables as contact material, opening speed, surface contamination, load inductance, and other factors. Several simple methods are commonly used, not all of which result in the desired effect.

Capacitor Protection

If a capacitor is connected across a contact, Fig. 2, the voltage across the capacitor will be zero and the change will be zero while the contact is closed. When the contact first opens, the capacitor provides a momentary path to maintain the current flow and prevents the high voltage from appearing across the

Abstracted from material published by North Electric Co., Electronics Div., Galion, Ohio.

opening contact. As the capacitor charges, the voltage increases and the contact gap widens. If the capacitor is the proper value the voltage will never reach the breakdown voltage of the open contacts and no arcing will occur. This is excellent protection on contact opening. However, when the contact recloses, the charged capacitor is short circuited through the contacts and may cause excessive erosion or even contact welding.

If the capacitor is connected across the load, Fig. 3, a reverse situation occurs. With the contact closed, the voltage on the capacitor is equal to the load voltage and it is fully charged. As the contact begins to open the capacitor discharges through the load and maintains a momentary current flow and a gradual decay of current through the load. If the capacitor is the right size, the current decay will be such a rate that the induced voltage will be low enough to prevent arcing. When the contact recuit conditions, there is an optimum R-C arc suppressor which gives maximum protection and longest contact life. This is the most popular form of arc suppression and R-C units are available in various popular values.

Resistor-Diode-Capacitor

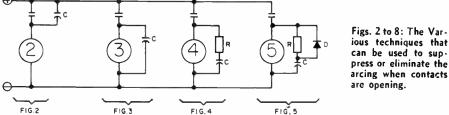
A further modification of the above method is possible where severe arcing occurs or where the ultimate insuppression is required. This involves the addition of a diode, Fig. 5. The diode serves as a "gate" which essentially switches in the resistor to limit the surge on contact closure and eliminate the series resistance on contact opening. By proper selection of the R-D-C elements, an almost perfect arc suppression circuit is possible. This method is also very effective in eliminating switching transients in solid state circuitry or where noise radiation is a problem. R-D-C units are available as packaged units.

Back-to-Back Diodes

Back-to-back diode units are often used as arc suppressors. Fig. 7. One of the diodes is used to block the current flow when the contact is closed; the other provides a nonlinear discharge path when the contact opens. When the contact first opens, the voltage rises sharply and the back resistance is reasonably low, increasing rapidly as the current decays. This has the "limiting" effect which causes a rapid current decay and does not affect release time significantly. However, the reverse resistance of the diode is appreciable and these units do not afford the degree of protection obtainable with other methods. These units are also quite dependent upon the current and voltage conditions and should not be used as general purpose contact protectors.

Non-Linear Resistors

A form of contact protection which is gaining in popularity, due



can be used to suppress or eliminate the arcing when contacts are opening.

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FIG.6

closes, however, a large charging current will surge through the contact and may cause welding. For these reasons, a single capacitor is not adequate protection except in rare circuits where current on contact closure can be carefully limited to a value within the contact rating. There is also the possibility that the capacitor may short, causing complete circuit failure.

Resistor-Capacitor

Adding a resistor in the arc suppression circuit, Fig. 4, limits the current surge on contact closure to a maximum value of E/R. By proper choice of R, the surge current may be kept within the contact rating. This resistance also limits the effectiveness of the capacitor on contact opening; and, therefore, should be kept as low as possible. For any given set of cir-

Rectifier Suppressors

Arc suppression by use of a single diode alone is possible in some instances, Fig. 6. While the contact is closed, only the reverse leakage current flows through the diode. When the contact opens, however, the direction of current reverses and the load is shunted by the low forward resistance of the diode. The load current therefore decays slowly and the induced voltage is small. However, unlike the R-C or R-D-C methods, there is no capacitor to limit the time during which current can flow. Not only is the initial rate of current decay reduced but the length of time current flows is materially increased. This effect will significantly increase the release time of the load relay; and, in fact, is often used for that purpose.

primarily to its small size, is the non-linear resistor, Fig. 8. They have approximately the same effect as the back-to-back diodes, are less expensive, and smaller in size. These units must also be carefully selected for circuit voltage. Due to their small size and low cost, many manufacturers are including these units across the coils of relays, stepping switches, and other electro-mechanical devices.

FIG.7

Summary

FIG.8

Where long life and reliable switching in dc inductive circuits are important, contact protection or arc suppression is mandatory. Most of the unreliability attributed to relays and most contact failure "data" are based upon circuit design where contact protection was nonexistent or improperly chosen.

ELECTROMECHANICAL COMPONENTS

IRVING M. GOTTLIEB Consultant 931 Olive Menlo Park, Calif.

Transistor circuits are often used to actuate dc electromagnetic relays. The occurrence of residual current in these circuits presents a problem. A relay circuit is given which minimizes this current.

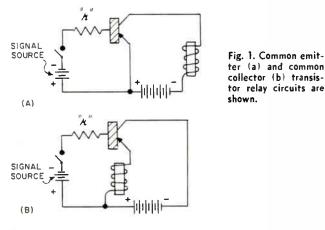
In Transistor Relay Circuits . . .

Minimizing Residual Current

SINGLE stage transistor circuits combining the functions of power amplification and switching are often used to actuate dc electromagnetic relays. This enables the use of cheaper and less-delicate relays than would result from direct energization of the relay solenoid. The two most common configurations, the common emitter and the common collector circuits, are shown in Fig. 1.

Reliability

Reliability of these circuits is enhanced by low residual solenoid current when the transistor is in its "OFF" or non-conducting state. Otherwise, the relay armature may open sluggishly, or may even fail to operate. Unfortunately, collector cut-off current is relatively high in germanium transistors connected as



dc common emitter or common collector amplifiers. This is seen when such amplifiers are used as switches by depriving the emitter-base diode of forward bias. In such circuits the collector cut-off current increases rapidly at greater than room temperatures. There is generally considerable variation from transistor to transistor. Thus, tampering with the spring tension of the relay armature would probably prove an unreliable compensation technique when production runs are involved. The economy of germanium transistors and the temperature stability of silicon transistors are required. Also required are the low collector cutoff current of the common emitter and common collector circuits. Even though these appear to be conflicting features, a good approach to their overall attainment is possible.

Circuit Comparisons

The reason for the difference in collector cut-off current in a given transistor when it is connected in the common base circuit, and when it is connected in either the common emitter, or the common collector circuit, is to be recalled. In Fig. 2 a pnp transistor is provided with properly polarized collector-emitter bias. No connection is made to the base lead. The current meter indicates a high reading compared to the situation shown in Fig. 3. Here the same bias is now connected from collector to base instead of from collector to emitter. Due to the construction of the transistor, an important difference exists in the two situations. In Fig. 3, the emitter region is not involved

in the circuit and, for practical purposes, does not contribute to the current. However, in Fig. 2, the base region, even though not connected to any external source, is in the path of the current loop. Due to thermally generated charge carriers, the depletion layer separating base and collector regions allows the flow of a small leakage current. In Fig. 2, the flow of this small current from emitter to base constitutes forward bias in the emitter-base diode. This causes charge injection from emitter to base, and normal transistor action ensues. Thus, the small base-collector leakage current is amplified by the current gain factor (B) of the transistor. It should be clear that this occurs because the transistor provides its own base signal, or bias. This being true, it appears possible to cause cut-off current in the common emitter circuit to be no more than in the common base circuit. That is, providing the effect of the internally produced base-emitter bias could be negated.

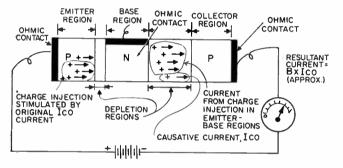


Fig. 2. Collector-emitter polarization of a pnp transistor as in common emitter and common collector circuits. No connection is made to the base lead.

Minimizing Circuit

The effect of the internally produced base-emitter bias is negated in a simple and practical way. A relay circuit incorporating a technique for overcoming internally developed base-emitter bias is shown in Fig. 4. Reverse bias is applied to the base-emitter diode. Although an additional voltage source is required, it is significant that consumption of dc power by the non-conduction transistor is actually much less than without such back-biasing. The value of "R" is much greater than the dc input impedance of the transistor so that there is negligible degradation of sensitivity. With a type 2N441 germanium power transistor, a 2000 ohm value for "R" and a $1\frac{1}{2}$ v. dry cell cause a reduction in collector cut-off current. Reduction is by a factor of 10 to 30 up to an ambient temperature of about 75°C. Improvement obtained will depend upon transistor leakage and current gain. as well as the ultimate temperature expected. In this example, "R" could be increased to 5000 ohms if improvement was only desired for moderate excess of room temperature, say about 10°C. In this case, current drain from the $1\frac{1}{2}$ v. source would be about $\frac{1}{3}$ ma. when the transistor was in its "ON" state from the application of external bias. It would be less when the transistor was in its "OFF" state.

Resistance "r"

Resistance "r" represents the internal resistance of the signal source plus whatever current limiting resistance might be added. "r" is low enough to permit the transistor to be driven hard enough to properly energize the relay solenoid. This may or may not imply saturation of the transistor. Aside from these considerations "r" is not critical and does not enter directly into discussion of the reverse bias technique.

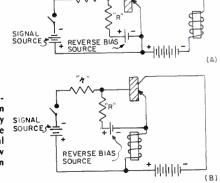
Resistance "R"

Although batteries are shown in the circuits, operation from ac power supplies involve no difficulty. The current demand from the reverse bias supply is so small that little additional expense results. In many cases it is not necessary to replace the power transformer with one having an additional winding. There is frequently enough window space between transformer coils and core legs to permit the addition of several turns of wire. This makes it easy to provide an additional source of ac for subsequent rectification and filtering. The voltage is not critical-the higher it is, the higher will be the value of resistance "R". Voltages between one and ten are practical. Due to the low current demand, half-wave rectification in conjunction with several microfarads of filtering is satisfactory. The value of "R" is best determined empirically. A value is readily found below which the residual collector current is not reduced. If "R" is then chosen to be about one-half of this value, enough safety margin will exist to maintain the low current despite considerable temperature rise.

Applications

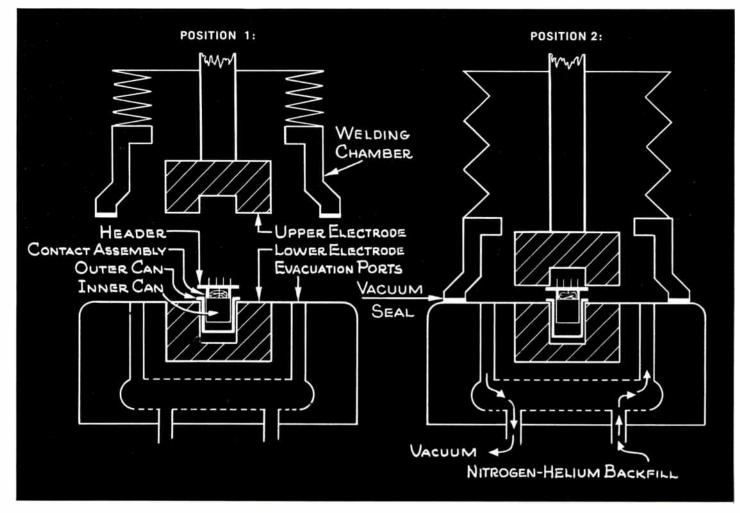
Although emitter-base reverse bias is advocated for relay circuits, it is possible that this technique may find application in computer, digital, or other switching circuitry wherein a closer approach to the ideal "OFF" state is desirable.

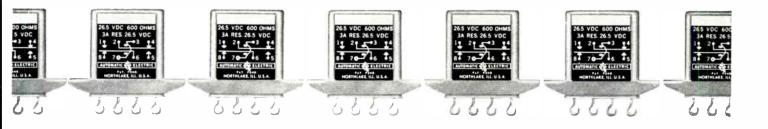
Fig. 4. Common emitter (a) and common collector (b) relay circuits with reverse bias to keep residual solenoid current low when transistor is in the "off" state.





Why A 's MM-22 military relay approaches <u>absolute</u> reliability





AE has licked the most common source of military relay failure – contact contamination.

You can run a "low level miss test" on a batch of MM-22's with certainty that the contact resistance on every one will remain remarkably low and consistent. A test at the full power rating will also demonstrate the contact reliability. As an example, MM-22's on a life test of 3 amperes 28 volts dc resistive had a contact resistance of *less than* 50 milliohms after $3\frac{1}{2}$ million operations.

One reason for this extreme reliability is found in AE's exclusive sealing method, graphically illustrated below. Note that no sealing hole or evacuation tube is used. After evacuation and backfilling of the welding chamber (including the relay), the outer can is resistancewelded to the relay and header assembly.

The final sealing operation is performed in a dry box

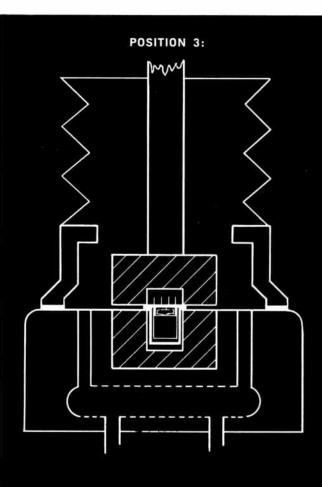
containing the sealing chamber and the welding electrodes. A pure and dry nitrogen atmosphere is maintained in the dry box and all operations are performed through glove ports.

If your tests of microminiature sealed relays have shown an alarming probability of system failure, then the MM-22 is the answer to your problem. For more information, write for Circular 1999 to: The Director, Military Equipment Sales, Automatic Electric Sales Corporation, Northlake, Illinois.

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How the AE MM-22 Relay is hermetically sealed by resistance welding

POSITION 1: Relay structure and outer can are loaded into cavity in lower welding electrode. Relay structure and outer can are held partly open. Operator presses button to initiate cycle which, from then on, is completely automatic.

POSITION 2: Welding chamber closes and is evacuated and then backfilled with nitrogen containing helium tracer.

POSITION 3: Upper electrode descends, pressing relay completely into outer can and then completes the weld. Welder then reverts to Position 1 and completed relay is ejected.



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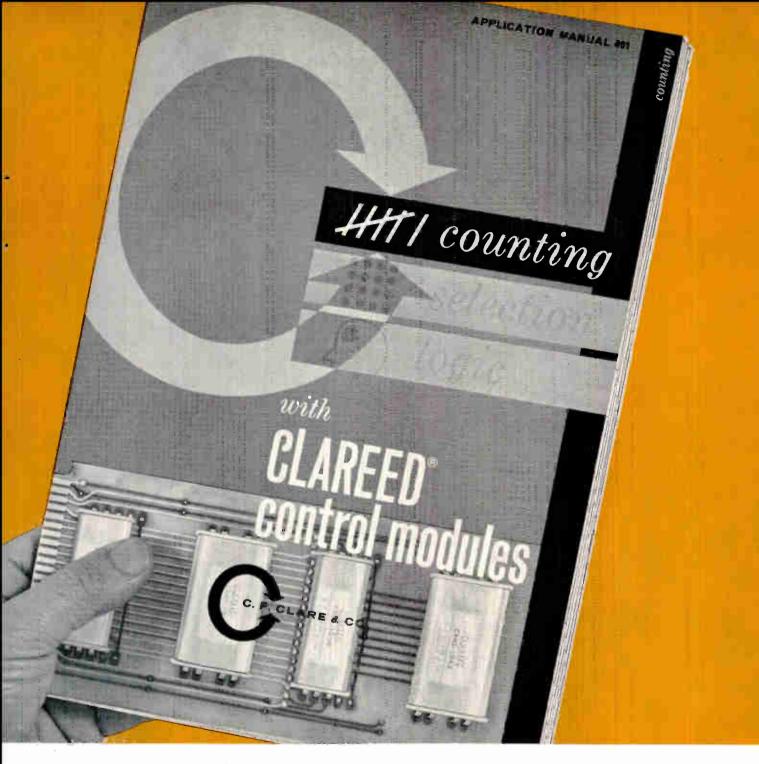
The Clareed Counting Module is

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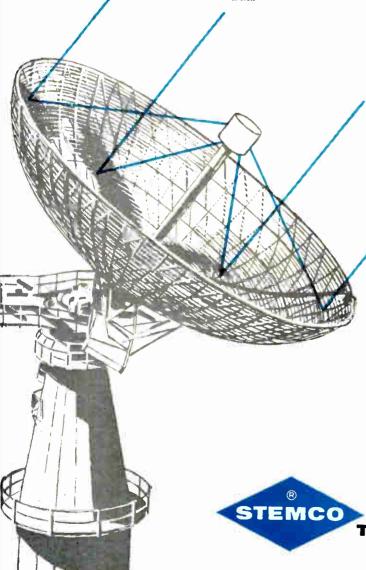
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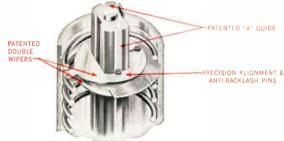


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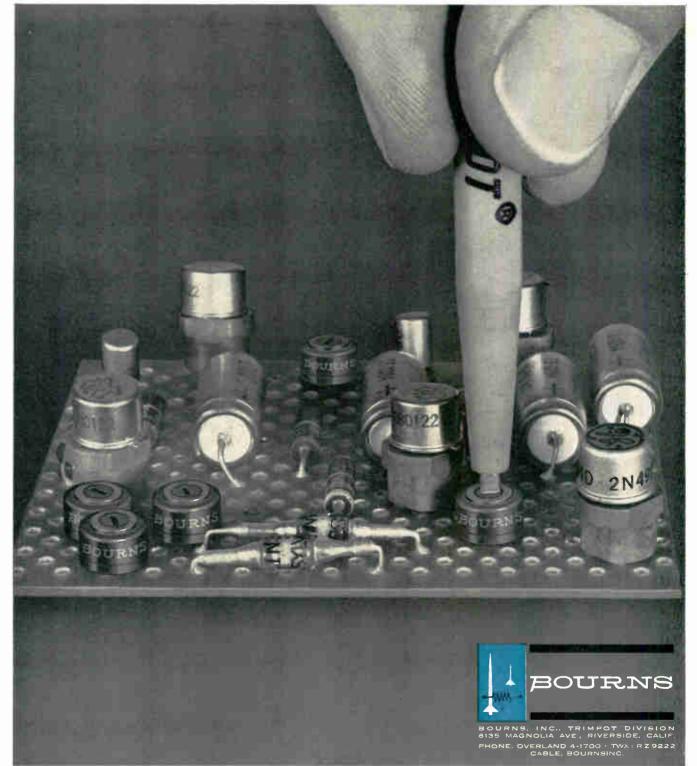
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1/2W. Standard-For radio, TV. Single, Twin or dual-concentric. 15/16* diam. 250 ohms to 10 megs.

1-1/2W. Wirewound-for military and instruments. 11/16" diam., 5/16" deep. 4 ohms to 30K ohms.

2.5W. Wirewound—For instruments and TV. Single or dual-concentric. 1-5/32[°] diam. 1 ohm thru 100K ohms. Also avail-able as 20 watt audio L and Bridged T Pad attenuators.

Write for Group B bulletins.



CERAMIC CAPACITORS

Ultraminiature-3 to 10VDC, 0.22-2.2 mfd.-for low power factor transistor apmfd.—for plications.

Temperature compensating—Discs, tubu-lars, 150 v to 6,000 VDCW. 1 mmf.—0.1 mf. Capacitance +100 to —5250 ppm.

mi. Capacitance +100 to -5250 ppm. Bypass - Coupling - Discs, tubulars, 150 v to 6,000 VI)CW, 1 mif. -0.1 mf. High Voltage - High Accuracy - High Voltage types, up to 30,000 VI)CW, High Accuracy types, $\pm 1\%$ tolerance, 500 VI)CW, up to 2,500 mmf.

Trimmer—Tubular or flat. Meet MIL-C-81A specifications. 1 mmf. to 400 mmf. 500 VDCW.

Feed-thru-10-5000 mmf., 500-1,500 VDCW, bushing, shoulder, ring, eyelet, resistor-capacitor combinations.

Specialties-Stand-off, button-shape, pot-ted, other capacitors.

Write for Group D bulletins.

ENGINEERED CERAMICS

High alumina – 85%, 95%, 99% – for high frequency, high temperature applications close tolerance (±.00025") designs. L6A Jan-I-10 grade.

Grade Jan-I-10-L5A steatite, Grade L2A Corderite, and Grade L2A Electrical Por-celain. For applications where high diclectric and compressive strength, high dimensional stability, low loss and low power factor are required, there is a CENTRALAB ceramic material for the job. CENTRALAB also specializes in metalizing of ceramics, for hermetic seals or me-chanical attachment of other ceramic or metal parts.

Write for Group X bulletins.

THE ELECTRONICS DIVISION OF GLOBE-UNION INC. 938F EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN In Canada: Centralab Canada Ltd., P. O. Box 400, Ajax, Ontario

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS



How do you prefer your Microdial[®]: Digital or Concentric Scale?

The Borg Microdial line (broadest in the industry) offers both types two digital series, and three concentric scale series. Whichever type you like for potentiometer control, remember:

1. Each Borg Microdial features large numerals that are well contrasted to their backgrounds for squint-free readability. 2. Each can be equipped with positive braking to prevent accidental setting changes. 3. Indexing accuracy is one part in a thousand, suitable to a potentiometer of .1% linearity, thus enabling you to get all the precision you pay for in a precision potentiometer. 4. Rugged design withstands rough handling and "panic" responses or setting changes. 5. Customization of counting wheels and gearing can give you practically any readout configuration you might require.

Most Microdial models come in a

variety of color combinations that contribute to appearance and permit coding for fast identification in panel groupings.

The Borg Microdial line is competitive too, as you can verify by contacting your nearby Borg technical representative or omnipresent Amphenol-Borg Industrial Distributor. Or, you can address specific inquiries to R. K. Johnson, Sales Manager:

Circle 157 on Inquiry Card



BORG EQUIPMENT DIVISION Amphenol-Borg Electronics Corporation, Janesville, Wisconsin.



Sensitive Relays at Sensible Prices



Price Electric Series 1000 Relays Now Feature ...

Sensitive Operation • Solder or Printed Circuit Terminals Open or Hermetically Sealed Styles . Low Cost

These versatile sensitive relays are designed for applications where available coil power is limited. They retain all the basic features, such as: small size, light weight and low cost, that make the Series 1000 General-Purpose Relays pace setters in their field.

Typical Applications

Remote TV tuning, control circuits for commercial appliances (including plate-circuit applications), auto headlight dimming, etc.

General Characteristics

Standard Operating Current: 1 to 7 milliamps DC at 20 milliwatt sensitivity Maximum Coil Resistance: 16,000 ohms

Sensitivity:

20 milliwatts at standard contact rating; 75 milliwatts at maximum contact rating. Maximum coil power dissipation 1.5 watts. **Contact Combination: SPDT**

Contact Ratings:

Standard 1 amp; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC. **Mechanical Life Expectancy:**

30,000,000 operations minimum.

Dielectric Strength: 500 VRMS minimum.

For Additional Information, contact:

PRICE ELECTRIC CORPORATION

323 Church Street • Frederick, Maryland MOnument 3-5141 • TWX: Fred 565-U

Tech Data

for Engineers

Choppers

Tech data entitled "Chopper Tech-nology: An Introduction" describes the basic forms and characteristics of choppers and defines common terms associated with them. Circuit performance and applications of electromechanical and transistor choppers are discussed. Airpax Electronics Inc., Cambridge Div., Cambridge, Md. Circle 451 on Inquiry Card

Thermostats

Tech data is available on a line of hermetically sealed, miniature thermostats designed for stringent military applications under severe environmental conditions. George Ulanet Co., 413-415 Market St., Newark 5, N. J.

Circle 452 on Inquiry Card

Rotary Switch

Tech data covering a ½ in. Submin-iature Low-Power Rotary switch is available from Oak Mfg. Co., Crystal Lake. Ill. The ½ in. rotary switch is a full 12-position unit featuring long life silver alloy contacts, gold flashed to prevent tarnish, double wiping design, and negligible contact noise and circuit resistance.

Circle 453 on Inquiry Card

Time Delay Relay

Tech data is available on the Dial Head AGASTAT time delay relay which features instantaneously recycling with a rest time of less than 0.035 sec.; easy adjustment; temp. range from -65 to $+165^{\circ}F$; and repeatability accuracy to within $\pm 10\%$ of the pre-set adjustment. Elastic Stop Nut Corp. of America, Eliza-beth Div., Elizabeth, N. J. Circle 454 on Inquiry Card

Motors

Tech data is available on hysteresis synchronous motors, induction mo-tors, ac permanent magnet generators and tachometers, and sine wave generators. McLean Syntorque Corp., West Hurley, N. Y. Circle 455 on Inquiry Card

AC and DC Motors

A 6-page, 2-color, booklet on ac and dc motors, pumps, blowers, and cus-tom engineered drive assemblies is available from The Piqua Machine and Mfg. Co., Piqua, Ohio. Included is information on uses for each motor and detailed dimensional drawings and performance specs.

Circle 456 on Inquiry Card

Fractional H.P. Motors

Howard Industries, Inc., 1760 State St., Racine, Wis. offers tech data on fractional horsepower motors with ratings from 1/2000 to 1 H.P. Cata-log contains information on motor parts sets, motor blowers and gear reduction units.

Circle 457 on Inquiry Card



How "complete" is a complete line?

Are you as confused about all this complete line talk as we are? What, for example, is a "complete" potentiometer line? This *should* include everything from the *cheap-and-dirty* kind you'll find on a bargain table-radio to the ultraaccurate precision type shown above. By such reckoning, our line of Borg Micropot[®] potentiometers is far from complete.

The Borg line is "complete" in a different way. Its range of sizes, ratings, and types makes it applicable to virtually every circuit requiring potentiometers with extreme accuracy, reliability and life expectancy along with small size, wide temperature ranges, and rugged resistance to shock, vibration and atmospheric contaminents.

In other words, the Borg Micropot line *is* a complete line—of precision units for precision applications. This is as true of the new 2100 series shown above as of the many other series in the Borg line. As true of single-turns as of

Circle 159 on Inquiry Card



BORG EQUIPMENT DIVISION Amphenol-Borg Electronics Corporation,

multi-turns. As true of commercial mod-

There's a lot more to the Borg line

than its completeness. It is competitive.

Borg Micropot potentiometers are

competitively priced, competitively dis-

tributed (through Amphenol Industrial

Distributors), and competitively deliv-

ered. Find out for yourself. Contact your

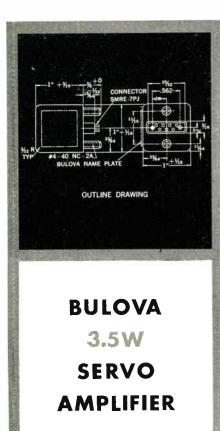
nearby Borg technical representative,

Amphenol Distributor, or write to R. K.

els as of military models.

Janesville, Wisconsin.

Johnson, Sales Manager.



SERVO AMPLIFIER				
Power Output :	3.5 W into 450Ω effective resistance (size 11 motor) 2 W into 800Ω effective resistance (size 8 motor)			
Input DC Power :	No Load 1 Watt			
At 28 VDC ±10% - (0.5 V P-P Max. Allow Ripple)	Load 7 watts with 3.5 watt load			
Voltage Gain:	2.500 ±3 DB (under all environmental conditions & independent of load)			
Phase Shift:	10° max. under linear operating conditions at 400 CPS (nom.) 30° max. over entire bandwidth.			
Harmonics :	Max. 2nd harmonic input must be less than 5 MV. Other harmonics should not affect performance.			
Signal Frequency:	400 CPS (nom.)			
Output Voltage :	40 V RMS			
Type of Output:	Direct push-pull			
Output Impedance:	1000 (max.) resistive			
Gain Adjustment :	By means of external series resistor at input			
Bandwidth :	300-500 CPS			
Dead Band (no output) :	0.25 MV (referred to input)			
Max, Signal Input	25 V RMS with no damage to amplifier			
Operating Temperature :	-55°C to +125°C max. mounting base temp.			
Weight:	1 or.			
Shock & Vibration :	Meets MIL-E-5400 & MIL-E-5272 (fully potted)			
Storage Temperature :	-65°C to +150°C			
Input Impedance :	10,000D resistive, constant			

nents of specificati Designed to meet enviro MIL-E-5400 MIL-E-5272

MILE-5400 MILE-5272 In addition to their "more than superior" performance in extreme environments, the Bulova wide line of Transistorized Control System Components promises maximum flexibility in system design with a mini-mum of ounces and inches. In a wide range of Servo Amplifiers, Buffer Ampli-fiers and Quadrature Rejection Filters, you will find the one with characteristics to satisfy your requirements. For information on how Bulova can assist you, write Department 2595. Department 2595



Tech Data

for Engineers

Chopper Catalog

This 12-page, 2-color general instrument chopper catalog gives complete data on all military and industrial choppers including miniature SPDT and DPDT models, applicable Mil specs., residual noise and drift data, mechanical and electrical specs., incoming inspection and engineering measurement techniques. James Electronics, Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Circle 458 on Inquiry Card

AC Generators

AC generators from less than 1 up to 1000kw are included in the Kato line, described in a colorful brochure from Kato Engineering Co., Mankato, Minn. Kato generators are made in brush or brushless types in a wide range of sizes, voltages and freqs. Circle 459 on Inquiry Card

Relays

Complete data, 32-pages, 2-color, is given on Series A 5a and 10a max. contact rating versions, pico-minia-ture and pure ac relays. Included are specifications, dimensional drawings, enclosure types and ordering information for 45 typical units. Relay Div., Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif. Circle 460 on Inquiry Card

Cooling Equipment

McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J., is offering a 48-page catalog on their line of packaged blowers, propeller fans, centrifugal blowers, ring fans and accessory items. All mechanical and electrical characteristics of each model are included with performance model are included with performance special section is given to basic de-sign information for ventilating electronic equipment using forced - air cooling. Mathematical formulae and graphs are provided for problems in cooling solid state circuitry or tube assemblies.

Circle 461 on Inquiry Card

Pressure Potentiometers

Special Product Note 2851 describes a series of plate mounted miniaturized pressure potentiometers available in ranges from 0-5 to 0-300psia in one basic miniaturized configuration. Trans-Sonics, Inc., P.O. Box 328, Lexington, Mass. Circle 462 on Inquiry Card

Synchros

"Synchro Engineering Specification Catalog" 40 pages, 2-colors, available from The Bendix Corp., Montrose Div., So. Montrose, Pa., contains a section on design data which includes an introduction to synchros, a classification of standard synchro units and pre-standard synchro units, and a list of synchro characteristics. Also included are spec. tables on Size 11 Mil-S-20708 synchros which includes specs., and outline drawings and data on Sizes 18, 23, 30, 31, 37, and Mil-S-2335 synchros, Type 1, 3, 5, and 6. Circle 463 on Inquiry Card

RELIABILITY ACCURACY ECONOMY



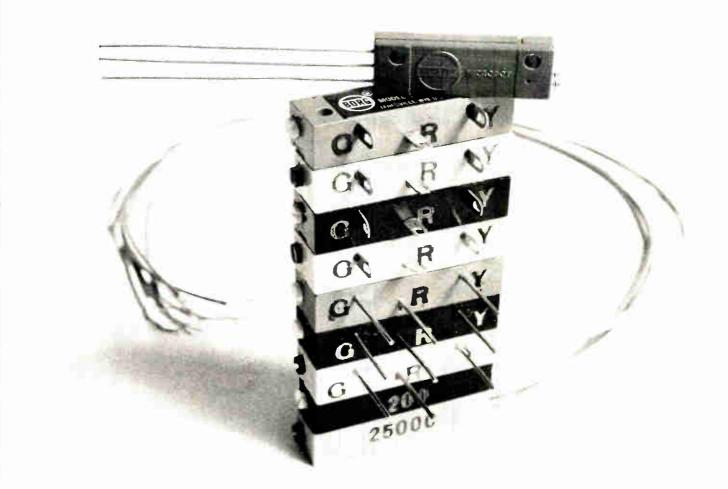
CURTISS-WRIGHT Transistorized Electronic Time Delay Relays

Curtiss-Wright "T" series relays employ advanced solid state circuitry providing better than $\pm 3\%$ accuracy on standard models. Adjustable or preset time delays available from 0.1 to 300 seconds . . . fast recovery following deenergization at any time. "Wearever" control circuit with no moving parts withstands 2000 cps 20g vibration, 50g shock and acceleration, Input voltage 22-32 VDC—reverse polarity and transient protected. Complies with applicable MIL specifications. Fast delivery on standard units. Custom designs available.

> Write for latest complete components catalog #511



Circle 162 on Inquiry Card



The complete Borg Trimmer line starts at the top

Everything must start someplace. 'The complete Borg line of Trimming Micropot^{**} potentiometers can be said to start with its latest addition, the subminiature $(1'' \times \frac{3}{16}'' \times \frac{5}{16}'')$ 2700 series. This new Micropot is not only tiny, but a high-temperature, humidityproof model as well.

However, if a quarter of an inch isn't important to your application, there are six other Borg Trimmer series from which to choose:

- 2800—High temperature, humidity proof, wirewound.
- 990—High temperature, wirewound.
- 992—General purpose, wirewound.
- 993-General purpose, carbon.
- 994—General purpose, humidity proof, wirewound.
- 995—General purpose, humidity proof, carbon.

Here are some of the advantages of-

fered by Borg Trimmers: 1. Singlepiece, welded terminations. 2. Lowmass contacts. 3. 100% noise test. 4. 100% contact resistance check. 5. 100% ratcheting test. 6. Resistances from ten ohms to one meg.

Selecting the right Borg Trimmer can be a lot easier if you'll call your nearby Borg technical representative or Amphenol-Borg Industrial Distributor. Or, if you prefer, write directly to R. K. Johnson, Sales Manager:

Circle 163 on Inquiry Card



BORG EQUIPMENT DIVISION

Amphenol-Borg Electronics Corporation, Janesville, Wisconsin.





Motors (Concluded)

published by Bodine Electric Co., 2500 West Bradley Place, Chicago 18, Ill. (Price: \$1.00).

The following companies contributed information for this article:

The Bodine Electric Co., 2500 W. Bradley Place, Chicago The pointe factors of the second secon

Western Gear Corp., 132 West Colorado Bivd., Pasadena,

4. Western Gear Corp., 102 Gear Chill. Calif. 5. The Bendix Corp., Bendix Pacific Div., 11600 Sherman Way, North Hollywood, Calif. 6. Thor Power Tool Co., 1421 Barnsdale Rd., LaGrange Park, 111. 7.

6. Thor Power Tool Co., 1421 Barnsdale Rd., LaGrange Park,
7. Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.
8. The General Electric Co., Schenectady 5, N. Y.
9. The Barber-Colman Co., Rockford, Ill.
10. The Itedmond Co., Owosso, Mich.
11. The Ohio Electric Mfg. Co., 5400 Dunham Rd., Maple Heights, Ohio.
12. G. H. Leland, Inc., Dayton, Ohio.
13. Electronic Specialty Co., 4612 W. Jefferson Blvd., Los Angeles 16, Calif.
14. The Garrett Corp., Airesearch Manufacturing Div., 9851-9951 Sepulveda Blvd., Los Angeles 45, Calif.
15. Muirhead Instruments, Inc., 441 Lexington Ave., New York
17. V. S. Electrical Motors, Inc. Box 2058 Terminal Annex, Los Angeles 54, Calif.
18. IMC Magnetics Corp., 570 Main St., Westbury, L. L. N. Y.
19. Dynamic Air Engineering, Inc., 7412 Maie Ave., Los Angeles, Calif.
20. Small Motors, Inc., 2076 Elston Ave., Chicago 14, Ill.

Dynamic Air Engineering, Inc., 7412 Male Ave., Los Angeles, Calif.
 Dynamic Air Engineering, Inc., 7412 Male Ave., Los Angeles, Calif.
 Small Motors, Inc., 2076 Elston Ave., Chicago 14, Ill. 21, U. S. Industries, Inc., Western Design & Electronics, 6312 Hollister Ave., Goleta, Calif.
 The General Industries Co., Elyria, Ohio.
 Bill Haydon Co., 232 No. Elm St., Waterbury 20, Conn. 24, Kearfott Div., General Precision, Inc., Little Falls, N. J. 25, General Controls Co., 801 Allen Ave., Glendale 1, Calif. 26, Howell Electric Motors Co., 8100 Florissant Ave., St. Louis 36, Mo.
 Gleason-Avery, Inc., 45 Aurelius Ave., Auburn, N. Y. 29, Air Marine Motors, Inc., East Bethpage Rd., Plainview, L. L., N. Y.

•D•I]

FASTER.... EASIER SWITCHING

New Convenient Tabs on...

THUMBWHEEL SWITCH Modules

> Equally accurate for gloved or barehand operation. Especially useful when manual settings are changed often. Large, clear numbers, High legibility because only se-

lected number is visible. Can be furnished in 8, 10, 12 or 16 positions with single or multi-wafer construction in lug or time-saving removable type printed circuit wafers. Digital, binary, multiples of each, or multiples of both available with or without internal lighting. Ask for technical details today.

4-MODULE

ASSEMBLY



ENGINEERING NEWS-#14

FULL LINE OF MINIATURE SNAP-ACTION SWITCHES

Dut.



ENGR.

CONTROL SWITCH DIVISION



Jul



SPECIFICATIONS

	Amps @ 28 VDC or 120 VAC			Approx. Weight
Model No.	Resist	Induc.	Circuitry	Lbs.
B7001	7	4	S.P.N.O.	.005
B7021	7	4	S.P.N.O,	.010
T2106	10	5	2 Cir.	.010
T2108	10	5	2 Cir.	.016
T2150	3	1	D.P.D.T,	.010
T2151	3	1	D.P.D.T.	.016
Т3103	5	3	S.P.D.T.	.009
Т3106	5	3	S.P.D.T.	.013
T4203	1		S.P.D.T.	.004
T4205	1		S.P.D.T,	.013
Т-3	7.5	2.5	S.P.D.T.	1.6 Grams

NOTE: All models above (except T-3) are available with maintained or momentary action. Self-sealing boot available for any bushing mounted model, as shown on T2150. All models available with flange or bushing type mounting. Basic switch Model T-3 is available with a wide variety of standard and special actuators.

> These miniature pushbutton and toggle switches are typical examples of our complete line of miniaturized switches. Whatever your requirements for miniature hand-operated or mechanically-operated switches, we can meet your needs from our hundreds of standard and custom units. We offer an almost unlimited range of variations in configuration, actuation, ratings, operating characteristics, etc.

For more technical information on switches and indicator lights, write for FREE CATALOG No. 180.



CONTROLS COMPANY OF AMERICA

CONTROL SWITCH DIVISION 1420 Delmar Drive • Folcroft, Pennsylvania TELEPHONE LUdiow 6.7500 TWX SHRN-H-502

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading electronic parts Distributors.

Circle 168 on Inquiry Card

SUBMINIATURE INDICATOR LIGHTS Moisture-proof. Only 35, 64 inch overall, 60,000 hour life with 5V lamp. Translucent lens colors. Available with MS or commercial type lamp.

Three lens styles.

L10,000 L10.100 L10,200

MINIATURE SNAP ACTION LOW COST Time Delay Relays

For commercial use, economical Curtiss-Wright thermal time delay relays, hermetically sealed in glass, are a compact and reliable design for many control, switching and timing applications. Precision built for high performance and long life. Ambient temperature compensated. Conservatively rated, these new rugged, small sized units are preset for time delays from 3 to 60 seconds.



Write for latest complete components catalog #503



Tech Data

for Engineers

Relays

An 8-page catalog describing a new series of mercury-wetted contact relays is available from Potter & Brumfield Div. of American Machine & Foundry Co., Princeton, Ind. Also included are formulas for calculating contact operating characteristics, stroboscopic photo-drawings, tables of resistance values and valves of max. voltage, termination wiring diagrams and algebraic formula with nomogram for the selection of contact protection. Circle 480 on Inquiry Card

Fans and Blowers

This 24-page Quick Reference Catalog on fans and blowers is available from Rotron Mfg. Co., Inc., Woodstock, N. Y. Included are condensed electrical and mechanical specs. with graphs on the Rotron line of fans and blowers designed for electronic and instrumentation cooling. Propeller, tubeaxial, and vaneaxial fans, and squirrel cage centrifugal, radial wheel, and multistage blowers are covered.

Circle 481 on Inquiry Card

Servo Components

A 16-page catalog offering a complete line of size 5 motors, motor tachometers and synchros; a size 8 line, including synchros and resolvers; a size 11 line including synchros and resolvers; and size 15 and 18 lines is available from Daystrom, Inc., Transicoil Div., Worcester, Pa. The catalog gives outline drawings, tabulation of electrical characteristics and information on transistorized servo amplifiers. Photographs and curves included.

Circle 482 on Inquiry Card

Static Relays

This 2-color, 4-page PS-9 product bulletin describes 3 basic "ultRelay" models: Model AIE (Thermocouple Control Type), Model AIB (Single Control Type High Resistance), and Model AIC (Double or Differential Control Types). Catalog includes application information, wiring diagrams, specs., connection diagrams, arrangements and spacing outline dimensions. Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J.

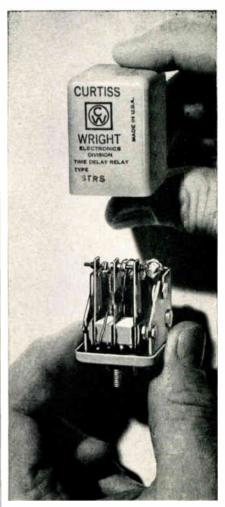
Circle 483 on Inquiry Card

Synchro Catalog

This 15-page condensed catalog, available from Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J., describes more than 65 synchros used in a variety of applications. Units presented include synchro control transmitters, control transformers, differentials, repeaters, Bu/Ord synchros, induction potentiometers (linear synchro transmitters), and resolvers for Size 5 to 25. Information is included on both 60 and 400crs types.

Circle 484 on Inquiry Card

Thermal Time Delay Relays



Instant Reset Voltage Compensated Vibration Resistant

Precision-built Curtiss-Wright thermal time delay relays reset instantly when de-energized — provide the same delay period for each succeeding cycle. Compensated for wide voltage variations. Available in either 28V DC or 115V AC, 60 or 400 cps. Chatterfree operation, under severe shock and vibration conditions. Small sized, hermetically sealed, temperature compensated for precise, reliable operation and long life. Preset time delays from 10 to 180 seconds with SPST, SPDT or DPDT snap action contacts.

Write for latest complete components catalog #516

ELECTRONIC FITTINGS CORPORATION ROUTE #7, DANBURY, CONNECTICUT a subsidiary of CURTISS-WRIGHT CORPORATION Circle 170 on Inquiry Card ELECTRONIC INDUSTRIES June 1962



WATERS

ctual Size



VISION

BY BUILDING PANEL MOUNT QUALITY INTO PRINTED CIRCUIT POTS

Anticipating the demand for a printed circuit pot with panel mount qualities, Waters designed the JPD/2. The JPD/2 Printed Circuit Pot maintained its high performance characteristics after being put through 3 times the rotational cycles required in MIL specs; vibration, shock, thermal cycling, load life tests, salinity and humidity tests did not impair its quality. The seal was found to approach that of a hermetically sealed pot.

Unwilling to enter a size-race that would compromise quality, Waters minimized only to improve performance and to assure production uniformity. Thus Waters minimized:

The number of component parts The space taken by the parts The number of hand-assembly operations And Waters also reduced costs.

The JPD/2 Printed Circuit Pot has a built-in dial face to indicate slider position. It is available in a resistance range from 10Ω to 20 K Ω . For further information write to: Dept. R3



WATERS MANUFACTURING, INC. WAYLAND, MASSACHUSETTS

ELECTRONIC INDUSTRIES · June 1962

Circle 171 on Inquiry Card

New Tech Data

Relays

Bulletin 100-N, available from Electronics Div., Iron Fireman Mfg. Co., 2838 S.E. 9th Ave., Portland 2, Ore., contains photographs and specifica-tion tables on 100JB-N, 6PDT, sensitive, microminiature type relays. The relays have 150mw sensitivity for dry circuit to high level switching. Circle 628 on Inquiry Card

Magnetic Clutches

Engineering and application in-formation on Fawick Magnetic Clutches and Brakes is contained in Bulletin No. M-106, available from Fawick Magnetic, Fawick Corp., 9919 Clinton Rd., Cleveland 11, Ohio. Il-lustrations, diagrams and detailed spec. charts in the 12-page manual explain construction and operation of all Fawick magnetic units. These include the SC clutch, the SA (powerapplied) and SB (spring-engaged) brakes. Circle 629 on Inquiry Card

Motors and Blowers

An 18-page, 3-color catalog "induction Motors and Blowers" is offered by Fasco Industries Inc., Rochester 2, N. Y. Information is included on two pole motors, 1/500 to 1/20 HP; 6 pole motors, 1 pole motors; 6 pole reversible motors; and centrifugal blowers. Included are photographs, descriptions, dimensional drawings, and performance curves.

Circle 630 on Inquiry Card

Servo Components

Diehl Mfg. Co., Small Motors Div., Somerville, N. J., is offering a condensed general catalog on servo components. The catalog covers 60 and 400CPS ac servomotors in output ratings from 1 to 750w, ac and dc tachometers, precision resolvers and phase shifters, servo amplifiers and dc components.

Circle 631 on Inquiry Card

Photoelectric Relays

New High-Speed Photoelectric Re-lays, SCW-136, describes versatile, high-speed, low-cost photoelectric re-lays activated by light increase or decrease. A table shows equipment combinations for operating ranges up to 70 ft. Diagrams and photograph show relay configuration, cabinet dimensions, knock-outs, and mounting provisions. General Electric Co., Schenectady 5, N. Y. Circle 632 on Inquiry Card

Tech. data including applications and the mechanical, and electrical characteristics of more than 60 mo-tors from Size 5 through Size 30 is included in a 16-page condensed catalog available from Kearfott Div., General Precision, Inc., Little Falls, N. J. Types of motors discussed include standard, synchronous, stepper, inertial damped, viscous damped, inertial damped, viscous damped, braked, and blower motors. Included are 60 and 400CPS types.

Circle 633 on Inquiry Card

Thermocouples

Full specifications for 6 types of Thrift/Therm Thermocouples are de-Scribed in Bulletin 207. Companion Bulletin 205 describes the Thrift/-Therm Kit, a package of 4 different units designed to measure temps. for 95% of all requirements. Thrift/-Harco Laboratories, Inc. - 300 to +2000°F. Harco Laboratories, Inc.,
 77 Olive St., New Haven, Conn. Circle 634 on Inquiry Card

Motor Fabrication

This 6-page folder illustrates a complete line of Possis automatic machines for electric motor fabrication. Coil winders, automatic cell and wedge inserters, armature winders, stator winders and automatic taping equipment for reproduction lines are included. Possis Machine Corp., 825 Rhode Island Ave. So., Minneapolis 26, Minn. Bulletin 6111M.

Circle 635 on Inquiry Card

Speed Reducers

Metron Instrument Co., 5302 S. Delaware St., Littleton, Colo., is of-fering a 12-page, 2-color brochure on their speed changing components for precision control of rotational speeds. Included are variable speed changers, speed reducers, special drives, flexible couplings, industrial tachometers, and speed changer kits.

Circle 636 on Inquiry Card

Ball Bearings

KuBar, Inc., 21 Erie St., Cambridge, Mass., is offering a 2-color, 8-page brochure entitled "Precision Ball Bearings." An interchangeability chart, referencing other bearing manufacturers and boundary dimensions and nomenclature of the basic bearings are also contained in the brochure.

Circle 637 on Inquiry Card

for Engineers

Variable Speed Drive

Bulletin 2200 describing ac-ac variable drive packages for 1/6 to 20 HP motors is available from Fidelity Instrument Corp., 1000 E. Boundary Ave., York, Pa. The 3-part package discussed in the bulletin consists of a magnetic amplifier control panel, a patented solid-rotor ac motor and a manual speed-control potentiometer.

Circle 638 on Inquiry Card

Pushbuttons

General purpose pushbuttons are described in a 12-page booklet avail-able from Westinghouse Electric able from Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa. Booklet B-7354 describes standard and special types of general pur-pose pushbuttons and enclosures for various uses in flush and surface mountings.

Circle 639 on Inquiry Card

Fan Units

"Whirl-Kool" units are efficient, compact, low cost integral fans for cooling electronic equipment. These quiet, lightweight, highly reliable fans quiet, lightweight, highly reliable ranks require no lubrication and mainte-nance. They are guaranteed for 5 years and power requirements are 105-125vac 60CPS, 1 θ . Ambient temp. range is from -20 to 50°C. Deltron Inc., 4th & Cambria Sts., Phila. 33, Pe. Pa.

Circle 640 on Inquiry Card

Industrial Plastics

A 16-page booklet on products and services of The Polymer Corp. and its subsidiaries and divisions, is available from The Polymer Corp., 2120 Fairmont Ave., Reading, Pa. The Fairmont Ave., Reading, Pa. The booklet outlines properties, uses, and availabilities of Polypenco nylon, Teflon, Fluorosint TFE base resin and other industrial plastics. Engineer-ing information on finishes for the Whirlclad coating system, Polymer's basic fluidized bed coating process, is also included.

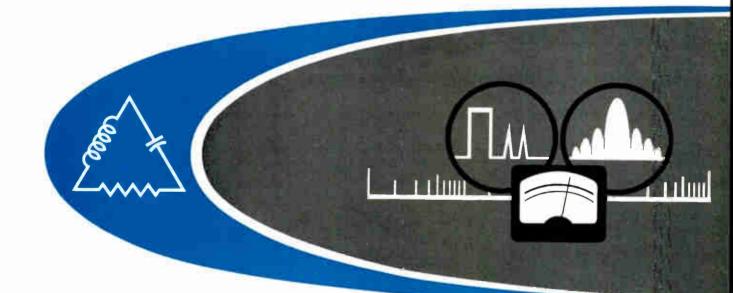
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Measurement & Test



- Making Microwave Measurements . . . G2
- Measuring Pulse Rate-of-Displacement . . . G9
 - How to Detect and Record . . . G13
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By PAT TUCCIARONE

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There are four basic measurements that are usually required in microwave work —VSWR and impedance, frequency, attenuation, and power. "How to" information for making these measurements is given here in simplified form.

Making Microwave

THERE are four basic measurements that one must be familiar with: voltage standing wave ratio (VSWR), power, attenuation, and frequency. At frequencies below 20 MC the measurement of VSWR is virtually unnecessary; at microwave frequencies, VSWR must be known accurately. Power, attenuation, and frequency measurements are required as they were for low frequency circuits, but the methods used to obtain these values are different.

Typical instruments required to generate microwave signals and to measure them are shown in Fig. 1. On the left is a klystron power supply (1a) and tube mount (1b) that contains an internal cavity reflex klystron. The power supply provides the necessary voltages for the operation of the klystron. In addition, there is a facility for providing modulation voltages both internally and externally. The reflex klystron is an oscillator capable of producing microwave energy when the proper voltage relationships exist between the various electrodes of the tube. The mount makes it possible to bring the required voltages from the power supply to the klystron via a cable and then, through a section of waveguide which is a part of the mount, the microwave energy is guided to the tuner (2) that follows. The power supply with its modulation circuits, klystron and mount, when combined into a single unit, is then a signal source. It is capable of providing pulse, square wave and sine wave modulated outputs in addition to CW.

Following the tuner, which is used to tune out reflections in the line, is a waveguide ferrite isolator (3), a non-reciprocal or one-way device which isolates the signal source from variable or unmatched loads. A magnetic field supplied by a permanent magnet contained within the isolator enables the ferrite materials to permit the transmission of electromagnetic waves in one direction only. Following the isolator is a cavity frequency meter (4). These meters are essentially resonant sections of coaxial line or circular waveguide whose resonant frequency is changed by means of a movable plunger. The position of the plunger is calibrated in terms of frequency. At the lower microwave frequencies (to about 4 KMC), coaxial cavities are used; at the higher microwave frequencies, right cylindrical waveguide cavities are more practical.

The next device in the setup is a direct reading precision attenuator of the rotary vane type (5) with an attenuation range of 60 db. The vane, upon which a dissipative material has been deposited, rotates about an axis which is parallel to the direction of propagation. The attenuation is a function of the angle between the vane and a plane parallel to the wide dimension of the waveguide. The expression relating the angular position of the vane to the attenuation is:

attenuation (db) = 40 log cos θ

where θ is the angle referred to above.

Following the rotary vane attenuator is a universal carriage and slotted section (6) and broadband probe (6a). The slotted section consists of a length of waveguide, with a narrow longitudinal slot in the center of the top wall. The carriage moves the broadband probe assembly along the length of the slot. Within the probe is a thin wire that forms the center of a coaxial line. The thin wire penetrates the waveguide through the slot and extracts a sample of r-f power. The probe is tunable so that it presents a shunt conductance across the transmission line. This will provide a maximum output, which is detected by a crystal. The crystal is an integral part of the probe assembly. To obtain the smallest value of shunt conductance (the smaller, the less the pickup wire reacts with the field within the waveguide), the penetration of the

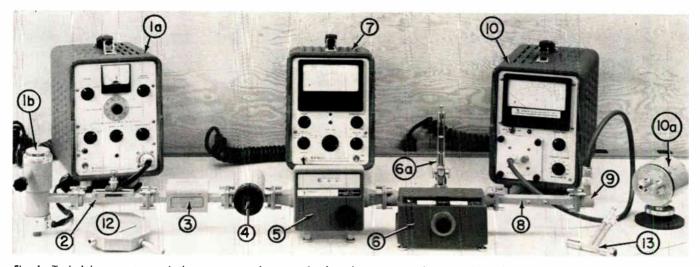


Fig. 1: Typical instruments required to generate microwave signals and to measure them are shown here.

Measurements

thin wire probe should be held to a minimum. The output of the crystal is a voltage which is directly proportional to the power sampled, provided that the crystal is operating in the square law region of its response characteristic. Square law operation of the crystal implies that its current reponse is proportional to the square of the input voltage or, in other words, the output voltage is directly proportional to the input power.

The detected output of the probe assembly is then fed to a VSWR amplifier (7). The meter of the amplifier is calibrated both in db and VSWR. The VSWR and db readings will be correct only if a square law detector is used to supply the amplifier input signal. A front panel control allows adjustment of the bandwidth from 4 to 40 cycles, centered about a 1000 CPs frequency. The amplifier gain is adjustable via a variable gain control and a switch calibrated in increments of 5 db. The amplifier is used to make VSWR or attenuation measurements.

Following the slotted section is a fixed waveguide attenuator (8) which may be used for accurate extension of the range of available power measuring equipment, or to provide isolation and padding. Affixed to the end of the attenuator is a waveguide to coax adapter (9) to provide a means for changing the transmission of microwave power from a waveguide to a coaxial line or vice-versa. The microwave power is then fed to a power meter (10) using a dry block calorimeter (10a) as a plug-in unit. The microwave power at the input to the dry calorimeter is evidenced as a dc voltage at the output terminals of the calorimeter. The power meter is calibrated to provide a direct readout of power. Other instruments, by no means an all-inclusive list, vital to the making of microwave measurements are a variable coaxial attenuator (12), coaxial tuner (13), waveguide thermistor mount, coaxial bolometer mount, standing wave detector, heterodyne frequency meter.

What follows are brief discussions of the measurement of the four basic microwave parameters.

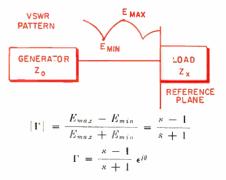
VSWR and Impedance

Standing waves in a transmission line occur when there is a mismatch or discontinuity in the line, so that some of the transmitted power is reflected back to the generator. The phase difference between incident and reflected power will cause the magnitude of the volfage at any point on the transmission line to be different from that of a point adjacent to it. Thus, a standing wave pattern results that repeats every half wavelength. The voltage standing wave ratio (VSWR) is essentially the ratio of the maximum amplitude to the minimum amplitude of the voltage standing wave pattern.

The impedance of a load, Z_x , can be determined knowing VSWR and θ where θ is the phase angle of the relection coefficient, Γ . VSWR, s, can be found by techniques described below while θ can be determined from

$$\theta = \frac{4\pi}{\lambda_g} \left(D - D_r \right) \pm \pi$$
 radians

where D is a voltage minimum location along the transmission line with Z_x at the reference plane and D_r is a voltage minimum location with a short circuit at the reference plane. $D - D_r$, then, is the shift of the voltage minimum location as a result of the change in load impedance.



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Measurements (Continued)

At the reference plane, $\frac{Z_x}{Z_o} = \frac{1+\Gamma}{1-\Gamma}$. Since the Smith chart is a plot of this relationship, and since both $|\Gamma|$ and θ can be determined, then the unknown impedance, Z_x , can be established using the Smith chart.

VSWR is the most significant of the microwave parameters in that its effect must be taken into account when the measurement of those parameters power, frequency, attenuation—is made. For example, in the measurement of power, if a generator with output impedance, Z_o , is connected via a uniform,

GENERATOR	Pinc	LOAD
Zo		$Z_{x} = Z_{0}$
	Prefi	

lossless transmission line of characteristic impedance, Z_o , to a load whose impedance, Z_x , is not equal to Z_o , then the total output power of the generator is made up of two components: incident power, P_{inc} ; and reflected power, P_{refl} . Then,

$$\frac{P_{\textit{refl}}}{P_{\textit{inc}}} \equiv |\Gamma|^2 = \left[\frac{s-1}{s+1}\right]^2$$

where Γ is the reflection coefficient and "s" is the VSWR. Similarly, when frequency and attenuation are being measured, the effect of VSWR must be taken into account to maintain maximum accuracies. This will be discussed in more detail in the frequency and attenuation measurement portions of this article.

One of the most common methods of measuring VSWR is by use of a slotted section and a VSWR amplifier, such as the PRD 277B, see Fig. 2. With the modulated signal source in operation, a maximum deflection is obtained on the meter of the VSWR amplifier by adjusting the modulation frequency control of the signal source, and by tuning the probe mounted on the slotted section. The probe is moved along the slotted section to a voltage maximum position, which is indicated by an increasing meter reading. The gain control of the VSWR amplifier is adjusted for full scale deflection. The probe is then moved to a voltage minimum. If the crystal in the probe, which is used to detect the signal is in square law operation, the VSWR is read directly from the meter.

If high values of VSWR are to be measured, the reading obtained from the VSWR amplifier at the voltage maximum point along the standing wave may not be correct because the crystal is operating in the non-square law region. Instead of reading the maximum and minimum voltages, convenient intermediate voltage values, located symmetrically at either side of a minimum, are selected. (Fig. 3.) This procedure is known as the "width of minimum" technique.

For VSWR greater than 10, and with square law detection, a useful and quite accurate approximation can be used to find the VSWR:

$$VSWR = \frac{\lambda_g}{2 \pi x_g}$$

where λ_g is the wavelength of the signal in the waveguide (see discussion of frequency) and x_o is the distance between the minimum and 3 db points. Thus, the probe assembly is moved along the slotted section until a minimum point is found and its location noted. The probe assembly is then moved until the meter reading on the VSWR amplifier increases by 3 db and this location is noted. The distance traveled between these two points is x_o . λ_g can be found using the methods outlined in the discussion of frequency. Substituting in the above equation will give the value of VSWR.

When measuring very low VSWR and its associated reflection coefficient angle, λ_g is difficult to determine in that both minima and maxima are very broad. Large errors could be introduced by trying to find their location by use of the VSWR amplifier. However, the expanded scale feature of the VSWR amplifier can be put to good use. A technique somewhat analogous to that used when making high VSWR measurements can be used. Symmetrical points are chosen about either maximum or minimum and unlike the method shown above, any convenient locations can be selected. Referring to Fig. 4, the maximum points shown are midway between x_1 and x_2 , x_3 and x_4 . Since the distance between successive maxima is one half wavelength, then

$$\frac{\lambda_q}{2} = \frac{x_4 + x_3}{2} - \frac{x_2 + x_1}{2}$$

When making VSRW measurements it is important to restate that minimum insertion of the probe into the slotted section is most desirable. This is to prevent setting up any reflections or disturbances due to the probe itself, and to insure that the crystal is not driven out of its square law region.

Some other techniques for measuring VSWR are through the use of impedance Tees and reflectometers. The latter technique is especially suitable when swept frequency measurements are to be made.

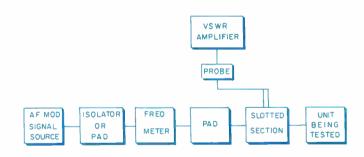


Fig. 2: Block diagram shows a VSWR measurement test setup.

Frequency Measurements

One of the properties or characteristics of an electromagnetic wave is frequency. Wavelength, λ , is related to frequency, f, by a proportionality factor, v, the velocity of propagation, which varies with the medium through which the wave is passing. Thus,

$$f\lambda = i$$

In free space, the velocity of propagation, v_o , is approximately 3 x 10⁸ meters/sec. and is given by

$$v_o = \frac{1}{\sqrt{\mu_o \epsilon_o}}$$

where μ_o is the permeability of free space and ε_o is the permittivity of free space. When an electromagnetic wave is propagated in a rectangular waveguide in its dominant mode, it can be shown that

$$\lambda_g = \frac{\lambda_o}{\sqrt{1 - \left(\frac{\lambda_o}{2a}\right)^2}}$$

where λ_{σ} is the apparent wavelength of the electromagnetic wave in the waveguide, λ_{σ} is its wavelength in free space and "a" is the larger internal dimension of the rectangular waveguide. Since λ_{σ} can be measured by the setup of Fig. 5, and v_{σ} and the larger dimension of the waveguide "a" are known, by using the following expression, the frequency of the electromagnetic wave can be determined:

$$T = \frac{v_v \sqrt{1 + \left(\frac{\lambda_g}{2n}\right)^2}}{\lambda_g}$$

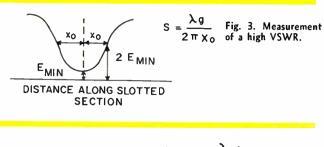
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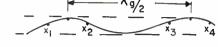
To measure the wavelength, λ_g , the distance between two successive minima or maxima is found and multiplied by two. By substituting in the above equation, then, frequency can be found to an accuracy of about 0.05%.

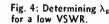
More direct methods of measuring frequency involve the use of cavity frequency meters or heterodyne frequency meters. Cavity frequency meters may be classified as either absorption or transmission type, see Fig. 6. A cavity frequency meter is able to measure frequency because of its resonant characteristics, which depend on the geometry of the cavity. The cavity geometry can be varied by a tuning plunger, thus allowing it to resonate at different frequencies. The absorption type frequency meter can be viewed as a band reject filter; the transmission type, a band pass filter.

When a cavity meter is used to measure frequency it should be in a well matched line so that no reflected impedances will effect the natural resonant frequency of the cavity. To reduce the reactive pulling on the cavity due to VSWR, attenuators can be used at both input and output of the cavity. Referring to Fig. 7, if an absorption type meter is used, there will be a greater deflection on the meter of the power monitor when the frequency meter is off resonance, with a marked decrease in deflection occurring when the frequency meter is tuned to the unknown frequency. The reverse is true if a transmission type of frequency meter is used. Thus, to measure the frequency, one need only adjust the tuning dial of the meter until the desired indication is obtained.

The heterodyne frequency meter technique uses a calibrated local oscillator signal, which is heterodyned with the unknown signal. The zero beat indication is determined audibly by a null or zone of silence. The beat may also be displayed on a cathode-ray tube. If the approximate frequency of the unknown signal is known, then the actual frequency is the integral multiple of the calibrated oscillator frequency which comes closest to the approximate frequency. Without any knowledge of the unknown frequency, except that it









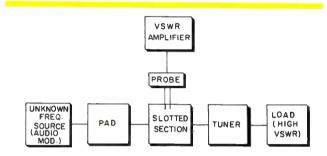


Fig. 5: Measurement of wavelength, λ_{g} , using slotted section.

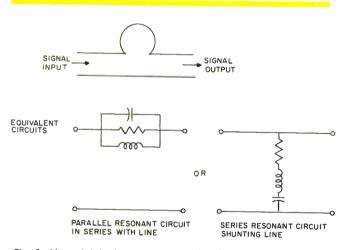


Fig. 6: Above (a) is the representation for absorption type cavity frequency meter. Below (b) is the representation for transmission type cavity frequency meter.

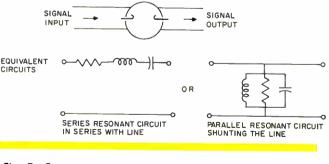
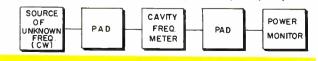
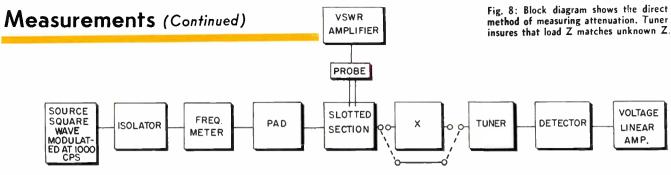


Fig. 7: Frequency measurement using a cavity frequency meter.



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is higher than the maximum calibrated local oscillator frequency, the unknown may be found by the determination of two successive zero beat readings of consecutive harmonics of the local oscillator. f_x is then:

$$f_x = \frac{f_1 f_2}{f_1 - f_2}$$

where, f_x is the unknown, f_1 is the higher beat frequency reading of the local oscillator and f_2 is the next lowest.

If the unknown frequency is known to be lower than the lowest calibrated local oscillator frequency, the unknown may be found unambiguously, but the measurement technique is a bit more involved.

Normally, heterodyne frequency meters are coupled to the source of an unknown frequency through level set attenuators (pads), or are loosely coupled through use of an antenna. Maximum accuracy is obtained when the unknown is a CW signal. With a modulated unknown signal, beat notes are generated due to the modulation side band frequencies in addition to the fundamental frequency of the unknown. For this reason, heterodyne frequency meters are not generally used to measure the frequency of a pulsed signal. In the case of CW signals, accuracies as good as 0.002% can be achieved.

Attenuation Measurements



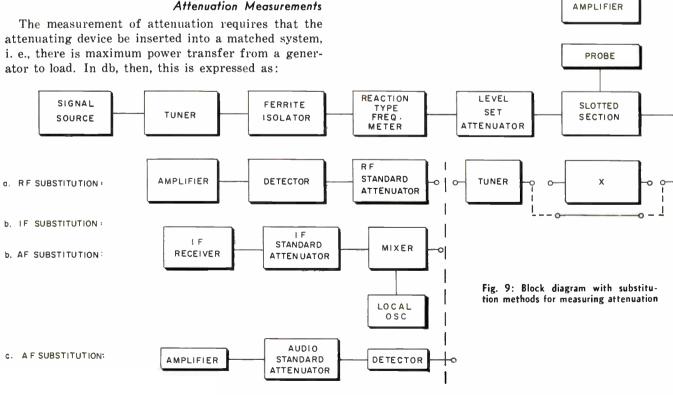
where A = attenuation in db

- P_1 = power delivered to load without the attenuator in the line
- P_2 = power delivered to load with the attenuator in the line.

Closely related to attenuation is insertion loss (IL). Its definition is similar to that shown above, except that there is no requirement for a matched line; that is, both generator and load may be of any arbitrary impedance. Frequently the term "insertion loss" is applied (really as a misnomer) to a variable attenuator to indicate the reduction of power delivered to a load when the variable attenuator is inserted into the system with an attenuation setting of zero db.

There are several ways of measuring attenuation. These are the direct method, substitution methods, and impedance measuring method. The particular method used will permit varying degrees of attenuation range and accuracies, as determined by the cost and complexity of the equipment required. Shown is a block diagram, Fig. 8, for measuring attenuation via the direct method. Note that the tuner is required to insure that the load impedance, as seen by the unknown, is a match. The unknown sees a match looking toward

VSWR



the left due to the presence of the variable level set attenuator.

The direct method involves the use of (1) a square law detector and (2) a voltage linear amplifier and readout device. Changes in attenuation due to the unknown are manifested by proportional changes in the output voltage. For example, if the attenuation is increased by 3 db, the output voltage is reduced to $\frac{1}{2}$ its original value. If the unknown is a fixed attenuator, the output indicator is set to read full scale without the attenuator in the circuit. The attenuator is then inserted, and the db change is noted on the indicator. Power attenuation is then $\frac{1}{2}$ the voltage attenuation indicated on the meter. Note, this is true only if the detector is square law.

If the attenuator is a variable one, using the procedures as outlined above with the attenuator dial set to zero will yield the "insertion loss." Once this has been obtained, the attenuator can then be varied and the attenuation figures taken from the meter readings. The markings on the attenuator dial are thus calibrated in terms of db of attenuation. Also, it may be desirable to return the attenuator dial to zero as the attenuation measurements are being made to insure that the reference level has not shifted. This technique is useful in general lab. work where a rapid measurement is required with a minimum of equipment. With the setup shown in Fig. 8, where the detector is a bolometer, a range of about 40 db with accuracies of 0.2 db can be realized.

In the substitution methods, r-f, i-f, and audio substitution, see Fig. 9, the procedure is basically the same for all three in that the unknown is compared to a previously calibrated attenuation standard. For example, in the r-f method, the unknown attenuator is inserted into the line after a reference level has been set. A calibrated attenuator is then adjusted to restore the original signal level. The change in the setting of the standard r-f attenuator gives the attenuation of the unknown directly. Thus, the calibrated attenuator must have a range greater than that of the attenuator to be measured or, at least, equal to it.

Attenuators that are used as standards are usually either of the waveguide-beyond-cutoff or resistive film types. The former have high insertion loss, are relatively narrow band, and the attenuation characteristic is due to reflection. The resistive film type have low insertion loss, can be made to be broadband, and attenuation is mainly due to dissipation of power. However, the waveguide-beyond-cutoff type of attenuator has an attenuation characteristic which can be calculated and is linear (within limits) as a function of frequency, whereas the resistive standard is not linear and must be calibrated over its dynamic range. Wire wound or film type attenuators are used in the audio technique of measuring attenuation. The waveguide-beyond-cutoff type is used in the i-f technique; and in the r-f method, resistive film attenuators are used (rotary vane or sidewall).

In the i-f and audio substitution methods there is an inherent advantage in that the standard attenuator need be calibrated at one frequency only. In the i-f technique, an r-f signal is heterodyned with a local oscillator signal. After linear mixing, the resulting i-f frequency passes through an i-f standard attenuator into an i-f receiver with a resulting signal level established in the i-f receiver. The unknown is then inserted into the r-f line, and the i-f attenuator is adjusted to restore the former level. The change in the setting of the i-f attenuator is equal to the attenuation introduced into the system by the unknown. The accuracy of this technique requires that frequency conversion be linear, i.e., that the i-f power is proportional to the r-f power. Thus, if the r-f signal is reduced by "N" db there is a correspondingly equal reduction of power in the i-f signal.

The audio substitution technique uses a detector, such as a bolometer, ahead of a calibrated audio attenuator. As in the methods above, the output level is maintained constant. The measurement is made by establishing a level on the amplifier with the unknown removed from the line. The unknown is then introduced into the r-f line with the audio level restored via the audio attenuation standard. In this case, however, the change in the setting of the standard is equal to twice the value of the unknown because it is ac voltage (not power) input to the audio standard which is proportional to the r-f power level. However, the detector must be operating in its square law characteristic for the 2:1 relationship to hold.

Use of the substitution techniques will afford attenuation measurement ranges of about 70 db using the r-f method, up to 75 db for the i-f method, and 40 db for the audio method. In general, the accuracy of the r-f method is limited by the calibration of the stand-

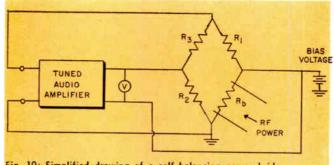


Fig. 10: Simplified drawing of a self-balancing power bridge.

ard r-f attenuator. The i-f method is limited by the dynamic range of mixer linearity. The a-f method is restricted by the range of square law response of the detector. Some of the sources of error and factors that apply to most attenuation measurements are:

- 1. power level variations in the r-f signal
- 2. line mismatches
- 3. amplifier non-linearity
- 4. db switch, movement and scale inaccuracies of the indicator
- 5. r-f leakage which may bypass the unknown attenuator
- 6. deviation of the detector from square law, and deviation of mixer from linear operation.

Power Measurements

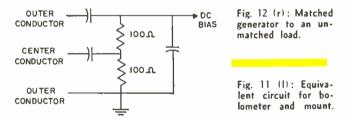
At frequencies below approximately 300 MC, one may describe power in terms of voltage, current, and phase. However, at microwave frequencies this is no longer possible. In order to make power measurements, one must resort to thermally sensitive elements

Measurements (Concluded)

such as bolometers and thermistors, or calorimetric techniques must be used where microwave power is converted to a heat equivalent.

A bolometer or thermistor is a temperature sensitive device whose resistance changes due to the heating effect of r-f power being absorbed by it. Bolometers have positive temperature coefficients, while thermistors have negative temperature coefficients.

One of the common methods of measuring microwave power is through use of a power meter of the self-balancing bridge type, one arm of which is a bolometer or thermistor. Because this technique is in such widespread use, a brief description will be given of the theory of operation of the self-balancing bridge (see Fig. 10). Resistances R_1 , R_2 , and R_3 are resistive arms of the bridge while R_b represents the resistance of the bolometer. The equivalent circuit for a coaxial bolometer and mount is shown in Fig. 11. The bolometer resistance is 200 ohms for dc or audio power while its r-f resistance is 50 ohms. The bridge is a coupling network between the input and output of the tuned audio amplifier such that an oscillating circuit is formed. The bridge is initially balanced by biasing the bolometer with both dc and a-f power to its 200 ohm operating resistance. When r-f power is applied to the bolometer, its resistance will change due to the additional heat introduced by the r-f power. The resultant unbalancing of the bridge causes the a-f power to be reduced in order to bring the bridge back into balance. This change in audio power is a measure of the r-f power which has been applied to the bolometer and is externally evidenced as an up-scale deflection of the



meter, which is calibrated in r-f milliwatts.

Note that before r-f power is introduced, the total bolometer power is audio (P_{audio}) plus dc power, (P_{dc}) . After r-f power is injected and the bridge has returned to a balanced condition, the total bolometer power is now comprised of the sum of the same dc power as before, plus r-f power (P_{rf}) and audio power (P'_{audio}) which is less than that which was used to bias the bolometer. Expressed in an equation:

$$P_{audio} + P_{dc} = P_{dc} + P_{rf} + P'_{audio}$$
$$P_{rf} = P_{audio} - P'_{audio}$$

where P'_{audio} is less than P_{audio} by an amount equal to

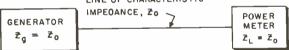
 P_{rf} . Thus, in order to make a power measurement on a self-balancing bridge type of power meter as shown in Fig. 1(11), with the bias current control set to Off, connect a bolometer (or thermistor) to the Bolo input terminal. If the approximate value of power to be measured is known, set the Range switch accordingly; if not, set to maximum range, 100 mw. Set the Temp Coefficient switch to its appropriate position

(+ for bolometers, - for thermistors). Turn the meter on and adjust the Bias Current switch for zero indication on the meter (bridge is in balance). Connect the bolometer or thermistor mount to the source of r-f power to be measured. The meter should now deflect up scale. The reading is r-f power in milliwatts. Disconnect and check the zeroing of the meter. If not zero, repeat the measurement. Although the instrumentation accuracy is 3% of full scale, errors introduced by VSWR of the bolometer mount, mount inefficiency, and the lack of equivalence between r-f and audio heating, may permit accuracies of only 6-15%.

In order to make more accurate measurements, then, a dry block calorimeter should be used. To make a power measurement with a dry block calorimeter type of power meter, one need only zero the meter with the Power Range switch set to the lowest scale (with no r-f input). The range switch is then set to the appropriate range, the r-f is introduced at the r-f input jack and the power is read directly from the meter. Accuracies of the order of 1.5-2.5% for the calorimeter and 2% for the instrumentation of the power meter are attainable. When power measurements are made, the VSWR in the line should be known accurately so that a correction for this source of error can be calculated. Thus, if the generator VSWR is unity (generator impedance, Z_g , is equal to the characteristic impedance, Z_o , of the uniform, lossless transmission line used), the power indicated on the power meter, P_m , will be less than the available power, P_a , being transmitted by the generator (see Fig. 12). Thus,

$$P_a = \frac{P_m}{1 - |\Gamma|^2}$$

UNIFORM, LOSSLESS TRANSMISSION LINE OF CHARACTERISTIC



Whenever power measurements greater than 0.5w are to be made, sampling methods using directional couplers which sample a precisely known quantity of power from the main line may be used. Alternatively, the unknown power may be attenuated by a known amount with the use of a precision attenuator. The high power is then calculated from the power meter reading and the value of attenuation used.

Conclusion

The foregoing statements have only touched lightly on the various techniques of the measurements discussed. For example, atomic frequency standards for measuring frequency have not been mentioned. In the measurement of power, a volume could be written on the analysis of errors to be considered in making those measurements. Similarly, much information is available in the literature concerning VSWR, impedance and attenuation measurements. Among other sources, microwave manufacturers are eager to provide technical information which can be of great help to the engineer. A good source is the PRD Reports from which much of the information contained herein has been derived.

By W. W. WHATLEY Senior Test Engineer Hughes Aircraft Co. Tucson, Arizona



Measuring Pulse Rate-of-Displacement

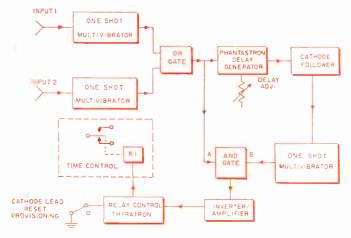
Time required to achieve a pre-selected displacement between two time related pulses must often be measured. A circuit is described which automatically makes this measurement using a simple combination of AND and OR gates, and a delay generator.

MANY pieces of equipment make use of pulses. These pulses can take on many forms in size. shape, and timing relationship. Regardless of characteristics, the pulse must be measured or analyzed during design and maintenance.

One of the tougher jobs is to measure the rate of change¹ in the intervals between two time-related pulses at certain increments in time, when one pulse is driven, or allowed to move randomly, from time coincidence with respect to the other.

With the design details given here, a circuit can be built which automatically makes the measurements. This circuitry can be adapted to other types of pulse measurements.

Fig. 1. Circuit is actuated by two synchronized pulse signals which are of sufficient amplitude to trigger the input multivibrators.



One shot multivibrators (Fig. 1) are connected in series with each input so that the OR gate will receive impulses of constant amplitude and duration at both of its inputs.

Outputs of the OR gate connect through a Phantastron delay circuit to input B of the AND gate, and directly to input A of the AND gate.

When the pulses at inputs A and B of the AND gate are in time coincidence, there is an output from the gate. This output is coupled to the Inverter/Amplifier (I/A).

The signal appearing at the output of the I/A is fed to the Relay Control Thyratron causing it to fire. Plate current, flowing in the Thyratron, energizes the timer control relay K1 which in turn controls a basic time measuring device.

A reset line is provided for the Thyratron circuit enabling remote resetting of the timer control relay.

Operation

When the two input signals are in time coincidence, the phantastron delay circuitry is energized simultaneously with the occurrence of the input signals. The delayed output signal is coupled to input B of the AND gate and the undelayed signal is coupled to input A of the AND circuit. Fig. 2 shows the time relationship between these pulses.

Since the signal being applied to input B of the AND circuit is delayed relative to the signal applied to input A of the AND circuit, there is no output

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^{1.} Rate of change is the total time required for a given time separation to occur between input pulses, regardless of directions of movement.

Rate of Displacement (Continued)

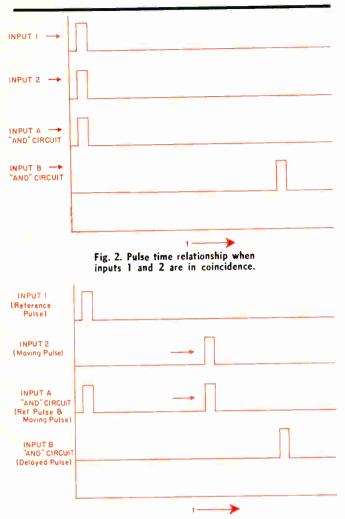


Fig. 3. Pulse time relationship when input 2 is being delayed relative to input 1.

 Fig. 4. Pulse time relationship when input 2 delay equals phantastron delay.

 INPUT 1 (Reference Pulse)

 INPUT 2 (Moving Pulse)

 INPUT 4 "AND" CIRCUIT (Ref. Pulse 8 Moving Pulse)

 INPUT B "AND" CIRCUIT (Deloyed Pulse)

 OUTPUT "AND" CIRCUIT 6 INPUT TO INVERTER/ AMPLIFIER

 OUTPUT TO INVERTER/ AMPLIFIER

 from the AND gate. Consequently, the I/A and Thyratron remain in their quiescent states.

If it is assumed that one input signal provides a time reference and that the other input is being displaced relative to the reference pulse, it is possible to measure the time required for the second pulse to move a pre-determined distance. This is a measure of the rate of change in the time domain.

Whichever pulse occurs first will cause the phantastron delay circuit to generate one cycle of delay. During the period of this delay, the phantastron is insensitive to all other incoming trigger pulses. As long as the second input pulse does not lag the first by an amount equal to the phantastron delay, there is no output from the AND gate and the circuit remains in its quiescent state the same as when the two input pulses were in coincidence. Fig. 3 shows this relationship.

Inputs to the AND gate will be in time coincidence when the pulse being displaced from the time reference has moved an amount equal to the phantastron delay. There will then be an output signal from the AND gate, I/A, and Relay Control Thyratron, thus energizing the timer control relay K1, Fig. 4.

If the timer control circuitry is so arranged that the timer begins to operate at the instant initial coincidence is lost, and stops with the energizing of the timer control relay, the timer will then read the rate of change between the two input pulses at any discrete interval of time as selected by the adjustment of the phantastron delay circuit. That is:

TIME DISPLACEMENT

RATE OF CHANGE =

TIMER READING

Time displacement can be set to any desired time by adjusting the phantastron delay.

Circuit Description

Waveform information was measured under conditions specified in notes of Fig. 5. Input pulses at P1 and P2 must be at least 10 volts in amplitude and $0.25 \ \mu secs$ in width. Diodes CR1 and CR3 are used to limit negative voltage excursions at the grids of tubes V1 and V10. The pulse through P1 triggers one shot multivibrator V1 and the pulse input to P2 triggers one shot multivibator V10. Time constants of these multivibrators (C2, R1, R6, and C4, R16, R20) are selected so that the duration of their output pulses is approximately 0.5 μ secs. Controls R2 and R21 are used to adjust the multivibrator outputs to equal amplitudes, assuring constant amplitude and duration inputs to the OR gate V2.

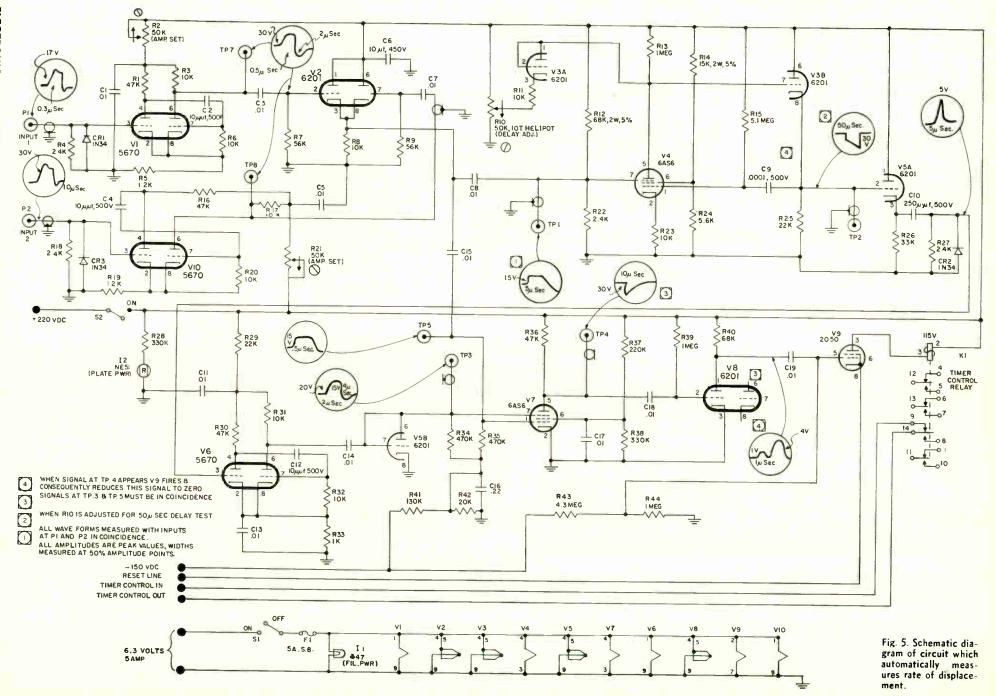
Output of the OR gate is taken across R8 and coupled through C8 to the suppressor grid of phantastron tube V4, and through C15 to the control grid of the AND circuit V7.

Bias for the suppressor grid of the phantastron is obtained by plate current through cathode resistor R23 and by voltage divider R12 and R22. Bias voltage thus developed insures that the phantastron will only function upon receipt of a trigger pulse of sufficient amplitude.

Tube V3a clamps the plate voltage of V4, determining the delay characteristics of the Phantastron



GII



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Rate of Displacement (Concluded)

circuit. Level of this clamp voltage can be set by adjustment of R10. Thus, discrete increments of time for which measurements are desired, may be selected.

Tube V3b serves as a recovery time cathode follower for the Phantastron circuit. In normal operation, a phantastron has a rather slow recovery time due to recovery time constant, consisting of control grid circuit capacitance and resistance. Addition of a cathode follower to the grid and plate circuits, as shown in Fig. 5, provides a low impedance discharge path for the grid circuit capacitor, greatly improving recovery time of the phantastron.

An output from the phantastron delay circuit is derived across cathode resistor R25 of the recovery time cathode follower V3b. This signal is connected to the grid of V5a, a cathode follower used for isolation purposes. Its output is coupled through a differentiating network, consisting of C10 and R27, to the grid of a one shot multivibrator V6. Diode CR2 in this grid circuit is used to clip the negative portion of the differentiated signal.

Capacitor C14 couples the output of the multivibrator V6 to the suppressor grid input of the AND gate V7. V5b is wired as a diode and is used to prevent the suppressor grid of V7 from going possitive and drawing grid current which could result in damage to the tube.

Bias voltage for both the control grid and the suppressor grid of the AND gate is obtained by means of a fixed voltage divider from the negative voltage supply.

When the inputs to the AND gate are coincident, the signal from the plate of that tube is fed through C18 to the control grid of L'A V8. Output of this stage is in turn coupled to the grid of the Thyratron V9, causing it to fire and energize timer control relay K1. In the circuit shown, the clutch voltage to an electrical timer is fed through normally closed contacts of K1. This voltage is applied simultaneously with the beginning of drifts of the pulses whether random or forced. When the relay energizes at the end of the measured drift period, the timer stops. Thus, the rate of drift has been recorded on the electric timer.

Pin 8 of the Thyratron V9 has been connected to a terminal on the power input connector to provide a remote reset capability for the circuit. By placing a switch in this circuit its continuity to ground can be interrupted. This returns relay K1 to its initial state allowing additional measurements to be made.

Performance

The circuit described has been in use for a considerable period of time and the results have been excellent. It has been used to measure drift rates for time changes of 50 to 500 μ secs. at repetition rates of 1,000 to 2,000 cps. Maximum drift time which can be selected for measurement for a given repetition rate is approximately equal to $\frac{3}{4}$ the period of the particular repetition rate. Further, it is obvious that if delay periods radically different from those for which the circuit was initially designed are required, it will be necessary to change the time constant in the phantastron control grid circuit. This is a simple and straightforward requirement and no difficulties should be anticipated.

Relay K1 was used to control a motor-driven electrical timer. By proper selection of circuit voltages and configuration, virtually any type of timing device can be used.

Acknowledgments

The author wishes to express his appreciation to Mr. W. W. McGehee, Engineering Supervisor. California Technical Industries, and Mr. R. W. Krawec for their assistance in the conception and development of this system.

Power Ratio	Voltage and Current Ratio	Decibels	Power Ratio	Voltage and Current Ratio	Decibels	Power Ratio	Voltage and Current Ratio	Decibels
1.0233 1.0471 1.0715 1.0965	1.0116 1.0233 1.0351 1.0471	0.1 0.2 0.3 0.4	2.2387 2.5119 2.8184 3.1623	1.4962 1.5849 1.6788 1.7783	3.5 4.0 4.5 5.0	158,49 251,19 398,11 630,96	12.589 15.849 19.953 25.119	22.0 24.0 26.0 28.0
1.1220 1.1482 1.1749 1.2023	1.0593 1.0715 1.0839 1.0956	0.5 0.6 0.7 0.8	3.5481 3.9811 5.0119 6.3096	1.8836 1.9953 2.2387 2.5119	5.5 6.0 7.0 8.0	1000.0 1584.9 2511.9 3981.1 6309.6	31.623 39.811 50.119 63.096 79.433	30.0 32.0 34.0 36.0
1,2303 1,2589 1,3183 1,3804	1.1092 1.1220 1.1482 1.1749	0.9 1.0 1.2 1.4	7.9433 10.0000 12.589 15.849	2.8184 3.1623 3.5481 3.9811	9.0 10.0 11.0 12.0	$ \begin{array}{r} 10^{4} \\ 10^{4} \times 1.5849 \\ 10^{4} \times 2.5119 \\ 10^{4} \times 3.9811 \\ 10^{4} \times 6.3096 \\ 10^{5} \end{array} $	100.000 125.89 158.49 199.53 251.19 316.23	40.0 42.0 44.0 46.0 48.0 50.0
1.4454 1.5136 1.5849 1.6595	1.2023 1.2303 1.2589 1.2882	1.6 1.8 2.0 2.2	19.953 26.119 31.623 39.811	4,4668 5,0119 5,6234 6,3096	13.0 14.0 15.0 16.0	$\begin{array}{c} 10^{5} \times 1.5849 \\ 10^{5} \times 2.5119 \\ 10^{5} \times 3.9811 \\ 10^{5} \times 6.3096 \\ 10^{6} \end{array}$	398.11 501.19 630.96 794.33 1,000.00	52.0 54.0 56.0 58.0 60.0
1.7378 1.8197 1.9055 1.9953	1.3183 1.3490 1.3804 1.4125	2.4 2.6 2.8 3.0	50.119 63.096 79.433 100.00	7.0795 7.9433 8.9125 10.0000	17.0 18.0 19.0 20.0	107 108 109 1010	3,162.3 10,000.0 31,623 100,000	70.0 80.0 90.0 100.0

Decibels (db) and Power, Voltage, & Current Ratios

To convert: Decibels to nepers multiply by 0.1151. Nepers to decibels multiply by 8.686. Where the power ratio is less than unity, it is usual to invert the fraction and express the answer as a decibel

MEASUREMENT & TEST EQUIPMENT

How to . . .

Detect and Record

INDUSTRY has been looking more and more toward electronics as a means of providing automatic high quality production. In this field it is becoming increasingly important not only to provide a suitable control system, but also to keep an accurate permanent record of various process parameters.

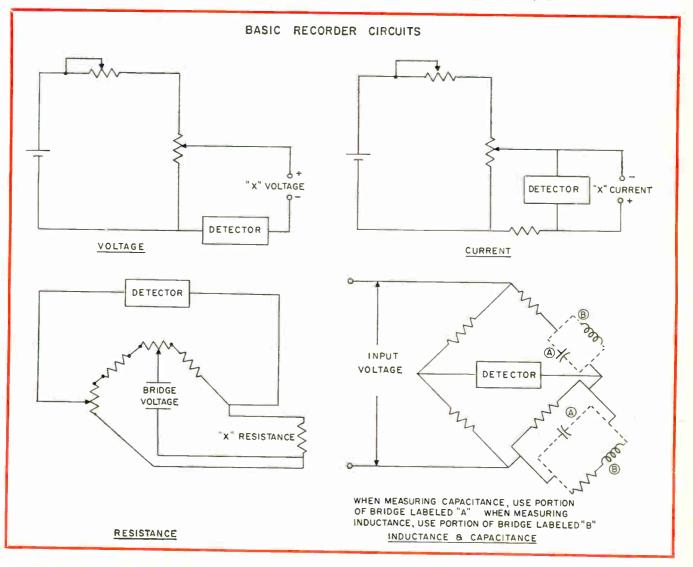
Modern recorders are, for the most part, sensitive only to variations in electrical quantities. If the parameter to be recorded is not electrical, it must be converted to an electrical signal. This conversion is accomplished by a suitable transducer.

The chart on the following page lists the basic types of transducers, the physical quantity they detect and the electrical output they produce. Since different electrical outputs are produced, different electrical circuits must be employed to record these outputs.

The basic circuits are illustrated below. The most commonly used circuits for recording variations in voltage and current are of the potentiometer type. Bridge type circuits are used to record variations in resistance, capacitance and inductance.

In some cases, it is desirable to use the recorder for actual control of the process. Along these lines some recorders are designed with a control system incorporated within the recorder; in others, suitable attachments are available for adapting the recorder as a control mechanism.

(Continued on page G14)



MEASUREMENT & TEST EQUIPMENT

Туре	Measurand	Units	Output	Recommended Recorder Circuit
-C Current, Voltage & Power De	tector			
hermal Converter	A-C valts, amps, watts	Volts, amps, watts, vars	Voltage	Potentiometer
cceleration Detectors			T D	W Datidas
ccelerometer	Acceleration	"g's" "g's"	Resistance Capacitance	Wheatstone Bridge Wien Bridge
ccelerometer	Acceleration Acceleration	"g's''	Inducton ce	Wien Bridge
ccelerometer	Acceleration	"g's"	Voltage	Potentiameter
Color Detector	receieranon			
hotatube	Wavelength	Å	Current	Potentiometer
onductance Detector (in liquids)	Electrolutio Conductores	mhas	Resistance	Wheatstane Bridge
Conductivity Cell	Electrolytic Conductance	mids	Keststandee	integration bridge
Density Detectors	Liquid Density	g/cc	Current	Potentiometer
robe Plummet Chamber adioactive Density Gage	Gas & Sturry Density	g/cc	Current	Potentiometer
imoke Gage	Smoke Density	3,	Current	Potentiometer
Displacement Detector				
Displacement Gage	Displacement	Lineal	Resistance	Wheatstone Bridge
Displacement Gage	Displacement	Lineal	Capacitance	Wien Bridge
low Detector				
low Meter	Flow Rate	Note A	Resistance	Wheatstone Bridge Wien Bridge
law Meter	Flow Rate	Note A Note A	Inductance Voltage	Potentiometer
urbine Flowmeter	Flow Rate		, en age	
requency Detectors	Vibration	CDS	Voltage	Potentiometer
hagneto strictive Devices Piezoelectric Devices	Vibration	cps cps	Voltage	Potentiometer
as Composition Detectors	Vapor Composition		Resistance	Wheatstone Bridge
nfrared Absorption Cell	Gas Composition	% Composition	Valtage	Potentiometer
hermal Conductivity Cell	Gas Composition	% Composition	Valtage	Potentiometer
umidity Detectors				
Coaxial Capacitor Tube	Humidity	%	Capacitan ce Resistance	Wien Bridge Wheatstone Bridge
Hygrometer	Humidity	%	Resistonce	- mieursione Dridge
ength Detectors		1 1 1	Voltage Pulse	Counter
Continuous Length Indicator	Length	Lineal	Voltage Fulse	Counter
evel Detectors			Resistance	Wheatstone Bridge
_evel Indicator	Liquid Level	Lineal — — Lineal	Capacitance	Wien Bridge
_evel Indicator _evel Indicator	Liquid Level Liquid Level	Pressure	Voltage	Potentiometer
Light Detectors Barrier Layer Photocell	Light	Nate B	Voltage	Potentiometer
Photoconductive Tube	Light	Note B	Resistance	Wheotstone Bridge
Phototube	Light	Note B	Current	Potentiometer
Moisture Detectors		Degrees	Resistance	Wheatstone Bridge
Bead Thermistors	Moisture	Degrees	Reststutice	
Blass Electrode	pH Concentration	pH	Voltoge	Potentiometer
	pri Concentration			
Pressure Detectors	Pressure	Pressure	Inductance	Wien Bridge
Bellows Pressure Goge Bourdon Tube	Pressure	Pressure	Voltoge	Potentiometer
Capacitive Pressure Goge	High Pressure	psi	Copacitonce	Wien Bridge
Cold Cothode Ion Goge	Low Vocuum	Micrans af Hg	Current	Potentiometer Potentiometer
on Goge	High Vacuum	Microns of Hg	Voltage Resistance	Wheotstone Bridg
Strain Gage Thermocouple Pressure Goge	Pressure Abs. Pressure	psi Microns of Hg	Voltoge	Potentiameter
		1		
Radiation Detectors	Ionizing Radiation		Current	Potentiometer
Ohmart Cell	Ionizing Rodiation		Current	Potentiometer
Speed Detector				
Photocell Goge	Velocity	Velocity	Voltage Pulses	Counter
Tochometer	Rotational Velocity	RPM	Voltage	Potentiometer
Stroin Detector				
Stroin Goge	Stress, Stroin	Note C	Resistonce	Wheatstone Bridg
Temperature Detector				1 111 1 1 0 1 1
Bolometer	Temperoture	Degrees	Resistonce Voltoge	Wheotstone Bridg Potentiometer
Contoct Thermometer	Temperature Temperoture	Degrees Degrees	Voltoge	Potentiometer
Pyrometer Thermistor	Temperoture	Degrees	Resistonce	Wheotstone Bridg
Thermocouple	Temperature	Degrees	Voltoge	Potentiometer
Thermopile	Temperature	Degrees	Voltoge	Potentiometer
Thickness Detectors				
Radioactivity Gage	Thickness	Lineol	Pulses	Counter Patentiometer
Ultrosonic Goge	Thickness	Lineal Lineol	Current Voltoge	Potentiometer
X-Roy Goge	Thickness	Lineoi		
Viscosity Detector	Viene it.	Continuisc	Voltage	Potentiometer
Flow Meter	Viscosity	Centipoise	tonage	, creation of the

NOTE A - Depending on the opplication, units may be a measure of linear velocity (ft./sec., in./min., etc.) or volume velocity (gol./min., cu.ft./sec., etc.)

NOTE B - Depending on the opplication, units may be a measure of wovelength (Angstroms) or intensity (condles).

NOTE C - Depending on the opplication, units may be a measure of stress (force per unit area, e.g. - psi) or stroin (deformation per unit length, e.g. - inches per inch).

Many manufacturers have developed equipments which take advantage of the excellent calibration accuracy which VLF transmissions provide. But often, the techniques required are confusing to those accustomed to high frequency and time comparison methods only. This article clarifies the situation for users and prospective users.



VLF Transmissions Aid in ...

Calibrating Frequency Standards

By DAVID RIVKIN

Measuring Instruments Motorola, Inc. 4501 W. Augusta Blvd. Chicago 51, III.

THE missile and space age demands greater accuracies and stabilities than are obtainable from comparison with HF standards stations. In 1959, the first of the vLF stations went on the air at Balboa, Canal Zone. This station, NBA at 18.0 KC, operated by the U. S. Navy has since been joined by an everincreasing network of vLF stations. With power outputs up to 2 megawatts, highly stable propagation characteristics, and long range reception, the current network of vLF stations provides the ability to calibrate frequency standards on a world-wide basis to within 1 x 10⁻¹⁰ in relatively short time.¹

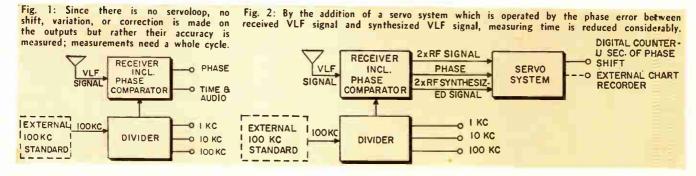
HF Limitations

Until a few years ago, frequency standards were calibrated against HF stations such as WWV and WWVH. Because of unstable HF radio propagation characteristics, the best accuracy that may be obtained by frequency comparison, even over a period of several days' observation, is limited to between $1 \ge 10^{-8}$ and $5 \ge 10^{-9}$. Using either an electronic counter or stable electro-mechanical clock to count the time intervals between time ticks, *comparison* accuracy of a couple parts in 10^{10} may be obtained over a period of a few weeks. However, besides the time required for the measurements, rather complex computations are involved.

VLF and LF Characteristics

Transmissions at VLF (3-30 KC) and LF (30-300 KC) have many unique characteristics when compared to HF transmissions (3-30 MC). These traits are:

- 1. Remarkable phase stabilities permitting frequency synchronization to $1 \ge 10^{-10}$ or better in a relatively short time,
- 2. Long distance (6,000 miles or better) reliable reception* making single and /or double channel receivers practical and feasible,
- 3. Diurnal shift predictable in time of occurrence,
- 4. Relative immunity to disturbances caused by thermonuclear explosions,



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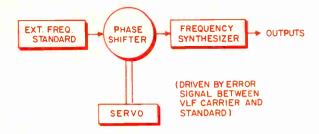


Fig. 3a: In this system the phase shifter output is apparently always phase coherent with VLF signal; however, this is not the case.

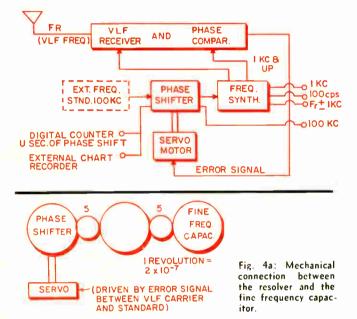


Fig. 3b: Though more expensive due to the addition of the output phase shifter, this system offers no more compensating advantages.

Fig. 4b: This oscillator is continually kept on frequency by servo system operation which drives the oscillator's frequency capacitor.

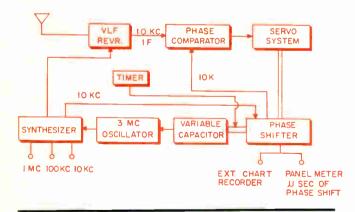
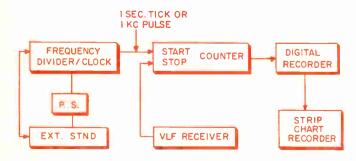


Fig. 5 (below): Though apparently most expensive of the methods suggested, this system's cost may be reduced by availability of equipment.



Frequency Standards (Continued)

- 5. Inability to synchronize clocks to better than 0.5 msec because of the high antenna rise time of the VLF pulse (15 msec at 18 KC), and
- 6. Transmission accuracies of $1 \ge 10^{-10}$ or better.

A moderately priced cesium beam standard (about \$15,000) can only be set to an accuracy of $1 \ge 10^{-9}$ unless it is referenced to an external standard such as vLF transmissions.** We can see that the use of VLF transmissions allows one to calibrate and maintain frequency standards to an order of stability and accuracy not heretofore obtainable at a reasonable cost in equipment or time.

VLF transmission accuracy is controlled by the world's most stable crystal standards which are referenced to cesium standards. These standards are in turn compared with the speed of rotation of the earth. By putting the complex equipment at the transmitter, the VLF receiver user obtains the benefit of many tens or hundreds of thousands of dollars of frequency standards at a nominal cost. Also, state of the frequency art advances will be incorporated at the transmitter. The VLF user will, therefore, have essentially an obsolescent-free system.‡

Even though VLF transmission use for frequency standard calibration is new, the system's merits have caused several manufacturers to enter the field. A number of different approaches or methods have resulted: this caused considerable confusion, since most people are familiar only with the methods of HF and time comparison.

1. Beat Frequency-Individual Observation

This is the least expensive but most time consuming and least satisfactory method of calibrating a frequency standard. One may record the beat difference on a chart recorder. The reason for excessive time consumption is the low frequency of the received signal. If the received signal is NBA at 18.0 KC, it takes over 15 hrs to obtain one full cycle for a difference in frequency of 1 part in 10° or more than $7\frac{1}{2}$ hrs to record one half of the beat note:

$$T = \frac{\Delta F}{F_r}$$

where ΔF is the frequency difference between the received signal, F_r , and the local oscillator, and T is the time required for one beat note cycle. Thus for NBA,

$$T = \frac{1 \times 10^9}{18 \times 10^3} = 55,556 \text{ sec} = 15.4 \text{ hours.}$$

If the frequencies differ by only one part in 10^{10} , then *ten times* as much time will be required.

^{*}The Switzerland Time Observatory at Neuchatel reports uninterrupted reception of NBA since 1959, conversation with the author by J. Bonanomi, Director, at 1961 WESCON, San Francisco.
**More expensive cesium standards provide accuracies of

Francisco. ** More expensive cesium standards provide accuracies of $x = 10^{-10}$ without reference to an external standard.² I The accuracy to which a frequency standard may be set is limited by both its long term and short term stability. Crystal frequency standards, commercially available, have upper stability limits of a few parts in 10^{10} /day.

In Fig. 1, the phase comparison is made at twice the received frequency so that the time required to hear one beat note is one-half that calculated above.

11. Servo System Driven Recorder Outputs The greatest drawback to Method I is the time required to achieve accuracies of parts in 10⁹ and or 10¹⁰. This can be improved by adding a servo system. Fig. 2, operated by the phase error between the received vLF signal and the synthesized vLF signal (here twice the vLF signal). This permits accuracies of parts in 10^{10} in only a few hours.

A counter dial calibrated in microseconds accumulates the phase shift error which may be converted into frequency:

	METHOD	APPROXIMATE PRICE	ADVANTAGES	DISADVANTAGES	RATING
Ι.	Best Frequency Individual observation.	\$1,500 & up	Price	Very long time required to make measurements to parts in 10 ⁹ and 10 ¹⁰ .	Not recommended.
11.	Servo System Driven Recorder outputs. (Drift Time Measuring).	\$2,500 & up	Measurements to accura- cies of a few parts in 10 ¹⁰ within a few hours.	External Standard must be manually adjusted.	Recommended for manual setting of external fre- quency standard on fre- quency.
111.	Phase shifting the output.	\$3,000-\$4,700	Same as Method II,	1-Very poor short term stability. 2-Follows diurnal shift. 3-More expensive than Method If with no com- pensating advantages.	Not recommended for oper- ating frequency standard. Acceptable for use as in Method II.
ĮV.	Internal local oscillator. Fine Frequency capacitator adjusted by Servo System.	\$5,900	1 Completely automatic frequency standard. 2 Good short term stability. 3-Eliminates diurnal shift problem. 4-Can also be used as in Mathed U.	More expensive but in- cludes internal oscillator.	Recommended for operat- ing frequency standard and/or manually setting external frequency standard.
V.	Electronic Counter	\$10,500	Method II. Same as Method II.	1 -Most expensive. 2-Most complex.	Acceptable only when all or most of equipment required is already available.

Table 1

Table 2

PRINCIPAL LF AND VLF FREQUENCY AND TIME STANDARDS STATIONS

CALL SIGN	NAA	GBR	NBA	NPG	NPM	WWVL	NSS	wwvb	MSF
PLACE	Cutler, Me., U.S.A.	Rugby. U. K.	Balboa, C. Z., Panama	Jim Creek, Wash., U. S. A.	Lualualei. Hawaii, U. S. A.	Sunset, Colo., U. S. A.	Annapolis, Md., U. S. A,	Boulder, Colo., U. S. A.	Rugby, U. K.
LATITUDE LONGITUDE		52° 22′N 1° 11′W	9°04′30″N 79°34′30″W		0.0.7.	40°02′15″N 105°27′05″W	U. J. A.	39°59′30″N 105°15′55″W	52°22′N 1°11′W
FREQUENCY ACCURACY STABILITY	14.7 KC ≠ 2x10 ⁻¹⁰ 5x10 ⁻¹¹ in 1962	16.0 KC	$\begin{array}{r} \textbf{18.0 KC} \\ \pm 2 x \textbf{10}^{-10} \\ \textbf{5x10}^{-11} \end{array}$	$\begin{array}{l} \textbf{18.6 KC} \\ = 2 x \textbf{10}^{-10} \\ \textbf{5} x \textbf{10}^{-11} \end{array}$	$\begin{array}{c} 19.8 \text{ KC} \\ \pm 2 x 10^{-10} \\ 5 x 10^{-11} \end{array}$	20.0 KC = $5x10^{-11}$ $2x10^{-11}$	22.3 KC = 2x10 ⁻¹⁰ 5x10 ⁻¹¹ in 1962	$\begin{array}{c} \textbf{60.0 KC} \\ \textbf{\pm5x10}^{-11} \\ \textbf{2x10}^{-11} \end{array}$	60.0 KC
OFFSET	-13x10-11 during 1962	-130x10 ⁻¹⁰	Same	Same	Same	Same	Same	Same	Same
MAXIMUM POWER STATUS SCHEDULE MODULATION	2000 KW Stabilized Continuous Maint. as required CW	300 KW Stabilized Daily approx. 22 hrs, Int. time signals telegraphic traffic	300 KW Stabilized Continuous Down for Maint. Wed. 1200–2100 CW-Time Pulses	1000 KW Stabilized Continuous except 1600–2400 UT on Thurs. CW	500 KW Stabilized Continuous except 1800–2300 UT on Wed. CW	15 Watts Stabilized Continuous CW Call sign at min. 00. 20, 40 each	500 KW Stabilized Continuous Maint. as required CW	2 Watts Stabilized Continuous except 1430 1530 UT daily CW Call sign at min. 00, 20, 40 each	10 KW Stabilized Daily 1430–153 UT 1000 cps for 5 min in each 15
TIME SIGNALS		0955–1000 1755–1800 U	Yes T	-		hour None at present		hour None at present	min. —
SPECIAL TRANSMISSIONS	30–40 min. past each hour		Vary – see current Time Service Announce- ment	40–50 min. past each hour, also tests on other frequencies	50 60 min. past each hour	-	50–60 min. past each hour		-

Frequency Standards (Concluded)

$$\frac{\Delta F}{F} = \frac{AT}{T} \cdot$$

If there were a drift of 36 μ sec in 5 hrs (18 x 10⁹ μ sec), the drift rate of the external standard would be

$$\frac{36 \ \mu \text{sec}}{18 \ \times \ 10^9 \ \mu \text{sec}} = 2 \text{ parts in } 10^9 / \text{day.}$$

An external strip chart recorder provides a more reliable and certain method of accumulating the phase shift difference. This gives a permanent record and eliminates the need of separately accumulating time as required when using the dial. The line slope shows the rate at which the external standard is drifting. The external standard can then be manually adjusted until a line with zero slope is obtained from the chart recorder.

In this approach, a servo system is an absolute must for using VLF stations to their maximum usefulness. The addition of the servo system, however, merely speeds up the gathering of data and reduces the time required for measuring. It does not by itself provide an accurate or corrected output; the local external standard must still be manually adjusted to achieve this result.

III. Phase Shifting the Output

Besides indicating the cumulative error, or drift, of the external frequency standard as done in Method II, the third, system also phase shifts the output of the external standard so that the output from the phase shifter is apparently always phase coherent with the vLF signal, Fig. 3a.

Phase shifting the output greatly reduces and appears to eliminate the need of manually correcting the local external standard to maintain the standard on frequency as compared to the VLF stations. This advantage is more apparent than real because of the very poor short term stability, caused by feeding the frequency standard output through the phase shifter as explained below. Since the output signals follow the VLF transmissions, including the diurnal shift, this system cannot be effectively used as a 24 hour-a-day or even 12 hour-a-day frequency standard.

Because the phase shifter is rotating at the difference frequency between the external standard and the VLF station, the signal frequency at the phase shifter output has apparently been corrected to be identical with the VLF station. On a long term average basis, this correction is accurate. The instantaneous or short term frequency stability for a 0.1 to 10 sec measuring period will, however, be very poor due to servo system jitter with noise, propagation variations, and hysteresis in the servo system. Thus, if the output signal at 100 KC is used as the controlling signal for a counter, it is doubtful if frequency measurements having a stability of even ± 5 parts in 10⁸ can be made.

Assume that a noise burst causes the phase shifter to move at a linear rate for 5 sec, and during that period the phase shifter moves a total of 6° (1/300 rps). If the phase shifter operates at 100 KC, the noise burst will cause the frequency at the phase shifter output to be in error by $(1/300)/10^5$, or 3.3 parts in 10⁸, for a time interval of 5 sec.

Since all other outputs are derived from the 100 KC signal, all signal outputs will have the same frequency error.

Presently, good standards have short term stabilities between 1 and 5 parts in 10^{10} .‡‡ Thus, this method has a potential to degrade the short term stability of a high stability frequency standard by 60 to 300 times. Also, as the phase shifting frequency is lowered, the degradation of stability becomes worse. If the phase shifting were done at 10 KC, the short term stability would be 10 times worse than shown above at 100 KC.

The long term, or *average* accuracy, is comparable to that obtained in Method II when the external standard is *manually* adjusted according to an average line drawn through the data from the strip chart recorder. Likewise, the accuracy directly out of the external standard is unaffected by the phase shifter. It would appear then that this method offers no real advantage over Method II.

IV. Internal Oscillator-Fine Frequency Capacitor Adjusted by Servo System

This approach, the most complex of the 4, is unique in one major respect: it is the only method which offers a complete within itself operating frequency standard. At a slightly higher price, an internal high stability oscillator has been added. This oscillator is continually kept on frequency by servo system operation driving the oscillator's fine frequency capacitor, Fig. 4b. Because of the extremely high servo system gear ratio and resulting long time constant of the system, the short term stability of the standard is not affected by noise and/or short term variations in VLF carrier propagation.

This system may be used as in Method II with an external oscillator. Compared to Method III, the advantages are:

- 1. Complete self-contained automatic frequency standard with internal high stability oscillator.
- 2. Better short term stability as outputs do not go through phase shifter driven by servo system.
- 3. Timer to disable servo correction of local oscillator during diurnal shifts. This provides greater frequency accuracy by eliminating frequency shifts during that time.

This appears to be similar to Method III which results in such poor short term stability. Going through the same calculations points up the significant difference. The simplified block diagram, Fig. 4a shows the mechanical connection between the resolver and the fine frequency capacitor.

It takes 25 revolutions of the resolver to produce a frequency change of 2×10^{-7} . Making the same assumption as in Method III, i.e., a 6° variation from zero phase error occurring in 5 seconds, we calculate the frequency error:

Stability
$$\left(\frac{\Delta F}{F}\right) = R \times \frac{1}{K} \times \Delta f$$

 $\frac{\Delta F}{F} = \frac{6}{360} \times \frac{1}{25} \times (2 \times 10^{-7}) = 1.3 \times 10^{-10}$

tt One limit of the VLF system, or any frequency setting systein, is the stability of the local oscillator. A poor local oscillator cannot be made into an excellent unit by adding a VLF receiver.

Where R is the number of revolutions of the phase shifter, K is the gear ratio constant between the capacitor and phase shifter, and Δf is the change in oscillator frequency for one revolution of the capacitor

The short term error in the previous system under the same conditions was calculated to be 3.3×10^{-8} or 250 times as bad. As already shown, the lower the frequency at which the phase shifting is done, the worse the comparison becomes.

Method IV may be analyzed in a second manner to help point up the difference between it and Method III. In Fig. 4b, we see that the servo system drives the phase shifter and this phase shifted output is fed to the phase comparator. The phase shifter, as in Method III, thus follows the short term variations in vLF carrier, noise bursts, etc. The crucial difference is that the movement of the phase shifter does not directly affect the frequency outputs of the synthesizer. The synthesizer outputs are affected by the movement of the fine frequency adjust capacitor which is geared down from the phase shifter.

The result is to provide a double servo loop; the first consisting of the rapidly moving phase shifter and the second of the slowly moving fine frequency capacitor. The result is tremendously improved short term stability or instantaneous frequency accuracy.

V. Electronic Counter

These four methods of using VLF transmissions were all directly related to one another, each being more complex than the preceding. This method takes a different tack. In equipment used, it is the most complex; and, the most expensive approach-about two to one. On the other hand, much of the equipment may already be available; then, the additional investment may be equal to or less than in the preceding methods.

The external frequency standard under test, or calibration, is used to drive a frequency divider, Fig. 5. This in turn furnishes the start signal for the time interval meter, or electronic counter. The stop signal is supplied by one of the VLF carrier cycles. For Station WWVL, which broadcasts CW, a 1 KC pulse is used to trigger the counter. The NBA carrier is keyed at a 1 pps repetition rate with carrier on for 0.3 seconds and off for 0.7 seconds. Here, a one second tick from the divider is used to trigger the counter. The frequency drift of the standard may then be calculated from the data accumulated on the digital recorder; or more conveniently, from the analog record of the strip chart recorder using the formula,

$$\Delta \frac{F}{F} = \Delta \frac{T}{T}$$

If there were a drift of 8 μ sec in 3 hrs (10.8 x 10⁹ μ sec) the drift rate of the standard would be

$$\frac{8 \,\mu \,\text{sec}}{10.8 \,\times \,10^9 \,\mu \,\text{sec}} = 7 \text{ parts in } 10^{10}/\text{day}.$$

Selection Criteria

After deciding which 1 of the 5 methods best meets your needs, one must still select the specific brand or manufacturer whose product will be purchased. Gen-

eral criteria would seem to include both communications and frequency standard experience on the manufacturer's part since the product must function as both a receiver and standard. Conservative design including adequate reserve gain to allow for future component aging and degradation is advisable. Also, a solid state product for longer trouble-free life seems almost axiomatic. Other characteristics are:

1. Modular construction using plug-ins—simpler repair and ease of adding future reception of additional stations.

2. Narrow r-f bandwidth-required to permit reception in noisy areas. Don't be misled by narrowness of entire system including servo portion. A good way to check-compare signal outputs of various units on an oscilloscope.

3. Good AGC action-required for operation over varying signal strength conditions; again check with a unit.

4. Servo system to drive recorder output-advisable for greatest use as shown under Methods I and II.

5. High gear ratio in servo system—improves short term stability in Methods III and IV and gives better results in general.

6. High quality servo components-better performance and reliability.

7. Superheterodyne receiver-more stable, easier to change frequency and preferable to have gain at more than one frequency.

8. Chart recorder output-the best way to accumulate data.

9. Signal operated relay disabling servo systemservo system to be disabled on loss of signal so that system will not hunt through noise and build up system errors.

10. Fine frequency adjust alarm indicator-applies only to Method IV. Alarm to indicate when servo system has driven oscillator out of fine frequency adjustment range. Adjustment of coarse frequency control to be at minimum of 6 month intervals.

11. Solution to diurnal shift problem-applies mainly to Methods III and IV. A means is required to eliminate the frequency shift caused by the twice daily diurnal shift.

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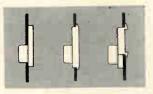


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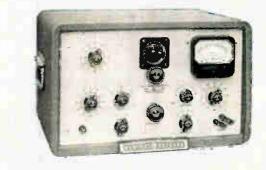
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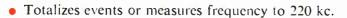
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Los Angeles HD:1:wood 5-6201

ELECTRONIC & ELECTROMECHANICAL INSTRUMENTATION & COMPONENTS MAXSON INSTRUMENTS DIVISION



PRECISION PHASEMETER MODEL 1010

The most accurate Phasemeter available:

- 0.1° Absolute, 0.01° Incremental Accuracy
- Frequency Range: 30 to 20,000 cps Phase Range: 0 to 360° without ambiguity •

Modular construction

SWITCHES

LE ATION

APPLICATIONS:

TESTING and INSPECTION of polyphase systems, goniometers, feedback amplifiers, filters, trans-formers and phase shifting networks MEASUREMENT of residual L and C in resistors

CALIBRATION of production line phasemeters HIGH ACCURACY TESTING of servo and synchro systems CONTINUOUS MONITORING of phase changes

with chart recorder

UHF WIDE RANGE - HIGH POWER OSCILLATOR AND POWER SUPPLY MODEL 1241

The only instrument featuring wide band coverage at high power levels

OUTPUT: Varies with frequency

- 200-500 mc. 40 watts
- 500-1000 mc. 25 watts

 0000-2800 mc. 10 watts
 Power output approximately 1 db down between 200-300 mc. and 2500-2800 mc.

ACCELERATION

MODEL

174

APPLICATIONS:

APPLICATIONS: MEASUREMENT of wave filter, antenna radiation pat-terns, noise & interference, VSWR & impedance TESTING of general purpose R-F SIGNAL SOURCE for attenuation measurements, power meter calibration, R-F cable testing, frequency meter calibration

TRANSMITTER where portability

LOW POWER is convenient

MODEL 1-085A

Precision

proved in critical missile

propellent

systems



MINIATURE ACCELERATION MAXSON SWITCH

DAMPED TYPE

MODEL 174 ACTUAL SIZE

Unidirectional, Single-Axis Switch Closes Elec-trical Circuit at a Preset Value of Acceleration APPLICATIONS: Arming switch in missiles, parachute release, sensing element in re-cording type accelerometers

MODEL 104

- 149
- g type accelerometers DESCRIPTION Multi-Step, Bidirectional switches. Successive closure of contacts occur at preset acceleration levels each contact remaining closed as long as preset acceleration is sustained. Bidirectional switch precisely set by customer over a range of -3g to +6g by means of external micro-meters. Curve showing "g" level vs. micrometer setting is supplied with each switch. Miniature unidirectional switch mak-ing a circuit after a specified delay time at a preset acceleration. Precision, unidirectional, 4-step switch, successively closing each of 4 contacts at their respective preset acceleration levels.
- 180
- 200-1
- 4 contacts at their respective product acceleration levels. Precision unidirectional switch break-ing a circuit at a preset acceleration and then making a circuit at a higher 209
- 216 A bidirectional version of model 174 switch. Compact 219
- unidirectional switch requiring sustained acceleration for a preset time before closing a circuit. Contacts remain closed until reset manually.

-L-man-Small Size Positive Action Rugged Construction Precise Operation **APPLICATIONS:**

SNAP ACTION TYPE

ACCELERATION SWITCH

"g" limiting switch for autopilots; emer-gency crash exit light control; safety devices based on the sensing of dan-gerous levels of acceleration or vibration; control devices in guided missiles; "g" indicator for flight-test recording. MODEL DESCRIPTION

- 131 154 Close at a preset acceleration level and open when acceleration 133* drops below the preset value. 185
- Provide manual reset so that the switch will remain closed after the preset acceleration is exceeded. 132 54*
- 161 Dual unit models consist of 2 switches packaged to permit bi-directional sensing.

Feature customer setting of acceleration

level by means of an external microm-eter. Curve showing "g" level vs. mi-crometer setting is supplied with each switch.

FOUR CHANNEL STATISTICAL RECORDER

MODEL 210

For "g" analysis of electronic equipment in transit

Direct Digital Readout
Four Digit Display Channel

- Wide Environmental Range
- Long Term Continuous Recording

Temp. Range: --60°F to 250°F Vibration: 20-2000 cps, 10g, no counting Impact: 25g, 12ms, no counting Radio Interference: Meets MIL-1-6181B requirements

Power Requirements: 28VDC, 0.6 amp Dimensions: 6 x 5 x 312 inches Weight: 54 ounces

APPLICATIONS:

When used in combination with a suitable transducer such as the Maxson Model 200 four-channel acceleration switch, the Model 210 recorder can be used for statistical analysis of "g" loadings in the fields of aircraft design, surface transportation, high-way and road engineering and crash and cafety safety analyses.



World Radio History

PRECISION FORK OSCILLATORS and FREQUENCY STANDARDS

Whatever your need...whatever your problem... in frequency ranges from 1 to 40,000 cycles, American Time Products has the package and/or the experience to assist you. For over 20 years American Time has been engineering and manufacturing reliable, accurate and rugged frequency standards, fork oscillators, etc. Some are offthe-shelf items. Others are custom developed units and systems such as: 1) tuning fork filters, 2) inverters, 3) precision power supplies, 4) timers, 5) fork optical choppers. For additional information on the sampling of units shown, on American Time's line, or regarding your own special needs, write Department 2613.

BULOVA American Time Products

61-20 Woodside Avenue, Woodside 77, N.Y.

Precision Fork Oscillators				Les,	TT	
TYPES	5 C	25	2001	.•2	50N	30
FREQUENCY	200 to 1,000 cp	s 200 to 1,40	0 cps 200	to 4,000 cps	50 to 360 cps	240 to 20,000 cps
ACCURACY	±.002% to ±.5%	±.002% to ±.5%	±.00	91%	±.05% to ±.01%	±.002% to ±.5%
TEMPERATURE RANGES	-65° to +125°0	C65° to +1	125°C +20	° to +30°C	-55° to +85°C +15° to +35°C	−65° to +125°C
OUTPUT	Dependent on external circuitry used	Dependent external circuitry us	on Appr 250, sed	rox 5 at 000 ohms	Dependent on external circuitry used	Dependent on external circuitry used
INPUT	28 volts or less	28 volts or	less Heat 6.3,	ter Volt. 12, 28	28 volts or less	28 volts ör less
B VOLTAGE			100 at 5	to 300V to 10 ma		
SIZE	5/16x3/4x3"	23/32 × 3″	3.3/4	4×4·1/2×6″	1 x 4·1/4"	1.19/22x 1.19/22x1.1/3"
WEIGHT	1-1/2 oz.	2 oz.	26 o:	z.	4 oz.	3·1/3 oz.
Precision requency Standards	Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Contractions Co					
ТҮРЕ	10	27	15	32	52	15P Portable
FREQUENCY	360 or 400 cps	360 to 1,300 cps	<u>360 cps</u> 400 cps	240 to 2,00	0 cps 30 to 360 cps	360 or 400 cps
ACCURACY	±.005%	±.002% to ±.5%	<u>±10 ppm</u> ±250 ppm	±.002% to ±.5%	±.05°C ±.01%	±50 ppm
TEMPERATURE RANGE	+10° to +35°C	-65° to +125°C	<u>-40° to +71°C</u> -40° to +71°C	-65° to +1	25°C <u>-55° to +35°(</u> +15° to +35°	
INPUT	1.4v at 6 microamps	28 volts or less	1.4v at 6 microamps	28 volts or	less 28 volts or le	ss Self-contained Battery
OUTPUŤ	0.1 volt	8 volts RMS	1 volt	5 volts	5 volts	1 volt
LOAD	50,000 ohms or more	70,000 ohms or more	50,000 ohms or mor e	50,000 ohn or more	ns 70,000 ohms or more	50,000 ohms or more
SIZE	1-3/8x1-3/8x3/8"	23/32×3″	1 × 2 × 2 · 1/4"	1-19/32× 1-19/32×1	1/5″ 1×4-1/8″	1 x 2 x 3-1/2"
WEIGHT	3/4 oz.	2 oz.	4 oz.	3·1/2 oz.	4 oz.	4 oz.

World Radio History

BALLANTINE VOLTMETERS

and other Electronic Measuring Instruments

ELECTRONIC VOLTMETERS

MODEL	FREQUENCY RANGE	VOLTAGE RANGE	INPUT IMPEDANCE	ACCURACY	Notes	PRICE
300	10 cps-150 kc	1 mV-100 V	0.5 Ms2 shunted by 30 pF	2%	Sensitive, general purpose VTVM	\$220
300E 300F	30 cps 100 kc	300 µV-300 V	2 Msz shunted by 20 to 30 pF	2%	9½ inch wide panel, with panel insulated from chassis. 300f is militarized version of 300E	\$260 \$320
3006	10 cps-250 kc	1 mV-1000 V	2 M <u>S≵shunted</u> by 10 to 25 pF	1% 20 cps-20 kc. 1 mV-250 V, 2% elsewhere	The most accurate and highly stabilized instrument in the Ballantine line of direct reading VTVM's	\$315
300H	10 cps 1 Mc	30 "V-300 V	2 MΩ shunted by 15 to 25 pF	2%-10 cps-700 kc 3%-700 kc-1 Mc	Similar to 300G except 2% accuracy over a wider frequency band. Replaces 300D	\$230
302C Battery Operated	2 cps-150 kc	V 1000 V ب 100	2 Mst shunted by 10 to 25 pF	3% 5 cps-100 kc; 5% elsewhere	Very sensitive, battery operated, for use where isolation from power line is essential, 60 db gain, no hum	\$255
305A Peak Reading	5 cps-500 kc, sine waves, Pulses 0 5 µs up, and 5 pps up	1 mV-1000 V Peak or Peak-to- Peak	2 Ms2 shunted by 5 to 15 pF	2% sine waves, 20 cps 200 kc; 4% elsewhere; 3% pulses above 3 µs and 100 pps; up tc 5% elsewhere	Peak or peak-to-peak VTVM for use on short pulses, noise, or sinusoidal signals	\$415
310A	10 cps-2 Mc; 5 cps-4 Mc as a null detector	100 µV-100 V (Down to 40 µV as nut) detector)	2 Ms2 shunted by 9 to 19 pF	3% 15 cps+1 Mc; 5% elsewhere	Very sensitive wide-band VTVM for wide range of voltage measurements. 10 eV sensitivity as null detector	\$250
314 Wide Band	15 cps-6 Mc	1 mV-1000 V 100 µV-1 mV without probe)	11 MQ shunted by 8 pF with probe or 1 MQ shunted by 25 pF without probe	3% 15 cps-3 Mc; 5% elsewhere	Wide-band, sensitive instrument equipped with probe for use 1 mV to 1000 V, or without probe to as low as 100 av	\$300
316 Infrasonic	0 05 cps-30 kc; 0.01 cps with corrections supplied	0 02 V 200 V Peak to Peak	10 MS shunted by 17 to 40 pF	376	Measures peak-to-peak voltages at frequencies as low as 0.01 cps and up to 30 kc on square waves or distorted sinewaves. Negligible "flutter"	\$330
317 Wide Band	10 cps 11 Mc	300 µV 300 ∨ (Down to 100 µV-as null detector)	10 M⊕ shunted by 7 pF with probe, 2 M⊕ shunted hy 11 to 24 pF without probe	2% 20 cps-2 Mc 4% 10 cps-6 Mc 6% 10 cps-11 Mc	Broadest frequency coverage VTVM in the line. Sensitive, ac- curate as VTVM or amplifier. Cathode follower probe makes possible accurate measurements several feet from the instrument	\$495 with probe
320 True RMS	5 cps 500 kc	100 µV-320 V	10 Mir shunted by 8 to 18 pF	3% 15 cps-150 kc. 5% elsewhere	Measures true rms of wide range of signals including pulse, noise, or disforted sinewaves. Accurate on signals having crest factor up to 15	\$445
350 True RMS	50 cps 20 kc	0.1 V 1199 9 V	2 Mg shunted by 15 to 45 pF	1/4 0% 0 1 V-300 V 100 cps 10 kc, 3/2 % outside these limits	Measures true-rms of distorted or pure sinewaves. Use, accuracy, Excellent as a laboratory reference or transfer standard for calibration of VTVM's or signal sources	\$720

ACCESSORIES for use with VTVM's are available to extend voltage range from 10 µV to 20.000 V, or to measure currents from 0.1 µA to 10 A.

ELECTRONIC TEST EQUIPMENT Exceptionally low noise VT amplifier, X10 or X100, 10 cps-150 kc, 2%. Particularly useful as pre-amplifier to extend sensi-tivity of VTVM's or scopes.

220C DECADE AMPLIFIER

420 DC and AC PRECISION CALIBRATOR 520 DIRECT READING CAPACITANCE METER

700 SENSITIVE INVERTER

710 LINEAR AC to DC CONVERTER

Provides one of the most convenient ways of measuring capacitance over an extremely wide range of values as encountered in paper, plastic, mica, ceramic, and air-dielectric types. Capacitance range: 0.01 pF to 12 µF. Accuracy: 2% above 0.1 pF. Price: \$335 An instrument for measurement of dc potentials as low as 10 microvolts by converting the dc to ac. Input voltage range: 10 μ V-100 V dc, Accuracy; better than 1% above 100 μ V, input resistance: 10 megohms for 1:100 or 50 megohims for 10:1. Price: \$365

Provides accurate, convenient way of calibrating voltmeters, oscillographs, and other voltage-sensitive devices. Voltage range: 0-10 V, rms, peak-to-peak, or dc. Frequency: 1 kc. Accuracy: better than 0.25%. Distortion and Hum: less than 0.25%. Output impedance (ac): 2-20 ohms. Output impedance (dc): 0-4000 ohms. Price: \$365

Accurately converts an ac voltage to a dc voltage which can be measured with a dc device such as a Digital Voltmeter. Features accuracy better than 0.25%. Input voltage range: 1 mV-1000 V. Frequency range: 30 cps-250 kc. Input impedance: 2 megohms shunted by 15 pF to 25 pF. Accuracy \pm 0.25% 50 cps-10 kc; \pm 0.5% 30 cps-50 kc; \pm 1% above 50 kc. Price: \$450

LABORATORY STANDARDS

The Selby-Behrent NBS design, 1 V to 300 V, 10 Mc to 1000 Mc. A basic laboratory standard to measure high voltages 390 these frequencies. Price: \$2250 The Hermach NBS design. 1 V to 50 V, 25 cps to 30 Mc. A basic laboratory standard particularly suited to calibration of 393 voltmeters and signal sources. Price: \$950 (with 5 probes) The Selby NBS design, 15 μ V to 1.5 V, 0 to 900 Mc. Possibly the most basic laboratory standard device for determining ac voltages in this ranke. 440 voltages in this range (for each thermocouple-radial resistor combination)

Write for brochure giving many more details



- Since 1932 -

BALLANTINE LABORATORIES, Inc. Boonton, New Jersey Phone: Deerfield 4-1432 TWX: BO

Phone: DEerfield 4-1432 TWX: BONTN 831

Price: \$115

Circle 178 on Inquiry Card

ELECTRONIC INDUSTRIES . June 1962





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photographs

A Complete Technical Guide to the Selection of **ELECTRONIC MEASURING EQUIPMENT**

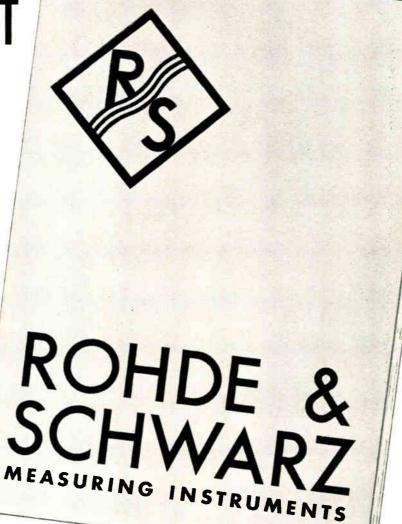


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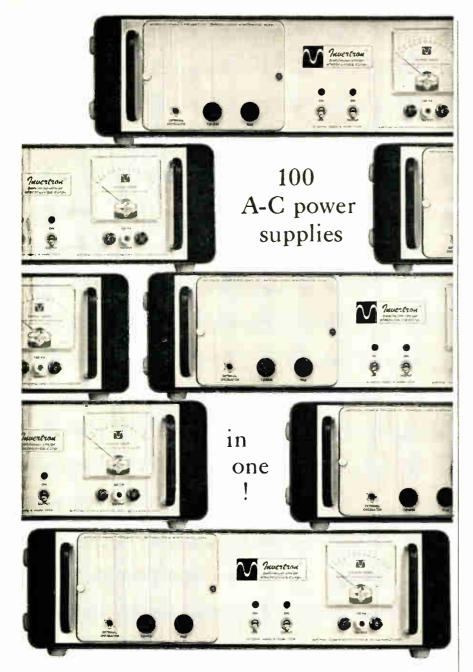


ELECTRONIC MEASURING EQUIPMENT FOR THE UNCOMPROMISING

World Radio History

111 Lexington Ave., Passaic, N. J. • PRescott 3-8010

Circle 179 on Inquiry Card



Never before has there been an a-c power source as flexible as the Behlman-Invar 161A Invertron. The unit features a wide variety of separate plug-in oscillators in both fixed and variable frequencies from 45 to 5000 cps. Finally, the electronic industry's need for a low-cost, general purpose a-c power supply has been realized.

The 161A is so flexible, in fact, that three of the units can be stacked. The three outputs can then be connected in a Y configuration, employing a 3-phase plug-in oscillator, to give 3-phase output at approximately 500 volt amperes.

The 161A is available either rack mounted or for bench use, and is only $5\frac{1}{4}$ inches high, 17 inches wide and 16 inches deep. Additional features include: extended frequency capability, excellent short term voltage amplitude stability and zero response time. The price is only \$420.00 f.o.b. Santa Monica, California. Prices on a variety of plug-in oscillators are available on request.

Behlman Invar also manufactures a broad line of both a-c and d-c laboratory power supplies as well as modular power supplies for rack mounting. Modules may be operated in series or in parallel for maximum output and flexibility of operation.

BEHLMAN-INVAR ELECTRONICS CORP. 1723 CLOVERFIELD BOULEVARD . SANTA MONICA,



Behlman-Invar representatives are: T. Leuis Snitzer Company—Los Angeles, La Jolla and Sunnyvale, California. • Cain and Company—Albuquerque, Geeat Neth, N.Y.: Boston; Orlando, Fla.; Philadelphia; Chicago; Dallas; Washington, D.C.

Tech Data

for Engineers

Transistor Tester

This Single Position Automatic-(SPA)Transistor Tester features automatic testing and sorting (manual load and unload) of up to 2000 transistors/hr. Other features include up to 100 ac or dc parameters (10 tests x 10 type specs.) and flexible, versatile programming by plug-in modules. This 2-color brochure includes photographs, specs., and op-tional features. Philco Corp., Lansdale Div., Lansdale, Pa.

Circle 485 on Inquiry Card

Chopper Circuits

Tech, report of test techniques and compiled data on residual noise present in chopper circuits is available from James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill. Circle 486 on Inquiry Card

Noise Analysis

A Tech. Report, entitled "A Prac-tical Approach to Transistor Noise" is available from Quan-Tech Laborais available from Quan-Tech Labora-tories, Inc., Boonton, N. J. The report deals with the origin and nature of the various types of electrical noise generated in transistors. Specific methods for the quantitative analysis of transistor noise are treated in of transistor noise are treated in detail.

Circle 487 on Inquiry Card

RF Power Levels

Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md., has ropolitan Ave., Kensington, Md., has available a brochure on precise meth-ods of determining r-f power levels, which discusses the sources of error of these methods. Entitled, "RF Power Bridges and Thermistor Mounts," the brochure also describes their line of precision power bridges, thermistor mounts and X-band power standards. Circle 488 on Inquiry Card

Spectrum Analyzers

A detailed engineers' product hand-book on counters, oscilloscopes, fre-quency meters, and spectrum ana-lyzers is available from Lavoie Laboratories, Inc., Morganville, N. J. Included are photographs, specs. and schematics. Also included is a section on automatic test equipment.

Circle 489 on Inquiry Card

Atomic Instruments

Baird-Atomic, Inc., 33 University Rd. Cambridge 38, Mass., is offering their Atomic Instrument Catalog. Included are analytical scintillation systems, scalers, analyzers, rate and survey meters, amplifiers and power supplies.

Circle 490 on Inquiry Card

Vibration Measuring

This 8-page, 2-color brochure offers tech data on a "Vibration Measuring System," which records complete data from accelerometer signals, including phase, distortion and amplitude. Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif.

Circle 491 on Inquiry Card

DIGITAL VOLTMETERS most complete line...by purpose...by price

As originator of the DVM and leading manufacturer of precision digital measuring instruments, Non-Linear Systems, Inc., offers you the world's most complete line of DC and AC digital voltmeters, digital ratiometers, digital ohmmeters, and multipurpose instruments. Look to NLS for the instrument you need in the price range you desire. Only NLS provides the benefits of dealing with a company that's been in the DVM business for more than a decade — unmatched servicing follow-through, useproven design superiority, and uncompromising instrument quality. Contact any of the 19 NLS sales and service offices listed in this buyers guide for complete engineering information on standard instruments and custom instrumentation systems.

High-Speed A/D Converters

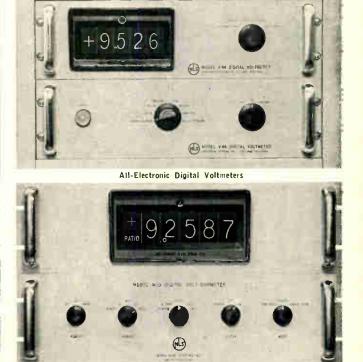
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To Measure	Model	Digits	Speed, Sec./Reading	Range	Type of Digital Output	Price
Volts, Ratio	M25	5	1.1 constant	100μv·1kv. .00001:1- 99.999:1 .1Ω-1 meg.	Decimal voltages	\$5,985
and Ohms	M24	4	.33 constant	100μv-1kv. .0001:1- .9999:1 .1Ω-1 meg.	Decimal voltages	\$5,585
	V35B	5	2.3 max.	100μν-1kv. .00001:1- .99999:1	Decimal contacts	\$3,985
Volts and	V35RB	5	2.3 max.	100μν-1kv. .00001:1- .99999:1	Decimal voltages	\$3,385
Ratio	484A	4	l avg.	1mv-1kv. 00.01%- 99.99%	Decimal voltages	\$1,460
	RS2	4	l avg.	1mv-1kv. 00.01%- 99.99%	Internal printer	\$3,63
	15	4	67x10 ⁻⁶ constant	100μγ- 100γ.	B-C-D or binary volts	\$4.98 \$5,48
	V44	4	5x10 ³ constant	1mv·1kv.	Decimal & B-C-D volts	\$6,18
Volts	CH2	4	1x10 ⁻² approx.	1mv-1kv.	Decimal & B-C-D volts	\$6,58
	V64B	4	0.75 avg.	1mv-9.999v. special to 1kv.	None	\$885
Voltage	R65A	5	1.5 avg.	00.001%- 99.999%	None	\$2,13
Ratio	R65B	5	1.5 avg.	00.001%- 99.999%	Decimal voltages	\$2,33
	V60	4	1.5 avg.	10μν- 99.99mv.	None	\$1,66
Millivolts	V60A	4	1.5 avg.	10 <i>μ</i> ν- 99.99mv.	Decimal voltages	\$1,96
Ohms Deviation	D024	4	.33 constant	00.01%- 99.99%	Decimal voltages	\$5,58
Ohms	784	4	l avg.	.10. 10 meg.	Decimal voltages	\$1,46
Digital- Analog	16	4	4x10 ⁻⁶ constant	.001v 9.999v.		\$3,08
AC, Low-Level DC, Data Logging, Go/No-Go	AC NLS	and lov	 level DC, data a wide range 	a logging, and .	ccuracy measurer go/no-go testing umentation for s	. Also,

Prices and specifications are subject to change without notice. Prices F.O.B. destination U.S.A.

Accuracy is $\pm 0.01\%$ of reading ± 1 digit except for millivoltmeters which have accuracy of $\pm 0.1\%$ of reading ± 1 digit (precision is ± 1 digit). V35B-V35RB ratio accuracy is $\pm 0.005\%$ of reading or ± 1 digit. Input impedance is generally 10 megs for voltage measurements, 1,000 megs for ratio (10 megs on M25's two highest ratio ranges). Input impedance of Models 15 and 15B is 625 ohms/volt. Decimal digital outputs are 10 lines/decade.



Five-Digit and 4-Digit Instruments that measure Volts, Ratio and Ohms



Five-Digit and 4-Digit medium-priced Voltmeter-Ratiometers





World Radio History



95A Sensitive DC Meter to cover 42 ranges. This wide range meter provides both voltage $(1 \,\mu\nu$ to $1000 \,\nu$) and current $(0.1 \,\mu\mu$ a to 1 amp) measurements. Features: ease of range and level recognition fast response low drift 10 megohms input resistance on all voltage ranges zero center meter and priced at \$550.

The 95A can satisfy many of your measurement needs. Write for complete specifications.

Let us know your contemplated 95A application so that we may consider it for inclusion in our forth coming DC Voltmeter Applications Brochure.



Tech Data

for Engineers

Oscilloscopes

Tech data is available on the Primer-Scope Mark I and Mark II which are small, portable oscilloscopes. The Mark II is a Dual-Trace oscilloscope. Also included are condensed spees. on industrial oscilloscopes, and cathode ray tubes. Waterman Products Co., Inc.. 2445-63 Emerald St., Phila. 25, Pa.

Circle 492 on Inquiry Card

Spectrum Analyzer Techniques

This 58-page booklet, offering detailed measurement techniques using spectrum analyzers, along with a history and general theory of operation. is offered by Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y. A portion of the handbook describes and lists the specs. and applications of Polarad Spectrum Analyzers currently available, including the new lightweight, transistorized, Model SA-84T.

Circle 493 on Inquiry Card

Power Resistor Decades

Clarostat Mfg. Co., Inc., Dover. N. H., is offering a new catalog on power resistor decades. Complete electrical and mechanical specs. are described. The Clarostat power resistor decade permits the accurate decading of resistance under actual heavy-load conditions in test, experimental, or component circuitry.

Circle 494 on Inquiry Card

Angle Repeater

Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J., has tech. information available on their Precise Position Repeater, Model PPR-10 which provides both a visual readout and binary coded data output of the angular position with 20 sec.-of-arc accuracy and 4 sec.-of-arc resolution. Circle 495 on Inquiry Card

Microwave Test Equipment

A booklet describing a line of microwave test equipment is now available from the Westinghouse Electronic Tube Div., Box 284, Elmira, N. Y. The 10-page, illustrated, 2-color booklet describes test sets used for testing klystrons, magnetrons, TWT's and switch tubes. In addition, travelingwave pulser and missing-pulse-detector equipment is included. Booklet ET-6109.

Circle 496 on Inquiry Card

Capacitance Bridge

Precision capacitance bridges for testing solid tantalum, foil tantalum, wet tantalum, aluminum electrolytic. and metallized paper capacitors are described in Engineering Bulletin No. 90,010 available from Special Products Div., Sprague Electric Co., North Adams, Mass. Included are outline drawings, specs., and descriptions.

Circle 497 on Inquiry Card

Circle 182 on Inquiry Card

ELECTRONIC INDUSTRIES · June 1962

World Radio History

WORLD'S WIDEST SELECTION OF **Instrument Calibration Consoles**

Choice of direct-comparison, regulated-power-supply and AC-DC transfer methods of calibration. Feature simplified operation, wide electrical ranges, safety circuits and accuracies to meet all requirements for working or reference standards. Accuracy is certificated by RFL and traceable to primary standards at National Bureau of Standards.



MODEL 829 calibrates AC and DC instruments from 0.25 mV to 2000 V and 2 µA to 20A; direct reading accuracy of 1% or 0.5% using charts supplied.

MODEL 829D is similar but with 0.5% direct reading FS accuracy and 0.25% with charts. Most popular calibrator, some 1000 Model 829 series units are in service.



MODEL 1900 is a semi-automatic. servo-type unit for calibrating DC ammeters and voltmeters to .05%

ammeters and voltmeters to .05% of reading. 21 ranges from 150 μ V to 1500 V and 20 ranges from 15 μ A to 30 A. MODEL 1967 is similar for AC meters with 20 ranges from 1.5 mV to 1500 V and 19 ranges from 15 μ A to 75 A; 50 to 3200 c/s.



MODEL 1605 calibration/transfer standard for measuring to 15 A and 1500 V DC and AC from 30 c/s to 50 kc/s (to 30 mc/s with adapters). Includes voltbox, shunt-box, potentiometer, standard cell, galv. and thermal converter. Accuracy 0.1% direct reading. MODEL 1605A similar except .05%

direct reading accuracy.



MODEL 2120 AC-DC precision power supply for use with Model 1605/A, or any AC-DC transfer standard, accurate meter or suitable monitoring system for instrument calibration. Provides stable outputs to 30 A and 1500 VDC and AC from 50 c/s to 50 kc/s at 10 to 100 VA with low harmonic distortion and high stability,

and Magnetics Equipment

Electronic magnetizers operating on capacitor discharge principle with pulse lengths from 2 to 30 milliseconds, precisely controllable demagnetizer systems and solid state, laboratory quality magnetic measuring instruments.



MODEL 107A provides 12,000 and 24,000 ampere-turns to magnetize most instrument and medium size magnets using standard bar or special adapters.

MODEL 1221 provides 10,000 ampere-turns for small magnets. MODEL 1500 supplies 40,000 ampere-turns for magnetizing barium ferrite and large meter magnets.



MODEL 942 saturates Alnico magnets to 34 lbs, and high flux ceramic shapes of any pole configuration. Produces charging currents from 100.000 to 200,000 ampereturns with plug-in transformers; up to 3600 watt-seconds with wirewound fixtures. Equipped with safety interlocks for operator protection. Low power consumption.



MODEL 889A used with Model 206A Booster Unit or Model 107A Magnet Charger to demagnetize permanent magnets to any desired flux level. Provides a precision method for treating instrument assemblies, including core type mechanisms, to within fractions of a per cent. Employs DC pulsing principle with vernier control.

Manufacturers of Crystal Impedance Meters, Var. Freq. Power Supplies, Special Hardware and . .



MODEL 1890 employs flat and axial InAs Hall effect probes for direct measurements of magnetic flux densities over 14 ranges from 1 gauss FS to over 20 K gausses. Accuracy better than 3%. MODEL 2000 uses two flat InAs probes for magnetic field gradient measurements and has 17 ranges

from 0.1 gauss FS to 20 K gauss.

MODEL 459A (Improved TS-330) measures resonance and anti-resonance of quartz crystals for capacitance, inductance and performance index over frequency range of 800 kc to 15 mc.

MODEL 531 (TS-683) covers range of 10-140 mc. MODEL 541A (TS-710) from 10-1100 kc and MODEL 1207 (AN/TSM-15) from 75-200 mc.



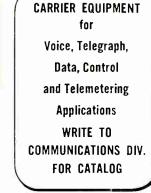
MODEL 250 variable freq. power supply provides regulated 115 V output over freq, range of 40-3000 cps with harmonic distortion less than 0.3% at 100 VA and stability 0.1% to 0.2%. Choice of four plug-in oscillators. Maximum load 250 VA. With external oscillator, output can be varied from 0 to 115 V.

Write to Test & Service Prod. Div. for complete data on any product groups of interest. Factory approved representatives in 21 countries can arrange demonstrations and help with applications. All products are warranted for one year.

World Radio History



SEALNUTS perform dual function of mounting and sealing electrical switches. Eleven stock styles fit most toggle, rotary and push-button types. Meet Spec. MIL-B-5423. MODEL 10 Cart provides versatile mounting facility for elect, equip, Heavy gauge steel, one side takes 19" panels, inside shelf adjustable,







TYPE 541A -rack-mount Type RM41A



TYPE 543A with 100X Magnifier -rack-mount Type RM43A



TYPE 545A with Sweep Delay -rack-mount Type RM45A



TYPE 555 DUAL BEAM with Sweep Delay (Includes Indicator Unit, Power Unit, 2 Time-Base Units, 4 Probes, Time-Base Extension, 7 other accessories.)

These Tektronix DC-to-30 MC Oscilloscopes

Similar Characteristics

Risetime-12 nsec with fast-rise plug-in units · Calibrated Sweep Range-0.1 µsec/cm to 5 sec/cm · Fastest Sweep (Magnified)-20 nsec/cm · Amplitude Calibrator-18 square-wave voltages · Accelerating Potential-10 Kilovolts · Triggering Facilities-Fully automatic or amplitude level selection

Tektronix 5-inch CRT · Balanced Signal-Delay Network · DC-Coupled Unblanking • Illuminated Graticule • Beam-Position Indicators • Electronically-Regulated Power Supply • Low-Frequency Reject • High-Frequency Sync • Output Waveforms available from front panel . (Rack-Mount Models fit into a standard 19-inch rack.)



Tektronix Type	Calibrated Sweep Magnifier	Calibrated Sweep Delay	Single Sweep	Vertical Scale	Price (without plug-ins)
555	5X	1⁄2 μsec to 50 sec		6 cm with 2 cm overlap	\$2650
545A	54	1 μsec to 10 sec	YES	4 cm	1550
RM45A			163		1650
543A	2X, 5X, 10X,				1300
RM43A	20X, 50X, 100X				1400
541 A		NO	NO		1225
RM41A	5X		NO		1325

Other Tektronix Oscilloscopes also accept the letter-series plug-ins:

Туре	Description	Passbands with fast-rise units	Features	Price (without plug-ins)
585	High-Speed	dc-to-30 mc	Normaily designed for dc-to-95 mc applications with other plug-ins, these oscilloscopes accept letter-series plug-inswhen used with Type 81 Plug-In Adapter at	\$17 2 5
581	Fast-Rise Oscilloscopes		\$135. Type 585 has additional facility for sweep-delay applications.	1425
551	Dual-Beam Oscilloscope	dc-to-25 mc	Common X—Independent Y Deflection. Otherwise, characteristics similar to Type 555 Dual-Beam Oscilio- scope, but no sweep delay.	1850
536	XY Curve Tracer	dc-to-11 mc	Requires 2 plug-in units. Uses Type T Time-Base Unit (40 nsec/div with 5X Magnifier to 2 sec/div) at \$240, in horizontal amplifier, other letter-series plug-in in vertical amplifier, for conventional oscilloscope operation.	1085
535A	* General		Except for risetime/passband characteristics, the Type	1400
533A	Purpose	dc-to-15 mc	530-Series Oscilloscopes and their rack-mount counter- parts, have capabilities similar to the Type 540-Series	1125
531 A	Oscilloscopes		Oscilloscopes and their rack-mount counterparts.	995

*Type 530-Series Oscilloscopes also available in rack-mount models. Prices without plug-in units:

Type RM35A at \$1500, Type RM33A at \$1225 and Type RM31A at \$1095.

Tektronix, Inc.

P. O. BOX 500 • BEAVERTON, OREGON / Mitchell 4-0161 • TWX-BEAV 311 • Cable: TEKTRONIX

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex. • Atlanta, Ga. • Baltimore (Towson) Md. • Boston (Lexington) Mass. • Buffalo, N.Y. • Chicago (Park Ridge) III. • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio • Denver, Colo. • Detroit (Lathrup Village) Mich. • Endicott (Endwell) N.Y. • Greensboro, N.C. • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission) Kan. • Los Angeles, Calif. Area (East L.A. • Encino • Pasadena • West L.A.) • Minneapolis, Minn. • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N.J) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale) Ariz. • Portland, Ore. • Poughkeepsie, N.Y. • Stamford, D.C. (Annandale, Ya). TEKTRONIX CANADA LTD: Montreal, Quebec • Toronto (Willowdale) Ontario.

ENGINEERING REPRESENTATIVES: Kentron Hawaii Ltd., Honolulu, Hawaii. Tektronix is represented in twenty-five

overseas countries by qualified engineering organizations. European and African countries, the countries of Lebanon and Turkey, please contact TEKTRONIX INTERNATIONAL A.G., Terrassenweg 1A, Zug, Switzerland, for the name of your local engineering representative. Other Overseas areas, please write or cable directly to Tektronix, Inc., International Marketing Department, P. O. Box 500, Beaverton, Oregon, U.S.A. Cable: TEKTRONIX.

> Circle 184 on Inquiry Card World Radio History

accept any of these Tektronix Plug-In Units



Change the plugin unit and you equip these Tektronix Oscillo-

scopes with high performance needed for particular applications. The oscilloscope with various letter-series plug-ins through Type M, the four-trace unit, fits general-purpose applications. The oscilloscope with other letter-series plugins—from Type N, the pulse-sampling unit, through Type Z, the differential-comparator unit—fits special-purpose applications.

Each oscilloscope and plug-in combination performs simply and reliably in the many laboratory applications within its capabilities. For complete information on the characteristics of any of these combinations, please call your Tektronix Field Engineer.



General - Purbose Wide - Band High-Gain Unit • Calibrated Sensitivity—5 mv/cm to 50 mv/cm • Risetime—30 nsec • Passband —2 c to 12 mc • Calibrated Sensitivity—50 mv/cm to 20 v/cm • Risetime—18 nsec • Passband dc to 20 mc.



General-Purpose Dual-Trace DC Unit • Calibrated Sensitivity-50 mv/cm to 20 v/cm • Risetime-15 nsec • Passband-dc to 24 mc.



General-Purpose High-Gain DC Differential Unit • Calibrated Sensitivity—1 mv/cm to 50 v/cm • Risetime—0.18 µsec • Passband—dc to 350 kc—increasing to 2 mc.



General-Purpose Low-Level AC Differential Unit • Calibrated Sensitivity $-50 \mu v/cm \circ 10 m v/cm$ • Risetime $-6 \mu sec$ • Passband -0.06 c to 20 kc – increasing to 60 kc.



General-Purpose Wide-Band DC Differential Unit · Calibrated Sensitivity—50 mv/cm to 20 v/cm · Risetime—18 nsec · Pass-



General - Purpose Wide - Band High-Gain DC Unit • Calibrated Sensitivity—5 mv/cm to 20 v/cm • Risetime—23 nsec • Passband =dc to 15 mc.



General-Purpose Fast-Rise DC Unit • Calibrated Sensitivity-50 mv/cm to 20 v/cm • Risetime-12 nsec • Passband-dc to 30 mc.



General-Purpose Fast-Rise Highgain Unit • Calibrated Sensitivity -5 mv/cm to 2 v/cm • Risetime -15 nsec • Passband-3 c to 24 mc • Calibrated Sensitivity-50 mv/cm to 20 v/cm • Risetime-12 nsec • Passband-dc to 30 mc.



TYPE M

TYPE G

band-dc to 20 mc.

General-Purpose Four-Trace Unit • Calibrated Sensitivity--20 mv cm to 10 v/cm • Risetime--17 mec • Passband--dc to 20 mc



Pulse-Sampling Unit-fordisplaying repetitive high-speed signals by the sampling process • Calibrated Sensitivity-10 mv/cm • Risetime-0.6 nsec • Passband -dc to 600 mc.



Operational - Amplifier Unit- for displaying operations of integration, differentiation, function generation, linear and non-linear amplification - Calibrated Sensitivity—50 mv/cm to 20 v cm • Risetime—14 nsec • Passband -dc to 25 mc.

Differential-Comparator Unit-for

displaying an equivalent vertical

scale length up to ± 2000 cm at

50 mv/cm · Calibrated Sensitivity

-50 mv/cm to 25 v/cm . Rise-

time-24 nsec • Passband-dc



\$325 Unit

Transducer and Strain-Gage Unit -for displaying mechanical quantities converted to a change in resistance, capacitance, or inductance • Calibrated Sensitivity-10 µstrain/div to 10 000 µstrain/ div • Risetime -60 µsec • Passband -dc to 6 kc.

TEST UNIT AND POWER SUPPLY UNITS ALSO AVAILABLE TYPEP FAST-RISEUNIT

\$525

For checking vertical amplifier response, 4-nscc risetime.

TYPE 127 POWER SUPPLY UNIT . . \$650 For powering one or two plug- n uni s, 18-nsec risetime (with fast-rise units).

TYPE 132 POWER SUPPLY UNIT . . \$390 For powering one plug-in unit, 23-ns+c risetime (with fast-rise units).

TYPE 133 POWER SUPPLY UNIT . ISSO For powering one plug-in unit, dc-to-100 kc frequency response, ±5 valts output, 2-ohm source impedance.



Transistor Risetime Unit – for displaying simultaneously delay, rise, storage, and fall times of transistors • Calibrated Sensitivity –0,5 ma/cm to 100 ma/cm • Risetime – 12 nsec • Passband – dc to 30 mc.



Diode-Recovery Unit—for displaying forward and reverse switching characteristics of semiconductor diodes • Calibrated Sensitivity—1 to 20 ma forward current, 0 to 2 ma reverse • Risetime—12 nsec • Passband—dc to 30 mc.



TYPE 2

to 13 mc

HOW DO YOU TEST AN X-Y Plotte

In an automobile, transmissions can be designed to give top speeds by sacrificing acceleration – but it's a poor bargain, as a quick road test will show. Similarly, in an X-Y analog plotter high slewing speeds can be obtained by sacrificing acceleration. Again it's a poor bargain because highest plotting accuracy depends upon high static accuracy combined with a *perfect balance between acceleration and velocity limits*. EAI's Model 1100E Variplotter has this desired balance as a simple 'road test' developed by EAI engineers can graphically demonstrate.

As a matter of fact, everything about the Model 1100E Variplotter has been engineered to give you the utmost in plotting performance. Developed to speed up engineering control, testing and design operations, it consistently produces faster, more accurate plots of X-Y related data.

The development of the Model 1100E has resulted from EAI's years of pioneering research and development in the field of automatic plotting. It provides outstanding accuracy of 0.075% F.S. – less than the width of the line drawn by the pen. Arm acceleration



is 250 inches/sec.². Pen acceleration is 750 inches/sec.². The high velocity of the 1100E is augmented by this faster acceleration to assure outstanding dynamic performance.

Repeated testing under actual operating conditions proves that the principle of the Variplotter, Model 1100E design virtually eliminates backlash, and provides drift-free operation for periods of 8 hours or more. This superior repeatability has been amply testified by users who report that even after overnight shut-down, the Model 1100E resumes plotting with no noticeable drift.

A complete line of accessories—including bi-variant function generator, digital data plotting (manual or automatic) and time base generator—makes the EAI Variplotter the most versatile automatic plotting method available. The Model 1100E can be easily converted to operate as a function generator—or will plot digital information manually from a keyboard as well as automatically from punched cards or paper tape—by simple addition of compatible components.

Check these features...

Portable desk-top size – Large plotting surface (11" x 17") – Vacuum hold down – High dynamic and static accuracy – Rugged construction – Ease of maintenance – Differential input – Plug-in input network – Superior repeatability.

Ask your EA1 representative to show you the simple laboratory test that proves the superiority of the Model 1100E Variplotter,—or write for Bulletin AP 810-1.

ELECTRONIC ASSOCIATES, INC.

Long Branch, New Jersey

Circle 185 on Inquiry Card



You can play practically any instrumentation tune you want on the versatile Mincom CM-100 Magnetic Tape Recorder/Reproducer. Seven or fourteen tracks, 1 or 1.2 mc at 120 ips—with the rugged reliability possible only with Mincom's longitudinal recording on fixed heads. Analog recording/reproducing, or simultaneous post- and predetection capabilities in FM/FM modulation, PCM, PCM/FM and virtually all other FM-type carrier systems. CM-100 is mechanically simple: Mincom's exclusive DC tape transport provides dynamic braking, plus instant pushbutton choice of six speeds with no belt changes. With its system flexibility, its minimum down time and maintenance, the CM-100 can be the answer to your instrumentation requirements for years to come. Write today for specifications.



Los Angeles 25, California · Washington 4, D.C.

World Radio History

Circle 186 on Inquiry Card

FIRST CHOICE

of leading companies and laboratories...and here are some of the reasons why...

AC null indicator bridge is balanced when eye is open. AC generator is on when eye is green.

Terminals for connecting external generator. AC detector gain control.

Bridge is on when light is red.

Resistive tuning network for minimizing hum and harmonic signals in detector.

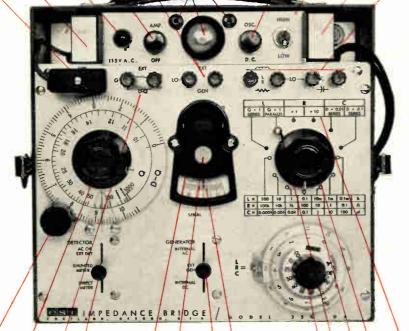
Shielded detector lead.

Detector output terminals for meter or oscil-loscope display.

AC-DC generator switch and AC generator voltage control.

Switch for setting the DC level for maximum sensitivity resistance measurements. esistive tuning network for setting oscillator

frequency. reminals for connecting unknown compo-nent and for making special connections for unusual measurements. All bridge cor-ners available on front panel. Terminals for



D-Q Vermer control/makes bridge/balance easier.

D-Q dial balances the bridge and indicates value of dissipation factor D or quality fac-tor Q as indicated by circuit selector switch.

Terminals permit extension of D and Q ranges by connection of external resistance.

witch chooses between external detector terminals which normally have the bridge AC detector connected to them and the galvanometer. It also chooses the strunted or direct galvanometer connection. Switch chooses

The zero position of the galvanometer can be set.

Galvanometer can be locked when the bridge is moved.

Q range values multiplied by Q dial set-ting give value of dissipation factor D or quality factor Q Two Resistance Multipliers D-Q ti Range dial chooses value and units

Circuit selector switch chooses bridge circuit. Range value and units multiplied by LRC dial reading give value of unknown.

IRC dial balances the bridge. 12,005 dial

divisions of resolution for finding resistance capacitance or inductance value. Resistance bridge null is read on galvanom-

leter.

Switch chooses between generator connected to external generator terminals and in-ternal AC and DC generators.

MODEL 250 - DA UNIVERSAL IMPEDANCE BRIDGE

Resistance to 0.1%, eight ranges; Capacitance to 0.2%, seven ranges; Inductance to 0.3%, seven ranges. Simple in-line readout – 12,005 dial divisions of resolution. This is the bridge that has been the industry pacesetter since its introduction -the bridge that dollar for dollar offers the f.o.b. Portland, Oregon immediate delivery. most in honus advantages.





Send for Catalog Sheet C-16

Electro Scientific Industries

7524 S.W. MACADAM . PORTLAND 19, OREGON

Circle 187 on Inquiry Card

World Radio History

Tech Data

for Engineers

Panel Meters

A completely revised, up-to-date series of technical catalog sheets on panel meters is available from Gen-eral Meters, Inc., P.O. Box 1701, Grand Junction, Colo. The sheets are color coded for easy reference and contains specs., Mil specs, types of movements, and commercial and mili-tary accuracies. Illustrations are retary accuracies. Illustrations are re-produced actual size for convenience of case and instrument designers.

Circle 498 on Inquiry Card

Microwave Measurement

Wilton Co., 717 Loma Verde Ave., Palo Alto, Calif., has an article on analysis and measurement of phase characteristics in microwave systems. This article contains phase information valuable to engineers doing work with microwave tubes, components, and semiconductors and in physical science research areas such as linear accelerators.

Circle 499 on Inquiry Card

Magnetic Field Probe

Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chi-cago 22, Ill., is offering tech. data #156, which illustrates and describes an ac magnetic field evaluation probe. Included is information on its con-struction and calibration.

Circle 500 on Inquiry Card

Hall Effect Generators

Data Sheet No. 62400, 4 pages, de-scribes Beckman® Hall Effect Gen-erators. Information includes operating theory, suggested uses, detailed specs., dimensional drawings, illustrations and ordering information. The Beckman device has typical in-put resistances of 100 to 600Ω , simplifying load matching and give more efficient use of output power. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. Circle 501 on Inquiry Card

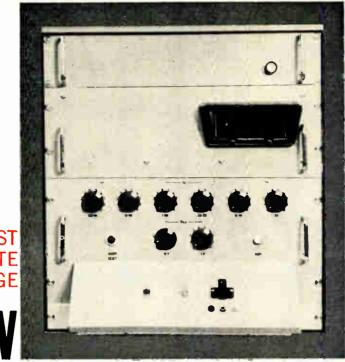
DC Null Sensor

Verco Inc., 1430 130th N.E., Bellevue, Wash., is offering data on their solid state electronics for measuring and monitoring. Included is information on a hazardous current monitor, voltage limit detector, freq. source, overspeed indicator, battery voltage tester, ripple meter, load meter and linear ammeter. Circle 502 on Inquiry Card

Temperature Sensing

This 28-page bulletin includes information on temp. sensing such as representative specification drawings, representative specification drawings, degree-by-degree tables of typical re-sistance vs. temp. ratios, the REC temp. conversion chart covering °C, °F, °R and °K from absolute 0 to 16,-000°C, and a bibliography. Included is a detailed discussion on the theory, design and application of pletinum as design and application of platinum resistance sensors, and a comparison of other types of temp. sensors. Rose-mount Engineering Co., 4900 W. 78th St., Minneapolis 24, Minn. Bulletin 9612.

Circle 503 on Inquiry Card ELECTRONIC INDUSTRIES · June 1962



FAST ACCURATE FULL RANGE

1, A TO 10 AMP PULSED TRANSISTOR BETA TESTER

FEATURES:

300 $_{\mu}$ SEC. PULSED-DIRECT READING DIGITAL PRESENTATION of hFE from 2–999 with an accuracy of ± 1 digit. No conversion charts necessary.

EASY SET-UP AND PROGRAMMING allows even inexperienced operators to perform the complete load, test, unload cycle in about 3 seconds on all types of NPN, PNP transistors.

EXTREME CIRCUIT, CALIBRATION STABILITY is attained by closed loop, feedback system. Output cable provided to drive permanent test recording equipment.

SELF-PROTECTING, LONG-TERM RELIABILITY features result from built-in short detector which locks out system, protects both the equipment and transistor being tested. High reliability Fairchild Silicon Planar transistors and diodes used throughout all measurement, detector and logic circuits.

APPLICATIONS:

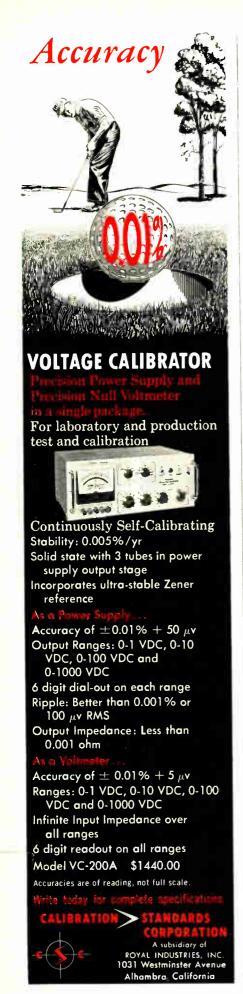
INCOMING INSPECTION OPERATIONS, where small lots of different transistor types are received, are simplified and speeded. Makes 100% inspection feasible.

ENGINEERING EVALUATION TESTING. Transistors can be remoted in hot or cold environments to test hFE under temperature stress conditions. This tester permits data taking for rapid hFE characterization over a wide range of collector currents and collector to emitter voltages.

 $\label{eq:specifications} \begin{array}{c} \text{SPECIFICATIONS FAIRCHILD TYPE 840-1} \\ \text{DIRECT READING h_{FE} TESTER \\ \\ \text{READOUT RANGE: h_{FE} from 2 to 999 (read directly) \\ \text{READOUT ACCURACY: 2% or 1 digit \\ \\ \text{PROGRAM RAWGE: $1c-1$ μ A to 10 amp. \\ (in 1 μ A steps). \\ \\ \text{V}_{EE}-1$ volt to 29 volts \\ (in $.1$ volt steps). \\ \\ \text{STANDARD PULSE DUTY CYCLE: 0.7% (approx.) \\ \end{array}$



Circle 188 on Inquiry Card



Tech Data

for Engineers

Transistor Testing

Tech. data is available from Sandrs Associates, Inc., 95 Canal St., Nashua, N. H. on their Universal Transistor Circuit-mount. The mount in Tri-Plates Strip Transmission Line is for the evaluation of high freq. transistors at either UHF or microwave freq. and permits accurate measurement of cutoff freq., rise time and other critical circuit parameters.

Circle 504 on Inquiry Card

Non-destructive Testing

This 16-page catalog, titled "Non-destructive Inspection Equipment and Modern Industry," covers products of the Norelco Industrial Radiographic Equipment Div., and is available from Phillins Electronic Instruments. 750 Philips Electronic Instruments, 750 So. Fulton Ave., Mt. Vernon, N. Y. Included in the brochure are sections on 150 and 300kv units (MG 150 and MG 300), Constant Potential Radiog-raphy with high resolution, Frac-tional Focus and Rod Anode X-ray tubes, X-ray tube suspension systems, and Self-Contained Portables (PG 260 300). Photographs and descriptions are included.

Circle 505 on Inquiry Card

MEASUREMENTS' $\sqrt{2}\sqrt{2}$ STANDARD PULSE GENERATOR



Fast rise time, less than 0.1 microsecond.

Wide, calibrated continuous frequency range, 60 cps to 100.000 cps.

Triggered and free-running operation.

Continuously variable calibrated pulse width, 0.5 to 60 microseconds.

High amplitude positive and negative pulses, +200 v to -150 v.

This new instrument is a versatile. compact unit. useful in a wide range of applications in TV. radar, computeri telemetering and nuclear fields. Model 179 is uniquely suited for

production line testing and laboratory work where clean-shaped pulse waveforms of known repetition rate and width are required.

WRITE FOR BULLETIN



Circle 190 on Inquiry Card

<u>NEW...TYMETER</u> and 24 HOUR READ OU

Front Panel Mount Desk or Bench Use Digits Resettable Individually

Also available in: IMPULSE TIMERS ELAPSED TIMERS COUNT DOWN TIMERS

Write for Catalog and Complete Line Showing Specifications

TYMETER ELECTRONICS-PENNWOOD NUMECHRON CO. 7249 FRANKSTOWN AVE. PITTSBURGH 8. PA.



Circle 191 on Inquiry Card

ELECTRONIC INDUSTRIES · June 1962

SEND-without obligation—for this valuable technical information on advanced measuring techniques:

PAPPLICATION NOTES

Hewlett-Packard Application Notes include theoretical and "how to do it" information on a wide variety of measuring techniques. These notes are available to you without cost or obligation. Application Notes are derived from the experience of ϕ engineers, both in general areas of measurement and in solving specific measurement problems. Here is a partial list of titles:

- #25 Cathode Ray Tube Phosphors
- #44D Sampling Oscilloscope Accessories and How to Use Them
- #52 Frequency and Time Standards
- #53 Transmission Line Testing Using the Sampling Oscilloscope
- #54 Improvements in Microwave Swept Frequency Techniques
- #56 Microwave Mismatch Error Analysis
- #57 Noise Figure Primer

Other Application Notes cover such subjects as measuring FM signals, measuring rf pulse carrier frequency, microwave spectrum synthesis, waves on transmission lines, square wave and pulse testing, measurement of cable characteristics, instruments for transducer applications, distortion and intermodulation. The Application Notes Index gives a complete listing.

Fill in and mail the attached postcard for Application Notes of interest to you, or for the complete index of titles.

See the reverse side of this page for other helpful publications



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NDARDS

Engineers in electronics and allied fields!

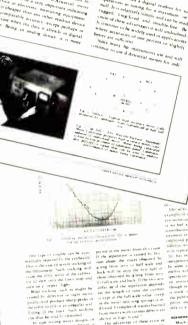
Here are factual reports on new measurement techniques, new instruments...yours for the asking! Just join the regular readers of the

JOURNAL

Published throughout the year, the by Journal is yours without charge. Just check appropriate box on the card, tear out and mail.

TYPICAL JOURNAL SUBJECTS

- How doppler shift records provide satellite range and height data
 The effect of μ-circuit non-linearity on the amplitude stability of RC oscillators
- A new frequency/time standard with 5x10¹⁰/day stability
- 📕 Increased accuracy in 🏘 meters through servo calibrating methods
- 📕 A parallax-free no-glare CRT for 🏘 oscilloscopes
- Broader information capabilities in the clip-on dc milliammeter
- The transistorized RC oscillator



Increased Accuracy in she Meters Through Servo Calibrating Methods

In high ensuine mean decays or a lacent on high ensuine some detexts of the all harden variations some detexts of the place order manumal the generation of manumal the generation are where the manufacture will on generative some manufacture and the some of the manufacture of the lacent detext of the some solution generation with the formed that the solution takes the solution of the mean energies of the solution of the soluti more with enable higher accords predictations to be excluded local methods and the second local brough no change is a proclamation in more than the second local methods in the published proclamation with one process and the users with on fact receive and the user with on fact receiver and an exclusion existence of the proclamation. The second distance of the second local brain accords of the process belongs on Lange

Much on the verdin too the working of thos proves belongs to be approximately approximately approximately be approximately approximately approximately diversion working on the work of some provided out the work of some proposal approximately approximatel

Please send #25 #44D #52	these APPLICATION NOTES #53 #54 #56 #57 Complete Index	
Ask my & repres	ailing list for the & JOURNAL entative to send me the 1962 & Short Form Catalog sentative to send me the & Microwave Catalog <u>plete</u> address, giving mail station or other delivery code.	

NEW!

Now available ... the new 1962 Hewlett-Packard Short Form Catalog, incorporating data and pictures on new @ instruments, plus virtually the entire @ line. Available, too, is the % Microwave Catalog, offering complete information on Hewlett-Packard's array of full-range tested instruments and equipment, for microwave measurement. Just contact your nearest % representative for your copy, or check the appropriate box on the return postcard.



my home address

World Radio History

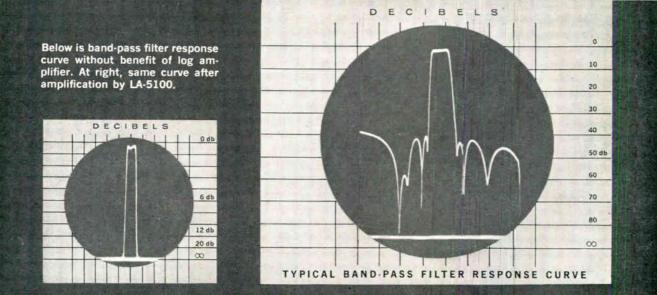


rf LOGARITHMIC AMPLIFIER Model LA-5100

500kc to 100mc



Accurate to within ±1db over 80-db dynamic range



This extremely accurate log amplifier enables exact measurements of attenuation in networks, filters, amplifiers, and other devices exhibiting dynamic operating ranges down to 90 db. Total rf response of device under test can be displayed in a precise logarithmic ratio on a standard dc-coupled oscilloscope. Write for complete technical data.

- Gives true log presentation over frequency range 500kc-100mc, with flatness better than $\pm \frac{1}{2}$ db.
- Four calibrated ranges: Logarithmic 0-40, 0-60, 0-80 db (readable to 90 db) and one linear range 0-20 db (variable gain).
- Continuously variable log-expand control permits uncompressed presentation of first 5 db of each range.
- Direct-reading meter for point-by-point measurements.
- Oscilloscope output jack for sweep display measurements.
- Designed for rack mounting: 7" x 14¹/₂" x 19".

\$795.00

JERROLD ELECTRONICS CORPORATION

Industrial Products Division, Dept. ITE-144 Philadelphia 32, Pa. Jerrold Electronics (Canada) Ltd., Toronto • Export Representative: Rocke International, New York 16, N.Y.

World Radio History



AUTOMATIC TESTING*

Model LA 303

*More than one test per second with unskilled labor saves over 50% of cost!

Lavoie's Robotester provides rapid and reliable automatic checkout of components, assemblies and systems. Fully programmable by punched tape, the Robotester eliminates human error and releases highly specialized technicians for other critical tasks.

Unsurpassed versatility through pre-programmed tape insures adaptability throughout the production line.

Tests:

Resistances Insulation resistances AC and DC volts Capacitive and inductive reactance Complex impedance

Features:

Low cost Small physical size Better service and reliability Easy to program Go-No-Go testing Permanent printed test record Self-checking and fail safe

Let us show you how Robotester can serve you.

Lavoie Laboratories, 9nc.

MORGANVILLE, NEW JERSEY . LOwell 6-2600 . TWX MWN-1250

Since 1939, one of America's leading manufacturers and designers of: Oscilloscopes, Spectrum Analyzers, Frequency Standards, Frequency Comparators, Pulse Generators, Digital Counters, Automatic Test Equipment. See The Complete Lavoie Line—Booth 451 WESCON

Tech Data

for Engineers

Noise Control

"The Why and How of Noise Control" discusses fundamentals of industrial noise control. The 16-page book-let shows how to set up a noise control program and the equipment needed in setting up the program. H. H. Scott, Instrument Div., Dept. "P," 111 Pow-dermill Rd., Maynard, Mass. Circle 506 on Inquiry Card

Test Instruments

Tech data is available on r-f voltmeters, dc voltmeters, capacitance and inductance bridges, ac and dc null detectors, r-f distortion meters and UHF grid dip meters. Included are photographs, an specs. Boonton Electronics Corp., Morris Plains, N. J. Circle 507 on Inquiry Card

Voltage Calibration

Ballantine Laboratories, Inc., Boonton, N. J., is offering an 8-page tech-nical report entitled, "Techniques and Errors in High Frequency Voltage Calibration." This paper discusses the techniques and errors involved in applying a group of high-freq. voltage standards developed by NBS to typi-cal problems such as the calibration of electronic voltmeters. Photographs, outline drawings, schematics, charac-teristics, and charts are included. Circle 508 on Inquiry Card

Cryogenic Equipment

This 8-page, 2-color booklet presents data on Sulfrian Cryogenics' line of low temp. containers, vessels and equipment. Cutaway illustrations show construction characteristics of liquid nitrogen vessels, helium and hydrogen containers and open dewars. Sulfrian Cryogenics Inc. 1290 Cen-Sulfrian Cryogenics, Inc., 1290 Cen-tral Ave., Hillside, N. J.

Circle 509 on Inquiry Card

Digital Ohmmeters

This 6-page, pocket-size, folder gives brief descriptions and specs. on a line of 4 and 5 digit, all-solid-state, digital voltmeters and ohmmeters. Electro Instruments, Inc., 8611 Balboa Ave., San Diego 11, Calif

Circle 510 on Inquiry Card

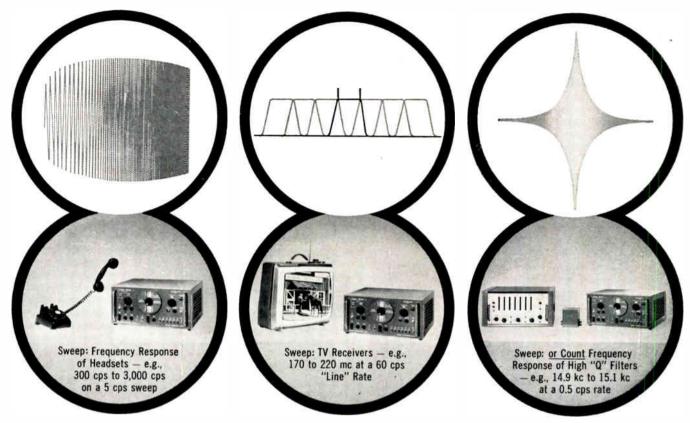
Meter-Relays

Specs. including dimensions, sensitivities, case styles and prices are included in a catalog on locking contact meter-relays. Bulletin No. 5, 23 pages, 2 colors, includes operating features and standard circuits and is available from Assembly Products, Inc., Chesterland, Ohio. Circle 511 on Inquiry Card

Frequency Standard

The Hill Reference Frequency Standard System 81000 series is described in an 8-page 2-color booklet. Modular components included are: 2.5MC primary freq. reference source; 7YLF phase comparator models; interoscillator phase comparator; and a time-correction panel. Hill Electronics, Inc., Mechanicsburg, Pa. Circle 512 on Inquiry Card

Circle 194 on Inquiry Card



Complete VERSATILITY... Audio, Video, VHF

KAY Ligna-Sweep skv. All-Electronic **SWEEPING OSCILLATOR**

50 CPS TO 220 MC IN 12 BANDS • WIDE RANGE OF SWEEP WIDTHS VARIABLE REP RATES • MANUAL AND AUTOMATIC OPERATION

- Single wide-sweep video displays from 10 mc down to 1 kc.
- Linear and logarithmic sweeps of 0.2 cps to 30 cps; or sweep locked to line frequency.
- Audio Sweep of 50 cps to 20,000 cps.
- 8 fixed, narrow-band video frequency sweeps for repetitive operations.
- Fundamental frequency 10 mc to 220 mc (widths to 30 mc plus).
- $\bullet\,$ High-level output of 1 V rms into 70 ohms. AGC'd to $\pm\,$ 0.5 db over widest sweep.
- Manually-operated control for varying oscillator frequency.
- Fixed pulse-type markers or variable marker provision.

Price: \$1295.00 F.O.B., Factory (\$1425.00 F.A.S., New York).



The wide frequency range, extensive choice of sweep widths and repetition rates make the Kay Ligna-Sweep SKV a most useful sweeping oscillator.

SKV a most useful sweeping oscillator. For high frequency work, the unit provides 9 sweep bands, operating at fundamental frequencies for wide, stable sweeps from 10 to 220 mc. At the low end of the spectrum, an audio frequency sweep from 50 to 20,000 cps is provided. High order stability permits frequency sweeps to as low as 50 cps.

sweeps to as low as 50 cps. For checking high-Q circuits and low-frequency response characteristics, either log or linear sweeps at variable rep rates down to 0.2 cps are available. This wide choice of sweep rates (continuous to 30 cycles, and fixed line lock) makes it easy to select that highest *rcp rate* which gives both an *accurate response* display and easiest, brightest viewing on the scope screen. With the manual frequency control, the trace on the scope screen may be held and examined in detail, (counted precisely, measured on a VTVM) at any frequency point on the scope display.

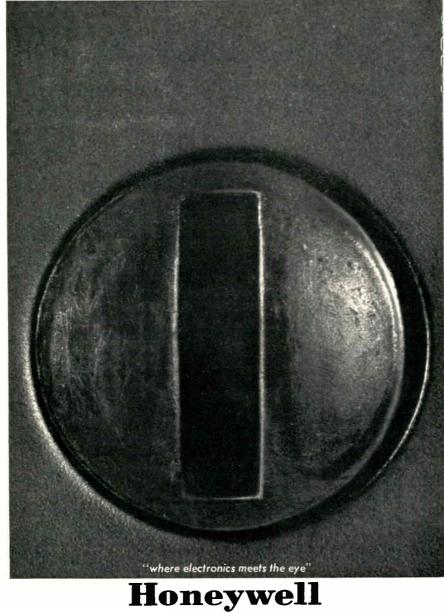


World Radio History

Circle 195 on Inquiry Card

SUPERFLUOUS Tech Data

The zero adjuster is superfluous on Honeywell sealed, ruggedized meters, even though it is required by specification. The reason is that these Honeywell meters are designed and manufactured to pass qualification tests and regular monthly production acceptance tests without any zero adjustment. It takes an excellent meter to pass all of the tests, one after another, without "fixing" the meter after each test segment by resetting the pointer to zero. Try it and see for yourself. Ask your present supplier if he will certify that his products have been qualified and are regularly tested in this manner. If his answer doesn't satisfy you, our answer will. Write to Honeywell, Precision Meter Division, Manchester, N.H.



for Engineers

Ratio Transformers

Tech. brochure, 2 colors, describes precision, general purpose ratio trans-formers, featuring an accuracy of 0.001%, high imput impedance, low effective series impedance, and very low phase shift. Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Circle 513 on Inquiry Card

Voltmeter

Potentiometric Voltmeter Model 951 Potentiometric Voltmeter Model 951 is described in tech. data, 3 colors, available from Smith-Florence Inc., P.O. Box 717, Redmond, Wash. Specs include input voltage and power, 117v, 60CPS, 10, 10w; potentiometer accuracy, 0.005%; and instrument ac-curacy 0.01% absolute.

Circle 514 on Inquiry Card

Sweep Generator

Model 501 Sweep Generator, with a freq. range of 100CPS to 32MC, is described in tech. data available from Northeastern Engineering, Inc., 25 So. Bedford St., Manchester, N. H. Two plug-in heads cover the range and give high overlap in the 10 sepa-rate bands provided. The all electronic sweep eliminates the problems associated with sweep motors and mechanical type sweeps. Circle 515 on Inquiry Card

Measure - - - -MILLIVOLTS - - - - -- - - - NANOAMPERES accurately at low cost with DYNATRAN's ---



Model 1829 SENSITIVE DC VTVM

Write for complete information about this and other quality instruments for laboratory, production, incoming inspection and quality control.



electronics corporation

178 HERRICKS ROAD MINEOLA, NEW YORK PIoneer 1-4141

Circle 197 on Inquiry Card ELECTRONIC INDUSTRIES · June 1962

Circle 196 on Inquiry Card

Precision Meters

World Radio History

Tech Data

for Engineers

Instrument Brochure

A 6-page, 3-color illustrated folder, Instruments for Industry, is available from General Radio Co., W. Concord, Mass. Instruments described include continuously adjustable autotransformers, sound and vibration measuring equipment, and stroboscopes. Circle 516 on Inquiry Card

Thermocouple Cataloa

This 56-page catalog on a line of thermocouples for industrial use is available from Wheelco Industrial Instruments Div., Barber-Colman Co., Rockford, Ill. The catalog not only carries descriptive information on these products, but also includes engineering information concerning thermocouple usage and application. Catalog TC13A.

Circle 517 on Inquiry Card

Microwave Test Set

PRD Electronics, Inc., 202 Tillary Street, Brooklyn 1, N. Y., is offering a 10-page report entitled "A Microwave Calibration Test Set For A Seven Octave Band." The equipment described is capable of making all fundamental measurements, i.e., pow-er, frequency, VSWR, and attenua-tion in the freq. range from 300 to 40,000 MC.

Circle 518 on Inquiry Card

Digital Voltmeter

Six-page Bulletin 311 describes Model 550 Digital Voltmeter. Illus-trations of individual plug-in modules, as well as internal views of the complete instrument are shown. Frank-lin Electronics, Inc., Bridgeport, Pa. Circle 519 on Inquiry Card

Test Equipment

The Triplett Electrical Instrument Co., Bluffton, Ohio, has available test equipment catalog No. 43-T, covering their complete line of volt-ohm-milliammeters, combination V-O-M and VTVM's, signal generators, sweep generators, transistor testers, and their 5 in. oscilloscope Model 3441-A. Circle 520 on Inquiry Card

Panel Instruments

Circular Z-69 discusses the features and specs, of a complete line of panel meters available as stock items from Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., New-ark 14, N. J.

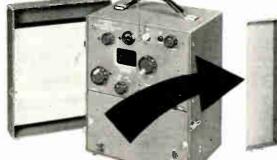
Circle 521 on Inquiry Card

Core Testing

Application Bulletin No. 200 describes a method of making a low cost test system for fast switching memory cores by adding the output pulse currents of 4 Rese Model 203 Pulse Generators. Included is a block diagram of the test system, a drawing of the positive and negative current pulses and a photographic illustration of the 4 generators connected to an oscilloscope and to a core under test. Rese Engineering Inc., A and Court-land Sts., Phila. 20, Pa.

Circle 522 on Inquiry Card

YOUR GERTSCH FM-3 FREQUENCY METER CONVERTED TO MEET FCC REQUIREMENTS





Frequency Meter

World Radio History

FM-3

FM-3A 2-Way Communication Frequency Meter

- factory conversion provides direct reading of all allocated channels in the 150-170 mc band

All Gertsch Model FM-3 frequency meters can now be factoryconverted to measure and generate all assigned channels in both 150-170 mc, and 450-510 mc bands.... with ±.00025% (2.5ppm) accuracy. Instrument features a single 1-mc crystal which is easily standardized against WWV.

Converted units can also be operated as standard FM-3 instruments through 20 to 1,000 mc, at .001% accuracy.

Conversion includes: an all transistorized converter module, a new front panel and carrying case, and a built-in amplifier (with speaker). Also, a front-panel jack allows input of external audio signals, such as those from a Gertsch Model DM-3 deviation meter. Space for a DM-3 is provided in the case.

Compact size — only 131/2" W x 111/2" D x 133/4" high.

New Gertsch frequency meters are also available in both battery operated and AC power supply units. New meters incorporate same features as converted instruments.

Send for literature on FM-3A series.

GERTSCH PRODUCTS, Inc. 3211 South La Cienega Boulevard, Los Angeles 16. California/UPton 0.2761 - VErmont 9-2201



ACCURATE RESEARCH STARTS WITH Rutherford PULSE INSTRUMENTATION

Model B-11 REMOTELY PROGRAMMABLE PULSE GENERATOR

Designed specifically for automated check out systems, this allpurpose Pulse Generator may be programmed to fill a broad range of requirements.

Model B-10 TRANSISTORIZED PORTABLE HIGH-SPEED PULSE GENERATOR

A versatile, general purpose portable unit for field and laboratory use featuring a self-contained, rechargeable battery pack which allows independent operation "in the field" as well as from standard line voltage.

Model B-9 HIGH QUALITY PULSE AND TIME DELAY INSTRUMENTATION

Designed on the modular building block concept and featuring accurate transistorized circuitry in a wide range of specifications. It provides special purpose generators to meet any pulse requirement.

Model B-7B HIGH REPETITION RATE PULSE GENERATOR

High performance and wide versatility—50v into 50 ohms @ 30% duty factor, rep. rate to 2 mc, widths .05 us to 10,000 us, delays to 10,000 us. Rack mountable new single unit construction.

Model B-5A 10 MEGACYCLE PULSE GENERATOR

Built to the most exacting standards of precision engineering, offers an unparalleled combination of good clean pulses and high repetition rate with no greater than 8 mus rise and fall time.

Model B5-2 HIGH SPEED 10 MEGACYCLE OOUBLE...PULSE GENERATOR

Producing 2 pulse trains derived from a single oscillator—featuring output pulse adjustable in width from 20 mus to 12.5 us, rise and fall time no greater than 8 mus.

Model B-2A a general purpose pulse instrument

Produces pulses of accurately controlled widths, amplitude and time delay at low impedance. Internal oscillator gives rep. rates from 10 cycles to 100 kc. Pulse widths from .08 us to 1,000 us.

Model A-2 and Model A-4 TWO TIME DELAY GENERATORS

Feature low jitter, linear scales, small repetition rate effects, external connector provided for delay voltage so that unit may be externally time modulated, easily read dial controls.

Model A9 PULSE AND TIME DELAY SYSTEMS

A highly accurate, jitter free time delay generator featuring time delays from 0.8 to 100,000 usec. Multiple outputs including gates and ramp available at front panel connectors.

For complete bulletin on Rutherfords Instruments write to Dept. EI-662



Circle 199 on Inquiry Card

21 separate C-BAND frequency signals with ±0.0001% accuracy!



Model G110C Signal Generator

This unique laboratory instrument from Frequency Engineering combines both precise frequency control at a large number of points AND maximum operating simplicity. Any one of 21 frequency signals can be selected and peaked by the single front panel control...ideal for quality control requirements in microwave tube testing!

Exact frequency is derived from a standard crystal oscillator by multiplication and mixing circuits followed by a high-sensitivity gang-tuned filter to eliminate spurious signals.

SPECIFICATIONS

Frequency Range	. 5000-6000 mc
Accuracy	±0.0001%
Generator Power Output	1 mw minimum
Output Signals	
in incren	nents of 25 mc
Spurious Responses	60 db down
Oimensions 19" Rack	Panel, 12" High

For complete details, ask for Bulletin A10162

We invite your inquiries on custom frequency control equipment and components for laboratory, field, or system use. For information on microwave stalos, multiplexers, filters, wavemeters, reference cavities, discriminators, and stable signal sources write:



Circle 200 on Inquiry Card

ELECTRONIC INDUSTRIES · June 1962

Tech Data

for Engineers

Deviation Meter

Deviation Meter Model 140 is covered in tech data available from Measurements, a McGraw-Edison Div., Boonton, N. J. Specifications include a carrier freq. range of 25 to 1000MC; and sensitivity of 25 to 100mv at freqs. to 500MC; 100 to 1000mv at freqs. to 1000MC.

Circle 523 on Inquiry Card

Spectrum Analyzers

Tech. data is available on: audio spectrum analyzers; CW oscillators; a complete line of high freq. attenuators; precision random noise generators; and a noise measurement test set. Specs. and photograph included. Kay Electric Co., Dept. EEM-5. Maple Ave., Pine Brook, N. J. Circle 524 on Inquiry Card

Harmonic Measurement

Tech. data is available on EMTECH Harmonic Measuring Set HMS-L1 offering fundamental freq. range of 755-985MC; harmonic freq. range of 1500-3000MC.; a minimum detectible signal, 1mw.; accuracy of harmonic amplitude measurement, ± 3 db.; and simplicity of operation. Electromagnetic Technology Corp., 1375 California Ave., Palo Alto, Calif.

Circle 525 on Inquiry Card

High Voltage Testing

A complete engineering application analysis, entitled "High-Voltage Testing: It Can Be Nondestructive" is available from Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill. The bulletin details the causes of insulation breakdown, the minimizing of destructiveness by current limiting and many other pertinent aspects of insulation testing. Bulletin 5-15.4.

Circle 526 on Inquiry Card

Test Instruments

Short Form Catalog 1962 available from Marconi Instruments, 111 Cedar Lane, Englewood, N. J., includes photographs and specs. on their line of: signal generators — AM, FM, and sweep; bridges—L C & R; FM deviation meters, Q meter and accessories, receivers—FM and AM; and systems test gear: multi-channel, and SSB.

Circle 527 on Inquiry Card

Miniature Recorder

The Amprobe Recorder is a rugged, compact instrument for making permanent records of any variables such as voltage. current, power, temp., pressure, or flow, etc. It weighs 20 oz., holds enough paper for 360 hours of continuous recording and gives an accuracy of $\pm 2^{\prime} c$ (dc) and $\pm 3^{\prime} c$ (ac) full scale. The unit measures $521/32 \times 31.32 \times 1.11/16$ in. Amprobe Instrument Corp., 630 Merrick Rd., Lynbrook, N. Y.

Circle 528 on Inquiry Card

Circle 201 on Inquiry Card -



Just <u>how</u> hot is very important, if the spot happens to be a rivet on the skin of a supersonic aircraft's wing, or on the nose cone of a missile plunging through the atmosphere. The device shown above is designed to take its own temperature, functioning both as a rivet and as an accurate temperature transducer. Its physical configuration is that of a standard precision-head, 100° countersunk aircraft rivet; but it also incorporates a chromel-alumel surface thermocouple, accurate within 2°F up to 500°F, and within 3% of 1% of output beyond 500°.

The Rivetemp thermocouple is re-usable; fastens in place quickly by means of a standard push-on "speed nut." Low in cost, it is one of many fastresponse, high-accuracy, low-mass thermocouple designs made by ATL for aerospace and processing applications. Would you like details? Please write the address below.

ADVANCED TECHNOLOGY LABORATORIES 369 Whisman Road • Mountain View 33 • California



American Standard and Standards ore trademorks of American Radiator & Standard Sonitory Corporation

New Tech Data

Pulse Generators

Argonaut Associates Inc., P. O. Box 273, Beaverton, Ore., are offering a 1962 instrumentation catalog describing characteristics of a modular group of differential preamplifiers, electrometers, intermediate and out-put amplifiers, single ended and differential isolation units, pulse gene-rators, calibrators, and regulated power supplies.

Circle 657 on Inquiry Card

Commutating Switch

Tech. data on the Rotary Commutating Switch is available from Pre-cision Specialties, Inc., P.O. Box 118, Pitman, N. J. Information includes photograph and dimensional drawing, as well as background information, complete description, specs. and uses. The unit is for measuring low level signals from transducers or thermocouples at high speed. Circle 658 on Inquiry Card

Laboratory Amplifiers

An 8-page tech. brochure describ-ing Glennite Transistorized Laboratory Amplifiers is available from Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. The illustrated booklet gives information on the company's combination interchangeable power supply and rack-mounting chassis which accommodates 6 interchangeable plug-in modules. Four different modules are available, in-cluding a voltage amplifier, voltage amplifier and meter, ac galvanometer amplifier and dc galvanometer amplifier.

Circle 659 on Inquiry Card

Sensing Equipment

Schaevitz Engineering, P.O. Box 505, Camden 1, N. J., is offering a 16-page short form catalog describ-ing their sensing, indicating, record-ing, and controlling equipment. Us-ing a "building-block" concept, the equipment can be applied to the equipment can be applied to the measurement and control of most physical quantities such as displace-ment, pressure, force, acceleration, weight, thickness, contour, level, flow stress and strain.

Circle 660 on Inquiry Card

Casting Resin

Stycast 1264 is a clear, almost water white casting resin which when fully cured has high characteristics of toughness and impact strength. Pre-liminary Tech. Bulletin 7-2-26 gives specs. and makeup instructions. Emerson and Cumming, Inc., Canton, Mass. Circle 661 on Inquiry Card

Digital Voltmeter

Digi-Tec Model 200, a small, low cost portable digital de voltmeter is primarily for production use. Certified accuracy is 0.2% full scale. Manually selected voltage ranges run Manually selected voltage ranges run from 0.000 to 1020vdc. Resolution and readability is ½ digit (0.05% full scale) United Systems Corp., 918 Woodley Rd., Dayton 3, Ohio. Circle 662 on Inquiry Card

Glass Processing

Revised edition of Bulletin S-1057, "Processing Glass with Selas Gradiation® Heating," is available from Se-las Corp. of America, Dresher, Pa. This 16-page bulletin includes updated information on new develop-ments in the field of glass processing and complete description of how Gradiation[®] heating is used in a variety of operations from annealing to tempering, fire-polishing to processing.

Circle 663 on Inquiry Card

Phenolic Resins

A 12-page illustrated catalog for 1962 (CDC-381-A), describing Lexan^{T.M.} polycarbonate resins and pholic resins, varnishes and molding powders, is available from the Chemical Materials Dept., General Electric Co., 1 Plastics Ave., Pittsfield, Mass. Also included are phenolic foundry resins, industrial resins, laminating varnishes and resins, and Methylon® coating resins. Circle 664 on Inquiry Card

Electronic Enclosures

Tech. data is available on both Military Type (26 in. deep) and Com-mercial Type (24 in. deep). Included in the information is general specs., notes, basic frames, components and accessories, ventilation and cooling and ordering information as well as dimensional drawings. Holbrook Mer-rill Co., 1150 Kifer Rd., Sunnyvale, Calif.

Circle 665 on Inquiry Card

Bobbin Coil Winders

Two types of automatic bobbin coil winders, for winding 400 to 1,000 coils/hr. with wire sizes of AWG 16 to 50 and finer, are described in tech. data from Leesona Corp. 333 Straw-berry Field Rd., Warwick, L. I. The No. 115 is a high-speed, single-head winder for spool-wound coils used in high sensitivity instrument relays and field coils for small motors. The No. 116 is a multi-head, automated winder for the same types of coils. Circle 666 on Inquiry Card

for Engineers

Silicone Cataloa

A new and revised 8-page, 2-color catalog describing the complete line of GE's silicones and their uses is available from General Electric Co., Sili-cone Products Dept., Waterford, N. Y. The 1962 catalog, CDS-129D illus-trated with photos and tables, contains data pertaining to the various silicone products, including a useful selector guide for silicone rubber.

Circle 667 on Inquiry Card

Cushioning Tape

TESA Foam Stik Tape cushions components and electronic assemblies against damage. It is self-adhesive and quickly applied by pressure. The tape is also designed to keep out dust, soot, and insects and is available in rolls of varying thicknesses, widths and lengths. It has high resistance to and lengths. It has high resistance to chemicals, fumes, rot, rust and mil-dew. United Mineral & Chemical Corp., 16 Hudson St., New York 13, N. Y.

Circle 668 on Inquiry Card

Ultrasonic Generators

Product Bulletin 150 gives information and specs. on a complete line, plus optional accessories, of 4 sizes of ultrasonic generators for conveyor-ized, batch or manual production line cleaning and degreasing. All generators are designed to operate either transducerized tanks or immersible transducers, interchangeably. Na-tional Ultrasonic Corp., 95 Park Ave., Nutley 10, N. J.

Circle 669 on Inquriy Card

Soldering Irons

Tech data is available on Weller Magnastat® Controlled Temperature Soldering Irons. Information includes specifications, tables, outline draw-ings on both soldering irons and sold-ering iron tips. Weller® Electric Corp., 601 Stone's Crossing Rd., Corp., 601 Easton, Pa. Circle 670 on Inquiry Card

Crystal Crucibles

Information is available on the production of single crystal crucibles, us-ing Magnesium Oxide single crystals as the actual crucible itself. With the purity of 99.97 + %, they are being produced in 2 sizes: one which has an internal dimension of 1cm. in dia. x 1cm. deep and another which has internal dia. of 0.5 cm. and a depth of 0.5cm. Semi-Elements, Inc., Saxon-burg Blvd., Saxonburg, Pa.

Circle 671 on Inquiry Card

Tech Data

for Engineers

Counting Systems

Proportional Counting Systems and associated equipment described in Bulletin PC-62, 16 pages, is available from Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind. The systems and equipment are used for precise detection and measurement of alpha, beta and gamma radiation in the industrial and nuclear research fields. Information is included on proportional counting converters, dual proportional counter, radiation laboratory systems, decade scalers, accessories and replacement parts.

Circle 529 on Inquiry Card

DC Parameter Tester

Model #TM-101 is a manual tester for measuring 5 transistor de parameters on both npn and pnp transistors. Tests performed are collector to base leakage (ICBO); emitter to base leakage (IEBO); emitter to base breakdown voltage (BV_{EBO}); collector to base breakdown voltage (BV_{CBO}); and collector to emitter breakdown volt-age (BV_{CEO}). Accuracy is $\pm 1\%$ of Accuracy is $\pm 1\%$ of full scale with worst case combination of load variation, ±10% line voltage variation, and ±25°C temp. variation from 20°C amb. Indamer Electronics, 1038 W. Evelyn, Sunnyvale, Calif. Circle 530 on Inquiry Card

Frequency Standard

Tech. data is available on Mon-tronics Inc.'s Model 200 Synchronized Frequency Standard for use in communications systems, standards, laboratories, navigation and guidance systems and precision measurements laboratories. Model 200 features: locked to NBS or U. S. Naval Observ-200 features: atory; all electronic servo for max. reliability; all solid state circuitry; and absolute accuracy to 2×10^{10} . Montronics Inc., 1212 W. Main, P. O. Box 135, Bozeman, Mont. Circle 531 on Inquiry Card

Test Instruments

Tech data is available on a line of impedance bridges, distortion analyzers, noise analyzers, ac and dc, voltmeters, signal generators, displacement and vibration analysis, and control system analysis systems. Wayne Kerr Corp., 1633 Race St., Phila. 3, Pa.

Circle 532 on Inquiry Card

Standards Catalog

catalog containing more than 2,000 American standards as well as recommendations of the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) is available from the American Standards Assoc., Dept. P 298, 10 E. 40th St., New York 16, N. Y. This 76-page brochure provides reference to approved American Standards in areas of acoustics, symbols and abbreviations, electrical engineering, ferrous materials and metallurgy, nuclear energy, and safety. Circle 533 on Inquiry Card



KEITHLEY AC AMPLIFIERS

ease the search for microvolt signals

The Keithley Model 103 provides the best attainable signal-to-noise ratio for input impedances of either 100 k ohms or 10 megohms. (The equivalent input noise resistance on the low noise position is only 3 k ohms.) Bandwidth of 0.1 cps to 100 kc covers a wide range of uses; eleven high and low frequency cuts permit restricted bandwidths for minimum noise.

Applications include Hall Effect studies, bridge null detection, and semiconductor investigations, as well as such biophysical applications as recording nerve action potentials.

bandwidth 0.1 cps to 100 kc using 11 high and low frequency cutoffs.

input impedance in the "Normal" mode is 10 megohms; in the "Low Noise'' mode, 100 k ohms,

amplifier gain either 100 or 1000, adjustable to precise values.

input single-ended or differential.

differential rejection is at least 80 db.

power-from batteries or the Keithley Model 1031, a separate. solid state power supply with noise characteristics equivalent to batteries.

noise performance is selected with a "Normal "and "Low Noise" switch. Chart gives noise level of maximum gain from 10 cps with shorted input.

Frequency of high cutoff point	Maximum noise, microvolts RMS referred to input		
	Normal (10 meg impedance)	Low Noise (100 k impedance)	
100 kc	3.0	1.9	
30 kc	1.9	1.1	
10 kc	1.4	0.8	
3 kc	0.9	0.6	
1 kc	0.7	0.4	
300 cps	0.5	0.3	
100 cps	0.4	0.25	

prices: Model 103, \$245; rack, \$255 1031 Power Supply, \$245; rack, \$255



The Keithley Model 102B amplifier combines a 400megohm input with high gain and low noise. It is an ideal scope preamplifier, especially for high source impedance signals. The 102B provides accurate signal amplification from piezo-electric devices; it is excellent for noise studies in solid state research, and shock and vibration analysis.

Features of the unit include a driven shield input. decade gains from 0.1 to 1000, selectable bandwidths of 2 cps to 150 kc or 2 cps to 1.7 mc, and a 5-volt, 50-ohm output for scopes and recorders.

input impedance over 400 megohms at 3 μμf.

gain accuracy of 1% at midband for all gain settings.

low noise level, below 10 µv rms from 10 cps to 150 kc at maximum gain, input shorted.

rise time of 0.3μ sec at highest gain. two accessory low capacitance

probes available. price: \$335

send for complete specifications . . .

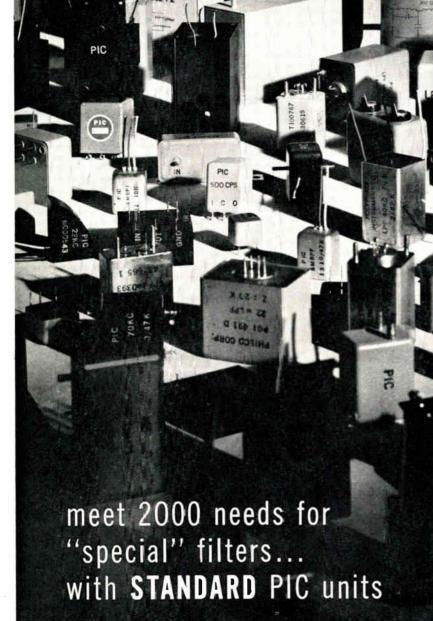


KEITHLEY INSTRUMENTS 12415 EUCLID AVENUE CLEVELAND 6, OHIO

electrometers • micro-microammeters • microvoltmeters • milliohmmeters

ELECTRONIC INDUSTRIES · June 1962

World Radio History



PIC

you can do it by taking these two steps:

1. Check the Selection Guide for PIC Filters. It catalogs 252 filters. They cover a frequency range of 5 cycles to 500KC. Sizes range from microminiature telemetering filters to neavy duty power filters.

Then, if this doesn't locate the filter you need . . .

2. Ask PIC to run your filter specifications through its file of over 2000 filter production drawings. An average of one new filter design has gone into these files every working day for more than 10 years. A filter meeting the specs you submit can be produced, in the majority of cases, from drawings in this file.

Send today for your copy of the Selection Guide for PIC filters. For complete information, write us on your company letterhead.

OLYPHASE INSTRUMENT COMPANY

Bridgeport, Pennsylvania

TRANSFORMERS . FILTERS . MAGNETIC AMPLIFIERS . DELAY LINES

Tech Data

for Engineers

Ozonators

OREC 03C Series Ozonators have high ozone output for use in transistor oxidation processes. They pro-duce ozone up to 36 grams/hr. and may be used for both laboratory and production process applications. Ozone Research and Equipment Corp., 3840 N. 40th Ave., Phoenix, Ariz. Circle 534 on Inquiry Card

Monitor System

Descriptions of uses and perform-ance data on the Electra Operations Monitor Systen, a versatile solid-state system for checking and con-trolling low-level signals is included trolling low-level signals is included in a 4-page technical bulletin avail-able from Electra Systems Corp., Electra Way, Fullerton, Calif. The unit was developed for continuous, precise monitoring of operating levels of induction processes incrumentaof industrial processes, instrumenta-tion systems and military checkout equipment.

Circle 535 on Inquiry Card

Limit Testing

Trio Laboratories, Inc., Plainview, L. I., N. Y., is offering a "Handbook of Limit Instrumentation," a 20-page manual devoted to the theory and ap-plication of limit testing. In addition to general considerations of limit testing, the handbook gives detailed specs. of TRI/LIM, Trio/lab's new line of modular limit test systems.

Circle 536 on Inquiry Card

Gyro Test Equipment

Static and dynamic test equipment for complete performance evaluation of gyros, accelerometers, and similar instruments are described in a 7-page catalog available from Micro Gee Products, Inc., 6319 W. Slauson Ave., Culver City, Calif. Included are tech data sheets on static tilt tables, linear acceleration tables, oscillating rate tables and other instruments. Circle 537 on Inquiry Card

DC Ratiometer

Tech data is available on a new low-cost DC rationeter with full five-digit resolution. The R65A offers plug-in stepping switches, precision wire-wound resistors and snap-out readout for fast bulb replacement. It will measure dc voltage ratio from 0.00001.1 to 0.00000.1 0.00001:1 to 0.99999:1 with an accuracy of 0.01% of reading plus 1 digit. Balancing time averages 2 sec. Input impedance is 1000 megs. Non-Linear Systems, Inc., Del Mar, Calif. Circle 538 on Inquiry Card

Spectrometer Systems

Varian Assoc., 611 Hansen Way, Palo Alto, Calif., is offering a cata-log covering its line of Nuclear Mag-netic Resonance and Electron Paramagnetic Resonance Spectrometer systems and components. The 12-page catalog is illustrated and con-tains a brief description of the tech-nique of NMR and EPR spectroscopy.

Circle 539 on Inquiry Card

Circle 206 on Inquiry Card

Tech Data

for Engineers

Environmental Closures

Packaging Pointers No. 2, 4 pages, discusses the importance of correct closure design for military containers for proper environmental protection. for proper environmental protection. Included are 6 design criteria for a suitable closure. Also included are 5 drawings of typical Zero closure ex-trusions. Zero Mfg. Co., 1121 Chest-nut St., Burbank, Calif. Circle 672 on Inquiry Card

Bearing Catalog

A quick reference 8-page condensed catalog listing miniature, instrument, spindle, and turbine bearings is avail-able from The Barden Corp., 200 Park Ave., Danbury, Conn. Catalog C-4 includes information in a wide range of low torque, high speed, high temp. and extended life bearings in open shielded and sealed, flanged and unflanged types.

Circle 673 on Inquiry Card

Ultrasonic Machining

This 16-page illustrated booklet ex-This 16-page illustrated booklet ex-plains the theory of ultrasonic ma-chining and details applications in drilling, slicing, engraving, trepan-ning and shaping hard and brittle materials such as glass, ceramics, germanium, stainless steel, tool steel, and precious jewels. Bulletin 2-300 available from Commercial Apparatus available from Commercial Apparatus and Systems Div., Raytheon Co., 225 Crescent St., Waltham 54, Mass. Circle 674 on Inquiry Card

Subminiature Connectors

Tech. data is available on subminiature electronic connectors, con-stant contact printed circuit board connectors, and right angle printed circuit board connectors. Included are dimensional tables, photographs, and outline drawings. Winchester Electronics, Inc., Willard Road, Norwalk, Conn.

Circle 675 on Inquiry Card

Terminals

This 12-page, 2-color, catalog gives complete engineering data and tabu-lations for 500 different types, sizes and configurations of Trinseel Teflon terminals, including miniature and subminiature stand-offs, feed-thrus, plugs and connectors. Alisco Co., 809 Stewart Ave., Garden City, N. Y. Circle 676 on Inquiry Card

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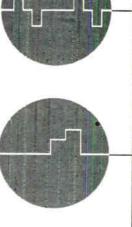
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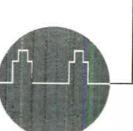
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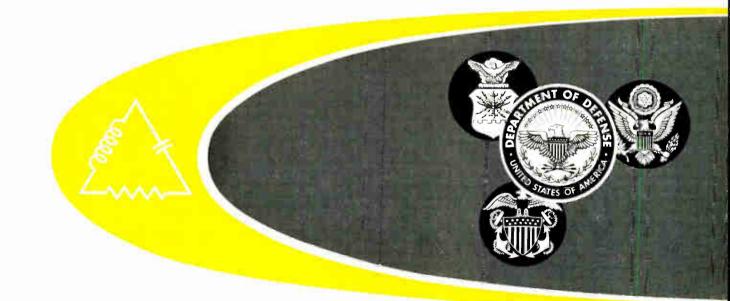
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Military Electronics



- 1962 Military Electronic Procurement Directory . . . H2
 - Government Contract Awards H6
 - Key Guided Missile Contractors . . . H8
- Satellites Currently in Orbit and Transmitting . . . H10
 - Manufacturers' Data Currently Available . . . H16

ELECTRONIC INDUSTRIES

1962 MILITARY ELECTRONIC PROCUREMENT DIRECTORY

This is an up-to-date listing of key AIR FORCE, NAVY and ARMY procurement and other personnel, indicating the organizational placement of these men, many of whom are concerned with electronic procurement.

U. S. ARMY

The Pentagan Wash 25 D C Phone Liberty 5-6700 or dial OX and the exten-

Phone Liberty 5-6700 or dial OX and the extension The U S Army is reorganizing its commands. In the new concept, procurement will be handled by the U S ARMY MATERIEL DEVELOPMENT & LOGISTIC COMMAND. It may be June '62, or later, before this plan will be in complete operation. In the meantime, the interim data below cavers, to a certain extent, the facilities we formerly reparted under the heading U S ARMY ORDNANCE CORPS

CHIEF OF ORDNANCE	ensian
Lt Gen J H Hinrichs	56261
INDUSTRIAL DIV Maj Gen G C Carlson	55371
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C C Fawcett INDUSTRIAL GROUP	X3103/5140
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 X81/11

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 EXEC OFF Lt Col J N Kopke
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AND DEVELOPMENT
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X8048

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Philadelphia 3 Pa		Chief A Testa	X8176	PROCUREMENT MGMT DIV C
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and electronics systems of the Army a	na, as	PROC BR A-3	,	Telephone and telegraph equipment, wire cable and card assemblies and reels
authorized, of other federal and foreign lishments. Principal functions carried out		Electrical measuring and testing equipme	ent, re-	Chief Maj R P Schafer
end include formulating procurement p	olicion	lays, contacts, solenoids		Asst H Walton
procurement, quality assurance, centralize	d sup-	Chief Mai B F Stone	X8179	COM PROC BR C-22, 23, 25
ply and stock contral for equipment and	l parts	Asst D Shuman	X678	Teletype and facsimile equipment, engine
COMM GEN	pana	PROC BR A-4, 5		transmission equipment mounting hardware.
Brig Gen Charles S Hays	X8000	Recorders, reproducers, intercams, speaker	s, cails,	and measuring tools
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Col Dauglas O Toft	X8001	Chief Capt R E Frye Jr	X508 X507	Asst F Toscano
EXEC OFF		Asst Michael Curce	×307	MISSILES SYTM PROC BR
Lt Cal Harry A Stuart	X8101	PROC MEMT DIV B	X410	Chief C Fravel
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E J O'Neill	X749	PROC BR B-11 Electron tubes, transistars, crysta's		Chief L Mizdail
DEP FOR IND PREP		Chief vacant		PROCUREMENT SRVCS DIV
L A Kapust	X300	PROC BR B-12		Chief M Wexler
DEP FOR SUPPLY MGMT		Dry storage and thermal batteries		BIDDERS INFO BR
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J Bergman	X231	Meteoralogical and photographic		PROCESSING BR
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ASST DEP FOR PROC	X300	Purchases under \$2500, EPDO's		Asst H Shein
S Rabinowitz	X501	Chief L Karafin	X543	PROPERTY & ADMIN DIV
ASST DEP FOR PROC (CONTRACTING)		TECH ASSTC & SPCL PRDCTS PROC BR		Chief F J McAdams
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for assistance in contract clarification, for guid-
ance in getting an bidders' lists and for course!
in submitting bids on current solicitation

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materials, installations of fixed-plant co	
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build direction and disposal direction Chief S Johnson

ELECTRONIC INDUSTRIES · June 1962

X2105

MILITARY PROCUREMENT OFFICES

U. S. ARMY ADVENT MANAGEMENT AGENCY

Ft Monmouth N Phone Liberty 2-4000

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U. S. AIR FORCE

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EXEC Lt Col W R Joyner	7-1157
PROGRAM MNGMT OFC	
Col W S Collinson	5-012B
OFC OF PROCUREMENT COMMITTEE	
S Arnovitz	7-4100
POLICY CONTROL OFC L R Poe	5-4190
PROD ENG DIV Col R O Mitterling	7-0293
PROCUREMENT DIV Col R A Johnson	7-7141

AIR PROCUREMENT DISTRICTS

SAN FRANCISCO Oakland Army Terminal Oakland 14 Calif Phone TWinoaks 3-4100 Phone TWinoaks 3-4100 Qualifies monufacturers of electronic equipment for central procurement activity of A F which includes all of U S and qualifies bidders for res and dev in the electronics field COMMANDING OFF Lt Col R E Hails SMALL BUSINESS R Quinn INDIANAPOLIS 2355 S Tibb Ave Indianapolis 41 Ind ATLANTA 41 Exchange PI SE 41 Exchange PI SE Atlanta 3 Ga BOSTON BOSTON Boston Army Base Boston 10 Mass Boston 10 Mass CHICAGO 5555 S Archer Ave Chicago 38 (II) DALLAS 500 S Ervay Dallas I Tex CLEVELAND 113 St Clair Ave NE Cleveland 14 Ohio DAYTON Wright-Patterson AFB DETROIT 6233 Concord Ave Detroit 11 Mich LOS ANGELES 1206 S Maple Ave Los Angeles 15 Calif MILWAUKEE 770 N Plankinton Ave Milwaukee Wisc NEWARK 21B Market St Newark N NEW YORK III E l6th St New York 3 N Y OGDEN Hill AFB Utah ORLANDO Orlando AFB Fia PHOENIX 2875 Sky Harbor Blvd Phoenix Ariz PHILADELPHIA 1411 Walnut St Philadelphia 2 Pa ROCHESTER P O Box 1669 Rochester 3 N SAN DIEGO 3054 Rosecrans PI San Diego 10 Calif ST LOUIS 1114 Market St St Louis 1 Mo

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Tempo D Bldg 6th & Independence Ave SW Wash 25 D C Phone Liberty 5-6700 or OX and the extension DIRECTOR Dr. K. Millsaps 662 DIRECTOR Dr K Millsap DIR OF PROCUREMENT Lt Col G W Bollinger 66257 61513

OFFICE OF AEROSPACE RESEARCH

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SPACE SYSTEMS DIV

Mail A F Unit Post Office Los Angeles 45 Calif Location 5800 Arbor Vitae St Los Angeles Calif Phone SPring 6-1444 MISSION: Responsible for handling A F Space programs and development projects in support of other military branches and governmental agencies

ELECTRONIC INDUSTRIES · June 1962

U. S. AIR FORCE

COMMANDER Maj Gen O J Ritland VICE COM Brig Gen R E Greer PROCUREMENT Col C E Moore

BALLISTIC SYSTEMS DIV

Moil A F Unit Post Office Los Angeles 45 Calif Location 5800 Arbor Vitae St Los Angeles Calif Phone ORchard 0.1444 MISSION: Responsible for Atlas, Titan and Minuteman programs including design, construc-tion and supervision of all site activities in the field

teld COMMANDER Moj Gen T P Gerrity DEP COMM Moj Gen D R Ostronger DIR OF PROCUREMENT Col J A O'Leory

AERONAUTICAL SYSTEMS DIV

Wright-Potterson AFB Doyton Ohio Phane CLearwater 3-7111 MISSION: Responsible for developing aeronauti-cal systems such as Skybolt, Dyno-Saor, C-141 Jet Transport COMMANDER Maj Gen W A Davis VICE COM Brig Gen A T Culberson PROCUREMENT Cal H A Budd

ELECTRONIC SYSTEMS DIV

L G Honscom Field Bedford Moss Phone CRestview 4-6100 COMMANDER Brig Gen C H Terhune Jr DIR OF PROCUREMENT Col R A Scurlock

ARNOLD ENG DEVELOPMENT CENTER

Tullohomo Tenn Phone: GLendole 5-2611 COMMANDER Maj Gen W L Ragers VICE COMM Cal J O Cabb PROCUREMENT J F Fuquo

A F MISSILE DEVELOPMENT CENTER

Hollomon A F Base New Mexico Phone: (At Alamagorda) GRanite 3-6511 COMMANDER Col R S Gorman VICE COMM Col W H Cleveland DIR OF PROCUREMENT Lt Col J B Turner

AIR PROVING GROUND CENTER

Eglin A F Bose Flo COMMANDER Moj Gen R H Worren VICE COMM Col H M West Jr DEP FOR PROCUREMENT Lt Col K H Brittle

ROME AIR DEVELOPMENT CENTER

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A F SPECIAL WEAPONS CENTER

Kirtland A F Base N Mex Phone CH 7-1711 COMMANDER Maj Gen C M McCarkle PROCUREMENT DIR Lt Col M N Myrick

A F MISSILE TEST CENTER

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A F FLIGHT TEST CENTER

Edwords A F Bose Colif Phone CLifford 8-2111 COMMANDER Brig Gen I L Bronch DIR OF PROCUREMENT Lt Col J M Venoble Jr

ROME AIR DEVELOPMENT CENTER

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DEPARTMENT OF THE NAVY

BUREAU OF NAVAL WEAPONS

18th & Constitution Ave NW Wash 25 D C Offices at Main Novy Bldg Munitions Bldg and "W" 8ldg Phane Liberty 5-6700 or dial OXford and then the desired extension MISSION: Responsible for research, development, design, test, operating standards, manufactur-ing, alteration, repair, overhaul, material effec-tiveness, disposition and salvage of all naval weapons, naval and Marine Carps aircroft, air-barne torgets, drones, etc., and supporting equipment and functions relating thereto Extension Extension

CHIEF OF BUREAU RAdm P D Stroop DEP CHIEF RAdm K S Mosterson ASST CHIEF FOR RES DEV TEST 62465 62430

ASST CHIEF FOR RES DEV TEST RAdm F L Ashworth 63343 Avionics Branch Col A C Lowell 64324 ASST CHIEF FOR CONTRACTS RAdm J W Bottoms 62436 Small Business Specialist J F Lenohan 64972 PURCHASE DIV DIR Copt K L Jeffory Jr 62905 GROUND ELECTRONICS DIV DIR 6472

Cdr J A Duncon ASST CHIEF PRODUCTION & QUALITY CONTROL Copt J D Arnold 64275

66225

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Bldg Temp 3 17th & Constitution Ave NW Wosh 25 D C Phone Liberty 5-6700 or dial OXfard then the desired extension MISSION: Responsible for basic and applied research bearing on naval problems CHIEF OF NAVAL RESEARCH RAdm L D Coates 64911 DEP & ASST CHIEF COpt J M Ballinger 62525 DEP & CHIEF SCIENTIST Dr F J Weyl 64356 DIR OF PROCUREMENT SERVICES Cdr H D Maore 65321

Cdr H D Moore 65321 ASST CHIEF FOR RESEARCH 64049 Copt W H Keen 64049 RESEARCH DIR Dr S Silvermon 61181 PHYSICAL SCIENCES DIV Dr W E Wright 65673 Electronics Dr A Shostok 64301

BUREAU OF SHIPS

Wosh 25 D C Phone Liberty 5-6700 or dial OXfard, then the extension desired MISSION: Responsible for shipboard apparatus, codor sonor, electric end-items; also MISSION: Responsible tar snippaarie apparent radia, radar, sonar, electric end-items; also shares responsibility far equipment with BuWeap Extension

L/	1enaion
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DEP & ASST CHIEF RAdm R L More	63391
DIV OF CONTRACTS Copt G C Wells	62112
Asst Dir of Contracts D E Weatherly Jr	64568
Electronics A Heck	61437
Electronics Purchasing Branch E H Kach	61803
ASST CHIEF FOR TECH LOGISTICS	
RAdm R B Fulton (octing)	61714
Electronics Materials Branch F M Berg	61446
ELECTRONICS DIV	
Dir Copt R B Bradley Jr	64586
Rodor Bronch Cdr D B Wilder Jr	65577
Communications Branch Capt S Swacker	64056
Sanar Branch Capt J Wallace	61230
Electronic Worfore & Ports Branch	
Cdr E L Hurd	66752

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NAVY ELECTRONICS SUPPLY OFFICE

Building 3400 Great Lakes III Phone DE 6-3500 COMMAND & PURCHASE DIV Copt W Schleef Buying Branch Lcdr J C Gaetzman

SELECTED GOVERNMENTAL AGENCIES

NATIONAL AERONAUTICS & SPACE ADMINISTRATION*

1520 H St NW Wosh 25 D C Phone EXecutive 3-3260, also DU 2-and the ex-

Extension ADMINISTRATOR J E Webb DEP ADMINISTRATOR Dr T K Dryden PROCUREMENT & SUPPLY DIV 6411

Booklet "Selling to NASA" voolable free from J M Roey, ot obove oddress AMES RESEARCH CENTER Maffett Field Calif Procurement Officer A S Hertzo

NASA FLIGHT RESEARCH CENTER Edwards Calif Procurement Officer M E Bowling

GODDARD SPACE FLIGHT CENTER Greenbelt Md Procurement Officer G H Tyler LANGLEY RESEARCH CENTER Longley Station Hompton Vo Procurement Officer S L Butler

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Procurement Officer D Long JET PROPULSION LAB Colif Inst of Tech Posourement Officer T W Condee LAUNCH OPERATIONS CENTER Office of Procurement & Contracts Cocoo Beoch Flo Procurement Officer G A Michoud

SPACE NUCLEAR PROPULSION OFFICE AEC Headquorters Germantawn Md (Wash 25 D C) Procurement Officer G Kimboll HEADQUARTERS PROCUREMENT BRANCH NASA Wash 25 D C Procurement Officer A A Clagett

ADVANCED RESEARCH **PROJECTS AGENCY**

Reports direct to Dir of Defense, Res & Eng The Pentagon (Rm 3E160) Phone: Liberty 5-6700 or dial OX and the exten-

sion MISSION: Responsible for research in ballistic missile defense, detection and identification of underground and high altitude nuclear tests, propellant chemistry, materials, energy conver-sion, remate area conflict and technical aspects of arms control Extension

DIRECTOR Dr J P Ruino 78255 DEP DIRECTOR (Science) (Not assigned) DEP DIRECTOR (Management) W H Gadel (All contracting is dane through the Services)

FEDERAL AVIATION AGENCY

1711 New York Ave NW Wosh 25 D C Phone STerling 3-2100 ADMINISTRATOR N E Holoby DEP ADMINISTRATOR H W Gront MATERIAL PROGRAM DIV (Contracts) C M Estep Rm 2402 Tempo 5 Wash D C

ATOMIC ENERGY **COMMISSION***

Germontown Md Mail Wash 25 D C Phone HAzelwood 7-7831

Extension CHAIRMAN Dr G T Seobord 3251 GEN MANAGER A R Luedecke 4174 DIV OF HEADQUARTERS SERVICES (Purchosing) DIV C DIV OF HEAVYONING - 5290 E H Glade 5290 *Booklet "Selling to AEC" available from Div of Contracts, Att J H Wells (Continued on page H-14) *Booklet

World Radio History

Government Contract Awards

The following list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies from January to December 1961. These contract awards appeared in "Commerce Business Daily" (Synopsis of U. S. Government Proposed Procurement Sales and Contract Awards,) issued daily by the U. S. Department of Commerce. It does not list classified contracts or awards for less than \$25,000.

A 1 1	323,532
Accelerators	
Accelerometers	119,284
Altimeters	95,134
Amplifiers	7,697,098
Analyzers	908,422
Antennas & systems	15,343,230
Astro trackers	1,821,807
Astro indexers to the test to the	205,657
Attenuators	35,637
Audio multiplex units	
Batteries	22,351,054
Beacons	936,770
Buffers	44,156
Brushes	52,042
Cable assemblies	5,185,386
Cable, coaxial	419 441
	661 187
Cable R-F	125,309
Cable, special purpose	
Cable, telephone	5,476,859
Call sign cipher device	781,333
Calibration set	1,761,008
Calibrators	1,313,299
Calorimeter	75,913
Capacitors Cells, fuel	1,333,596
Calle fuel	57,097
Clinic, ruer	88,052
Chamber, cable terminal	259,350
Chest set	
Chopper, electronic	67,250
Coder/decoder	12,681,752
Coil assemblies	26,568
Coils	79,467
Communications equipment	15,029,507
Comparators	593,522
Compensators	3,210,874
Computers	13,127,010
	853,432
Connectors	390,112
Consoles	
Control, equipment	451,699
Control group	725,154
Controls	1,940,623
Converters	3,237,143
Coordinate data set	1,691,862
Cores, magnetic memory	49,888
Correlators, Video	207,677
Counters	173,172
	260,148
Coupling units	115,872
Crystal units	
Data key generator	306,996
Data link, time div	500,000
Data plotter, electronic	79,900
Data processors	3,503,825
Delay lines	305,253
Demodulator	115,402
Detection system	70,000
Detectors	
	268 891
Derectors	268,891
Devars, cryogenic Digital tape handlers	268,891 27,294 38,250

Discriminators	281,815
Drone surveillance system	2,227,988
Dummy load	141,268
Duplexer tee assembly	42,004
Duplicator, magnetic tape	98,413
Echo box	83,655
Echo sounders	436,002
Electron beam welding equip-	172 421
ment	173,431
Electronic ovens, microwave	37,156
Facsimile set	53,369
Filters	260,500
FM/FM system	928,279 40,520
Frequency changer, automatic.	41,065
Frequency divider and clock	104,139
Frequency synthesizer	63,091
Fuses, radar	181,006
Ground readout equipment	66,000
Guidance systems	350,000
Gyroscopes	8,433,541
Handsets	115,735
Headset-handset	2,022,619
Headsets	1,853,014
Hydrophones	46,875
IFF equipment	58,725
Indicators	10,272,621
Infrared equipment	58,800
Intercommunications equipment.	1,398,821
Interrogator sets	150,000
Inverters	667,177
Jammer, transportable	600,000
Lie detectors, recording	52,099
Loudspeakers	707,609
Magnetic tape	385,248
Measuring set	551,459
Measuring system	206,268
Meters	8,377,486
Microanalyzer, electron probe	59,630
Microphone assemblies	31,675
Microphones	2,978,595
Microscopes	158,445
Microwave terminal equipment. Mode selectors	87,953 245,022
Module, digital	61,917
Monitors	771,847
Motors	271,899
Multicouplers, antenna	858,004
Multiplex equipment	295,215
Navigation equipment	4,401,399
Oscillators & assemblies	2,889,442
Oscillographs	401,640
	7,070,345
Oscilloscopes	
Oscilloscopes	1,201,128
Oscilloscopes Page printer sets Patching system, R-F	1,201,128 89,631

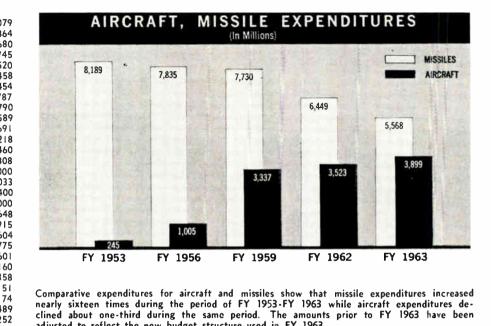
Plotting board, tactical display	467,906
Power monitor Power supplies	44,530
Power supplies	2,939,102
Preproduction equipment	4,075,363
Pulse networks	116,344
Radar	94,219,294
Radias sole	319,379
Radiac sets Radiacmeter	
	736,785
Radio direction finders	3,809,721
Radio sets	36,984,279
Radiosonde sets	3,834,794
Radomes	591,791
Reactor	44,485
Receivers	21,792,034
Receiving system	2,207,942
Recorder/reproducer	6,672,647
Recorders	3,302,112
Recording equipment	1,467,073
Rectifiers	124,129
Rectifiers References, AC	43,226
Regulator, voltage	29,162
Relay armatures	1,311,068
Relays & assemblies	1,447,370
Reproducer units	339,453
Resistors	2,451,201
Resolvers	683,894
Resolvers Resonator, selector cavity	34,981
Semiconductor device set	30,326
Semiconductor devices	1,547,764
Servo equipment	2,515,329
Signal generators	3,072,107
Simulators	2.083,758
Simulators	153,014
Sonar Equipment	11,630,095
Sonobuoys	1,198,440
Sounding Equipment	156,923
	355,392
Spectrometers	52,327
	781,321
Spectrum analyzer	655,000
	449,401
Standards	•
Static frequency changers	147,892
Switchboards	3,617,188
Switches	3,190,019
Switching system System analyzer, R-F Systems, digital	485,930
System analyzer, K-r	130,000
Systems, digital	193,575
Systems, microwave relay	41,195
Systems, processing	180,000
Systems, radio	10,296,626
Systems, telemetering	90,967
Tape handler, digital	30,578
Tape, magnetic	1,238,192
Telegraph equipment	3,727,938
Telemetry equipment	3,897,507
Telephone equipment	16,414,193

ELECTRONIC INDUSTRIES • June 1962

Govt. Awards (cont.)

Teletype equipment	6,434,079
Terminals	116,864
Test equipment	9,484,680
Test sets	9,599,745
Thermocouple	32,520
Timers	439,458
Towers	3,627,454
Tracking system, infra-red	42,787
Trainers	6,723,790
Transceivers	9,023,589
Transducers	2,748,691
Transformers & assemblies	858,218
Translator, magnetic tape	46,460
Transmission line system, Coaxial	64,808
Transmission system, photo	1,250,000
Transmitters	19,242,033
Transponders	2,663,400
Tropospheric scatter equipment	1,500,000
Tubes, electron	45,040,648
Tubes, klystron	2,319,915
Tubes, magnetron	6,304,604
Tube, TWT	110,775
Tuner	140,601
Tuning drives	230,160
Tuning forks	36,358
TV equipment	1,309,151
Ultrasonic cleaners	80,174
Vibrators	56,489
Waveguide equipment	187,252
Wind measuring sets	521,355
X-Ray equipment	1,233,509

MILITARY PROCUREMEN



Comparative expenditures for aircraft and missiles show that missile expenditures increased nearly sixteen times during the period of FY 1953-FY 1963 while aircraft expenditures declined about one-third during the same period. The amounts prior to FY 1963 have been adjusted to reflect the new budget structure used in FY 1963.

Source: Aerospace Industries Association

CONTRACT AWARDS-FIRST QUARTER OF 1962

Accelerometers	64,375
Actuators	253,697
Actuators Amplifiers	5,170,017
Analyzing systems	69,191
Antennas & systems	2,655,227
Attenuators	59,350
Batteries	851,030
Blowers	64,122
Blowers Cable assemblies	595,514
Cable, R-F	43,010
Cable, telephone	54,458
Calibration equipment	84,943
Calibrators	156,991
Calibrators Capacitors	107,304
Cavity, tuned	48,969
Chaff, countermeasures	397,562
Chopper, electronic	43,194
Communication statellite mobile	
ground stations	5,000,000
Communications equipment	8,676,964
Computers	29,895,720
Connectors	1,098,243
Control systems	339,583
Controls	324,596
Controls Converters	535,503
Counters	421,964
Counters Coupling units	1,011,499
Data processing equipment	879,350
Decoders	40,778
Demodulation equipment	83,984
Detectors	693,387
Digital system	355,901
Discriminator	50,840
Discriminator system, subcarrier.	36,959
Display system, remote	355,600
Drone system	500,000
Duplexer	64,343
Dynamic demonstrators	99,022
Encoder system	99,443
Filters	1,001,726

Eine control custom	4.000.000
Fire control system	2,500,000
Global tracking network	9,186,829
Gyroscope equipment	
Handsets	550,390
Headsets	1,870,992
Hydrophones	35,123
Indicators	3,421,182
Intercommunications system	40,364
Loudspeakers	640,532
Magnetic tape dataplotter	
system	52,500
Magnetron assembly, stabilized	27,423
Measuring systems	6,990,774
Meters	1,019,159
Microphone assemblies	47,971
Monitors, R-F	76,804
Multicouplers	678,554
Navigation equipment	2,284,521
Oscillators	624,820
Oscillographs	29,650
Oscilloscopes	168,033
Plotting system, digital	54,960
Power supplies	99,845
Printers	84,101
Public address system	57,558
Radar	26,758,264
Radiacmeters	203,645
Radiac set	996.614
Radio direction finder	1,312,000
Radio sets	29,847,239
Radio terminal sets	6,283,790
Radiosonde sets	497,663
Radomes	2,914,622
Receivers	4.877.227
Receiving system	1,299,818
Record reproduce mechanism	51,000
Recorders	2,173,932
Recorder/reproducer	637,258
Recording oscillograph system	37,169
Regenerators, time code	99,950
Regenerators, time code	77,730

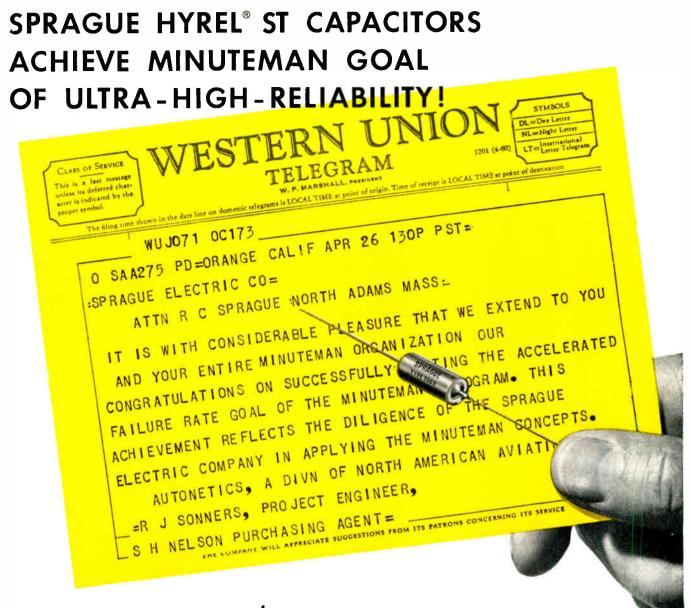
0	Relay armatures	150,835
0	Relays & assemblies	
9	Resistors	
0	Semiconductors	
2	Servo equipment	575,049
3	Shelters, electric equipment	1,974,409
2	Signal generators	
4	Simulators	
2	Sonobuoys	
	Standards	
0	Spectrum surveillance system .	
3	Switchboard	
4	Switches	
9	Switching equipment	
i i	Tape, recording	
4	Tape transports	
4	Target location system	
Í.	Telegraph equipment	
0	Telemetry equipment	1,259,081
0	Telephone equipment	515,810
3	Teletypewriter equipment	2,735,288
0	Test equipment	9,487,776
5	Test sets	
1	Timers	. 69,850
8	Tracking system, beacon	53,008
4	Trainers	. 2,899,169
5	Transceivers	. 3,623,934
4	Transducers	
0	Transformers	. 288,781
9	Transmission systems	. 5,187,242
0	Transmitters	. 942,889
3	Transponders	1,074,985
2	Tuning units	818,197
7	Tubes, electron	. 7,966,525
8	Tubes, klystron	. 1,382,334
0	Tube, magnetron	
2	Tubes, TWT	420,679
8	TV equipment	. 302,835
9	Viewing set infrared	375,166
0	X-Ray equipment	. 227,578

Key Guided Missile Contractors

(With names of their top GM men and their Personnel Directors)

Aerojet-General Corp. 332 Irwindale Ave., Azusa, Calif. Aeronutronic, Div. of Ford Motor Co. Ford Road, Newport Beach, Calif. Avco Corp. 201 Lowell St., Wilmington, Del. Beech Aircraft Corp.	C. C. Ross, V. P. Engineering R. P. Jackson, Mgr. Marketing	L. L. Thompson
Aeronutronic, Div. of Ford Motor Co. Ford Road, Newport Beach, Calif. Avco Corp. 201 Lowell St., Wilmington, Del.	R. P. Jackson, Mar. Marketing	
201 Lowell St., Wilmington, Del.	Ki II Guottoni, mgit montomig	R. F. Fallon
Beech Aircraft Corp.	Dr. C. J. Burton V. P. Defense & Ind. Prods. Group	E. W. Stupace
Wichita, Kan.	R. H. Anselm, Mgr. Missile Eng.	J. E. Isaacs
Bell Aero Systems Co. Buffalo 5, N. Y.	W. M. Smith, V. P. & Mgr. Rockets Div.	N. C. Euler
Bendix Corp. Bendix Prods. Aerospace Div. South Bend 20, Ind.	R. E. Whiffen, Gen. Mgr.	D. L. Kirkpatrick
Boeing Co. Seattle 14, Wash.	L. A. Woods	F. Huleen
Douglas Aircraft Co.	V. P. & Gen. Mgr. Aerospace Div. C. R. Able	L. W. Tixier
Santa Monica, Calif. General Dynamics/Astronautics San Diego 12, Calif.	V. P. & Gen. Mgr., Missile & Space Div. M. Rosenbaum, Ch. Eng.	R. M. Smith
General Electric Co. Washington, D. C.	G. P. Metcalf, Regional V. P.	J. K. Swanson G. E. Co., Valley Forge Space Tech. Center P. O. Box 8555 Phila. I, Pa.
General Precision, Inc. 1150 McBride Ave. Little Falls, N. J.	R. N. Brown, Exec. V. P. Kearfott Div.	P. Kull
Goodyear Aircraft Corp. Akron, Ohio	E. A. Brittenham, Chief. Eng.	C. Jones
Grumman Aircraft Eng. Corp. Bethpage, L. I., N. Y.	R. M. Carbee, Asst. Chief Missile Eng.	J. G. Gavin, Jr.
Hughes Aircraft Corp. Culver City, Calif.	N. 1. Hall, V. P. Eng.	N. W. Gibson
Lear, Inc. Santa Monica, Calif.	K. R. Hahn, Exec. V. P.	H. Perryman
Ling-Temco-Vought P. O. Box 6267, Dailas 22, Texas	J. R. Clark V. P. & Gen. Mgr. Astronautics Div.	R. C. Farmer
Lockheed Missiles & Space Cc. Sunnyvale, Calif.	R. R. Kearton, V. P. & Gen. Mgr. Space Systems Div.	W. R. Wilson
Marquardt Corp. Yan Nuys, Calif.	S. E. Weaver, V. P. Marketing	J. F. Stengel
Martin Co., The Baltimore 3, Md.	A. C. Hall, V. P. Space Systems Div.	D. V. Dorman
McDonnell Aircraft Corp. St. Louis, Mo.	B. G. Bromberg, V. P. Space & Missile Eng. Div.	W. R. Orthwein, Jr.
Minneapolis, Honeywell Reg. Co. Minneapolis, Minn.	C. L. Davis, V. P. Military Prods. Group	R. E. Marceau
North American Aviation, Inc. Los Angeles, Calif.	H. R. Raynor, Exec. V. P. Space & Info. Systems Div.	A. F. Urbiha
Northrop Corp. Hawthorne, Calif.	W. E. Gasich Asst. Gen. Mgr., Tech.	J. Richardson
RCA Camden, N. J. Republic Asiation C	W. G. Bain, V. P. & Gen. Mgr. Communications & Aerospace	N. J. Cappello
Republic Aviation Corp. Farmingdale, L. I., N. Y. Pure Assess the L.C.	A. R. Crawford, V. P.	C. Ketson
Ryan Aeronautical Co. San Diego, Calif.	F. W. Fink, V. P. Eng.	W. Wagner
Space Technology Labs. P. O. Box 95001 Los Angeles 45, Calif.	Dr. E. B. Doll	R. C. Potter
Sperry Gyroscope Co. Great Neck, L. I., N. Y.	S. Agabian, V. P.	R. Hamlett
lhiokol Chemical Corp. Bristol, Pa.	H. R. Ferguson, Exec. V. P.	J. Lorenz
Thompson Ramo Woolridge, Inc. Canoga Park, Calif.	Dr. R. P. Johnson, V. P. Electronics Group	F. P. Melograno
Jnited Aircraft Corp. 5. Hartford, Conn.	C. M. Kearns, V. P. & Gen. Mgr. Corp. Systems Center	N. B. Morse
Nestinghouse Electric Corp.	R. O. Schlegelmilch	D. C. Lee

ELECTRONIC INDUSTRIES · June 1962



Failure rate of .001%/1000 hours* has now been reached!

• Following comprehensive life tests, Sprague HYREL ST Solid Tantalum Capacitors have now attained Minuteman's component development objective. Minuteman ultra-high-reliability demands quality 100 times greater than that of former "highly-reliable" capacitors. This standard allows only one failure in 200,000 units per 1000 hours of test under Minuteman use conditions.

• Behind this achievement is an unequalled test history of more than 130 million unit-hours. Backing this performance is Sprague's record of pioneering in highly reliable capacitors, which earned us the oppor-

*At 60% confidence level by accelerated qualification tests.

SPRAGUE COMPONENTS

CAPACITORS TRANSISTORS MAGNETIC COMPONENTS RESISTORS MICRO CIRCUITS INTERFERENCE FILTERS PULSE TRANSFORMERS PIEZOELECTRIC CERAMICS PULSE-FORMING NETWORKS TOROIDAL INDUCTORS HIGH TEMPERATURE MAGNET WIRE CERAMIC-BASE PRINTED NETWORKS PACKAGED COMPONENT ASSEMBLIES FUNCTIONAL DIGITAL CIRCUITS ELECTRIC WAVE FILTERS

tunity to participate in the Air Force's Minuteman Component Development Program at Autonetics, a division of North American Aviation, Inc.

• All of the special processes and quality control procedures that make HYREL ST Capacitors the most reliable in the world can now help you in your military electronic circuitry. A tantalum capacitor engineer will be glad to discuss the application of these capacitors to your missile and space projects. Write to Mr. C. G. Killen, Vice-president, Industrial and Military Sales, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Circle 208 on Inquiry Card



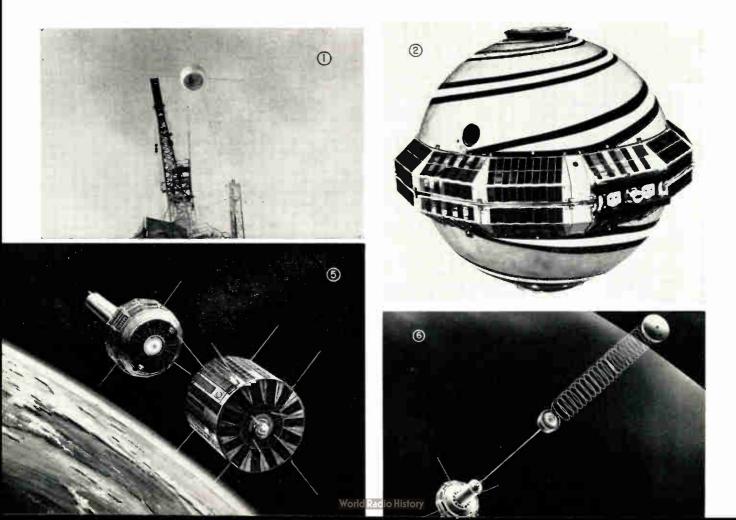
"Sprague' and '@' are registered trademarks of the Sprague Electric Co.

ELECTRONIC INDUSTRIES • June 1962

SATELLITES CURRENTLY IN

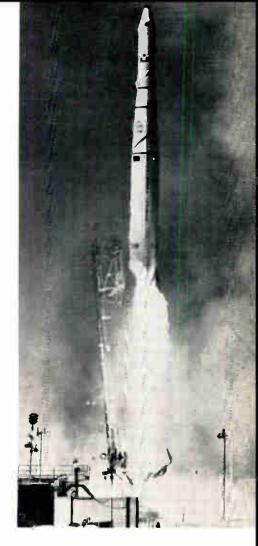
Photo No.	Project	Project Director	Launch Date	Estimated Life (years)	Perigee Apogee (miles)	Orbiting Time (minutes)	Instrumentation
1	Vanguard I	U. S. Navy	3-17-58	200	406 2444	133.8	2 transmitters; external temp. sensors.
2	Transit II-A	U. S. Navy	6-22-60	50; trans- mitting – 1	389/665	101.7	5 transmitters; 2 ultra-stable oscillators; in- frared scanner; electronic clock; Canadian receiver to measure galactic noise.
3	Courier I-B	U. S. Army	10-4-60	Several; transmitt- ing – 1	501/658	107	4 transmitters; 4 receivers; 5 tape recorders; 2 microwave antennas; transitorized telemetry generator; FM VHF telemetry transmitters; 4 whip antennas; VHF diplexer; command decoder.
4 (bott	Transit IV-A om)	U. S. Navy	6-29-61	1	534/623	103.7	4 transmitters; memory system; electronic clock.
4 (mid	lnjun dle)	U. S. Navy	6-29-61	Indefinite	534/634	103.8	1 transmitter; 12 particle and proton detectors.
5	Transit IV-B	U. S. Navy	11-15-61	5	582/700	105.6	Stable oscillators; 4 transmitters; phase modulators; memory system; clock.
5&6	TRAAC	U. S. Navy	11-15-61	5	562/720	105.6	Gravity gradient stabilization equipment; satel- lite design experiments; back-up for parts of Transit experiments; particle detectors; 1 transmitter.
7	Tiros IV	NASA	2-8-62	4 months	471/525	100.4	5 transmitters; 2 camera systems with clocks and recorders for remote pictures; infrared sensors; heat budget sensors; magnetic orien- tation control; horizon sensor; North indicator.
8	Orbiting Solar Observatory	NASA	3-7-62	6 months	343/369	96.15	Devices for 13 different studies of solar electro- magnetic radiations; dust particles; and thermal radiation on spacecraft surface materials. 2 independent and parallel transmitters.

* As of the date this issue went to press.



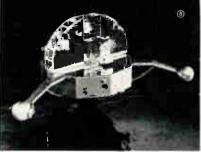
ORBIT AND TRANSMITTING*

Transmitting Frequency (MC)	Power Supply	Comments
108.024	Mercury batteries charged by 6 groups of solar con- verters.	Revealed Earth to be pear-shaped. Corrected geographical map errors.
162; 216	Completely solar powered. Nickel cadmium battery for power storage.	Data being analyzed.
107.9709	19,200 solar cells; nickel cadmium batteries for power storage.	Several messages successfully received and transmitted. Test feasibility of "delayed repeater" satellites.
54; 150; 324; 400	Solar cells; nickel cadmium batteries. Pu 238 thermo- electric generator.	First satellite to use nuclear generator (SNAP). Test all-weather global naviga- tion system.
136.5	Solar cells.	Injun failed to separate from Greb III. Injun to measure cosmic radiation.
54; 136.8; 150; 324; 400	SNAP; solar cells; nickel cadmium battery.	SNAP furnishing current for 2 trans- mitters. R & D all-weather global navi- gation system.
54;136.65; 324	Solar cells; nickel cadmium battery.	Test gravity system for satellite attitude control. Obtain data on the Inner Van Allen Belt.
136.23; 136.92	9,260 solar cells; 63 nickel cadmium batteries	R & D of weather satellite system. Data from TV cameras was used for current operational weather analysis and fore- casting. Only the beacons are still trans- mitting.
136.744	Nickel cadmium batteries and 1860 solar cells.	Measure solar electromagnetic radiation in the ultra-violet, x-ray, and gamma ray regions. Investigate dust particles in space and improve future spacecraft design.









World Radio History





NEW MIDGET 482 CONNECTOR—full interchangeability with existing MS type miniature connectors with bayonet lock

In addition to its versatility the new Midget 482 connector meets the environmental requirements of MIL-C-26482 and meets or exceeds the requirements of MIL-C-0026482 where applicable. Plus a host of other dependable features including:

• crimp style removable contacts • shells of high strength impact extruded aluminum • cadminum plated with olive drab irridite finish • closed entry sockets meeting or exceeding M1L-C-26636 requirements where applicable • resilient inserts permanently bonded to shell • bayonet coupling with positive lock for easy mating.



In the last four years METHODE ELECTRONICS, INC.'S business in military components has expanded 1400%. The remarkable progress stems from:

MILITARY COMPONENTS VOLUME EXPANDED 1400 Per Cent

- Development of special proprietary equipment to perform the precision manufacturing requirements necessary for military guality wiring devices.
- Design of specialized high environmental components to meet tomorrow's requirements.
- A quality doctrine with controls patterned after the classic MIL-0-9858 format and further supplemented with engineering management team orientation to product manufacture and inspection.



PROCUREMENT

(Continued from page H5)

NATIONAL BUREAU OF STANDARDS

(Commerce Dept) Conn Ave & Von Ness St NW Wosh 25 D C Phone EMerson 2-4040 DIRECTOR Dr A V Astin DEPUTY DIR Dr R D Huntoon SUPPLY DEPT G B Kefover Procurement Sect C B Kipps

PUBLICATIONS HELPFUL IN SELLING TO THE MILITARY & GOVERNMENT

1. "Selling To Novy Prime Controctors" (July 1961) p. 89. Helpful suggestions, followed by listing of hundreds of prime controctors. Obtoinable from Supt. of Documents, U. S. Govt. Printing Office, Wosh. 25. D. C., price 50 cents.

2. "General Pracurement Information" (July 1961) p. 32. Lists hundreds of items from many guided missiles together with the nomes of their prime controct suppliers. U. S. Govt. Printing Office, price 15 cents or free from Off. Secty. Defense, Information Office, Wash. 25, D. C.

3. "Selling To The Military" p. 27. Generol Information. Items Purchased. Location of Militory Purchasing Offices, etc. U. S. Govt. Printing Office, price 25 cents.

4. "How To Sell Ta The Armed Forces In Europe" (Jon. 1959) p. 14. Listing of whot is being bought and the lacation of the foreign purchosing offices for these items. Believed to be obtainable from Off. Secty. of Defense, Information Office, free.

5, "Air Force Small Business Specialists" p. 10. A listing of nomes, addresses and phone numbers. From Secty. of Defense, Information Office, Air Force Desk, free.

6. "Armed Services Procurement Regulations." Information Office, Sec. of Defense, Wash. 25, D. C., free.

D. C., free. 7. "The Army Procurement Procedure." Information Office, Sec. of Defense, Wash. 25, D. C., free.

8. "The Air Farce Procurement Procedure." Information Office, Sec. of Defense, Wash. 25, D. C., free. 9. "Navy Procurement Directives." From U. S.

9. "Navy Procurement Directives." From U. S. Govt. Printing Office of \$7 per year, subscription.

10. "Doing Business With The Federal Government" (Jon. 1961) p. 58. Contents: Govt. procurement methods; Militory procurement General Services administration; Other civil agencies with supply activities responsibility of the govt. contractor, Believed available from General Services Administration, Wosh. 25, D. C., free.

II. "Commerce Business Daily." A doily list of govt. procurement invitations, subcontracting leads, contract owards, etc. Published by Dept. of Commerce. Subscription \$20 per year. U. S. Dept. of Commerce, Room 1300, 433 West Von Buren St., Chicago 7, III.

12. "How To Sell To Agencies Within The Deportment Of Defense" (Morch 1958) p. 52. Generol Procurement Policies, followed by helpful list of multitudinous items purchosed together with their purchosing locotions. U. S. Govt. Printing Office, 40 cents.

13. "Federal Purchasing Directory," o 6-page folder and chart, showing principal agencies and materials bought. Obtainable from General Services Administration, Regional Office Bldg., Wash. 25, D. C., free.

14. "Procurement Hondbaok" (1959). By Generol Services Adm. A very generol book but helpful to those selling to GSA. From U. S. Govt. Printing Office, price \$1.50.

15. "Selling to NASA." Avoilable free from J. M. Roey, NASA, 1520 H St., N.W., Wosh. 25, D. C.

16. "Selling to AEC." Avoilable free from J. H. Wells, Div. of Contracts, Atomic Energy Commission, Wash. 25, D. C.

ELECTRONIC INDUSTRIES · June 1962

World Radio History



Specifications of Model S32A Oscilloscope

VERTICAL AMPLIFIERS

FREQUENCY RESPONSE:

DC—1 mc at 10 mV/cm DC—10 mc at 100 mV/cm

RISE TIME: 35 nS Max. VERTICAL DEFLECTION: 5 cms at all frequencies. The vertical amplifiers are adjusted for optimum response to a fast squarewave.

INPUT ATTENUATOR

9 position frequency compensated, direct reading in volts per cm. 10/100 mV, 20/200 mV, 50/500 mV, 1V, 2V, 5V, 10V, 20V, 50V/cm. Input Impedance $1M\Omega + 30$ pf

Voltage measuring accuracy 5%

TIME BASE

18 calibrated Sweep Speeds plus continuously variable. 500, 200, 100, 50, 20, 5, 2, 1 milliseconds per cm 500, 200, 100, 50, 20, 10, 5, 2, 1 microseconds per cm —expansion control gives X10 increase. Slower speeds can be obtained by internal adjustment.

Time measurement accuracy 10%.

X EXPANSION

Continuously variable up to over 10 screen diameters (50 cms). Trace expands symmetrically about center of screen. X-shift control positions any portion of expanded trace on screen.

TRIGGERING

Automatic for repetitive signals up to about 1 Me.

TRIGGER LEVEL CONTROL

Selects any point on input signal slope for repetitive, random, or single shot triggering.

TRIGGER SELECTOR

Positive, negative, or TV Line and Field. Internal or external.

BUILT IN CALIBRATOR

Stabilised 1V p-p (\pm 2%) 60 cps squarewave for checking voltage and time calibration.

CATHODE RAY TUBE

3" flat faced, PDA tube operated at 3.5 kV. Screen phosphor, P1 Medium persistence normally supplied. Long Persistence P7 to order. Removable green filter improves contrast at high ambient illumination. SIZE

13³/4" x 8" x 6¹/2"

Weight 16 lbs.

HIGH IMPEDANCE PROBE

P32. A X10 voltage divider with an input impedance of $10M_{\Omega}$ + 8 pf. Price \$10.

The Avnet System

MEN/METHODS/MATERIALS/MANAGEMENT

AVNET INSTRUMENT CORP.



AVNET ELECTRONICS CORP.

LOS ANGELES, CAL.; SUNNYVALE, CAL.; SEATTLE, WASH.; SALT LAKE CITY, UTAH; PHOENIX ARIZ.; CHICAGO, ILL.; WESTBURY, L. I.; BURLINGTON, MASS.

AVNET markets from its stocking facilities:	BENDIX SCINTILLA CONNECTORS	MECHANICAL PRODUCTS	SPÉRRY SEMICONDUCTORS	BABCOCK RELAYS	SILICON TRANSISTHRS	Rush me further information on the S32.4 Oscilloscope. NAME
	SPRAGUE CAPACITORS	U. S. SEMCOR SEMICONDUCTORS	SCOPES OSCILLOSCOPES	CLARE RELAYS	MICRODOT CONVECTORS LERCO HARDWARE	TITLE Clip this section to your letterhead and mail to: East of Mississippi: THE ANNET SYSTEM, Publications Section
AVNET AUTO CONNECTOR AND CABLE TESTER	AVO MULTIRANGE METERS	WIDNEY DORLEC CONSTRUCTION SYSTEM	GENALEX TUBES	SULLIVAN PRECISION MEASURING APPARATUS	SERVO DESIGN AND TESTING EQUIPMENT	70 State Street, Westbury, Long Island West # Mississippi THE AVNET SYSTEM, Publications Section 5877 Rodeo Rd., Los Angeles 16, Cal. Your request will the expedited within 90 minutes of receipt.

New Tech Data

for Engineers

Features of the Series 610, 710, and

810 miniature non-environmental connectors are described in a new 10-

page bulletin from the Data Recorders Div. of Consolidated Electrody-namics Corp., sub. of Bell & Howell Co., 360 Sierra Madre Villa, Pasa-dena, Calif. These connectors are for

military and commercial uses where

environmental characteristics are not

Circle 688 on Inquiry Card

Revised 68-page catalog of plastic

sheets, rods, tubes, films, blocks and

flat tubings is available from Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich. Catalog lists available sizes, weights, color ranges, textures, purchasing specs. grades and prices. Includes revised and ex-

Connectors

required.

Plastic Catalog

Laminate Guide

A guide listing Synthane Grades for tubes, rods and sheets corresponding to NEMA, Mil Spec., Mil Spec. Type, Navy Type, Type LTS, Federal Spec., Bureau of Aeronautics, AAF Spec. and ASTM Specs is available from Synthane Corp., Oaks, Pa. Circle 678 on Inquiry Card

Terminal Blocks

Catalog No. 162, 2-color, 16-pages, describes a complete line of more than 373 terminal blocks including new fully insulated feed-through and new fully insulated feed-through and track-type blocks. Also included are specs., blueprints, and prices of both parts and complete blocks. Curtis Development & Mfg. Co., 3218 N. 33rd St., Milwaukee 16, Wis. Circle 679 on Inquiry Card

PC Board Connectors

A line of 50Ω Printed Wiring Board Connectors is described in a 10-page catalog available from Micon Elec-tronics, Inc., Roosevelt Field, Garden City, L. I., N. Y. The connectors are available in straight and right angle configurations, male and female snapon and screw-on types, and are de-signed to fit standard 0.100 printed circuit board holes.

Circle 680 on Inquiry Card

Nylon to Nylon Bonding

A solution to the problem of bonding nylon to nylon surfaces is ob-tained by the use of RAISEAL 5002, newest of a series of adhesives. Because it is a thermosetting resin, the bond's heat stability is high at temps. up to and above the softening points of most plastics. This material may also be used in the bonding of nylon to most metal and plastic surfaces. Radiation Applications, Inc., 36-40 37th St., L. I. City 1, N. Y.

Circle 681 on Inquiry Card

Computer System

"Honeywell 1800 Facts and Figdescribes the Honeywell 1800 ures" electronic computer system. Features of the 1801 Central Processor, includ-ing Parallel Processing and Ortho-tronic Control, the 1801B Floating Point Arithmetic option, the various input-output equipment and automatic programming aids are included. Minneapolis-Honeywell Regulator Co., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills 81, Mass. Circle 682 on Inquiry Card

Tapes

The illustrated 6-page folder describes numerous ways double-coated tapes can be used in industry. Included are 35 illustrations which tell how "Scotch" brand double-coated paper, cloth, transparent film, plastic film and adhesive transfer tapes are used. Folder P-DNF(915) LP from Dept. J1-10, Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. Circle 683 on Inquiry Card

Epoxy Stripper

Information is available on specially formulated cold stripper to remove epoxy coatings and almost all types epoxy coatings and almost all types of synthetic finishes, including japans, wrinkles, and baked enamels. Fidelity #931 Epody and General Purpose Stripper is particularly effective in the stripping of epoxy encapsulated electronic components. Fidelity Chem-ical Products Corp., 470 Frelinghuy-sen Ave., Newark 14, N. J. Circle 684 on Inquiry Card

Circle 684 on Inquiry Card

Wires & Cables

Rockbestos Wire & Cable Co., Div. of Cerro Corp., Nicoll and Canner Sts., New Haven 4, Conn., is offering tech. data on their line of aerospace and electronic wire and cables. Included are airframe wires, hook-up wires, ground support cables, coaxial and miniature high temp. cables. wires.

Circle 685 on Inquiry Card

Insulators

Coors Porcelain Co., 600 Ninth St., Golden, Colo., has a 22 page brochure available on Ceramic Insulators. Subjects covered in the booklet are: How Ceramic-to-Metal Seals are Made, Mechanical and Electrical Properties Mechanical and Electrical Froperties of High Strength Alumina Ceramics and information on Coors "B," "C," "D," Line Standard Terminal Insula-tors. Photographs, line drawings and specs are included.

Circle 686 on Inquiry Card

Coaxial Connectors

receptacles, hoods, caps, Plugs. jacks, adapters, and terminals are described in an 8-page, 3-color brochure available from Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif. Bulletins CX-5 through 12, include diagrams and specs. on plugs that can be obtained in straight or angle screwtypes and slide-on versions and re-ceptacles including printed circuit and bulk head feed-thru types. Circle 687 on Inquiry Card

panded 2-page comparison table of chemical, electrical, and mechanical properties of 14 plastics families.

Circle 689 on Inquiry Card

RFI Shielding

Information concerning TECK CELL^{T.M.}, metal honeycomb structure for combining RFI shielding and free air cooling for electronic packages is presented in tech. data available from Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J. Data Sheet RF-16 includes uses, limitations, controlling rates, material specs. price ranges and ordering instructions. Circle 690 on Inquiry Card

Precision Wire

Molecu-Wire Corp., Eatontown-Freehold Pike, Scobeyville, N. J., are offering an 8-page, 2-color brochure on precision wire covering the properties, characteristics and possible uses of Protoloy and Electroloy. Pro-toloy is a nickel chromium alloy and Electroloy, a nickel-chromium-iron alloy. Included are illustrations, charts and diagrams of detailed relationships; temp. resistance curves; phys-ical characteristics and mechanical properties.

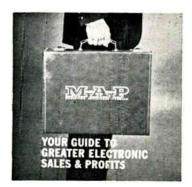
Circle 691 on Inquiry Card

Plastic Capabilities

A 16-page catalog lists products and capabilities for advanced military and industrial applications. It covers firm's line of laminated plastics, printed circuit boards, flexible insulation, molded plastics, vulcanized fibre and mica products. Catalog A-61. Con-tinental-Diamond Fibre Corp., Newark, Del.

Circle 692 on Inquiry Card



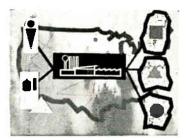


The full story of how ELEC-TRONIC INDUSTRIES' M-A-P (Marketing Assistance Program) can help you—is now available for viewing in a 14minute film presentation. A phone call to your nearest "EI" Representative will bring him to your office.



A Complete Market Research Department at Your Disposal: The services of ELECTRONIC INDUSTRIES' Research Department are available to you, together with a corps of over 250 experienced, strategically located, field investigators. They can help you determine:

Sales potentials by industry and territory
 Buying influences • Degree of product recognition and acceptance • Relative standing of competitors • New product applications
 Buyers' job interest and aptitudes . . . and virtually any other information essential to the effective marketing of your company's products.



96% of Your Market: The ELECTRONIC INDUSTRIES Census—developed and maintained at a cost of over \$200,000, reports in depth on the 6000 electronic plants which account for 96% of the total annual purchase of electronic products.

ELECTRONIC INDUSTRIES' unique product classification system identifies, with complete information, plant by plant, on each industry product manufactured.

Punched on 45,000 IBM Cards: to simplify your task of isolating and organizing the precise marketing data you need, the complete findings of the ELECTRONIC INDUSTRIES CENSUS have been transferred to punched IBM cards.

What are the Characteristics of Today's Electronic Engineer?

• What is his average age? • His average income? • His net worth? • How many children does he have? • What is his education? • What are his ambitions? • What would prompt him to change jobs?

These and many other important questions about the personal and job characteristics of the electronic engineer are answered in ELECTRONIC INDUSTRIES' Profile of the Electronic Engineer—available as a handy deck of 2,000 punched IBM cards, or (in summary form) in a printed report.



JOSEPH DRUCKER 56th and Chestnut Streets Philadelphia 39, Pennsylvania SHerwood 8-2000 (Area Code 215)

GERALD B. PELISSIER (Metropalitan N. Y.) 100 E. 42nd Street New York 17, New York OXford 7-3400 (Area Code 212)

JOHN PICKERING, JR. 10 High Street—Rice Bldg. Boston, Massachusetts Llberty 2-4460 (Area Code 617)

AL KAISER 62 LaSalle Road West Hartford, Connecticut ADams 6-4237 (Area Cade 203)

ROBERT COBURN 930 Keith Bldg. Cleveland, Ohio SUperior 1-2860 (Area Code 216)

GEORGE H. FELT 360 North Michigan Ave. Chicago, Illinois RAndolph 6-2166 (Areo Code 312)

MENARD DOSWELL, III 198 S. Alvorado Street Los Angeles, California DUnkirk 7-4337 (Areo Code 213)

BURT UNDERWOOD 198 S. Alvaroda Street Los Angeles, California DUnkirk 7-4337 (Area Code 213)

DON MAY 1355 Market Street San Francisca, Califarnia UNderhill 1-7107 (Areo Code 415)

JOHN W. SANGSTON 1776 Peachtree St., N.W. Atlanta 9, Georgia 875-1255 (Area Code 404)

HAROLD E. MOTT Meadows Bidg. Expressway at Milton Dallas, Texas EMerson 8-4751 (Area Code 214)

MAX HOLSINGER 67/68 Jermyn Street St. James'-Fifth Floor London, England

MAX HOLSINGER Huttenstrasse 17 Am Ernst Reuter Platz, Dusseldorf, West Germany



World Radio History

New Tech Data

Frequency Standards

Comprehensive manual of freq. and time standard systems is available in Application Note No. 52 from Hew-lett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. The textural por-tion of this 46-page manual is divided into 5 main sections. The first section contains a general discussion of freq. and time control, radio propaga-tion, time scales, etc. The second, third and fourth contain detailed considerations of system operation, freq. determination, and time determina-tion. The 5th section includes information on system stability and spectral purity. Illustrations, charts and tables are also included.

Circle 540 on Inquiry Card

Rectifier Testers

Bulletin #TAO includes information on a complete line of test instruments designed for testing controlled rectifiers. Units covered are Direct Reading I_{gt}/V_{gt} meters, Dynamic Test Sets, and High Current Pulse V_F Meters. Also included is a modular test instrument for conducting operating life tests at elevated temps. un-der different load conditions. Triconix, Inc., Bear Hill Rd., Waltham, Mass.

Circle 541 on Inquiry Card

Strain Recording

Brush Instruments Div., of Clevite Corp., 37th & Perkins, Cleveland 14, Ohio, is offering a 20-page illustrated booklet entitled, "Strain Recording with Brush Direct Writing Record-ers." Described are applications of strain gages and strain gage based transducers for measuring strain tentransducers for measuring strain, tension, thrust, load, torque, etc. Photo-graphs, circuit charts and diagrams are included.

for Engineers

Circle 542 on Inquiry Card

Signal Generators

Empire Devices Inc., Amsterdam, N. Y., is offering Catalog No. 614, with an 8-page supplement, covering their line of microwave signal gen-erators, noise and field intensity impulse generators, power meters, modulation meters, meters, density crystal mixers, and microwave components.

Circle 543 on Inquiry Card

Instrument Catalog

A Short Catalog ES-10, 24 pages, 2 colors, on precision test instruments, lists the complete Bruel & Kjaer line of integrated sound, vibration and data analysis instrumentation. B & K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

Circle 544 on Inquiry Card

Servometers

A different approach offering accuracy response and versatility of indi-cation and control instruments is explained in a 4-page brochure available from Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y. Exploded views show how a new filmpot meter movement operates. Sche-matics explain how the movement, with a low-inertia coil and low-torque wipers, works with an infinite resolution feedback pot and solid-state servo amp.

Circle 545 on Inquiry Card

Pressure Instruments

A 16-page catalog available from Glassco Instrument Co., 777 So. Ar-royo Pkwy., Pasadena, Calif., explaine the operation and characteristics of Bourdon Helix pressure instruments and their major uses. In addition, standard "off the shelf" pressure gauges, switches, and switch and gauge combinations are illustrated and described in detail.

Circle 546 on Inquiry Card

Oscillographs

Revised Product Digest No. 160 contains pictures and brief descrip-tions of Midwestern Instruments' complete line of products. General performance information is contained on both wet-process and directreadout oscillographs, galvanometers, bridge balance units and galvanometer amplifiers. Midwestern Instru-ments, Inc., P. O. Box 7509, Tulsa 18, Okla.

Circle 547 on Inquiry Card

RESEARCH CORPORATION **DYNAMICS**

presents an advanced concept in ... Optical Shaft Angle Encoders — OPTISYN®

OPTISYN is a high-accuracy incremental electro-optical digitizer for reliable indication of shaft position, shaft rate, and direction of shaft rota-tion. It employs a unique rotating moire fringe to produce high signal levels, valuable error compensation, and long operating life. OPTISYN is standard equipment on operational missiles, a proven component for inertial accelerometers, gimbal systems, pedestal data systems — both military and industrial.

DRC



WHY INCREMENTAL OPERATION? Incremental transducers are inherently simpler and

Incremental circuitry is likewise simpler and more reliable — fewer transmission leads

Incremental encoders facilitate accumulation of total shaft angle in binary or decimal codes

Incremental systems allow floating-zero operation for convenient placement of reference point

DISTINCTIVE FEATURES OF INCREMENTAL OPTISYN ean

High resolution per turn in small size - a measure to seconds of are, at high shaft rate Maximum pulse-to-pulse error can be within 0.00025 of spacing

Remarkable cumulative accuracy — a mtotal accumulated error of ± 0.25 guanta a maximum

lligh reliability — projected 6 years mean-time-to-failure

Rugged - meets MIL-E-5272C

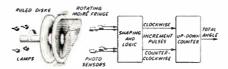
High speeds with low wear — non-contacting design eliminates contact bounce, critical contact alignment, and abrasive wear

Rapid readout rates — counting rates as high as 300,000 to 500,000 quanta per sec.

Low torque—low-inertia shaft carried on matched precision ball bearings

Wide-aperturc optics — provides valuable error-compensation, high signal level, and allows reduced-voltage lamp excitation for long life Std. synchro mounts - simplifies installation OPTISYN OPERATION

OPTISYN OPERATION OPTISYN OPERATION OPTISYN uses two transparent disks having pre-cise ruled patterns of alternately opaque and clear sectors. The anchored disk has one (1) more opaque sector than the rotating disk, resulting in the moiré fringe illustrated. Four quadrature light sources (d-c or a-c excitation) illuminate four corresponding sensors. Maximum light is transmitted at one point on the pattern, while 180° away, cell illumination is minimum. A fall rotation of the input shaft causes the moiré pat-tern to rotate n times, n being the number of opaque lines on the rotating disk, Outputs of the photo-sensors, operating into simple solid-state circuits, indicate digital shaft position, rate, and direction of rotation.



MILITARY APPLICATIONS include pickoffs for gimbal systems, accelerometers, radar and optical pedestal mounts, servo controls for airborne and shiphorne use, telemetry, data processing systems, and motor commutators.

INDUSTRIAL APPLICATIONS include pickoffs for lead-screw drives, tool carriage positioners, indexing tables, tape speed controls, digital data transmission, and rolling and drawing stands.

STANDARD MODELS

Size 11: Miniature high-precision encoder scries designed for space and airborne uses where size and weight are critical.

Sizes 23 and 35: High-resolution performance provided in a standard package. Useful for more general military and industrial applications.

Size 27: Recommended for low-cost industrial applications; provided with bearings scaled against dust and dirt; heavy-duty shaft and scaled shaft are optional.

	Size II	Size 23	Size 27	Size 35			
Kesolution* (counts/rev)	25 to 2048	400 to 4096	400 to 3600	400 to 16,384			
Shaft inertia (gm-cm²)	2	40	40	205			
Diameter (in.)	1.062	2.312	2.75	3,500			
Length (in.)	1,325	15/16	2.25	1.406			
Weight (oz.)	3.5	7	17	20			
Max. operating case temp. (°C)	75	75	66	75			
Obtainable from OPTISY'N operating through							

07 01 07

standard shaping and logic circuits.

All models have a projected life of 6 years or 2×10^8 shaft revolutions, whichever occurs sooner; maximum shaft rotation rate of 3000 rpm; photo circuit output of 2-photas sinusoidal waveform; lamp excitation of 240 ma. at 5 volts d-c or 400 cps a-c.

ASSOCIATED CIRCUITRY such as solid-state amplifiers, flip-flops, and logic circuits are avail-able from DRC, and provide logic level signals for driving digital circuitry. DRC also has capability to design complete analog-digital data systems.

OTHER TYPES of OPTISYNS are offered in varied resolutions and shapes: Integrating Accelerom-eter Optisyns (pancake type) for digital readout of velocity information: Optisyn Gimbal Read-outs for inertial navigation platforms, permitting direct digital readout with reliability and life exceeding conventional analog readout, DRC de-velopment programs are underway to carry OPTISYN accuracy into the 5-second region.

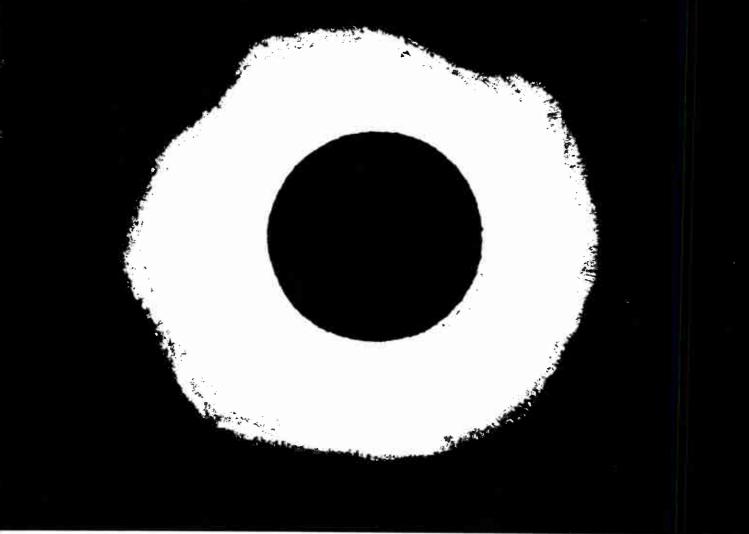
SPECIAL OPTISYNS will be developed to meet your particular needs.

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1 THOMPSON-6 x 12 x 18 SURFACE HYDRAULIC

1 NEVEN BENCH GRINDER COMPLETE WITH DIAMOND WHEEL

1 MONOSET TOOL & CUTTER GRINDER

SAWS

1 REID-6 x 12 x 18 SURFACE

36 INTERNAL

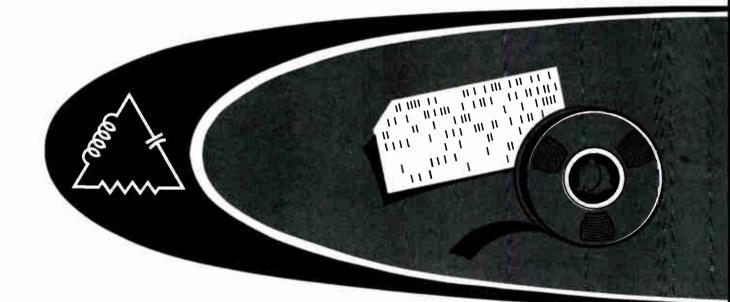
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Data Processing & Automation



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By RICHARD G. STRANIX

Features Editor Electronic Industries

AUTOMATION-



THE word automation usually brings to mind thoughts of complex systems—replacing scores of workers at a time—requiring vast initial investments.

Does automation necessarily mean severe unemployment?

We've probably all heard the pros and cons of automation but a little history lesson on the development of our present telephone system might prove awakening!

Legend and Fact

There is a story that goes something like this. Years ago when telephones had just been accepted. young men operated the cumbersome switchboards. As time passed, these men were replaced by women -and the cries of male employment only champions. But it soon became the accepted thing to hear a pleasant feminine voice when placing a call. Then came the dial system-and the cries of employment champions. The story continuesit is conservatively estimated that for today's satisfactory, 24-hour telephone service every working female in this country would have to be an operator had not the dial system been installed!

Although this story greatly aided the public relations of the telephone systems, they were the first to pre-

Fig. 1: By segmenting the vibratory bowl feeder, different parts can be handled and obsolescence avoided upon part redesign.

DATA PROCESSING & AUTOMATION

Automation is a bug-a-boo for two basic reasons: one, employees think it will cost them their job; two, employers think it will cost them a fortune. Here are some interesting, and revealing, facts.

What It Really Means

sent a more accurate account. Here's the way they presented the story. Dial service is now a little more than 40 years old. If the ratio of operators to the number of telephones handled remained the same, we would now need one million operators. It is estimated that 250,000 new operators would be required each year—retraining costs would be \$180 million annually. And even then we probably would not have the service efficiency which we have today.

There are approximately 175,000 operators in the Bell System alone today; 50,000 new operators are required each year.

Now, there are very few people who object to the dial system.

That's just a sample of how history can prove first thoughts wrong. As a followup—what about all the people that are employed at making the dialing and switching system equipment? New jobs were created for them!

We do not have our head buried so far in the sand that we cannot see there will be many cases of unemployment—nor are we so heartless as to say, "So what?" Automation can and will cause some unpleasantness.

But I think we are deviating from what we started to say. Let's go back to those original thoughts of large, complex machines.

Why do we immediately think of automation as big, somewhat clumsy, machinery? Probably because that is the facet that has received the limelight. And that may be why the little manufacturer thinks that he will never be able to go the automation route.

Fig. 2: Typical data sheet used in collecting information required for automation feasibility study.

APPLICATION DATA SHEET

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Part Drawings: 1 2 3 4		Under Separate Cover			Side by	Side 🗋 Ône Above	Other 🗋 Spaced @	
Fixture Drawings: 1 2 3 4	4 5 6 7 8 9 10 1	Not Avsileble Return		Bowl Meteriel: Alu	uminum 🗋 Carl	on Steel 🗀 Steinless	Steel 🔲 No Preference 🗆	
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				Bowl Supply Mathe	ed: Hand Load	Machine Load	Hopper Load 🔲 Hopper Cep	ecity cv. ft.
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Show direction of feed by Arrow	ws.	3 PRODUCTION		J.I.C. Specification	ns Required*:	'es □ No □; 115V é	i0 Cycle Power Aveilable 🗀	
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			» M Adequate Answer	Dry 🖸	Plated 🗌	No Burr	Other Parts Intermixed	
				Wet	Painted 🗌	Some Broken 🗖	Chips Present	0
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OTUER

Automation (Continued)

Attacking the Problem

Does automation have to always be a bug-a-boo? Can't it be considered a blessing? Can't it be put within the reach of the little manufacturer? Can't it be looked for, instead of feared by, the employee?

Let's attack the problem systematically: one, get the employee to help; two, keep the costs low.

All production lines. large or small, have repetitive operations. Repetition leads to monotony and dissatisfaction. That last condition can almost always be directly related to quality control problems. To relieve the situation, let's get the human element out of the repetitive act.

How do we get employee assistance? Run a suggestion program, if necessary. Have the employees describe their most monotonous tasks. Then see if this can't be eliminated—and the worker used to better advantage elsewhere. If the worker complained of the monotony, he doesn't have cause for complaint should the task be eliminated, or reduced—and he still has another job to undertake.

But what if some jobs are abolished and the worker has no other job to undertake? And how about union complaints? We recently carried a news item (*Electronic Industries*, May 1962, Page 207) which told of how U. S. Industries, Inc., is trying to nip this problem in the bud. It has established a labor-management foundation with the International Association of Machinists. The foundation's first assignment will be to make a study to determine how automation-displaced workers can be retrained. USI will finance the foundation by paying "dues" for every automation machine that it sells or leases to another company in the U. S. It is estimated that dues will range in annual amounts from \$25 to \$1,000 per machine.

While the idea of retraining workers displaced by automation is not in itself new, the establishment of a foundation jointly with labor is unique. Actually, the government and many of the larger corporations affected by automation have recognized the problem for years and have been quietly pouring thousands of dollars into their own retraining projects. A few companies have used retraining to remove the automation dispute from bargaining tables.

Transfer machine used to oil clock movements on the production line.



That's some general background on automation. Now for the real job. How do you go about automating a task?

How to Automate

You could call in your production engineer (if you have one), and ask him. But he probably won't know how—otherwise he would have approached you on it before. Or maybe he just doesn't know how to do it inexpensively.

How about a consultant? He might know—but his retainer might be a little stiff.

Why not call in an automation machine manufacturer? He's got the "know-how," the team, and the desire to compete economically.

With some thought—usually, at no charge—this manufacturer's team can tell you if automation of the monotonous task is feasible. practical, and what it will cost.

Impressed by the news item already mentioned, we recently visited U. S. Industries. Inc., Automation Div., Silver Springs, Md. Here's the way their team usually operates.

The "outside" man—field representative, sales engineer, or what-have-you—views the operation and gets enough information to thoroughly understand the problem. In fact, he gets all the information that he can—because the particular operation may be so closely connected to another, perhaps a non-monotonous machine operation, that with a little thought two operations can be automated at once—by the one piece of machinery. To ensure that he has all the necessary information, he completes an application data sheet, Fig. 2, and sends it, along with samples of the item. or items, to be handled, to the "inside" man.

The "inside" man may actually be many men; but initially, he is the application engineer in the marketing department. This engineer reviews the data sheet to see if the operation can be handled by items directly "off the shelf." This is usually not the case because the field man would have recommended these items immediately. However, the application engineers are specialists and they might be able to see something in the requirement that the field man did not. Also, if stock items with minor modifications can do the job, the application engineer so specifies.

Assuming that the requirement cannot be satisfied by "off the shelf" items, the applications engineer studies the data sheet to determine the feasibility of automating the operation. If not feasible, he so advises the field man.

But let's assume that automation is feasible. The data sheet and any other information that the application engineer may have obtained are directed to custom engineering. Remember, this department is involved only if major modifications, or complete systems, are involved.

As in any other engineering study, a project engineer is assigned. It is his responsibility to study the specifications, consider all the possible courses of action, develop each possibility, and after a thorough analysis, present his concept of how the operation should be automated. In support, he prepares an estimate of the time requirement to complete the job.

Radio History

DATA PROCESSING & AUTOMATION

By ARTHUR FREILICH



Vice President, Chrono-Log Corp. Broomall, Pa.

> The computer process control field is growing rapidly. This is indicated by the number of computers now available for process control applications. This up-to-date comparison covers characteristics of these computers.

1962 Computer Control Survey

 O^{N} February, 1960, ELECTRONIC INDUSTRIES published a comparison table covering the characteristics of nine digital computers that were available at that time for process control applications. These computers were being applied to the control of batch and continuous processes in the petroleum, chemical and power industries. In order to provide an up-to-date comparison of process control computer hardware, a new survey of these machines has been prepared.

The rapid growth of the computer process control field in the last two years is indicated by the fact that there are now 24 digital computer systems being offered for use in these applications. Of these 24 systems, 20 are designed specifically for process control. Similarly, in early 1960, there were approximately 20 computers on order or installed in process control applications. Latest estimates of control computers presently on order or installed in process control range as high as 180 machines.

In this report, "digital computer process control" is defined as on-line control, calculation, or logging of variables in chemical, petroleum, steel, ceramic, power, utility. and other continuous-flow processes.

Explanation of Table

Table compares major characteristics of the several makes of computers offered for process control. But because of different machine configurations, it is impossible to draw exact comparisons on all characteristics. So be sure to read carefully the footnotes by which we attempt to introduce, where necessary, some common comparison basis for divergent data. Where possible, data were obtained from the manufacturer; where other sources were used, that fact is indicated.

Most points of comparison are the same as those in the February, 1960, report.¹ Only the *new* items of comparison will be explained in this report; the reader is referred to the original report for other details.

This article is based on an article by the author which appeared in the July, 1959, issue of the ISA Journal (Instrument Society of America).

¹ "General Purpose Digital Computing Systems," Arthur Freilich, p. 70, Electronic Industries, Vol. 19, No. 2, Feb. 1960.

Working Memory

Process control requires the storage of large amounts of data. To reduce cost, many computers utilize inexpensive bulk storage. However, such lowercost bulk storage (generally a drum or disk) has the disadvantage of relatively-slow average access time. To circumvent this problem, many computers provide high-speed working memory with less capacity than the bulk memory, but much shorter access times. Working memory consists of a core memory or fastaccess registers. Where there is no difference in the working memory and the bulk memory, such as in machines using only core storage, the memory is termed "homogeneous."

Block Transfer Bulk to Working Memory

Since access time for data in a bulk memory is slow, it is desirable to transfer blocks of data occurring in successive bulk memory locations between bulk memory and the working memory. In this way, bulk memory access time applies only to the waiting time for the *first word* of data; succeeding words are transferred as fast as they can be read from, or written in, the bulk memory. Variable block transfer allows the programmer to determine the length of the block to be transferred; that is, the number of words of data. *Fixed* block transfer limits the programmer to a single block size for transfers.

Time to Perform Calculations #1 and #2

The calculations used are shown in Figs. 1 and 2. Fig. 1 is a typical operating-guide type calculation, exclusive of input switching. Fig. 2 is the same calculation, taking into account input switching. Because of various input-output configurations and because of different ways of handling the computation, the times shown in the table should be used only as a general guide.

Priority Interrupt Logic

Process control applications generally preclude use of a fixed program sequence since the program must (Continued on page 18)

Digital Computers Available for Process Control

MANUFACTURER	NORTH AME	TICS DIV. R. AVIATION Ach, Calif.	BENDIX COMPUTER Los Angeles, Calif.		COMPUTER Control Co. W. Los Ang. Calif.	DAYSTROM, INC. La Jolla, Calif.		FERRANTI ELEC. INC. Hempstead, N.Y.	GENERAL Phoenix,
Computer	RECOMP	RECOMP	G-20	G-15	DDP	50-49	100-136	ARGUS (9)	GE-312
Internal Number Base	Binary	Binary	Octal	Binary	Binary	Binary	Binary	Binary	Binary
Operating Mode	Serial	Serial	Parallel	Serial	Parallel	Serial	Serial- Parallel		Serial
Word Length (Plus sign)	40 bits	40 bits	33	29	19 (35)	20	24	11	19
Bulk memory type	Disc	Disc	Core	Drum	Core	Drum	Drum	Core (8)	Drum
Bulk memory cap., min. (words)	4,096	4,096	4,096	2,176	4,096	32,000	32,000	1,024	8,000
Bulk memory cap., max. (words)	4,096	4,096	32,768	2,176	16,384	100,000 per drum	100,000 per drum	3,072	54,000
Bulk memory average access time	9 ms	9 ms	3 μs	14 ms	2.5 μs	25 ms	25 ms	2 μs	6.25 ms
Working memory type	Homogeneous plus Fast Access	Homogeneous plus Fast Access	Homogeneous	Homogeneous	Homogeneous	Core	Core	(8)	Fast Access Registers
Working memory capacity, min. (words)	16	16	N/A	N/A	N/A	1024	1024	N/A	128
Working memory capacity, max. (words)	16	16	N/A	N/A	N/A	16,384	16,384	N/A	128
Working memory average access time	0.95 ms	1.75 ms	N/A	N/A	N/A	20 µs	20 µs	N/A	0.78 ms
is block transfer from bulk to working memory available?	Fixed, 8 Words	Variable, 1 to 8 Words	N/A	A/A	N/A	Yes	Yes	N/A	
Instruction type	Single Address	Single Address	Single Address	Modified Oble. Address	Single Address	Single Address	Single Address	Single Address	Single Address (10)
Memory words/Instruction	1/2	1/2	1	1	1	1	1	1	1 or 2
Instruction complement, normal Instruction complement, max.	72	49 (1)	106 106	500 500	50 128	49 49	115 136	54 64	80
Clock frequency	160 kc	160 kc	1 mc	107 kc	1 mc	100 kc	100 kc	500 kc	250 kc
Add time, w/o access	0.54 ms	0.54 ms	2 μs	0.27 ms	2 μs	0.66 ms (20)	0.056 ms (20)	apr. 18 μs	0.098 ms
Multiple time, w/o access aver.	10.8 ms	10.8 ms	42 μs	2.9 ms	40 μs	5.06 ms (20)	1.4 ms (7) (20)	apr. 95 μs	2.16 ms
Time to perform calculation #1	83.0 ms (15)	78.0 ms (15)	1.48 ms	127 ms	5 μs	39.38 ms	3.08 ms		34.4 ms (15)
Maximum input switching speed (Low-level my inputs)	(2)	(2)	(2)	(2)		30 to 500/sec	30 to 500/sec		114/sec (12)
Time to perform calculation #2	(2)	(2)	(2)	(2)	63 µs	57.7 ms	3.53 ms		78.4 ms (15)
ls priority interrupt legic available?	No	No	Yes	No	Yes	Yes	Yes		No
Can I/O operations proceed simultaneously with arithmetic and logical functions?	No	No	Yes	Yes	Yes	No	Yes		Yes
Weight (lbs)	197	250	2,000	965	1,300	2,000	3,000		2,730
Power required	115 v, 3 amps	115 v, 3 amps	3.5 kva	3.8 kva	115 v, 1 kw	< 2 kw	< 3 kw		6 kva
Internal temperature control	Blowers	Blowers	Blowers (34)	Blowers (34)	Forced Air				Optional Air Cond.
Can computer be isolated from ambient atmosphere?	No	No	No	No	No	Yes	Yes		Yes
Price (approximate)	\$95,000 (3)	\$65,000 (3)	\$389,600 (3)	\$56,300 (3)	\$130,000	(2)	(2)		\$100-450,000

NOTES

- (1) Plus floating point commands (optional).
- (2) This is a general purpose computer not specifically designed for, but applicable to, process control. Input conditioning equipment, A/D and D/A conversion, and input-output switching systems must be added to make a complete process-control system.
- (3) For computer, typewriter, tape 1/0.
- (4) Four digits.
- (5) On a multiple basis, according to manufacturer.
- (6) Per A/D input unit-several parallel units optional.
- (7) Includes serial access; with parallel access, 0.08 ms.
- (8) Argus has pegboard instructions for program steps and constants (128 constants and up to 4,096 program steps). Core memory is for data only. Drum memory up to 50,000 words also available.
- (9) Data from source other than manufacturer.
- (1D) Also 1 + 1 instructions.
- (11) 8.3 ms of total time shown is to store the result.
- (12) Assumes eight parallel amplifier channels.

- (13) Assumes filter on each line, but single amplifier and A/O converter for system.
- (14) Assumes 20 filters and input amplifiers.
- (15) Based on optimum coding.
- (16) 0.1% accuracy with one amolifier/point, 0.5% accuracy with one amplifier for system.
- (17) Includes A/D conversion, first 8 input channels, typewriter and paper tape.
- (18) Some instructions require two words.
- (19) 80 instructions are available from a total of several hundred.
- (20) Includes access time.
- (21) Results stored in main memory since bulk memory normally used only for program storage.
- (22) An additional 1.5 kw required for air conditioner.
- (23) Bailey. 755 system uses PB-250 computer. See Bailey 755 for input switching of Bailey system.
- (24) Uses Packard-Bell PB-250 computer.
- (25) For first drum; additional drums available to 8,000,000 words.
- (26) For first core unit. Multiple core units available.
- (27) Exclusive of transfers to bulk memory. With bulk memory transfers, calculation time is 23.5 ms.

DATA PROCESSING & AUTOMATION

ELECTRIC CD. Arizona	INFORMA- TION SYS- TEMS, INC. Skokie, III.	LEEDS & NORTHRUP CO. Philadelphia, Pa.	GENERAL PR	PE DIVISION Recision inc. Ik, Calif.	MINNEAPOLIS- HONEYWELL REG. CD. Pottstown, Pa.	PACKARD- BELL COM- PUTER CORP. Los Angeles, Calif.	BAILEY METER CD. Cleveland, Ohio	RADIO CORP. DF AMERICA Natick, Mass.	Canog	PUTER CD. a Park, alif.
GE-412	609	LN-3000	L-50D	L-1000	290	PB-250	755	RCA 110	RW-300	TRW-330
Binary	Binary	Binary	Binary	Binary	Binary and BCD	Binary	(24)	Binary	Binary	Binary
Paraliei	Serial	Serial	Serial	Serial	Parallel	Serial		Serial	Serial	Serial
19	39	22	30	31	17	21		24	18	28
Drum	Disc	Drum	Drum	Drum	Drum (32)	Delay Lines	Drum	Drum	Drum	Drum
16,384	4,000		4,096	7,808	8,192	2,320		4,096	8,000	4,000
57,344	100,000	16,256	4,096	15,232	32,768	15,888	28,000/drum	32,000 (25)	16,000	100,000
8.3 ms		8.3 ms	8.3 ms	8.3 ms	17 ms		16.7 ms	8.3 ms (9)	8.3 ms	8.3 ms
Core	Core	Fast Access Registers	Homogeneous	Fast Access Registers	Core	Delay Lines		Core	Fast Access Registers	Fast Access Registers
4,096	4,096	4	N/A	200	1,024	2,320		256	16	128 + 1
8,197	16,384	16	N/A	200	4,096	3,856		4,096 (26)	32	256 + 1
20 µs	24 µs	0.5 ms	N/A	1 ms	<20 µs	12 µs		10 µs	2.08 ms	2.08 ms (29)
Variable, 128 to 1024 Words	Yes	No	N/A	Fixed, 8 Words	Variable, Up to 256 Words	Variable		Variable, Up to 4096 Words	No	Yes (Variable)
Single Address	Single Address	Single Address (10)	Single Address	Double Address	Single Address	Single Address		Single Address	1 + 1 Dbi. Addr.	Single Address
1	0.5	1	1	1	1 (18)	1		1	2	1
> 100	64	16	16	43	85	57		68	21	35
	64	64			< 100 (19)			75	>35	>70
400 kc	167 kc	170 kc	136 kc	123 kc	50 kc	2 mc		936 kc	153.6 kc	246 kc
20 µs	720 μs	0.52 ms	0.23 ms	0.25 ms	0.14 ms (20)	12 µs		58 µs (20)	0.39 ms	0.13 ms
440 μs	2.8 ms	2.7 ms	18 ms	18 ms	0.8 ms (20)	276 µs		751 μs (20)	2.99 ms	4.1 ms
2.1 ms (11)	31.7 ms	58.9 ms (15)	915 ms	193 ms	9 ms (21)	< 9 ms		6.5 ms (31) (27)	42 ms (15)	31 ms (15)
14/sec (12)	40/sec (13)	16/sec (14)	60/sec (16)	60/sec (16)	up to 200/sec	1000/sec	5/sec	60/sec	480/sec (30)	480/sec (30)
56.1 ms (11)	57 ms	58.9 ms (31)		210 ms	14 ms (21)	(2) (23)	46 ms	6.5 ms (31) (27)	42 ms (31) (15)	31 ms (31) (15
Yes	Yes	Yes	Yes	Yes	Yes			Yes	No	Yes
Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4.000	1,000	450	1,100	1,250	1,600	130			645	600
<10 kva	2 kw	500 w	2 kva	2 kva	1.4 kw (22)	110 w		5 kva	500 w	285 w
Optional 'Air Cond.				Internal Air Cond.	Internal Air Cond.	Not Required		Heat Exchangers	Not Required	Air Cond. Optional
Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
150-750.000	\$130,000	\$100,000 (3)	\$84,500 (17)	\$97,400 (17)	\$175,000 (33)	\$40,000 (3)		\$125,000 (28)		

(28) Computer with 256 words of core memory.

•

- (29) Time shown is random access in a 256-word block. Access time is 0.5 ms in an 8-word block.
- (30) Assumes 1024 inputs, 32 filters and amplifiers.

Assume all data, instructions, etc., are in working memory, if non-homogeneous memory is used: 1. Read in new input X (exclusive of input switching time, input selection time, settling time, or A/D conversion) 2. Calculate (A) (X) + B = Y 3. Compare Y to C to insure that Y < C

- 4. Compare Y to D to insure that Y > D
- 5. Calculate Z = $\sqrt{(E)(Y)}$ (with accuracy of 10 bits 0.1%)
- 6. Calculate J = (ZF G) (K)/H + L 7. Store J in bulk memory (use average access time)
- 8. Store Z in bulk memory (use average access time)

Figure 1. Sample Calculation No. 1-a typical problem used to compare computation speed of the several computers.

- (31) Input selection and conversion are independent of program. Computer has access to latest data.
- (32) Magnetic tape I/D also available as standard, with transfer rate of 15,000 characters/second.
- (33) Nominal figure; price varies with memory capacity, and does not include peripheral equipment.
- (34) These figures apply to central processor only.
- (35) 25 bits available.
- (36) 12 characters per instruction.
- (37) Computer with paper tape 1/0, 12k character memory and typewriter.
- (38) Assumes data from last point is in storage and conversion in progress.

Same as Calculation #1, but assume that input X must be obtained from an analog-input, low-level, process-signal from a thermocouple-type transducer; include selection time, switching time, settling time, and A/D conversion time.

Figure 2. Sample Calculation No. 2-same as Figure 1, but including input switching.

Digital Computers Available for Process Control

MANUFACTURER	TRW COMPUTER CO., Canoga Park, Calif.	IBM. San Jose. Calif.	ELECTRI	GHOUSE C CORP., rgh, Pa.
Computer	TRW-340	IBM-1710	PRODAC 510	PRODAC 580
Internal Number Base	Binary	Decimal	Binary	Binary
Operating Mode	Serial-	Serial	Parallel	Parailei
Word Length Plus Sign	Parallel 28	Variable	18 bits	18 bits
Bulk memory type Bulk memory cap. min. words Bulk memory cap. max. words Bulk memory cap. max.	Drum 8,000 100,000 8,3 ms		Drum 16,000 64,000 per drum 8,3 ms	Drum 16,000 64,000 per drum 8,3 ms
Bulk memory average access time	Core	Core	Core	Core
Working memory type Working memory capacity min. • words Working memory capacity max. words Working memory average access time Is block transfer from bulk to working memory available?	4,000 16,000 8 µs Yes variable	20,000 Characters 60,000 Characters 20 µs N A	4,096 16,384 4s Yes variable	4,096 32,768 4 us Yes variable
Instruction type Memory Words instruction Instruction complement, normal Instruction complement, max.	Single Address 1	2 Address 36 36 49	Single Address One 65 83	Single Address One 73 91
Clock frequency Add time, w o access Multiple time, w o access aver. Time to perform calculation -1	490 kc 16 μs 131 μs	0.48 ms 4 3.4 ms 4 20 ms	1.5 mc 12 µs 20 38 µs 20 1.586 ms	1,5 mc 12 µs (20) 38 µs (20) 1,524 ms
Maximum input switching speed low-level my inputs Time to perform calculation =2		20 sec 25 ms 38	75 sec 6	75 sec 6
ls priority interrupt logic available?	Yes	Yes	Yes	Yes
Can I O operations proceed simultaneously with arithmetic and logical functions?	Yes	Yes	Yes	Yes
Weight : Ibs Power required Internal temperature control Can computer be isolated from ambient atmosphere?	500 w Not required	2,000 208 v. 15 a Blowers No	< 7 kva Air Cond. Optional Yes	< 7 kva Air Cond. Optional Yes
Price approximate		75,000 37	\$150 400.000	\$200 500,000

(Continued from page 15)

be responsive to ever-changing process conditions. Priority interrupt logic permits a change in process conditions to interrupt the computer program and, without losing any part of the previous calculation, switch the computation to that portion of the program which is designed to handle the new condition. Various process conditions are assigned priority ratings, and interrupt is based on performing the highest priority computations first, followed by those of lower priority. Emergency conditions in the process would have priorities dependent on the urgency of action required.

When no high-priority tasks are required, the computer can perform system checks, process studies and other routine tasks. Although programmed priority interrupts are possible, the inclusion of priority interrupt logic in the computer eliminates the need for complex programming and conserves program space and computing time.

Simultaneous Input/Output and Computation

Where input/output (I/O) computations can proceed *simultaneously* with computations, the computer can perform computations without waiting for input data; the computer has available to it the latest input data. To the extent that these operations can proceed simultaneously, the computer can conserve computing time.

EDWARD GLENN McCOY

Senior Engineer, Data Systems Div., Radiation, Inc., Melbourne, Florido

How to Design . . .

Counters Using

Inhibiting logic can control the functions of a flip-flop counter. Here is a method which uses it to provide flexible counter operation. This non-standard tool requires a minimum of components.

A COUNTER having a count-down capability of ten, six, and five can be mechanized by the addition of two diodes to a standard counter configuration. The following "ground rules" apply:

(1) A "True" logic level is defined as -5 vdc.

(2) A "False" logic level is defined as 0 vdc.

(3) Positive clock-pulses or sources are used to turn the flip-flops "off" to minimize "turn off delay time."

(4) In the analysis, only the involved gates will be shown for each application.

(5) Since the maximum count-down requires ten states, four flip-flops will be required to mechanize the counter. They are designated A_1 , A_2 , A_4 and A_5 —where the subscripts designate the binary value of the flip-flop when it is set at "1".

TRUTH TABLES

	9	Count	-dow	n by	10		Cou	unt-d	own	by 6	Cou	int-d	0WD	b <u>y 5</u>
		A1	^A 2	A 4	* 8		A 1	A 2	A 4	* 8	A1	A 2	A_4	A.8
t	+0	0	0	0	0		0	0	0	0	0	0	0	0
t	+1	1	0	0	0		1	0	0	0	1	0	0	0
t	+2	0	1	0	0		0	1	0	0	0	1	0	0
t	+3	1	1	0	0		1	1	0	0	1	1	0	0
t	+4	0	0	1	0		0	0	1	0	0	0	1	0
t	+5	1	0	1	0		1	0	1	0				
t	+6	0	1	1	0									
t	+7	1	1	1	0									
t	+8	0	0	0	1	Fig	1.	Deci	rad	modes of a	nera	tion	of	the
t	+9	1	0	0	1					fined by th				



Inhibiting

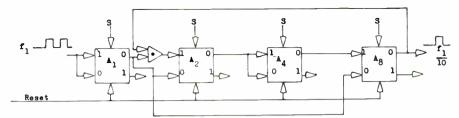


Fig. 2: Representation of the logic required to implement a count-down by 10.

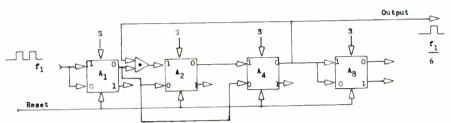


Fig. 3: Representation of the logic required to implement a count-down by 6.

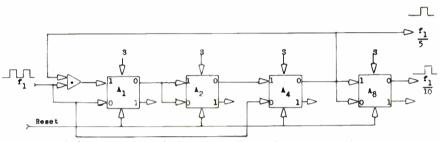


Fig. 4: Representation of the logic required to implement a count-down by 5.

Desired modes of operations of the counter are defined by the Truth Table, as shown in Fig. 1.

Logic

Count-down by 10

Reference should be made to Fig. 2, which is a representation of the logic required to implement a count-down by 10.

The counters are initially shown in the reset condition. A positive input source of clock-pulses or triggers—from another counter decade—sequences the flip-flops A_1 through A_8 until a binary count of nine is reached. At time t+9 (Fig. 1), binary counters A_1 and A_8 are set "1". Therefore, the output of flip-flop A_8 , which is at a -5 v., inhibits the input control gate associated with the set "1" input of flip-flop A_2 .

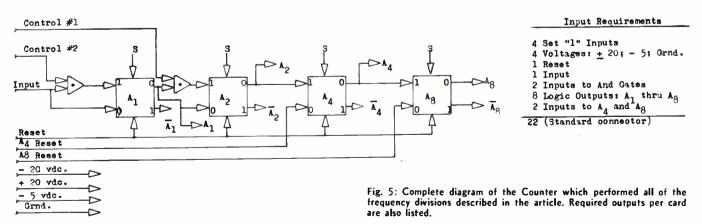
Consequently, although the next input clock-pulse sets flip-flop A_1 "0", the positive output waveform of A_1 is inhibited from setting the A_2 flip-flop. However,

the output of flip-flop A_1 (approximately +5 v.) resets flip-flop A_8 to re-enable the set "1" input control gate of flip-flop A_2 for subsequent recount operations. An output frequency of one-tenth the input frequency is derived from the True output of the A_8 flip-flop, as shown.

Count-down by 6

Reference should be made to Fig. 3, which is a diagram of the logic required to implement a countdown by 6. It is pointed out, for the reader's benefit, that only the control of the input AND gate associated with flip-flop A_2 has been changed.

An input of " f_1 " clock-pulses sequences the counters until a binary count of five is reached at t+5. At this time interval (Fig. 1), flip-flops A_1 and A_4 are set "1". The True output of flip-flop A_4 which is set at -5 v., inhibits the input control gate of the set "1"



ELECTRONIC INDUSTRIES · June 1962

Inhibiting Logic (Concluded)

input of flip-flop A2. The next input clock-pulse at t+6 resets flip-flop A_1 . The positive output (+5 v. pulse) is inhibited from setting flip-flop A2, but resets flip-flop A₄ and the counter is returned to a state suitable for re-counting.

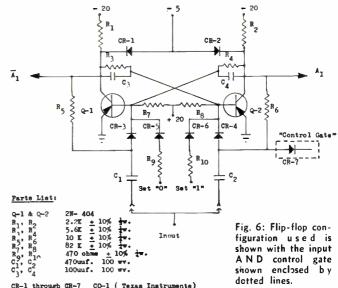
An output derived from the True side of flip-flop A_4 provides an output which is one-sixth the input frequency. Although flip-flop $A_{\rm s}$ is set and reset every six time interval, this caused no difficulties in the specified application.

Count-down by 5

The last mode of operation to be described is the count-down by five, which is represented by the logic diagram shown in Fig. 4.

This counter counts in a normal binary fashion until a binary count of four is reached (refer to Fig. 1) at t+4. At this time interval, the True output of flip-flop A_4 (which is set at -5 v.) inhibits the input AND gate of the set "1" side of flip-flop A₁. However, the next clock-pulse or trigger resets flip-flop A₄ which removes the inhibitor. An output derived from the True side of flip-flop A₄ provides an output which is one-fifth the input frequency.

An additional feature is that a division by ten can be derived by taking the output from the True side of the As flip-flop instead of the A4 flip-flop. A symmetrical output waveform from the True side of the A_8 flip-flop is a biquinary division of the input frequency.



CO-1 (Texas Instrumente)

Logic Diagram and Schematic

A complete logic diagram of the counter which performed all of the frequency divisions described in this article (at 100 KC.) is shown in Fig. 5. Also shown in Fig. 5 are the required twenty-two outputs per card. A schematic diagram of the flip-flop configuration used is shown in Fig. 6. The input AND control gate is shown by dotted lines on the schematic.

While the counter was designed for a specific application, the methods employed to derive the desired operation can be used to provide other modes of operation depending on the design requirements.

Computer Reports

New Tech Data

Program Timer

Model PT-96 is basically a master decade counting device, capable of generating selective timed outputs within a range of from 0 to 10,000 sec., with time spacing of 10msec. Accuracy of timing through the full range is $\pm 0.01\%$. Block diagram, dimensional drawings, connector data, photographs and definition of signals are included. Electronic Products are included. Electronic Products Corp., 2315 Cecil Ave., Baltimore 18, Md.

Circle 599 on Inquiry Card

Digital Modules

This 28-page catalog, S-1, contains information on S-PAC Digital Modules. Included are schematics, technical descriptions and details spec. of 2 complete series of approx. 60 different compatible, high-reliability plug-in modules for digital computers and systems. Operating freq. range is from dc to 1 and 5MC. Also included are loading rules, typical waveforms, mechanical packaging fea-tures, information on logic symbol stickers, core memory systems, and related products. Computer Control Co., Inc., 983 Concord St., Framingham, Mass.

Circle 600 on Inquiry Card

for Engineers

Nytronics, Inc., 550Springfield Ave., Berkeley Heights, N. J., has tech. data available on their Wee® N. J., has Lines. Wee Lines are sectionalized delay lines. Each section is designed and manufactured to be a discreet value of delay time. The total number of sections of the delay line determines the overall delay time. Circle 601 on Inquiry Card

Shift Register Brochure

Delay Lines

This 4-page brochure describes a line of standard magnetic shift registers. Features included in the brochure are low power dissipation, operational stability, packaging flexibility and low cost. EPSCO-Components and low cost. EPSCO-Components 275 Massachusetts Ave., Cambridge 39, Mass.

Circle 602 on Inquiry Card

Magnetic Core Memory

A line of magnetic core memory components and systems described in a full-color brochure is available from Fabri-Tek, Inc., P. O. Box 8046, Min-neapolis 16, Minn. Information is included on core memory planes, stacks, temperature-controlled stacks and complete memory systems.

Circle 603 on Inquiry Card

Applied Dynamics, Inc., 2275 Platt Rd., Ann Arbor, Mich., is offering a 12-page Computer Application Report entitled "Analog Component Requirements for Solving the Six-Degree-of-Freedom Orbital Flight Equations." It illustrates how this important and complex simulation can be done on an analog computer with a total of 179 operational amplifiers, 37 potentiom-

eters, 93 quarter square multipliers, and 23 function generators. Circle 604 on Inquiry Card

Magnetic Programming

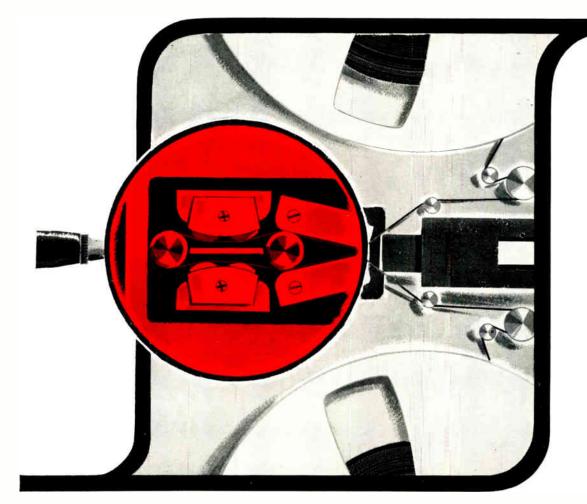
Bulletin B contains complete details on a digital pattern generator, which gives all magnetic programming without switches, contacts or patch cards. Information includes uses, features, general description, electrical and mechanical specs., optional equipment and accessories, and photographs. Cybetronics, Inc., 132 Calvary St., Waltham, Mass.

Circle 605 on Inquiry Card

Optical Scanner Units

This 6-page, multi-colored brochure describes a selected data page reader an optical scanning machine capable of selecting and reading specified data from a business document and converting the information into business machine language for computer proc-Farrington Electronics, Inc., essing. Alexandria, Va.

Circle 606 on Inquiry Card



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World Radio History



Circle 220 on Inquiry Card



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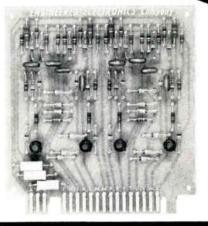
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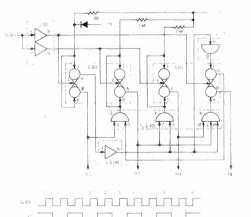
World Radio History



EECo G-SERIES CIRCUIT APPLICATIONS

10-M^c_s SYNCHRONOUS N/10 COUNTER

Error-free synchronous N/10 counting at clock speeds up to 10 Mpps is normally a costly operation in terms of the electronics involved. The EECo circuit shown here, however, is an economical one in spite of its high reliability, because it employs low-cost EECo G-Series extended service digital circuit modules. ■ This 10-Mc synchronous N/10 counter uses a 1-2-4-8 code. It is made up of four G-Series circuit cards.





* PAT. APPLIED FOR

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The G-Series is a complete family of high-quality, low-cost extended service digital circuits on cards. Units are designed for either synchronous or non-synchronous applications and feature standard input impedances, compatible standard signal levels, conservative electrical specifications, repairability, and keying for error-free insertion. In addition, they offer the unique feature of integral protection against power supply shorting damages.* Units in frequency sub-groups lower than 10 Mc will be available shortly.

The circuit illustrated is typical of the many practical applications of EECo G-Series extended-service digital circuit modules. We stand

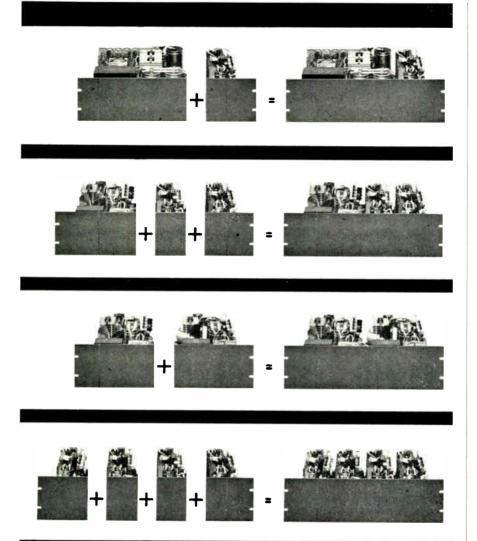
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■ Fifty-four transistorized dc power supplies are available in modular units with nine voltage ranges from 1 to 37 volts and six power sizes, with current ranges from .7 to 25 amperes. They provide almost unlimited versatility in the design of electronic equipment.

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Behlman-Invar representatives are: T. Louis Snitzer Company – Los Angeles. La Jolla and Sunnyvale, California • Cain and Company – Albuquerque; Great Neck, N. Y.; Boston; Orlando, Fla.; Philadelphia; Chicago; Dallas; Washington, D.C.

Circle 223 on Inquiry Card

Tech Data

for Engineers

Silicon Logic Modules

This 8-page, 3-color brochure describing a line of silicon logic modules is available from Packard Bell Computer Corp., 1905 Armacost Ave., Los Angeles 25, Calif. Covering 13 circuit modules, the brochure gives general descriptions and operating characteristics which include operation over a temp. range from -55 to 100°C at a freq. of 1MC.

Circle 548 on Inquiry Card

Tape Readers

Short-form catalog illustrating and describing a line of OMNI-DATA electrostatic paper - tape recorders, chopped-reflected-light tape readers, and high-performance tape reelers is available from Omnitronics, Inc., sub. of Borg-Warner Corp., 511 N. Broad St., Phila. 23, Pa.

Circle 549 on Inquiry Card

Delay Lines

Tech data is available on the line of variable, audio, lumped constant, distributed constant, and subminiature lumped constant delay lines. Information is also included on magnetostrictive delay lines, networks and filters. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 550 on Inquiry Card

How To Get Things Done Better And Faster



BOARDMASTER VISUAL CONTROL Cives Graphic Picture—Saves Time, Saves Money, Prevents Errors

- ☆ Simple to operate—Type or Write on Cards, Snap in Grooves ☆ Ideal for Production, Traffic, Inventory
- ☆ Ideal for Production, Traffic, Inventory Scheduling, Sales, Etc. ☆ Made of Metal. Compact and Attractive.
- A Made of Metal. Compact and Attractive. Over 750,000 in Use.

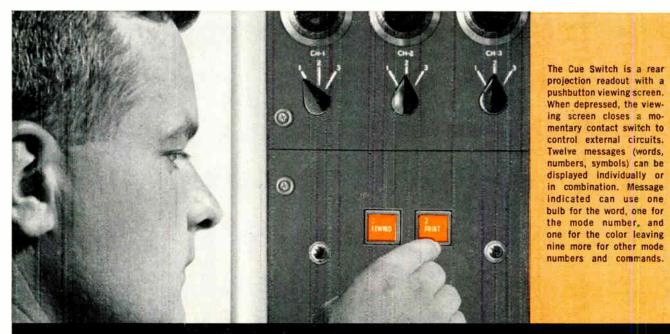
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Write for Your Copy Today GRAPHIC SYSTEMS Yanceyville, North Carolina

Circle 224 on Inquiry Card

World Radio History

How to reduce panel space by more than 90%



with I.E.E Cue INDICATOR SWITCHES

Twelve individual messages that can be read out singly or in combination are combined with a pushbutton viewing screen on the Cue Switch to reduce panel space requirements to one square inch—a reduction of 90% or better!

Used with a stepping switch, the Cue Switch can initiate sequential command functions while indicating the mode of operation. It can be used to interrogate circuits and then read out conditions.

Where an operator must follow a check list, the Cue Switch can read out "WAIT FOR WARMUP," "OK TO PROCEED," or other instructions. For computer applications, the Cue Switch can be used as a mode of operation indicator while enabling the operator to start and stop the operation. For elevator applications, the Cue Switch can be used to call for the elevator car, then indicate the floor location of the car as it moves.

The electrical and mechanical simplicity and the quality construction of IEE Cue Indicator Switches provide a high degree of reliability. Economical pricing (single units \$55) gives you a switch/read-out combination adaptable to a wide range of practical applications.

Human Factors Considerations

IEE Cue Indicator Switches give you optimum control discernability by having instructions or commands appear on the face of the switch to be depressed—all characters are displayed on the same plane with 170° viewing angle—de-energized characters are not visible—minimum panel area is required for legible display.

Call your nearest IEE sales engineering representative for additional information and demonstration.

Specifications

DIMENSIONS: (overall) 2 inches high; 1 inch wide; 4 inches (with standard terminal assembly), 4.75 inches (with quickdisconnect terminal assembly). Pushbutton viewing screen 1" square.

WEIGHT: 5 ounces.

STANDARD CHARACTERS AVAILABLE: 0 through 9, "on" and "off;" other words, symbols and characters also available.

COLOR OF CHARACTERS AVAILABLE: White, Amber, Yellow, Red, Blue, Green. Special colors available on request.

CHARACTER SIZE: 56" high standard single numeral. Other sizes available from 46" to 56". Maximum size of letters, words, symbols should fit within a 34" diameter maximum circumscribed circle.

VARIATIONS PERMIT IDENTICAL FRONT PANEL APPEARANCE: Switch and 12message display, switch only, display only, switch-pilot light.

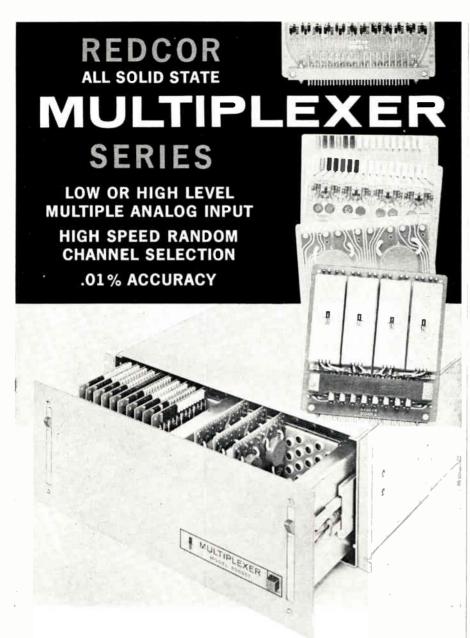
SWITCHES: 2 PDT mom. cont., 2 PDT alt. act.

World Radio History

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

5528 Vineland Avenue North Hollywood, California Phone: TR 7-1144





- REDCOR Multiplexers are a new generation of solid state data acquisition components, designed for scanning multiple high and low level analog inputs.
- Sequential or random access control is achieved universally by "on line" general purpose computers, special purpose digital systems or under internal programming.
 Outstanding features include:
- Outstanding features include:
 - High input impedance ... 1000 megohms with completely variable input levels, 10mV - 10 volts
 - Unusually low cross talk...less than 0.01% at 1 kc/s with very fast switching speeds...100 kc/s
 - Complete flexibility by means of patch board control... random access of up to 100 channels
 - Completely integral amplifier and power supplies in 7-inch panel height

All REDCOR data acquisition components are completely compatible for systems applications.

For complete specifications, write to Dept. E1662



7760 Deering Ave., P. O. Box 1031 · Canoga Park, Calif. Telephone: Dlamond 8-5892 / TWX CNPK-5503

Circle 226 on Inquiry Card

Automation

(Continued from page 1-4)

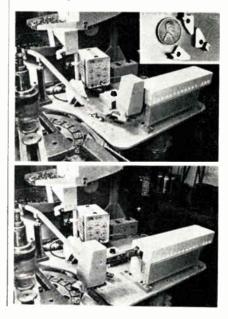
Naturally, his work is reviewed. When custom engineering is in agreement that this is the best solution, the time estimate is returned to marketing where it is converted into a dollar estimate. At USI. this is a fixed estimate, i.e., it is the complete price that the system, as specified, will be delivered and installed for, come what may. This quote then goes to the prospective customer through the field man.

If the customer decides upon automation and places the order, the job is assigned to the same project engineer that made the original estimate. If he is too heavily scheduled to handle the job, another engineer may be assigned. After an engineering briefing, the alternate engineer is usually in a position to carry through the original engineer's concept.

The project engineer is responsible for the job, or the equipment. until it is finally accepted by the customer.

To properly install, maintain, and advise on future modifications, a well-trained service force is also necessary. So that these service

Fig. 3: A set of fingers on the transfer machine picks up typewriter part (inset) from gravity feed chute, conveys it horizontally, and precisely places it into a close tolerance nest. Controller, segmented feeder bowl, and supply hopper are seen in the background. Note the level sensor.



personnel will be thoroughly oriented on the intricacies of any sophisticated systems which are being supplied, they are brought into the plant during manufacture of such systems. Members of this force have direct communication with the members of the customs engineering department.

Other Aspects

Now let's touch on a few of the other aspects in which a potential customer might be interested. Even with a relatively inexpensive "off the shelf" item, what about the obsolescence factor if the manufacturer should change the design of the item he wishes to handle. At USI, this is taken into consideration. In most simple automation jobs, only two pieces of equipment are involved: A segmented vibratory bowl feeder, Fig. 1, and a transfer machine called a TransfeRobot 200, Fig. 3.

The segmented bowl is probably the greatest contribution to freedom from obsolsecence. As seen in the illustration. a section of the outside rail of the bowl-about one third of the circumference, is detachable. It is this part only, in the feed system, that would have to be replaced if the handled item design was changed. Of course, there would probably have to be a change in the pick-up that handles the item being transferred-this is also only a minor change. A wide variety of mechanical, pneumatic, magnetic. and other accessory "fingers" are available.

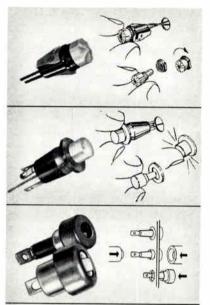
These transfer machines can pick-up, turn over, insert, shuttle. or rotate with precision. They can also be used to combine, assemble, weld, stake, rivet, mark, oil, hold together, glue, and scores of other uses.

The above holds true for systems also—though other parameters may have to be considered and altered.

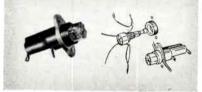
That's the automation story sure it can mean considerable machinery; but, it can also mean inexpensive relief from monotony usually doing a superior job.

The author wishes to express his thanks to H. E. Hayne and E. Miduch of U. S. Industries, Inc., Automation Div., for their assistance in preparing this article. Sub-miniature test and sensing components for front panel servicing

These tiny "tell-tales" for every piece of equipment make servicing and troubleshooting simple. Use them to monitor electrical and mechanical functions — tell operator when malfunction occurs — help spot source of trouble — simplify checking — adjustments — protect costly components.







Write for Vest Pocket Guide and Samples:

THE ALDEN PAN-I-LITE

3 times greater light efficiency • 1/6 the size of miniature bayonet bulbs • Easier mounting, snap in • Quick and easy to replace from front of panel • Visible from any angle, any distance • Non refracting • No bulky focusing or refracting devices • Variety of colors and voltages (6v, 12v, 28v in candescent, 110–220v Neon).

THE ALDEN PAN-I-LITE SWITCH

Tiny push-button, snap-in indicator gives positive indication -180° visibility \cdot one-piece replaceable bulb lens \cdot use as press-to-test indicator or remote control switch \cdot In 6, 12, 28v incandescent blue, red, green, white, yellow \cdot Quick snap-ring mount.

ALDEN STAK-IN TEST JACKS

Exclusive molded-in eyelet permits fast, low-cost machine assembly • No nuts, washers, sleeves • Won't vibrate loose, turn, or fall out • Rugged Nylon insulation • Reliable 360° Beryllium contact.

ALDEN STACKING AND PATCH CORDS

Miniaturize your computer with tiny cord sets • stack and patch for positive interconnections • reliable integrally molded units take any standard .080" test prod • resilient contact • lead length to your specs is covered in flexible rubber.

ALDEN FUSE-LITES

Here's a compact panel-mounting fuseholder that indicates when fuse is blown. Fuse blows — lite blows. Takes standard '4" x 1'4" fuse. Protect your equipment with Alden Fuse-lites. For 6, 12, 28, 110 and 220 volts, 15 amps to 110 volts, 7.5 amps at 220 volts.

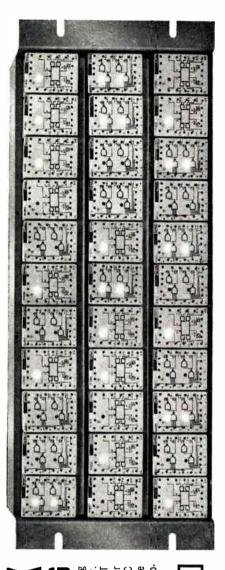


6123 N. Main St., Brockton, Massachusetts

ELECTRONIC INDUSTRIES · June 1962

Circle 227 on Inquiry Card

World Radio History





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Plainview,

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Dept.

Algebra and comp exclusive ''lease·l

for

Write

Tech Data

for Engineers

Card Reader

Tech data is available on the Speedreader 2000 a system using photo-sensing. It reads cards at speeds from 400 to 3000 cards/min. Speedreader 400 to 3000 cards/min. Speedreader 2000 reads any number of columns in cards of either the Remington Rand or IBM type. Hopper capacities are 4000 cards. Uptime Corp., 175 Com-merce St., Broomfield, Colo.

Circle 557 on Inquiry Card

Delay Lines

Bel Fuse Inc., 198 Van Vorst St., Jersey City, N. J., has data available on Nanalines[®], new nanosec. delay lines for use with high speed cir-cuitry. Lines are available with time delays of 5 to 100 processing time for delays of 5 to 100 nsec; rise-time for a 100 nsec delay line is 9 nsec. Circle 558 on Inquiry Card

Disc Files

A 12-page catalog titled, "Modular Mass Memory," covers the Bryant Series 400 disc files, with capacities from 30 million to 720 million bits. General information and specs, are provided on the files which are avail provided on the files which are avail-able with from 1 to 24 discs. Bryant Computer Products, div. Ex-Cell-O Corp., 852 Ladd Rd., Walled Lake, Mich.

Circle 559 on Inquiry Card

Computer Brochure

This 6-page 2-color brochure de-scribes the Digital Data Processor (DDP-19), designed for real time ap-(DDP-19), designed for real time ap-plications, data acquisition and reduc-tion, and scientific problem solving. DDP-19 has a 19-bit word, core mem-ory with 5MC cycle and 3MC access times. Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64. Calif.

Circle 560 on Inquiry Card

Intercom

Fisher Berkley Corporation, 1475 Powell St., Emeryville 8, Calif., has available a 30 page manual on their Ektacom[®] and Bennett[®] intercom equipment. Complete specs. show how to obtain max. flexibility. Diagrams and schematics are included.

Circle 561 on Inquiry Card

Magnetic Tape Heads

Photographs, dimensional drawings and complete specs. cover 10 different types of Magnetic Heads and Drum Systems. Magne-Head Div., General Instrument Corp., 3216 West El Se-gundo Blvd., Hawthorne, Calif.

Circle 562 on Inquiry Card

Tape Adapter

Tech. data describing the EECO 754 Magnetic Tape Adapter which gives the IBM 1401 Computer the capability of reading and writing magnetic tape in GE/ERMA or GE 210 format is available from the 210 format, is available from the Electronic Engineering Co. of Cali-fornia, Box 58, Santa Ana, Calif. Circle 563 on Inquiry Card

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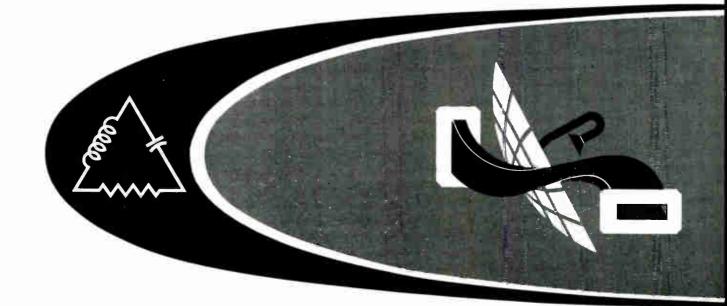
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Microwave



- Microwave Antennas J2
- Standard Waveguide Characteristics . . . J5
- - Manufacturers' Data Currently Available ... J29

Туре	Configuration	ohms	% %	Isotrope	Dipole
Smali Dipole				1.74	-0.4
¹ ⁄2 λ Dipole /Thick Tube L/D = 276	$\xrightarrow{\frac{1}{2}\lambda}$	60	34	2.14	0 Reference Dipole
¹ ⁄2 λ Dipole /Thick Tube L/D = 51	Similar to above	49	55	2.14	0
$\frac{1}{2} \lambda$ Dipole Cylinder L/D = 10	Similar to above	37	100	2.14	0
$\frac{1}{4} \lambda$ Folded Dipole	$\overbrace{}^{+\frac{1}{4}\lambda}$	6000 (resistive) 260 (av. surge Z)	5	1.64	-0.5
¹⁄₂ λ Folded Dipole	$\overbrace{}^{\frac{1}{2}\lambda}$	300	45	2.14	0
1 λ Dipole Cylinder	•1λ> 	150	130	3.64	1.5
¹ ⁄2 λ Biconical	$\sum_{i=1}^{i=1} \sum_{j=1}^{i}$	72	100	2.14	0
1 λ Biconical	$\sum_{i=1}^{i+1} \sum_{j=1}^{i+1} \sum_{i=1}^{j}$	350	200	2.14	0
Crossed Dipoles or Turnstile/ (1 stack)	\rightarrow	150	50	-0.86	3
Turnstile 2 stack ¹ ⁄ ₂ λ / separation	Similar to above except stacked			2.14	0
Super Turnstile /or Batwing 1 Sections 3 Sections 6 Sections 12 Sections				2.14 7 10.14 13	0 4.8 8 10.9
4 Bay Helical				15.14	13

150

20

Typical Antennas-Horizontal Polarization

Z,

ک B

Gain (db) above

 $\frac{1/2}{2} \lambda$ Dipole and Reflecting/ Sheet Microwave Antennas

Antenna design is generally conceded to be for the specialists. However, equipment and system designers must have some knowledge of antennas. As an aid, we present some basic information about antennas in graphical form.

WHILE antenna design is generally left for the specialists, a knowledge of general types of antennas is necessary for any engineer concerned with electromagnetic radiations.

Here we present basic information about most of the more common antenna types in tabular form. The general classes of antennas listed in the tables are the dipole, array and aperture types.

Antenna gain is usually expressed as x db's above an isotropic or dipole antenna. A half-wave dipole antenna is most commonly used as the standard to compare antenna gain. One reason is that such an antenna can be built and used as the standard while a true isotrope cannot. Also, an isotropic radiator of coherent waves does not exist¹ because it cannot satisfy Maxwell's equations. However, the properties of such an imaginary antenna are easily visualized, and the concept of an isotropic radiator is often found useful in the analysis of antenna systems. Hence, antenna gain is often listed in db's above an isotrope.

World Radio History

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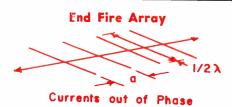
		7	Δ Β	• Gain (dt) above
Type	Configuration	Z, ohms	%	Isotrope	Dipole
¼ λ Dipole		28	40	2.14	0
Folded Unipole		150	45	2.14	0
¹ ⁄2 λ Coaxial Dipole		50	16	2.14	0
Biconical Coaxial Dipole		72	200	2.14	0
Disk-cone	V			2.14	0
Biconical Horn		150	25	14.14	12

Typical Antennas-Vertical Polarization

When selecting an antenna, five parameters must be considered: impedance (Z_r) , bandwidth (ΔB) , polarization, gain, and pattern. The equipment and its application will, to a great extent, determine or set the limits for these parameters.

The chart material used here was supplied by O. M. Salati, Asst. Prof., Moore School of E. E., University of Pennsylvania and Mr. David F. Bowman, Manager Microwave Engineering, I-T-E Circuit Breaker Co.

1. Frederick E. Terman, "Electronic and Radio Engineering," 4th edition, *McGraw-Hill*, page 871.



Theoretical Gain of Two End Fire $\frac{1}{2} \lambda$ Elements for Various Spacings "a"

а

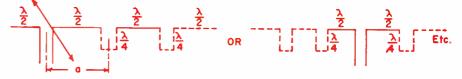
5/8 1/2 3/8 1/4 1/20

1/8

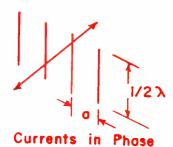
Gain, db

above dipole

1.7 2.2 3.0 3.8 4.1 4.3 Collinear Array (Radiation-Bidirectional)



Spacing "a" between centers of adjacent	Number of $\frac{1}{2} \lambda$ elements in array versus gain in db above a reference Dipole						
$\frac{1}{2} \lambda$ elements	2	3	4	5	6		
$a = \frac{1}{2} \lambda$	1.8	3.3	4.5	5.3	6.2		
$\mathbf{a} = \frac{3}{4} \lambda$	3.2	4.8	6.0	7.0	7.8		



	Broad S	ide Array				
Theoretical Gain o elements at different		Theoretical Gain of Broadside $\frac{1}{2} \lambda$ eler for different numbers of elements.				
Spacing in wavelengths "a"	Gain, db above dipole	Number of elements	Gain, db above dipole			
5/8 3/4 1/2 3/8 1/4 1/8	4.8 4.6 4.0 2.4 1.0 0.3	2 3 4 5 6	4.0 5.5 7.0 8.0 9.0			

Microwave Antennas (Concluded)

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Reflector Focussing	Sketch	Primary Uses	Secondary Uses	Special Forms	Advantages	Disadvantages
Paraboloidal reflector and point source feed	(C.	Pencil beam 10 db or more gain	Fan beam	Offset reflector	Simplicity, low weight	Blockage unless offset. Dish re- flection unless offset
Cylindrical parabolic reflector and line source feed		Fan beam	Pencil beam	 Offset reflector Parallel plates to form pillbox 	Flexibility in controlling aspect ratio of fan-beam widths	Blockage unless offset. Dish re- flection unless offset
Corner reflector and dipole feed	and the second s	Pencil beam 10 to 14 db gain, half-wave dipole as feed	Element in multi- element array		Very high aperture efficiency in arrays	
Cassigrain and Schwarzschild systems	((Monopulse and scanning pencil beams			Beam scan by feed movement	High sidelobe level occurs without extensive avoidance procedures
Toroidal reflector and scanning feed	Feed	Wide angle scanning in one plane	Multiple simultan- eous beams by use of multiple feed elements		Beam scan by feed movement	Low efficiency of reflector area utilization
	f≈.45r Vertical Section Thru Feed			Phase-corrected line source feed		Low efficiency of reflector area utilization
Spherical reflector and scanning feed		Wide angle scanning both planes				

APERTURE TYPE ANTENNAS I

APERTURE TYPE ANTENNAS II

	Lens Focussing	Sketch	Possible Lens Media	Advantages	Disadvantages
Parasitic Arrays	Delay lens n > 1	Feed Cross Section Cylin- drical or Rotational	Natural dielectrics: polystyrene glass, ceramics fiber glass dielectric foams. etc.	No aperture blocking; any polarization possible; wide bandwidth; scanning of beam by feed move- ment; little	Weight
R R R D D D D D D D D D D D D D D D D D			Artificial dielectrics: metal discs, strips, spheres; dielectric spheres; dielectric plates with voids	reaction on feed	
R R R = Reflector D = Deflector 4 Element		E Poin	Path-length medium: parallel conducting plates perpendicular to "E" field and corrugated or slanted for delay	No aperture blocking; wide bandwidth	Single polarization
Number of Gain, db Front to Back Elements above dipole Ratio, db	Advance lens n < 1		Metal-plate waveguide Metal-rod medium		Single polarization narrow bandwidth (2 to 10%)
2 4 to 5 10 to 15 3 6 to 7 15 to 25 4 7 to 9 20 to 30 5 9			Parallel conducting objects parallel to "E" field to increase phase velocity		

World Radio History

STANDARD WAVEGUIDE CHARACTERISTICS

						RECOMM	NENDED OPERAT	ING BANGE TE	MODE	CL	JTOFF		ATTEN		MAX cw
	A-N	MATES WITH	I FLANGE	MATE-	INTERNAL	Frequency	Wavelength	Wavelength	0 MODE Wavelength	5	Wave	/	100 ft.		Megawatts
AND	TYPE	Cover	Chake		DIMENSIONS	kmc/sec	Air cm	Guide cm	Guide in	Freq. kmc	length cm	n Law Freq.	High Freq.	Law Freq.	High Freq.
L	RG 69/U	UG-417A/U UG-417A/U			6.500x3.250	1.12- 1.70	26.766-17.634	45.706-20.857	17.994-8.212	.908	33.020	.424	.284	11.9	17.2
	KG 103/0		UG-417A/U	Alum.						.700	33.020	.269	.178	11.9	17.2
	· · · · · · · · · · · · · · · · · · ·	UG-435A/U	UG-435A/U		4.300x2.150	1.70- 2.60	17.634-11.530	29.878-13.575	11 7/0 5 0//	1.070		.788	.516		
	KG 105/U	UG-437A/U	UG-437A/U	Alum.		1.70* 2.00	17.034-11.000	29.070-13.373	11.763-5.344	1.372	21.844	.501	.330	5.2	7.5
	RG 112/U	/	UG-553/U	Brass	2 (001 700	0.00 0.00	10 (0) 0 00					.877	.572		
	RG 113/U	UG-554/U	UG-554/U	Alum.	3.400×1.700	2.20- 3.30	13.626- 9.084	22.175-10.681	8.730-4.205	1.736	17.272	.751	.492	3.5	4.7
c	RG 48/U	UG-53/U	UG-54A/U	Brass								1.48	1.01		
	RG 75/U	UG-584/U	UG-585/U	Alum.	2.840x1.340	2.60- 3.95	11.530- 7.589	19.181- 8.924	7.552-3.513	2.078	14.427	.940	.641	2.2	3.2
^	/	UG-149A/U	UG-148B/U	Brass	1070 0070							2.79	1.93		and a second sec
	RG 95/U	UG-407/U	UG-406A/U	Alum.	1.872x0.872	3.95- 5.85	7.589- 5.124	12.594- 6.083	4.958-2.395	3.152	9.510	1.77	1.22	1.4	2.0
c	RG 50/U	UG-344/U	UG-343A/U	Brass								3.85	3.08		
0	RG 106/U	UG-441/U	UG-440A/U	Alum.	1.372x0.622	5.85- 8.20	5.124- 3.656	7.560- 4.294	2.976-1.691	4.301	6.970	2.45	1.94	.56	.71
ы	RG 51/U	UG-51/U	UG-52A/U	Brass								5.51	4.31		
п	RG 68/U	UG-138/U	UG-137A/U	Alum.	1.122x0.497	7.05-10.00	4.252- 2.998	6.385- 3.525	2.514-1.388	5.259	5.700	3.50	2.74	.35	.46
v	RG 52/U	UG-39/U	UG-40A/U	Brass								8.64	6.02		
X	RG 67/U	UG-135/U	UG-136A/U	Alum.	0.900x0.400	8.20-12.40	3.656- 2.418	6.088- 2.848	2.397-1.121	6.557	4.572	5.49	3.83	.20	.29
	RG 91/U	UG-419/U	UG-541/U	Brass								12.8	11.2		
U	RG 107/U	UG-419/U	UG-541/U	Silver	0.622×0.311	12.40-18.00	2.418- 1.665	3.754- 1.960	1.478772	9.487	3.160	6.14	5.36	.12	.16
	RG 53/U	UG-595/U	UG-596/U	Brass								27.7	19.8		
К	RG 121/U	UG-597/U	UG-598 / U	Alum.	0.420×0.170	18.00-26.50	1.665- 1.131	2.664- 1.334	1.049525	14 048	2.134		19.6	.043	.058
	RG 66/U	UG-595/U	UG-596/U	Silver						14.040	2.704	13.3	9.50	.045	.056
V	RG 96/U	UG-599/U	UG-600/U	Silver	0.280×0.140	26.50-40.00	1.131749	1.866882	.735347	21.075	1.422	21.9	15.0	.022	.031
	RG 97/U	UG-383/U	UG-383/U	Silver	0.224x0.112	33.00-50.00	.909600	1.508705	.549278	26.342	1.138	31.0	20.9	.014	.020
	RG 98/U	UG-385/U	UG-385/U	Silver	0.148×0.074	50.00-75.00	.600400	.994472	.391186	39.864	.752	52.9	39.1	.0063	.0090
	RG 99/U	UG-387/U	UG-387/U	Silver	0.122×0.061	60.00-90.00	.500333	.844395	.332156	48.351	.620	93.3	52.2	.0042	.0063

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The Hall effect is not new—it has been around for many years. However, it now has some interesting applications in the microwave field. Here is how the Hall effect theory was applied to the design of a microwave power meter.

> By ANTHONY D. RUGARI Rome Air Development Center Air Force Systems Command USAF, Griffiss A.F.B., N.Y.

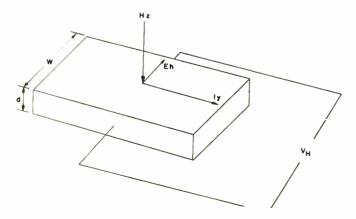
For Microwaves . . .

A Hall Effect Power Meter

I T is a well-known fact that the Hall effect phenomenon is suitable for the measurement of microwave power. Professor Barlow and co-workers, University College, London, have published numerous papers describing the application of the Hall effect in germanium to microwave power measurement. The dc voltages which resulted were relatively small in magnitude. The results obtained here, with the intermetallic compounds, are approximately two orders of magnitude better. This, therefore, enhances the realizability of a microwave power meter using the Hall effect phenomenon.

A model of a waveguide containing a Hall crystal is examined to determine the extraneous effects which exist along with the Hall effect phenomenon and the influence which these effects have on the magnitude of the dc Hall voltage.

Fig. 1: Hall crystal representation is shown by sketch.



As a result, the design of a Hall effect power meter capable of accurately measuring from 1 to 250 watts of CW power at S-band frequencies is described.

Hall Effect Theory

(1)

An expression for the Hall voltage, resulting when a magnetic field is applied perpendicular to the direction of current flow in a current-carrying conductor, can be derived using basic electromagnetic theory. Consider the vector quantities shown in the Hall crystal representation of Fig. 1. A Lorentzian Force, F, is exerted on the current carriers by the magnetic field, Hz,

 $\vec{F} = e \ \vec{v} \ \times \ \vec{B}$

v is the velocity of the current carriers

B is the magnetic induction, and

e is the electronic charge.

Since \vec{v} and \vec{B} are mutually perpendicular,

$$F = \vec{n} \ e \ v_y \ Bz, \tag{2}$$

where

 \vec{n} defines the direction perpendicular to the y z plane. An alternate expression for the force F can be written as

$$\vec{F} = c \ \vec{E}_H,\tag{3}$$

where

$$E_H$$
 is the Hall electric field, $E_H = v_y Bz$. (4)

The current density, Jy, is given by the following expressions: $Jy = e v_y u.$ (5)

where

$$\iota$$
 is the number of $\frac{\text{carriers}}{\text{cm}^3}$, $Jy = \frac{Iy}{wd}$ (6)

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World Radio History



A microwave power meter designed for S-band frequencies uses an indium arsenide phosphide Hall crystal.

and

ly is the current flow in the y direction.

$$\frac{dy}{vd} = \mathbf{r} \, v_y \, u. \tag{7}$$

Substituting for c_y in Eq. 4.

$$E_H = \frac{-Iy}{md} \frac{1}{e_H} Bz.$$
 (8)

By definition, the Hall constant, R_H is

$$R_H \cong \frac{\mu}{\sigma}$$
 (9)

where

$$\mu \text{ is the carrier mobility or } \frac{\text{drift velocity}}{\text{electric field}} \stackrel{\circ}{\xrightarrow{}} \frac{\text{cm}^2}{\text{e-sec}},$$

 σ is the conductivity of the conductor, and $\sigma = u e u$. (10) Therefore,

$$R_H = \frac{1}{en} \tag{11}$$

$$E_R = R_R - \frac{ly}{nd} B_{\perp}. \tag{12}$$

Since

$$E_H = \frac{1}{a}.$$
 (13)

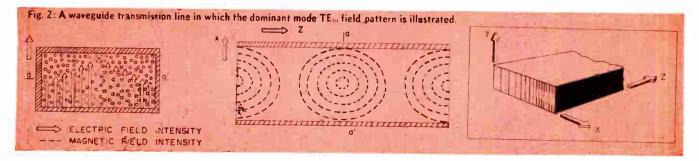
$$V_{H} = -\frac{R_{H}}{d} ty Bz.$$
(14)

A review of the preceding equations indicates that the Hall voltage is optimized when:

1.

the conductor has a low carrier concentration, hence, a semiconductor: the conductor has high carrier mobility: and the conductor is very thin, that is, d is made small.

The direction of E_B , and, therefore, the polarity of V_H , is dependent upon the direction of the current and magnetic field vectors. A reversal or a 180° change in either Iy or Bz, but not both, will cause a 180°



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Power Meter

(Continued)

POWER X POWER

Fig. 4: A waveguide transmission line with a Hall crystal positioned inside of it.

change in the direction of E_{II} and thus a reversal in the polarity of V_{II} .

Researchers have shown that the dc properties of mobility are not appreciably changed at frequencies exceeding those of the microwave band. Therefore, Eq. 14 may be written in terms of a sinusoidal varying \vec{E} and \vec{H} field where the current flow in the conductor is proportional to \vec{E} and the magnetic induction is proportional to \vec{H} .

$$V_{II} = \frac{K E y H z}{2} \left[\cos \Delta \phi - \cos \left(2 \omega t + \phi_1 \right) \right]$$
(15)

where

K is a constant determined by the Hall crystal properties and also the propagation medium parameters,

- $\Delta \phi$ is the phase difference between Ey and Hz , and
- ϕ_1 is the phase angle of the resulting ac term.

It is seen that a dc component and an ac component result. The magnitude of the dc component is dependent upon the phase difference between Ey and Hz, and is a maximum when the two quantities are in electrical phase. This dc term was measured and is discussed here.

Waveguide Field Configuration

In considering a waveguide transmission line in which the dominant mode, TE_{10} , is prevalent, the field pattern is as shown in Fig. 2. The electric and magnetic fields are mutually perpendicular. The electric field has a y component only, which is an electrical phase with the x component of the magnetic field. The magnetic field has a z component also which is 90° out of electrical phase with the electric field. Since Eq. 15 indicates a dependency of the Hall voltage on the electrical phase difference between E and H, it is evident that the positioning of the crystal in the waveguide is of extreme importance.

Figure	e 3
Semiconductor	Properties

	Energy Gap	(µ) Mobility CM ² /V	Hall		
	ev	Electron	Hole	Constant (R _H)	
Si	1.1	1200	500	~103	
Ge	0.68	3800	1900	~103	
In As	0.35	23,000	200	120	
In As P		35,000		200	
In Sb	0.18	60,000	1200	200	
		1 D			

$$V_H \simeq \frac{\mu}{\sigma} \frac{IB}{d} \qquad R \simeq -\frac{\mu}{\sigma}$$

Semiconductor Material Properties

It was pointed out in a preceding review⁸ of the Hall effect equations that the Hall voltage is directly proportional to mobility. Observation indicates the Hall constant rather than mobility is the more important parameter. This would be true only if there were a constant current source supplying the current bias to the conductor and an unlimited power dissipation capability of the conductor. Since this is obviously not true, it can be easily shown that the resistivity term in the Hall voltage equation cancels out and, therefore, mobility is of primary importance.

$$V_{H} \simeq \frac{\mu}{\sigma} \frac{IB}{-d} \simeq \mu p \frac{IB}{-d}$$
 (16)

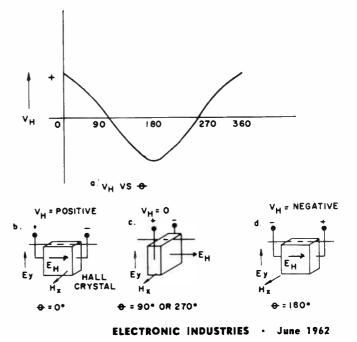
$$V_{II} \simeq \mu \frac{EB}{d}$$
 (17)

The properties of Si and Ge are compared with those of several of the intermetallic compounds in Fig. 3. It is seen that indium antimonide, In Sb, has the largest majority carrier mobility with In As P. In As, Ge and Si following in descending order. The electron mobility of the intermetallics is approximately one to two orders of magnitude larger than that of Ge. Indium antimonide has a poor temperature coefficient and, therefore, was not used in our experiments.

DC Effects in a Waveguide

A waveguide transmission line in which a Hall crystal has been positioned, Fig. 4, is now examined. The





de output voltage present at the Hall electrodes may consist of the following components.

$$Vo = V_H + V_E + V_R + V_{TH}$$
(18)

where

Vo is the dc output voltage,

 V_{II} is the dc Hall voltage,

 V_E is the dc voltage due to the Ettingshausen effect,

- V_R is the rectification voltage, and
- V_{TH} is the thermal component.

Since we are interested only in the Hall voltage component, let us examine each of the above components as the crystal is rotated 360° about a symmetrical axis in the xz plane. The 0° reference is chosen for the crystal position as shown in Fig. 4. The direction of rotation is counterclockwise.

The conditions which define the presence of a Hall voltage are that the direction of the current bias in the crystal, the direction of the magnetic flux density and the direction of the Hall electric field are all mutually perpendicular. The direction of the Hall electric field, in our model, is defined by the position of the Hall electrodes. It is possible that a Hall electric field exists and also that $V_H = 0$, if the Hall electrodes are placed such that relative to the Hall electric field, they lie in an equipotential line. This condition is present in our model when $\theta = 90^{\circ}$ and 270°. At $\theta = 0^{\circ}$, the Hall voltage is a maximum. At $\theta = 180^{\circ}$, the Hall voltage is again maximum; however. its polarity is opposite to the polarity at V_{μ} at $ar{ heta}\,=\,0^\circ.$ A pictorial and graphical representation of W_{II} vs. θ is shown in Fig. 5.

The Ettingshausen effect describes the appearance of a thermal gradient mutually perpendicular to the direction of a longitudinal electric current and a transverse magnetic field

$$\frac{dT}{dy} = -A_E B_x J_y. \tag{19}$$

The Ettingshausen coefficient has been measured for indium arsenide and found to be small in comparison with the Hall coefficient. A rough approximation indicated that the dc component contributed by this effect was many orders of magnitude smaller than the expected dc Hall voltage. Therefore, this effect is neglected and further discussion omitted.

The presence of a dc rectification voltage is due to the non-ohmic properties of the Hall electrodes and the non-symmetrical placement of the Hall contacts. The magnitude of this component is directly proportional to the residual output of the crystal and thus to the current bias. A graphical representation of Vrvs. θ is shown in Fig. 6.

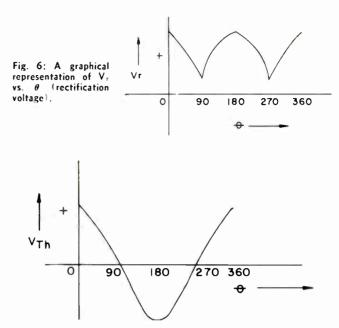


Fig. 7: V_{TH} versus θ (thermal voltage) is shown graphically.

There are 3 significant conditions which will cause a thermal gradient in the Hall crystal, in the direction of E_{H} , and result in a dc voltage as defined by one of the thermoelectric effects. These are as follows: Excessive current bias; Uneven heating of the Hall crystal due to disturbances in the transmission line caused by the transmission line components; Uneven heating of the Hall crystal due to disturbances in the transmission line caused by the Hall crystal itself.

The thermal gradient due to excessive current bias was experimentally determined to be negligible for excessively large currents approaching crystal burnout. For the purpose of this analysis the thermal gradients due to disturbances caused by the transmission line components and the crystal itself may be treated simultaneously. The assumption is made that the thermal voltage has the same polarity as the Hall voltage at $\theta = 0^{\circ}$. Then at $\theta = 90^{\circ}$ and $\theta = 270^{\circ}$. this component should be at a minimum and approaching zero. At $\theta = 180^{\circ}$, the direction of the thermal gradient has been reversed and, therefore, the thermal voltage has a polarity opposite to its polarity at $\theta = 0^{\circ}$ (see Fig. 7).

Since the rectification voltage is always of one polarity, it can easily be isolated from the sum of the Hall voltage and thermal voltage. This is accomplished by comparing the positive maximum dc output voltage with the negative maximum dc output voltage, which are 180° apart as shown in Eq. 20.

^a MINIMUM
THERMAL

$$V_{II} + V_{IA} = + \frac{V_o - (-V_o)}{2}$$
. (20)
(Continued on following page)
 E_y
 E_y
 E_y
 E_y
 E_y
 $Fig. 8: Hall crystal positioning in a waveguide's standing wave field.$

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Power Meter (Continued)

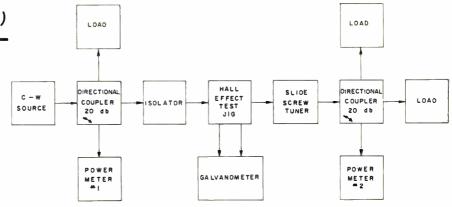


Fig. 9: The test setup shown was used for measuring the thermal emf of crystal.

If the rectification voltage is large compared to $V_H + V_{TH}$, it will shift the negative maximum (-Vo) such that it will appear as a positive voltage.

The remaining problem is to isolate the Hall voltage from the thermal voltage. An examination of the properties of the two quantities indicates that there are 3 parameters which are sufficiently different and may allow isolation of either component:

Rise time: A true Hall voltage should have a very fast rise and decay time when the power is pulsed on and off at a fast rate. The rise and decay time of any thermal component will be slow.

Phase dependency: The magnitude of the Hall voltage is dependent upon the phase difference between the current flow in the Hall crystal and the incident magnetic flux. The thermal voltage has no phase dependency.

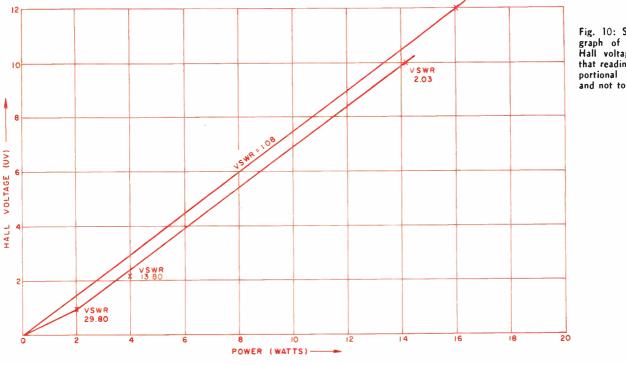
Thermal voltage: The thermal voltage is derived from a thermal gradient due primarily to the electric field in the transmission line. It is independent of the magnetic flux. The Hall voltage depends upon the cross product of E and H.

Knowing that the thermal voltage is primarily caused by the E field, it is possible to negate the effects

of disturbances in the transmission line due to transmission line components by proper placement of the Hall crystal (Fig. 8). In position 8a, the thermal voltage should be essentially zero and in the 8b position, the thermal voltage should be a maximum. It is much more complicated to isolate the complex disturbances caused by the crystal. One possible means of accomplishing this is to plate the ends of the crystal with a material having a conductivity much higher than the conductivity of the crystal. The disturbances will still be present; however, they will have no effect on the crystal which will not see the disturbances. The crystal should be positioned to minimize transmission line disturbances to insure maximum power transfer to the load. The following experiment was performed to determine the relative magnitudes of the Hall and thermal voltages in a transmission line as a function of VSWR and Power.

Analysis of Thermal vs. Hall Voltage

An experimental analysis of the thermal component using the rise time method was not feasible because of the small magnitudes of dc output voltages which are obtainable from the Hall crystal in this applica-



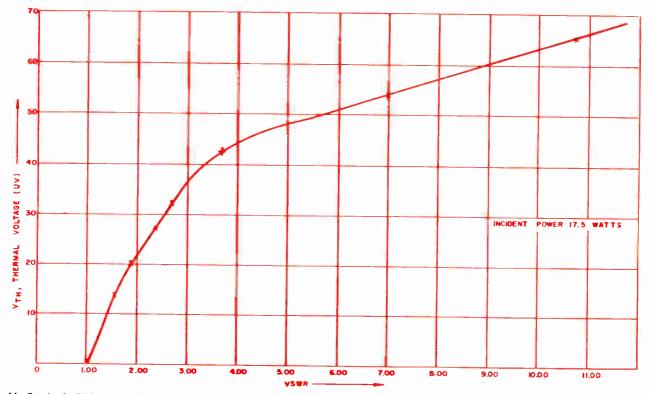


Fig. 11: Graph of VSWR versus thermal voltage. The thermal component is about 2 µv for a VSWR of 1.08.

tion. A phase shifter was built which would allow a change in the phase of the current bias in the crystal with respect to the incident magnetic flux. The results reported in RADC-TN-60-164, may be construed to be somewhat ambiguous and, therefore, a third method was used to isolate V_{II} from V_{TII} .

This method required the insertion of known standing waves in the transmission line. The Hall crystal was positioned for maximum and then for minimum thermal effects. Another requirement was that the mismatch caused by the crystal was small compared to other mismatches. Some interesting conclusions resulted from observing the dc output voltage, Vo, for a series of known standing waves.

The test setup of Fig. 9 was used to perform this experiment. The standing wave was introduced in the transmission line by insertion of the probe associated with the slide screw tuner. Also, the tuner allowed the positioning of the standing wave for maximum and minimum heating of the crystal. After the standing wave was so positioned, the incident and reflected power was calculated from the readings of the two power meters. The VSWR was then calculated.

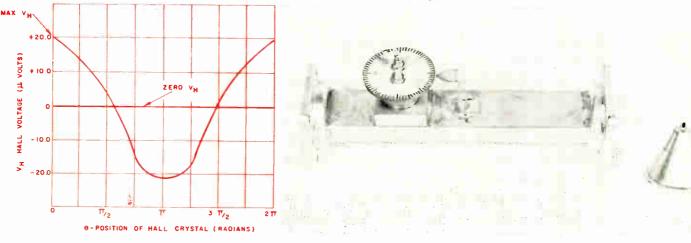
The assumption was made that the thermal voltage would be caused solely by mismatches in the transmission line and, therefore, for an ideal transmission line, VSWR = 1.00, the thermal voltage is equal to zero.

The crystal was placed in the transmission line such that theoretically a de Hall voltage should be observed and also such that it caused minimum disturbance in the transmission line. The following initial measurements were then performed.

- a. VSWR of the transmission line *minus* the crystal is equal to 1.06.
- b. VSWR of the transmission line *plus* the crystal is equal to 1.08.

(Continued on following page)

Fig. 12: An indium arsenide crystal was placed in the waveguide shown. A plot of v_h vs. the angle of rotation, θ was made.



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Power Meter (Continued)

The dc output voltage was then observed for several standing waves when the crystal was positioned for minimum thermal effects. This allowed isolation of the disturbance caused by the transmission line components but not by the crystal. The readings are plotted in Fig. 10. It would be expected that if these voltages were due to a thermal effect, they would increase proportionally with increasing VSWR. It is seen that they do not increase proportional to increasing VSWR but are proportional to power. The readings were then compared to the readings of dc voltage vs. power for a transmission line having a VSWR of 1.08.

It is concluded that the dc voltage readings recorded when the crystal is positioned for minimum thermal effect are Hall voltage readings, the error caused by the Hall crystal disturbance is included. Also, the readings recorded for a fixed VSWR of 1.08 are primarily Hall voltage readings with a somewhat larger error caused by a disturbance or VSWR of 1.08.

The next problem was to determine the effect of large disturbances on the dc output voltage reading. The Hall crystal was positioned for maximum heating effects. The dc output voltage was recorded for several known standing waves. The readings thus recorded contained both thermal and Hall voltage components. They were corrected in accordance with the previous discussion and recorded. A graph of V_{TH} vs. VSWR is shown in Fig. 11. It is seen that the thermal component is approximately 2 μ v. for a VSWR of 1.08 and an incident power of 17.5 watts.

The thermal component is approximately an order of magnitude less than the Hall component for small VSWR of 1.10 or less. The error increases proportionally for larger mismatches. However, if the mismatch is known and is truly a standing wave, then the Hall crystal can be positioned such that the disturbance will not affect the Hall voltage reading and the forward power can be accurately measured. If the disturbance is caused by the crystal, other means must be taken to minimize the thermal voltage.

X-Band Hall Voltage Measurements

An indium arsenide, In As, crystal was placed in a waveguide transmission line as shown in Fig. 12. The crystal was mounted on a conical-shaped base to allow 360° rotation of the crystal in the waveguide. The insertion depth of the crystal was kept at a minimum in order to keep the disturbances, caused by the crystal, down to a minimum. The size of the active crystal was small in comparison to the waveguide cross section. A plot of the dc Hall voltage, v_{II} vs. the angle of rotation, θ , was made when the transmission line was propagating 50 mw average of pulsed power at a frequency of 9050 MC. A maximum of +20microvolts was measured at $\theta = 0^{\circ}$, and at $\theta = 180^{\circ}$ (effective power reversal) the dc Hall voltage changed polarity and was $-20 \mu v$. At $\theta = 90^{\circ}$ and 270° , the Hall voltage was 0, as predicted. Thus for this particular sample and insertion depth, a sensitivity of 0.40 y.v./mw. of power was obtained.

Microwave Power Meter

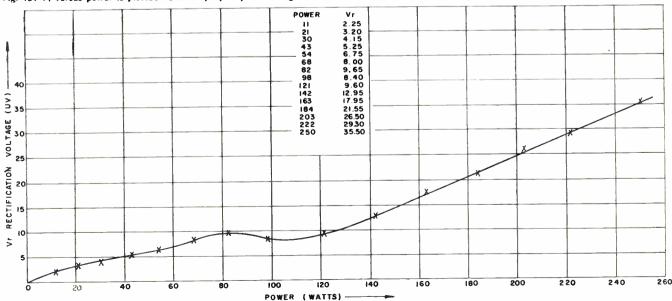
The parameters which must be considered in the design of a Hall effect power meter may be categorized as follows:

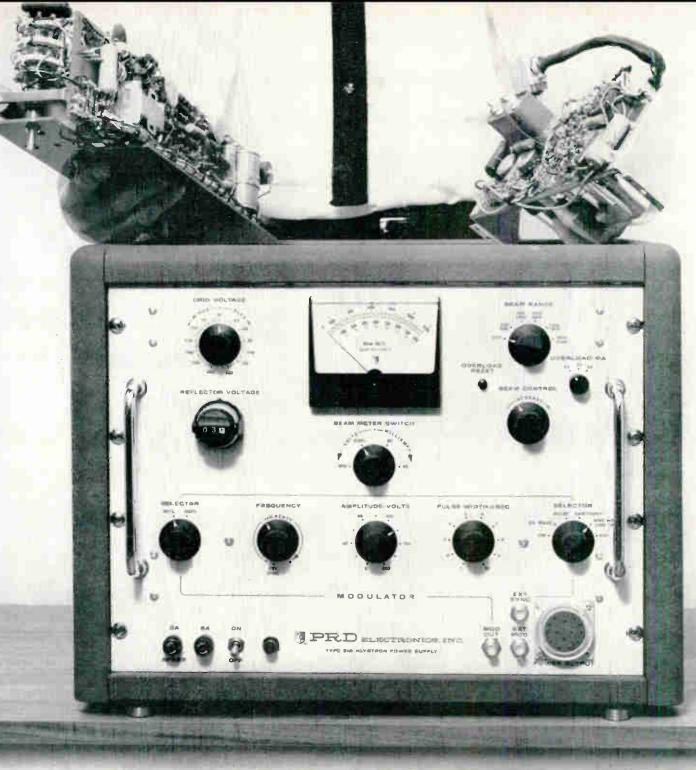
- a. Electric and magnetic field configuration in the transmission line.
- b. Semiconductor material properties.
- c. Hall crystal position in the transmission line.
- d. Disturbances caused by the transmission line components.

These parameters have all been discussed in this report.

A microwave power meter was designed at S-band frequencies using an indium arsenide phosphide Hall crystal. The crystal was placed in the waveguide section at a position close to the side walls of the waveguide. The VSWR of the transmission line, minus the (Continued on page J-16)

Fig. 13: Vr versus power is plotted here. Graph plot points are given in the table at the top center of graph.





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Power Meter (Concluded)

crystal, was measured as 1.06. The additional disturbance of the Hall crystal increased the VSWR to 1.08. The crystal was also positioned for minimum thermal effects due to the transmission line VSWR of 1.06. The ends of the crystal were lined with tinfoil to minimize the thermal effects due to the crystal disturbance.

The maximum negative and positive Hall voltages were found to occur at $\theta = 75^{\circ}$ and 255° , respectively. A definite rectification component was noticed due to the non-ohmic properties of the Hall electrodes. A plot of Vr vs. power is shown in Fig. 13 and a plot of the Hall voltage vs. power is shown in Fig. 14. The power readings were measured with a Hewlett-Packard Calorimeter Power Meter, having an accuracy of $\pm 5\%$.

It is seen that a dc Hall voltage of 0.733 microvolts corresponds to 1 watt of power. The stability of the power meter was checked over a period of 8 hours and no noticeable drift was detected.

Conclusions

Microwave power measurement techniques are constantly being investigated. An explanation for this arises from the fact that existing microwave power measurement techniques consider only one parameter of power, that is, they consider only the electric field intensity. This may readily result in measurement errors and limitations, for example, when the VSWR is reasonably high, measurement errors result and special precautions are required. The Hall effect allows a true power measurement in that both the electric field and the magnetic field must be present before a dc Hall voltage is obtained, therefore, the results of this study are believed to be of extreme significance to microwave power measuring instrumentation.

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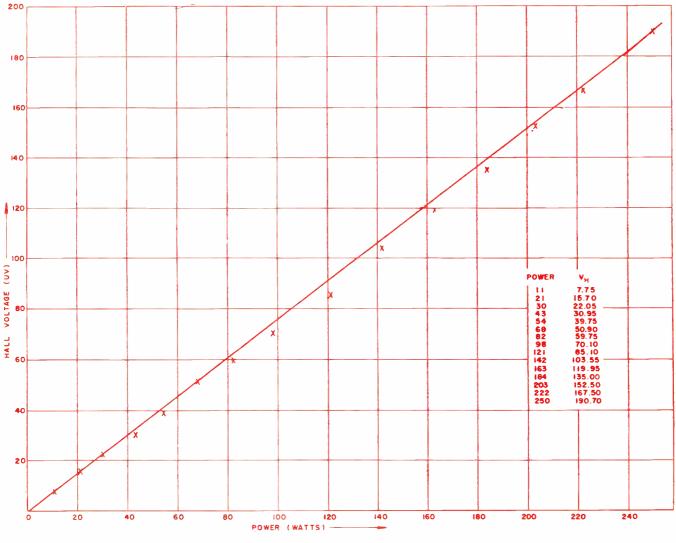
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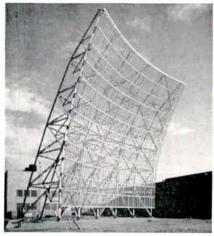
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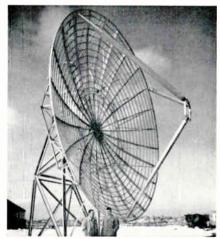
Fig. 14: Hall voltage versus power is plotted. The power levels used are the same ones used in the graph of Fig. 13.



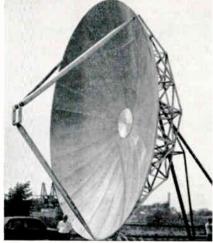
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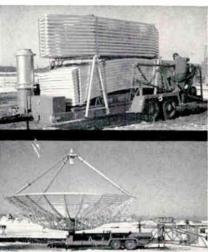
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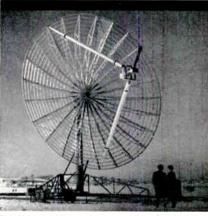
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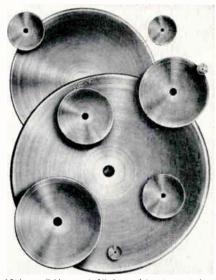
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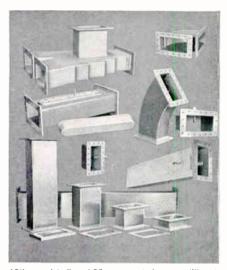
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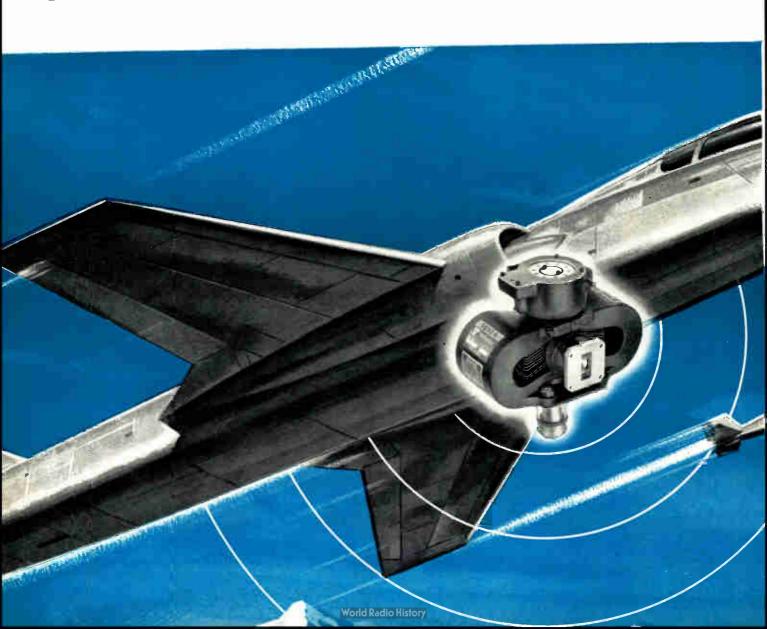
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X-Band Tunable Magnetron SYLVANIA-7692A

FEATURES: 220KW peak power over 8550 to 9650MC. Lightweight 12-lb. package • Superior tuner design • Linear tuning • Reduced jitter • Improved memory behavior • Mechanical simplicity/ruggedness • Low pushing figure • Compatible with MIL-E-5272A environments.

Sylvania-7692A is readily adaptable to either hand or servo tuning methods. It features Sylvania inductive post tuning which utilizes fewer moving parts—e.g., single tuning head, only one vacuum-barrier bellows—thereby enhancing reliability. Short "free length" of the tuner posts—only 0.20"—eliminates possibility of mechanical and electrical resonances. Tuner post guide ring assures precise post alignment, serves as an effective electrical and thermal ground for the tuning post structure.

Improved starting characteristics of 7692A provide exceptional pulse memory behavior: instantaneous switching from 0.25 to 2.5 μ sec. pulse widths causes less than 0.5% missing pulses; fixed pulse stability under adverse conditions of voltage pulse rise time and pulse width is better than 0.1%. Jitter characteristics, too, are improved—less than 200KC in frequency and 10 nsec. in time.

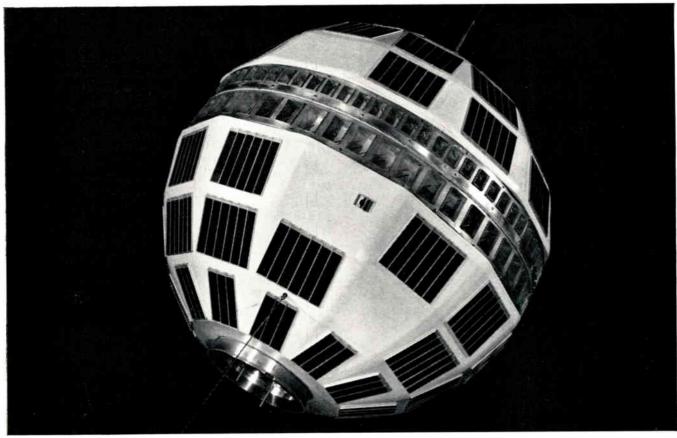
Your Sylvania Sales Engineer has full info on the many other advantages of Sylvania-7692A, such as typical field life of 1000 hours, safety margin on window ''suck-in,'' stability under vibration. Ask him.

For technical data on a specific type, write Microwave Device Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, N. Y.

CIRCLE 14 ON READER-SERVICE CARD



□ Telstar orbits with FXR Products



Model of Telstar experimental communications satellite. The dual row of slotted antennas can be seen around the equator of the sphere. Patches of solar cells on the shell convert sunlight into electricity to provide power.

Telstar orbits with FXR products

Project Telstar—the first privately financed space effort—is a Bell System communications experiment, carried out in cooperation with N.A.S.A. Telstar will test the use of broadband repeater satellites for overseas communications. The program will also check out tracking techniques and ground equipment. Intercontinental telephone and TV trials will be conducted. Telemetry data on radiation and numerous conditions in the space environment will be gathered, too. The vehicle is a step toward continuous global communications with microwave radio.

When Telstar orbits the earth FXR products will go with it. ■

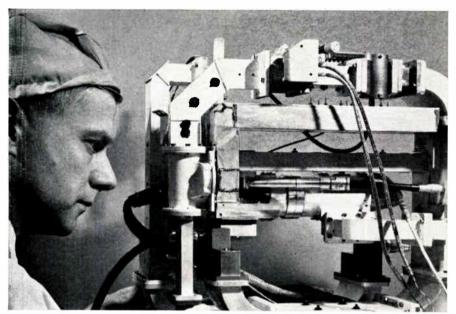
Antenna probes specially made for relay sphere

The waist of the relay satellite has a double row of antennas for transmitting and receiving microwave signals. The probes within the antenna slots—120 of them—were custom produced by FXR to Bell Telephone



Section of satellite shows equatorial antenna slots. Upper row transmits, lower row receives microwave signals.

Laboratories design. They consist of long and short probes tooled from beryllium with Tellon insulators. \blacksquare



The waveguide "plumbing" is shown undergoing tests before final assembly of satellite. Microwaves are received, amplified, and transmitted back to the ground in Telstar.

FXR waveguides in satellite

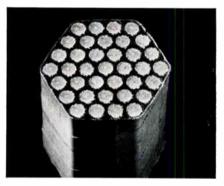
FXR fabricated 13 of 20 waveguidetype pieces in the satellite. These waveguides—"straights" and "bends" —were precision fabricated of lightweight magnesium to exacting Bell Telephone Laboratories specifications. Some of the components are used to filter signals from the crowded spectrum. FXR is a major supplier of waveguides and waveguide components for systems application: custom or standards of aluminum, brass, copper, coin silver or magnesium.

Amphenol cable used at tracking station



Antenna at the Andover tracking station was erected this winter. Cable is shown being carried during construction.

At the giant Andover, Maine, tracking station, 37 lengths of Amphenol RG 11 A/U coaxial cable measuring a total of over 28 miles, connect the tracking horn with the control building. RG 11 A/U is a copper braid coaxial cable with a non-contaminating jacket of polyvinyl chloride and polyethylene core. It's a standard FXR cable made to rigid specifications that meet or surpass military requirements.



Cross-section of RG 11 A/U cable that connects antenna horn to transmitting equipment. Thirty-seven lengths—a total of 28 miles—of this standard FXR cable were used.

FXR is your single source of Amphenol cable and wire, microwave test equipment and subsystems, FXR waveguide switches, DK coaxial switches, Amphenol and ipc coaxial connectors.

The RF Products and Microwave Division Amphenol-Borg Electronics Corporation 33 East Franklin Street, Danbury, Connecticut.



World Radio History



LEADING PRODUCER OF DELAY LINES

LECTRONICS CORP. 534 Bergen Boulevard, Palisades Park, New Jersey



Magnetostrictive Delay Lines



200







Distributed Constant Delay Lines



Miniature Delay Line Series 37-74



Miniature Transponder Delay Line — Series 52-44

MAGNETOSTRICTIVE DELAY LINES

Ranges from 10 to 10,000 $\mu sec;$ Frequency 200 KC to 1 MC R.Z.; per MIL specs upon request. Efficiently designed for optimum size, temperature, coefficient, and signal to noise.



Series

400

VARIABLE DELAY LINES

- Direct Readout Variable Decade Delays. Ranges: 0-9.99 to 0-999 µsec. Series 100 Push-button Decade Delays. Ranges: 0-5.075 to 0-50.1 µsec. Rise Series 200 time .20 to 2.0 μ sec. Impedance 1000 ohms. Continuously Variable Delays. Ranges: 0.10 µsec to 0.70 µsec. Rise Series 400 time .03 to .095 p.sec. Impedances 100 to 1500 ohms. Continuously Variable Video Delays. Ranges: 0.9 μ sec to 0-15 μ sec. Impedances 1000 to 56 ohms. Rise time .2 to 3.0 μ sec. Series 500 Variable Delay Lines. Ranges: 0-2.0 μ sec to 0-15 μ sec. Impedances 100 and 1000 ohms. Rise times .17 to .90 μ sec. 60 step switch provides resolution to 1/120 of total delay. Series 600 Series 700 Miniature Variable Delay Networks. Ranges: .125 µsec to 1.50 µsec. Impedances 1500 to 93 ohms. Pulse attenuation - 1.0db (max.) all units. Rise time .03 to .30 µsec.
- Series 800 Miniature Trimmer Delay Line. Ranges: 0-50 to 0-250 µsec. Resolution less than 1 µsec. Designed for printed board mounting. Size only: .75"w x .35"h x 2.25" and 4.0"

LUMPED CONSTANT DELAY LINES

Standard LC Series: Delay/rise ratio from 10-30 for delays of .25 to 50 $\mu sec.$ Millisecond Series: Delay/rise ratio from 20-50 for delays of 10 μsec to 5 millisec. Custom built Delay/rise ratios to 170 to 1.

AUDIO DELAY LINES

Delays to 100 Millisec. Low insertion loss, extremely linear phase shift. To customer specifications.

DISTRIBUTED CONSTANT DELAY LINES

Cylindrical or rectangular for printed board mounting. Delays from .02 to 1.2 $_\mu sec.$ Impedances from 100 to 1800 ohms. Excellent pulse characteristic. Low cost.

MINIATURE DELAY LINE SERIES

Better than 35-1 Delay/rise ratio in a $3\frac{1}{2}$ cubic inch package. Typical design model 37-74: Delay time 2.5 μ sec. Attenuation — less than 2 db. Rise time: less than .075 μ sec.

MINIATURE TRANSPONDER DELAY LINE TYPICAL DESIGN MODEL 52-44

In only 6 cubic inches. Delay time $20.3\pm.1~\mu sec.$ Rise time 0.45 μsec max. Impedance 470 ohms. Attenuation 4 db. Also model 52-77 for 24.65 μsec in 9 cubic inches.

MINIATURE FILTER SERIES

Low pass and high pass filters with $f_{\rm c}$ from 1.5 to 300 KC; Attenuation of 40 db at and beyond 2.5 X $f_{\rm c}$ for low pass and 40 db at and below .4 X $f_{\rm c}$ for high pass. Insertion loss less than 2 db. Temperature -20° C to $+85^\circ$ C. Size only $34'' \times 34'' \times 14_8''$.

CUSTOM FILTERS

Exacting phase characteristics can be met for low, high, and bandpass filters in small case sizes, and at very competitive prices.

Electrical and mechanical modifications upon request.



700



Series

500

Lumped Constant Delay Lines







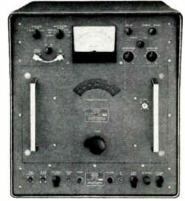
Miniaturized Filter Series

Circle 234 on Inquiry Card

is now 🐲 the top 🐲 frequency 🐲 that can 🐲 be detected 🐲 by the 🐲 POLARAD MODEL R 🐲 MICROWAVE RECEIVER 400 to 84,200 mc

Now the most complete Microwave Receiver has the highest frequency coverage (if we are permitted the redundant superlative).

As microwave work advances into higher and higher frequencies, the Model R keeps pace. Now Polarad has added frequency coverage from 45.3 to 84.2 gc. It's done, by the way, with a unique set of mixers incorporating integral crystals; and a local oscillator. Polarad's development engineers have designed the Model R Receiver with the most capabilities that can be put



in a single box. The Model R is an AM-FM receiver; a pulse receiver; and a sensitive microwave power meter all rolled into one. It has a direct reading frequency dial, UNIDIAL® tuning control, AGC and AFC, as well as audio, video, recorder and trigger outputs. Hundreds and hundreds of Model R users know Polarad will continue to keep their basic microwave test receivers as advanced as their own research. Have you checked the many jobs a Model R can do for you? Ask your local Polarad representative.

SPECIFICATIONS

FREQUENCY RANGE: 400 to 84,200 mc covered in 9 plug-in tuning units. A broadband tuning unit covering 2000 to 75,000 mc is available for antenna pattern measurements. SENSITIVITY: To -85 dbm depending upon frequency range. FREQUENCY DIAL ACCURACY: ±1% RANGE OF LINEARITY: 60 db with AGC. I-F BANDWIDTH: 3 mc. VIDEO BANDWIDTH: 2 mc.



43-20 Ppeg	34TH	STREET,	LONG	ISLAND	CITY	1,	NEW	YORK	

	TRONICS CORPORATION: t, Long Island City 1, New				AR	
Gentlemen: Please send me specifications of	further information and n:	1-2	в 34	с 5 б	D 7 8 9	E F 10 11 12
Model R Micro Notes On Micro	wave Receiver owave Measurements					
My application is	5			_		
Name						
Title	Mail Station	De	pt			
Company			-	-		
Address		_	_			
City	ZoneS	tate				100

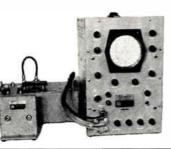


rf instruments and coaxial components

AUTOMATIC IMPEDANCE PLOTTERS

- · Measure and plot rf impedance or transfer characteristic as a continuous function of frequency from 0.1 to 1700 mc.
- Impedance versus frequency curve is automatically plotted as it would be seen at any point desired.
- Entirely self-contained, except for use of an external oscillator.

SLOTTED LINES



 High-precision universal slotted lines with a wide variety of interchangeable tapered reducers and tunable probes. • Rated residual SWR is under 1.010.

Rated error in detected signal under 1.005. Several models covering various bands from 37.5 to 4,000 mc.

COAXIAL SWITCHES

- For use in rigid 31/8" and 61/8" coaxial transmission line.
- Low SWR.
- Motor-driven or manually operated.
- Very high peak power models for radar applications.



0-1100 mc.

INSTRUMENT HYBRIDS

- Inherent high isolation independent of frequency. Rated residual unbalance from 40 to 60 db.
- Wide range of frequency bands from 45 mc to 3600 mc for use with all transmission line sizes from Type N to $6\frac{1}{8}$ ".
- over the frequency range, with equal loads.

INSTRUMENT LOADS

Excellent stability and low reflection. Suitable as secondary standards. SWR of Type N termination under 1.02,



- Available in nearly all rigid and flexible coaxial transmission line sizes.
- Models for use at liquid nitrogen temperatures.

OTHER AMCI PRODUCTS

Line Stretchers Tapered Reducers Impedance Standard Lines Adjustable Matching Networks Dipoles

VOR Antennas TV Broadcasting Antennas directional and omnidirectional **Diplexing Filters** Vestigial Sideband Filters Please write for complete catalog or specific information.



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Alabama,

Instruments For Measurements PHOENIX number ENterprise 1252

Arkansas, Oklahoma, Texas (Dallas Area) Dannemiller-Smith, Inc. 2712 W. Mockingbird Lane Dallas, Texas FLeetwood 7-8249

California (Los Angeles Area), Nevada

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New Jersey

L & M Associates 511 Victor Street Saddle Brook, New Jersey Diamond 3-3070

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Ohio (Cleveland Area), Pennsylvania (Western Area) Dayton Associates 8211 Avery Road Cleveland 41, Ohio JAckson 6-3990

Oregon, Washington (Seattle Area) Paratech 9210 28th N. W. Seattle 7, Washington SUnset 4-6447

Pennsylvania (Eastern Area) L & M Associates 3810 Brookview Road Philadlephia 14, Pa. GErmantown 8-5666

Canada (Montreal Area) Electrodesign 9124 St. Lawrence Blvd. Montreal 11, Canada DUpont 9-5914

Canada (Toronto Area) Electrodesign 35 Mulholland Street Toronto, Canada RU 7-0991

Canada (Ottawa Area) Electrodesign 428 Rideau St., Suite 100-A Ottawa, Canada SH 9-6837

- Constant coupling in both magnitude and phase

LOW NOISE TWT EXTENDS RADAR RANGE

A limitation on the effective range of a radar equipment is the noise level in the receiver: the limiting range is reached when signal to noise ratio approaches unity. The signal to noise ratio in the equipment cannot be better than that in the first stage, therefore the use of a low noise amplifying tube in that stage is of paramount importance.

STC offers two tubes of eminently suitable design for use in S-band:

Type W9/2E for broadband coverage with a gain of 40 dB and noise factor of about 8.5 dB. It is intended for operation over the whole frequency range 2.5 to 4.1 Gc/s with fixed voltages. An aluminium foil mount is available with coaxial r.f. connectors.

Type W10/3E for narrow band operation with about 23 dB gain and 6·8 dB noise factor with the grid voltages set for optimum noise factor at the appropriate centre frequency.

W10/3E has a frequency range 2.7 to 3.3 Gc/s in solenoid circuit 495—LVA—003 with waveguide r.f. connectors or frequency range 2.8 to 3.8 Gc/s in solenoid circuit 495— LVA—006 with coaxial r.f. connectors.

NEW BACKWARD WAVE OSCILLATORS

The new K- and Q-Band backward-wave oscillators in the STC range incorporate a d.c. isolator in the output waveguide to permit operation with grounded cathode as well as grounded output terminal. These oscillators are tuned purely by variation of the line (slow wave structure) voltage which may now be positive to ground. Two grids are provided for amplitude modulation: grid 2 set positive relative to cathode and grid 1 at zero, or negative with a superimposed modulating signal requiring only low energy.

* SPECIAL ANNOUNCEMENT:

Improvements to the K-band oscillator have more than doubled its original output power at the upper frequencies.



Type Y333/1E

ABRIDGED DATA

(Gc/s)

18-26-5

26.5-40

Freq. Range Line Voltage Output Power

(V)

650-3000

700-3200

Band

к

۵

Valve Code

Y322/1E

Y333/1E







Standard Telephones and Cables Limited

VALVE DIVISION: BRIXHAM ROAD · PAIGNTON · DEVON · ENGLAND USA enquiries for price and delivery to ITT Components Division, P.O. Box 412, Clifton, N.J.

World Radio History

ITT

(mW)

30 to 200

10 to 80

1kc to 25mc

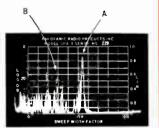
up to 3mc

2µv USABLE SENSITIVITY

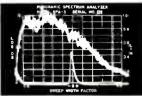


MORE CAPABILITIES for More Applications

PANORAMIC SPA-3/25 SPECTRUM ANALYZER



Analysis of multiplexed volke communications circuit pinpoints high channel level (A) due to "singing" or oscillations. Adjacent channels at 4 kc intervals, some voice modulated, are also seen. Voice peaks (B) show up clearly. 40 db log scale.



Noise spectrum analysis using internal video smoothing filter displays average noise level versus fraquency in easily appreciated form. Internal marker pips are 500 kc apart.

HIGHLIGHT SPECIFICATIONS

 $\begin{array}{c} \mbox{Frequency Range 1 kc-25 mc (usable to 200 cps) (SPA-3 to 15 mc) \\ \mbox{SweepWidth Adjustable, calibrated from 0 to 3 mc } \end{array}$

from 0 to 3 mc Center Frequency Adjustable, calibrated from 0 to 23.5 mc.

Markers Crystal controlled, 500 kc and harmonics to 25 mc.

Resolution I-F bandwidth adjustable, 200 cps thru 20 kc

Sweep Rate : to 60 sweep /sec. con tinuously adjustable Sweep op erated synchronized to power line, or non-synchronized.

Amplitude Scales Linear, 40 db Log and Power

Attenuator 100 db calibrated

Response Flatness ±15% or ±1.5 db up to 23.5 mc Input Impedence 72 ohms.

(50 ohms optional. High impedence probe PRB-1, optional) Wide frequency coverage to 25 mc, scanning width to 3 mc and sensitivity to $2\mu\nu$ plus many other exceptional performance characteristics enable the SPA-3/25 to provide accurate graphic measurement of virtually all types of signals; CW, AM, FM, pulsed, and noise. Its versatility and convenience for a multitude of applications have resulted in widespread acceptance.

The calibrated sweep width and center frequency controls are readily adjusted to select broadband scans or high resolution "zoomed in" analyses. Resolution capability is 200 cps. Crystal controlled markers check the frequency calibrations. The high persistence 5" CRT readout includes 3 selectable calibrated level scales: linear, 40 db log, and power. An adjustable smoothing filter facilitates single line noise density plotting. (See screen photo at lower left) Scanning rate is adjustable from 1 to 60 cps.

For applications requiring measurement only up to 15 mc, specify Model SPA-3. It includes all the outstanding features of the Model SPA-3. 25. A companion Sweep Frequency Generator, Model G-6 is used with the SPA-3/25, SPA-3 for single line response plotting to 15 mc. With the G-6, testing and alignment of filters, I-F's, and other networks are performed in a fraction of the time required for manual tuning methods.

Comprehensive technical bulletins are available on SPA-3/25, SPA-3, G-6, and other Panoramic instruments used from 0.5 cps to 44 kmc.



 Panoramic Electronics, Inc.
 540 South Fulton Avenue, Mount Vernon, N. Y. Phone: (914) OWens 9:4600

 Farmerly Panaramic Radia Products, Inc.
 TWX: MT-V N.Y.-5229 • Cables: Panoramic, Mount Vernon, New York.

 Circle 238 on Inquiry Card

World Radio History

HIGH POWER VARACTORS

Questions — to be read in anxious voice by Frequency Multiplier Designers

- **Answers** to be read by a top-notch Manufacturer of Varactor Diodes
- **Q** Are there any varactors that can be hit with real power yet?
- A Yes! The new MA-4050 and MA-4060 series of power varactors can be driven with as much as 20 watts at VHF-UHF in frequency multiplier circuits.
- Are efficiencies good with these varactors?
- A Yes! Typical efficiencies when driven in the 100 megacycle region are — 70-80%-doubling • 50-70%-tripling • 40-50%-quadrupling.
- **Q** Can performance be improved at frequencies above the VHF-UHF range?
- A Yes! Because of the higher power now available at VHF-UHF frequencies, overall multiplier system output power will be improved.
- **Q** Can present reversible cartridge varactors handle these newly available power levels?
- A Yes! The new MA-785 Varactor Mount permits reversible cartridge varactors to be operated at maximum power levels in any application. The MA-785 units, made of high conductivity copper, approach the thermal effectiveness of an infinite heat sink (95%).

Q Is there anything else I should know?

A Yes! The transistor-style packages have dual diodes with common cathode mounted for use in push-pull circuits and hexagonal stud-mounted packages have single diodes • Both packages provide optimum heat transfer • Individual zero bias junction capacitances of 20 to 40 picofarads (minimum) are available (MA-4050B, 4060B and MA-4050A, 4060A respectively) • Breakdown voltage exceeds 80V and series resistance measured at 500 Mc is less than 3 ohms.

Q Are these varactors available?

A Yes! Now, from your nearest Microwave Associates Distributor or from the factory directly. The varactor mounts are also available. Prices are attractive.

Q What if I need more power?

A It's probably already available. These varactors can handle all the power practically available from UHF transistors. If you want more power . . . just ask!

RECOMMENDED VARACTORS

MA-4060

MA-4050

These recommendations are based on Microwave Associates' considerable experience in designing, building and testing varactors and varactor multipliers. As improved technologies permit, our recommendations will be modified. Contact the factory for the latest information.

DRIVE FREQ.	DRIVE POWER (WATTS)						
(Mc)	20	10	5	2.5	1		
30-60	**MA-4050A *MA-4060A	**MA-4050A *MA-4060A	*MA-4060A MA-4347G	*MA-4060B MA-4347F	MA-4346F		
60-120	**MA-4050A *MA-4060A	**MA-4050B *MA-4060A	*MA-4060B MA-4347F	MA-4347E	MA-4346E		
120-240	**MA-4050B	**MA-4060B MA-4347F	MA-4347E	MA-4347D	MA-4346E		
240-480		MA-4346F	MA-4347D	MA-4347C	MA-4346D		
480-960		MA-4346E	MA-4346D	MA-4346C	MA-4346C		

*Stud mounting

**Stud mounting, two junctions for parallel or push-pull circuits All others, in MA-785 heat sink mount, or equivalent.

MICROWAVE ASSOCIATES, INC.



World Radio History

United Kingdom Sales: Microwave and Semiconductor Devices, Ltd. Skimpot Trading Estate, Luton, Bedfordshire, England

Other Export Sales: Microwave International Corp. 36 W. 44th Street, N.Y.C., N.Y., U.S.A. Cable: Microken BURLINGTON, MASSACHUSETTS • WESTERN UNION FAX TWX: BURLINGTON. MASS. 942 • BROWNING 2:3000

18 NEW LEL Mixer-Preamplifier MODELS OPERATE in C and X Bands.



They feature the same **rugged** reliability and performance efficiency which are characteristic of 1000 other **EE** Mixer-Preamplifier Models_many now being specified or already operating under the **exacting** conditions typical of missile and satellite systems requirements. They are small and **LIGH**...draw very little power...and they're ready **NOW**.

MODEL NO.º	FREQUENCY RANGE	SIG. PORT	L.O. PORT	
CBO	3.95-4.50Gc	UG407/U	Type N	
CCO	4.50-5.15Gc	UG407/U	Type N	
CDO 5.15-5.85Gc		UG407/U	Type N	
CEO	CEO 5.85-6.50Gc		Type N	
CFO 5.85-7.13Gc		UG441/U	Type N	
CGO	6.5-7.6Gc	UG441/U	Type N	
XAO	7.12-8.5Gc	UG138/U	UG137A/U	
XBO 8.5-9.6Gc		UG135/U	UG136A/U	
XCO	9.6-10.5Gc	UG135/U	UG136A/U	

"Nuvistor Models Designated (-8); Transistor Models (-6).

Specifications

	Dpeer, callere			
	-8 MODELS	6 MODELS		
Gain	20 db	20 db		
IF	30, 60 or 70 mcs	30, 60 or 70 mcs		
Bandwith	8 mc	12 or 20 mc		
Noise Figure	9 db max. (XBO-8) 8 db max. (CBO-8)	11 db max. (XBO·6) 10 db max. (CBO·6)		
Isolation (L.O. Port-Sig	. Port) 15 db (Typ.)	15 db (Typ.)		
	40 VDC @ 15 ma max. 3 VAC @ 0.3 amp max.	\pm 20 VDC @ 10 ma max.		
Size	1½" x 1½ 3½" x 3½	x 4" (XBO-8, XBO-6) x 2¾" (CBO-8, CBO-6)		
Weight	Weight 10 oz. (XBO-8, XBO-6) 17 oz. (CBO-8, CBO-6)			
Material	Aluminum, Silver Plate, Rhodium Flash			
۲L.O.	Power Required (all mod	leis) 2mw (Typ.)		

- -----

Circle 240 on Inquiry Card

Send for New LEL Catalog



new generation optical tooling

micro-alignment telescope and accessories





The Micro-Alignment Telescope is the basic instrument for every optical tooling application requiring a highly accurate reference line to establish and check straightness, parallelism and squareness. This precise alignment instrument has full magnification of 32X or 45X, from zero to infinity; direct reading to .001" or .0002". A complete range of accessories increases the versatility of the Micro-Alignment Telescope.

2-EYEPIECE ADAPTER is equipped with one straight and one right-angle eyepicce; a single knob switches view from one to the other. This permits use of the telescope by two persons without change of eyepiece focus; or provides practical record by Minox or TV camera.

ZERO OFFSET OPTICAL SQUARE incorporates pentagonal prism which turns line of sight 90°, \pm 1 second of arc; intersection of the angle coincides with the geometrical center of the spherical mounting. Straight-through sighting to 1 second of arc is also a feature of the square.

auto-collimating microptic theodolite

An exact survey type instrument reading both horizontal and vertical angles direct to 1 second of arc. Convenient, portable, accurate, the Microptic Theodolite is the universal optical tooling instrument for setting up and aligning machine tools, radar antennas, atomic reactors, missile and ground support equipment.

FOR COMPLETE DESCRIPTION OF THESE "NEW GENERATION" OPTICAL TOOLING INSTRUMENTS ASK FOR CATALOG TE-62.



Division of Engineering and Scientific Instrumentation

EQUIPMENT COMPANY

431 S. DEARBORN ST. . CHICAGO 5, ILL.

Circle 241 on Inquiry Card ELECTRONIC INDUSTRIES • June 1962

World Radio History

Tech Data

for Engineers

Microwave Catalog

This 12-page, 2-color brochure covers microwave antennas ranging from 400MC. thru 12.7GC. with the design data and tables showing gain, beamwidth, side lobe characteristics, etc. A section is included on design and manufacturing facilities. Bulletin 620, Mark Products Co., 5439 W. Fargo Ave., Skokie, Ill.

Circle 564 on Inquiry Card

Power Splitter

Tech data is available from Astrolab Inc., 120 Morris Ave., Springfield, N. J., on their Power Splitter with freq. range at 250 to 4000MC. Characteristic impedance, 50Ω ; vswR is 1.15 to 1.0 max.; Power is 300w average; Insertion loss is 0.2db.

Circle 565 on Inquiry Card

Microwave Oscillators

Catalog 62-A from Trak Microwave Corp., 5006 N. Coolidge Ave., Tampa, Fla., gives illustrations, specs, and performance curves on miniature microwave oscillators, amplifiers and harmonic generators.

Circle 566 on Inquiry Card

Microwave Amplifiers

Wave Particle Div., Paradynamics, Inc., 10 Stepar Place, Huntington Sta., L. I., N. Y., is offering tech. data on electronically swept microwave signal sources (BWO & VTM) microwave levelers, millimeter wave length signal sources, TWT amplifiers, and universal TWT power supplies.

Circle 567 on Inquiry Card

Microwave Isolator

Tech data including photographs, descriptions, applications, specs., and typical performance characteristics charts on an X-band wide-temp. range load isolator; C-band communications microwave isolator; UHF three-port circulator; and a C-band miniature Y-circular is available from Solid State Systems Div., Motorola, Inc., 3102 N. 56th St., P. O. Box 5409, Phoenix 10, Ariz.

Circle 568 on Inquiry Card

Microwave Information Kit

Andrew Corp., P. O. Box 807, Chi-cago 42, Ill., is offering an antenna system information kit for microwave engineers. Included are catalogs on Heliax flexible air dielectric cable, microwave antennas and accessories, rigid coaxial transmission lines, hubloc antennas, microwave log periodic antennas covering 300 to 3000 mc, and a tech. bulletin entitled, "Per-formance Aspects of Dish Radomes" plus a parabolic antenna system computer and transmission line and waveguide selector. The parabolic antenna system computer is for calculating parabolic antenna radiation, characteristics, performance of passive repeaters, free space and tropospheric forward scatter, propagation attenuations and thermo noise and equivalent noise in.

Circle 569 on Inquiry Card



NEW, EXOTIC WAVEGUIDE DIRECTIONAL COUPLERS

As MicroMatch® has identified a complete line of high-quality coaxial directional couplers for the past 14 years, so MicroGuide now identifies a new line of waveguide directional couplers. And you can new specify MicroGuide with equal confidence whenever you have a requirement for S, C, X or L band directional couplers.

The model WL271, illustrated, is an example of a standard model modified to meet a specific customer requirement: L Band; 1100-1700 MCs.; 2RF sampling probes 30 and 72 db below main line Incident Power, and 1 probe 53 db below main line Reflected Power; directivity 35 db minimum; 150 KW average; 30 megawatts peak power. All this in a package 1/10th the size of a conventional waveguide coupler.

Find out how readily and inexpensively your most exacting S, C, X, and L Band coupler requirements can be satisfied. Write us at 185 N. Main St., Bristol, Connecticut, outlining your specifications in terms of frequency range, power level, coupling attenuation and type of waveguide.

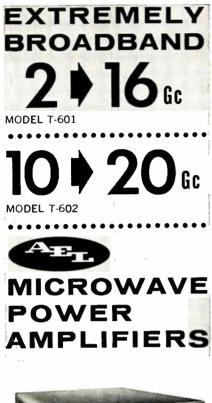
VISIT OUR BOOTH NO. 2222 AT THE I.R.E. SHOW

M. C. Jones Electronics Co., Inc.

World Radio History



Circle 242 on Inquiry Card





with 1 watt output guaranteed over most of range

FEATURES:

· Permanent magnet focusing on all tubes

- · Ruggedly built for long service
- · Continuously variable gain controls
- CW, pulsed or AM modulated operation

PRICES:

Model T-601 . . . 2-16 Gc \$3,990. Model T-602 . . . 10-20 Gc \$4.950.

ALSO AVAILABLE FROM AEL . . . A COMPLETE LINE OF OTHER LOW AND MEDIUM POWER MICROWAVE POWER AMPLIFIERS.

Write for more information



Tech Data

for Engineers

Microwave Catalog

A 32-page catalog of microwave instrumentation is available from Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. This catalog deals only with the generation, trans-mission, and measurement of microwave phenomena. For convenience in use, the contents have been arranged by freq. range, rather than by model number. Photographs, specs. and a section on microwave measuring techniques is included.

Circle 570 on Inquiry Card

Ferrite Components

Rantec Corp., Calabasas, Calif., is offering tech data on their coaxial ferrite junction devices. Information is included on coaxial 4-port circulator, coaxial isolators, coaxial 3-port circulators, and coaxial switches, modulators and variable attenuators.

Circle 571 on Inquiry Card

Microwave Components

Melabs, 3300 Hillview Ave., Stan-ford Industrial Park, Palo Alto, Calif., is offering a condensed catalog and product summary No. 861 describing their line of microwave instrumentation and special products and microwave components. Included are electronically tuned signal generators, a crystal video receiver, electronically tuned superhet receiver, low noise TWT amplifiers, parametric amplifiers, masers, telemetry receivers, an-tennas, satellite r-f checkout systems, band separation filters, diode switches or modulators, and isolators. Circle 572 on Inquiry Card

Test Equipment

Waveline Inc., Caldwell, N. J., is offering an improved and expanded catalog on Microwave Test Equip-ment containing information on over 1000 precision instruments of a stand-ard product line covering from 2.60 to 90.0GC. Complete technical information, descriptions, photographs, and price list are included.

Circle 573 on Inquiry Card

Waveguide Bends

This 44-page, 2-color catalog, BE61, describes in detail more than 170 models covering EIA waveguide sizes from WR28 to WR650. The catalog includes VSWR curves on many of the models described. Engineering in-formation including a discussion of formation, including a discussion of Bend theory, waveguide reference and termination dimensions with tolerances, as well as illustrations of the various styles available, is included. Microwave Development Laboratories, Inc., 15 Stratmore Rd., Natick Indus-trial Centre, Natick, Mass. Circle 574 on Inquiry Card

Traveling Wave Tubes

Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif., is offering a catalog which covers their line of backward wave amplifiers, forward wave amplifiers, backward wave oscillators, and special purpose tubes.

Circle 575 on Inquiry Card



MICROWAVE DELAY LINE IS

ALL NEW

Tapped X-Band MicroDelay Lines for 8.2 to 12.4 Gc operation provide as many as 8 different delay times from 0.1 to 0.9 microseconds in 0.1 microsecond steps. Units can be employed to provide two or more delay times simultaneously; may be used in cascade with one or more fixed length MicroDelay Lines to provide range from 0.1 to 2.5 microseconds in 0.1 microsecond steps.

IT IS

Easily Interconnected to experimental equipment.

Fully Tested - individual data supplied with each assembly.

Fully Pressurized to prevent moisture entrapment.

Compact and Light yet rugged.

IT OFFERS

Low Attenuation below 4.0 db per 0.1 microsecond.

■ Low VSWR Values - including fine structures-across full operating band.

■ Reliable Performance. There are no moving parts-no electrically controlled switches to fail.

PRICES RANGE FROM \$1150 TO \$2400. NORMAL DELIVERY SCHEDULE-10 DAYS.

Write for additional information. Your inquiries are also invited on special requirements which cannot be filled by standard microwave units.



A Division of

FRANKLIN TECHNICAL CORP.

KULPSVILLE, PENNSYLVANIA

Telephone: ULysses 5-0019 Circle 244 on Inquiry Card ELECTRONIC INDUSTRIES · June 1962

Tech Data

for Engineers

Microwave Reference

Contains 111 pages, 2-color, of well illustrated microwave test equipment and reference information. Test equipment (60-pages) includes: direct reading freq. meters; slotted lines and probes; detector-mixer mounts, terminations; adapters; SWR indicator; receivers; and swept oscil-lators. Reference data (51-pages) contains: freq. impedance, power and attenuation measurement data; standattenuation measurement data; stand-ard waveguide characteristics; con-version tables; tables of constants; in-formation on klystron power supplies and basic microwave symbols and equations. Diagrams, charts, sche-matics, and photographs through-out. Sperry Microwave Electronics Co., Clearwater, Fla.

Circle 576 on Inquiry Card

Microwave Components

A 16-page condensed catalog of microwave components and a description of development and production facilities is available from Airtron, a div. of Litton Industries, 200 E. Hanover Ave., Morris Plains, N. J. Included are photographs and specs. of representative ferrite devices, rigid waveguide components, rigid and flexible waveguide, and solid state materials and devices.

Circle 577 on Inquiry Card

Antenna

Ground plane antenna Model 10-2 has a freq. range from 70 to 300 MC. Constructed of corrosion resistant materials throughout and suited to severe environmental applications. Plas-Tron Corp., 815 S.W. Viewmont Drive, Portland 1, Ore.

Circle 578 on Inquiry Caid

Wavelength Tables

Antenna Systems, Inc., Hingham, Mass., offers wavelength tables from waveguide size WR-430 to WR-2300. These computer-calculated tables of constants for rectangular waveguide, give lengths in free space and wave-guide sizes in both centimeters and inches. They also give the ratio of the guide wavelength to the free space wavelength and vice versa for purposes of scaling as well as the cutoff wavelength and cutoff freq. of the guide.

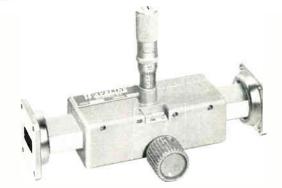
Circle 579 on Inquiry Card

Microwave Components

Budd Stanley Co., Inc., 175 Eileen Way, Syosset, L. I., N. Y., is offering a 205-page catalog on their line of microwave test instruments and components. Some products listed include fixed waveguide attenuators, variable calibrated flap attenuators, precision multi-hole directional couplers, series Tees, standards gain horns, standard reflection waveguide terminations. shorting waveguide terminations, shorting waveguide switches, E and H plane waveguide bends and coaxial slotted lines. Descriptions, photo-graphs, outline drawings, electrical and mechanical specs and applicable military specs plus a section on basic principles of microwaves are included.

Circle 580 on Inquiry Card





Waveline offers a new complete line of Waveguide Slide Screw Tuners to cover the frequency range of 5.85 to 40.0 Gc. This complete series is a group of six standard models that are designed for minimizing VSWR values in a waveguide transmission system.

These Slide Screw Tuners consist of a section of precision waveguide, slotted longitudinally in the center of one broad wall, and an accurately constructed carriage which supports the probe assembly. The carriage is mounted on the waveguide section and is varied longitudinally along the waveguide by means of a helical rack and pinion mechanism.

Complete shielding of the waveguide slot is achieved at all times and VSWR values of 20 to 1 or higher can be reduced to 1.02 without introducing appreciable insertion loss. Sufficient longitudinal travel is provided in each unit to assure any desired phase shift.

Waveline Model No.	Frequency Range, Gc	Waveguide Type
483	5.85 to 8.20	RG-50/U
583	7.05 to 10.0	RG-51/U
683	8.20 to 12.4	RG-52/U
783	12.4 to 18.0	RG-91/U
883	18.0 to 26.5	RG-53/U
1083	26.5 to 40.0	RG-96/U





Just off the press - a 28page working tool for microwave engineers. Gives complete mechanical and electrical specifications on inventoried items. Shows photographs and dimension drawings.

- Half-X, K_u, Turboline, Large X (X₁). X-Band, Half X₁.
- Bends, twists, flanges, transitions, and single elements.

Catalog and price list sent on request.

TURBO MACHINE CO. LANSDALE, PA. Phone: Area Code 215, ULysses 5-5131

Circle 246 on Inquiry Card



all metal **OMNI-DIRECTIONAL** GAIN ANTENNAS 0G-4--150 Mc. Reg. 4 db gain 0G-6 450 Mc. Reg. 6 db gain Max. VSWR 1.3 ta 1 UNIQUE PARALLEL FEED SYSTEM prevents lobe shifts which can occur during icing, etc., in conventional series-fed arrays. Rugged all anodized aluminum construction with extra heavy center support assures lona life. SCALA RADIO COMPANY

2814 19th St., San Francisca 10, Calif.

Complete Antenna Coverage 40 to 1000 Megacycles Write for additional information.

Circle 248 on Inquiry Card

Tech Data

for Engineers

Instruments/Components

"Instruments and Components" Catalog SJ-61, describes a line of r-f instruments and coaxial components. It includes characteristics, dimensions and prices of slotted lines, tapered re-ducers, adapters, and instrument loads. Also included is information on calibrated mismatches, impedancematching tuners and networks, trans-mission-line hybrids, line stretchers, and variable calibrated attenuators. The 34-page catalog is available from Alford Mfg. Co., 299 Atlantic Ave., Bacton Mage Boston, Mass.

Circle 581 on Inquiry Card

Microwave Antennas

Telerad, Div. of The Lionel Corp., Route 69-202, Flemington, N. J., is offering a 42-page catalog on microwave products covering coaxial transmission line equipment, antennas, waveguide, accessories, components and systems. Photographs, schematics, cut-aways, specs and engineering data are included.

Circle 582 on Inquiry Card

Thin Films

Metavac, Inc., 45-68 162nd St., Flushing 58, N. Y., is offering a com-prehensive 10-page brochure describ-ing their high vacuum thin film tech-nology products. The brochure is di-vided into 2 sections. One describes evaporated thin film products having microwave applications; the other illustrates various precision coated products for optical and infrared uses. Some of the products included are: resistance elements for coaxial and waveguide attenuators, microwave resistance cards, thin metal film resistors, lenses, domes, and coatings for lasers. Specs., illustrations, out-line drawings, and transmission data are included.

Circle 583 on Inquiry Card

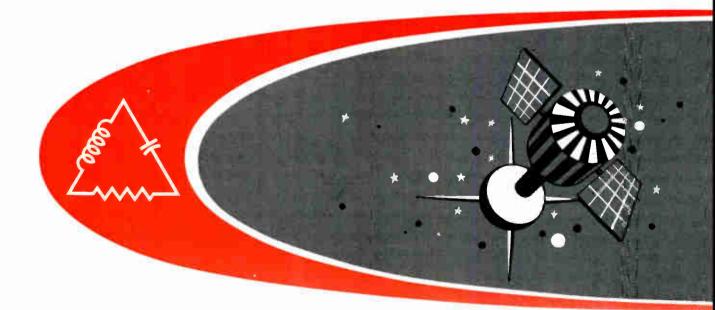
Microwave Components

This 10-page, 2-color brochure covers the following components: high power waveguide isolator; harmonic filter covering from 5.925-6.425GC; broadband waveguide isolators; coaxial isolators; waveguide switches; axial isolators; waveguide switches; waveguide assemblies including a microwave bridge, a pressurized as-sembly and a "Tee"—isolated du-plexer; waveguide Y-T circulators; coaxial isolators with type "N" con-nectors; and ferrite microwave com-ponents and sub-assemblies including ponents and sub-assemblies including slide screw tuner, adjustable isolators and mechanical variable attenuators. Caswell Electronics Corp., 414 Queens Lane, San Jose 12, Calif. Circle 585 on Inquiry Card

ADS OF INTEREST IN OTHER SECTIONS dealing with "Micrawave" Philca (Lansdale Div.), Spec. Prads.p. C46 Div.



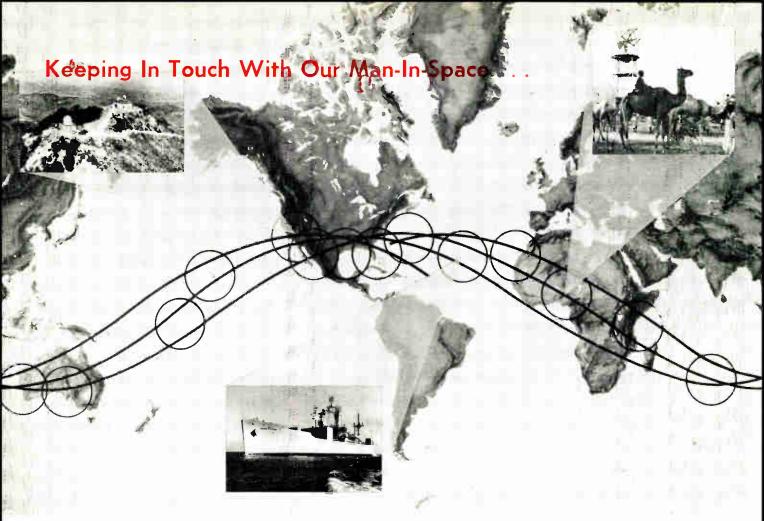
Space Electronics



Project Mercury's World-Wide Communications Net . . . K2

Manufacturers' Data Currently Available . . . K11

- Future Space Satellites & Missions . . . K12
 - Space Frequency Allocations . . . K20



(Photos courtesy of Burns and Roe, Inc., U. S. Naru and VISA)

Mercury Control: "5, 4, 3, 2, 1, zero, liftoff." Astronaut: "It is a little bumpy along about here."

- Mercury Control: "You have a go of at least 7 orbits."
- Astronaut: ". . . all systems are O. K."
- Mercury Control (later): ". . . . recommend you fly-by-wire."

PROVIDING voice communications between Earth and Project Mercury's man-in-space has cost the U. S. thousands of man-hours and around \$75 million dollars.

The vast. complex, ground communications network. which keeps our Earth-orbiting astronaut in almost continual contact, covers around 60.000 miles of the Earth's surface. All told, about 140.000 circuit miles interconnect the 16 tracking and communications sites to Goddard Space Flight Center, Greenbelt. Md. and Mercury Control Center at Cape Canaveral, Fla.

Land lines, submarine cables, and point-to-point radio (both microwave and HF) link radio, teletype

Electronic Industries feels fortunate in being able to provide these first technical details on Project Mercury Communications. We are indebted to Mr. George A. Cassels, Communications Branch, Goddard Space Flight Center, Greenbelt, Md., for his gracious effort and technical assistance. and computer equipments together. Only proven circuits, tested and tried radio paths, etc., are used. Every media of communication used was selected only after study of data collected by NBS (National Bureau of Standards) over the past 25 years. All circuits are duplicated, or stand-by circuits are available in case of emergency. Every piece of equipment has at least one "double" and sometimes more than one.

Telephone. teletypewriter and high-speed data (1,000 bits sec.) information are carried on the network in "real-time." Transmission time for a message, from one site to any other site, is a little over 1 second. There are about 35,000 miles of voice channels interconnecting 13 sites. Around 96,400 circuit miles of teletype channels connect all the sites (radar data comes from 13 sites). Some 5,500 circuit miles of high-speed data lines run between Goddard Space Flight Center (GSFC) and Cape Canaveral.

Project Mercury is a proving ground—a basis—for our advanced space missions. Because of this fact, its Ground Communications and Tracking Network was only designed for a moderately long lifetime of from 3 to 4 years. More sophisticated and sensitive networks are even now being installed around the world.

Where existing facilities for Mercury's Network were available, NASA used them. Where they weren't. NASA constructed new sites. Where land sites were impossible, ships were used. Every effort was made to keep the astronaut in continual contact. The Mercury Network does just this.

Astronaut: "Roger, am remaining fly-by-wire."

To keep in continuous contact with an Earth-orbiting capsule was NASA's unique problem. A world-girdling, ultra-reliable network of teletype, radio and high-speed data systems was the solution.

PROJECT MERCURY's World-Wide Communications Net

By LOUIS S. GOMOLAK Assistant Editor ELECTRONIC INDUSTRIES

The network was too large and complicated for any one company to take on alone. A 5-company team is responsible for this vast, vital, network. Western Electric Co. is prime range contractor and is responsible for technical management of the 18 tracking and telemetry stations in the net. International Business Machines Corp. (IBM) supplied computers, computer programming and simulation displays. Bell Telephone Laboratories is the systems engineering contractor, responsible for communications and control displays. Burns and Roe, Inc., has logistic support, site construction and site facility responsibilities. Bendix Aviation installed radar, ground-air communications, telemetry and site display equipments.

The network's first successful test was in September of '61 with the monitoring of an unmanned, single orbit, capsule. In November of '61, it successfully monitored the MA-5 (ENOS, the chimp) in a 2-orbit flight. February 20, 1962, put the network to its sternest and most vital test. The Ground Communications Network came through with flying colors. To quote NASA officials, "Tracking and telemetry were beautiful."

The Network's Keystone

Goddard Space Flight Center (GSFC) is the keystone in this communications network. All information passes through GSFC. The only exception is data on the life-support equipment. Goddard is the keystone because of economy; it costs less to link all the sites to one message center than to interconnect the sites to each other.

Radar data, telemetered capsule instrument readings, voice exchanges between site and spaceman-all

ELECTRONIC INDUSTRIES • June 1962

pass through GSFC. The radar data is digested in Goddard's dual IBM 7090 computers and forwarded to the sites and Mercury Control Center (MCC) at the Cape. Through a complex switching arrangement. voice contacts with the capsule are spread around the world. All of this is done almost instantly.

Just how is this done? What actually happens when the capsule comes "in view" of a site? What happens before and after the capsule's arrival? How are transmission interference problems avoided or dealt with? What is some of the equipment and how does it operate? (Continued on following page)

GODDARD SPACE FLIGHT CENTER

Airview of the keystone in Project Mercury's Ground Communications and Tracking Network. From left to right: Research Projects Bldg.; Space Projects Bldg.; Central Flight Control and Range Tracking Bldg. Latter holds computers, switching center and the network communications facilities.

(Photo courtesy of NASA)



Mercury Network (Continued)

The Mercury Network can be divided into 4 systems or operations. These are: Inward Teletype System; Outward Teletype System; and the Computing and Tracking Operations. The first we'll take a look at will be the Inward Teletype System—data from the sites of Goddard and Mercury Control.

Inward Teletype System

All teletype messages from the sites are funneled to Goddard. Simultaneously: messages pour in from the site the capsule has just left; the site with capsule "in view"; and the site about to acquire the capsule. To avoid mass confusion, each message is assigned an address or Call Directing Code (CDC). These codes tell the automatic switching and relay equipment where to send the incoming message. The CDC also tells the priority of the message.

A capsule, traveling at 17,500 mph, has approximately 6 minutes "in view" time at any one site. But, during this 6 minutes the capsule is also being monitored by adjacent sites. Message traffic will pour in from all these sites. This much traffic could make for delay or for adjacent site transmission interference, with the "in view" site's messages. To avoid this, the circuits incoming to Goddard are divided into 2 groups. (There are at least 2 circuits between GSFC and any site, for simultaneous sending and receiving). One group contains 9 circuits, the other has 8. Of this total of 17, five circuits are part-time and 3 are shared by 2 or more sites.

These shared and part-time circuits are interesting. The part-timers are used only when mission conditions exist (either in test or actual mission time). They help out with the traffic on the shared circuits. These part-time circuits allow adjacent sites to "leap-frog" data to GSFC. An example here will probably be helpful.

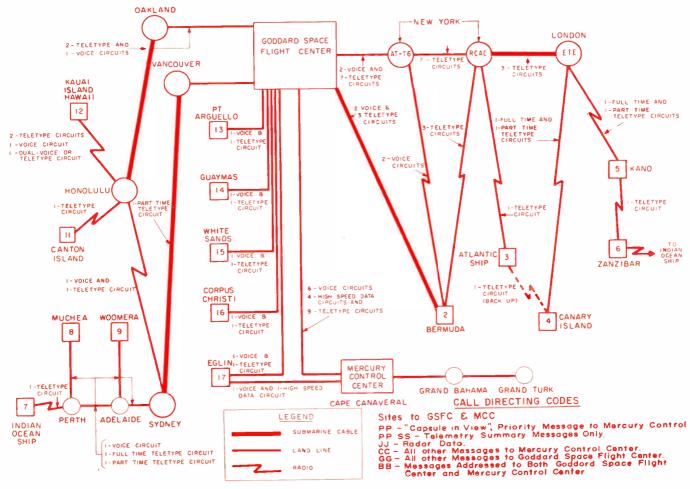
The Indian Ocean Ship (IOS), Muchea (MUC) and Woomera (WOM), Australia, and Canton Island (CTN) all share the same full-time circuit to Goddard. The following is what happens when the part-time circuit is added. The capsule has just left IOS, is over MUC, and is approaching WOM and CTN. The ship uses the full-time circuit to finish sending the large amount of data it has to forward. Muchea is using the part-time circuit for its information. By the time the capsule is near Woomera, the ship has finished transmitting and WOM takes up the full-time circuit. When Muchea finishes with its data, the capsule is just approaching Canton Island. CTN now picks up the part-time circuit Muchea was using. All this information is received at Goddard without delay or adjacent site interference.

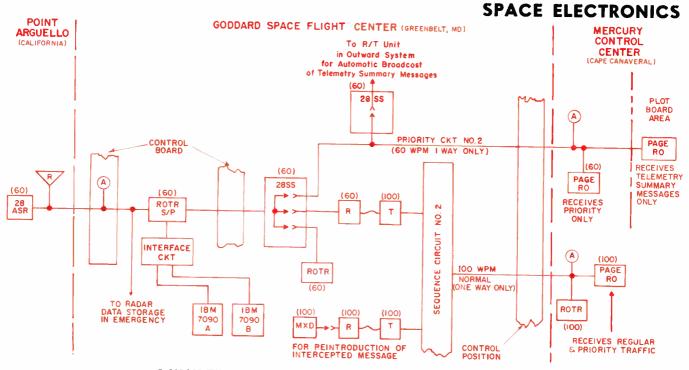
Let's look at what happens when a message is received at GSFC. Where does it go? What happens if

NETWORK FACILITIES

Breakdown of the 140,000 circuit miles, stretching over some 60,000 miles of the Earth's surface. Land lines, submarine cables and radio

are used to connect the world-wide sites to the Goddard Space Flight Center and the Mercury Control Center. *Diagram courtesy of NASA*





1-WAY TELETYPE-FEEDING DATA INTO GODDARD SFC

Typical layout for teletype circuit from a site to Goddard Space Flight Center and Mercury Control Center. Radar and telemetry messages, from Pt. Arguello, come into the ROTR S/P (receiving machine) Radar converted to digital form and sent to computers. Priority and regular traffic goes to 28SS (switching unit). Priority traffic chooses

the wrong CDC or no CDC has been assigned? Is all incoming information treated the same?

One thing should be pointed out before we proceed. The Mercury Ground Communications Network is a fully-automatic communications network, with manual capabilities in case of emergency. Everything being as it should, a message can be sent anywhere in the world-wide network in a little over a second, without manual handling at any time.

A typical message path is from Pt. Arguello, Calif., to Goddard and Mercury Control. This example, with slight modification, will fit all other sites in the net.

Pt. Arguello's long range radar "picks-up" the capsule as it comes "in view." The 28ASR and the

Inward Teletype System Equipment Symbols

(60) = 60 wpm teletype.

(100) = 100 wpm teletype.

28ASR = Automatic Sending and Receiving Teletypewriter.

R = Radar digital data to teletype form converter.

= Open Circuit Alarm. A

ROTR S/P = Receiving Only Typing Reperforator—Serial to Parallel. Receives incoming signals from line, forwards non-radar data to 28SS unit, converts serial (punched) radar data into parallel (digital) form and sends to computers. Interface Ckts. = feed both IBM 7090 computers simultaneously with radar data

from ROTR S/P. 2855 = 28-type Station Selector Unit.

ROTR = Receiving Only Typing Reperforator. Automatically copies incoming mes-

sages. Tape Transmitter Gate of Multi-Gate Unit. Tape transmitter for manual

relay of intercepted messages. $\mathbf{R} \sim \mathbf{I} = \text{Reperforator-Transmitter Unit (R/T)}$. Takes 60 wpm data, changes it

to 100 wpm and automatically forwards messages to Mercury Control. Messages with ``PP''

Priority Ckt. No. 2 = Priority circuit for Group 2 sites. code automatically choose this line to Mercury Control.

Sequency Circuit No. 2 = Delivers both regular and priority messages, at 100 wpm, to Mercury Control from Group 2 sites. "PP" messages automatically choose this line also, for reliability.

Page RO — Page message Receiving Only Unit.

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both Priority Ckt. No. 2 and Sequence Ckt. No. 2 for reliability. Messages for GSFC and MCC are recorded in the ROTR Unit (recording unit at GSFC) for post flight analysis. Messages are received at MCC on 2 separate units for reliability in case one circuit fails. Nearly 100 items pass from the sites to GSFC and MCC.

Radar Digital Data Converter send nearly 100 items of information, at 60 WPM teletype speed, to GSFC. These items include: radar data; telemetered capsule environment, instrument readings and equipment checks.

At Goddard, the ROTR S/P "sees" the CDC of "JJ" (radar data) and "blinds-off" the other equipment on the inward line. The receiving machine converts the serial (punched) data to parallel (digital) form and sends it on to the computers. The computers digest the data and generate 37 different pieces of information, which are then sent to Mercury Control. In case something goes wrong with the ROTR $S/P\mbox{, and God-}$ dard's spare ROTR S/P's are in use, the radar data

Outward Teletype System Equipment Symbols

Trans Start = Transmitter Start Unit. "Poll" all line transmitters for trafficto-go and also for ''up'' or ''down'' status,

PB = Push Button Unit. When button is pushed on this unit, it automatically assigns a CDC and sends the message to an R/T Unit. One on each 28ASR and LBXD

28 ASR = Automatic Sending and Receiving Machine.

LBXD = Gate of 28-type Multiple Tansmitter. One in each Group, at Goddard, for transmitting taped messages to the sites.

MXD = Tape Transmitter Gate of Multi-Gate Unit. For manual transmission of messages to sites. (By passes automatic equipment, for use in emergencies.) 28 DIST = Converts digital (parallel) radar data to punched (serial) form and forwards acquisition and other radar messages to R/T Units. Two at computer outputs and 2 as stand-bys.

ROTR = Receiving Only Typing Reperforator. For intercepting messages for manual relay from an MXD unit.

RO = Receiving Only. Receives 60 wpm teletype messages.

RO MON = Receiving Only Monitor. Monitors all messages and in case of equipment malfunction can store messages and prevent their loss.

 $\mathbf{R} \sim \mathbf{T} = \mathrm{Reperforator}$ Transmitter Unit. Changes 100 wpm messages to 60 wpm and forwards messages to sites. Will also store messages if outgoing line is being used.

R-T Control = Reperforator-Transmitter Control Ckt. Switches message to the desired line's R/T Unit.

Mercury Network (Continued)

will not be lost. Connected electrically ahead of the receiving equipment is emergency equipment which will store incoming radar data till the computers are back in "up" status.

The ROTR S/P also "sees" other CDC's. These include "PP" (priority) and "CC" (Mercury Control). These messages will go straight through Goddard to MCC. Depending on the CDC, the 28 Station Selector equipment does a number of things, simultaneously. These are: send "PI" data directly to Mercury Control over Priority Circuit No. 2, and also to an R/T unit; send "CC" data directly to an R/T unit; record all incoming messages in the ROTR unit tied to this circuit. When Pt. Arguello sends a Telemetry Summary Message, it is automatically sent to Mercury Control and also to a Summary Broadcast transmitter in Goddard's Outward Teletype System, for transmission to all the sites. At Mercury Control, these messages are shown on the main plot board.

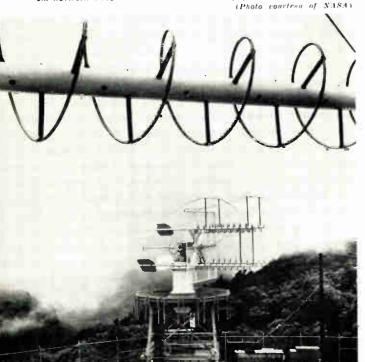
Messages sent to the R T unit are converted into 100 WPM form and sent to MCC. The equipment that handles these R/T units does a number of simultaneous acts and deserves a closer look.

The equipment associated with Sequence Ckt. No. 2, prevents stations from monopolizing circuit time and aids in "line-sharing." This sequence equipment: places a demand for an outgoing line as soon as the ROTR S/P "sees" the CDC; it starts an R/T unit if the outgoing line is idle; if the line is in use, the sequencer equipment will start the R/T unit as soon as the line is free; if more than one R/T unit has tape, the equipment allows each unit a turn to send one message until any backlog is cleared up.

In case of equipment breakdown or messages with an erroneous CDC or no CDC, Goddard will intercept.

HAWAIIAN QUAD-HELIX

Quad-helix telemetry antenna at Kauai, Hawaii. One of 18 tracking and communications sites in the Mercury Network, Kauai is one of six network sites with command control equipment.



These messages will then be manually reinserted into the network with the MXD unit.

All equipment at Goddard is in duplication. The lines from GSFC to MCC are also duplicated (2 Priority Circuits and 2 Sequence Circuits). Priority messages follow duplicate paths. Any message with a CDC of "PP" will automatically select Priority Circuit No. 2 and Sequency Circuit No. 2 (if the site is in group 1, it will be PC No. 1 and SC No. 1).

Outward Teletype System

Let's follow messages from Mercury Control and Goddard to Pt. Arguello. Again, this circuit is representative of the other 16 outward circuits from MCC and GSFC to the sites.

Messages originating at MCC and GSFC are taped. The tape is inserted into the 28ASR (MCC) or the LBXD (GSFC). In the case of Mercury Control, the operator pushes a button on the push button unit. A CDC is automatically assigned and the message is on its way, over 100 wPM lines to GSFC. If the circuit (at Goddard) Mercury Control wants is free, the message automatically goes to an R/T unit, is converted to 60 wPM teletype form and transmitted to Pt. Arguello. If, for some reason, Goddard is using the line, MCC's message is stored in the R/T unit till the line is free. Then it is automatically forwarded.

At Goddard the message goes from the LBXD to the R/T unit and is forwarded. Messages also come to the R/T units from the 7090's. The 7090's are constantly generating capsule acquisition messages. These contain azimuth, range, elevation angle and the time at which the capsule should come "in view." The messages are transmitted to the sites concerned, 3 times, about 20 minutes apart. From the computers the message goes to the 28 DIST. The 28 DIST converts the digital (parallel) data into punched (serial) form and sends it to an R/T unit.

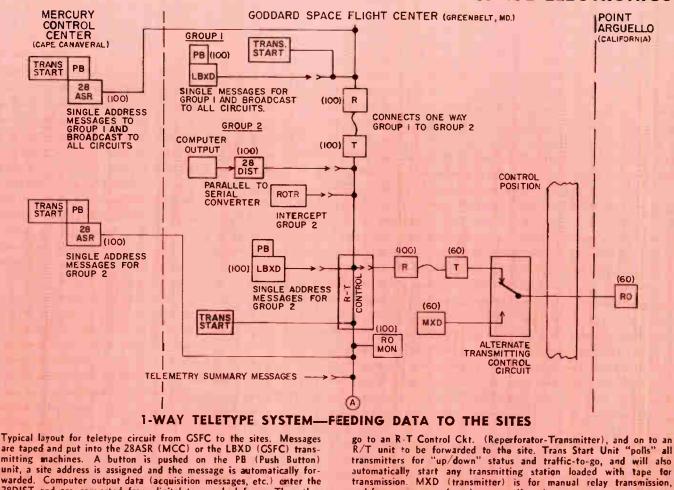
In case of an open circuit, down equipment or other malfunctions, an alarm is sounded. Goddard intercepts any messages, or diverts them to "up" equipment. If intercepted, the messages are then manually forwarded to the sites by the MXD units. Also, if there is an erroneous CDC assigned, Goddard intercepts and manually (MXD) forwards the message.

If Mercury Control wants to emergency broadcast to all sites, it throws a switch and has exclusive use of all outgoing circuits. The emergency message path is from the transmitter (at MCC) linked to Group 1 circuits (at Goddard) through an automatic switch to Group 2 circuits.

As with the Inward System, there are a total of 17 outgoing circuits. Five of these are part-time and 3 are shared. The part-time circuits allow simultaneous transmission to adjacent sites or to more than one receiving unit at the same site, without transmission delay or interference.

One of the most important pieces of equipment in the Outward System is the Trans Start Unit. Both MCC and GSFC have these units connected to their tape sending equipment. The Trans Start Unit continuously and automatically "polls" all transmitter stations for "up/down" status and any "traffic-to-go." A Transmitter Start Code (TSC) is sent to each sending station in a pre-determined pattern. If the transmitter has no message to send, it replies with a "V"

SPACE ELECTRONICS



(no-traffic) signal. The Trans Start Unit then auto-

28DIST and are converted from digital to punched form. Then they

matically "polls" the next transmitter. If the transmitter has a message to send, the Trans Start Unit automatically starts the machine and the message is forwarded. The procedure for transmitting follows. The transmitter first sends the CDC. It then stops and waits for a "V" (invitation to transmit) signal from the selected line's R/T unit. When the transmitter gets this "V," a second CDC is sent, followed by an end-of-address code and the message text. When the message text ends, the transmitter pauses 2 seconds and then sends an end-of-message code. The code: automatically switches the R/T unit back to a waiting condition; and starts the Trans Start Unit "polling" again.

During the "polling," lights at the Control Position indicate which station is sending. The Position also has keys for: stopping the "polling"; skip "polling" certain transmitters if desired.

To sum-up the Outward System. GSFC and MCC push a button, a CDC is assigned and the message sent. GSFC neither delays nor stores any message unless the circuits are being used or equipment is down. There is no message loss from "down" gear or erroneous CDC's; GSFC will intercept and manually relay the message. Goddard can intentionally intercept outgoing messages if there is trouble at site receiving equipment or a line is open. GSFC and MCC can broadcast to all sites simultaneously, by pushing a single button and transmitting the message once. In an emergency, MCC can throw a switch and have exclusive control of all out-going circuits.

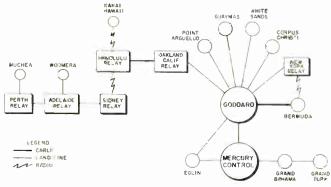
and for use in case of equipment malfunction.

Voice Network

Mercury Control at the Cape has an indication that the Freedom 7's heat and re-entry shield is loose. MCC checks with astronaut, through Hawaii, and finds he has no such indication. The Mercury Flight Controllers decide to be safe and leave the retro-package on the capsule, until it is over Texas during re-entry. This information is passed to Pt. Arguello over Mercury's Voice Communications Network. Controllers

MERCURY'S VOICE NETWORK

Layout of Project Mercury's Voice Network. SCAMA (Switching Conferencing and Monitoring Arrangement). located at Goddard, controls hook-up between any 2 or all of the net's sites.



Mercury Network (Continued)

at the Cape hear Arguello's Flight Controller give the instructions to the astronaut. An emergency has been met successfully.

Project Mercury's Voice Network was designed primarily for just such occasions. The command control sites (able to control capsule maneuvers, retrofiring, etc.), are linked to the Goddard Space Flight Center. There are 6 command sites: Mercury Control. Bermuda; Muchea, Australia; Pt. Arguelo; and Guaymas, Mexico. Also, 10 of the tracking sites: MCC; Bermuda; Muchea; Woomera; Kauai, Hawaii; Pt. Arguello; Guaymas; White Sands, N. Mex.; Corpus Christi, Tex.; and Eglin, Fla., are connected to GSFC.

In Goddard is the Switching, Conferencing and Monitoring Arrangement (SCAMA). This is the switching center for the voice network. Here, any 2 or all of the sites on the net can be linked together for a number of purposes. These include: actual missions; practice missions; during actual missions—monitoring the astronaut's voice communications and for pass-off of capsule radar contact; and general and administrative conferences.

The network contains about 35,000 miles of voice channels, for nearly continuous 2-way voice contact with the astronaut. Two frequency ranges are used: 1 channel between 15 and 30 MC and 3 channels between 200 and 300 MC. Four-wire circuits are used throughout the net (2 wires in each direction). This 4-wire technique keeps distortion to a minimum, allows for good volume levels and has a high-degree of reliability. Land lines, overseas radio links, submarine cable and microwave relay are used. All of this is necessary because some of the sites are half-way around the world, Muchea and Woomera, Australia for example. The submarine cable to Hawaii, via Oakland, Calif., was chosen for reliability and ease of transmission. The East-West paths have had a poor radio performance history, and there isn't any room in this vital, life and death, network for "drop-outs" or "fading."

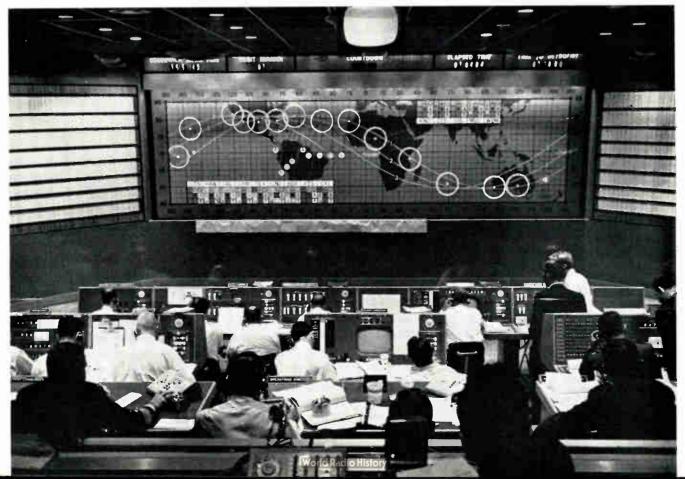
During missions the voice network sites are linked into one loop. All of these sites can monitor network traffic, but only those having a need to talk are allowed to. The SCAMA operator, at GSFC, controls this "talk-access-capability." Each site is allowed to talk, in turn. as the capsule comes "in view." Each site's Flight Controller is then able to talk directly with the Flight Controller at the Cape.

If conditions are right, the whole network is able to monitor transmissions between the astronaut and the "in view" site.

With several radio links, the net has a problem with atmospheric and storm noise. The radio link from Australia to Honolulu is especially susceptible. To counteract this interference, when Kauai, Hawaii, has the capsule "in view," special measures are taken. Honolulu, during Kauai transmission time, has a switch, which it throws and opens the transmission circuit from Sidney. Even though transmission is

MERCURY CONTROL CENTER AT THE CAPE

Mercury Control personnel during the first orbit of the Friendship 7. Man next to naval officer (Recovery Commander) is the Operations Director. Directly in front of him are the Mercury Flight Directors. Capsule is just leaving Australia. (Photo courtesy of N.18.1)



stopped, Woomera and Muchea are still able to listen in on the net's traffic.

The mission network hook-up has several important reasons-for-being. The net's 4 main purposes follow. 1. MCC gets "real-time" information on the capsule. This lets Mercury Control counteract emergencies as they are in progress. 2. If for some reason the capsule must be brought out of orbit in a hurry, MCC can immediately direct (much faster than by teletype) the nearest command site (to the capsule) to change the settings for retro-firing. 3. With all the network sites monitoring the astronaut-Earth communications, the sites are ready at any instant to begin action in an emergency. 4. More exact radar tracking is possible. When 2 sites, say Pt. Arguello and Guaymas, have overlapping radar and command transmitter coverage, the voice net allows them to pass-off the capsule without loss of coverage or mix-up of signals. Pt. Arguello tells Guaymas the exact moment it ceases transmitting. Guaymas begins its own transmitting the next second. This avoids simultaneous transmission of command and radar beacon signals from both sites, causing capsule equipment to damage itself. The SCAMA operator (at Goddard) connects just the sites concerned (using telephone-switchboard-type cord circuits) together.

The telephone lines used in the continental limits portion of the network are leased from U. S. common carriers. Outside of the continental limits, a combination of leased (from foreign carriers) and constructed radio and wire circuits are used.

Computing and Tracking Operations

The final part of the Mercury Ground Communications and Tracking Network we'll look at will be the Computing and Tracking Operations.

The tracking system uses 2 types of radars—Verlort and the AN/FPS-16. Tracking procedure for a site having both types, has the Verlort "pick-up" the capsule as soon as possible. Verlort data is manually switched (at the site) for teletype transmission. As the capsule "closes" with the site, the switch is thrown to the FPS-16. When the capsule moves out of '16

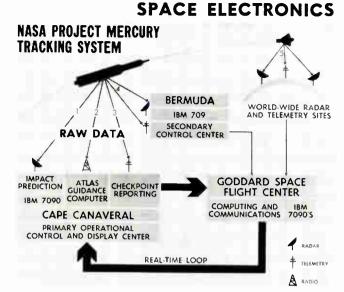
range, the switch is thrown back to the Verlort system.

Except for continual coverage of the first minutes of flight, radar data is sent back to Goddard in samples taken every 6 seconds. The radar data, plus the Greenwich Mean Time. is put into tape form

LONG RANGE RADAR

Pt. Arguello's long range precision tracking radar. Called the Verlort, it is atop Mount Tranquillon, 2,200 feet above sea level. Tracking procedure has the Verlort "pick-up" the capsule as soon as it is "in view." When the capsule closes with the site, the tracking is switched to the AN/FPS-16 (short range radar). When the capsule is out of '16 range, tracking is switched back to the Verlort. Radar "skin tracks" the Mercury Spacecraft to determine roll, pitch and yaw.

(Official U. S. Nary photo)



TRACKING PROCEDURE

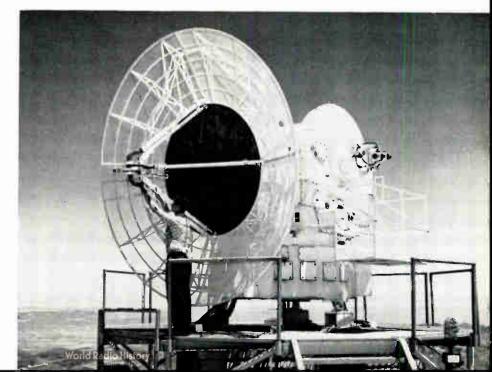
Diagram courtesn of IBMA

Radar data (1) automatically converted into computer language and sent to the IBM 7090 at the Cape. Guidance data (2) from vehicle radioed to Atlas Guidance Computer at Burroughs-General Electric Complex at Cape. Telemetry data (3) from vehicle reports mission check points, lift-off, booster separation, etc. Radars and telemetry equipment (4) at Bermuda feed IBM 709 at BDA to help determine if an acceptable orbit is being achieved. Network tracking and telemetry stations (5) send data back to Goddard, helping to establish capsule's exact orbit.

and forwarded to GSFC's 7090's. The computers take the data, digest it and other incoming and preset information and forward to Mercury Control some 37 items vital to the flight. These items are sped over highspeed data (1,000 bits/sec.) lines, and used to run wall maps, plot boards and display devices.

The computers also generate display information that is sent to the sites and that runs display equipment at Goddard itself.

Mercury Control Center has a wide variety of equipment. Included are 14 control consoles, 36 computer operated displays, and units for recording and displaying almost 100 capsule telemetered items of information. (Continued on Following Page)



Mercury Network (Concluded)

Goddard display equipment includes 2 plot boards, each driven by 4 Digital-to-Analog Converter channels. These X vs. Y plots can be made to show for example, capsule heights vs. flight path angle.

Computing Operations

Reliability in Project Mercury's Computing Operations, as in the other parts of the Ground Communications and Tracking Network, is by duplication. Goddard uses 2 IBM 7090's in parallel.

GSFC's computers have been programmed: 1. To recognize where data is coming from. 2. To determine what kind of data it is (radar, telemetry, or manually inserted). 3. To assess the reasonableness of the new data as compared to programs already stored in the computer's memory. 4. To shift automatically from one computational method to another as the mission dictates (from launch to orbital to re-entry calculations). 5. To take raw data, digest it, and deliver results-simultaneously and continuously. 6. To accept up to 32 interruptions, one on top of the other (incoming and outgoing data, manual interrogations, timing information), and then on a priority basis, to go back and pick-up where it left off. 7. To digest all incoming data into output for display purposes and also send capsule acquisition messages to the sites.

Goddard's computers are not the only ones in the network. Bermuda and the Cape also have them. The Cape's Impact Predictor is an IBM 7090 and is used to predict where the rocket would land if its power cut-off during climb to orbit altitude. Another computer at the Cape is in the Burroughs-General Electric Complex. This special purpose computer is part of the guidance system of the Mercury launch vehicle. It receives radar, plus telemetry, data from the vehicle itself.

Bermuda has an IBM 709 computer, which when combined with BDA's radar data, gives Bermuda its own data on the capsula, and aids the Flight Controllers at the Cape in deciding if the capsule should be inserted into orbit, or if the mission should be aborted.

GODDARD COMPUTING ROOM

Main computing room at Goddard Space Flight Center. Over 37 vital items of information are produced here and forwarded to Mercury Control for display. Large objects in center are the X-Y Plot Boards. Over 5,000 miles of high-speed data lines connect Goddard to the computers at Cape Canaveral, Fla. (Photo countery of NASA)



There are about 5,500 circuit miles of high-speed data lines between Goddard and Cape Canaveral. This circuit mileage is in the form of 4 separate data lines. Two come from the Burroughs-General Electric special purpose computer. The other two come from the Impact Predictor 7090.

Three of the major computer program systems are: Launch; "Where the capsule will be"; and "Where the capsule is now."

Launch computations (from liftoff till the capsule is out of the Cape's range) have 2 phases—normal and abort. The normal covers: liftoff to tower separation (safety tower); tower separation to capsule separation; and post capsule separation. During this phase, a continuous prediction of time for retro-fire and impact point is computed and displayed in case the mission must be aborted.

If Mercury Control decides an abort is necessary, the radar data is converted to vector point and velocity. The time for retro-fire and the impact point are computed, displayed and the capsule is brought back to Earth.

The orbiting phase contains the "Where the capsule is going to be" and "Where the capsule is now" programs, which are run simultaneously. The former is properly called the Orbit Prediction Macro-System. It develops an output table of predicted positions and corresponding velocities of the capsule flight. A set of pre-planned orbital parameters are manually fed into the computers and aid in solving the solutions determining the capsule orbit.

The latter, or "Where the capsule is now," program, is called the Differential Correction Macro-System. It determines the instantaneous orbit parameters. A variety of facts are involved here. Included are: edited radar observations; the orbit prediction table (from preceding paragraph); and the pre-planned orbit parameters. The pre-planned orbit is corrected and this information is displayed as instantaneous orbit elements. The same orbit differential correction process is also used to predict capsule re-entry trajectory and landing point. As a hint of computational accuracy, Mercury Control's radio and television comments stated, "On the basis of his present flight trajectory, we estimate he (Lt. Col. John H. Glenn, Jr.) will land about a mile from a destroyer (USS Noa) associated with the USS Randolph at the end of the third orbit." He actually landed about 5 miles away.

Conclusion

Project Mercury's Ground Communications and Tracking Network is vast and complex, yet extremely reliable. We have tried to give as accurate and detailed an account as space permitted. Reliability, which is literally a matter of life and death, is attained in a high degree. Duplication of equipment, circuits and systems is extensively used. Most of the Network is automated. Project Mercury's Ground Communications and Tracking Network, as our first tracking and communications network, is truly a shining example of American know-how and effort.

We wish to thank the Western Electric Co., International Business Machines Corp., Bell Telephone Laboratories, Burns and Roe, Inc., and especially NASA's Goddard Space Flight Center for information made available to us.

New Tech Data

for Engineers

Space Technology

"General Electric Valley Forge Space Technology Center," an 8-page pamphlet describes the main features of this first large space center in the United States built by private indus-try. Designated PIB-58, the pamphlet is illustrated with facility photos and is illustrated with facility photos and drawings. Information includes gen-eral description, a list of facilities and details of the Space Environment Simulation Laboratory. General Elec-tric Co., Missile and Space Vehicle Dept., 3198 Chestnut St., Phila. 1, Pa.

Circle 693 on Inquiry Card

Microwave Components

Short Form Catalog, No. SF 202 describes coaxial attenuators, balanced mixers, hybrid power dividers, directional couplers, coaxial hybrid tees, and coaxial phase shifters. Included are photographs and specifications. Merrimac Research and Development, Inc., 517 Lyons Ave., Irv-ington 11, N. J.

Circle 694 on Inquiry Card

Log-Periodic Antenna

Performance details and applicareflormance details and applica-tions are described in tech. data on a vertically polarized monopole log-periodic antenna for ionosphere sounder systems. G/A Model 726-4/64 offers low and constant vswr, 10db gain and low take-off angle. Granger Associates, 974 Commercial St., Palo Alto, Calif.

Circle 695 on Inquiry Card

UHF Bandpass Filters

Melpar, Inc., Special Products Div., Sub. of Westinghouse Air Brake Co., 3000 Arlington Blvd., Falls Church, Va., is offering tech data on their line va., is onering teen data on their line of uhf bandpass filters featuring center freqs. of 400 to 1500 mc; bandwidths of 5 to 20% and signal rejection greater than 20 db at one bandwidth from filter center freq.

Circle 696 on Inquiry Card

FM Instruments

Condensed catalog is available from Electro - Mechanical Research, Inc., Sarasota, Florida, describing their line of FM instruments and accessories for airborne telemetering. Descriptions and condensed specs. on FM subcarrier oscillators, FM mixers and amplifiers, and VHF power amplifiers and telemetry transmitters are included.

Circle 697 on Inquiry Card

Telemetry Systems

Acton Laboratories, Inc., 533 Main St., Acton, Mass., is offering a gen-eral catalog which describes their phase measuring and phase stand-ards equipment, precision dial drives, mechanical products, and Rotoflex® Commutators. The commutator designed for rocket and satellite tele-metry systems has a noise level guaranteed less than 10mv.

Circle 698 on Inquiry Card

Antenna Towers

Tech data is available on the Trylon Type 2400H tower for microwave communications. Also included is information on special towers for military uses, prefabricated cables and guys, and towers for vHF-UHF point-to-point communications. Wind Tur-bine Co., West Chester, Pa.

Circle 699 on Inquiry Card

Microwave Absorbers

Electronautics Corp., Maynard, Mass., has available data sheet #6-9000-1 describing Hi-Pow, a newly developed microwave absorbing material for use in high power terminations, dummy loads and as high temp., high vacuum attenuators. Attenuation at X-band varies from 30db/in. to 200db/in.

Circle 700 on Inquiry Card

Rotary Joint Design

Sage Laboratories, Inc., 3 Huron Dr., E. Natick Industrial Park, Na-Dr., E. Natick Industrial Fark, Na-tick, Mass., is offering 3 new tech. dis-cussions entitled, "Microwave Crystal Diodes," "Noise Figure & Sensitivity of Mixers & Video Detectors" and "Rotary Joint Design." The discus-sions include outline drawings, schematics, diagrams, and characteristic charts.

Circle 286 on Inquiry Card

Compensated Crossbars

Tech. Bulletin No. 60-301, 4 pages, 2 colors, entitled "Wide Band Com-pensated Crossbars," will be of interest to engineers working in radar, telemetry, communications, video, and data processing. The illustrated bul-letin discusses the inter-related problems of frequency-response fidelity, crosstalk, and impedance match, and the way in which they are compound-ed in signal-switching systems as the freq. spectrum widens to 30MC. James Cunningham Son & Co., Inc., Honeoye Falls, N. Y.

Circle 287 on Inquiry Card

Reflector Antennas

WDL-TR-1500 entitled, "Reflector Antennas for Radio and Radar As-tronomy," is available from Philco Corp., Western Development Labs., 2875 Febian Way, Polo Alto Colif Corp., Western Development Labs., 3875 Fabian Way, Palo Alto, Calif. The 91 page booklet is the result of a world-wide survey of electro-mechani-cal data on reflector type radio tele-scopes. Data is tabulated according to country and operating radio ob-servatory, for each antenna in order of increasing physical cross-sectional area above ten source meters. An exarea above ten square meters. An ex-tensive list of references is included.

Circle 288 on Inquiry Card

Multiplex System

A 4-page tech. bulletin on the Type LD Telephone Multiplex System for radio is offered by Farinon Electric, 935 Washington St., San Carlos, Calif. Included is data on equipment opera-tion, electrical and mechanical design detail and options.

Circle 289 on Inquiry Card

Slotted Lines

Complete specs. are provided for various types of waveguide, compo-nents, test components and special products. Included in the catalog are slotted line and matched loads, slide tuners, high power pressurizable phase shifters, movable tunable terminations, multihole tuners and precision traveling detectors. This 22-page catalog is available from Elec-tronic Specialty Co., Technicraft Div., 116 Waterbury Rd., Thomaston, Conn.

Circle 290 on Inquiry Card

Microwave Test Equipment

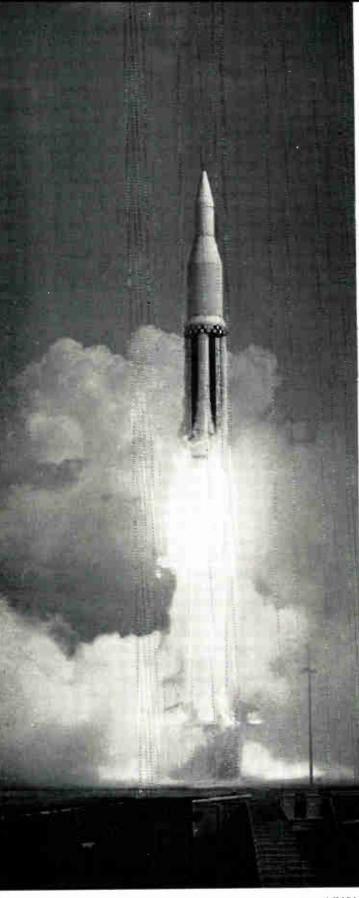
California Technical Industries, Div. of Textron, Inc., 1421 Old County Rd., Belmont, Calif., is offering a 22page catalog on microwave test equip-ment which features VSWR measuring systems, magnetron r-f supplies, variable polarization antennas and automatic radome beamship measuring system.

Circle 291 on Inquiry Card

Telemetry

Applied Electronics Corp. of New Jersey, Metuchen, N. J., has tech. data available on their solid state telemetry equipment. Featured is PCM digital telemetry systems, PDM multicoders completely transistorized, PAM, Model MAH-3 series of pulse amplitude modulation multicoders, solid state commutators, and dc amplifiers.

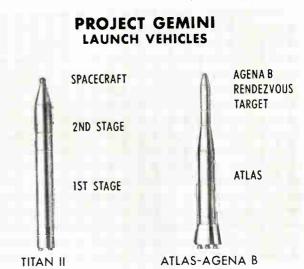
Circle 292 on Inquiry Card



Future Space Satellites and Missions

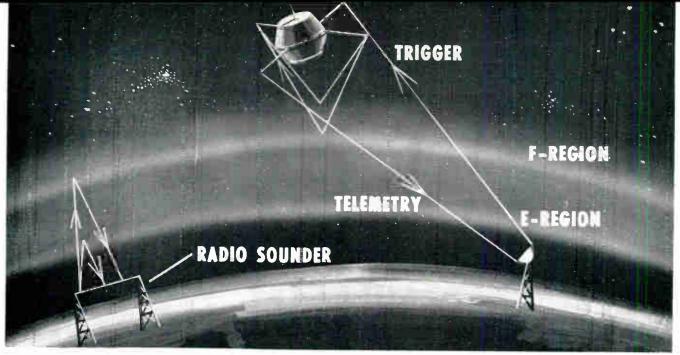


(Photo courtesy of XASA)



(Photo courtesy of NASA)

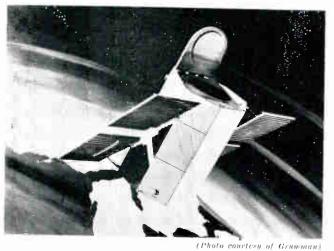
SATURN C-1 version at liftoff, Oct. 27, 1961. Upper 2 stages were dummy loads. Thrust: 1.3 million lbs. Nine more shots scheduled. C-2 version (3 to 4 million lbs. thrust) for circumlunar mission about 1966. Nova (12 to 20 million lbs. thrust) is scheduled for Apollo launching and lunar landing before 1970.



TOPSIDE SOUNDER (S-48): NASA's scientific satellite is scheduled for launching in the 3rd quarter of 1962. It will measure

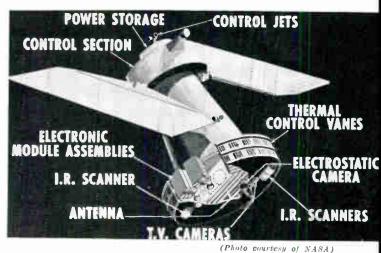
(Photo court sy of N.18.1)

ionospheric electron density above the peak ionization of the F-2 layer, which will be 252.9 to 463 5 kilometers.



ΟΑΟ

NASA's Orbiting Astronomical Observatory is scheduled for laurch inlate '63 or early '64. Carrying 1,000 lbs. of equipment, it will measure cosmic phenomena (24 hour orbit).

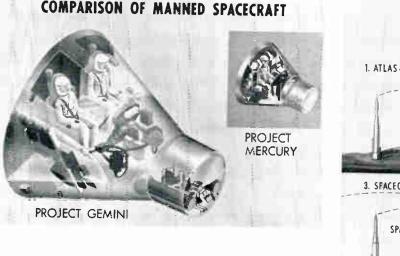


NIMBUS

Scheduled for a late 1962 launch. NASA's Meteorological satellite is follow-on to the highly successful Tiros Series. Will carry advanced TV cameras and radiation detectors.

GEMINI: Two-man spacecraft will have around 50% more volume and weigh about two to three times as much as its predecessor Mer-

cury. Unmanned flights are scheduled for possible launchings in 1963 or 1964. Saturn may be used in later flights.



World Rad

 PARDECE GEAGNINE

 I. ATLAS - AGENA B LAUNCHED

 AGENA B

 AGENA B

 B. SFACECRAFT LAUNCHED

 AGENA B

 Bracecraft

. . Satellites and Missions

(Continued)

MARINER

NASA's Deep Space Probe will be sent to Venus later this year. It is designed to scan the planet for temperature distribution; find out what the atmosphere is made of; and measure any planetary magnetic fields that may be present.

(Phala constess of AASA)

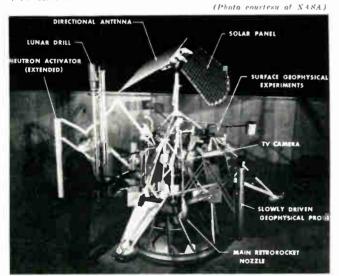
RELAY

This active repeater communications satellite will carry 2 communications transponders able to receive and transmit television, 2-way telephone and other wide-band data. Planned to receive on 1725mc and re-transmit on 4170mc. Will also conduct experiments in radiation effects on components.

(Photo courtesy of NASA)

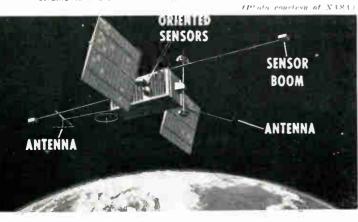
SURVEYOR

Lunar Survey Craft for soft land (6 mph) on the moon. Launch: 1963. Will analyze moon surface materials and radio results back. Carries 4 TV cameras for detailed observations.

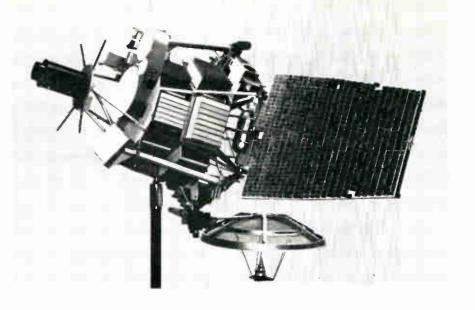


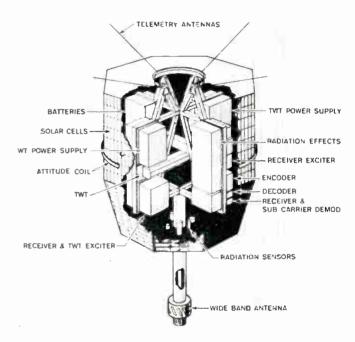
OGO

NASA's Orbiting Geophysical Observatory is in developmental status. Will be first standardized satellite—carrying up to 50 experiment instruments in a stock structure.



ELECTRONIC INDUSTRIES · June 1962

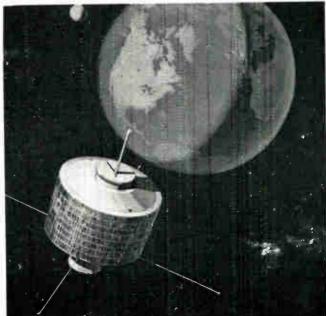




SYNCOM

In a 22,300 mile, near synchronous orbit, this communications satellite will relay telephone and telegraph signals. The Mk. II version will make possible 1,200 2-way telephone calls simultaneously. NASA has scheduled launching for late in 1962.

Photo courtesy of Hughes)





Hughes is hiring! Numerous opportunities now exist in a variety of advanced projects and studies. Examples include: The SURVEYOR-which will soft land an instrumented payload on the moon. ARPAT-terminal anti-missile defense system. VATE-automatic test equipment for ballistic missiles. SYNCOM-synchronous-orbit communications satellite. BAMBI-ballistic anti-missile booster intercept. Positions are open at all levels for specialists with degrees from accredited universities:

CONTROLS ENGINEERS. Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, control systems, control techniques, transistorized equalization networks and control servomechanisms.

CIRCUIT DESIGNERS. Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

INFRARED SPECIALISTS. To perform systems analysis and preliminary design in infrared activities for satellite detection and identification. air-to-air missiles AICBM, infrared range measurement, air-to-air detection search sets, optical systems, detection cryogenics and others.

SYSTEMS ANALYSTS. To consider such basic problems as: requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

Please airmail vour resume to:

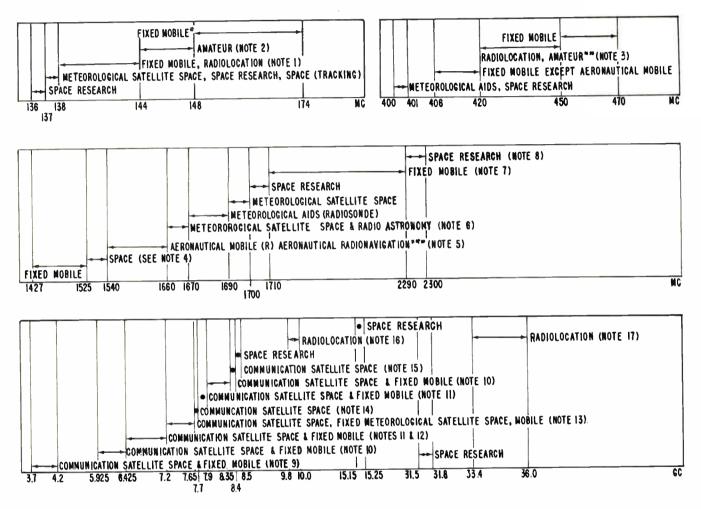
Mr. Robert A. Martin Head of Employment **Hughes Aerospace Divisions** 11940 W. Jefferson Blvd. Culver City 51, California



ELECTRONIC INDUSTRIES • June 1962

World Radio History

Extract from Federal Communications Commission Docket No. 13552 (Enclosure 1 to Doc. 5713/6-4.9.1.) Section 8. Conclusions—The U. S. A. has concluded that, in order to: a. Accommodate aerospacecraft, b. Accommodate me-teorological satellites, c. Augment the Space and Earth-Space (space research) bands contained in the Geneva Radio Regulations, and d. Provide frequency allocations in the immediate future for the reliable exchange, via communication satellite relay, of high-capacity information between points on the earth's surface, including ships, air-craft and aerospacecraft, the Table of Frequency Allocations should be amended as follows:



NOTES

1. Permitted service.

2. The frequencies 144.0 and 148.0 MC, with a maximum bandwidth of 20 KC, may be used for satellite command purposes subject to agreement between administrations concerned and those whose services, operating in accord-ance with the Table, may be affected.

* 287, footnote as contained in Geneva Radio Regulations. ** 317, 318, footnote as contained in Geneva Radio Regulations.

*** 341, footnote as contained in Geneva Radio Regulations but with the limits of the appropriate band changed to read: 1540-1660MC.

3. The frequencies 420.0 and 450.0MC, with a maximum bandwidth of $25\kappa c$, may be used for satellite command purposes subject to agreement between administrations

purposes subject to agreement between administrations concerned and those whose services, operating in accord-ance with the Table, may be affected. 4. In the band 1525-1535MC, telemetry only; in the band 1535-1540MC, command only. 5. The use of the band 1540-1660MC by the aeronautical mobile (R) service is limited to radiocommunications along civil routes for flights utilizing space radiocommuni-cation techniques and which may be operating in the space environment space environment.

In the band 1600-1660Mc the aeronautical radionavigation services will be protected from harmful interference from the aeronautical mobile (R) service for an unspecified period of time.

6. The radio astronomy service is authorized to use the band 1664.4 - 1668.4MC. The radio astronomy service shall be protected from harmful interference from services operating in other bands only to the extent that those services are protected from each other.

7. The band 2110-2120Mc may be used for command of spacecraft engaged in deep space research, subject to agreement between administrations concerned and those whose services, operating in accordance with the Table, may be affected.

8. For deep space research only.

9. For transmission only by communication satellite stations whose field strength at the earth's surface is be-low that which will cause harmful interference to stations

in the fixed and mobile services. 10. For transmission only by earth stations, subject to agreement between administrations affected.

11. Transmission by earth stations in this band is sub-ject to agreement between administrations affected. When used for communication satellite stations, the field strength at the earth's surface shall be below that which will cause harmful interference to stations in the fixed and mobile services.

12. The band 7.12-7.13GC may be used for command of spacecraft subject to agreement between administrations affected.

13. For transmission only by communication satellite and meteorological satellite stations whose field strength at

Frequency Allocations

the earth's surface is below that which will cause harmful interference to stations in the fixed and mobile services. Meteorological satellite stations share 100MC of this band.

14. For transmission only by communication satellite stations.

15. For transmission only by earth stations.

16. The band 9.9-10.0GC may be used for satellite weather radar for precipitation detection.

17. Satellite weather radar for cloud detection share 100 MC of this band.

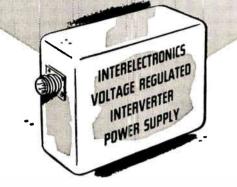
APPENDIX 1* GUIDE FOR USE OF THE 1959 I.T.U. SPACE AND EARTH-SPACE RESEARCH BANDS BAND, MC **PRIMARY USE** REASON SECONDARY USE 10.003-10.005 lonosphere research. Marked propagation effect; can be Ultra-range telemetry, low altiused world-wide with standard tude satellite. receivers and antennas. 136-137 Tracking in center-third of the Replaces the IGY 108 MC; minimum lonospheric measurements in band; telemetering in the other noise area for tube receivers. World-wide tracking net is availassociation with the above two-thirds. band. Narrow band telemetering. able. 183.1-184.1 No planned use. 400-401 Telemetering; low scan rate TV Conventional transistors are practical. Deep space research with very for geophysical and astronomical large antennas. satellites; navigation satellites. 1427-1429 Telemetering; narrow-band TV: Excellent for deep space with very large antennas. Very low propagadeep space; development of precision minitrack. tion effects. 1700-1710 Wide-band TV for meteorological For meteorological and data transmis-Planet radar. satellites. sion where wide-band is needed; likewise for radio-relay. 2290-2300 Primary telemetering and tracking Nearly the ideal frequency area for "Double-doppler" cross-band band for deep space research. 85 foot parabolic reflector antennas. velocity measurements. Very low cosmic noise. BAND, GC 5.25-5.255 No planned use. 8.4-8.5 The 100 MC bandwidth here permits Communication satellite research Space navigation application: -earth-to-earth relay experiwide-band communications relay. planet radar; meteorology ments. Deep space probes. (with 15.15 and 31.5 GC bands). 15.15-15.25 Space relay. High directivity. Meteorology (used with 8.4 and 31.5 GC bands). 31.5-31.8 Space relay; re-entry telemetering. Meteorology (used with 8.4 and 15.15 GC bands). High directivity-small antennas. Penetration of plasma layer.

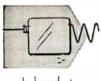
* Appendix 1 summarizes the present use of the 1959 OARC Space Research Bands. Appendix 2 shows recommended augmentation of Appendix 1.

APPENDIX 2b PROPOSED NEW INTERNATIONAL SPACE RESEARCH BANDS

IN ITU BANDS	NEED	REMARKS		
137–174 MC	Two frequencies for earth-to-space satellite command purposes. One should be at 144 MC and the other at 148 MC, each 20 KC band- width.	The selection of these band-edge frequencies, 144 and 148 MC, would produce the minimum impact on existing services—a "command" is usually a single pulse of less than one second duration—adjacent services will not be aware of its presence.		
406–470 MC	Two frequencies for earth-to-space satellite command purposes. One should be at 420 MC and the other at 450 MC. The bandwidth should be 25 KC.	The selection of these band-edge frequencies, 420 and 450 MC, should produce a minimum impact on the existing services, reasoning as above.		
1435-1660 MC	The band 1525–1540 MC for space use, for both telemetering and command purposes.	The too-narrow band 1427–1429 MC should be de- leted. The band 1525–1535 MC would be used for space-to-earth telemetering, and the band 1535–1540 MC for earth-to-space services, such as command, interrogation and control of the space vehicle.		
1700–2300 MC	The band 2110-2120 MC for deep space com- mand, footnote status.	Suggested footnote: The band 2110–2120 MC may be used for earth-to-space-probe command purposes subject to agreement between administrations con- cerned and affected. This band would be paired with the 2290–2300 MC deep-space research band for command purposes.		
5.925-8.4 GC	A command band 7.12–7.13 GC for command of research satellites using the 8.4–8.5 GC space research band, footnote status.	Suggested footnote: The band 7.12–7.13 GC may be used for command of spacecraft subject to agree- ment between administrations concerned and affected. This band is paired with the 8.4–8.5 GC space research band for command, interrogation and control purposes.		

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Circle 251 on Inquiry Card

Tech Data

for Engineers

Microwave Components

Specs. and uses are detailed in tech data from the Instrument Div., LFE data from the Instrument Div., LFE Electronics Inc., Dept. 1079, 714 Bea-con St., Boston 15, Mass., on precision microwave instruments and compo-nents. Information is included on their Series 814A and 816L ultra-stable microwave oscillators; Series 820XLK crystal locked klystron os-cillators; and Model 240 disturbance waveform analyzer waveform analyzer.

Circle 293 on Inquiry Card

Traveling Wave Tubes

Microwave Electronics Corp., 4061 Transport St., Palo Alto, Calif., is offering tech data on their traveling wave tubes. Characteristic charts, complete electrical specs, and photo-graphs are included on low noise tubes, medium power tubes, low power tubes, and Serrodyne and special purpose tubes.

Circle 294 on Inquiry Card

Microwave Accessories

Antlab, Inc., 6330 Proprietors Rd., Worthington, Ohio, has a 1962 short form catalog including antenna pat-tern recorders, microwave receivers, boresight systems, entered boresight systems, antenna pattern integrators, radome mounts and forkcontrolled oscillators. Schematics, photographs, outline drawings and specs. are included. Circle 295 on Inquiry Card

Diaital Computers

This 12-page tech bulletin contains information on the SDS 900 Series digital computers. The high speed, low cost computers are solid state, single address formits are solid state, single address, ferrite core memory machines for general-purpose scientific and special-purpose systems in-tegration. Scientific Data Systems, Inc., 1542 15th St., Santa Monica, Calif.

Circle 296 on Inquiry Card

Shunt Tees

Tech. data is available from Air-com Inc., 48 Cummington St., Boston 15, Mass. on their line of series and shunt tees, hybrid tees, precision bends, coax-waveguide a dapters, straight sections, twists, and waveguide stands.

Circle 297 on Inquiry Card

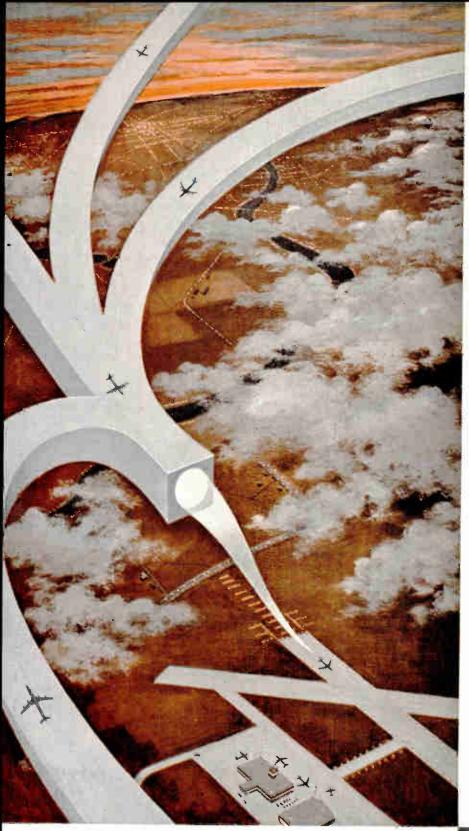
Recording Paper

This 8-page illustrated booklet de-scribes Alfax Type "A2" electrosensi-tive recording paper for commercial facsimile, industrial and scientific data recording purposes. Photos, graphs and tables explain the advan-tages and characteristics of the recording paper which is for slow and medium speed recording uses. Alfax Paper & Engineering Co., Alden Re-search Center, Westboro, Mass. Circle 298 on Inquiry Card

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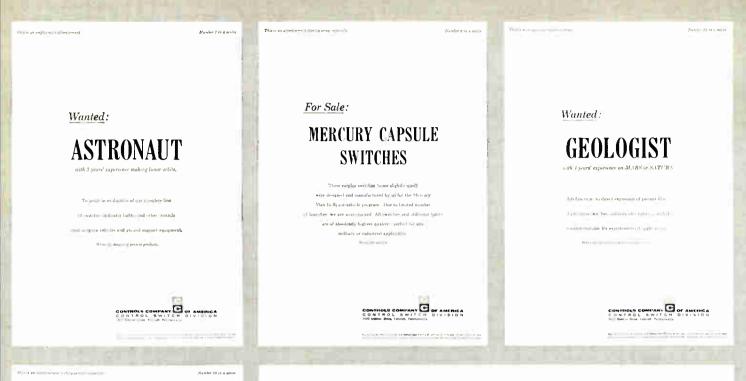
For complete information on Avco's Air Traffic Control Central, write: Director of Marketing, Electronics and Ordnance Division, Avco Corp., Cincinnati 41, Ohio.

Avco's computer-directed Air Traffic Control Central, AN /GSN-11

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Brazing News #86, available from Handy & Harman, 850 Third Ave., New York 22, N. Y., contains in-formation on a method for joining copper and copper alloys by silver

for Engineers

Tech Data

Silver Brazing

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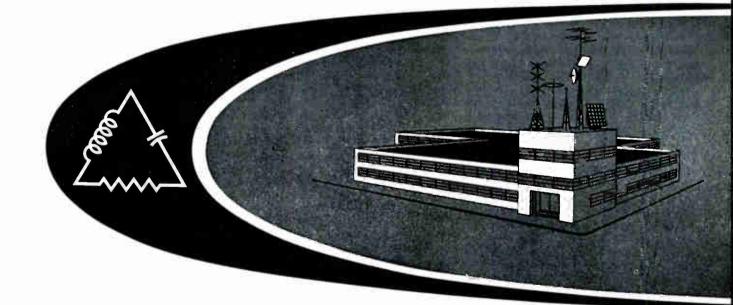
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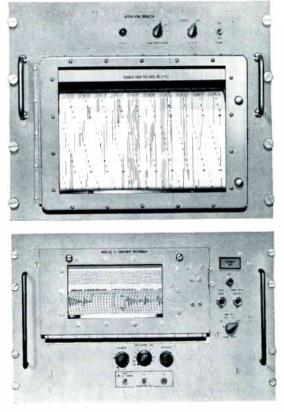
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RIES

A listing of the names and addresses of manufacturers in the electronic and allied industries. All the information in this listing and in the product listing section has been supplied by the manufacturers.

A A METAL PRODUCTS INC 154 ELLIOT ST BRATTLEBORD VT AAA WIRF WORKS INC 45 FOX ST NEW HAVEN CONN ABALON PRECISION MFG CORP 540 CASANOVA ST NEW YORK 59 N Y ABACUS INC 1718 TWENTY FIRST SANTA MONICA CALIF ABBEON INCORPORATED 1700-15 MMAICA AVC 179-15 JAMAICA AVE JAMAICA 32 N Y ABBOIT SCREW & MFG CO 6525 N CLARK ST CHICAGO 26 ILL ABC FAIRCO INC 543 MONTEREY PASS RD MONTEREY PK CALIF ABESTE CDRP ABC FAIRCO INC 343 MONTEREY PASS RD MONTEREY PK CAL: ABCSTE CORP 49 ACKERMAN ST PLOOWFIELD N J ABRAMS INSTRUMENT CORP 606 E SHIAWASSEE ST LANSING 1 MICH ABTRONICS INC 64 S P ST LIVERMORE CALIF ACCESSORY CONTROLS EQUIPMENT 805 BLOOMFIELD AVE WINDSOR CONN ACCESSORY PROD CO DIV OF TEXTRON INC 616 WHITTIER BLVD WHITTIER CALIF ACCURATE ELECTRONICS CO 2005 BLUE ISLAND AVE CHICAGO B ILL ACCURATE ELECTRONICS CO 2005 BLUE ISLAND AVE CHICAGO B ILL ACCURATE ELECTRONICS CO 2015 BLUE ISLAND AVE CHICAGO B ILL ACCURATE ELECTRONICS CO 2418 ALABAMA AVE HOUSTON 6 TEXAS ACCURATE INSTRUMENT CO 2418 ALABAMA AVE HOUSTON 6 TEXAS ACCURATE SPECIALTIES CO INC 345 LODI ST MACKENSACK N J ACCURATE SPECIALTIES CO INC 341 DIST MACKENSACK N J ACCURATE SPECIALTIES CO 31811 W LAKE ST CHICAGO 24 ILL ACC ELECTRONICS INC 2979 N ONTARIO ST BURBANK CALIF ACE DIL 6 ELECTRONICS CO 914 LINCOLN HWY METUCHEN N J ACE DRIL BUSHING CO INC 3407 FOUNTAIN AVE LOS ANG CALIF ACE ELECTRONICS ASSOC 99 DOVER ST SOMERVILLE MASS AC ELECTRONICS INC 3407 FOUNTAIN AVE LOS ANG CALIF ACE ELECTRONICS ASSOC 99 DOVER ST SOMERVILLE MASS AC ELECTRONICS SASOC 914 DISON RD HUNTINGDN VALLEY PENNA ACE PAISTIC O 91-30 VAN WYCK EXPWY JAMAICA 35 N Y ACE SPING MFG CD 1458 STARESPEARE AVE WEW YDRK 52 N Y ACE SPING MFG CD 1450 VAN WYCK EXPWY JAMAICA 35 N Y ACE SPING MFG CD 146 32ND ST PROOKLYN N Y ACE SYCAMORE INC SYCAMORE INC SYCAMORE INC ACENT ACETO CHEMICAL CD INC AD 40 40 LAWRENCE ST FLUSHING N Y ACF ELECTRONICS DIV RIVEPORALF WD ACF ELECTRONICS DIV ACF INDUSTRIES INC RIVEPRALE WD ACF ELECTRONICS DIV ACF INDUSTRIES INC 11 PARK PL PARAMUS N J ACHESON COLLDIDS CD 1931 WASHINGTON AVE PORT HURON MICH ACKERMAN ENGRAVERS 43 22 LONG ISLAND CITY N Y ACKERMAN-GOULD CO INC 10 NEIL COURT PO BDX 188 OCEANSIDE LI N Y ACME BATTERY CDRP 200 HENRY ST STAMFDRD CDNN ACME BRASS FDUNDRY CD OF S A INC 716 WYOMING ST SAN ANTONID 3 TEXAS ACME ELECTRIC COP WATER ST CUBA N Y ACME ELECTRIC COP 99 READING ST BOSTON MASS ACME INDUSTRIAL CO 200-222 N LAFLIN ST CHICAGO 7 ILL ACME MGG 6 GASKET CD 738 N 41 ST PHILA PA ACME MODEL ENGG CO 6224 15TM AVE BROOKLYN 19 NY ACME MODEL ENG CO NEWPORT KY ACME CO 1255 DIXWELL AVE NEW HAVEN 14 CDNN 1255 DIXWELL AVE NEW HAVEN 14 CONN

ACOPIAN TECHNICAL CO 927 SPRUCE ST EASTON PA ACOUSTICA ASSOCIATES 10400 AVIATION BLVD LOS ANGELES 45 CALIF ACOUSTIC RESEARCH INC 24 THDRNDIKE ST CAMBRIDGE MASS AC RAY ELECTRONICS INC 910 N 20 AVE HOLLYWOOD FLA 4CR0 DIV ROBERT SHAW FULTON CONTROL CO 2040 E MAIN ST COLUMBUS OHIO ACR0 ELECTRONIC PRODUCTS CO 119 ST MIHIEL DR RIVERSIDE N J ACROMAG INC 13360 TELEGRAPH RD DETROIT MICH ACROMARK CD ACROMARK CD 309 MORRELL ST ELIZABETH NJ ACRO PRODUCTS CO ACRO PRODUCTS CO 369 SHURS LANF PHILADELPHIA 28 PA ACRO TOOL 6 DIE WORKS 4554 BROADWAY CHICAGO ILL ACRO WELDER MFG CO 1719 W ST PAUL AVE MILWAUKEE WISC AC SPARK PLUG ELECT DIV 1925 KENILWORTH PL MILWAUKEE WISC ACTAN ELECTRONICS INC ENGRG MFG 6 DEV CORP 130 COUNTY COUNTHOUSE RO NEW HYDE PARK NY ACTIONCRAFT PRODUCTS 2 YENNICOCK AVE PORT WASHINGTON N Y ACTIONCRAFT PRODUCTS 2 YENNICOCK AVE PORT WASHINGTON N Y ACTON LAB 1180 RAYMOND BLVD NEWARK N J A C TRANSFORMER CORP 89 MADISON ST NEWARK S N J ADAGE INC 292 MAIN ST CAMBRINGE MASS ADAM METAL SUPPLY INC 463 48TH AVE LONG ISLAND CITY N Y ADAMS 6 WESTLAKE CO 1025 N MICHIGAN ELKHART IND ADAMS ELFCTRONICS INC 16 CHARLES ST BANGOR MICH ADAMS RITE MFG CO 540 W CHEVY CHASE DR GLENDALE 4 CALIF ADAMS RUSSELL CO INC 05 SITH ST CAMBRIDGE MASS ADC PRODUCTS DV OF MAGNETIC CONTROLS 6405 CAMBRIDGE ST MINN MINN ADCON DIV WAYNE-GEORGE CORP 322NEEDHAM STREET NEWTON 64 MASS ADCRAFTERS CO 335 W HURON ST CHICAGO ILL 2 YENNICOCK AVE PORT WASHINGTON N Y ADCON DIV WAYNE-GEDRGE CORP 322NEEDHAM STREET NEWTON 64 MASS ADCRAFTERS CO 325 W HURON ST CHICAGO ILL ADDRESSOGRAPH MULTIGRAPH CORP 1200 BABBITT RD CLEVELAND OHID 1200 BABBITT RD CLEVELAND OHID 1200 BABBITT RD CLEVELAND HETALS CORP 1444 WASHINGTON AVE HUNTINGTON W VA ADEPT INDUSTRIES INC 1646 W HUNTING PARK AVE PHILA 40 PA ADHESIVE PRDDUCTS CORP 1640 BOONE AVE NEW YDRK 6D N Y ADLER ELECTRONICS INC 1 LEFEVRE LAND ST CHICAGD ILL ADVANCE CARBON & ELECTRIC MFG CO 2505 MARIPOSA ST SAN FRANCISCD 10 CALIF ADVANCE GLEVE MACHINE CORP 5511 HDLMES AVE LDS ANG CALIF ADVANCE GLEVE MACHINE CORP 5519 HDLMES AVE LDS ANG CALIF ADVANCE GLEVE MACHINE CORP 538 PETERSDN AVE CHICAGD 51 ILL ADVANCE ROSS ELECT CORP 360 WASHINGTON ST BURLINGTON IDWA ADVANCE ROSS ELECT CORP 100 F ST BELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ROSS ELECT CORP 1010 W MADISON WASHINGTON IDWA ADVANCE ELECTRONICS INC 94 SILAS DEANE MWY ROCKY HILL CONN ADVANCE ELECTRONICS INC 95 WHISMAN RD MT VIFW CALIF ADVANCED ELECTRONICS INC 94 SILAS DEANE MWY ROCKY HILL CONN ADVANCED ELECTRONICS INC 94 SILAS DEANE HWY ROCKY HILL CONN ADVANCED ELECTRONICS INC 94 SILAS DEANE HWY ROCKY HILL LIN Y ADVANCED ELECTRONICS INC 94 SILAS DEANE HWY ROCKY

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June 1962

ELECTRONIC MANUFACTURERS_A TO Z

ALL'AMERICAN ENGG CO

AIRCONDUCTORS 367 E ALDNDRA GARDENA CALIF AIRCRAFT 6 ELECT SPEC 22 GREEN ST BROWNSBURG IND AIRCRAFT ARMAMENTS INC INDUSTRY LANE COCKEYSVILLE MD AIRCRAFT FITTING CD 701 FEDERAL HWY DANIA FLA AIRCRAFT INSTRUMENTS CD 304 KING DF PRUSSIA RD RADNDR PENNA AIRCRAFT RADID CORP RDONTDN N J AIRCRAFT RADID CORP BOX 907 NDRISTOWN PA AIR ELECTRONICS CD 7250 HINDS AVE N HOLLYWOOD CALIF AIRESEARCH MFG CD ARIZDNA DIV GARRETT CDRP 402 S 36TH ST PHDENIX ARIZ AIRC COPP TINBETTS RD BOX 1517 RDCHESTOR AIRESEARCH MFG CD ARIZDNA DIV GARREIT C 402 S 36TH ST PHDENIX ARIZ AIREX CDRP TIBBETTS RD BOX 1517 RDCHESTER N H AIR FILTFR CORP 4554 W WODLWORTH AVE MILWAUKEE WISC AIRFLYTE ELECTRDNICS CO 535 AVENUE A BAYONNE N J AIRGUIDE INSTRUWYENT CO 2210 WABANSIA AVE CHICAGO ILL AIR MARINE MOTORS INC 2210 WABANSIA AVE CHICAGO ILL AIR MARINE MOTORS 369 BAYVIEW AVE LOS ANG CALIF AIR MARINE MOTORS 369 BAYVIEW AVE AMITYVILLE L I N Y AIRMATIC VALVE INC 7314 ASSOCIATE AVE CLEVELAND 9 OHIO AIRMATICS SYSTEMS CORP 441 MARKFT ST SADDLF BROOK NJ AIR MARE DIV ROCKWELL STANDARD CORP 25000 MILES RD CLEVELAND OHIO AIR TAUDENDALE FLA AIRPAX ELECT INC SEMINOLE DIV FORT LAUDENDALE FLA AIRPAX ELECTRONICS INC 2550 E FOOTHILL BLVD PASADENA CALIF AIRPAX ELECTRONICS INC 2550 E FOOTHILL BLVD PASADENA CALIF AIRPAX PRODUCTS CO JACKTOWN RD CAMBRIOGE MD AIR REDSTINC MATEDOSI DNC MATEORD FENNA AIRFEC INC 139 E 15T AVE ROSELLE N J AIR REDUCTION SALES CO REDUCTION CO 150 E 42 ST NEW YORK N Y AIR-SHIELDS INC HATBORD PENNA AIRTECI NC 139 E IST AVE ROSELLE N J AIR TRANSPORT MFG CO 1114 N SYCAMPER AVE LOS ANGELES CALIF AIRTRON A DIV OF LITTON INDUST 200 E HANOVER AVE TORONTO B ONT CANADA AIRTRONICS INC 521 RIVER RD BETHESDA MD AIRTRONICS INC CORP 6900WEST RD BOX 8576 FT LAUDERDALE FLA AIRTRONICS INCL CORP 6900WEST RD BOX 8576 FT LAUDERDALE FLA AIRTRONICS INCL CORP 6902 CHURCH AVE BRODKLYN 3 N Y A 6 J MFG CO 912 WHIGH TOD AVE CHICAGO ILL AIX CONDENSER CO 923 WRIGHTWODD AVE CHICAGO ILL AIX ELECTROTHERNIC CORP 402 CHURCH AVE BARDINGTON ILL AIX CONDENSER CO 932 WRIGHTWODD AVE CHICAGO ILL AIX ELECTROTHERNIC I CORP AJAY PARK TRENTON N J A WFG CO INC 410 S HAGER AVE BARRINGTON ILL AIX CONDENSER CO 150 N UNION ST AKRON OHID ALX (INC 363 W ARDEN ST GLENDALE 3 CALIF ALADDIN ELECTRONICS DIV ALADDIN INDUSTRIES 703 MURREESBOR OR DASHVILLE ID TENN A LA INDUSTRIES INC 150 N UNION ST AKRON OHID ALC BIC CONSMDHOCKEN PA ALAN WDOD STEEL CO CONSMDHOCKEN PA ALAN WDOD STEEL CO CONSMDHOCKEN PA ALAN INSTRUMENTS INC 110 N KIMBALL AVE CHICAGO ILL ALCONDE INS AVE TRENTON N J ALCE LECTRONIC FONDUCTS INC 3 WOLCOTT AVE LAWRENCE MASS ALCOND HAL PRODUCTS INC 3 WOLCOTT AVE LAWRENCE MASS ALCOND X INC ALS STEMBAND ANG THENTON H J ALCO ELECTRONIC 6 IMPULSE P O NA 125 WESTBORO MASS ALCON NINC B BOADWAY NEW YDRK N Y ALCON ELECTRONIC 6 IMPULSE P O NA 125 WESTBORO MASS ALCOND STEEL CO 7342 39TH AVE KENOSHAN WISC ALCOND STEEL CO 7359 N MAIN ST BROCKTON 6A MASS ALCOND YSTEMS CO 111 LAKF AVE TUCKAMOE N Y ALCOND LETCTRONIC 6 IMPULSE P O NA 125 WESTBORON MASS ALDEN PRODUCTS INC 735 MARACT ST CAMDEN N J ALDEN ELECTRONIC 6 INFOLSE ALDEN SYSTEMS CO 111 LAKF AVE TUCKAMOE N MASS ALDEN PRODUCTS INC 735 MARACT ST CAMDEN N J ALSAF SARAMOUNT BLVD PICO RIVERA CALIF ALTA VETUCKAMOE N MASS ALDEN PRODUCTS INC 736 MARKET ST CAMDEN N J ALSAF PAPER 6 ENG CD INC 742 39TH AVE KENOSHANS ALFON PATALANTIC AVE BOSTON ID MASS ALF

ALL AMERICAN ENGG CO BDX 1247 WILMINGTON DEL ALL AMERICAN TOOL 6 MFG CD 8027 LAWNDALE AVE SKOKIE ILL ALLARD INSTRUMENT CDRP 146 E 2ST MINEDLA N Y ALL CHANNEL PRODUCTS CDRP JERSEY SHDRE PENNA ALLEGANTY INSTRUMENT CD 1091 WILLS MOUNTAIN CUMBERLAND MD ALLEGMENY ELFCTRONICS CHEMICALS CO 20 LEAR ST BRADFORD PA ALLEGMENY ELECTRONIC CHEMICALS CD LEWIS RUN PENNA ALÉEGHENY ELECTRONIC CHEMICALS CD LEWIS RUN PENNA ALLEGMENY PLASTICS INC RDUTE 51 THORN RN RD CDRAPDLIS PENNA ALLEN AVIONICS INC 255 E 2ND ST MINEOLA N Y ALLEN-BRAOLEY CD 136 W GREENFIELD AVE MILWAUKEE 4 WISC ALLEN BUSINESS MACHINE INC 333 COMWERCE S W GRAND RAPIDS MICH ALLEN ELFCTROIC 6 EQUIPMENT CD 2101-2117 N PITCHER ST KALAMAZOO MICH ALLEN ELECTRONIC CORP 937 INDUSTRIAL AVE PALO ALTD CALIF ALLEN ELECTRONICS CORP 92 BRANCH ST PONTIAC MICH ALLEN ELFETRIC & EUGIPMENT CD 2101-2117 N PITCHER ST KALAMAZOO MICH ALLEN ELFETRONIC CORP 97 BRANCH ST PONTIAC MICH ALLEN FUECTRONICS CORP 92 BRANCH ST PONTIAC MICH ALLEN FOG CO BLOOWFIELD CONN ALLEN TOOL CORP 308 MALTBIE ST SYRACUSE NY ALLIED CHMICAL DIV GENERAL CHEM CDRP 40 RECTOR ST NEW YORK 6 NY ALLIED CONTROL CO INC 141 RIVER RD NUTLEY 10 N J ALLIED CONTROL CO ORC 2 EAST END AVE NEW YORK 6 NY ALLIED CONTROL CO INC 141 RIVER RD NUTLEY LOND 40 RECTOR ST NEW YORK 21 N Y ALLIED CONTROL CO INC 141 RIVER RD NUTLEY LOND ALLIED CONTROL CO INC 141 RIVER RD VE LEVELAND ONIO ALLIED CONTROL CO INC 141 RIVER MATEO AVE SAN BRUNO CALIF ALLIED CONTROL CO INC 141 RIVER MATEO AVE SAN BRUNO CALIF ALLIED STATA MONICA BLVD MOLLYWOOD CALIF ALLIED SANTA MONICA BLVD MOLLYWOOD CALIF ALLIED SANTA MONICA BLVD MOLLYWOOD CALIF ALLIES ANCT AVE SAN BRUNO CALIF ALLIES CHAMERS COLUMBUS & PREBLE AVES PITTSBURGH PA ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART ST MILWAUKEE 1 WISC ALLIS CO LDUIS 427 E STEWART AVE CARDEN CITY NY ALLOY BELLOWS INC 18125 ROSELAND RO CLEVELAND 12 OHIO ALLOY BELLOWS INC 350 CAMBRIDER DR CLEVELAND CITY AN ALLOY BELLOWS INC 361 CAMBRIDE ROD COMUNICATION PROD DIV BOX 520 MINERAL WELLS TEX ALL STAR PRODUCTS INC 350 SIG MARGAN AWE L IS CITY N Y ALLOY BELDUES INC 40 RUGG RD ALLSTON MASS ALL STAR PRODUCTS INC 350 ARAPAND RO RICHARDON NJ ALLYN INC WELCH 30 ARAPAND RO RICHARDON NJ ALLYN ALPAR MFG CORP 220 DEMETER ST PALO ALTO CALIF ALPHA CORP 820 ARAPAND RD RICHARDSON TEXAS ALPHA METALS INC 56 WATER ST JERSEY CITY 4 N J ALPHA MUDYKDTE CORP 65 HARVARD AVE STAMFORD CONN ALPHA WIPE CORP 200 VARICK ST NEW YORK N Y ALPHADUCT WIRE 6 CABLE CO 25 VAN DYKE AVE NEW BUNSWICK N J ALPINE ELECTRIC COMPONENTS INC WATERBURY CONN ALPITEC INC 49 GLEASON AVE STAMFORD CONN ALSOP ENGRG CORP MILLDALE CONN ALSTEC LANSING CORP 1515 S MANCHESTER AVE ANAMEIM CALIF ALTHOR PRODUCTS 2301 BENSON AVE BROOKLYN N Y

ALTO FONIC TAPE SERVICE INC 211 LAMBERT ST PALO ALTO CALIF 210 SCIENTIFIC CO 355 COMMERCIAL ST PALO ALTO CALIF ALTO SCIENTIFIC AND 1301 ALCON OF AMERICA 1301 ALCON PARENCA 1304 ALLEN INDUSTRIES 35 6 13 JUT CLINTON MD ALWAC COMPUTER DIV EL-TRONICS INC 1304 DE LECITRONIC MARDWARE CO INC 38 DATAC REST MANTHORME CALIF AMATOM ELECITRONIC MARDWARE CO INC 38 DATAC REST AND AND ALCON 38 DATAC REST AND AND ALCON ALWAC COMPUTER DIV EL-TRONICS INC AMELER PENNA AMCO ENG CO 7333 W AINSLIE ST CHICAGD ILL AMECD DIV ANTENNAVISION INC 24.49 W OSGORN RD PHOCNIX ARIZ ALCO INC DUNAM RD BEVERLY MASS AMELICAN ALWRINAW CO 215 CENTRAL AVE LUDISVILLE KY AMERICAN ALERIANY MASS AMERICAN ALERIANY AND ALCOLIF AMERICAN ALWRINW CO 2202-2023 STONER AVE LOS ANGELES 25 CALIF AMERICAN BOSCH CAPP ROOSEVELT FIELD ST MOUNT ALES AND SCH CAPP ROOSEVELT FIELD ST MOUNT ALES AND SCH CAPP ROOSEVELT FIELD ST MOUNT AMERICAN BACK CORP 5000 PARKSIDE PHILA PA AMERICAN BACK CORP 5000 PARKSIDE PHILA PA AMERICAN BACK SHOE CO RAYMOND ATCHLEY DIV 2335 CONTRA AVE LOS ANGCALIF AMERICAN BASCH CAPP ROOSEVELT FIELD SA MOUNT ALES AND SCH CAPP ROOSEVELT FIELD SA MOUNT AMERICAN CHAIN 6 CABLE BRISTOL CO 127 RRISTOL ST WATERBURY CONN AMERICAN CHAIN 6 CABLE BRISTOL CO 127 RRISTOL ST WATERBURY CONN AMERICAN CHAIN 6 CABLE BRISTOL CO 127 RRISTOL ST WATERBURY CONN AMERICAN CHAIN 6 CABLE BRISTOL CO 127 RRISTOL ST WATERBURY CONN AMERICAN CHAIN 6 CABLE DATA MASTERS CORP 80 MAZEL ST GLEW COVE NY AMERICAN BEALEST AND FORMA CORP 3000 LARKSIDE CLEVEND ONIO AMERICAN CHAIN 6 CABLE DATA MASTERS CORP 305 LINCOLMER VELLAN MANOR NY AMERICAN BRAKE SHOE CO CAMMOND NY AMERICAN CHAIN 6 CABLE DATA MASTERS CORP 305 LINCOLMER CLUE AND COVE RASS AMERICAN BEALE AND AMERICAN BEALE LARCE CORP 305 LINCOLMA PENNA AMERICAN BEALE LARCE CORP 305 LINCOLMA PENNA AMER

AMPLITEL INC 342 W 40 ST NEW YORK 18 N Y AMPLIVOX LTD ABBEY MFG EST MT PLSNT WENBLEY MIDDLESEX ENGLAND AMTEL AMERICAN MICROWAVE & TELEVISION 1369 INOUSTRIAL RD SAN CARLDS CALIF AMTHOR TESTING INST CD 45 53 VAN SINDEREN AVE BROOKLYN N Y AMTHON CORP AMER MACH & FOUNDRY POTTER & BRUMFIELD OIV

AMER MACH & FOUNDRY POTTER & BRUMFIELD OIV MARICAN MAGNETICS CORP P DON 98 CARTERVILLE ILL AMERICAN MEASUREMENT & CONTROL INC 240 CALVARY ST WALTHAM 54 MASS AMERICAN MEASUREMENT & CONTROL INC 240 CALVARY ST WALTHAM 54 MASS AMERICAN MEASUREMENT & CONTROL INC 33 W 42ND ST NEW YORK 36 N Y AMERICAN METACOLIMAX INC 61 BROADWAY NEW YORK 6 N Y AMERICAN MICROPHONE CO OIV G CELECT CO 400 S WTMAN AVE ROCKFORD ILL AMERICAN MICROPHONE CO OIV G 400 S WTMAN AVE ROCKFORD ILL AMERICAN MICROPHONE CO 400 S WTMAN AVE ROCKFORD ILL AMERICAN MICROPHONE CO 51 BROADWAY NEW YORK 6 NY 3150 INDUSTRIAL RD SAN CARLOS CALIF AMERICAN MICROWAVE & TV CORP 3201 37TH AVE NE MINNEAPOLIS 18 MINN AMERICAN DATCAL CO INSTRUMENT DIV BOX A BUFFALO 15 N Y 301 37TH AVE NE MINNEAPOLIS 18 MINN AMERICAN OPTICAL 1 MARLBORO ST KEENE NH AMERICAN OPTICAL 1 MARLBORO ST KEENE NH AMERICAN PRODUCTS MFG CO 311 AVE NEW YORK 36 N Y 331 3 AVE NEW YORK 36 N Y 331 3 AVE NEW YORK 36 N Y 331 3 AVE NEW YORK 36 N Y 340 FORREST ST NETUCHEN N J AMERICAN PRODUCTS MFG CO 312 73 ORLEADDER ST NEW ORLENAS LA AMERICAN PRODUCTS MFG CORP 73 30 ALPANDER ST NEW ORLENAS LA AMERICAN RESEARCH CORP 75 N MOUNTAIN RD HARTFORD CONN AMERICAN RESEARCH & WFG CORP 3940 N KILPATRICK & WE CHICAGO 41 ILLINOIS AMERICAN RESEARCH & WFG CORP 3940 N KILPATRICK AVE CHICAGO 41 ILLINOIS AMERICAN SEALANCH & ME HIDDLE VILLAGE NY AMERICAN SEALANCH & ME MIDDLE VILLAGE NY AMERICAN SEALANCH OCOP 3940 N KILPATRICK AVE CHICAGO 41 ILLINOIS AMERICAN SEALANCH & WF DODLIS MINN AMERICAN SILVER CO 360 TRINCE ST FLUSHING SA N Y AMERICAN SILVER CO 360 TRINCE ST FLUSHING SA N Y AMERICAN SILVER CO 360 TRINCE ST FLUSHING SA N Y AMERICAN STANDARD CONTON 10 ROCKWOOD ST ROCHESTER N Y MERICAN STANDARD CONTON INC AMERICAN STANDARD CONTOL DIV 500 TRUMBULL AVE DETROIT MICH 369 MISMAN RD MOUNTAIN VIEW CALIF AMERICAN STANDARD CONTOL DIV 500 TRUMBULL AVE DETROIT MICH AMERICAN STANDARD COP 500 TRUMBULL AVE DETROIT MICH AMERICAN STANDARD COP 500 TRUMBULL AVE DETROIT MICH

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B C ARES LO 131 LEXINGTON ST WALTHAM MASS AMGLO COPP 4333 RAVENSWOOD AVE CHICAGO 13 ILL AMI INC 1500 UNION AVE GRAND RAPIDS 2 MICH AMP INC CAPITRON DIV 155 PARK AVE FLIZABETHTOWN PA AMP INCORPORATED EISENHOWER RLVD HARRISBURG PENNA AMPEREX ELECTRONICS CORP SLATERVILLE R I AMPEREX ELECTRONICS CORP 3LOUFFY AVE HICKSVILLE N Y AMPER AUDIO/SUB AMPEX CORP 1020 KIFER RD SUNNYVALE CALIF AMPEX MAGNETIC TAPE PRODUCTS OPELIKA ALA AMPEX MAGNETIC TAPE PRODUCTS OPELIKA ALA AMPEX MAGNETIC TAPE PRODUCTS OPELIKA ALA AMPEX PROFESSIONAL PROD CO BOX 500 REDWOOD CITY CALIF AMPEK MAGNETIC TAPE PRODUCTS OPELIKA ALA AMPEX PROFESSIONAL PROD CO BOX 500 REDWOOD CITY CALIF AMPHENOL CONNECTOR 1830 S 54TH AVE CHICAGO 50 ILL AMPHENOL WESTERN DIV 9201 INDEPENDENCE AVE CHATSWORTH CALIF AMPLIFIER CORP OF AMER AMPLIFIER CORP OF AMER

AMPLIFIER CORP OF AMER 398 BROADWAY NEW YORK N Y

ELECTRONIC MANUFACTURERS-A TO Z

APCO MOSSBERG CD 205 LAMB ST ATTLEBORO MASS APEL CO SUB RAYTHEON CO 213 E GRAND AVE S SAN FRAN CALIF APEX COATED FABRICS CD 12 E 22 ST NEW YORK 1D N Y APEX COLI TRANSFORMER CORP 1919 S FAIRFIELD AVE CHICAGO B ILL APEX MACHINE CO 14 13 118TH ST COLLEGE POINT 56 N Y APEX WIRE CABLE CORP 237 375 BROOKLYN N Y A P M CORP 41 MONECK ST ENGLEWOOD N 1 1369 INDUSTRIAL RD SAN CARLDS CALIF AMTHOR TESTING INST CD 45 53 YAN SINDEREN AVE BROOKLYN N Y AMTRON CORP 17 FELTON ST WALTHAM S4 MASS AMY ACEVES 6 KING 11 W 42 ST NEW YDRK N Y ANACONDA ALUMINUM CD BOX 1634 LOUISVILLE KY ANACONDA ALUMINUM CD 20-21 WAGARAW RD FAIRLAWN NJ ANACONDA ALUMINUM CD 20-21 WAGARAW RD FAIRLAWN NJ ANACONDA WIRE 6 CABLE CO 25 BROADWAY NEW YDRK 4 N Y ANACOND WIRE 6 CABLE CO 14 733 ARMINTA ST BOX 472 YAN NUYS CALIF IATAJA ARMINTA ST BOX 472 YAN NUYS CALIF ANALOGUE CONTROLS INC 200 FRANK RO HICKSVILLE N Y ANALOGUE CONTROLS INC 200 FRANK RO HICKSVILLE N Y ANALOGUE CONTROLS INC 200 FRANK RO HICKSVILLE N Y ANALOGUE CONTROLS INC 30 GAMFIELD RO ECOAR GROVE N J ANALOGUE CONTROLS INC 980 N FAIR OAKS AVE PASADENA CALIF 980 N FAIR OAKS AVE PASADENA CALIF 980 N FAIR OAKS AVE PASADENA CALIF 985 MAIN ST CHATHAM N J ANATRAN DIV OF ENDEVCO CORP 43 W UNION ST PASAOENA CALIF ANCHOR METALS DIV D S KENNEDY 6 CO ANNISTON ALA ANCHOR PLASTICS CO 3030 HOLLISTER RO TETERBORO N J ANCO INSTR DIV AMER NAME PLANE 6 MFG CO 4254 W ARTHINGTON SI CHICAGO ILL ANDERS LECTRONICS INC 300 BOOK RO NFFDHAM HGTS MASS ANDERSEN LAB INC 501 NEW PARK AVE W HARTFORD CONN ANDERSON A SONS INC MORTH ELECTRONICS INC 300 BOOK RO NFFDHAM HGTS MASS ANDERSON LAB INC 501 NEW PARK AVE W HARTFORD CONN ANDERSON A SONS INC MORTH ELECTRONIC VE FRANKLIN PARK ILL ANDERSON A SONS INC MORTH ELECTRONIC LAB 127 CI BRIDGE PLAZA N LONG ISLAND CITY N Y ANCHOR SPECINF UNC 501 NEW PARK AVE W HARTFORD CONN ANDERSON A FROMARY ILL ANDERSON A SONS INC MORTH ELECTRONIC LAB 127 CI BRIDGE PLAZA N LONG ISLAND CITY N Y ANDREW CALIF CORP 74 1 MARYLAND AVE CLAREMONT CALIF ANDREW CORP 606 BEECH ST WHITBY ONTARIO CAN ANDREW CORP 607 HILLAYON AVE FORT WORTH TEXAS ANDRWEDA TINC 1151 VIERS MILL RD WHEATON MD ANELEX CORP 1300 CAUSEWAY ST BOSTON MASS ANDOW PALEX YE BOSTON MASS ANDOW ANT BONS AND ST BONSTON MASS A P M CORP 41 HONECK ST ENGLEWOOD N J APPALACHIAN ELECTRONIC INSTRUMENTS INC 810 MONRDE AVE RONEEVERTE W VA APPARATUS DEVELOPMENT CO 115 MAIN ST WETHERSFIELD 9 CONN APPLE FREQUENCY MEASURING SERVICE 409 UNION AVE BURLINGTON N C APPLETON CO INC HARRY 136 SAN FERNANDO RD LOS ANG CALIF 136 SAN FERNANDO RD LOS ANG CALIF 12838 WEBER WAY HAWTHORNE CALIF 12838 WEBER WAY HAWTHORNE CALIF APPLIED DEVELOPMENT CORP 12838 WEBER WAY HAWTHORNE CALIF APPLIED DYNAMICS INC ANN ARBOR MICH 213 E GRAND AVE SAN FRANSOCSO CALIF APPLIED TECTRONICS CO SUB 213 E GRAND AVE SAN FRANSOCSO CALIF APPLIED MAGNETICS CORP 1407 NORMAN FIRESTONE RD SANTA BARB AIRPOT GOLETA CALIFORNIA APPLIED PHYSICS CORP 2724 S PECK RD MONROVIA CALIF APPLIED PHYSICS CORP 2404 N MAIN ST WALMUT CREEK CALIF APPLIED RESEARCH INC 76 S BAYLES AVE PORT WASHINGTON NY APPLIED RESEARCH LARS 3717 PARK PL GLENOALE CALIF APPLIED TECHNOLOGY CORP 73 03 GRAND AVE MASPETH N Y APM CO 72 MAIN ST ROCKAWAY N J ARCAM EASTERN LTD P 0 BOX 158 STA C HAMILTON ONT CANADA ARCH GEAR INC 4336 E 10TH CT HIALEAH FLA ARCH GEAR WORKS INC ARCAN EASTERN LTD P O BOX 158 STA C HAMILTON ONT CANADA ARCH GFAR INC 4335 E 10TH CT HIALEAH FLA ARCH GFAR WORKS INC 97 HOLMES ST OUINCY MASS ARCH INSTRUMENT CO 101 HOLMES ST N QUINCY MASS ARCO ELECTINC COMMUNITY DRIVE GREAT MECK N Y COMMUNITY DRIVE GREAT MECK N Y COMMUNITY DRIVE GREAT MECK N Y ARCON ELECTRONICS DIV OF ARCON INDUST BOX 31 3052 BURNEY PL LOS ALAMITOS CALIF BOX 31 3052 BURNEY PL LOS ALAMITOS CALIF AR 6 DA ENGG CO 135 MAIN ST BELEVILLE NJ ARDE ASSOC ENGRG DIV 11 HILL ST NEWARK N J ARDE ONTLAND INC MO SECOND ST PORTLAND MAINE AR 0 DA ENGG CO 105 MAIN ST PORTLAND MAINE AR F PROTLAND INC AR F PRODUCTS LABORATORY "NC 94 GREEN ST JAMAICA PLAIN 30 MASS A R F PRODUCTS INC 0 A 050 ST RANTON N M ARF PRODUCTS INC GRADMER RD RATON N M ARGONNE ELECT MFG CORP 111 JERICHO TPKE SYOSSET LI N Y 112 ARK TENNEN TONG ILL ARKAY INTERNATIONAL INC B 06 VAN WYCK EXPSWAY RICHMOND HILL 18 NY ARKAY NONG ORNE CORP 703 CURTIS ST HIDDLETOWN OHIG ARME ELECT NONG SI NE YO LOS ANGELE SOLUTE ARMOLD CERAMICS INC 1 E STIN ST N BERGEN N J ARMSTRONG WHITWORTH EQUIP MUCCLECOTE GLOUCESTER ENG ARMOLD CERAMICS INC 1 E STIN ST NEWYORK 22 NY ARNOLD ENG G CO P O BOX G MARENGO ILL ARNOLD BUX BUT CHICKNU HLE ANDREWS TOWER INC 1420 LAYTON AVE FORT WORTH TEXAS ANDROWERS TOWER INC IIISI VIERS MILL RD WHEATON MD ANELEX CORP 130 CAUSEWAY ST BOSTON MASS ANKO MFG CO 5025 N 124TH ST MILWAUKEE 13 WIS ANNIS CO R B 1101 N DELWARE ST INDIANAPOLIS IND ANSLEY MFG CO ARTHUR NEW MOPF PA ANSONIA WIRE & CABLE CO 111 MARTIN ST ASHTON R I 112 MATENNA CHEMICALS 017 GENERAL ANILINE 6 FILM CORP 433 HUDSON AVF NEW YORK N Y ANTENNA CHEMICALS 017 OF ST BURLINGTON IOWA ANTENNA STSTEWS INC MIRGMAN INDUST CO DIV OF ALL PROD CO BOX 110 MINERAL WELLS TEXAS ANTENNA SYSTEWS INC HINGHAM INDUST CENTER HINGHAM MASS ANTHONYA 6 CO J L 115 BAKER ST PROVIDENCE R I ANTI CORROSIVE METAL PRODUCTS INC P 0 BOX 1894 ALBANY N ANTI CORROSIVE METAL PRODUCTS CO CASTLETON-ON-HUDSON N Y ANTION ELECTRONICS LABS 1226 FLUSHING AVE BROOKLYN 37 NY ANTAB INC 1226 FLUSHING AVE BROOKLYN 37 N Y ANTAE INC 1226 FLUSHING AVE BROOKLYN 37 N Y ANTAE INC 201 W WILLOW ST CHICAGO 47 ILL ANTRONIC CORP 201 W WILLOW ST CHICAGO 47 ILL ANTRONIC CORP 212 WUONTROSE AVE CHICAGO ILLINOIS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 MASS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 MASS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 MASS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 MASS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 MASS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 MASS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 MASS APAHOUSER CORP OF N E 1312 EOYLSTON ST AOSTON 15 11924 W WASHINGTON BLVD LOS ANGELES CALTF ARRA RESFARCH ASSOCIATES 27 BOND ST WESTBURY N Y ARROW MACHINIST & FABRICATORS 154 E 3RD ST MT VERNON N Y ARROW RADIO CO 1829 DAVENPORT RD TORONTO ONTARIO CANADA ARROWHEAD PRODUCTS 4011 KATELLA AVE LOS ALAMITOS CALTF AF & T ELECTRONICS INC LITTLE ROCK ARK ARAST ELECTRONICS INC 1101 MCALMONT LITTLE ROCK ARK ART DECORATING CO 4201 HUDSON BLVD N BERGEN N J

ELECTRONIC MANUFACTURERS-A TO Z

ART WIRE & STAMPING CO 227 HIGH ST NEWARK 2 N J ARTISAN ELECTRONICS CORP 171 RIDGEDALE AVE MORRISTOWN N J ARTISAN METAL WORKS CO 11400 MADISON AVE CLEVELAND 2 OMIO ARTISAN ELECTRONICS CORP 171 RIDGEDALE AVE MORRISTOWN N J ARTISAN METAL WORKS CO 11400 MADISON AVE CLEVELAND 2 OHIO ARTOS ENGG CO 2757 S 28TH ST MILWAUKEE WISC ARTONICI INSTRUMENT CO 11232 TRIANGLE LA SILVER SPRING MD ARTRONICS INC 82 SANFORD ST HAMDEN CONN ARTIED CO INC 36T WORTHINGTON ST SPRINGFIELD 3 MASS ARVEY CORP 300 COMMUNIPAW AVE JERSEY CITY 4 N J ARVIN INDUSTRIES INC COLUMBUS IND ASCOP DIV ELECTRO MECHANICAL RESCH INC 44 WALLACE RD PRINCETON N J ASHEVILLE-SCHOONMAKER MICA CO 900 JEFFERSON AVE NEWPORT NEWS VA ASHLAND ELECTRIC PRODUCTS INC 3200 COMENNE SIVO LONG ISLAND CITY 1 N Y ASKANIA REGULATOR CO 700 JEFFERSON AVE NEWPORT NEWS VA ASHLAND ELECTRIC PRODUCTS INC 3200 COMENNES UND LONG ISLAND CITY 1 N Y ASKANIA REGULATOR CO 700 JEFFERSON AVE NEW YORK N 4 42T W CHEVY CHASE DR GLENGALE CALIF 75 WILSON MILLS RD CHESTERLAND OHIO ASSOCIATED CHEVT CHASE DR GLENGALE CALIF ASSOCIATED COMPOINT NEW YORK Y ASSOCIATED COMPOINT NEW YORK N ASSOCIATED CHEVREN YORK 20 N Y ASSOCIATED CHECTRICAL INDUSTRIES LTD 155 CHARING GROSS RD LONDON W C 2 ENGLAND ASSOCIATED ELECTRICAL INDUSTRIES LTD COMPUTER SLS DPT NEW PS LECISTR ENGLAND ASSOCIATED ELECTRICAL INDUSTRIES LTD COMPUTER SLS DPT TRFFRD PK MMCMSTR ENGLAND ASSOCIATED ELECTRICAL INDUSTRIES LTD MILITARY RDR SLS DPT NEW PS LECISTR ENGLAND ASSOCIATED ELECTRICAL INDUSTRIES LTD MILITARY RDR SLS DPT NEW RS LECISTR ENGLAND ASSOCIATED ELECTRICAL INDUSTRIES LTD MILITARY RDR SLS DPT NEW RS LECISTR ENGLAND ASSOCIATED ELECTRICAL INDUSTRIES LTD MILITARY RDR SLS DPT NELCKDD RD LELESTR ENGLAND ASSOCIATED ENG CORP 65 KENT ST BROOKLUNE MASS ASSOCIATED FROMOUST RD GLEN RIDGE N J ASSOCIATED PRODUCTION CO 162 N CLINTON ST CHICAGO ILL ASSOCIATED RESEARCH INC 3787 W BELMONT AVE CHICAGO ILL ASSOCIATED RESEARCH INC 3797 M BUNDAT AVE CHICAGO ILL ASSOCIATED RESEARCH INC 3797 M BUNDAT AVE CHICAGO ILL ASSOCIATED RESEARCH INC 3797 M BUNDAT AVE CHICAGO ILL ASSOCIATED RESEARCH INC 3797 M BUNDAT AVE CHICAGO ILL ASSOCIATED RESEARCH INC 3797 M THE A BELMONT AVE CHICAGO ILL ASSOCIATED SPECIALTIES CO ISTOL CONN ASSOCIATED TESTING LABS IO9 ROUTE 46 WATNE N J ASSOCIATED TESTING LABS IO9 ROUTE 46 WATNE N J ASSOCIATED TESTING LABS IO9 ROUTE 46 WATNE N J ASSOCIATED TESTING LABS IO9 ROUTE 46 WATNE N J ASTATIC CORP 230 WARBOR ST CONNEAUT OHIO ASTRA TECHNICAL INSTRUMENT CORP 9905 W JEFFERSON BLVD CULVER CITY CALIF ASTRODATA INC 240 E PALAIS RD ANAMEIM CALIF ASTRODATA INC 240 E PALAIS RD ANAMEIM CALIF ASTROMATIC DIV CONTROL CO OF AMER IA0 WASHINGTON ST EL SEGUNDO CALIF ASTROMATIC DIV CONTROL CO OF AMER IA0 WASHINGTON ST EL SEGUNDO CALIF ASTROMATIC DIV CONTROL CO OF AMER IA0 WASHINGTON ST EL SEGUNDO CALIF ASTROMATIC DIV CONTROL ST INDIANAPOLIS IND A STRO SYSTEMS INC 220 E 23RD ST NEW YORK N Y ASTROTHEM CORP 1625 BELLENFONTAINE ST INDIANAPOLIS IND A T ELECTRONICS INC BOX IBA1 NEW MAVEN CONN ATELIERS DE MONTAGES ELECT T7 RUE ST CMARLES PARIS IS EME FRANCE ATKINS 6 MERRILL INC POST RD SOUTH SUDBURY MASS ATINSON LAB INC TOS OSANTA MONICA BLVD LOS ANGELES CALIF ATKOMATIC VALVE CO INC 345 W ABBOTT ST INDIANAPOLIS 25 IND ATLANTIC E SEACH CORP SHIRLEY MWY AT EDSALL RD ALEXANDRIA VA ALANTIC RESEARCH CORP 30 HYMES AVE GROTON CONN ATLANTIS ELECTRONICS GORP 30 HYMES AVE GROTON CONN ATLANTIS ELECTRONICS CORP 30 HYMES AVE GROTON CONN ATLANTIS ELECTRONICS CORP 30 HYMES AVE GROTON CONN ATLANTIS ELECTRONIC CORP 30 HYMES AVE GROTON CONN ATLANTIS ELECTRONICS CORP 30 HYMES AVE GROTON CONN ATLAS CONNECTORS CORP 30 HYMES AVE GROTON CONN ATLAS TRATFORJE RAOLTS CO 131 WALNUT ST MERTITOW PA ATLAS CONNECTORS CORP 30 HYMES AVE GROTON CONN ATLAS CONNECTORS CORP 31 HALNUT ST MERTITOW PA ATLAS CONNECTORS CORP 33 HIN ST ANSONIA CONN ATLAS TRATFORJE RODORS CO 131 WALNUT ST MERTITOW PA ATLAS CONNECTORS CORP 34 HAS SOUND CORP 1AAS SOUNDE CORP 1AAS SOUNDE COR ATLAS SOUNDE COR ATLAS TRANSFORMER CO 3975 FAIRMOUNT EXT SAN DIEGO CALIF ATLAS TRANSFORMER CO 3975 FAIRMOUNT EXT SAN DIEGO CALIF ATLAS TRANSFORMER CO 3975 FAIRMOUNT EXT SAN DIEGO CALIF ATLAS TRANSFORMER CO 3975 FAIRMOUNT EXT SAN DIEGO CALIF

ATMO SEAL CO 3475 CARDIFF AVE CINCINNATI OHIO ATOCON CORP 527 N UNION ST GALION OHIO ATOHM ELECTRONICS T648 SAN FERNANDO RD SUN VALLEY CALIF ATOMIC ACESSORIES INC 811 W MERRICK RD VALLEY STREAM N Y ATOMIC LABS INC 3086 CLAREMONT AVE BERLELEY CALIF ATTLEBORO REFINING CO 36 UNION ST ATTLEBORO MASS AUBURN INDUSTRIAL PARK AUBURN MASS AUBURN MASS AUBURN MASS AUBURN MASS AUBURN MAG CO PEASE AVE & STACK ST MIODLETOWN CONN AUDAX INC 109 01 STTH AVE CORONA N Y AUDEX CO AUDEX CO 3968 XENWOOD AVE MPLS HINN AUDIO ACCESSORIES 279 RROADWAY AMITYVILLE N Y AUDIO CRESTERS 1601 BLUFF ROAD MONTEBELLO CALIF AUDIO DEVICES INC 44 MADISON AVE NEW YORK 22 N Y AUDIO DEVICES INC RECTIFIER DIV 620 E DYER RD SANTA ANA CALIF AUDIO DEVICES INC RECTIFIER DIV 620 E DYER RD SANTA ANA CALIF AUDIO DEULIMENT CO 15 MABOR ROAD PORT WASHINGTON N Y AUDIO EDULIMENT CO 135 W YOMING AVE DETROIT MICH AUDIO MASTRUMENT CO 135 W 14 ST NEW YORK 12 N Y AUDIO INSTRUMENT CO 135 W 14 ST NEW YORK 11 N Y AUDIO PRECISION AIDS INC SCARBOROUGH PK OSSINING N Y AUDIO PRECISION AIDS INC SCARBOROUGH PK OSSINING N Y AUDIO PRECISION AIDS INC SCARBOROUGH PK OSSINING N Y AUDIO TASTRUMENT CO 135 W 4 ST NEW YORK 11 N Y AUDIO PRECISION AIDS INC SCARBOROUGH PK OSSINING N Y AUDIO PRECISION AIDS INC AUDIO PRECISION AIDS INC AUDIOTAPE CORP 25 PARER AVE GLENBROOK CONN AUDIOTAPE CORP 16 4 ACCH ST PHILA PA AUGAT BROS 310 FREY AVE ATTLEBORD MASS AULT MAGNETICS CO 331 N E CLEVELAND MINN 18 MINN AUREX CORP 315 W ADANS ST CHICAGO 10 ILL AUSTIN ELECTRONICS DIV AUSTIN CO 76 9TH AVE NEW YORK 11 NY AUTOLECTRIC CO 34 20 45 ST LONG ISLAND CITY N Y AUTOCONTROL LABORATORIES INC 35251 W INPERIAL MW LOS ANGELES 45 CALIF AUTOMAT ELECTRONICS CO 399 WYCKOFF AVE BROKLYN 27 N AUTOCONTROL LABORATORIES INC 34 20 45 ST LONG ISLAND CITY N Y AUTOCONTROL LABORATORIES INC 3521 WINFERIAL MWY LOS ANGELES 45 CALIF AUTOMATIC CONTROL SANGELES AS CALIF AUTOMATIC CONTROL CO 995 UNIVERSITY AVE ST PAUL 4 MINN AUTOMATIC CONTROL CO 975 UNIVERSITY AVE ST PAUL 4 MINN AUTOMATIC WITH LIR ROD CORP 323 BERRY ST BROKLYN N Y AUTOMATIC WITH CO 400 PRUSSIA PENNA AUTOMATIC WITH ANG ST PERVALL 4 MINN AUTOMATIC WITH ALPROD CORP 323 BERRY ST PROKULYN N Y AUTOMATIC WITH ALPROD CORP 323 BERRY ST PROKULYN N Y AUTOMATIC WITH ALPROD CORP 323 BERRY ST PROKULYN N Y AUTOMATIC WITH ALPROT CORP 323 BERRY ST PROKULYN N Y AUTOMATIC WITH ALPROT CALIF AUTOMATIC WITH ALPRAY COUDER CALIF AUTOMATIC MINA ANAGEMENT INC 400 PRUSCIS FF R 216 W 18 ST NEW YORK 11 N Y AUTO-SWAGE PRODUCTS INC AUTO-SWAGE PRODUCTS INC SHELTON CONN AUTO TEST INC 600 S MICHIGAN AVE CHICAGO 5 ILL AUTO TEST INC 411 W 8TH ST NEILLSVILLE WISC AUTOTRON INC 3629 N VERMILION ST DANVILLE ILL MUTOTRONICS INC AUTOTRONICS INC P O BOX 208 FLORISSANT MO

AUTRON ENG INC 1301 WILSHIRE BLVD LOS ANGELES 17 CALIF AUTRONICS CORP 180 N VINEOO AVE PASADENA CALIF AVCO CROSLEY DIV BOX 116 EVENDALE OHIO AVCO CORP ELECTRONICS & ORDNANCE DIV 2630 GLENDALE CINCINNATI 41 OHIO AVCO LYCOMING DIV 530 S MIAN ST STRATFORD CONN AVEY DIV MOTCH & MERRYWEATHER 25 E 3RD ST COVINGTON KY AVIATION INSTRUMENT & GEAR 2051 W 9TH AVE HIALEAM FLA AVIEL ELECTRONICS INC 1735 BERKELEY ST SANTA MONICA CALIF AVIONI SU PO BOX 200 NIAGARA-ON-THE-LAKE ONTARIO CANADA AVHET CORP 5877 RODEO RD LOS ANG CALIF 1262 N LAWRENCE STATION RD SUNNYVALE CAL AVHET ELECTRONICS CORP OF N CALIF 1262 N LAWRENCE STATION RD SUNNYVALE CAL AVHET ELECTRONICS CORP OF N CALIF 1262 N LAWRENCE STATION RD SUNNYVALE CAL AVHET ELECTRONICS CORP 70 STATE ST WESTBURY N Y AVO LTD 80 SNOPE RD PORT WASH N Y TO STATE ST WESTBURY N Y AVO LTD 80 SHOPE RD PORT WASH N Y AVTRON MFG INC 10409 MEECH AVE CLEVELAND 5 OHIO AXEL ELECTRONICS INC 134 20 JAMAICA JAMAICA N Y AXLER ASSOCIATES INC 102-42 43 AVE NEW YORK 68 N Y B

BABBITT CHEWICAL CO BOX 457 MATTAPOISETT MASS BABCOCK 6 WILCOX CO TUBULAR PRODUCTS DIV BEAVER FALLS PA BABCOCK 6 WILCOX BAILEY METER CO 2980 EUCLID AVE WILCLIFFE OHIO BABCOCK 6 WILCOX DIAMOND POWER SPEC CORP BOX 415 LANCASTER OHIO BABCOCK ELECT CORP 1640 MONROVIA AVE COSTA MESA CALIF BABCOCK RELAYS 1640 MONROVIA AVE COSTA MESA CALIF BABCOCK RELAYS 1640 MONROVIA AVE COSTA MESA CALIF BACH AURICON INC 6900 ROMAINE AVE COSTA MESA CALIF BACH AURICON INC 6900 ROMAINE AVE COSTA MESA CALIF BACH FOR SHON TO 1255 BRYDGES ST LONDON ONT CANADA BACHE 6 CO SEMON 636 GREENWICH ST NEW YORK 14 N Y BACON INDUSTRIES 192 PLEASANT ST WATERTOWN 72 MASS BAER CO N S BACHE & CO SEMON 636 GREENWICH ST NEW YORK 14 N Y BACON INDUSTRIES 192 PLEASANT ST WATERTOWN 72 MASS BAER CO N S 1-11 MONTGOMERY ST HILLSIDE 5 N J BAILEY MFTER COMPANY 1030 IVANNOE RD CLEVELAND 10 OMIO BAILEY METER CO 29801 EUCLID AVE WICKLIFF OHIO BAIRD ATOMIC INC WALTHAW MASS BAKER CHEMICAL CO J T PHILLIPSBURG N J BAICE SEARCH LABS CAPACITOR DIV 49-93 EDISON PL NEWARK 2 N J BALCRAK INC MACHINE TOOL DIV 0 ISNEY ST CINCINNATI 9 OHIO ELECTRONICS DIV BALDWIN HAMILTON CORP WALTHAM MASS BALDWIN WFG CO INC 140 HOMER ST WATERBURY CONN BALDWIN PIANO CO 1801 GILBERT AVE CINCINNATI 2 OHIO BALLANTINE LABS INC BOONTON N J BALCRAC CO F 1701 N CALMOUN ST FT WAYNE IND BALTEAU ELECTRIC CORP NEW 6 MEADOW STS STAMFORD N Y N S BANCROFT 6 CO 209 COOPER ST WESTMONT COLLINGSWOOD N J BAR WORK MFG CO INC 1190 HIGHLAND AVE WATERBURY CONN BAR WORK MFG CO INC 209 ZOTH ST BEOOKLYN 32 N Y BARER 6 MOWARD CO EAST AVE WESTERLY R I BARER 6 MOWARD CO EAST AVE WESTERLY R I BARER 6 COLMAN CO AIRCRAFT 6 MISSILE PROD DIV ROCKFORD ILL BARBER COLMAN CO AIRCRAFT 6 MISSILE PROD DIV ROCKFORD ILL BARBER COLMAN CO AIRCRAFT 6 MISSILE PROD DIV ROCKFORD ILL BARBER COLMAN CO AIRCRAFT 6 MISSILE PROD DIV ROCKFORD ILL BARBER COLMAN CO ELECT COMPONENTS DIV ROCKFORD ILL BARBER COLMAN CO AIRCRAFT 6 MISSI BARDON STOCKWELL CO 205 RROADWAY CAMRRIDGF MASS BARCOCCHEMICAL PRODUCTS CO 701 S LAS

BARIUM & CHEMICALS INC WILLOUGHBY OHID BARIUM CHEMICALS INC STEUBENVILLE OHID RARKER & WILLIAMSON INC CAMAL & BEAVER STS BRISTOL PENNA BARKER PRODUCTS CO WEST BRIDGEWATER MASS PARSDALE VALVES S125 ALCOA AVE LOS ANGELES 58 CALIF BARNES OEVELOPMENT CO 213 W RAITIMORE AVE LANSDOWNE PA BARNES ENGINEERING CO 30 COMMERCE RO STAMFORD CONN BARNES ENGINEERING CO 4425 W IAST CHICAGO ILL BARNES METAL PRODUCTS CO 4425 W IAST CHICAGO ILL BARNET INST CU 830 COMMERCE ST CLARKSVILLE TENN BARNET ST CLARKSVILLE TENN BARNET INSTRUMENT CO EIGHTH AVE NORTH CASSAOY COLUMBUS OHIO BARNET IST LLA DEMINERALIZER CO 31 LANESVILLE TERR BOSTON 31 MASS BAR RAY PRODUCTS INC 211 25TH ST BROOKLYN N Y BARRETT ELECTRONICS CORP 630 DUNDEE RO NORTHARBOK ILL BARRETT ELECT CORP WESTERN DIV 837 COMMERCEIAL ST PALO ALTO CALIF BARRETT ELECT CORP WESTERN DIV 837 COMMERCIAL ST PALO ALTO CALIF BARRETT ELECT CORP WESTERN DIV 837 COMMERCIAL ST PALO ALTO CALIF BARRETT ELECT CORP WESTERN DIV 837 COMMERCIAL ST PALO ALTO CALIF BARRETT ELECT CORP WESTERN DIV 837 COMMERCIAL ST PALO ALTO CALIF BARRETT ELECT CORP WESTERN DIV 837 COMMERCIAL ST PALO ALTO CALIF BARRETT ELECT CORP WESTERN DIV 837 COMMERCIAL ST PALO ALTO CALIF BARRETT ELECT CORP WESTERN DIV 837 COMMERCIAL ST PALO ALTO CALIF BARRET ELECTRONICS CORP 512 BROADWAY NEW YORK N Y BARTA GRIFFIN CO PO BOX 808 72 COMMERCIAL ST WORCT MASS BARTM ENGRG 6 MFG CO INC 198 HIGHLAND AVE WATERBURY CONN BASTON INSTRUMENT CORP 500 MONTERY PASS RD MNTEREY PK CALIF BARWOOD ELECTRONICS INC 199 HANSE AVE FREEPORT L I N Y PENN CONTROLS INC BASCO DIV 1007 S12TH ST WATERTOWN WISC BASIG 6 EXPERIMENTAL PHYSICS BASIG 6 EXPERIMENTAL PHYSICS BASIG 6 EXPERIMENTAL PHYSICS BASIG 6 EXPERIMENTAL PHYSICS BASIC 6 LOMGI INCORP 1762 BAUSCH ST ROCHESTER N Y BAYSICH TINCOS CON BAYSID TIMENS BAYSIDE TIMENS The brock of the second 1683 JERROLD ST SAN FRANCISCO 24 CALIF

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B 6 H INSTRUMENT CO INC 3479 W VICKERY BLOG FT WORTH TEXAS BIDDLE CO JAMES G 1316 ARCH ST PHILADELPHIA 7 PA B I F INDUSTRIES 345 HARRIS AVE PROVIDENCE R I BIGS CO CARL H 1547 FOURTEENTH ST SANTA MONICA CALIF 343 MARKIS AVE PROVIDENCE R I BIGGS CO CARL H 1547 FOURTEENTH ST SANTA MONICA CALIF BIO-RAD LABS 32ND AND GRIFFIN AVE RICHMOND CALIF BIOPHYSICAL INSTRUMENTS INC 20 HERMAN ST PHILA PA BIOS LABS INC 17 W 60 ST NEW YORK N Y RIRD 6 CO RICHARD H 1 SPRUCE ST WALTHAM 54 MASS BIRO 6 CO RICHARD M 1 SPRUCE ST WALTHAM 54 MASS BIRO 6 CO RICHARD M 1 SPRUCE ST WALTHAM 54 MASS BIRO 6 CO RICHARD M 1 SPRUCE ST WALTHAM 54 MASS BIRO 5 LECTRONIC CORP 30303 AURORA RD CLEVELAND 39 OHIO BIRD 51 ELECTRONIC CORP 30303 AURORA RD CLEVELAND 39 OHIO BIRDAIR STRUCTURES INC 254 RANO ST BUFFALO 12 N Y BIRMINGHAM SOUNO REPRODUCDERS LTD MONARCH WKS POWER LANE STAFFORDSHIRE ENG BIRNBACH RADIO CO 145 HUDSON ST NEW YORK 13 N Y THE BIRCHER CORP INDUSTRIAL OIV 745 S MONTEREY PASS RD MONTEREY PK CALIF BISCHOF DIE ENGRAVING 1405 16TH ST RACIME WISC BISHOP 6 CO PLATINUM WORKS J MALVERN PENNA BISHOP MFG CORP 10 CANFIELD RD CEDAR GROVE NJ BITTERMANN ELECTRIC CO BARLOW ST CANAAN CONN 10 CANFIELD RD CEDAR GROVE NJ BITTERMANN ELECTRIC CO BARLOW ST CANAAN CONN BIWAX CORP 3445 HOWARD ST SKOKIE ILL B & K MFG CO 1801 W BELLE PLAINE AVE CHICAGO 13 ILL BLACK 6 DECKER MFG CO E PENNA AVE TOWSON 4 MD BLACK 6 WEBSTER INC 370 PLEASANT ST WATERTOWN MASS BLACK LIGHT FASTERN CORP 24 KINKEL ST WESTBURY N Y BLACK LIGHT FASTERN CORP 24 KINKEL ST WESTBURY N Y BLACK LIGHT FASTONIC SINC 4868 N SHERIDAN RD CHICAGO ILL BLACKBUR ELECTRONIC CORP 55 W 7 ST WYOMING PA BLACKHAWK ENGINEERING CO P O BOX 146 JANESVILLE WISC BLACKSTONE CORP 1111 ALLEN ST JAMESTOWN N Y BLACO MFG CO 6541 EUCLID AVE CLEVELAND OHIO BLAINE ELECTRONICS INC 14757 KEŚWICK ST VAN NUYS CALIF BLAWEKNOX CO/BLAWEKNOX EOUIP DIV PITTSBURGH 38 PENNA 541 EUCLID AVE CLEVELAND OHIO BLAINE ELECTRONICS INC IATST KESWICKS I VAN NUYS CALIF BLAW-KNOX CO/BLAW-KNOX EQUIP DIV PITTSBURGH 395 PENNA BLEMART CO L D 10 FISKE PL MT VERNON N Y BLICKMAN INC 701 GREGORY AVE WEEHAWKEN N J BLICKY ELECTRIC CO UNION STATION BLOG ERIE PA BLINEY ELECTRIC CO UNION STATION BLOG ERIE PA BLINEY ELECTRIC CO D' O BOX 757 POMONA CALIF BLISS ELECTRONIC CORP BOX 66 SUSSEX NJ BLOCK ASSOC 795 PUTNAN AVE CAMBRIDGE MASS BLOCKSOM & CO STH CANAL ST MICHIGAN CITY INO BLOWINGOALE RUBBER CO P O BOX 191 ABERDEEN MD BLOWINGOALE RUBBER CO 12653 WESTERN AVE BLUE ISLAND ILL BLOUE MELECTRIC CO 138 E CHATHAM ST BLUE ISLAND ILL BLOM INGOALE RUBBER CO 2500 BRADLEY PLACE CHICAGO ILL BODINE ELECTRIC CO 138 E CHATHAM ST BLUE ISLAND ILL BLOE ME ELECTRIC CO 3510 BRADLEY PLACE CHICAGO ILL BODINE INC HIGH Y HACE CHICAGO ILL BODINE STOC WICHTA I KANSAS BESCH MFG COR 315 SIEGEL ST BROKLYN N Y BOGING AIRPLANE CO 0ET 2000 WICHTA I KANSAS BOESCH MFG COR 315 SIEGEL ST BROKLYN N Y BOGING AIRPLANE CO 52 IOWA AVE PATERSON 3 NJ BOGIAT PRODUCTS DIV GENERAL TIRE 6 RUBBER CD 70 GARON ST LAWENCE MASS BOMCL LABS INC 318 SIEGEL ST BROKLYN N Y BOGADE ST LAWENCE MASS BOMC LABS INC 319 AST RISTERNE Y DANE YORL IN N Y BOGIAT PRODUCTS DIV GENERAL TIRE 6 RUBBER CD 70 GREEN ST SILVEROALE PA BOGND E LECTRIC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMAC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC LABS INC 361 363 RANTOUL ST BEVERLY MASS BOMC CORP 314 MAIN ST MAYNARD MASS BOMC CORP 314 GAD CARTHUR E 365 S ALEXANORIA AVE LOS ANGELES & CALIF

ELECTRONIC MANUFACTURE BOTS AIRCRAFT NUT CD NEWTON TURNPIKE NORMALK CONN THE BORDEN CO CHEMICAL DIV 1 CLARK ST NO ANDOVER MASS BORDEN CHEMICAL CO DIV BORDEN CO P 0 BOX 430 COMPTON CALIF BORDEN CHEMICAL CO DIV BORDEN CO P 0 BOX 430 COMPTON CALIF BORDEN CHEMICAL CO 5000 LANGODN ST BOX 9522 PHILA PA BORG EQUIP DIV AMPHENOL BORG ELECTORP 120 MAIN ST JANESVILLE WISC BOGG-WARNER CONTROLS 3300 NEWPORT BLVD BOX 1679 SANTA ANA CALIF ROSCO. FLECT INC 0 SG TON AUTO GAGE CO TO WEST ST PITTSFIELD MASS BOSTON AUTO GAGE CO TO WEST ST PITTSFIELD MASS BOULE VAD FLECTRONICS INC 1229 WASHINGTON BLVD CHICAGO ILL BOULENAD FLECTRONICS INC 1229 WASHINGTON BLVD CHICAGO ILL BOULENAD RECORDING STUDIOS INC 632 N DEARBORN ST CHICAGO ILL BOURNS INC 0 136 MAGNOLIA AVE RIVERSIDE CALIF BOWNS LABS INC 118 HAYWARD AVE AMFS IOWA BOM SOLDER PRODUCTS CO 2 SI FREEMAN ST BROKULY N Y BOWESS BATTERY 5 SPARK PLUG CO 1231 FREEMAN ST BROKULY N Y BOMEST INSULATERY 5 SORMALK CONN BOX-MAR ELECTRICAL SERVICE CO 1371 MISSING TO RD FT WAYNE IND BOX MISSTON ST SAN FRANCISCO 3 CALIF BOM BUT INSTUATED ST SAN FRANCISCO 3 CALIF BOX ELECTRICAL SERVICE CO 1371 HISSION ST SAN FRANCISCO 3 CALIF BOX CONDELUFFTON RD FT WAYNE IND BOX ANG CORP DIV GEN BROKZE CORP 200 CENTRAL AVE PALO ALTO CALIF BRAC MEG CORP DIV GEN BROKZE CORP 200 CENTRAL AVE MENKR 3 N J BRAD THOMPSON INDUST INC 3 BIO TAMARISK ST INDIO CALIF BRAC MEG CORP DIV GEN BROKZE CORP 200 CENTRAL AVE MENKR 3 N J BRAD THOMPSON INDUST INC 3 BIO TAMARISK ST INDIO CALIF BRACD HE SEMICONDUCTORS CORP 275 WELTON ST NEW HAVEN CONN BRADLE SEMICONDUCTORS CORP 275 WELTON ST NEW HAVEN CONN BRADTHOWPSON INDUST INC 3 BIO TAMARISK ST INDIO CALIF BRADTEND COMPONENTS INC 3 BIO TAMARISK CORP 275 WELTON ST NEW HAVEN CONN BRADTHOW SON INDUST INC 3 BIO TAMARISK CORP 275 WELTON ST NEW HAVEN CONN BRADTHOWPSON INDUST INC 3 BIO TAMARISK ST INDIO CALIF BRADTEND COMPONENTS INC 3 BIO TAMARISK ST INDIO CALIF BAND THOMPSON INDUSTINC BADERN COMPONENTS INC BAND REX DIV AMER ENKA CORP BADERN DIV AMER ENKA CORP BADERN DIV AMER ENKA CORP MAUTALLUAGLICAL-CHEMICAL CO BOD GO S AVE PHILADELPHIA 26 PA BAND REX DIV AMER ENKA CORP MOTTE 6 N WINDHAM COM BRAND REX DIV AMER ENKA CORP MOTTE 6 N WINDHAM COM BRAND REX DIV AMER ENKA CORP MAUTAL VINDHAM CON BRAND REX DIV AMER ENKA CORP A 1 S JEFFERSON RD WHIPPANY N J BRANSON INSTRUMENTS INC 37 BROWN HOUSE RD STAMFORD CON BRAND NOL 6 INSTRUMENT CO INC 140 FIFTH AVE MATHORNE N J BREANSON INSTRUMENTS INC 31 BROWN HOUSE RD STAMFORD CON BRAND ROL BINSTRUMENTS INC 31 BROWN HOUSE RD STAMFORD CON BRAND ST INSTRUMENTS INC 31 BROWN STRUMENTS INC 31 BROWN STRUMENTS INC 31 BROWN STRUMENTS INC 31 BROWN STRUMENTS INC 31 DECTT AVE UNION NJ BREAN COL 6 INSTRUMENT CO INC 140 FIFTH AVE HAWTHORNE N J BREANSON INSTRUMENTS INC 31 SROWN ST BRIDGFORT 2 CON BRING LARS 31 SEC CORPS 31 SEC CORPS 31 GRAND ST BRIDGFORT 2 CON BRIGGEORT BRASS CO 30 GRAND ST BRIDGFORT 2 CON BRIGGEORT BRASS CO 30 GRAND ST BRIDGFORT 2 CON BRIGGEORT BRASS CO 30 GRAND ST BRIDGFORT 2 CON BRIGGEORT BRASS CO 30 GRAND ST BRIDGFORT 2 CON BRIGGEORT BRASS CO 30 GRAND ST BRIDGFORT 2 CON BRISTOL CO 30 GRAND ST BRIDGFORT 2 CON BRISTOL CO 40 DOX 1790 EI WATERBURY COM BRITISH RADIO LELECTRONICS LID 133 JEFFERSON PL NW WASHINGTON DC BRISTOL CO 503 BRONDWAY CHICAGO 4D ILL BROM SHORT ST DETRONICS LID 133 JEFFERSON PL NW WASHINGTON DC BRITISH RADIO ELECTRONICS LID 133 JEFFERSON PL NW WASHINGTON DC BRITISH RADIO ELECTRONICS LID 133 JEFFERSON PL NW WASHINGTON DC BRITISH RADIO ELECTRONICS LID 133 JEFFERSON PL NW WASHINGTON DC BROM SHORT ST DETRONICS LID 133 JEFFERSON PL NW WASHINGTON DC BROM SHORT ST DETRONICS LID BROM SHORT ST DETRONICS LID BROM SHORT ST DETRONICS IS OHID B

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BUSSMANN MFG CO DIV MCGRAW EDISDN UNIVERSITY AT JEFFERSON ST LOUIS MO BUTCHER CO L H 3628 E OLYMPIC BLVD LDS ANG CALIF B/W CONTROLLER CORP 2200 E MAPLE BIRMINGHAM MICH B W MFG INC PHILLIPS RADIO DIV KOKOMO IND 321 S UNION ST KOKOMO IND B-W MFGRS INC PHILLIPS RADIO DIV 721 N WEBSTER ST KOKOMO IND BY-BUK CO 4314 W PICO BLVD LOS ANGELES 19 CALIF 4314 W PICO BLVD LOS ANGELES 1º CALIF BYREX CORP 50 HUNT ST NEWTON MASS BYTREX CORP 50 HUNT ST NEWTON 58 MASS

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CABLE 6 WIRE PRODUČÍŠ CO CHICAGO RD SWANTON OHIO CABLE DESIGNS INC 66 RUSHMORE ST WESTBURY LI N Y CABLE SPEC OF CONN 95 KITTS LANE NEWINGTON CONN 95 KITTS LANE NEWINGTON CONN CABRAL WDTORS INC 51 VICTDRY LANE LOS GATOS CALIF CADDELL-BURNS MFG CO 40 E 2 ST MINEOLA N Y CAIG LARS 46 STANWOOD RD NEW HYDE PARK N Y CALBEST ELECTRONICS CO 4801 EXPOSITION BLVD LOS ANGELES 16 CALIF CALCON MFG CO 100 DARIAND AVE WASHINGTON DA CALCON HARGET IN BLUD LOS ANGELES IN CALIF CALCON HARGE CO I DO DAKLAND AVE WASHINGTDN PA CALCOR SPACE FACILITY INC IDIO W PHILADELPHIA WHITTIER CAL CALCULAGRAPH CORP INC 272 RIDGEDALE AVE BOX 72 HANOVER NJ CALEDONIA ELECTRONICS 5 TRANSFORMER CORP P O BOX 98 CALEDONIA N Y CALEDDNIA ELECTRONICS 5 TRANSFORMER CORP MAPLF ST CÂLEDONIA N Y CALEDDNIA ELECTRONICS 6 TRANSFORMER CORP MAPLF ST CÂLEDONIA N Y CALEDDNIA ELECTRONICS 6 TRANSFORMER CORP MAPLF ST CÂLEDONIA N Y CALEDDNIA ST VINCHESTER MASS CALIF MASNETIC CONTROL CORP 1992 VALERIO ST HOLLYWOOD CALIF CALIF TECHNICAL INDUST DIV TEXTRON INC 1421 OLD COUNTY RD BELMONT CALIF CALIFONE CORP 5922 BOWCROFT ST LOS ANGELES 16 CALIF I 1922 VALERIO ST HOLLWOOD CALIF CALIF TECHNICAL INDUST DIV TEXTRON INC 1421 OLD COUNTY RD BELMONT CALIF CALIFORNIA COMPUTER PROD INC B714 CLETA ST DOWNEY CALIF CALIFORNIA COMPUTER PROD INC B714 CLETA ST DOWNEY CALIF CALIFORNIA CESTSTOR CORP 1631 COLORADO AVE SANTA MONICA CALIF CALIFORNIA CHESISTOR CORP 1631 COLORADO AVE SANTA MONICA CALIF CALIFORNIA CHESISTOR CORP 1631 COLORADO AVE SANTA MONICA CALIF CALIFORNIA CHESISTOR CORP 1632 VALERIO ST N HOLLYWOOD CALIF CALIAGO DIV CALIF MAGNETIC CONT CORP 1922 VALERIO ST N HOLLYWOOD CALIF CALVORO PRODUCTS CO 318 PICO BLVO LOS ANG CALIF CALVENT ELECTRONICS INC 18601 S SANTA FE AVE COMPTON CALIF CALVIDEO ELECTRONICS INC 18601 S SANTA FE AVE COMPTON CALIF CAMBICOK CORP SUB WALTHAM MASS CAMBRIDGE FILTER CORP 738 ERIE BLVD E SYRACUSE 3 N Y CAMBRIDGE FILTER CORP 738 ERIE BLVD E SYRACUSE 3 N Y CAMBRIDGE FILTER CORP 738 CRIE ANTHEY FONDERD PLASTICS CO WEST FIKE RD CAMBRIDGE OMIO CAMBRIDGE FILTEN WORK CAMBRIDGE PATTEN WORKS 35 FIFST ST CAMBRIDGE MASS CAMBRIDGE PATTEN WORKS 35 SIFST ST CAMBRIDGE MASS CAMBRIDGE PATTEN WORK 36 N Y 23000 GROESBECK MWY ROSEVILLE MICH CAMBRIDGE FAITEN WORK 23 N Y CAMERA SCREW & MFG CO DIV TEXTRON INC 600 18 AVE ROCKFORD ILL CAMBRIDGE FILTER NORK 36 N Y CAMERA MART INC 135 W 43RD ST NEW YORK 36 N Y CAMERA MART INC 135 W 43RD ST NEW YORK 36 N Y CAMERA MART INC 135 W 43RD ST NEW YORK 23 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 23 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 23 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 23 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 23 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 23 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 36 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 36 N Y CAMERA MART INC 135 W 63RD ST NEW YORK 36 N Y CAMERA MART INC 136 CUMMINGTON ST BDSTON MASS CAMERA MART INC 137 CAMERA TINC 138 CUMMINGTON ST BDSTON MASS CAMERA MART INC 1390 SHERBODOK ST WONTREAL P O CANADA CAMDAIAN WAT FELECTS 6214 COTE DE LIESSE RD ST LENTY QUE CANADA CAMDAIAN

CANADIAN RADIUM URANIUM DV CANRAD PRES IND 43 W SIXTEENTH ST NEW YORK N Y CANADIAN RESEARCH INSTITUE 85 CURLEW DRIVE DON MILLS ONT CANNON CO C F SPRINGWATER N Y CANNON ELECTRIC CO EASTERN DIV PINGREE LEAVITT STS SALEM MASS CANNON ELECTRIC CO 3208 MUMBOLDT ST LOS ANGELES 31 CALIF CANNON ELECTRIC CO 3208 MUMBOLDT ST LOS ANGELES 31 CALIF CANNON ELECTRIC CO PINGREE 6 LEAVITT STS SALEM MASS CANNON ELECTRIC CO 3208 MUMBOLDT ST LOS ANGELES 31 CALIF CANNON ELECTRIC CO 2801 AIRLINE PHOENIX ARIZ CANOGA DIV UNDERWOOD CORP 15330 CXNARD ST VAN NUYS CALIF CANGGA ELECT CORP 15330 CXNARD ST VAN NUYS CALIF CANGGA ELECTRIC ON INDUSTRIES 10136 E RUSH ST EL MONTE CALIF CAPCON INC 61 STANTON ST NEW YORK 2 N Y CAPCON INC 61 STANTON ST NEW YORK 2 N Y CAPEMART CORP DYNAMIC ELECTRONICS DIV 87046 123TH ST RICHMOND HILL 18 LI NY CAPITOL CITY MFG CO 857 KING AVE COLUMBUS OHIO CAPITOL MACHINE CO 36 BALMFORTH AVE DANBURY CONN CAPP5 5 CO 20 ADDISON PL VALLEY STREAM L I N Y CAPTIVE SEAL CORP 121 CLINTON RD CALDWELL N J CAPTRAN CORP 1910 N ELSTON AVE CHICAGO ILL CARAD CORP 1910 N ELSTON AVE CHICAGO ILL CARAD CORP 3381 JUNIPERO SERRA BLVD PALO ALTO CALIF CARBOLINE CO 32 HANLEY IND CT ST LOUIS MO CARBONNEAU INDUSTRIES INC 100 LEXINGTON AVE S W GRAND RAPIDS 4 MICH ELECTRONICS DIV CARBORUNDUM CO LATROBF PA CARBORUNDUM CO THE REFRACTORIS DIV 1ATDOBE DA LEXINGTON AVE S W GRAND RAPIDS 4 MICH ELECTRONICS DIV CARBORUNDUM CO LATROBF PA CARBORUNDUM CO THE REFRACTORIS DIV LATROBE PA CARBORUNDUM CO GLOBAR PLANT P 0 BOX 339 NIAGARA FALLS N Y CARDION ELECTRONICS INC 65 RUSHWORE ST WESTBURY NEW YORK 65 RUSHWORE ST WESTBURY NEW YORK CARDOD DIV CHEMETRON CORP MONEE ILL CAROWELL CONDENSER CORP 30 E MONTAUK HYW LINDENHURST N Y 30 E MONTAUK HYW LINDENHURST N Y CARLETON AVIATION CO INC EAST AURORA N Y CARLING ELECTROIC ENG 505 NEW PARK AVE W HARTFORD 10 CONN CARLETON AVIATION CO INC EAST AURORA N Y CARLING ELECTRIC INC 505 NEW PARK AVE W HARTFORD 10 CONN CARLSTEDT RESEARCH INC 2501 E 68TH ST LONG BEACH CALIF CARME INDUSTRIES 22 N 22 H ST KENILWORTH NJ CAROL ELECT DIV WE TORRANCE CALIF CARNE INDUSTRIES 22 N 22 HT ST KENILWORTH NJ CAROL ELECT DIV WEECO INC CAROL ELECT ORP 315W STEPHEN MARTINSBURG W VA 315W STEPHEN ST MARTINSBURG W VA 315W STEPHEN NANTINSBURG W VA 315W STEPHEN MARTINSBURG W VA 315W STEPHEN ST REALOING CARD CARPENTER STELL CO ALLOY TUBE DIV SPRINGFIELD RO UNION NJ CAROLL PRESSED METAL INC 133 DEWEY ST WORCESTER MASS CARCITHER SFEEL CO INC 101IANAPOLIS IND CARROLL PRESSED METAL INC 133 DEWEY ST WORCESTER MASS CARCITHERS & FERNANDEZ MASS CARCITHERS & FERNANDEZ MASS CARTER PARTS CO 3401 W MADISON ST SKOKIE ILL CARTARISEAL CORP 23 MASHINGTON ST HUDSON MASS CARTER PARTS CO 3401 W MADISON ST SKOKIE ILL CARTARISEAL CORP 23 MASHINGTON ST HUDSON MASS CARTER PARTS CO 3401 W MADISON ST SKOKIE ILL CARTARISEAL CORP 23 MASHINGTON ST HUDSON MASS CARTER PARTS CO 2601 N HOWARO ST PHILA P CONPUDYNE CORP PROCESS CONTROL DIV 604 S WARMINSTER RD MATBORD PA CEDAR ENG DIV CONTROL DATA CORP 5806 W 36TH ST ST LOUIS PK MINN

COMMUNICATION MEASUREMENTS LABS 30 LELAND AVE PLAINFIELD N J CELANDAY PLAINFIELD N J CELANDS AVE PLAINFIELD N J CELANESE PLASTICS CO TO MADISON AVE NEWARK 2 N J CELANESE PLASTICS CO DIV OF CELANESE CORP 180 MADISON AVE NEW YORK 16 N Y CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 550 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 555 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 550 MAHWAH N J CELCO CONSTANTINE ENG LABS CO P O BOX 510 LODE UNION 3150 N 32ND ST MILWAUKEE WISC CENTRALAB DIV GLOBE UNION 326 N BREMEN MILWAUKEE WISC CENTRAL DYNAMICS LID 147 MYUS BLVD DPL CLAIRE OUE CANADA CENTRAL ELECTRONICS ME 127 M BELMONT AVE CHICAGO 13 ILL CENTRAL ELECTRONICS ME 127 M BELMONT AVE CHICAGO 13 ILL CENTRAL RESEARCH LABS P I MAILROAD ST COLUMBIANA ONIO CENTRAL SCIENTIFIC CO OF CALIF 104 MARTIN AVE SANTA CLABA CLABA CLABA CLABA CLABA CENTRAL RESEARCH LABS RED WING MINN CENTRAL SCIENTIFIC CO OF CALIF 1040 MARTIN AVE SANTA CLARA CALIF CENTRAL SCIENTIFIC CO OF CANADA LTD 146 KÊNOAL AVE TORONTO 4 ONT CANADA CENTRAL SCIENTIFIC CO 1700 IRVING PARK RD CHICAGO ILL CENTRAL TRANSFORMER CO 900 W JACKSON BLVD CHICAGO 7 ILL CENTRAL TRANSFORMER CORP APCADIA FLA CENTRAL TRANSFORMER CO 900 W JACKSON BLVD CHICAGO 7 ILL CENTRAL TRANSFORMER CORP ARCADIA FLA CENTROL ENG CD 119 E LEXINGTON INDEPENDENCE: MO 119 E LEXINGTON INDEPENDENCE: MO 119 E LEXINGTON INDEPENDENCE: MO 1300 CENTURY COIL CORP 1522 N CLYBOURN AVE CHICAGO 10 ILL CENTURY ELECT INST INC 1806 PINE ST ST LOUIS MO CENTURY ELECT CO 111 ROOSEVELT AVE MINEOLA N Y CENTURY LIGHTING INC 521 W 43 ST NEW YORK N Y CENTURY PLATING CO 229 FERRIS AVE WHITE PLAINS N Y CENTURY PLATING CO 229 FERRIS AVE WHITE PLAINS N Y CENTURY PLATING CO 229 GUEENS BLVD LONG ISLAND CITY N Y CENTURY PROJECTOR CORP 3202 QUEENS BLVD LONG ISLAND CITY N Y CERAMASEAL INC P O BOX 25 NEW LEBANON CENTER N Y CERAMICS INCE MANYAH N J CERAMICS INTERNATIONAL CORP 39 SIDING PLACE MANYAH N J CERBERUS AG WERK FLEKTRONENTECHNIK MANNEDORF SWITZERLAND RONSON METALS CORP CERIUM METALS 6 ALLOYS DI 45 MFRS PL NEWARK N J CERTO SALES CORP 300 PARK AVE NEW YORK N Y CERTOR SALE SCORP 300 PARK AVE NEW YORK N Y CERTOR SALES CORP 300 PARK AVE NEW YORK N Y CERTOR SALES CORP 300 PARK AVE NEW YORK N Y CERTOR SALES CORP 300 PARK AVE NEW YORK N Y CERTOR SALES CORP 300 PARK AVE NEW YORK N Y CERTOR SALES CORP 300 PARK AVE NEW YORK N Y CERTOR LECTRONIC CORP 713 MANILTON ST GENEVA ILL CETRON ELECTRONIC CORP 713 MANILTON ST GENEVA ILL CETRON PLACE ARCADIA CALIF CFI CORP CETRON ELECTRONIC CORP 715 HAMILTON ST GENEVA ILL CETRON ELECTRONIC CORP ROLYN PLACE ARCADIA CALIF CFI CORP 1 COTTAGE PLACE MINEOLA N Y 415 E BEACH INGLEWOOD CALIF CHACE CO W M 1600 BEARD AVE DETROIT 9 MICH 415 E DUARTE RD MONROVIA CALIF CHACE CO W M 1600 BEARD AVE DETROIT 9 MICH CHADWICK-HELMUTH CO 472 E DUARTE RD MONROVIA CALIF CHALCO ENGINEERING CORP 15126 S BROADWAY GARDENA CALIF CHANPION DEARMENT TOOL CO 5 MAIN ST MEADVILLE PENNA CHANPION DEARMENT TOOL CO 5 MAIN ST MEADVILLE PENNA 427 OLIVE ST P O BOX 1408 SANTA BARB CALIF CHANEL INDUSTRIAL PARK CHARLESTON S C STARK INDUSTRIAL PARK CHARLESTON S C STARK INDUSTRIAL PARK CHARLESTON S C CHASE BRASS 6 COPPER CO MILL DIV 236 GRAND ST WATERBURY 20 CONN CHASE MILS SERV DIV CHASE BRASS 6 COPPER C) 236 GRAND ST WATERBURY 20 CONN CHASE MILS SERV DIV CHASE BRASS 6 COPPER C) 236 GRAND ST WATERBURY 20 CONN CHASE MILS SERV DIV CHASE BRASS 6 LEECTRIC IN 530 W MT PLEASANT AVE LIVINGSTON N J CHATHAM ONTROLS CORP 33 RIVER ST CHATHAM N J CHATILLON SONS JOHN 85 CLIFF ST NEW YORK N Y CHEMALLOY ELECTRONICS CORP GILLESPIE AIRPORT SANTEE CALIF

CHEMOUT DIV CENTRE CIRCUITS INC BOX 799 STATE COLLEGE PA BOX 199 STATE COLLEGE PA 123 SUSSEX AVE NEWARK N J CHEMICAL COMMERCE 123 SUSSEX AVE NEWARK N J ENDICOTT ST DANVERS MASS CHILD ELESCTRONIC ENG 783A BOTHELL WAY N E SEATLE VASH 783D VASE INDUCED HIGHLAND PARK ILL 6450 GRID VAN NUYS CALIF 783D WARE INDUCED HIGHLAND PARK ILL 6450 GRID VAN NUYS CALIF 7823 W ARHITAGE AVE CHICAGO 14 ILL 7910 WASHINGTON BLYD BELLWOOD ILL 7910 WASHINGTON BLYD BELLWOOD ILL 7910 CHICAGO GANCE AVE SPASADENA CALIF 1010 SYCAMORE AVE SPASADENA SCALIF 1010 CHIEFFIELD AVE CHICAGO ILL 1055 N SHEFFIELD AVE CHICAGO ILL 1060 SYMIN STORE CORP 2583 WEST CHESTER PIKE BROOMALL PENNA 2510 WASA ST COMPANE SCALIF 100 HAGEMAN ST CHANNEL STATE CON 100 STANDA ST CANOLE SCORP 100 STATE SCO CLARK ELECTRONIC LABS BOX 165 PALM SPRINGS CALIF CLARKE H JOY CO 27003 KNICKERBOCKER RD BAY VILLAGE OHIO

ELECTRONIC INDUSTRIES

June 1962

CLARKSDN LABORATORIES INC 1450 FFRRY ST CAMDEN N J CLARDSTAT MFG CD WASHINGTON ST DOVER N H CLARD STAT MFG CD WASHINGTON ST DOVER N H CLARY CORP 408 JUNIFERD ST SAN GABRIEL CALIF CLAUSS CUTLERY CD 223 PROSPECT ST FREMDNT DHIO CLEAR BEAM ANTENNA CORP 21341 RDSCOE BLVD CANOGA PARK CALIF CLEARTONE REPRODUCTION CORP 23-14 122ND ST COLLEGE POINT N Y CLEGG LARS DIV CLEGG INC RT 53 MT TABOR N J CLETRON INC 1974 E 61 ST CLEVELAND 30 OHID CLEVELAND CONTAINER CO 6201 BARBERTON AVE CLEVELAND 2 OHIO CLEVELAND FABRICATING CO 7424 BESSEMER AVE CLEVELAND OHIO CLEVELAND GRAPHITE BRONZE DIV CLEVITE CORP CALDWELL OHIO CLEVELAND FABRICATING CO TA24 BESSEMER AVE CLEVELAND OHIO CLEVELAND GRAPHITE BRONZE DIV CLEVITE CORP CALDWELL OHIO CLEVELAND METAL SPEC CO 1783 E 21 ST CLEVELAND OHIO CLEVELAND METAL SPEC CO 1783 E 21 ST CLEVELAND OHIO CLEVELAND METAL SPECIALTIES CO 15316 INDUSTRIAL PKWY CLEVELAND OHIO CLEVELAND WELDS PLANT 1133 E 152 ST CLEVELAND OHIO CLEVITE HARRIS PRODUCTS INC 6545 CARNEGIE AVE CLEVELAND 3 OHIO CLEVITE HARRIS PRODUST INC 6545 CARNEGIE AVE CLEVELAND 3 OHIO CLEVITE ORDNANCE DIV CLEVITE CORP 540 E 105TH ST CLEVELAND B OHIO CLEVITE ORDNANCE DIV CLEVITE CORP 540 E 105TH ST CLEVELAND 8 OHIO CLEVITE TRANSISTOR 200 SMITH ST WALTHAM MASS CLIFTON PRECISION PRODUCTS CO INC BROADWAY AT MARPLE CLIFTON HGTS PA CLIFTON PRECISION CLOCRADO SPRINGS COLD CLUPARD INSTRUMENT LAB 7390 COLERAIN AVE CINN OHIO CLUPARD INSTRUMENT INC 513 E WASH ST PARIS TENN CLOGH BRENGLE CO 6014 BROADWAY CHICAGO ILL CLOVER INDUSTRIES INC 578-588 YOUNG ST TONAWANDA N Y CLOWES CERAMICS CORP 3711 CALHOUN AVE CHATTANOOGA TENN CLUM WFG CO 601 NATIONAL MILWAWKEE WISC CLY DEL WFG CO INC D ONX 1367 WATERBURY 20 CONN C M WFG CO 103 DEWEY ST BLOOMFIELO NJ CO-OPERATIVE INDUSTRIES INC 100 OAKDALE RD CHESTER N J COAST OF STA-SAL & MFC CO 2335 W WASHINGTON BLVD LOS ANGELES CALIF COAST AND STAINGTON BLVD LOS ANGELES ST CALIF COAST AND STAINGTON BLVD LOS ANGELES ST CALIF COAST AND CALE AND CONN COBENN INC PASSAIC AVE CALDWELL N J COHAN EPER CO COAXIAL COMPONENTS CORP 391 LUDLOW ST STAMFORD CONN COBEMN INC PASSAIC AVE CALDWELL N J COHAN CPRE CO 142 W 14 ST NEW YORK 11 N Y COHN CORP SIGMUND 121 S COLUMBUS AVE MOUNT VERNON N Y COHU ELECTRONICS INC KIN TEL DIV 5725KEARNY VILLA RD SAN DEIGO CALIF COIL COMPANY OF AMERICA 212 WASHINGTON ST NORTHVALE N J COIL ENG 6 MFG MARKLE IND COIL ENG 6 MFG CO ROANOKE IND COIL ENG 6 MFG CO ROANOKE IND COIL COMPANY OF AMERICA 213 WASHINGTON ST NORTHVALE N J COIL COMPANY OF AMERICA COIL ENG 6 MFG MARKLE IND COIL THOING EQUIP CO RAILROAD PLAZA OYSTER BAY N Y COILCRAFT INC CARY ILL COILS ELECTRONICS CO 2939 49 N 2ND ST PHILA 33 PENNA COLBER CORP 26 BUFFINGTON ST IRVINGTON 11 N J COLF RADIO WORKS R6 WESTVILLE AVE CALDWELL N J COLBER CORP 26 BUFFINGTON ST IRVINGTON 11 N J COLF RADIO WORKS 86 WESTVILLE AVE CALDWELL N J COLEMAN CABLE 6 WIRE CO 1900 N RIVER RD RIVER GROVE ILL COLEMAN ELECTRONICS INC 133 EAST 162ND ST GARDENA CALIF COLFMAN INSTRUMENTS INC 42 MADISON ST MAYWOOD ILL COLIN CAMPRELL CO INC MIRY BROOK RD DANBURY CDNN COLLECTRON CORP 304 E 45TH ST NEW YORK 17 N Y COLLINS CORP G L 2820 E MULLETT ST LONG BEACH CALIF COLLINS RADIO CO 855 35 ST N E CEDAR RAPIDS IOWA COLLINS RADIO CO 1930 HILINE DR DALLAS 7 TEXAS COLLINS RADIO CO OF CANADA LTD 11 BERMONDSEY RD TORONTO ONT CAN

CDLLINS RADID CO 19700 SAN JDAQUIN RD NEW PORT BEACH CALIF CDLLINS RADID TEXAS DIV 1200 ALMA RD RICHARDSDN TEXAS COLLINS RADIO CD 315 2ND AVE S E CEDAR RAPIDS IOWA CDLLYER INSULATED WIRE CO 249 RDDSEVELT AVE PAWTUCKET R I CDLMAN ELECTRONIC PRDUCTS INC 1017 N E 3RD AVE AMARILLD TEX COLORIAL, ALLOYS CO RIDGE AVE 6 CRAWFORD STS PHILADFLPHIA 29 PA COLORADD RESEARCH CDRP BROOWFIFLD COLO COLSON CORP 440 SOMERVILLE AVE SOMERVILLE 43 MASS COLLINS RADID CO COLUMBU A REC O SUPPLY CO BROWF IFLD COLO COLSON CORP 440 SOMERVILLE AVE SOMERVILLE 43 MASS CDLUMBIA ELECT MFG CO 4519 HAMILTON AVE CLEVELAND OHIO COLUMBIA METAL BOX CO 260 E 143 ST NEW YORK 51 N Y COLUMBIA PRODUCTS CO 6625 SHAKESPEARE RD COLUMBIA S C COLUMBIA PRODUCTS CO 6625 SHAKESPEARE RD COLUMBIA S C COLUMBIA PRODUCTS CO 799 7 AVE NEW YORK N Y COLUMBIA RECOROS 799 7 AVE NEW YORK N Y COLUMBIA RECOROS MACDADE BLVD 6 BULLENS LA WOODLYN PA COLUMBIA TAPE MILLS INC BANK ST E GREENVILLE PA COLUMBIA TECHNICAL CORP 24 30 BRKLYN QUEENS EXPWY WOODSIDE 77 N Y COLUMBIA CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN CARBON CO MAPICO IRON OXIDES UNIT 380 MADISON AVE NEW YORK 17 N Y COLUMBIAN ROPE CO AUBURN NY COLUMBUS ELECTRONICS CORP 1000 SAW MILL RIVER RD YONKERS N Y COLUMBUS PROCESS CO 2851 SOUTHEASTERN AVE COLUMBUS IND COLUMN MACHINE CO MOULTON ST GEORGETOWN MASS COLVIN LABS INC 364 GLENWOOD AVE E ORANGE N J COMAR ELECTRIC CO 3349 ADDISON ST CHICAGD 18 ILL COMBINED ELECT INC 4616 W 26TH ST CHICAGD 1LL COMED LASTICS INC 9834 JAMAICA AVE RICHMOND HILL N Y COMERCOM MFG CO 880 S ROSE PL ANAHEIM CALIF COMMER PLASTICS 6 SUPPLY CO 630 BROADWAY NEW YORK N Y COMERCIAL PLASTICS CO 945 GEORGE ST CHICAGO ILL COMMERCIAL PLASTICS CO 945 GEORGE ST CHICAGO ILL COMMERCIAL PLASTICS CO 950 BROADWAY NEW YORK N Y COMERCIAL PLASTICS CO 9652 I AVE NEW YORK N Y COMERCIAL PLASTICS CO 9655 I AVE NEW YORK 20 N Y COMET LTD BERNE SWITZERLAND COMMONWEALTH METAL CRAFTS NORTH AVE 6 AMORY STS WAKEFIELD MASS COMMUNICATION SCO 300 GRECO AVE CORAL GABLES FLA COMMUNICATION SCO 300 GRECO AVE CORP BOX 824 STATE COLLEGE PA COMPONENTS FOR RESEARCH INC 979 COMERCIAL ST PALO ALTO CALIF COMPONENTS FOR RESEARCH INC 9797 COMMERCIAL ST PALO ALTO CALIF COMPONENTS SPEC INC 9778 PLEASANT ST BELMONT 79 MASS COMPONENTS SPEC INC 9 YREES PLACE MERRICK L I N Y COMPACT CONTROLS CO INC 1633 N HALSTED ST CHICAGO 14 ILL COMPONENTS SPEC INC 9 T78 PLEASANT ST BELMONT 79 MASS COMPONENT RESEARCH CO INC 164 MAIN ST DENVILLE N J COMPONENT RESEARCH CO INC 1653 N HALSTED ST CHICAGO 14 ILL COMPONENT RESEARCH CO INC 1653 N HALSTED ST CHICAGO 14 ILL COMPONENT RESEARCH CO INC 1653 N HALSTED ST CHICAGO 14 ILL COMPONENT RESEARCH CO INC 105 NANKE DN CO INC EASTERN DIV 2251 BARY AVE LOS ANGELES CALIF COMPUTER CONTROL CO INC EASTERN DIV 250 GARIBALDI AVE LOOI NJ COMPUTER ENGINEERING ASSOCIATES INC 350 N HALSTEAD PASADENA CALIF COMPUTER ENGINEERING ASSOCIATES INC 350 N HALSTEAD PASADENA CALIF COMPUTER ENGINEERING ASSOCIATES INC 320 N HALSTEAD PASADENA CALIF COMPUTER ENGINEERING ASSOCIATES INC 320 N HALSTEAD PASADENA CALIF COMPUTER ENGINEERING ASSOCIATES INC 320 N HALSTEAD PASADENA CALIF COMPUTER ENGINEERING CORP 11612 OLYMPIC BLVD LOS ANGELES CALIF COMPUTER MA CON-ELCO 1711 S MOUNTAIN AVE MONROVIA CALIF

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CRAME DIV GIANNIAI CONTROLS CORP CRATE PACKING CO 6400 OAKTON ST MORTON GROVE ILL CRANE SYST & CONTROLS GROUP HOOKSETT INDUST PARK MANCHESTER N H HOOKSETT INDUST PARK MANCHESTER CRESCENT CO 20 CENTRAL AVE PAWTUCKET R I CRESCENT COMMUNICATIDNS CORP 43 MEMPSTEAD ST N LONDON CONN CRESCENT FAGB (A RESEARCH CO 5440 N PECK RD EL MONTE CALIF CRESENT FABRICATORS CORP 3951 60TH ST WOODSIDE 77 N Y CRITTENDEN TRANSFORMER WORKS 13011 S SPRING ST LOS ANG CALIF CRITTENDEN TRANSFORMER WORKS 1220 N ADEAU ST LOS ANG CALIF CROMAME INC CRITTENDEN TRANSFORMER WORKS 1220 N ADEAU ST LOS ANG CALIF CRONAME INC 6283 HOWARD ST CHICAGO ILL CROSS CO H 3229 BERGENLINE AVE UNION CITY N J CROUSE HINDS CO BOX 131 SYRACUSE NY CROVEN LTD 500 BECH ST WHITBY ONT CANADA CROWN CONTROLS CORP 40 44 S WASHINGTON NEW BREMEN OHIO CROWN CONTROLS CORP 40 44 S WASHINGTON NEW BREMEN OHIO CROWN CONTROLS CORP 40 44 S WASHINGTON NEW BREMEN OHIO CROWN ENG DIV DATA TECH INC 3821 COMMERCIAL N E ALBUWERQUE NEW MEXICO CRUCIBLE STEEL CO OF AMERICA P 0 BOX 2518 PITISBURGH 30 PENNA CRYOSENICS INC STAFFORD VA CRYSTAL RESEARCH PRODUCTS W MEONI & PROSPECT AVE DUMONT NJ CRYSTALOWICS INC 249 STH ST CAMBRIDGE MASS CRYSTALX-WESTLAKE CORP W LENNI RD LENNI MILLS PA CTS CORP ELKMART IND CTS JF SHEVILLE INC CTS INC P O BOX 152 BERNE IND CTS OF ASHEVILLE INC MILLS GAP ROAD SKYLAND NORTH CAROLINA CUBEX CO 3322 TONIA AVE ALTADENA CALIF 3322 TONIA AVE ALTADENA CALIF CUBIC CORP 5575 KEARNY VILLA RD SANDIEGO CALIF CUMMINS CHICAGO CORP 4740 RAVENSWOOD CHICAGO ILL CUMMINS PORTABLE TOOLS DIV JOHN OSTER MFG CO 5055 N LYDELL AVE MILWAUKEE IT WISC CUNNINGHAM & SONS JAMES 33 LITCHFIELD ST ROCHESTER N Y CURRY ARTS 522 GREEN RIDGE ST SCRANTON PENNA CUNNINGHAM & SONS JAMES 33 LITCHFIELD ST ROCHESTER N Y CURY ARTS 522 GREEN RIDGE ST SCRANTON PENNA CURTIS DEVELOPMENT & MFG CO 3218 N 33 ST MILWAUKEE 16 WISC CURTIS DEVELOPMENT & MFG CO 3276 N 33RD ST MILWAUKEE 16 WISC ELECTRONICS DIV CURTISS WRIGHT E PATERSON N J CURTISS WRIGHT CORP 9733 COORS RD NW BX 10044 ALBUQUEREUE N M CURTISS-WRIGHT CORP ELECTRONICS DIV 35 MARKET ST EAST PATERSON NJ CURTISS-WRIGHT CORP WRIGHT AERONAUTICAL DIV WOOD RIDGE NJ CUSH CRAFT 621 HAYWARD ST MANCHESTER N H CUSTOM COMPONENTS INC P 0 BOX 248 CALDWELL N J CUSTOM ELECT MFG CORP 5009 E ADMIRAL PLACE TULSA OKLA CUSTOM SCIENTIFIC INSTRUMENTS INC 541 DEVON ST KFARNEY NJ CUTER HAMMER INC 436 W12 ST MILWAUKEE WISC CUTLER HAMMER COP 1025 LINE ST CAMDEN N J CYCLE EQUIPMENT CO 17400 SHELBURNE WAY LOS GATOS CALIF CYCLE TANSFORMER CORP 356 GLENWOOD AVE ORANGE N J D DACO INSTRUMENT, CO TILLARY & PRINCE STS BROOKLYN I N Y DAGE ELECTRIC CO 67 N 2 ST BEECH GROVE IND THOMPSON RAMO WOOLDRIDGE INC DAGE DIV w 10 ST MICHIGAN CITY IND DAHLSTROM METALLIC DOOR CO BUFFALO 2 STS JAMESTOWN N Y DAISLEY CO INC RAY 585 W HOFFMAN AVE LINDENHURST N Y DAKOTA ENGG INC 4315-4317 SEPULYEDA BLVD CULVER CITY CALIF DALE ELECTRONICS INC DIV OF LIONEL CORP ROX 408 COLUMENUS NERR DALE ELECTRONICS INC SIOUX DV DIV OF LIONEL CORP YANKTON S D

CRAIG SYSTEMS INC LAWRENCE MASS CRAMER DIV GIANNINI CONTROLS CORP

MAANUFACTURERS - A TO Z DALES CO FRANKLIN 185 F WILL ST AKRON OHIO DALES MFG CO WABASSO FLA DA-LITE SCREEN CO WARSAW IND DALLONS LABS 120 KANSAS ST EL SEGUNDO CALIF DALLONS SEMICONDUCTORS DIV DALLONS LABS INC 5066 SANTA MONICA BLVD LOS ANGELES 29 CAL DALWELD CO INC 240 HIGHLAND AVE NEEDHAM HEIGHTS 94 HASS DAMON ENGINEERING INC 240 HIGHLAND AVE NEEDHAM HEIGHTS 94 HASS DAMON ENGING STUDIOS 117 W14 ST KANSAS CITY 5 MO DAMPE CHASER INC 240 HIGHLAND AVE NEEDHAM HEIGHTS 94 HASS DAMON ECORDING STUDIOS 117 W14 ST KANSAS CITY 5 MO DAMPE CHASER INC 200 S LARAMIE AVE CHICAGO 50 ILL DANIELS MO DANIELS MO DANIELS MO DANIELS MO DANIELS MO DANIELS MO DANIES INC C R DANIELS MO DANIELS MO DANIE SPECIALITIES INC 2100 S LARAMIE AVE CHICAGO 50 ILL DANA ELEC CO 93 MAIN ST WINSTED CONN DATE ELECTRIC MFG CO BANTAM CONN DATA DISPLAY INC 1820 COMO AVE ST PAUL MINN DATA INSTRUMENTS 12038 SATICOY N HOLLYWOOD CALIF DATA STSTUMENTS 12038 SATICOY N HOLLYWOOD CALIF DATA STSTUMENTS 12038 SATICOY N HOLLYWOOD CALIF DATA STSTEMENTS 12038 SATICOY N HOLLYWOOD CALIF DATA STSTEMENTS 12038 SATICOY N HOLLYWOOD CALIF DATA STSTEMENTS 12038 COMO AVE ST PAUL MINN DATA INSTRUMENTS 12038 DIVISION AIR LOGISTICS COP 2415 AMSLER ST TORRANCE CALIF DATA SYSTEMS DEPT 301 HARBOR BLVD COSTA MESA CALIF DATA TECHNOLOGY INC 3821 COMMERCIAL NE ALBUQUERQUE N MEX DATASCAN INC DA DATA DATA STST MALTHAM WASS DATASCAN INC DATA TECHNOLOGY INC 3821 COMMERCIAL NE ALBUQUERQUE N DATAMETRICS INC 87 BEAVER ST WALTHAM MASS DATASCAN INC P O BOX 785 CLIFTON N J DATEX CORP 1307 MYRTLE AVE MONROVIA CALIF DATRAX DIV AUTO INDUST INC 3501 LOMITA BLVD TORRANCE CALIF DATRAX DIV AUTO INDUST INC 3501 LOMITA BLVD TORRANCE CALIF DATRAX DIV A WHENRY CO 4443 E SLAUSON AVE MAYWOOD CALIF DATRAX DIV W WHENRY CO 4443 E SLAUSON AVE MAYWOOD CALIF DAVEN CO ROUTE 10 LIVINGSTON NJ DAVIDOFF CHARLES 198 BROADWAY NEW YORK 38 NY DAVIES MULDING CO HARRY 1428 WELLS ST CHICAGO ILL DAVIES SUPPLY 6 MFG CO 41600 MERAMEC ST ST LOUIS 16 MO DAVIS 6 CO J W 9212 DENTON DR DALLAS TEXAS DAVIS ELECTRIC CO 9212 DENTON DR DALLAS TEXAS DAVIS ELECTRIC CO 230 SPRING AVE CAPE GIRARDEAU MG DAVISON CHEMICAL CO ERWIN TENN DAVISON CHEMICAL CO BOX 488 POMPTON PLAINS N J DAWE INSTRUMENTS LTD WESTERN AUE LONDON FUC DAVISON CHEMICAL CO BOX ASB POMPTON PLAINS N J DAWE INSTRUMENTS LTD WESTERN AVE LONDON ENG DAWELD CO INC 13 BERTEL AVE MOUNT VERNON N Y DAY-RAY PRODUCTS INC 1133 MISSION ST S PASADENA CALIF DAYSTROM INC MILITARY ELECTRONICS DIV ARCHBALD PENNA DAYSTROM INC MILITARY ELECTRONICS DIV ARCHBALD PENNA DAYSTROM INC CONTROL SYSTEMS DIV ARCHBALD PENNA DAYSTROM INC CONTROL SYSTEMS DIV ARCHBALD PENNA DAYSTROM INC CONTROL SYSTEMS DIV 4455 MIRAMAR RD LAJOLLA CALIF DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV 614 FRELINGHUYSEN AVE NEWARK 12 N J DAYSTROM TRANSISTOR CORP WORCESTER PENNA DAYSTROM MESTON INDUST DIV DAYSTROM INC MANCHESTER RD POUGHKEEPSIE N Y DAYTON MISTAVE FORT LAUDERDALE FLA DAYTON AIRCRAFT PRODUCTS INC 812 NW IST AVE FORT LAUDERDALE FLA DAYTON AVIATION RADIO 6 EQUIP CO BOX 312 BUSINESS RT 25 TROY DHID DAYTRONIC CORP 223 227 JEFFERSON ST DAYTON 0HID DBM RESEARCH CORP P 0 80X 3431 ORLANDO FLA DE AN CONTROLS INC 944 DDRCHESTER AVE DORCHESTER MASS DEARBORN ELECTRONIC LASS INC P 0 80X 3431 ORLANDO FLA DE ANCONTROLS INC WATER ST MAZARDVILLE CONN DECHERT PRANA DECLMETER PRODUCTS CO STAR ROUTE BOX 67 LITILETON COLO STAR ROUTE BOX 67 LITILETON COLO DECKER CORP PALWYRA PENNA DECLMETER RD BALA CYNWYD PENNA DECCHECTRONICS INC DECKER CORP DECKER CORP 45 MONUMENT RD BALA CYNWYD PENNA DECO ELECTRONICS INC 1000 CONNECTICUT AVE N W WASHINGTON D C DECOURSEY ENGG LAB 11828 W JEFFERSON BLVD CULVER CITY CALIF DEE ELECTRIC CO 1708 BELMONT AVE CHICAGO ILL DEFIANCE PRINTED CIRCUIT CORP 144 COMMERCIAL ST MALDEN MASS

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DIAMONITE PRODUCTS MFG CO DIV U S CERAMIC TILE CO SHREVE DHIO DI-AN CONTROLS INC 944 DORCHESTER AVENUE DORCHESTER MASS 944 DORCHESTER AVENUE DORCHESTER HAS DIAPHLEX DIV 2700 N SOUTHPORT CHICAGO 14 ILL DIATRON INC BOX 3426 BELLARE TEXAS DICE CO J W 16 HIGHWOOD AVE ENGLEWOOD N J DICKSON ELECTRONICS CORP 248 WELLS FARGO AVE SCOTTSDALE ARIZ DICON CORP DICON CORP P 0 BOX 177 PORT WASHINGTON N Y DICTAPHONE CORP 730 THIRD AVE NEW YORK N Y DICTAPHONE CORP DICTAPHONE CORP 375 HOWARD'AVE BRIDGEPDRT CONN DIE-FORM CIRCUITS INC 6045 W OGDEN AVE CHICAGO 50 ILL DIEREL DIE & MFG CO 6505 OAKTON ST MORTON GROVE ILL DIEHL MEG CD FINDERNE AVE SOMERVILLE N J FINDERNE AVE SUMERVILLE N U DIELECT INC CORAL ST BOX 44 FORDS N J DIELECTRIC MATERIAL CO 1811 W BRYN MAWR AVE CHICAGO ILL DIELECTRIC PRODUCTS ENGG CO RAYMOND ME DIELECTRIC PRODUCTS ENGG CO DEDIDECTADA ME RAIMOND ME DIELECTRIC PRODUCTS ENGG CO BRIDGETON ME DIETZ CO MENRY G INC 12-16 ASTORIA BLVD LONG ISLAND CITY 2 N Y DIETZ CO S J 9 E WESLEY ST MACKENSACK N J DIETZ DESIGN INC GRANDVIEW MO DIGITAL DESIGN CDRP BOX 21 CLAY N Y DIGITAL SYSTEMS INC 812 DODSWORTH AVE COVINA CALIF DIGITECH INC 382 DANBURY RD WILTON CONN B12 DODSWORTH AVE COVINA CALIF DIGITECH INC 382 DANBURY RD WILTON CONN DIGITECH INC 130 WATER ST S NORWALK CONN DIGITECH INC 300 BRADWAY RD HOUSTON TEXAS 060 S ARGYO PARKWAY PASADENA CALIF 060 S ARGYO PARKWAY PASADENA CALIF DIGITRAN CO DIV ENDEVCO CORP 45 W UNION ST PASADENA CALIF DIGITRAN CO DIV ENDEVCO CORP 45 W UNION ST PASADENA CALIF DIGITRAN CO DIV ENDEVCO CORP ALDERTSON AVE ALBERTSON L I N Y DILECTRIX CORP ALLEN BLVD 6 GRAND AVE FARMINGDALE LI N Y DILECTRIX CORP ALLEN BLVD 6 GRAND AVE FARMINGDALE LI N Y DILETRIX CORP ALLEN BLVD 6 GRAND AVE FARMINGDALE LI N Y DILECTRIX CORP 1461D KESWICK ST VAN NUYS CALIF DIMCO-GRAY CO 207 E 6 ST DAYTON 2 OHIO DINION COIL CO CALEDONIA N Y DIOTRON INC 3650 RICHMOND ST PHILA PENNA DILT-MCO GOMPASS 6 INSTRUMENT CO BOEING FIELD BOX 37 SEATTLE WASH DIT-MCO INC ELETRONICS DIV 911 BROADWAY KANSAS CITY MO DI-TRAN CORPORATION 11307 HINDRY AVE LOS ANGELES 45 CALIF DITMORE FREIMUTH CORP 2517 E NORWICH ST MILWAUKEE WISC DIXON CORP BURNSIDE BRISTOL R 1 DIXON CRUCIBLE CO JOSEPH 382 DANBURY RD WILTON CONN BURNSIDE BRISTOL R I BURNSIDE BRISTOL R I DIXON CRUCIBLE CO JOSEPH 167 WAYNE ST JERSEY CITY 3 N J OJECO DIV DJORDJEVIC ENGG CO 1A7 WAYNE ST JERSEY CITY 3 N J OJECO DIV DJORDJEVIC ENGG CO 1933 N DAMEN CHICAGO 47 ILL DJORDJEVIC ENG CO 1933 N DAMEN CHICAGO 1LL DKE ELECTRIC BASES CORP 27 WRIGHT ST NEWARK NJ DMETER MFG CO 22 24 LARKIN PLAZA YONKERS N Y THE ODALL CO 254 N LAUREL AVE DES PLAINES ILL DOCKENDORFF 6 CO INC 606 LINDLEY ST BRIDGEPORT CONN DOLIN METAL PRODUCTS INC 313 LEXINGTON AVE BROOKLYN N Y DDLINKO 6 WILKENS INC 1907 SUMMIT AVE UNION CITY N J DON BOSCO ELECT SUB OF HOWELL ELECT MOTORSCO LITTELL RD HANOVER N J DONGAN ELECTRIC WFG CO 2987 FRANKLIN ST DETROIT MICH DON LAN ELECTRONICS CORP SUB GUANTATRON INC 2520 COLORADO AVE SANTA MONICA CAL DONNE NELECTRONICS CORP SUB GUANTATRON INC 2520 COLORADO AVE SANTA MONICA CAL DONNE ST WALTAW MASS DORE CO JOHN L PO BOX 7772 HOUSTON 7 TEX DORMEYER CORP 700 N KINGSBURY AVE CHICAGO 1LL DORMEYER INDUSTRIES 3418 MILWAUKEE AVE CHICAGO 41 ILL DORMEYER INDUSTRIES KENTLAND INDIANA DORME 6 MARQUEN KENTLAND INDIANA DORNE 6 MARGOLIN 29 N Y AVE WESTBURY N Y DORSETT ELECTRONICS 119 W BOYO NORMAN OKLA

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DYNAMETRICS CORP NORTHWEST INDUST PARK BURLINGTON MASS DYNAMIC LAIR ENGG INC 7412 MAIE AVE LOS ANGELES 1 CALIF DYNAMIC CONTROLS CD 2225 MASSACHUSETTS AVE CAMBRIDGE MASS DYNAMIC ELECTRONICS INC 87-46 123RD ST RICHMOND HILL N Y DYNAMIC GEAR COM INC 175 DIXOM AVE AMITYVILLE N Y OYNAMIC INSTRUMENT CORP 59 NEW YORK AVE WESTBURY N Y DYNAMIC MEASUREMENTS CO DAVISVILLE 6 TERMOOD RD WILLOW GROVE PA DYNAMIC MEASUREMENTS CO DAVISVILLE 6 TERMOOD RD WILLOW GROVE PA DYNAMIC SINST CO 583 MONTEREY PASS RD MONTEREY PK CALIF DYNAMU MAGNETRONICS CORP DIV MAICO ELECT INC 21 N 3 ST MINNEAPOLIS MINN DYNAPAR CORP 437 E STEWART MILWAUKEE WISC DYNATONICS CONPORTION 200 MICHAEL DRIVE SYDSSET NY DYNATRONICS CALE ENGG CORP 136 SAN FERNANDO RD LOS ANG CALIF DYNATRONICS INC P O GOX 2566 ORLANDO FLA DYNAVOX CORP P 0 BOX 2566 ORLANDO FLA DYRAYOX CORP 40-50 21ST ST LONG ISLAND CITY I N Y DYNFL INC 12723 S SPRING ST LOS ANG CALIF DYTRONICS CO BOX 3676 COLUMNUS OHIO DYTRONICS INC DIV OF TAYLOR FIBDR ROCHESTER 53 MICHIGAN D2US FASTENER CO 125 UNION ST WEST ISLIP N Y

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MANUFACTURERS – A TO 2 ELECTRICAL INSULATION CO INC 1245 MARCONI BL COPIAGUE N Y ELECTRICAL INSTRUMENT CORP 200 HARVARO AVE STAMFORD CONN ELECTRICAL INDUSTRIES 691 CENTRAL AVE MURRAY HILL NJ ELECTRICAL PRODUCTS RESEARCH & DEV CO INC 1206 CHERRY ST TOLEDO 4 OHIO ELECTRICAL REFRACTORIES CO E CLARK ST E PALESTINE OHIO ELECTRICAL SPECIALTY CO 138 ELEVENTH SJAN FRANCISCO CALIF ELECTRICAL SPECIALTY CO 138 ELEVENTH ST SAN FRANCALIF ELECTRO-AIR CLEANER CO INC 0LIVIA 6 SPROUL ST MCKEES ROCKS PA ELECTRO-CERAMICS INC 2645 S 2ND W SALT LAKE CITY UTAM ELECTRO CHEMICAL ENGRAVING CO INC 1100 BROOK AVE BRONX N Y ELECTRO CHEMICAL ENGRAVING CO INC 1100 ROOK AVE BRONX N Y ELECTRO CHEMICAL ENGRAVING CO INC 1100 ROOK AVE BRONX N Y ELECTRO CHEMICAL ENGRAVING CO INC 1100 ROOK AVE BRONX N Y ELECTRO CHEMICAL DIV REPUBLIC FOIL INC SALISPURY NC ELECTRO CHEMICAL INVERFUBLIC FOIL INC SALISPURY NC ELECTRO CHEMICAL DIV REPUBLIC FOIL INC SALISBURY NC ELECTROCHEMICAL INDUSTRIES INC 35 ARMORY ST WORCESTER 3 MASS ELECTRO CIRCUITS' INC 176 WALKER STREET LOWELL MASS ELECTRO DIV BURROUGHS CORP 460 SIFRRA MADRE VILLA PASADINA CALIF ELECTRO-DEVELOPMENT CO LIFO WALKEN SINEET LUMELL HASS ELECTRODATA DIV BURROUGHS CORP 460 SIFRRA MADRE VILLA PASADENA CALIF ELECTRO-DEVELOPMENT CO 14701 KESWICK ST VAN NUYS CALIF ELECTRO DEVICES INC 4 GODWIN AVE PATERSON N J ELECTRO DEVICES INC 4 GODWIN AVE PATERSON N J ELECTRO FLEG SINC 3 VICTORIA AVE LOS ANGELES 43 CALIF ELECTRO-ETCH CIRCUITS INC 7112 SO VICTORIA AVE LOS ANGELES 43 CALIF ELECTROFLEX HARTFORD CONN ELECTROFLEX HARTFORD CONN ELECTROFLOR INC 7356 SANTA MONICA BL LOS ANGELES CALIF ELECTRO GEAR CORP ELECTRO PROD DIV 132 W COLORADO BLVD PASADENA CALIF ELECTRO INPULSE LAB INC 208 RIVER ST RED BANK N J ELECTRO INFURMENT INC 8611 BALBOA AVE SAN DIEGO 11 CALIFORNIA ELECTRO INTERNATIONAL INC GREENWOD ACRES SECOND ST ANNAPOLIS MD ELECTRO-LOGIC CORP 110 W 131 ST LOS ANGELES 61 CALIF ELECTRO LOGIC CORP 1375 CALIF AVE PALO ALTO CALIF ELECTROMAGNETIC TECHCORP 1375 CALIF AVE PALO ALTO CALIF ELECTROMAGNETIC TECHCORP 1375 CALIF AVE PALO ALTO CALIF ELECTROMATIC EQUIP CO 562 ALBERMARLE RD CEOARHURST N Y ELECTROMATIC EQUIP CO 582 GLENCOE AVE VENICE CALIF ELECTROMECHANICAL DIV GENERAL RIVETERS INC 785 HERTEL AVE BUFFALO T N Y ELECTROMECHANICAL DIST PERKASTE PA ELECTROMECHANICAL SPECIALTIES CO 407 N MAPLE DR BEVERLY HILLS CALIF ELECTROMECHANICAL SPECIALTIES 528 LABBERT RD WHITTIER CALIF ELECTROMECHANICAL SPECIALTIES CO 407 N MAPLE DR BEVERLY HILLS CALIF ELECTROMECHANICAL SPECIALTIES CO 407 N MAPLE DR BEVERLY HILLS CALIF ELECTROMECHANICAL SPECIALTIES 528 LABBERT RD WHITTIER CALIF ELECTROMECHANICAL SPECIALTIES 540 DOSTOCK 10 YT ELECTROMECHANICAL SPECIALTIES CO 703 MAIN ST BURBAWK CALIF ELECTROMECHANICAL AR INC 5 WODDSTOCK 10 YT ELECTROMECHANICAL SPECIALTIES OF 703 MAIN ST BURBAWK CALIF ELECTROMECHANICAL SPECIALTIES 604 HVVER ST SOUTH MACKENSACK NJ ELECTROMECHANICAL SPECIALTIES OF 703 MAIN ST BURBAWK CALIF ELECTROMECHANICAL SPECIALTIES OF 704 MAIN ST BURBAWK CALIF ELECT 103 MAIN SI BUNDAME CALIF ELECTRO-MINIATURES CORP 004 HUYLER ST SOUTH HACKENSACK NJ ELECTROMODE P 0 BOX 1052 ROCHESTER 3 N Y ELECTRO MOTIVE MFG CO INC WILLIMANTIC CONN THE ELECTRO NUCLEAR SYS CORP 9449 SCIENCE CENTER DR MINN MYNN ELECTROPHONO 6 PARTS CORP 330 CAAL ST NEW YORK N Y ELECTRO PHYSICS CO 297 BROADWAY NEW YORK 7 N Y ELECTRO PHYSICS LABS 1900 WALKER AVE MONROVIA CALIF ELECTRO PHYSICS LABS 1900 WALKER AVE MONROVIA CALIF ELECTRO PHYSICS LABS 1900 WALKER AVE MONROVIA CALIF ELECTRO PRODUCTS LABS INC 4501 N RAVENSWOOD AVE CHICAGO 40 ILL ELECTRO PRODUCTS DIV WESTERN GEAR CORP 132 COLORADO ST PASADENA CALIF ELECTRO PRODUCTS INC 15050 SCHAFER HWY OETROIT MICH ELECTRO-POLSE INC 11861 FEALE ST CULVER CITY CALIF ELECTRO SCIENTIFIC IND INC 7574 MAIN SI WERSTER MASS ELECTRO SOLID CONTROLS INC 8001 BLOOMINGTON FREEWAY MINN MINN ELECTRO-SONIC LARS 33-54 36 ST LONG ISLAND CITY 6 N Y ELECTRO SWITCH CORP KING AVE WEYMOUTH 88 MASS

ELECTRONIC INDUSTRIES June 1952

ELECTRO-SWITCH & CONTROLS INC 5753 CAMILLE AVE CULVER CITY CALIF ELECTRO-TEC CORP 1 HENDERSON DRIVE WEST CALDWELL NJ ELECTRO TEC CORP VIRGINIA DIV BOX 219 BLACKSDURG VA ELECTRO-TECHNICAL LABS 5134 GLENHONT DR HOUSTON 36 TEXAS ELECTRO TECHNICAL PRODUCTS 113 E CENTRE ST NUTLEY N J ELECTRO TECHNICAL PRODUCTS 1130 E OCEAN AVE LA HABRA CALIF ELECTRO TECHNICAL PRODUCTS 1130 E OCEAN AVE LA HABRA CALIF ELECTRO VISION LAB 41-00 A5TH ST LONG ISLAND CITY 1 N Y ELECTRO VOICE INC CARROLL CECLI STS BUCHANAN MICH ELECTRO NELO CO 35 GOFFLE ROAD HAWHORNE N J ELECTRON CORP 747 S CENTRAL EXPWY RICHAROSON TEXAS ELECTRON CORP BLOG 1 MAYNARD IND MASS ELECTRONIC APPLICATIONS INC 194 RICHMOND HILL AVE STAMFORO CONN ELECTRONIC ASSEMBLY CO INC 3 PRESCOTT ST ROXBURY 19 MASS ELECTRONIC ASSEMBLY CO INC 3 PRESCOTT ST ROXBURY 19 MASS ELECTRONIC ASSEMBLY CO INC 3 PRESCOTT ST ROXBURY 19 MASS ELECTRONIC ASSEMBLY CO INC 3 PRESCOTT ST ROXBURY 19 MASS ELECTRONIC ASSEMBLY CO INC 3 PRESCOTT ST ROXBURY 19 MASS ELECTRONIC 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S-ATO Z ELECTRONIC SPECIALTIES MFG CORP 100 LAMARTINE ST WORCESTER MASS ELECTRONIC SYSTEMS 7309 VARNA AVE N HOLLYWOOD CALIF ELECTRONIC SYSTEMS ENGG CO 2838 MILSHIRE BLVD OKLAHOMA CITY OKLA ELECTRONIC TIMERS CO PANA ILL ELECTRONIC TIME COIL CO 557 EAGLE ROCK AVE ROSELAND. NJ ELECTRONIC TUBE COIL CO 557 EAGLE ROCK AVE ROSELAND. NJ ELECTRONIC TUBE COIL CO 1200 E MERMAID LANE PHILA PA ELECTRONICS & GROANCE DV 2630 GLENOALE CINCINNATI OHIO ELECTRONICS & GROANCE DIV AVCO CORP CINCINATI OHIO ELECTRONICS BATTERIES INC 28 34 35 ST BROOKLYN N ELECTRONICS CORP OF AMERICA 1 MEMORIAL DR CAMBRIDGE 42 MASS ELECTRONICS DEVELOPMENT CO 3743 CAHUENGA BLVD N HOLLYWOOD CALIF ELECTRONICS DEVELOPMENT INC 521 MARVLYN AVF BDX 813 STATE COLLEGE PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS INC OF PA 2400 MARVLANO AVE WILLOW GROV E PA ELECTRONICS POUCTS DIV MARSHALL INDUSTRIES 430 N HALSTEAD ST PASADENA B CALIF ELECTRON RESEARCH INC P O BOX 327 EVANSVILLE IND ELECTRON RESEARCH INC 530 W 127H ST ERIE PENNA ELECTRONA ST PANORAMA CITY CALIF ELECTROPAC INC 3155 W SEGUNDO BLVD HAWTHORNE CALIF ELECTROPAC INC 210 PONTIUS AVE LOS ANGELES 25 CALIF ELECTROPAC INC 240 MADISON AVE REVANY NA MELES 25 CALIF ELECTROPAC INC 240 MADISON AVE NEW YORK 16 N Y ELEKTRO-SERV CO 400 JOHNSOM AVE BROOKLYN 37 N Y ELEMATICE GUIPMENT CORP 6731 S CHICAGO AVE CHAN YORK 16 N Y ELEMATICE GUIPMENT CORP 6731 S CHICAGO AVE CHAN HORICA CALIF ELEGIN INCRONICS DIV ELGIN NITURCHI ELECTRONIC SPECIALTIES MEG CORP ELGENCO INC 1231 COLORADO AVE SANTA MONICA CALIF ELGIN MICRONICS DIV ELGIN NAT WATCH CO 366 BLUFF CITY BLVD ELGIN ILL ELGIN MATIONAL WATCH CO 366 BLUFF CITY BLVD ELGIN ILL ELGIN TATIONAL WATCH CO 2435 N NAOMI ST BURBANK CALIF ELGIN LABS INC WATERFORO PA ELIN DIV INTL ELECT RESCH CORP 145 W MAGNOLIA BLVD BURBANK CALIF ELGON INSTRUMENTS INC ROUTE 130 NORTH BURLINGTON N J ELJAY CORP ELION INSTRUMENTS INC ROUTE 130 NORTH BURLINGTON N J ELJAY CORP 2908 MERBERT ST BALTIMORE MO ELK ELECTRONICS LABS INC 333 W 52 ST NEW YORK 19 N Y ELLIOIT ROS LONGON LTD DAHELLIT DIV ELSTREE WAY BOREHAMWOOD HERTS ENGLAND ELLIOIT BROS LTD BOREHAMWOOD HERTS ENGLAND ELLIOTT BROTHERS LONGON LTD RADAR DIV ELSTREE WAY BOREHAMWOOD HERTFORDSHIRE ENG ELLIS & WATRS PRODUCTS INC P 0 BOX 33 CINCINNATI 36 OHIO ELLIS & WATRS PRODUCTS INC P 0 BOX 33 CINCINNATI 36 OHIO ELLIS ASSOCIATES 67 LINCOLN AVE PELHAM N Y ELSTREE STRUMENT 30 CHASNER ST HAMPSTEAD LI NY 548 W MONROE ST CHICAGO 6 ILL ELM INSTRUMENT 30 CHASNER ST HAMPSTEAD LI NY ELM MFG CO INC PO BOX 14 HASTINGS ON HUDSON NY ELPAC INC 4270 ARTESIA ST FULLERTON CALIF P D B 41 NEW YORK 63 N Y EL-RAD MFG CO 4300 N CALIFORNIA AVE CHICAGO 18 ILL FLY SALES CO 130 LAFAYETTE ST NEW YORK 13 N Y ELZEE METAL PRODUCTS CO 775 39 ST BROOKLYN 32 N Y EMARCO CORP 1950 NEVA DRIVE DAYTON 14 OHIO EMC CORPORATION 180 E 6TH ST ST PAUL 1 MINN EMERSON 6 CUMING INC 869 WASHINGTON ST CANTON 1 MASS EMERSON PLECTRIC 8100 W FORISSANT AVE ST LOUIS 21 MO EMERSON PLASTICS CORP SEABURY AVE 6 BUTLER PL BRONX 61 N Y EMERSON RADIO 6 PHONOGRAPH CORP

EMERSON RADIO & PHONOGRAPH CORP 14 & COLES STS JERSEY CITY 2 N J

EMERSON-RITTENHOUSE CO INC 68 EAST ST HONEDYE FALLS N Y EMI COSSOR ELECTRONICS WOODSIDE DARTMOUTH NOVA SCOTIA EMI US 1750 VINE ST LOS ANG CALIF EMI US LTD FORT ATKINSON WISC FORT ATKINSON WISC EMI/US 13259 SHERMAN WAY NO HOLLYWOOD CALIF E M J MFG CO 760 REED SANTA CLARA CALIF EMMCO PLASTIC FAB DIV 68 VINE ST EVERETT MASS EMMERT MFG CO 1051 E MAIN ST WAYNESBORO PA EMPIRE DEVICES PRODUCTS CORP 37 PROSPECT ST AMSTEROAM NY EMPIRE PRODUCT SALES CORP 37 PROSPECT ST AMSTEROAM NY EMPIRE ELECTRONICS CO INC 60 SPRUCE ST PATERSON 1 NJ EMPIRE PRODUCT SALES CORP 37 PROSPECT ST AMSTEROAM N Y ENDECO ENGG DEVELOPMENT CO QF LOS ANGELES 8021 LONG BEACH VIXING WY LONG BEACH & CAL ENDEVGC CORP 161 E CALIFORNIA BLVD PASADENA CALIF ENFAB INC 312 F RROKAW RD SAN JOSE CALIF SIZ F BROKAW PD SAN JOSE CALIF ENFLO CORP FELLOWSHIP RO ROUTE 73 MAPLE SHAOE N J ENG NORTHWEST ENFLO CORP FELLOWSHIP RO ROUTE 73 MAPLE SHAOE N ENG NORTHWEST 2309 SHELLING MINN MINN ENG SPECIALITIES INC LAKEVILLE MINN ENGELMARD HANOVIA INC 100 CHESTNUT ST NEWARK 5 NJ ENGERMARD INDUSTRIES 850 PASSAIC AVF E NEWARK NJ ENGERAND INDUSTRIES 850 PASSAIC AVF E NEWARK NJ ENGERCE LECTRONICS CO 1441 E CHESTNUT AVE SANTA ANA CALIF ENGINEERED ELECTRONICS CO 1441 E CHESTNUT AVE SANTA ANA CALIF ENGINEERIMG ASSOCIATES 434 PATTERSON RD DAYTON 19 OHIO ENGS 6 MFG CORP OF TEXAS PO BOX 14216 OALLAS 34 TEXAS ENGIS EQUIP CO 431 E DEARBORN ST CHICAGO 1LL ENGISH ELECTRIC VALVE CO LTO CHELMSFORD ESSEX ENGLAND ENSIGN COIL CO 250 CULVER JENGLAND ENSIGN COIL CO 2520 S PULASKI CHICAGO 23 ILL ENTHONE INC 442 ELM ST NEW HAVEN 8 CONN ENTIGVEN SOLDERS LTD 113 N WATER ST ROCHESTER 4 N Y ENTRON INC 4902 LAWRENCE ST BLADENSBURG MD 113 N WATER ST ROCHESTER 4 N Y ENTRON INC 4902 LAWRENCE ST BLADENSBURG MD ENVIRONMENTAL EQUIPMENT CO 369 LINDEN ST BROOKLYN 27 N Y E O ELECTRONICS INC 14 MORRIS AVE MOUNTAIN LAKES NJ 14 MORNIS AVE MOULTANK CALIF SONETICS 3800 COHASSET BURBANK CALIF EPCO PRODUCTS INC 2500 ATLANTIC AVE BROOKLYN 7 NY 2500 ATLANTIC AVE BROOKLYN 7 NY EPIC INC EPIC INC 675 BARBEY ST NEW YORK 38 N Y EPM CORP 675 BARBEY ST BROOKLYN N Y EPOXY PRODUCTS OIV JOS WALDMAN 6 SONS 133 COIT ST IRVINGTON NJ EPPLEY LAB INC 12 SHEFFIELD AVE NEWPORT RI EPRAD INC 13206 (HERBEY ET TOLEOO A ONIO PRAD INC 1206 CHERRY ST TOLEDO 4 OHIO 1206 CHERRY ST TOLEDO 4 OHIO PSCO INC 388 COMMONWÉALTH AVE BOSTON 15 MASS FDSCO INC 275 MASSACHUSETIS AVE CAMBRIDGE 39 MASS EQUIPMENT AND SERVICE CO 7118 ENVOY CT DALLAS 7 TEXAS EQUIPTO DIV AURORA EQUIPMENT CO AURORA ILL EQUIPTO DIV AURORA EQUIPMENT CO AURORA ILL EQUIPTO ELECTRONICS CORP 319 N WEBSTER ST NAPERVILLE 6 ILL ERA DYNAMICS CEDAR GROVF NJ ERA RESEARCH INC 1009MONTANA AVE SANTA MONICA CALIF ERASER CO 1009MONTANA AVE SANTA MONICA CAL ERASER CO 1068 S CLINTON ST SYRACUSE 4 NY ERCA TOOL DIE & STAMPING CO 19 ASH ST BROOKLYN 22 N Y ERCO RAOIO LABS INC 637 STEWART AVE GARDEN CITY NY ERCOMA CORP 16 W 46TH ST NEW YORK 36 N Y ERCOC ENGG CORP 138 OFFICIAL RD ADDISON ILL ERICSON MFG CO 1660 HAYDEN AVE CLEVELANO OHIO ERIE ELECTRONICS DIV ERIE PACIFIC ERIE PACIFIC 12932 S WEBER WAY HAWTHORNE CALIF

ERIE RESISTOR OF CAMADA LTD 7 FRASER AVE TRENTON ONT CAMADA ELECTRONICS DIV ERIE RESISTOR CORP 644 W 12TH ST ERIF FA ERIE RESISTOR CORP 644 W 12 ST ERIF 64 ERIE TECHNICAL CERAMICS INC BOX 677 STATE COLLEGE PANNA ERIESDN SPECIALIZED TOOL CO P 0 BOX 424 PICO CALIF ERWOOD INC 1770 W BERTEAU AVE CHICAGO 13 ILL ESC ELECTRONICS CORP 000 RESS DALLSTON AVES SARATOGA SPRINGS NY ESSEX ELECTRONICS DIV SPECIALTY CO 1213 SAN FERNANDO RD LDS ANGELES 39 CALIF ESPEY MFG 6 ELECTRONICS CORP CONGRESS BALLSTON AVES SARATOGA SPRINGS NY ESSEX ELECTRONICS OF CANADA LTD 9 WRAGGE ST TRENTON ONT CANADA ESSEX ELECTRONICS OF CANADA LTD 9 WRAGGE ST TRENTON ONT CANADA ESSEX WIRE CORP 1601 WALL ST FT WAYNE 6 IND ESSEX ELECTRONICS CO OF AMERICA 6286 N CICERO AVE CHICAGO 46 ILL E T C INCORPORATED 900 E 67ST CLEVELAND OMIO ESTERLINE ANGUS INSTRUMENT COMPANY INC P000X 596 INDIANAPOLIS 6 IND ESTERLINE ANGUS INSTRUMENT CALIF EUGANCS ENG CO 200 N ALLEN AVE PASADENA CALIF EUGANCS ENG CO 200 N ALLEN AVE HORE PARK 36 MASS EURETA -RAY TUBE CORP 3230 N KILPATRIC AVE CHICAGO 41 ILL EUTECTIC WELDING ALOYS CHICAGO 41 ILL EUTECTIC WELDING ALOYS CHICAGO 41 ILL EUTECTIC WELDING ALLOYS CORP 3230 N KILPATRIC AVE HYDE PARK 36 MASS EUREKA -RAY TUBE CORP 3230 N KILPATRIC AVE HYDE PARK 36 MASS EUREKA -RAY TUBE CORP 3230 N KILPATRIC AVE HYDE PARK 36 MASS EUREKA -RAY TUBE CORP 3230 N KILPATRIC AVE CHICAGO 41 ILL EUTECTIC WELDING ALLOYS CORP 3320 N KILPATRIC AVE CHICAGO 117 157 BRIGHTON AVE BOSTON MASS EURETA CAREMERS EXACT ELECTRONICS INC P0 BOX 437 OCENSIOE CALIF EXACT WELGTING COLUMBUS 15 OHIO EXST NATICK WAS EXACT ELECTRONICS INC P0 BOX 437 OCENSIOE CALIF EXACT WELGTING SCLENS FACT ELECTRONICS INC P0 BOX 437 OCENSIOE CALIF EXACT WELGTING SCLUMBO DISTON HY EVELEAT A LECTRONICS INC P0 BOX ATTO VER RD BRONXVILLE 6 N Y EXECLEA CURPA 1200 OKAMAN RLYD DEFROIT MICH EXELECT RONICS INC P1 S00 AKTAY FERDELATES P1 BOO OX S33 RESEDA CALIF EXACT ELECTRONICS INC P1 S10 ACRETON SO CAMBRIDGE MASS E-2-MODU TS IN P-2-WAY TEMPLATES PO BOX 535 RESEDA CALIF E-2 WAY TOWERS INC 5901 E BROADWAY BX 5767 TAMPA 5 FLA F FABRA PRINT INC 801 S E BIH ST MINNEAPOLIS 14 MINN FABRA-PRINT INC 1331 E FRANKLIN MINNEAPOLIS MINN FABRA-PRINT INC 1111 E EXCELSIOR BLVD HOPKINS MINN FACTORY SERVICE CO 4015 N 21ST ST MILWAUKEE 9 WISC FAE INSTRUMENT CORP 16 NORDEN LANE HUNTINGTON STA L I N Y FAESY 6 BESTHOFF INC 25 E 61H ST NEW YORK 10 N Y FAFNIR BEARING CO 37 BOOTH ST NEW BRITAIN CONN FAFNIR BEARING CO 9000 DIRECTORS ROW DALLAS TEXAS FAFNIR REARING CO 9000 DIRECTORS ROW DALLAS TEXAS FAFNIR REARING CO 9000 DIRECTORS ROW DALLAS TEXAS FAFNIR TE PRODUCTS CORP COMMERCIAL ROW WALLKILL N Y FAIRBANKS WIRE CO WALNUT ST NEWBURGH N Y FAIRBANKS WIRE CO WALNUT ST NEWBURGH N Y FAIRBANKS WIRE CO WALNUT ST NEWBURGH N Y FAIRBANKS WIRE CO MALNUT ST NEWBURGH N Y FAIRCHILD CONTROLS CORP COMPONENTS DIV 25 PARK AVE MICKSVILLE L I N Y FAIRCHILD CONTROLS CORP 6111 E WASHINGTON BLVD LOS ANGELES CALIF FAIRCHILD RECORDING EOUIPMENT CO 10-40 45 AVE LONG ISLAND CITY, I N Y ELECTRONIC INDUSTRIES June 1962

<section-header><text> TEDERAL SCREW PRODUCTS INC 3917 N KEDZIE AVE CHICAGO 18 ILL FEDERAL SHOCKMOUNT CORP DIVISION OF THE KORFUND CO 1060 WASHINGTON AVE NEW YORK 56 NY FEDERAL STAMPING CO 7347 ATOLL AVE N HOLLYWOOD CALIF FEDERAL TOOL 6 MFG CO 3600 ALBAMA AVE MINNEAPOLIS 16 MINN AMERICAN SMELTING REFINING CO FEDERATED METALS DIV 150 ST CHARLES ST NEWARK 5 NJ FEEDRACK CONTROLS INC 8 ERIE DRIVE NATICK MASS FFILER ENGG 6 MFG CO 8026 N MONTICELLO AVE SKOKIE ILL FFINER 6 SONS P 522 W 45 ST NEW YORK N Y FELSINTHAL 6 SONS INC 6 3500 N KEDZIE AVE CHICAGO 18 ILL FFIT PRODUCTS MFG CO 7450 MCCORMICK BLVD SKOKIE ILL FELTERS CO 350 STH AVE NEW YORK 1 N Y FEN-TONE CORP 106 STH AVE NEW YORK 11 N Y FENAL ELECTRONIC INC 63 FOUNTAIN ST FRAMINGHAM MASS FFERMAL INC PLEASANT ST ASHLAND MASS FFERANTI ELECT INC INDUSTRIAL PK PLAINVIEW L I N Y FERRIS INDUSTRUMENT CORP 110 CORNELIA ST BOONTON N J FERROMAL ST BOOTON N J FERROTHERN CO __1861E 65TH ST CLEVELAND OHIO GREGG ST & RTE 17 LODI N J FERROTHERN CO-1861 E 65TH ST CLEVELAND OHIO FERROTRAN ELECTRONICS CO INC 693 BROADWAY NEW YORK 12 N Y FERROXCUBE CORP OF MAER 35 E BRIDGE ST SAUGERTIES N Y FF6M ELECTRONICS 12820 PANAMA ST LOS ANG CALIF FIBRE GLASS EVERCOAT CO BLUE ASH KIGLER MILLS RDS CINN OHIO CINCINNATI 36 OHIO BLUE ASH KIGLER MILLS RDS CINN OHIO CINCINNATI 36 OHIO FIDELITONE MICROWAYE INC 6415 RAVENSWOOD AVE CHICAGO ILL FIDELITY AMPLIFIER CO 1633 HALSTEAD ST CHICAGO ILL FIDELITY CHEMICAL PRODUCTS CORP 470 FRELINGHUYSEN AVE NEWARK 12 N J FIDELITY CHEMICAL PRODUCTS CORP 470 ARCH ST LANCASTER PA FILM CAPACITORS INC 3400 PARK AVE NEW YORK 56 NY FILMOHM CORP 48 W 25 ST NEW YORK 10 N Y FILTORS INC 30 SAGMORE HILL PORT WASH N Y

MANUFACTURERS - A TO FILTRON CO 131-15 FOWLER AVE FLUSHING 55 N Y FILTRON CO INC WESTERN DIV 10023 JEFFERSON BLVD CULVER CITY CALIF FINNELL SYSTEM INC ELKMART IND FINNEY CO 34 INTFRSTATE ST BEDFORD DHIO FIRE CONTROL CO INC 703 THORNTON ST WILMINGTON 1 DEL FIRST ELECTRONICS CORP 13 ST ANNE ST JAMAICA PLAIN MASS FISCHER & DORTER CO WARMINSTER PA FISCHER ELECTRONICS INC 2238 BAILEY AVE BUFFALO 11 N Y FISH-SCHURMAN CORP 109 N CAMAC ST PHILA 7 PA FISHER CONT 109 N CAMAC ST PHILA 7 PA FISHER CON P O BOX 327 HUNTINGTON IND FISHER ENG& INC P O BOX 327 HUNTINGTON IND FISHER ENG& INC P O BOX 327 HUNTINGTON IND FISHER ENG& INC PO BOX 307 MARSHALLTOWN IOWA FISHER PIERCE CO FISHER GOVERNOR CO BOX 307 MARSHALLTOWN IOWA FISHER PIERCE CO 170 PEARLS ST BRAINTREE MASS FISHER RADID CORP 2121 44 DR LONG ISLAND CITY N Y FISHER RESEARCH LAB 1975 UNIVER AVE PALO ALTO CALIF FISHER SCIENTIFIC CO 1 REAGENT LANE FAIR LAWN NJ FISHER SCIENTIFIC CO INSTRUMENT DIV INDIANA PENNA FISHER SCIENTIFIC CO INSTRUMENT D INDIANA PENNA FISHER SPECIAL MFG CO 446 MORGAN ST CINN OHIO FLAME RESEARCH INC BOX 10502 PITISBURGH 35 PA FLAMEMASTER CHEMICAL INC 3813 HOKE CULVER CITY CALIF FLEXONICS DIV OF CALUMET 6 HECLA 300 E DEVAN AVE BARILETT ILL FLEETWOOD LABS INC 35 ROCKWOOD PL N ROCHELLE N Y FLEXAUST CO <text>

FORWAY INDUSTRIES INC 122 GRFEN AVE WDONBYRY N J FDSTER TRANSFDRMER CD 3820 COLERAIN AVE CINNATI OHIO FDSTORIA CORP DEPT D2 BUCK 6 COUNTY LINE RDS HUNTINGDDN VAL PA FDSTORIA CORP 1200 MAIN ST FOSTORIA OHIO FDTO VIDED LABS 36-COMMERCE RD CEDAR GROVE N J FOURDEE INC 36-COMMERCE RD CEDAR GROVE N J FOURDEE INC 5440 E COLONIAL DR ORLANDO FLA FOURJAY INDUSTRIES 2801 ONTARIO AVE DAYTON OHIO FOX CO THOMAS T 304 MT PLEASANT AVE NEWARK 4 N J FDX PRODUCTS CO 4720 N 18 ST PHILA PA FOXBORO CO NEPONSET AVE FOXBORO MASS F & R ENTERPRISES 910 VALENCIA ST SAN FRAN CALIF FRAMCE MFG CO 10325 BEREA RD CLEVELAND 2 OHIO FRANKE GEAR WORKS INC P 6 K ENTERPRISES 910 VALENCIA SI SAN FRAN CALIF FRAMCE MEG CO 10325 BEREA RD CLEVELAND 2 OHIO FRANKE GEAR WORKS INC 4401 RAVENSWOOD AVE CHICAGO ILL FRANKEL CONNECTOR CO 27 VESTRY SI NEW YORK 13 N Y FRANKLIN ELECTRONICS INC E 4 TH SI BRIDGEPORT PA FRANKLIN ELECTRONICS INC 65 NE 22ND AVE MINN MINN FREPANK CO 711 W BROADWAY GLENDALE CALIF FREDERICK ELECT CORP 414 PINE AVE FREDERICK MD FREDERICK ELECT CORP 414 PINE AVE FREDERICK MD FREDERICK SLECT CORP 414 PINE AVE FREDERICK MD FREEDAN PRODUCTS CD 706 OKEEFE SI N ORLEANS LA FREEMAN CO 8TH 6 WALNUT YANKTON S D FREEMAY WASHER 6 STAMPING CO 4911 GRANT AVE CLEVFLAND DHIO FREENCHTOWN N J FREENCHTOWN N J FRECHAY RADIO MEG CO 164 W PARKER SI SCRANTON PA FREDUENCY ENG LABS BOX 504 ASBURY PARK NJ FRICK GALLAGHER MEG CO 200 S MICHIGAN WELLSTDN OHID FRIDEN CALCULATING MACHINE CO 2350 WASHINGTON AVE SAN LEANORD CALIF FRIDEN COMMERCIAL CONTROLS CORP 1 LEIGHTDN AVE ROCHESTER N Y FRONTIER ELECT CO 460B MEMPHIS AVE CLEVE OHIO FRIDEN COMMERCIAL CONTROLS CORP 1 LEIGHTDN AVE ROCHESTER N Y FUONT ELECT OC 460B MEMPHIS AVE CLEVE OHIO FRIDEN COMMERCIAL CONTROLS CORP 1 LEIGHTDN AVE ROCHESTER N Y FUONT ELECT OC 460B MEMPHIS AVE CLEVE OHIO FRIDEN COMMERCIAL CONTROLS CORP 1 LEIGHTDN AVE ROCHESTER N Y FUONT ELECT OC 460B MEMPHIS AVE CLEVE OHIO FRIDEN COMMERCIAL CONTROLS CORP 1 LEIGHTDN AVE ROCHESTER N Y FUOLE MACHAN INC 77 29 138 SI FLUSHING N Y FUULER COM B 904 W BLACKHAWK SI CHICAGD ILL FURANE PLASTICS INC 4316 BRAZIL SI LOS ANGELES 39 CALIF FURANS ELECTRIC CO 1000 MCKEE SI BATAVIA ILL FURANE PLASTICS INC 42 CHASNER SI MEMPSTEAD L I N Y FURANS ELECTRIC CO 1000 MCKEE SI BATAVIA ILL FURZEHILL LABS LTD THEOBALD SI BORHAMWOOD HERTS ENG FUSITE CORP 6000 FERNVIEW AVE CINCINNATI 12 OHIO F K NIC 40 ORD FRENVIEW AVE CINCINNATI 12 OHIO F K NIC 40 OND FERNVIEW AVE CINCINNATI 12 OHIO F K NIC 40 OND FRENVIEW AVE CINCINNATI 12 OHIO F K NIC 40 OND FRENVIEW AVE CI THEOBALD ST BOREMAMWOOD HERTS END FUSITE CDRP 6000 FERNVIEW AVE CINCINNATI 12 OHIO F X R INC 26-12 BOROUGH PLACE WODDSIDE 77 N Y FYR-FYTER ELECTRONIC 6 ALARM CORP EDISON N J

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- GABRIEL ELECTRONICS DIV GABRIEL CO MILLIS MASS GAI-TRONICS CORP 325 LANCASTER AVE READING PENNA GALLAND-HENNING NOPAK DIV 2753 S 31ST ST MILWAUKEE WISC GAP INSTRUWENT CORP 16 E MERRICK RD FREEPDRT N Y GAP INSTRUMENT CORP 17 BROKLYN AVE WESTBURY L I N Y GAR PRECISION PARTS 190 HERRY ST STAMFORD CONN GARDE MFG CD 35 JOHN ST CUMBERLAND R I GARDINER ELECTRONIC CO 2545 E INDIAN SCHOOL RD PHOENIX ARIZ GARDMER LAB INC P O 90X 5728 BETHESDA MD GARDMER-DENVER CO FRONT ST CUIMCY ILL GARLOCK ELECTRONIC PRODUCTS 402 MAIN ST PALMYRA N Y
- GARLOCK ELECTRONIC PRODUCTS 600 N 10TH ST CAMDEN 1 NJ GARNER T H CD 177 S INDIAN HILL BLVD CLAREMONT CALIF GARRARD SALES CORP 80 SHORE RD PORT WASHINGTON N Y GARY WELLS CD 361 ROCKAWAY AVE VALLEY STREAM N Y GASSER METAL PRODUCTS 69-15 50TH AVE WOODSIDE N Y GATES 6 CO GEO W HEMPSTEAD TRFK 6 LUCILLE AVE FRANK SO N Y GATES ELECTRONIC CO 2243 WHITE PLAINS RD BRONX N Y GATES ELECTRONIC CO 123 HAMPSHIRE ST DUINCY ILL GAVITT WIRE 6 CABLE CO DIV OF AMERACE CORP 455 N QUINCE ST ESCONDIDO CALIF GAVITT WIRE 6 CABLE CO DIV OF AMERACE CORP 8BROOKFIELD MASS GAYLOR PRODUCTS CO 11100 CUMPSTON ST N HOLLYWOOD CALIF GAVIGT WIRE ACABLE CO 181 N HILL ST PASADENA CALIF G C ELECT CD 400 S WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ESISTOR DIV 400 SO WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ESISTOR DIV 400 SO WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ESISTOR DIV 400 SO WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ESISTOR DIV 400 SO WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ESISTOR DIV 400 SO WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ESISTOR DIV 400 SO WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ESISTOR DIV 400 SO WYMAN ST ROCKFORD ILL G-C ELECTRONICS CO MORD A ELECTRONICS G-C ELECTRONICS CO KNOB & RESISTOR DIV 400 S WYMAN ST ROCKFORD ILL GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 400 S WYMAN ST ROCKFORD ILL GEARTRONICS CORPORATION 114 CHELMSFORD RD BILLERICA MASS GEBE ELECTRONIC SERVICE 4112 W JEFFERSON BLVD LOS ANG CAL GEE LAR MFG CO 400 WYMAN ST ROCKFORD ILL GEER MACHINE WORKS INC 200 NEVADA ST EL SEGUNDO CALIF GEFCO MFG CORP 101 PINE ST BOX 436 GRAYSLAKE ILL GEMCO ELECTRIC CO 25685 W EIGHT MILE RD DETROIT MICH GEMS CD SHEPPARD LANE BOX 255 FARMINGTON CONN Gereco MFG CORP 101 PINE ST BOX A36 GRAYSLAKE ILL GROC ELECTRIC CO 28685 W EIGHT MILE RD DETROIT MICH GEMS GEN AMERICAN TRANSPORTATION CORP 135 S LASALLE ST CHICAGO 90 ILL GENALE DIV BRITISH INDUSTRIES CORP 80 SHORE RD PORT WASHINGTON N Y GENERAL APPLIED SCIENCE LAB MERRICK 6 STEWART AVE WESTBURY N Y GENERAL ATOMATICS INC 31 ALMA ST PALO ALTO CALIF GENERAL ATOMATICS CORP ATRONIC PROD DIV 1200 E MERMAID LANE PHILA PA GENERAL ATOMATICS CORP ATRONIC PROD DIV 1200 E MERMAID LANE PHILA PA GENERAL ATOMICS CORP UNION HILL & CONSHOHOROCKEN PENNA GENERAL ATOMATICS INC 31 ALMA ST PALO ALTO CALIF GENERAL ATOMICS CORP UNION HILL & CONSHOHOROCKEN PENNA GENERAL AUTOMATICS INC 31 ALMA ST PALO ALTO CALIF GENERAL AUTOMATICS INC 31 ALMA ST DES PLAINES ILL GENERAL AUTOMATICS INC 31 ALMA ST DES PLAINES ILL GENERAL CAUTOMATICS DIV 10 AND AYE WEY YORK N Y GENERAL CABLE CORP 25 MASHINER ST DES PLAINES ILL GENERAL CABLE CORP 25 MASHINGTON ST PERTH AMBOY N J GENERAL CABLE CORP 25 MASHINGTON ST PERTH AMBOY N J GENERAL CABLE CORP 31 ATO NG AVE WEY YORK N Y GENERAL CABLE CORP 31 ATO NG AVE MEY YORK N Y GENERAL CABLE CORP 31 ATO RAILROAD ST ROME N Y GENERAL CABLE CORP 31 ATO INCIDIES DIV IND GENERAL CORP CRUSS MILL RD KFASBEY N J GENERAL COHICAL DIV 40 ACECTOR ST NEW YORK 6 N Y GENERAL COHICAL DIV 40 ACECTOR ST NEW YORK 6 N Y GENERAL COMMUNICATIDN CO 31 ALLER AVE GENDALE I CALIF GENERAL CONTROLS CO TRIMOUNT INSTRUMENT DIV 30 ANCORMICK BLVD SKOKIE ILL GENERAL CONTROLS CO TRIMOUNT INSTRUMENT DIV 30 AD DUE TERS INC 90 ON PICO BLUE DIS ANG CALIF GENERAL CONTROLS CO GANADA LTD 11 SURREY ST GUELPH ONT CANADA GENERAL CONTROLS CO GANADA LTD 11 SURREY ST GUELPH ONT CANADA GENERAL CONTROLS CO GANADA LTD 13 SURREY ST GUELPH ONT CANADA GENERAL CONTROLS CO TRIMOUNTAIN MICH GENERAL CONTROLS CO TRIMOUNTAIN DISC GENERAL CONTROLS CO CANADA LTD 13 SURREY ST GUELPH ONT CANADA GENERAL DYNAMICS FLECTMONISC GENERAL DYNAMICS FLECTMONISC DO DOX 1012 POMDA CALIF GENERAL DYNAMICS/SLECTINDING 140

GARLOCK ELECTRONIC PRODUCTS

GENERAL ELECTRIC CO 1034 66TH AVE OAKLAND 21 CALIF GENERAL ELECTRIC CD 10 MANSION ST P D BOX 278 COXSACKIE N Y GENERAL ELECTRIC CO APPARATUS SALES DIV 1 RIVER RD SCHEMECIADY 5 NY GENERAL ELECTRIC CO ELECTRONIC PARK SYRACUSE N Y GENERAL ELECTRIC CO SILICONE PRODUCIS DEPT A WATERFORD N Y GENERAL ELECTRIC CO CAROLINA WELDS PLANT GOLDSBORO NC GENERAL ELECTRIC CO 21800 TUNGSTEN RD CLEVELAND 17 OHIO GENERAL ELECTRIC CO 1285 BOSION AVE BRIDGEPORT CONN GENERAL ELECTRIC CO 1285 BOSTON AVE BRIDGEPORT CONN GENERAL ELECTRIC CO SHELBYVILLE IND GENERAL ELECTRIC CO 1285 BOSTON AVE BRIDGEPORT CONN GENERAL ELECTRIC CO SHELBYVILLE IND GENERAL ELECTRIC CO 100 W BROADWAY DOVER OHIO GENERAL ELECTRIC CO ANNISTON TUBE PLANT BOX 1400 ANNISTON ALA GENERAL ELECTRIC CO ATOM POWER EQUIP 2151 S 1ST ST SAN JDSE CALIF GENERAL ELECTRIC CO ANDID PRODUCTS DEPT 2200 N 22 ST DECATUR ILL GENERAL ELECTRIC CO CAPACITOR DEPT JOHN ST HUDSON FALLS N Y GENERAL ELECTRIC CO CATHODE RAY TUBE DEPT ELECTRONICSPARK SYRACUSE N Y GENERAL ELECTRIC CO CATHODE RAY TUBE DEPT ELECTRONICSPARK SYRACUSE N Y GENERAL ELECTRIC CO CATHODE RAY TUBE DEPT ELECTRONICSPARK SYRACUSE N Y GENERAL ELECTRIC CO CICUIT PROTECTIVE 41 WOODFORD AVE PLAINVILLE CONN GENERAL ELECTRIC CO COMPONENTS ARIZ GENERAL ELECTRIC CO COMPONENTS ARIZ GENERAL ELECTRIC CO SUBJERY 1 RIVER RD SCHENECTADY N Y GENERAL ELECTRIC CO FUEL COMPONENTS DIV 1 RIVER RD SCHENECTADY N Y GENERAL ELECTRIC CO INDIRY CONTROL DEPT 1501 ROANORE BLVD SALEM VA GENERAL ELECTRIC CO INDIRY CONTROL DEPT 1501 ROANORE BLVD SALEM VA GENERAL ELECTRIC CO INDIGTY CONTROL DEPT 1501 ROANORE BLVD SALEM VA GENERAL ELECTRIC CO INDIATY CONTROL DEPT 1501 ROANORE BLVD SALEM VA GENERAL ELECTRIC CO INDIATY CONTROL DEPT 1501 ROANORE BLVD SALEM VA GENERAL ELECTRIC CO INDIATY CONTROL DEPT 1501 ROANORE BLVD SALEM VA GENERAL ELECTRIC CO MAGNETIC MATERIALS SEC EDMORE MICHIGAN GENERAL ELECTRIC CO MISSILE PRODUCTION SEC LAKESIDE AVE BURLINGTON VT GENERAL ELECTRIC CO MISSILE PRODUCTION SEC LAKESIDE AVE BURLINGTON VT GENERAL ELECTRIC CO MISSILE PRODUCTION SEC LAKESIDE AVE BURLINGTON VT GENERAL ELECTRIC CO MISSILE PRODUCTION SEC LAKESIDE AVE BURLINGTON VT GENERAL ELECTRIC CO MISSILE PRODUCTION SEC LAKESIDE AVE BURLINGTON VT GENERAL ELECTRIC CO MISSILE PRODUCTION SEC LAKESIDE AVE BURLINGTON VT GENERAL ELECTRIC CO MISSILE FORDUCTION SEC LAKESIDE AVE BURLINGTON VT GENERAL ELECTRIC CO MONANCE DEPT NELA PARK CLEVELAND 12 OHIO GENERAL ELECTRIC CO POWER TUBE DEPT NELA PARK LEUCTRIC CO POWER TUBE DEPT NELA PARK LEUCTRIC CO SPECIALTY CONTHOL DEPT 9 D BOX GENERAL ELECTRIC CO SEMICONDUCTOR DEPT SYRACUSE N Y GENERAL ELECTRIC CO SEMICONDUCTOR DEPT P 0 BOX 812 WAYNESBORO VA GENERAL ELECTRIC CO SPECIALTY MOTOR DEPT 1635 BROADWAY FORT WAYNE 2 IND GENERAL ELECTRIC CO TELEVISION RECEIVER DEPT ELECTRONICS PARK SYRACUSE N Y GENERAL ELECT CO X RAY DEPT 4855 ELECTRIC AVE MILWAUKEE WISC GENERAL ELECT CONTROL INC 0001 BLOOMINGTON FREEWAY MINN MINN GENERAL ELECTCONTROL INC 4430 FOREST LANE GARLAND TEXAS GENERAL ELECTCONYAMICS CORP 4430 FOREST LANE GARLAND TEXAS GENERAL ELECTRONICS INC 101 HAZEL ST PATERSON N J GENERAL ELECTRONIC LAB INC SIMON ST NASHUA NH GENERAL ELECTRONIC LAB INC SIMON ST NASHUA NH GENERAL ELECTRONIC LAB INC 320 S UNION SPARTA MICH GENERAL FORMULATIONS INC 320 S UNION SPARTA MICH GENERAL FORMULATIONS INC 320 S UNION SPARTA MICH GENERAL INDUSTRIES CO RTE 97 BELLEVILLE OMIO GENERAL INSTRUMENT CORP DARLINGTON SC GENERAL INSTRUMENT CORP 65 GOUVEURNER ST NEWARK N J

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MANUGRACTURERS - A CO Z GRAND COIL WINDERS 14306 LAKESHORE AVE GRAND HAVEN MICH GRAND TRANSFORMERS INC DECHTREE 6 MARION SIS GRAND HAVEN MICH GRAND TRANSFORMERS INC PAP AW AVE BENTON HARBOR MICH GRANE T H CO 17 S INDIAN HILL BLVD CLAREMONT CALIF GRANTER STATE MACH CO INC 14 JOIETTE STATE MACH CO INC 15 MAI SI S BOSTON MASS GRANT PULLEY 6 HARDWARE CORP INDUSIRIAL DIV HIGH ST W NYACK N Y GRANT PULLEY 6 HARDWARE CORP INDUSIRIAL DIV HIGH ST W NYACK N Y GRAPHICE SYSTEMS 20 DAWILLEY 6 HARDWARE CORP 94 LONG BEACH AVE LOS ANGELES CALIF GRAPHICS INC 90 BELLEVILLE TURNPIKE KEARNT N J GRAPHICS INC 90 BELLEVILLE ROAD YANCEYVILLE NC GRAPHICS INC 90 BELLEVILLE TURNPIKE KEARNT N J GRAPHICE METALLIZING CORP 1050 NEPERHAM AVE YONKERS NY GRASON-STRADLER CO INC WEST CONCORD MASS GRAY G MILL RD ANDALUSIA PA GRAY MADIO CO 91 O PEEST HILL BUVD W PALM MEACH FLA GRAYMILL ND ANDALUSIA PA GRAY MILL RD ANDALUSIA PA GRAY MILL DO TRONICS INC 29 DURINGTON AVE CLARENDON HILLS ILL GRAAT HALLS PAOUCTS CO INC GRAT FALLS AVE ROCHESTER N H GRAT HALLS AVE ROCHESTER N H GREAT FALLS AVE ROCHEST GREENE CORP G G WAREN PA GREENE TWEED 6 CO NORTH WALES PA GREENLEAF DIV OF SYSTRON DONNER CORP 7814 MAPLEWOOD INDUST ST LOUIS MO GREENTRE ELECTRONICS CORP 2020 PLACENTIA AVE COSTA MESA CALIF GREGORY MAGNETIC INDUST INC 2133 N E 19TH AVE FT LAUDEROALE FLA GREIBACH INSTRUMENT SCORP 315 NORTH AVE NEW ROCHELLE N Y GREINER CO EMIL 22 N MODER 5T NEW YORK 13 N Y GREIBACH INSTRUMENT SCORP 315 NORTH AVE NEW ROCHELLE N Y GREINER CO EMIL 22 N MOORE ST NEW YORK 13 N Y GREMER GCO 923 LONGYIEW RD KING OF PRUSSIA PA GREMEN MFG CO 7 NORTH AVE WAXEFIELD MASS GRIES REPRODUCER CORP 5 2NO ST NEW MOCHELLE N Y GROOV-PIN CORP 1125 HENDRICKS CAUSEWAY RIDGEFIELD N J GROVER PHOTO PROD 341 ARDEN GLENDALE CALIF GRUENBERG ELECTRIC CO INC 9 COMMERCIAL AVE GARDEN CUTY N Y GOMERCIAL AVE GARDEN CUTY N Y GUARDIAN ELECTRIC MFG CO 1350 W CARROLL ST CHICAGO 12 ILL GUARDIAN ELECTRIC MFG CO 333 W CARROLL CHICAGO ILL GUDERNOD BROS SILK CO 225 W 34 ST NEW YORK 1 N Y THE GUDEMAN CO 340 HURON ST CHICAGO ILL GUDERNOD ST NEW YORK 1 N Y THE GUDEMAN CO 340 HURON ST CHICAGO ILL GUDENAN CO OF CALIF 7473 AVE 304 YISALIA CALIF GUIDANCE TECHNOLOGY INC 2500 BROADWAY SANTA MONICA CALIF GUIDE LAMP DIV 2913 PENDLETON AVE ANDERSON IND GUILD ELECTRONICS INC 388 BROADWAY NEW YORK N Y GULTON INDUSTRIES INC CM MAGENETICS DIV 13031 CERISE AVE MAWTHORME CALIF GUIDT INDUSTRIES INC CM ST INSTUMENT CORP 4563 MONTROSE AVE CHICAGO ILL GULTOM INDUSTRIES INC CM MAGENETICS DIV 13031 CERISE AVE MAWTHORME CALIF GUILON INDUSTRIES INC CM MAGENETICS DIV 13031 CERISE AVE CHICAGO ILL GULTOM INDUSTRIES INC COM MAGENETICS DIV 13031 CERISE AVE CHICAGO ILL GULTOM INDUSTRIES INC COM ANGENTICS DIV 4563 MONTROSE AVE CHICAGO ILL GULTOM INDUSTRIES INC COM ANGENTICS DIV 4563 MONTROSE AVE CHICAGO ILL GULTOM INDUSTRIES INC COM ANGENTICS DIV 4563 MONTROSE AVE CHICAGO ILL GULTOM INDUSTRIES INC ONTHOLOG DIV 4563 MONTROSE AVE CHICAGO ILL GULTOM INDUSTRIES INC ONTHOLOG DIV 4563 MONTROSE AVE CHICAGO ILL GUITOM INDUSTRIES INC ONTHOLOG DIV 4564 GUAKER BRIDGE RD TRENTOM N J GULTOM INDUSTRIES INC ONTHOLOG DIV 4564 GUAKER BRIDGE RD TRENTOM N J GULTOM INDUSTRIES INC ONTHOLOG DIV 4564 GUAKER BRIDGE RD TRENTOM N J GULTOM INDUSTRIES INC ONTHOLOG DIV 4564 GUAKER BRIDGE RD TRENTOM N J GULTOM INDUSTRIES INC ONTHOLOG DIV 4564 GUAKER BRIDGE RD TRENTOM N J GUULTOM INDUSTRIES INC ONTHOLOG DIV 4564 GUAKER B GURLEY W & L E 514 FULTON ST TROY N Y

G-V CONTROLS INC G-V CONTROLS INC OKNER PARKWAY LIVINGSTON N J GWILLIAM CO 342 FURMAN ST BROOKLYN] N Y GYRA ELECTRONICS CORP WASHINGTON & ELM STS LA GRANGE ILL LA GRANGE ILL GYREX CORP GYREX CORP 3003 PENNA AVE SANTA MONICA CALIF GYRO ELECTRONICS CO 36 WALKER ST NEW YORK N Y H HACKENSACK CABLE CORP 110 ORCHARD ST HACKENSACK N J HACKER INSTRUMENTS INC SHERWOOD LANE PASSAIC AVE CALDWELL TW N J HAGAN CHEMICALS 6 CONTROLS INC BOX 1346 PITTSBURGH PA HAIRSPRING VIBRATING CO 406 32ND ST UNION CITY N J HAL HEN CO 36 14 11 ST LONG ISLAND CITY N Y HALEDY ELECT CO 1949 51 MCDONALD AVE BROOKLYN N Y HALEX CORP 27302 W 7 MILE RD DETROIT MICH HALL MFG CO 3901 WESLEY TERRACE SCHILLER PK ILL HALL MFG CO 3901 WESLEY TERRACE SCHILLER PK ILL HALLETY MFG CO 5910 BWCRAFT ST LOS ANGELES CALIF HALLICAFTERS CO 4001 W 5TH AVE CHICAGO 26 ILL HALLICAFTERS CO 401 W 5TH AVE CHICAGO 26 ILL HALLICATINEN INSTRUMENTS 1341 T ST BERKELEY CALIF HALLMAR INST COP 2215 COMMERCE ST DALLAS TEXAS HALM INSTRUMENT CO 180 GLEN MEAD RD GLEN MEAD N Y HALDGEN INSULATOR 6 SEAL CORP 9960 PACIFIC AVE FRANKLIN PARK ILL 2215 COMMERCE ST DALLAS TEXAS HALM INSTRUMENT CO 180 GLEN HEAD RD GLEN MEAD N Y HALDGEN INSULATOR & SEAL CORP 9960 PACIFIC AVE FRANKLIN PARK ILL HANLON & WILSON CO 321 PENN WOOD AVE PITTSBURGH PA HAMILTON ELECTRONICS CORP 2726 W PRATT AVE CHICAGO ILL HAMILTON HALL INC 227 N WATER MILWAUKEE WISC HAMILTON KENT MFG CO 427 GRANT ST KENT OHIO HAMILTON STANDARD ELECTRONICS DEPT MAINS ST BROAD RROOK CONN HAMILTON STANDARD ELECTRONICS DEPT MAINS TB ROAD RROOK CONN HAMILTON WATCH CO ELECT OIV COLUMBIA AVE LANCASTER PA HAMLITON WATCH CO ELECT OIV COLUMBIA AVE LANCASTER PA HAMLITON WATCH CO ELECT OIV COLUMBIA AVE LANCASTER PA HAMLITON WATCH CO ELECT OIV COLUMBIA AVE LANCASTER PA HAMLITON WATCH CO FLOR HAMILTON WATCH CO INC MARS HILL N CAROLINA HAMNAR ELECTRONICS CO INC P O ROX 531 PRINCETON N J HAMNCOK TELECONTROL CORP 143 SOUND BEACH AVE OLO GREENWICH CONN HANDE HOUSEHOLD PROOUCTS 408 12 ST BRONCLYN NY HANDY 6 HARMAN BRIDGEPORT CONN HANDY 6 HARMAN BRIDGEPORT CONN BRIOGEPORT CONN HANDY 6 HARMON 330 N GIBSON RD EL MONTE CALIF HANOVIA LAMP DIV/ENGLEHART INOUSTRIES INC 100 CHESTNUT ST NEWARK 5 N J HANSEN MFG CO R R I PRINCETON IND HARDER CO DONALD C 2580 K ST SAN DIEGO 2 CALIF HARDMAN CO H V 583 CORTLANDT ST BELLEVILLE 9 N J HARKINS RADIO INC HARDMAN CO H V 583 CORLANDT ST BELLEVILLE 9 N J HARKINS RADIO INC 4444 E WASHINGTON ST PHOENIX ARI2 HARMON KARDON INC 320 MAIN ST WESTRURY LI NY HARMON LICHTENSTEIN 6 CO 26 BROADWAY NEW YORK 4 N Y HARMON LICHTENSTEIN 6 CO 26 BROADWAY NEW YORK 4 N Y HAROWE SERVO CONTROLS INC W CHESTER PK AT WESTRUW RD W CHESTER PA HARMES ERVO CONTROLS INC W CHESTER PK AT WESTRUW CONN HARRER LEADER INC 1046 S MAIN ST WATERNURY CONN HARRISON LABS 45 INDUSTRIAL RD BERKELEY HGTS N J HARRISON PAINT 6 VARNISH CO 1329 HARRISON AVE S W CANTON 1 OHIO HARRISON SHATPE CORP 8060 SALT LAKE AVE HUNTINGTON PK CALIF HARRISTAHL LABORATORIES 474 E 2ND ST BROOKLYN 26 N Y HARSHAW CHEMICAL CO 1945 E 97 ST CLEVELAND 6 OHIO HART MFG CO 128 BARTHOLOMEW AVE HARTFORD CONN

MART MFG CO ANN ARBOR MICH HARTLEY PROD RESCH LAB 397 W 21 ST HOLLAND MICH HARTLEY PRODUCTS CO HARTLEY PROD RESCH LAB 397 W 21 ST HOLLAND MICH HARTLEY PRODUCTS CO 517 519 E 162 ST NEW YORK N Y HARTMAN ELECTRICAL MEG CO 175 N DIAMONO ST MANSFIELO OHIO HARVEY ALUWINUM 19200 S WESTERN AVE TORRANCE CALIF HARVEY WELLS ELECTRONICS INC R 6 D DIV E NATICK INDUSTRIAL PARK NATICK MASS HARVEY WELLS ELECTRONICS INC R 6 D DIV E NATICK INDUSTRIAL PARK NATICK MASS HARWEY WELLS ELECTRONICS INC R 6 D DIV E NATICK INDUSTRIAL PARK NATICK MASS HARWEY WELLS ELECTRONICS INC R 6 D DIV E NATICK INDUSTRIAL PARK CALIF HASHALD CO INC 1245 CHICAGO AVE EVANSTON ILL HARWICT HINDLE INC 40 HERMON ST NEWARK N J HARWORT MFG CO 409 EL COMINO REAL MENLO PARK CALIF HASSALL INC JOHN CANTIAGUE RD WESTBURY LI N Y HASTINGS-RAYDIST INC NEWCOMB AVE HAMPTON VA MATHAWAY INSTRUMENTS DIV LIONEL 5800 E JEWELL AVE DENVER 22 COLO HAVEG INDUSTRIES INC 900 GREENBANK RD WILMINGTON 8 DELA HATIM FG CO 436 CLEVELAND AVE ST PAUL MINN HAWLEY PRODUCTS CO 3313 N 6TH ST ST CHARLES ILL HAYDON CORP 3815 9TH AVE NEW YORK 34 N Y THE A W HAYDON CO 4060 INCE BLYD CULVER CITY CALIF HAYDON CORP 245 E ELM ST WATERBURY 20 CONN HAYDON LORD 245 E ELM ST TORRINGTON CON HAYDON DIV GENERAL TIME CORP 245 E ELM ST TORRINGTON CONN HAYDON ST WATERBURY CONN HAYDON ST WATERBURY CONN HAYDON ST WATERBURY CONN HAYES INST WATERBURY CONN HAYES STELLITE CO 1020 PARK AVE KOKOMO IND HAYE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST SPRINGFIELO 9 MASS HAYNES STELLITE CO 1020 PARK AVE KOKOMO IND HAZELTINE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST MATERBURY CITY IND HAZELTINE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST MICHIGAN CITY IND HAZELTINE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST MICHIGAN CITY IND HAZELTINE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST MICHIGAN CITY IND HAZELTINE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST MICHIGAN CITY IND HAZELTINE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST MICHIGAN CITY IND HAZELTINE ELECTRONICS OUVHAZELTINE CORP 742 E 6TH ST MICHIGAN CITY IND HAZELTAN ST MATERBURY CON IND HAZELTANE ST SP MATHES SIELLIE CO 1020 PARK AVE KOKOMO IND MAYS CORP 742 E BTH ST MICHIGAN CITY INO HAZELTINE ELECTRONICS DIV/HAZELTINE CORP 59-25 LITTLE NECK PKWY LITTLE NECK 62 N Y H B INSTRUMENT CO AMERICAN BRISTOL STS PHILA PA HEALY-RUFF CO 2255 UNIVERSITY AVE ST PAUL 14 MINN HEARVER CO INC 2646 CASTRO VALLEY BLVO CASTRO VALLEY CAL HEATH CO SUB OF DAYSTROM INC BENTON HARBOR MICH HEATRON CO 333 EBRTS ST YORK 'PA HEHN LESTER C 30 MANORHAVEN BLVD PRT WASH N Y HEINEMANN ELECTRIC CO BRUNSWICK PIKE TRENTON N J HEINENAN ELECTRON ON J HEINENCO CARL 711 CONCORD AVE CAMBRIDGE 38 MASS RRUNSWICK PIKE TRENTON N J HEINRICK CO CARL 711 CONCORO AVE CAMBRIDGE 38 MASS HEINZ MUELLER ENGG CO 4725 IOWA ST CHICAGO 51 ILL HEINZE ELECT CO 685 LAWRENCE S T LOWELL MASS HELCO PRODUCTS CORP 7832 BALBOA BLVO VAN NUYS CALIF HELDOR MFG CORP 238 LEWIS ST PATERSON N J HELICAL PROD CO INC 622 THIRO ST HERMOSA BCH CALIF HELI-COIL CORP SHELTER ROCK LANE DANBURY CONN HELIPOT DIV BECKMAN INSTRUMENTS INC 2500 FULLERTON CD FULLERTON CALIF HELIPOT DIV DE BECKMAN INSTRUMENTS INC 3 SIX POINTS RO TORONTO 18 ONT CANADA HELKO PRODUCTS CO 243 W 55 ST NEW YORK 19 N Y HELLER CO GERALD K 2673 WESTERN ST LAS VEGAS NEV HELLIF CO 877 STEWART AVE GARDEN CITY NY 2673 WESTERN ST LAS VEGAS NEV HELLIGE INC 877 STEWART AVE GARDEN CITY NY HELWIG CO 2350 N 30TH ST MILWAUKEE 10 WISC HEMINWAY 6 BARTLETT MFG CO 500 S AVE NEW YORK 36 N Y HENNEKE ENG CO STONE RIDGE N Y HENRY 6 MILLER INDUSTRIES INC 673 GARFIELD AVE JERSEY CITY 5 N J HENSCHEL CORP 14 CEDAR ST AMESBURY MASS HEPPNER MFG CO BOX 608 ROUND LAKE ILL HERCULES CHEMICAL CO INC 416 RROADWAY NEW YORK 13 N Y HERMASEAL CO 1010 N MAIN ST ELKHART IND HERMES PLASTICS INC 13-19 UNIVERSITY PL NEW YORK 3 N Y HERMES-SONIC CORP 13-19 UNIVERSITY PL NEW YORK N Y HERMES-SONIC CORP 13-19 UNIVERSITY PL NEW YORK N Y HERMES-COMPL CORP 13-19 UNIVERSITY PL NEW YORK N Y HERMES-COMPL CORP 13-19 UNIVERSITY PL NEW YORK N Y HERMESTIC SEAL CORP 14 CEDAP CORP 14 CEDAP MILLER UNIVERSITY PL NEW YORK N Y HERMES-COMPL CORP 14 CEDAP MILLER CORP 15 DUNIVERSITY PL NEW YORK N Y HERMETIC SEAL CORP

HEROLD RADIO 6 ELECTRONICS CORP MT VERNON N Y HERZOG MINIATURE LAMP WORKS 50 17 5 ST LORG SJELNAD CITY N Y HETCO INC 110-114 TREMONT ST EVERETT MASS HEVI-OUTY ELECTRIC CO DIV BASIC PROD CORP 3002 W BURLEIGH ST PO BOX 563 MILWKEE WIS HEWLETT PACKARD CO 1501 PAGE MILL RO PALO ALTO CALIF HEXACON ELECTRIC CO 161 W CLAY AVE ROSELLE PARK N J HEXCEL PRODUCTS INC EASTERN DIV MAVRE DE GRACE MO HEYER INDUSTRIES INCORPORATED 500 CORTLANDT ST BELLEVILLE N J HEYMAN MFG CO 147 MICHIGAN AVE KENILWORTH N J H 6 H MACHINE CO INC NOBLE 6 JACKSON STS NORRISTOWN PA H 6 H PRODUCTS CO 766 RAMSEY AVE HILLSIDE N J HICKOK ELECTRICAL INSTRUMENT CO 10514 DU PONT AVE CLEVELAND 8 OHIO HICO CORP 76 COOLIDGE HILL RD WATERTOWN MASS HIDYNE INSTRUMENT 6 ENGRG CO 309 ANDERSON ST TULLAHOMA TENN HIEATI ENGG CO 2228 N HOLLYWOOD WAY BURBANK CALIF HI G INC BRAOLEY FIELD WINDSOR LOCKS CONN HIGH SPEED HAMMER CO 313 NORTON ST ROCHESTER N Y MIG INC BRADLEY FIELD WINDSOR LOCKS CONN MIGH SPEED MAMMER CO 313 NORTON ST ROCHESTER N Y HIGH VACUUM EQUIPMENT CORP KINETICS DIV 2 CHURCHILL RD HINGHAM MASS HIGH VACUUM FURNACE 6 ELECT DV 90 AIRPORT RD CONCORD N H HIGH VACUUM FURNACE 6 ELECT DV 90 AIRPORT RD CONCORD N H HIGH VOLTAGE ENG CORP BURLINGTON MASS HIGHLAND DESIGN INC 90 MAGNOLIA AVE WESTBURY N Y HIGHSIDE CHEMICALS INC 11 COLFAX AVE CLIFTON N J HILDERAND JOHN CO 45 BRIGHTON ST BELMONT MASS HILL ELECTRONICS INC 300 CHESTNUT ST MECHANICSBURG PA HILL ELECTRONIC FONDUCTS CO 55 NASSAU AVE BROOKLYN 22 N Y HI LO MFG CORP 1122 REMPORT AVE CHICAGO, ILL HINDLE TRANSFORMER CO WOODS CHURCH RD RD 3 FLEMINGTON NJ HI-PAR PRODUCTS CO 340 LUNENBURG ST FITCHBURG MASS HI OWENDS THACKENSACK N J HID DIV AEROVOX CORP OLEAN N Y 340 MUDSON ST HACKENSACK N J HIG DIV AEROVOX CORP OLEAN N Y HI-G DIV AEROVOX CORP BOX 68 MYRILE BEACH S C HI-SHEAR RIVET TOOL CO 2600 W 247TH ST TORRANCE CALIF HISONIC INC P 0 BOX 534 SHAWNEE KANS HI SPEC ELECTRONICS CORP 7328 ETHEL AVE HOLLYWOOD CALIF HI-SPEED EQUIPMENT CO 73 POND ST WALTHAM 54 MASS HITCHINER MFG CO INC P 0 BOX 330 MILFORD NH HITEMP INC 1532 CALIFORNIA AVE MONROVIA CALIF HITEMP WIRES INC 1200 SHAMES DRIVE WESTBURY NY HI TEST CHEMICAL CORP 722 64TH ST BROOKLYN 20 N Y HOBBS CORP JOHN W DIV STEWART-WARNER CORP SPRINGFIELD ILL HOBBS MFG CO 26 SALISBURY ST WORCHESTER MASS HOBSON BROS 26 SALISBURY ST WORCHESTER MASS HOBSON BROS 9940 LAWRENCE AVE CHICAGO ILL HOFFMAN CO P R 321 CHERRY ST CARLISLE PA HOFFMAN ELECT CORP SEMICONDUCTORS DIV 1001 N ARDEN DR EL MONTE CALIF HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD OIV 2621 S HILL ST LOS ANGELES 7 CALIF HOFFMAN ELECTRONICS CORP 2705 LEE ST EVANSTON ILL HOFFMAN ELECTRONICS CORP 3740 GRAND AVE LOS ANG CALIF HOFFMAN ENG CORP 9TH 6 TYLER ANOKA MINN HOGAN FAXIMILE CORP 6335 GREENWICH ST NEW YORK N Y -HOKE INC 635 GREENWICH ST NEW YORK N Y-HOKE INC I TEMAKILL PARK CRESSKILL N J HOLEX INC P O BOX 148 HOLLISTER CALIF HOLLAND ELECTRONICS 772 E 53 ST BROOKLYN N Y HOLLINGSWORTH CO FORT LAUDERDALE FLA HOLO-KROME SCREW CORP HARTFORD 10 CONN HOLT INSTRUMENT LABS DIV HOLT HARKWOOD CO INC OCONTO WISC HOLTZER CABOT DIV NATL PNEUMATIC CO 125 AMORY ST BOSTON 19 MASS HOLUB INDUSTRIES INC 413 DE KALB AVE SYCAMORE ILL

HOMALITE CORP 11-13 BROOKSIDE DR WILMINGTON DEL HOME ELECT MEG CO 14914 BURBANK BLVD VAN NUYS CALIF HOMMEL CO HOPE 6 MAPLE STS CARNEIGIE PENNA HOREWELL CONTROLS LTD VANDERMOOF AVE TORONTD ONTARID CANADA HOKER CHEMICAL CORPORATION 28. TROGUOIS ST NIAGARA FALLS N Y HOOVER ELECTRIC CO 2100 STONER AVE LOS ANGELES CALIF HOOVER ELECTRONICS CO 110 W TINONIUM RD TIMONIUM MD MOPKINS ENG CO 12900 FOOTHILL BLVD SANFERNANDO CAL96 HORLICK CO INC WM I 266 SUMMER ST BOSTON 10 MASS HOSKINE ALLOYS OF CANADA LTD TORONTO ONT CANADA HOSKINS MEG CO 4445 LAWTON AVE DETROIT MICH HOTPACK CORP Dob Summers ST BOSTON 10 MASS HOSKINE ALLOYS OF CANADA LTD TORONTO ONT CANADA HOSKINS MFG CO 4445 LAWTON AVE DETROIT MICH HOTPACK CORP 5074A COTTMAN AVE PHILA PA HOTWATT INC DANVERS MASS HOUDAILLE INOUSTRIES INC BUFFALO 11 N 7 2310 W LAWRENCE CHICAGO 25 ILL HOUSTON INSTRUMENT CORP BOX 22234 HOUSTON TEXAS HOWAD CRYSTAL HOLOERS INC 2600 GRAND AVE KANSAS CITY # MO HOWARD STRUENT CORP BOX 22234 HOUSTON TEXAS HOWADO CRYSTAL HOLOERS INC 2600 GRAND AVE KANSAS CITY # MO HOWARD INDUSTRIES INC 1760 N KOSTNER AVE CHICAGO 39 ILL HOWARD INDUSTRIES INC 1760 STATE ST RACINE WISC HOWARD INDUSTRIES INC 1760 STATE ST RACINE WISC HOWARD INSTRUMENT CO RED RAKE N J HOWELL INSTRUMENTS INC 3479 VICKERY BLYO FT WORTH TEXAS HOYT ELECTRICAL INSTRUMENT WORS 42 CARLETON ST CAMBRIDGE 42 MASS HR SINGFR INC SCIENCE PARK STATE COLLEGE PA HUBBARD - SPOOL OIV GARRETT IND HUBEN THOUSTRIES INC 1360 SUISEN ST KEARNY N J HUDSON WIRE CO WINSTED OIV 9528 ELM ST KEARNY N J HUDSON WIRE CO WINSTED OIV 991 MAIN ST WINSTED CONN HUDSON WIRE CO WINSTED OIV 9921 MAIN ST WINSTED CONN HUDSON WIRE CO WINSTED OIV 9931 MAIN ST WINSTED CONN HUDSON WIRE CO WINSTED OIV 9941 MAIN ST WINSTED CONN HUDSON WIRE CO WINSTED OIV 9952 ALIGKAFT CO-EL SEGUNO LDS ANGELES SUNNYVALE CALIF HUGHES AIRCRAFT CO-EL SEGUNO LDS ANGELES SUNNYVALE CALIF HUGHES AIRCRAFT CO-EL SEGUNO LDS ANGELES SUNNYVALE CALIF HUGHES AIRCRAFT CO ELECT PROD DIV P O BOX 21037 FULLETON CALIF HUGHES AIRCRAFT CO ELECT PROD DIV P O BOX 2103 TOUSON ARIZ HUGHES AIRCRAFT CO ELECT PROD DIV P O BOX 2103 TO KEMPORT BEACH CALIF HUGHES AIRCRAFT CO ELECT PROD DIV P O BOX 2103 TREMPORT BEACH CALIF HUGHES AIRCRAFT CO ELECT PROD DIV P O BOX 2103 TREMPORT BEACH CALIF HUGHES AIRCRAFT CO MICROWAVE TUBE PROD DIV 2000 SUPRTIOR AVE NEWPORT BEACH CALIF HUGHES AIRCRAFT CO CENT DID LOR PROTO DIV 2000 SUPRTIOR AVE NEWPORT BEACH CALIF HUGHES AIRCRAFT CO MICROWAVE TUBE PROD DIV 2000 SAN FERNANDO BLVD BURBANK CALIF HUGHES AIRCRAFT CO AT PA TWPK HATRORO PA HUWHREY IN GREEN GARDEN 12TH ERIE PA HULL CORP DAVISVILLE RD AT PA TWPK HATRORO PA HUMPHREY INC 2805 CANON ST SAN DIEGO CALIF HUNT CO PHILIP A 5150 GRANT AVE CLEVELAND OHIO HUNT CORP ASSA LINCOLN ST CARLISLE PA 5150 GRANT AVE CLEVELAND OHIO HUNT CORP 453 LINCOLN ST CARLISLE PA HUNT ELECTRONICS 2617 ANTON DR DALLAS TEXAS HUNTER SPRING AVE LANSDALE PA HUNTER TOOLS 9851 ALBURTIS AVE SANTA FE SPRINGS CALIF HUPPERT CO K H 6830 COTTAGE GROVE AVE CHICAGO 37 ILL HURLETRON INC EMS DIV 528 WEST LAMBERT ROAD WHITTIER CALIFORNIA HURLETRON INCOMPORATED ELECTRIC EVE EOP DIV 1938 E FAIRCHILD ST DANVILLE ILL HURON INDUSTRIES PO BOX 557 PORT HURON MICH HURST TOOL 6 MEG CO RD 46 PRINCETON IND HUSE-LIBERTTY MICA CO PEABODY INDUSTRIAL CENTER PEABDDY MASS HUYCK SYSTEMS CO DV OF HUYCK CORP 36D WOLF HILL RD HUNTINGTON STA L I N Y HY GAIN ANTENNA PRODUCTS CO 1135 N 22 ST LINCOLN NEBR HYCON MFG CD 700 ROYAL DAKS OR MONROVIA CALIF HYDRA POWER CO 10 PINE COURT NEW ROCHELL N Y HYDRAULIC PRESS MFG CO DIV KOEHRING CO MARION RD MT GILEAD OHIO HYORAULIC RES ELECT OIV 1675 SHELDON AVE SUNVALLEY CALIF HYORO MOLDING CO 100 SHARRON AVE PLATTSBURGH N Y HYDROMATICS INC 5 LAWRENCE ST BLOOMFIELD N J HYLETRONICS CORP 165 CAMBRIDGE ST BURLINGTON MASS HYPERION INC 127 COOLIDGE HILL RO WATERTOWN MASS HYSER LECT MFG CO 356 SEVENTH AVE MINN MINN HYSOL CANDAL ID P O BOX 53 POSTAL STA R TORONTO ONT CANADA HYSOL CALIF DIV 1706 POTEREO S EL MONTE CALIF HYSOL OF CALIF DIV 1706 POTRERO S EL MONTE CALIF HYSON MFG CO P O BOX N PASADENA CALIF 1 ICONIX INC 945 INOUSTRIAL PALO ALTO CALIF IDAHO MARYLAND MINES CORP MAGNETICS OIV 4310 SAN FFRNANDE RF GLENDALE 4 CALIF IDEAL AEROSMITH INC DIV ROYAL INDUSTRIES 3931 EVANS AVE CMEYENNE WYO IDEAL ELECTRIC 6 WEG CO 300 E 1 ST MANSFIELD OHIO IDEAL INDUSTRIES INC 5127 PARK AVE SYCAMORE ILL IDEAL INDUSTRIES INC PETERSBURG ILL IDEAL PRECISION METER CO 214 FRANKLIN ST BROOKLYN 22 NY IDEAS INC 214 IVINSON AVE LARAMIE WYO IOENTIFICATION SERVICE CORP 144 W 46 ST NEW YORK 36 N Y IDESPATCH OVEN CO 619 S E 8 ST MINNEAPOLIS MINN IE MEG ICONIX INC 619 S E 6 31 FINILAUE CHICAGO 12 ILL 18 MFG 3039 CARROLL AVE CHICAGO 12 ILL IERC DIV INTERNIL ELECT RESCH CORP 135 W MAGNOLIA BLVD BURBANK CALIF I H MFG CO 121 GREENE ST NEW YORK N Y 157 OFTICAL COMPANY The construction of the second construction of the second second

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World Radio History

ELECTRONIC INDUSTRIES . June 1962

ELECTRONIS KING LABS INC 127 SOLAR ST SYRACUSE 3 N Y KING RADIO CORP 139 S PROCKWAY BX 106 OLATHE KANS KINGS ELECTRONICS CD INC 40 MARBLEDALE RO TUCKAHOE NY KINGSLEY MACMINE CO 850 CAHJENGA BLVD HOLLYWOOD 38 CAL KINNELECTRONICS CORP 4125 HAYWARO AVE BALTIMORE 15 MD KINNELECTRONICS CORP 4125 HAYWARO AVE BALTIMORE 15 MD KINNEY VACUUM DIV THE NEW YORK AIR BRAKE CO 3529 WASHINGTON ST BOSTON 30 MASS KINNEY VACUUM DIV THE NEW YORK AIR BRAKE CO 3529 WASHINGTON ST BOSTON 30 MASS KINNEY VACUUM DIV THE NEW YORK AIR BRAKE CO 3529 WASHINGTON ST BOSTON 30 MASS KINNEAN WEG CO INC 54 MILL ST LACONIA N H KIP ELECTRONICS CORP 15 58 127 ST FLUSHING N J KIRSCH MUSIC COP 15 58 127 ST FLUSHING N J KISTLER INSTRUMENT CORP 15 WEBSTER ST N TONAWANDA NY KLANN ORGAN SUPPLY CO PARK STATION WAYNESBORO VA KLEER-TRONICS INC 1933 OCEAN AVE SAN FRANCISCO CALIF KLEER VUE NFG CO INC P O BOX 10326 PITISBURGH 34 PA KLEIN ELECT CO LEO 826 WASHINGTON BLVD CULVER CITY CALIF KLEINSINGHING NUPLY LO BS26 WASHINGTON BLVD CULVER CITY CALIF KLEIN 6 SONS MATHAS 7200 MCCORMICK RD CHICAGONA MARCHAMT INC COUNTY LINE RD DEERFIELD ILL KLEIN 6 SONS MATHAS 7200 MCCORMICK RD CHICAGO 45 JLL KLEIGL BROS UNIV ELEC STAGE LIGHTING CO INC 321 W SOTH ST NEW YORK 19 NY KLINCHER LOCKNUT CORP 2153 HILLSIDE AVE INDIAMAPOLIS 18 IND KLINCHER LOCKNUT CORP

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- SWISSALE PTITSBURGH 15 PENNA KOPPERS BLDG PTITSBURGH 19 PA KORFUND CO INC CANTIAGUE RD WESTBURY L I N Y KORRY MANUF CO 233 BTH AVE SEATLE WASH PT MFG CO ROSELAND N J RRAUTER 6 CO 365 IBTH AVE NEWARK N J KRAUS ELECTRONICS INC 363 CENTER DR PALO ALTO CALIF KRAUTER ELECTRONICS ONC 360 GROVE ST NEWARK 3 N J KRAUTE RELECTRONICS ONC 69 12TH AVE NEWARK 3 N J KRAUTER-WEDER TOOL CO 69 12TH AVE NEWARK 2 NJ KRECKMAN CO HERB CRESCO PA KRECKMAN CO HERB CRESCO PA KRESSILK PROD INC 37 MURRAY ST NEW YORK CITY N Y KRESSILK PROD INC 13 MURRAY ST NEW YORK 7 NY KRISS ELECTRONICS INC 191-195 ORATON ST NEWARK 4 NJ KROKER ENGG 6 DEVEL CO 9947 FRANKLIN AVE FRANKLIN PARK ILL KROMM-HITE CORP 580 MASSACHUSETTS AVE CAMBRIDGE 39 MASS KRYLON INC FORD 6 WASHINGTON STS NORRISTOWN PA KRYSTINAL CORP BOX 60 FOX ISLAND RD PORT CHESTER N Y KTV TOWER COMMUNICATION EGUIP CO BOX 294-82D S HAMILTON ST SULLIVAN ILL KUMM ELECTRONICS INC 1801 MILS AVE NORWOOD 12 OHIO

MANUFACIUKERS-A IO Z KULICKE & SOFFA MFG CO 401 N BROAD ST PHILA 8 PA KULITE BYTREX CORP 50 HUNT ST NEWTON MASS KULITE SEMICONDUCTOR PROD INC 1030 HONYT AVE RIDGEFIELD NJ KULITE TUNGSTEN CO 1040 HOYT AVE RIDGEFIELD NJ KULKA ELEC CORP 633 S FULTON ST MT VERNOH NY KURANA ELECTRIC CO SUB CRESCENT PETHOLEUM CO 191 NEWEL ST BROOKLYN 22 N Y KURTSTON ELECTRIC CO SUB CRESCENT PETHOLEUM CO 191 NEWEL ST BROOKLYN 22 N Y KURTSTON ELECTRIC CO SUB CRESCENT PETHOLEUM CO 191 NEWEL ST BROOKLYN 22 N Y KURTSTON ELECTRIC CO SUB CRESCENT PETHOLEUM CO 191 NEWEL ST BROOKLYN 22 N Y KURTSTON ELECTRIC CO SUB CRESCENT PETHOLEUM CO 191 SPOADWAY DAYTON 1 GHIO KUTHE LASS 102 BAY ST STATEN ISLAND 4 NY KURASFORMER CORP 81 WATER ST OSSINING N Y K W ENGINEERING WORKS PIN OAK COURT MENOMONEE FALLS WISC KUIKHEAT WFG CO 3732 SAN FERNANDO RD GLENDALE CALIF KYLE PRODUCTS 9 6 MARION S MILWAUKEE WISC LAB CORP E ONONDAGA SKANEATELES N Y LABELLE INDUSTRIES INC 510 S WORTHINGTON ST OCONOMOWOGC WISC LABLINE INC 3070 W GRAND AVE CHICAGO 22 ILL LAB INDUST DE PHYSIQUE APPLIQUEF 67 RUE MARIE ANNE COLOMBIER 67 BAGNOLET SEINE PARIS FRANCE LABORATORY EWUIPMENT CORP LARCYTEW HILLTOP RD ST JOSEPH MICH LABORATORY FOR ELECTRONICS INC 1079 COMMONWEALTH AVE BOSTON 15 MASS LAB-TRONICS INC 3656 N LINCOLN AVE CHICAGO 13 ILL LACESA ENGG CORP 5614 W GRAND AVE CHICAGO 39 ILL LACONIA MALLEABLE IRON CO INC 71 WATER ST LACONIA N H LAI I 6 E DIV 2133 ADAMS AVE SAN LEANDRO CALIF THE LAKE CHEMICAL CO 3052 W CARROLL AVE CHICAGO ILL LAKE CITY INC SUB OF CONTROLS CO OF AMERICA 110 WOODSTOCK ST CRYSTAL LAKE ILL LAKE MEG CO LAB CORP THE LAKE CHEMICAL GO 3052 V CARROLL AVE CHICAGO ILL LAKE MEG CO 3233 CHESTNUT ST OAKLAND 7 CALIF LAMACO OF FLORIDA BOX 1366 HAINES CITY FLORIDA LAMACHE MEG CO 3935 25TH AVE SCHILLER PARK ILL LAMBDA ELECTROMICS CORP 515 BROAD HOLLOW RD HUNTINGTON L I N Y LAMINAIR INC 18530 S BROAD HOLLOW RD HUNTINGTON L I N Y LAMINAIR INC 10530 S BROAD HOLLOW RD HUNTINGTON L I N Y LAMINAIR INC 10530 S BROAD HOLLOW RD HUNTINGTON L I N Y LAMINAIED SHEET PRODUCTS CORP 449 NEPONSET ST NERWOOD HASS LAMINATED SHEET DRODUCTS CONN LA MOREE C D 2433 BITKDALE ST LOS ANGFLES 31 CALIF LAMDIE CHEMICAL PRODUCTS CO CHESTERTOWN HD LAMPKIN LAB INC FDC DIV BRADENTON FLA LAMCKER GLASS CORP LANCASTER OHIO LAMC & SESSIONS CO 5025 W 73 ST CHICAGO ILL LAMCASTER GLASS CORP LANCASTER OHIO LAMC & SESSIONS CO 5025 SIST AVE GORP 1730-1802 IST ST SAY FERNANDO CALIF LAMOA IR INSTRUMENT 6 ELECT DIV 40 D HESTER SAN LEANORO CALIF LANDAI HE INSTRUMENT 6 ELECT DIV 40 D HESTER SAN LEANORO CALIF LANDAI ME INSTRUMENT 6 ELECT DIV 40 D HESTER SAN LEANORO CALIF LANDAI ME INSTRUMENT 6 ELECT DIV 40 D HESTER SAN LEANORO CALIF LANDAI ME INSTRUMENT 6 ELECT DIV 40 D HESTER SAN LEANORO CALIF LANDAI ME INSTRUMENT 6 ELECT DIV 40 D HESTER SAN LEANORO CALIF LANDAU METAL PROD CORP 2 62 SIST AVE GLOBA ISLAND CITY N Y LANDSVERK ELECTROMETER CO 61 SONORA AVE GLENDALE CALIF LANDAU METAL PROD CORP 2 64 SIST NEW YORK 36 N Y LANDSVERK ELECTROMETER CO 61 SONORA AVE SANTA MONICA CALIF LANDAU METAL PROD CORP 2 64 SIST NEW YORK 36 N Y LANDSVERK ELECTROMETER CO 61 SONORA AVE SANTA ANA CALIF LANGE MACHINE WORKS INC 166 N MAY ST CHICAGO 7 ILL LAMGE MACHINE WORKS SAN DIEGO CALIF LANGEMACHINE WORKS SAN DIEGO CALIF LAN

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50 E 42N0 ST NEW YORK 17 N Y KELSEY-HAYES CO 38-81 HURON RIVER DR ROMULUS MICH KELVIN ELECTRIC CO 5919 NOBLE AVE VAN NUYS CALIF KEMET CO DIV UNION CARBIDE CORP PO BOX 6087 CLEVELAND 1 OHIO KEMET CO DIV OF UNION CARBIDE CORP 11901 MADISON AVE CLEVELAND 1 OHIO KEMLITE LABS INC 1819 W GRAND AVE CHICAGO 22 ILL KEMODE MFG CO 161 W 18 ST NEW YORK 11 N Y KEMTRON ELECTRON PRODUCTS INC 14 PRIACE PL NEWBURYPORT MASS KEN-DEL PRODUCTIONS INC 515 SHIPLEY ST WILMINGTON 1 DEL KENNEDY 6 CO D S 432 S' MAIN ST COMASET MASS KENNEDY INDUSTRIES 1581 E CHARLES ST BANNING CALIF KENNEDY 121 DAREIDDANY N 1

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ELECTRONIC MANUFACTURERS-A TO Z

LAPP INSULATOR CÔ RADIO SPECIALTIES DIV 318 GILBERT ST LE ROY NY LA POINTE INDUSTRIES INC 155 W MAIN ST ROCKVILLE CONN LA ROSE G ASSOC INC W T BOX F LANS STA TROY NY LARSON INSTRUMENT CO GREENBUSH RD ORANGEBURG N Y LAS LAB INC 1113 N ROLLING RD BALTIMORE MD LAURENK RADIO MFG CO 3927 WAYNE RD WAYNE MICH LAVELLE AIRCRAFT CORP STERLING ST NEWTOWN PA LA VEZZI MACHINE WORKS 4035 W LAKE ST CHICAGO 44 ILL LAVDIE LABS INC MATAWAN-FREEMOLO RD MORGANVILLE NJ LEACH CORP INET DIV MATAWAN-FREEHOLD RD MORGANVILLE NJ LEACH CORP INET DIV 18435 SUSANA RD COMPTON CALIF LEACH CORP LEACH RELAY DIV 5915 AVALON BLVD LOS ANGELES 3 CALIF LEACH CORP SPECIAL PRODUCTS DIV 717 NORTH CONEY AZUSA CALIF LEACH & GARNER CO INDUSTRIAL DIVISION LEACH & GARNER BLDG ATTLEBORO MASS LEAR INC ASTRONICS DIV 3171 S BUNDY DR SANTA MONICA CALIF 11D IONIA AVE NW GRAND RAPIDS MICH LEAR INCORPORATED INSTRUMENT DIVISION 110 IONIA AVENUE N W GRAND RAPIDS MICH LEAR ROMEC DIV LEAR INC ELYRIA OMIO LEAR ROMEC DIV LEAR INC ELYRIA OHIO LECLANCHE S A 40 AVE DEGRANDSON YVERDON SWITZERLAND LECTROHM INC 5560 NORTHWEST HWY CHICAGO ILL SSGO NORTHWEST HWY CHICAGO ILL LEDEX INC 123 WEBSTER ST OAYTON 2 OHIO LEE ELECTRIC INC 566 52ND ST WEST N Y N JERSEY LEECRAFT WEG CO INC 2116 4ATH RD LONG ISLAND CITY N Y LEEDAL INC 2929 S HALSTEO CHICAGO ILL LEED INSULATOR CORP 781 E PICO BLVD LOS ANGELES 21 CALIF LEEOS 6 NORTHRUP CO 4901 STENTON AVE PHILA PA L E E INC 6225 N Y AVE N W WASHINGTON 1 D C LEESONA CORPORATION WARWICK RHODE ISLAND LEETRONICS INC 0 D DISTENTION TO PARY ANNEX WHITTIER CALIF LEETORDICS INC 0 D BEININGSVILLE PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEIGHTON LABS H W YORK RD 6 SUNSET LANE HATBORO PA LEITCH HUARD CORP STARK 6 COMMERCIAL ST MANCHESTER N H LEITCH HUARD CORP STARK 6 COMMERCIAL ST MANCHESTER N H LEKTRA LABS INC 133 W WESTERN AVENUE PLYMOUTH IND LEL INC 75 AKRON ST COPIAGUE NY LEMERT ENGG CO 1313 WESTERN AVENUE PLYMOUTH IND LENK MFG CO 1751 N WESTERN AVE CHICAGO 47 ILL LEONARD ELECT PROD CO INC 67 87 34TH ST BROKLYN N Y LERKURT ELECTRIC CO 1313 WESTERN AVE CHICAGO 47 ILL LEONARD ELECT PROD CO INC 67 87 34TH ST BROKLYN N Y LEFEL HIGH FREGUENCY LABS 34-18 37 AVE WOODSIDE 77 NY LEFEL HIGH FREGUENCY LABS 34-18 37 AVE WOODSIDE 77 NY LEFEL HIGH FREGUENCY LABS 34-18 37 AVE WOODSIDE 77 NY LEFEL HIGH FREGUENCY LABS 34-18 37 AVE WOODSIDE 77 NY LEFEL HIGH FREGUENCY LABS 34-18 37 AVE WOODSIDE 77 NY LEFEL TROMONYAL TO SANGELES 7 CALIF LESALLECTRONICS INC 315 VARNEY ST BUNBANK CALIF LESULE S AROUNDAY NE YORK 12 N Y 17320 LEANCHOR YE NO RATE AND AND S

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LITTON SYSTEMS INC APPLIED SCIENCE DIVISION 8335 WARNER DRIVE CULVER CITY CALIFORNIA LITTON SYS INC GUIDANCE & CONTROL DIV 5300 CANDGA AVE WOODLAND HILLS CALIF LITTON SYST INC GUIDANCE & CONTROL DIV 2211 WEST NORTH TEMPLE SALT LAKE CITY UTAH LITTON SYSTEMS CANADADLIMITED 123 REXDALE BLVD REXDALE TORONTO ONT CAN LIVINGSTON AUDIO PRODUCTS CORP BOX 202 CALDWELL N J LIVINGSTON ELECT CORP 320 RUNNYMEDE RD ESSEX FALLS N J LMB LMB LMB 2528 W 9TH ST LOS ANGELES CALIF LOCKHEED AIRCRAFT LOCKHEED AIRCRAFT SER ONTARIO AIRPORT ONTARIO CALIF LOCKHEED ELECT CO STAVID DIV U S ROUTE 22 PLAINFIELD N J LOCKHEED ELECT CO INFORMATION TECHNOLOGY DIV US HIGHWAY 1 METUCHEN NJ LOCKREEV CO LOCKMEED ELECT CD STAVID DIV U S ROUTE 22 PLAINFIELD N J LOCKNEEV CO INFORMATION TECHNOLOGY DIV US HIGHWAY 1 METUCHEN NJ LOCKREY CO P O BOX J SOUTHAMPTON N Y LOEWS-MYDROPRESS DIV 111 5TH AVE NEW YORK 3 N Y LOEWS-MYDROPRESS DIV 2171 W WASHINGTON BLVD LOS ANGELES 18 CAL LOGEMAN CO C W 633 BERGEN ST BROOKLYN 38 NY LOGETRONICS INC 500 E MONROE AVE ALEXANDRIA VA LONDON CHEMICAL CO INC 1535 N 315T AVE MELROSE PARK ILL LONG INC CHEMICAL CO INC 1535 N 315T AVE MELROSE PARK ILL LONG INC CHEMICAL CO INC 203 9TH ST LORAIN OHIO LORAL ELECTRONICS CORP 203 9TH ST LORAIN OHIO LORAL SELECTRONICS CORP 204 9 ST DON RIVER AVE NEW YORK 72 N Y LODD MAG OUNTY RAVE NEW YORK 19 N Y LOUD MACHIME WORKS INC 969 E 2ND ST POMONA CALIF 100THAN MFG CO DIV FERRO CORP 2000 HARVY AVE E LIVERPOOL OHIO LOUTHAN PLANT REFRACTORIES DIV FERRO CORP 2000 HARVY AVE E LIVERPOOL OHIO LOUTHAN PLANT REFRACTORIES DIV FERRO CORP 2000 HARVY AVE E LIVERPOOL OHIO LOUTHAN PLANT REFRACTORIES DIV FERRO CORP 2000 HARVY AVE E LIVERPOOL OHIO LOUTHAN PLANT REFRACTORIES DIV FERRO CORP 2010 JALCLEDE STATION NJ LUCAS MILHAUPT ENGG CO 3030 LALEDE STATION NJ LUCAS MILHAUPT ENGG CO 3031 S LAKE DR CUDAHY WISC LUCCI AIRCRAFT INC SARASOTA-BRADENTON AIRPORT SAROSOTA FLA LUFKIN RUE CO 1730 HESS ST SAGINAW MICH LUDLOW-SAVLOR WIRE CLOTH CO 634 S NEWSTEAD AVE ST LOUIS MO LUDWIG MONOLD MFG CO CHESTER PIKE 6 FOLCROFT AVE FOLCROFT PA LUFKIN RUE CO 1730 HESS ST SAGINAW MICH LUMAS A NEWSTEAD AVE ST LOUIS MO LUDWIG MONOLD MFG CO CHESTER PIKE 6 FOLCROFT AVE FOLCROFT PA LUFKIN RUE CO 1730 HESS ST SAGINAW MICH LUMAS A NEWSTEAD AVE ST LOUIS MO LUDWIG MONOLO MFG CO 0 D O NA 32 TDLEDO 1 OHIO LUMA ELECTRIC EQUIPMENT CO P O BOX 132 TDLEDO 1 OHIO LUMA ELECTRIC EQUIPMENT CO P O BOX 132 TDLEDO 1 OHIO LUMANOR INC 630 TERNINAL WAY COSTA MESA CALIF LUMINOUS PROCESSES INC 444 GREN BAY D KENILWORTH 694 MAIN ST WALTHAM 54 MASS LUPER 6 SUNBERG AVON ILL LUTHER ELECTRONIC MEG CO 5728 W MASHINGTON BLVD LOS ANGELES 16 CALF LUXO LAMP CANDA LTD 370 STE CROIX BLVD MONTREAL 9 P 0 CANADA LUXO LAMP CORP DOCK STREET PORT CHESTER N Y LUXO LAMP CORP 1683 JERROLO AVE SAN FRAN CALIF LYMAN ELECTRONIC CORP P 0 BOX 1649 SPRINGFIELD 1 MASS LYN TRON INC 5350 RIVERTON AVE N HOLLYWOOD CALIF LYNCH COMPUNICATION SYSTEMS INC 695 BRYANT ST SAN FRANCISCO CALIF LYNCH CORPORATION 2306 CRYSTAL ST ANDERSON IND LYNCH MEG CO R H 7831 ARROYO DR SAN GABRIEL CALIF LYNCA 6 TRUCK CO INC ONEONTA N Y LYON MERCAFT SERVICE 2701 N ONTARIO ST BURBANK CALIF LYON MERL PRODUCTS INC P O BOX 671 AURORA ILL

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MACK ELECTRIC DEVICES INC 48 GLENSIDE AVE WYNKOTE PENNA MACK ANGINEERING 2626 31ST AVE SO MINNEAPOLIS 6 MINN MACKAY RADIO 6 TELEGRAPH CO MARINE DIV 133 TERMINAL AVE CLARR N J MACKAY RESEARCH LABS P O BOX 148A BENSON ARIZ MACKENZIE ELECTRONICS INC 1025 N MCCADOEN PL HOLLYWOOD 38 CALIF MACLEDO E HANDOPL 10 ROLAND ST CHARLESTOWN 29 MASS MADIGAN CORP 2119 W CENTRAL AVE ORLANDO FLA MADIGAN CORP 2119 W CENTRAL AVE ORLANDO FLA MADIGAN ELECTRONIC CORP 200 STONEHINGE LANE CARLE PLACE NY MAGNADYNE CORP PORT CHESTER NY MAGNAFLUX CORP PORT CHESTER NY MAGNAFLUX CORP 7328 W LAWRENCE AVE CHICAGO 31 ILL MAGNASYNC MFG CO 5546 SATSUMA AVE N HOLLYWOOD CALIF MAGNATRAN INC PO BOX 211 KEARNY NJ MAGNAVOX US HWY 11 E JEFFERSON CITY TENN MAGNAVOX 1505 E MAIN ST URBANA ILL MAGNAVOX CO 2255 CARMELINA AVE LOS ANG CALIF MAGNAVOX COMPANY THE 2131 BUETER RD FT WAYNE 4 IND MAGNE HEAD DIV GENERAL INST CORP 2660 S LACIENEGA BLVD LOS ANG CALIF MAGNE HEAD DIV GENERAL INST CORP 2660 S LACIENEGA BLVD LOS ANG CALIF MAGNE TRONICS INC 49 W 45 ST NEW YORK N Y MAGNE ESSORIES BOX 6960 WASHINGTON 20 DC AGRECTS CORES NAGRECTS SORIES NAGRECTS SORIES NAGRECTAFT ELECTRIC TO P 0 BOX 7186 TULSA OKLA MAGRECTAFT ELECTRIC CO 57575 N LYNCH AVE CHICAGO 30 ILL MAGRETIC ANALYSIS CORP 42-44 12TH ST LONG ISLAND CITY NEW YORK MAGRETIC CANALYSIS CORP 42-44 12TH ST LONG ISLAND CITY NEW YORK MAGRETIC CITCUITE LEMENTS INC 3722 PARK PL MONTROSE CALIF MAGNETIC CONTROLS CO 6403 CAMBRIDGE ST MINNEAPOLIS 16 MINN MAGNETIC CORE CORP MAGNETIC CONTROLS CO 6405 CAMBRIDGE ST MINN MINN MAGNETIC CORE CORP JOHN & LAWRENCE STS BOX 368 NEWBURGH N Y MAGNETIC CORP 7232 ETON AVE CANOGA PARK CALIF MAGNETIC DEVICES INC 712 EAST ST FREDERICK MD MAGNETIC INSTRUMENT CO INC 546 COMMERCE ST THORNWOOD NY MAGNETIC INSTRUMENT CO INC MAYES AVE 6 21 ST CAMDEN 1 N J MAGNETIC RECORDERS CO 7120 MERROSE AVE LOS ANGELS 46 CAL MAGNETIC RESCARCH CORP 3160 W EL SEGUNDO BLYD MAWTHORNE CALIF MAGNETIC SHIELD DIV PERFECTION MICA CO 1322 K LESTON AVE CHICAGO 22 ILL MAGNETICS DIV MAGNETICS DIV 5178 CROOKSHANK RD MAGNETICS INC MAGNETICS DIV 5178 CROOKSHANK RD MAGNETICS INC BUTLER PA MAGNETICS RESEARCH CO 179 WESTMORELAND AVE WHITE PLAINS N Y MAGNBON ENGINEERS INC 509 EMORY ST SAN JOSE 10 CALIF MAGTROL INC 240 SENECA ST BUFFALO 4 NY MAHLER RESEARCH FOUNDATION PD ROX 1159 NEW YORK 1 NY MAHONEY TELETRONIC LABS INC 209 16 AVE NEWARK 3 N J MAICO ELECTRONICS INC 21 N 3RD ST MINNEAPOLIS 1 MINN MAICO ELECTRONICS INC DYNAMU MAGNETRONICS DV 21 N 3 ST MINNEAPOLIS 1 MINN MAICO ELECTRONICS INC ENG DIV 123 NG TH MINEAPOLIS 1 MINN MAICO ELECTRONICS INC ENG DIV 123 NGTH 3RD ST MINN MINN MAICO ELECTRONICS INC ENG DIV 123 NGTH 3RD ST MINN MINN MAICO ELECTRONICS INC ENG DIV 123 NGTH 3RD ST MINN MINN MAICO ELECTRONICS INC ENG DIV 123 NGTH 3RD ST MINN MINN MAICO ELECTRONICS INC ENG DIV 123 NGTH 3RD ST HAMPTON VA MALDIR ELECTRONICS CORP 762 WYTHE AVE BROOKLYN 11 N Y MAKEPEACE DIV D E ENGLEMARD INDUSTRIES INC PINE 6 DENMAM STS ATLEBORD MASS MALCO MFG CO 4025 W LAKE ST CHICAGO 24 ILL MALLINCKRODT CHEMICAL WORKS 2 6 MALLINCKRODT STS ST LOUIS 7 MO MALLINCKRODT CHEMICAL WORKS 23-243 W SIDE AVE JERSEY CITY N J <section-header><code-block><code-block><code-block></code></code></code> MARCHANT MACHINING CDRP 4704 RHODE ISLAND AVE HYATTSVILLE MD MARCONI INSTRUMENTS 111 CEDAR DRIVE ENGLEWOOD N J MARCONIS WIRELESS TELEGRAPH CO LTD 750 3RD AVE NEW YORK 11 NY MARDIN ENEW YORK 11 NY MARDUTH PROD 1387 LEDGE RD HINCKLEY OHIO MARINE LECTRIC CORP 600 4TH AVE NEW YORK 11 NY MARDUTH PROD 1387 LEDGE RD HINCKLEY OHIO MARINE VIEW ELECTRONICS INC RB-06 VAN WYCK EXPRESSWAY JAMAICA 18 N Y MARINE VIEW ELECTRONICS INC RB-06 VAN WYCK EXPRESSWAY JAMAICA 18 N Y MARINE VIEW ELECTRONICS INC RB-06 VAN WYCK EXPRESSWAY JAMAICA 18 N Y MARINE VIEW ELECTRONICS INC S439 FARGO AVE SKORIE ILL MARKE COMPANY 3052 W CARROLL AVE CHICAGO ILL MARKEL GONDAL VE CHICAGO ILL MARKEL GONDAL AVE CHICAGO ILL MARKEL GONDAL STRANK SCHOOL LANE NORRISTOWN PA MARKITE CORP 155 WAVERLY PL NEW YORK N Y MARLIN-ROCKWELL CORP FALCONER N Y MARDUT CORP POMONA DIV 2709 N GAREY AVE POMONA CALIF MARGUARDT CORP POMONA DIV 2709 N GAREY AVE POMONA CALIF MARGUARDT CORP POMONA DIV 2709 N GAREY AVE POMONA CALIF MARGHALL CO 2065 HUNTINGTON DRIVE SAN MARINO CALIF MARSHALL CO 2065 HUNTINGTON DRIVE SAN MARINO CALIF MARSHALL ASSOCIATES INC 5209 W BROADWAY MINNEAPOLIS 22 MINN MARSHALL ASSOCIATES INC 5209 W BROADWAY MINNEAPOLIS 22 MINN MARSHALL ASSOCIATES INC 5209 N BROADWAY MINNEAPOLIS 22 MINN MARSHALL ASSOCIATES INC JOHN BOX 2463 BRIDGEPORT 16 CONN MARSHALLTOWN MFG CO 810 E NEYADA ST MARSHALLTOWN IOWA MARSHALL ASDCIATES INC ASING 204 BABYLON TURNPIKE ROOSEVELT LI NY MARTIN MARIETTA CORP ORLANDO DIV 204 BABYLON TURNPIKE ROSSEVELT LI NY MARTIN COMPANY ELECT SYS 6 PROD DIV BANTIN COMPANY ELECT SYS 6 PROD DIV DENVERI COLO MARTIN COMPANY ELECT SYS & PROD DIV BALTIMORE 1 MARYLAND MARTIN PROD INC 139 E CENTRAL BLVD PALISADES PARK N J MARTRDNICS INC 82 SANFORD ST HAMDEN 14 CONN

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10 VAN CORTLANDT AVE NEW YDEK 68 NY MECHANICAL INDUSTRIES PRODS CO 217 ASH ST AKRON R OHIO

ELECTRONIC INDUSTRIES June 1962

MECHANICAL INDUST SOUTHERN CORP 1500 S W 40TH ST FORT LAUDERDAL EFLA MECHANICAL PRODUCTS INC 1824 RIVER ST JACKSON MICH MECHATROL DIV SERVOMECHANISIMS INC 1200 PROSPECT AVE WESTBURY NY MECTRON CO MECTRON CO 166 RIOGE AVE NORTH PLAINFIELD NJ MECTRON CO 501 F 1ST AVF ROSFILF N J MEDCRAFT ELECTRONIC CORP 426 GREAT EAST NECK RD BABYLON NY MEDISTOR INST CO MEDISTOR INST CO 1443 NORTHLAKE WAY SEATTLE 3 WASH MEDTRONIC INC 3055 HIWAY NO 8 MINNEAPOLIS 18 MINN MELABS 3300 HILLVIEW AVE PALO ALTO CALIF WELCO PRODUCTS INC 301 5 AVE 5 MINNEAPOLIS 15 MINN MELCOR ELECT CORP 48 TOLEDO ST FARMINGDALE N Y MELETRON CORP 950 N HIGHLAND AVE LOS ACCOMMENTS 48 TOLEDO ST FARMINGDALE N Y MELETRON CORP 950 N HIGHLAND AVE LOS ANGELES 38 CALIF MELETRON CORP 940 N ORANGE DR LOS ANG CALIF MELODY MASTER MFG CO 2149 W ROSCOE ST CHICAGO 18 ILL MELPRAI NC 3000 ARLINGTON BLVD FALLS CHURCH VA MELRAIN CORP 2100 E FLETCHER AVE INDIANAPOLIS 3 IND MELORAIN CORP 2100 E FLETCHER AVE INDIANAPOLIS 3 IND MELORAITZ CO 48 PINE ST EAST PATERSON NJ MERLO PARK ENGG 711 HANLTON AVE MENLO PARK CALIF MEPCO INC 35-37ABETT AVE MORRISTOWN NJ MERCAST MFG CORP 2620 I ST LA VERNE CALIF MERCK & CO INC CHEMICAL DIV RANWAY N J MERCID CORP 4201 BELMONT AVE CHICAGO 51 ILL MERCID CORP MERCAST MFG COMP 2620 1 ST LA VENNE CALIF MERCAS 6 CO INC CHEMICAL DIV RAMWAY M J MERCOID CORP 4201 BELMONT AVE CHICAGO 61 ILL MERCURY AIR PARTS CO INC BX 135 9310 W JEFFERSON CULVER CITY CALIF MERCURY CONTACTS INC 1930 NEVA DRIVE DAYTON 14 0HD MERCURY RANSFORMEP CORP 339 E COTTAGE PL YORK PA MERCURY TRANSFORMEP CORP 12964 PANAMA ST LOS ANGELES 66 CALIF MERCURY TRANSFORMEP CORP 12964 PANAMA ST LOS ANGELES 66 CALIF MERCURY HAIS TREETSVILLE ONT CANADA MERCURY HAIS CONTACT INC 8739 MILLERGROVE DR WHITTIER CALIF MERCURY TRANSFORMEP CORP 12964 PANAMA ST LOS ANGELES 23 CALIF MERCURY TRANSFORMEP CORP 12964 PANAMA ST LOS ANGELES 23 CALIF MERCURY TRANSFORMEP CORP 1270 MITTIER BLVD LOS ANGELES 23 CALIF MERCURY TANSFORMEP CORP 1270 NORT AVE DIATHERMY CO 234 E 751H ST CHICAGO 49 ILL MERTIA CHEMICAL CO 234 E 751H ST CHICAGO 49 ILL MERTIA CRESEARCH 6 DFVELOPMENT INC 517 YUONS AVE TRVINGTON M J METACHEM RESINS CORP MERECO PRODS DIV 30 WELLINGTON AVE CRANSTON 10 R I 12270 NORT METAL TEATILE CORP 64 E 1ST AVE ROSELLE N J METAL CAFT ME CORP M K 377 JOTH AVE NEW YORK 34 N Y METAL CAFT ME CORP M K 377 JOTH AVE NEW YORK 34 N Y METAL CAFT ME CORP M K 373 YAN SINDEREM AVE BROOKLYN T N Y METAL FARRICATORS CORP 374 VAN SINDEREM AVE BROOKLYN T N Y METAL FORGING CORP 375 JOTH ST WALTHAM 54 MASS METAL FORGING CORP 374 JON ST WALTHAM 54 MASS METAL SPECIALTY PRODUCTS CORP 374 JON ST WALTHAM S4 MASS METAL SPECIALTY PRODUCTS CORP 374 SAN SINDEREM AVE BROOKLYN T N Y METAL FORGING CORP 374 JON ST WALTHAM S4 MASS METAL SPECIALTY PRODUCTS CORP 374 JON ST WALTHAM 54 MASS METAL SPECIALTY PRODUCTS CORP 374 JON ST WALTHAM S4 MASS METAL SPECIALTY PRODUCTS CORP 374 JON ST WALTHAM S5 MASS METAL SPECIALTY PRODUCTS CORP 375 JON ST WALTHAM S5 NEW BRUNSWICK N J METALECTRO LAS METALECTRO LAS 376 JON ST WALTHAM S5 LOLYWOOD CALIF METAL ST CONTROLS ST PLUSATING 55 N Y METAL CONSTENTS AVE CONTROLS ANG CALIF METALECTRO LAS METALECTRO LAS 376 MALEXEST FLUSHING S5 N Y METALECTRO LAS METALECTRO L

68 RUE VILLIERES DE 1 PARIS ZOEME FRANCE

S-AA TO Z METPRO INC R I 230 TORONTO AVE PROVIDENCE 5 R I HETROLOG CORP SUBB AIR LOGISTICS CORP 169 N HALSTEAD PASADENA CALIF METRON INSTRUMENT CO 432 LINCOLN ST DENVER 3 COLO METRONIX INC 75 WILSON MILLS RD CHESTERLAND OHIO. METROPOLITAN TELECOMMUNICATIONS CORP COLO WINDERS DIV AMES CT PLAINVIEW NY METZ REFINING CO 369 MULBERRY ST NEWARK 2 NJ MEYER MANUFACTURING 410 NW 2ND ST PIPESTONE MINN N & ELECTEONICS CORP 118 E 25 ST NEW YORK NY M-6 METAL PRODS CO 1217 MESSTER AVE CHICAGO 14 ILL H-1 STANDARD CORP 510 COMMUNIPAN AVE JERSEY CITY 4 NJ MICA CORP 4031 ELENDA ST CULVER CITY CALIF MICA INSULATOR DIV MINNESOTA MINING MEG CO 797 BROADWAY SCHEMECIADY 1 NY MICACRAFT PRODUCTS INC 53 CONTACL AVE ROCHELLE PARK N J MICACRAFT PRODUCTS INC 54 GOUVERNEUR ST NEWARK 5 N J MICACRAFT PRODUCTS INC 53 GOUVERNEUR ST NEWARK 5 N J MICACRAFT PRODUCTS INC 53 GOUVERNEUR ST NEWARK 4 NJ MICA FAB CO 54 GOUVERNEUR ST NEWARK 4 NJ MICAMOLD ELECTRONICS MEG CORP 63 GOUVERNEUR ST NEWARK 4 NJ MICAMOLD ELECTRONICS MEG CORP 63 GOUVERNEUR ST NEWARK 4 NJ MICAMOLT FABRICATORS INC 524 N RAVENSMOOD AVE CHICAGO 40 ILL MICHGAN MAGNETICS INC 524 N RAVENSMOOD AVE CHICAGO 40 ILL MICHIGAN MAGNETICS INC 500 FILL RD MUY 14 FORT WAYNE IND MICAMOLD ELECTRONICS MEG CORP 63 GOUVERNEUR ST NEWARK 4 NJ MICAMONTVILLE MICH MICHIGAN MAGNETICS INC 524 N RAVENSMOOD AVE CHICAGO 40 ILL MICHIGAN MAGNETICS INC 500 FILL RD MUY 14 FORT WAYNE IND MICAGRAF FABRICADS INC MICHIGAN MAGNETICS INC 500 TROWBRIDGE ST CAMBRIDGE 38 MASS MICON ELECTRONICS INC SUB METALCRAFT INC ROSSEVELT FIELD GARDEN CITY L I N Y MICRO DALANCING INC 191 MERRICCS RD GARDEN CITY N Y MICRO DALANCING INC 191 MERRICCS RD GARDEN CITY N Y MICRO DALANCING INC 191 MERRICCS RD GARDEN CALIF MICRODOT INC MAGNETICS DIV 500 BOWCROFT ST LOS SMG CALIF MICRODOT INC MAGNETICS DIV 500 BOWCROFT ST LOS ANG CALIF 220 PASADENA AVF S PASADENA CALIF MICRODOT INC MAGNETICS DIV 5960 BOWCROFT ST LOS ANG CALIF MICRO GEE PROD INC 6319 SLAUS AVE CULVER CITY CALIF MICROFLECT CO 3450 S 25 ST SALEM ORE MICROLAB SCO ME DE SALANT AVE LIVALCED MICROLAB STO W MT PLEASANT AVE LIVINGSTON N J MICROLECTRIC INC 19 DEBEVOISE AVE ROOSEVELT N Y MICROMAG INSTRUMENT CO 115 MALLECK ST ROXBURY 20 MASS MICROMAT CO S48 PIERMONT AVE HILLSIDE N J MICROMATIC MACHINE CORP 45 MORGAN AVE BROKLYN 37 N Y MICROMECH MFG CO 695 RAHWAY AVE UNION N J MICROMEGA CORPORATION 4134 DEL REY AVE VENICE CALIF MICROMETALS 695 RAHMAY AVE UNION N J MICROMEGA CORPORATION A134 DEL REY AVE VENICE CALIF MICROMETALS 72 E MONTECITO AVE SIERRA MADRE CALIF MICROMETALS 73 E MONTECITO AVE SIERRA MADRE CALIF MICROMETALS 74 E MONTECITO AVE SIERRA MADRE CALIF MICROMODULAR COMPONENTS DIV 80X 51 ANAHEIM CALIF MICROMOLD PRODUCTS CORP 1 SCHOOL ST YONKERS N Y MICROM GEAR MEG CO 73 PUSHMORE ST WESTBURY L I NY MICROMASE CORP 80X 1166 GREENNICH CONN MICRO PUMP CORP 80X 392 DANVILLE CALIF MICROFADIONICS INC 14844 OXNARD ST VAN NUYS CALIF MICROSECOND ELECT INC 3213 E WASHINGTON PHOENIX ARIZONA MICRO SOMIC INDUSTRIES INC 5305 CHICAGO AVE MINNEAPOLIS MINN MICRO SOMIC INDUSTRIES INC 349 LINCOLN ST HINGHAM MASS MICRO STATE ELECTROMICS CORP 152 FLORAL AVE MURRAY HILL N J MICRO SWITCH INDEPENDENCE IOWA MICRO SCHICK OC 695 RAHWAY AVE UNION NJ MICROTECH INC 145 F MINEOLA AVE VALLEY STREAM NY MICROTAVE DEVELOPMENT LABS 15 STRATHMORE ROAD NATICK MASS MICROWARE DEVELOPMENT LABS 15 STRATHORE ROAD NATICK MASS MICROWARE DEVELOPMENT LABS 15 STRATHORE ROAD NATICK MASS MICROWARE DEVELOPMENT LABS BURLINGTON MASS MICROWAVE DEVELOPMENT LABS 15 STRATHMORE ROAD NATICK MASS MICROWAVE ELECTRONIC TUBE CO INC 76 LAFATETTE ST SALEM MASS MICROWAVE ELECT CORP 4061 TRANSPORT ST PALO ALTO CALIF MICROWAVE ENG LABS 943 INOUSTRIAL AVE PALO ALTO CALIF

MICROWAVE SERVICES INTL INC ROUTE 46 CISCO RD DENVILLE NJ MID-CONTINENT ENGINEERING 1717 NORTHEAST NARSHALL MINN MINN MIDDLESSE PAPER TUBE CO 345 CHELMSFORD ST LOWELL MASS MID-EASTERN ELECTRONICS INC 32 COMMERCE ST SPRINGFIELD NJ MIDGET LOUVER CO 6-8 WALL ST NORMALK CONN MIDLAND INDUSTRIAL FINISHES CO E WATER ST WAUKGGAN ILL MIDLAND MFG CO 3155 FIBERGLAS RD KANSAS CITY 15 KANSAS MIDWEST COLL & TRANSF CO 1640 N HALSTED ST CHICAGO ILL MIDWEST ELECTRIC PRODUCTS INC 1515 N FRONT ST MANKATO MINN MIDWEST WETAL PRODUCTS INC 450 E DOMOVAN ROAD KANSAS CITY 15 KANS MIDWEST WETAL PRODUCTS INC 450 E DOMOVAN ROAD KANSAS CITY 15 KANS MIDWEST METAL PRODUCTS INC 1515 N FRONT ST MAKATO MINN MIDWEST METAL PRODUCTS INC 600,RNEE ILL MID-WEST SPRING CO ETMA ST MENTON IND MIDWESTERN INSTRUMENTS PO BOX 7509 TULSA OKLA MIKEST ROLDING G MFG CC 01100 ELEWDOD AVE PROVIDENCE 7 RI MILES REPRODUCER CO A12 BROADWAY NEW YORK 3 N Y MILFORD DEPT-NORDEN DIV-UNITED AIRCRAFT MILFORD RIVET 6 MACH CO MILFORD RIVET 6 MACH CO B01 ILL AVE AURORA ILL MILFORD RIVET 6 MACH CO B01 ILL AVE AURORA ILL MILER REPRODUCET CORP 7620 N W 36TH AVE MIAMI FLA MILLER MIC AND ST MAKE ILL MILFORD RIVET 6 MACH CO B01 ILL AVE AURORA ILL MILLER ASSOCIATES ISO EXCHANGE ST MALDEN 48 MASS MILLER ASSOCIATES P O BOX 7309 KALEZILLE CONN MILFORD RIVET 6 MACH CO B01 ILL AVE AURORA ILL MILFORD ST AND ST LOS ANGELES 3 CALIF MILLER CORP HARY MILLER CO J W 5917 S MAIN ST LOS ANGELES 3 CALIF MILLER CO M C 288 SADDLE RIVER RD UPPER SADDLE RV N J MILLER CORP HARRY 4TH 6 BRISTOL STS PHILA PA MILLER CORP HARRY 4TH 6 BRISTOL STS PHILA PA MILLER FLAC FOR DESEARCH LABS 5529 S 51H ST MILWAUKEE 7 WISC MILLER FRANKLIN P 6 SON INC 36 MEADOW ST EAST ORANGE N J MILLER-HARRIS INSTRUMENT CO 1134 S FIRST ST MILWAUKEE 4 WISC MILLER-TROJAN CO INC TROY OHIO MILLERS FALLS CO 57 WELLS ST GREENFIELD MASS MILL SWITCH CORP FRANKFORT IND MILLISSING CORP PD BOX 67 MILL CREEK RD GLADWYNE PA MILL FORD MILLI-SWITCH CORP PO BOX 67 MILL CREEK RD GLADWYNE PA MILLIPORE FILTER CORP 36 PLEASANT ST WATERTOWN 72 MASS MILLIPORE FILTER CORP P 0 BOX 427 BEDFORD MASS MILLITEST CORP P O BOX 427 BEOFORD MASS MILLITEST CORP 88 MADISON AVE HEMPSTEAD N Y MILLIYAC INSTR DIV COMU ELECTRONICS INC 2315 2ND AVE SCHENECTADY 3 N Y MILLIYAC INSTRUMENTS INC BOX 997 SCHENECTADY N Y MILRO CONTROLS CO INC 2800 MIDLAND AVE SADDLE BROOK N J MILTON-ROY CO 6301 49TH BOX 12169 ST PETERSBURG FLA MILWAUKEF RESISTOR CO 700 W VIRGINIA ST MILWAUKEE 4 WISC MILWAUKEF STATING CO 800 S 72 ST MILWAUKEE 14 WISC MINATRON CORP BELLE MEAD 9 N J MINIATURE INSTRUMENTS INC PEPTONE ELECTRONICS OIVISION 9440 SCIENCE CENTER DRIVE MINN 27 MINN MINCO PRODUCTS INC 740 WASHINGTON AVE MINNEAPOLIS 1 MINN MINCOM DIV MINN MINING 6 WEG CO 2010 M BRADDOK AVE PIITSBURGH 8 PA MINELCO 21 PLYMOUTH ST MOLBROOK MASS MINRALS 6 INSULATION CO MINELCO 21 PLYMOUTH ST HOLBROOK MASS MINERALS & INSULATION CO ROCHELLE PARK NJ MINI-MOLD INC 14759 BESSEMER ST VAN NUYS CALIF INICORD CORP OF AMERICA 1915 ATLANTIC AVE ATLANTIC CITY N J MINISINK RUBBER CO INC ORANGE COUNTY UNIONVILLE N Y MINITEC 5423 OELAWA'L AVE LOS ANGELES & CALIF MINNEAPOLIS ELICT 2233 UNIVERSITY AVE ST PAUL MINN MINNEAPOLIS-MONEYWELL HEILAND DIV

- 5200 E EVANS AVE DENVER COLO MINNEAPOLIS-HONEYWELL MICRO SWITCH DIV CHICAGO & SORING STS FREEPORT ILL

MUELLER BRASS CO IVELLER BRASS CO IVELLER ELECTRIC CO BECKENHAM KENT ENGLAND MUIRHEAD 6 CO LTD BECKENHAM KENT ENGLAND MUIRHEAD INSTRUMENTS ITD STRATFORD ONTARIO CANADA MUIRHEAD INSTRUMENTS ITO STRATFORD ONTARIO CANADA MULLARD FOUSE ONTIMICS CANADA MULLARD FOUSE TORRINGTON OL LONDON ENG MULLARD OVERSEAS LTD MOUCHARD OVERSEAS LTD MULLARD FOUSE TORRINGTON OL LONDON ENG MULLARD FOUSE TORRINGTON N J MULTI-AMP ELECT CORP 61F MYRTLE ST CRANFORD N J MULTI-AMP ELECT CORP 80 SHORE RD PORT WASHINGTON N Y MULTICORE SALES CORP 80 SHORE RD PORT WASHINGTON N Y MULTICORE SALES CORP 80 SHORE RD PORT WASHINGTON N Y MULTICORE SALES CORP 80 SHORE RD PORT WASHINGTON N Y MULTICORE SALES CORP 80 SHORE RD PORT WASHINGTON N Y MULTICORE SALES CORP 80 SHORE RD PORT WASHINGTON N Y MULTICORE SALES CORP 80 SHORE RD PORT WASHINGTON N Y MULTICORE SALES CORP 80 SHORE RD PORT WASHINGTON N Y MULTICONES SUD MULTI-AMP ELCT CON 21470 COOLIDGE HWY OAK PARK 37 MICH MULTONICS INC BX 227 1747 E MONTGOMERY AV ROCKVILLE MD MUNTO 6 SONS CHARLES 53 FAIRMOUNT AVE JERSEY CITY 4 N J MUNTZ INDUSTRIES INC 1000 GREY AVE EVANSTON ILL MUNTZ INDUSTRIES INC 1000 GREY AVE EVANSTON ILL MUNTZ INDUSTRIES INC 1000 GREY AVE EVANSTON ILL MUTT-GRIP CO INC 423 GLIDE ST ROCHESTER N Y MYT-GRIP ME CO INC 176 BROADWAY NEW YORK 33 N Y MYCALEX CORP OF AMERICA 125 CLIFTON BLUD CLIFTON NJ MYCALEX CORP OF AMERICA 125 CLIFTON BLUD CLIFTON NJ MYCALEY CORP OF AMERICA 125 SON SINCE A 375 VALLEY BROOK RD CANNONSBURY PA MYKROY INC 645 WHEELING ROAD WHEELING ILL MYTRON HFG CO ELECTRONIC MANUFACTURERS-A TO Z

375 VALLET BRUCK RD CLASSING WYRROY INC 645 WHEELING ROAD WHEELING ILL MYTRON MFG CO 4522 BRAZIL ST LOS ANGELES 39 CALIF MYTRON PRODUCTS INC 656 ATKINS AVE BROOKLYN 8 NY

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NAGEL-CHASE MEG CO

MINNEAPOLIS-HONEYWELL BOSTON DIV 1400 SOLDIERS FIELD RO BOSTON MASS MINNEAPOLIS-HONEYWELL FALL RIVER DIV PENN 6 BAY STS FALL RIVER MASS MINNEAPOLIS-HONEYWELL FALE RIVER MASS MINNEAPOLIS HONEYWELL APARATUS CONTROLS DIV 2753 ATH AVE MINNEAPOLIS MINN MINNEAPOLIS HONEYWELL ORDANCE DIV 600 ZND ST N HOPKINS MINN MINNEAPOLIS-HONEYWELL ORDANCE DIV 2000 DIS ST N HOPKINS MINN MINNEAPOLIS-HONEYWELL SENICOND PROD DIV 1015 S 6 ST MINNEAPOLIS MINN MINNEAPOLIS-HONEYWELL SENICOND PROD DIV 1015 S 6 ST MINNEAPOLIS MINN MINNEAPOLIS-HONEYWELL SENICOND PROD DIV 1015 S 6 ST MINNEAPOLIS MINN MINNEAPOLIS-HONEYWELL SENICOND PROD DIV 1015 S 6 ST MINNEAPOLIS MINN MINNEAPOLIS-HONEYWELL SENICOND PROD DIV 1015 S 6 ST MINNEAPOLIS MINN MINNEAPOLIS-HONEYWELL SENICOND PROD DIV 1015 S 6 ST MINNEAPOLIS MINN MINNEAPOLIS-HONEYWELL SENICOND DIV 1015 S 6 ST MINNEAPOLIS MINN MINNEAPOLIS-HONEYWELL SENICOND DIV 1016 S MINN AVES PHILA PA MINNEAPOLIS-HONEYWELL SECISION METER OIV 00 BUSH ST ST PAUL 6 MINN MINNEAPOLIS-HONEYWELL SECIAL SYS OIV 00 BUSH ST ST PAUL 6 MINN MINN MINING MFG CO CHEMICAL DIV 900 BUSH ST ST PAUL 6 MINN MINN MINING MFG CO CHEMICAL DIV 900 BUSH ST ST PAUL 6 MINN MINNESOTA MINING 6 WFG CO 900 BUSH AVE ST PAUL 6 MINN MINNESOTA MINING 6 WFG CO 1000 DISH ST ST PAUL 6 MINN MINNESOTA MINING 6 WFG CO 10100 DISH ST ST PAUL 6 MINN MINNESOTA MINING 6 WFG CO 10100 DISH ST ST PAUL 6 MINN MINNESOTA MINING 6 WFG CO 103630 WODALE AVE MINN MINN MINNESTA MINING 6 WFG CO 10100 DISH ST ST PAUL 6 MINN MINNESOTA MINING 7 PAUL 6 MINN MINNESTA MINING 7 PAUL 6 MINN MINNESTER MACHINE CO 1500 S STI ST MINSTER OHIO MIRATEL INC 1 ST SE 6 RICHARDSON NEW BRIGHTON MINN MIRATEL INC 1 ST SE 6 RICHARDSON NEW BRIGHTON MINN MISCELLA INFRA-RED CO 280 BUG GRAND AVE MINNEAPOLIS MINN MISCELLA INFRA-RED CO 290 BUSH AVE CELEVELAND 4 OHIO II 31 SE & RICHARDSON ARE BRIGHTON MINN
WIRATELINC
1080 DIONNE ST ST PAUL 13 MINN
MISCE
1080 DIONNE ST ST PAUL 13 MINN
MISCELA INFRA-RED CO
E 73 & GRAND AVE MINNEAPOLIS MINN
MISKELLA INFRA-RED CO
E 73 & GRAND AVE CLEVELAND & OHIO
MISSILE SYSTEMS CORP CALIFORNIA DIVISION
11949 VOSE ST N HOLLYWOOD CALIF
MISSILE TRONICS CORP
243 4TH ST PASSAIC N J
MISSIMERS INC
3737 SAN FERNANDO RD GLENDALE CALIF
MISSOUPI RESEARCM LABORATORIES INC
2109 LOCUST ST ST LOUIS 3 MO
MITCHELL CAMERA CORP
666 W HARVARD ST GLENDALE 1 CALIF
MISSOUPI RESEARCM COP ASTROMICS DIV
666 W HARVARD ST GLENDALE 1 CALIF
MITCHELL CAMERA CORP
666 W HARVARD ST GLENDALE 1 CALIF
MITCHELL CAMERA CORP ASTROMICS DIV
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MITCHELL CAMERA CORP ASTROMICS DIV
666 W HARVARD ST GLENDALE CALIF
MITCHELL RAND MRG CORP
31 MURRAY ST NEW YORK 7 N Y
MITCONICS INC
132 FLORAL AVE MURRAY HILL NJ
M 6 O PLASTICS PRODUCTS
BOX A02 BANNARD ST FREEHOLD NJ
MOBL ELECTRONICS MFG CO
111 STATE RD 67 E ANDERSON IND
MODEL FNGG 6 MFG INC
50 FREDERICK ST HUNTINGTON IND
MODEL FNGG 6 MFG INC
50 FREDERICK ST HUNTINGTON IND
MODEL RECTIFIER CORP
1100 STATER DO 7 E ANDERSON IND
MODEL RECTIFIER CORP
1115 ATTE RD 67 E ANDERSON IND
MODEL RECTIFIER CORP
116 AVENUE BROOKLYN 34 N Y
MODERN INOUSTRIES INC
755 CAMILLE AVE CULVER CITY CALIF
MOOELCTRIC PRODUCTS CORP
ASBURY PARK N J
MODAWK MFG CO
P 0 BOX 1110 MIODLETOWN CONN
M944 HALSEY ST BROOKLYN 33 NY
MOMAK KIEE CABLE CORP
4 SUMMER ST LEOMINSTEM MASS
MOISTURE REGISTER CO
P 0 BOX 1110 MIODLETOWN CONN
M944 HALSEY ST PROLVENY 33 NY
MOMAK WIRE & CABLE CORP
4 SUMMER ST LEOMINSTEM MASS
MOISTURE REGISTER CO
P 0 BOX 1110 MIODLETOWN CONN
M0444 MIE & CABLE CORP
4 SUMMER ST LEOMINSTEM ASS
MOISTURE REGISTER CO
P 0 BOX 1110 MIODLETOWN CONN
M0444 MIE & CABLE CORP
4 SUMMER ST LEOMINSTEM ASS
MOISTURE REGISTER CO
P 0 BOX 1110 MIODLETOWN CONN
M04455 MIE ST PRILABULA OHIO
MOLE FILT AVE ASHTABULA OHIO
MOLE FILTA VE ASHTABULA OHIO
MOLE ARICES SED
401 BENEFIT AVE ASHTABULA OHIO
MOLE ARICES SED
Y 101 CALARD AVE TINLEY PARK ILL
MOLECUMIRE CORP
23 3806 GRAND AVE MINNEAPOLIS MINN

MONADNOCK MILLS 1977 FIRST AVE SAN LEANDRO CALIF MONAGHAM CO J 500 ALCOTT ST DENVER 4 COLO 500 ALCOTT ST DENVER 4 COLO MONITOR CONTROLLER 99 GROVE ST ROCKLAND MASS MONITOR PRODUCTS CO INC 815 FREMONT AVE S PASADENA CALIF MONITOR SYSTEMS INC FORT WASHINGTON PA MONDF INC 3751 PROSPECT AVE CLEVE OHIO MONDFILCON INC

 MONIOR STSTEMS INC.

 FORT WASHINGTON PA

 MONODF INC.

 3751 PROSPECT AVE CLEVE OHIO

 MONOSILICON INC.

 139 E 157ST GARDENA CALIF

 MONROE CALCULATING MACHINE COMPANY

 553 MITCHELL ST ORANGE N J

 MONROE CALCULATING MACHINE CO

 VALLEY DRIVE BRISTOL VA

 MONROE CALCULATING MACHINE CO

 VALLEY DRIVE BRISTOL VA

 MONROK CALCULATING MACHINE CO

 VALLEY DRIVE BRISTOL VA

 MONROK AVIATION CORP

 B01 ROYAL OAKS DR MONROVIA CALIF

 MONROKIS STATE ST SALT LAKE CITY 7 UTAH

 MONTGOMERY MFG CO

 206 S MAIN ST OVENSVILLE IND

 MONTRONICS INC

 1212 W MAIN ST BOX 135 BOZEMAN MONT

 MONTRONSE PRODUCTS CO INC

 AURURN INDUSTRIAL PARK AUBURN MASS

 MODTM MACHINE PRODUCTS CO INC

 40 DUDLEY ST PROVIDENCY LABS

 13 E FORT LEE RD BOGOTA N J

 MOORE ASSOCIATES INC

 893 AMERICAN ST SAN CARLOS CALIF

 MOORE CO HOWARD J

 105 E 16ST NEW YORK N Y

 MOORE CO HOWARD J

 105 E 16ST NEW YORK N Y

 MORE CO ROP JOHN B

 PO BOX O DEPT EI PERLESS BLOG NUTLEY U NJ
 MORSE INSTRUMENT CO 2D CLINTON ST HUDSON OHIO MOSAIC FABRICATION INC 205 CHAPIN ST SOUTHBRIDGE MASS MOSELEY CO F L 409 FAIR OAKS AVE PASADENA CALIF MOSER JEWEL CO 544 FAYETTE ST PERTH AMBOY NJ MOSINEE PAPER MILLS CO 544 FAYETTE ST PERTH AMBOY NJ MOSINEE PAPER MILLS CO MOSINEF WISC 9 SOUTH ST DANBURY CONN MOSLEY ELECTRONICS INC 4610 N LINDBERGH BRIDGETON MO MOSSMAN INC DONALD P PO BOX 265 BREWSTER NY MOSSMAN-ELLIDIT CORP 204 SO LARKIN AVE JOLIET ILL MOTIOGRAPH INC 2221 BARY AVE LOS ANG CALIF MOTOROLA AVIATION ELECTRONICS INC 10916 W ASHINGTON BLVD CULVER CITY CALIF MOTOROLA AVIATION ELECTRONICS INC 10916 W MASHINGTON BLVD CULVER CITY CALIF MOTOROLA AVIATION ELECTRONICS INC 10916 W ASHINGTON BLVD CULVER CITY CALIF MOTOROLA AVIATION ELECTRONICS INC 1400 W 30TH ST QUINCY ILL MOTOROLA INC 1400 N CICERO AVE CHICAGO 51 ILL MOTOROLA INC SEMICONDUCTOR PRODUCTS DIV MOTOROLA INC SEMICONDUCTOR PRODUCTS DIV 50D5E MCDOWELL RD PHOENIX ARIZ MOTOROLA INC 5055E MCDOWELL RD PHOENIX ARIZ MOTOROLA INC 9401 GRAND AVE FRANKLIN PARK ILL MOTORESEARCH CO 160D JUNCTION AVE RACINE WISC NOTSON CO J FRANK 1717 BETHLEHEM PIKE FLOURTOWN PA MOULIC SPECIALITES CO 1007 W WASHINGTON ST BLOOMINGTON ILL MOVIDLA MFG CO 1451 N GOROON ST HOLLYWOOD 28 CALIF MOXNESS PRODUCTS INC 1914 INDIANA ST RACINE WISC MOYEN CO C P 8157 MONTICELLO AVE SKOKIE ILL MP ENGINEERING CO FAIRFIELD 3 CONN M 6 O PLASTICS PRODUCTS ROX 402 RANNARD ST FREFHOLD NJ MUCKLE MFG CO U S HWY 14 OWATONNA MINN MUCON CORP 9 ST FRANCIS ST NEWARK 5 N J

NAGEL-CHASE NFG CO 2811 N ASHLAND AVE CHICAGO 13 JLL NAMEPLATES INC 281 PLOI ST BROOKLYN N Y NAMEPLATES INC 280 2739 ISTATION TOLEDO OHIO ARDA ORR 0 082 2739 ISTATION TOLEDO OHIO ARDA MICROWAVE CORG 0 080 774 2 READING FA NARCO FABRIC CO 0 0 80 7 43 2 READING FA NASCO FUNCE COR FIL 0 080 742 READING FA NASCO FUNCE COR 0 0 80 7 8 3 6TH ST MIAMI FLA NASCO FUNCE COR FIL 0 080 743 FLE FLONNICS INC 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 19 0 805 FR C REIGHTON DR NASHVILLE TENN 10 000 10 8 45 ST NEW YORK 36 N 20 0 805 ST REW YORK 36 N 20 0 805 ST SE COLUMENT INC 20 0 805 ST SE COLUMENT INC 20 0 805 ST SE REIDAN WP 10 00 1233 THEIDAN WP 10 10 123 THEIDAN NP 11 ALARAMA RD N W WASHINGTON P 0 C 13 ALARAMA RD N W WASHINGTON P 0 C 13 ALARAMA RD N W WASHINGTON P 0 C 14 ALARAMA RD N W WASHINGTON P 0 C 15 OR ONTH ST GENECA ILL 30 ADRIM ST KE REIDAN WF 30 ADRIM ST KE REIDAN WF 30 ADRIM ST SE REIDAN WF 30 ADRIM ST SE REIDAN WF 31 ALARAMA RD N W WASHINGTON P 0 C 31 ALARAMA RD N W WASHINGTON P 0 C 32 ADRINGTON SLO WASHINGTON D C 34 ALARAMA RD N W WASHINGTON P 0 C 35 ADRIM ST KE WY CK NE SI NC 36 ADRIM THILLE AVE SILVER SPRING MD 36 ADRIM THILLE AVE SILVER SPRING MD 37 ADRINGTON SLO WASHINGTON D C 38 ADRIM THILLE AVE SILVER SPRING MD 38 ADRIM THILLE AVE SILVER SPRING MD 39 ADRIM THILLE AVE SILVER SPRING MD 30 ADRIM THILLE AVE SILVER SPRING MD 30 ADRIM THILLE AVE SILVER SPRING MD 30 ADRIM THILE AVE SILVER SPRING MD 30 ADRIM THILLE AVE SILVER SPRING MD 30 ADRIM THILLE AVE SILVER SPRING 475 WASHINGTON ST NEWARK N J

ELECTRONIC MANUFACTURERS-A TO Z NEW HAMPSHIRE BALL BEARINGS INC ROUTE 202 PETERBOROUGH N H NEW HERMES ENGRAVING MACHINE CORP 1346 N HIGHLAND AVE LOS ANGELES 28 CALIF NEW HERMES ENGRAVING MACHINE CORP 154 W 14TH ST NEW YORK 11 NY NEW JERSEY ZINC CO 160 FRONT ST NEW YORK 38 N Y NEW JERSEY WOOD FINISHING CO AMBOY AVE WOODBRIDGE N J NEW JERSEY WOOD FINISHING CO AMBOY AVE WOODBRIDGE N J NEW LONDON INST CO INC 82 UNION ST NEW LONDON CONN NEWMAN CORP M M 79 CLIFTON AVE MARBLEHEAD MASS NEW PRODUCTS INC CAMERON VILLAGE STA RELEIGH N C NEWTON CO 55 ELM ST MANCHESTER CONN NEWTON INSERT CO 6500 AVALON BLVD LOS ANG CALIF NEW TRONICS CORP 3455 VEGA AVE CLEVELAND 13 OHIO NEW YORK AIR BRAKE CO 230 PARK AVE NEW YORK 17 N Y N Y MFG 6 GENERAL SUPPLY CD 144 46 TOTH AVE FLUSHING N Y NEW YORK COLL CO 684 E 133 ST NEW YORK 54 N Y NEW YORK TRANSFORMER CO 3 AVE ALPHAN J NEW YORK TRINSFORMER CO 3 AVE ALPHAN J NEW YORK TRIST ORILL CO INC 30 N CLIFTON ST CHICAGO ILL N T WIST DRILL MEG CORP 99 MAGNOLIA AVE WESTBURY N Y NFY CO J M P O BOX 990 HARTFORD 1 CONN

NEW HAMPSHIRE BALL BEARINGS INC

NFY CO J M P O BOX 990 HARTFORD 1 CONN NIAGRAR ALECTRON LARS BOX 128 MAIN ST ANDOVER N Y NIAGRAR ALECTRON LABS MAIN 6 GREENWOOD ST ANDOVER N Y NIAGRAR MACH 6 TOOL WKS 683 NORTHLANO AVE BUFFALO N Y NICAD DIV GOULD NATLONAL BATTERIES INC EASTHAMPTON MASS NICAD SOLU ONATL BATTERIES INC EASTHAMPTON MASS NICHOLS 6 CLARK INC 321 NEWBURY PORT TURNPIKE HATHORNE MASS NICHOLS ELECTRONICS 85 SO 13TH ST MINNEAPOLIS 3 MINN NICHOLS PRODUCTS CO 323 W MAIN ST MOORESTDWN NJ NIELSEN HARDWARE CORP 770 WETHERSFIELD AVE HARTFORD CONN NIEMAND BROS INC 45-10 94TH ST ELMHURST 13 N Y NILSSON ELECTRICAL LABORATORY INC 103 LAFAYETTE ST NEW YORK 11 N Y NOBLE 6 WESTBROOK MFG CO EAST HARTFORD 8 CONN NOEL MFG CO 3 W 18 ST NEW YORK 11 N Y

NEY CO J M P O BOX 990 HARTFORD 1 CONN

ELECTRONIC MANUFACTU NATL RADIO CO INC 37 WASHINGTON ST MELROSE MASS NATIONAL SCIENTIFIC LABS INC 2010 MASSACHUSETTS AVE WASHINGTON D C NATIONAL SCREW 6 MANUFACTURING CO 2440 E 75 ST CLEVELANO 4 OHIO NATL SEMICONOUCTORS LTO 230 AUTHIER SR MONTREAL DUE CANADA NATIONAL SPECTROGRAPHIC LABS INC 6300 EUCLIO AVE CLEVELANO 3 OHIO NATL SALANA STANDARO CO 8TH 6 HOWARD STS NILES MICH NATL TELEVISION TUBE INC ROUTE 46 SADOLE BROOK N J NATIONAL TELEVISION TUBE INC PD BOX 133 ROCHELE PARK NJ NATIONAL TELEVISION TUBE INC PD BOX 133 ROCHELE PARK NJ NATIONAL TELEVISION TUBE INC PD BOX 133 ROCHELE PARK NJ NATIONAL TELEVISION TUBE INC PD SOX 133 ROCHELE PARK NJ NATLONAL TELEVONIC CORP 95 PARK AVE NUTLEY N J NATIONAL UTRASONIC CORP 95 PARK AVE NUTLEY N J NATIONAL USION FLECT CORP ELECT DIV 1201 BELL ST BLOMINGTON ILL NATU NULTRASON ST SINCE 826 S ARRDYO PARKWAY PASADENA CALIF NATIONAL VULCANIZED FIBRE CO 2415 GARDNER RO BROADVIEW ILL NATIONAL VULCANIZED FIBRE CO NATIONAL VULCANIZED FIBRE CO 2415 GARDNER RO BROADVIEW ILL NATIONAL VULCANIZEO FIBRE CO BOX 311 WILMINGTON DELA NATIONAL VULCANIZEO FIBRE CO YORKLYN DEL NATL VULCANIZEO FIBRE CO MULBERRY LAFAYETTE KENNETT SQ PA NATL WATER LIFT CO DIV PNEUMO DYNAMICS CORP 2220 PALMER AVE KALAMAZOO MICH NATURAL LIGHTING CORP 630 S FLOWER BURBANK CAL NATVAR CORP 211 RANDOLPH AVE WOOORIDGE N J 211 RANDOLPH AVE WOODRIDGE N J NAUGLER ENGG INC 19 MADISON AVE BEVERLY MASS NAVCOR 19 MADISON AVE BEVERLY MASS NAVCOR 960 RITTENHOUSE RO VALLEY FORGE IND PK NORRISTOWN PENNA MAVIGATION COMPUTER CORP VALLEY FORGE INDUSTRIAL PARK NORRISTOWN PA NAYROR LAB INC E V 26 MANORHAVEN BLVD PORT WASH N Y NAZ-DAR CO 465 MILWAUKEE AVE CHICAGO 10 ILL NAZ-DAR CO 461 MILWAUKEE AVE CHICAGO 10 ILL NEDMAC INC 708-42ND AVE NO MINNEAPOLIS 12 MINN NEFF INSTRUMENT CORP 1088 HAMILTON RO DUARTE CALIF NELSON VACUUM PUMP CO GEO F 2133 4 ST BERKELEY 10 CALIF NEMS-CLARKE CO DIV VITRO COFP FAMERICA 919 JESUP-BLAIR DR SILVER SPRING MO-NEOSIL PRODUCTS CO 10 E 39TH ST NEW YORK 16 N Y NEPTUNE ELECTRONICS CO 30 W 15TH ST NEW YORK 11 NY NESAMAINY ELECT CORP EASTON RD NESHAMINY PA NESOR ALLOY PRODUCTS CO 666 PASSAIC AVE W CALDWELL N J NETWORK INDUSTRIES INC P O BOX 397 BAYONNE N J NETWORKS ELECT CORP 9750 DESOTS CHATSWORTH CALIF NEUSEN INC P K 511 DWYER ST ARLINGTON HGTS ILL NEUSAGE SIC P K 512 DWYER ST ARLINGTON HGTS ILL NEUSAGE AVE MEMPSTEAD N Y NEVADA AIR PRODUCTS CO 32 TENNESSEE AVE MEMPSTEAD N Y NEVADA AIR PRODUCTS CO 32 TENNESSEE AVE MEMPSTEAD N Y NEVADA AIR PRODUCTS CO 32 TENNESSEE AVE MEMPSTEAD N Y NEVADA AIR PRODUCTS CO 33 TENNESSEE AVE MEMPSTEAD N Y NEVADA AIR PRODUCTS CO 34 TENNESSEE AVE MEMPSTEAD N Y NEVADA AIR PRODUCTS CO 35 TENNESSEE AVE MEMPSTEAD N Y NEVADA AIR PRODUCTS CO 36 DO SOTS CHATSWORTH CALIF NEWARK CONTROLS CO 37 D DO SOT SOLUSA CALIF NEWARK CONTROLS CO 960 RITTENHOUSE RO VALLEY FORGE IND PK NEVEDA ANTENNA CO P O ROX 530 COLUSA CALIF NEWARK CONTROLS CO 15 WARD ST BLOOMFIELD N J NEWARK SPINNING & STAMPING 472 RLOY ST HILLSIDE N J NEWARK WIRE CLOTH CO 351 VEROMA AVE NEWARK N J NEWBURY INDUSTRIES INC NEWBURY OHIO NEWCASTLE FABRICS CORP 75 N 11TH ST BROOKLYN 11 N Y NEWCOM AUDIO PROD CO NEWCASILE FABRICS CORP 75 N LITH ST BROKLYN 11 N Y NEWCOMR AUDIO PROD CO 6824 LEXINGTON AVE HOLLYWOOD CALIF NEWCOMR SPRING CORP 77 E HAWTHORNE AVE VALLEY STREAM N Y NEWCOMB SPRING OF ATLANTA INC 1200 SPRING ST NW ATLANTA GA NEWCOMB SPRING OF CONN 510 QUEEN ST SOUTHINGTON CONN NEW DEPARTURE OIV GMC 269 N MAIN ST BRISTOL CONN NEW DEPARTURE OIV GMC 365 MAIN ST LISBON N H NEW ENG ELECT WORKS INC 365 MAIN ST LISBON N H NEW ENG LAND LANTAMMASS NEW ENGLAND LANTAMMASS NEW ENGLAND LANTAMFORD 575 ALBANY ST BOSTON MASS NEW ENGLAND TRANSFORMER CO 30 TOWER ST HUDSON MASS NEW ENGLAND TRANSFORMER CO 47 MGCRATH HWY SOMERVILLE 43 MASS NEW ENGLAND TRANSFORMER CO 47 MCGRATH HWY SOMERVILLE 43 MASS

NOBLE 6 WESTBROOK MFG CO EAST HARTFORD 8 CONN NOEL MFG CO 3 W 18 ST NEW YORK 11 N Y NON LINEAR SYSTEMS INC DEL MAR AIRPORT DE L MAR CALIF NONDUCK MFG CO CANAL ST S HADLEY FALLS MASS NOPCO CHEMICAL CO 60 PARK PLACE NEWARK N J NOPCO CHEMICAL CANADA LTO PO BOX 68 LONDON ONT CANADA NOPCO CHEMICAL CANADA LTO PO BOX 68 LONDON ONT CANADA NOPCO CHEMICAL CO PLASTICS DIV 175 SCHUYLER AVE NORTH ARLINGTON NJ NORCO PRODUCTS MFG CO 392 BLEECKER ST NEW YORK 14 N Y NORDEN DIV UNITED AIRCRAFT CORP HELEN ST NORWALK CONN NORDEN DIV UNITED AIRCRAFT CORP DATA SYS DPT 3501 HARBOR BLVO COSTA MESA CALIF WORMAN JONES INC SO MERIMACK N H HORPLEX FABRICATIRS INC BLACK RIVER FALLS WISC NORRIGH LASDICS CORP 107 W 18TH ST NEW YORK N Y NORRMAN LABORATORIES ERNST WILLIAMS BAY WISC N AMERICAN AYIATION INC MISSILE DIV IDT W JEASINGS COMP IDT W JEASINGS COMP NORMAN LABORATORIES ERNST WILLIAMS BAY WISC N AMERICAN AVIATION INC MISSILE DIV 12214 LAKEWOOD BLVD DOWNEY CALIF NORTH AMERICAN AVIATION AUTONETICS DIV 9150 E IMPERIAL HWY DOWNEY CALIF NORTH AMERICAN ELECTINON 1233 RD AVE W BIRNINGHAM ALA NORTH AMERICA LECTINON 11 LINDEN ST WEST LYNN MASSACHUSETTS NORTH ALANTIC INDUST INC 603 MAIN ST WESTBURY N Y NORTHEAST ELECT CORP AIRPORT RD CONCORD N H NORTHEAST ELECT CORP 30 WETHERBEES T ACTON MASS NORTH ELECT INC 8400 PILLSBURY AVE S MINN MINN NORTHERN ELECT INC 8455 BELDIT ST BURLINGTON WISC NORTHER METAL PRODUCTS CORP 9595 W GRAND AVE FRANKLIN PARK ILL NORTHERN ORDNANCE INC 48TH 6 MARSHALL ST NE ST PAUL 21 MINN

<text> 0 OAK MFG CO GRYSTAL LAKE ILLINOIS 0 DELL BROS 2950 GRANT RD MOUNTAIN VIEW CALIF 0GOEN COIL TRANSFORMER CO 3323 W CERMAK RD CHICAGO 23 ILL 0HIO BASS CO 380 N MAIN ST MANSFIELD OHIO 0HIO CARBON CO 12508 BEREA RD CLEVELAND 11 OHIO 0HIO CARBON CO 1177 MARQUETIE ST CLEVELAND 14 OHIO 0HIO CHEMICAL 6 SURGICAL EQUIPMENT CO 1130 GRAND ST HOBOKEN NJ 0HIO CRANKSHAFT CO TOCCO DIV 3800 HARVARD AVE CLEVELAND 5 OHIO 0HIO CRANKSHAFT CO TOCCO DIV 3800 HARVARD AVE CLEVELAND 5 OHIO 0HIO SEAMLESS TUBE DIV COPPERWELD STEEL CO SHELBY OHIO 0HIO SEMICONDUCTORS 1205 CHESAPEAKE AVE COLUMBUS OHIO 0HMITE GOP 4241 ALLENDORF DR CINN OHIO 0HMITE WFG CO 3601 HOWARO ST SKOKIE ILL 0HMWEVE CO INC 43 DACY ST WEST HARTFORD CONN 0IL RITE CORP

OIL RITE CORP 2318 WALDO BLVD MANITOWOC WISC OK ELECTRONICS CORP 7 HUNT PL NUTLEY 1 NJ

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PACIFIC MERCURY ELECT INC 8345 HAYVENHURST AVE SEPULVEDA CALIF PACIFIC MERCURY TY MFG CORP 8345 HAYVENHURST AVE SEPULVEDA CALIF PACIFIC OPTICAL CORP DIV CHICAGO AERIAL IND 120 GLASGOW AVE INGLEWOOD I CALIF PACIFIC RELAYS INC 13915 SATICOY ST VAN NUYS CALIF PACIFIC SCIENTIFIC CO P 0 BOX 22019 LOS ANGELES 22 CALIF PACIFIC SEMICONDUCTORS TINC 14520 AVIATION BLVD LAWNDALE CALIF PACIFIC SEMICONDUCTORS TINC 14520 AVIATION BLVD LAWNDALE CALIF PACIFIC SEMICONDUCTORS TINC 14520 AVIATION BLVD LAWNDALE CALIF PACIFIC TECHNICAL CO 2047 SAWTELLE BLVD LOS ANGELES 25 CALIF PACIFIC TRANSDUCER CORP 1836 W PICO BLVD LOS ANGELES 25 CALIF PACAFIC UNIVERSAL PROD CORP 1905 ARMACOST AVE LOS ANGELES 25 CALIF PACKARD BELL CLOPUTER CORP 12333 W OLYMPIC BLVD LOS ANGELES 64 CALIF PACKARD BELL ELECTRONICS 2341 MICHIGAN AVE SANTA MONICA CALIF PACCARD BELL ELECTRONICS 2331 MICHIGAN AVE SANTA MONICA CALIF PACCARD INSTRUMENT CO P 0 BOX 428 LAGRANGE ILL PACO FRECIRONICS CO INC 70-31 84TH ST GLENDALE 27 LI N Y OKONITE CO PASSAIC N J OLSEN TINIUS TESTING MACH CO EASTON ROAD WILLOW GROVE PA OLTRONIX INC 247 UNDERWOOD DR NW ATLANTA 5 GA OLYMPIC INSTRUMENTS INC VASHON WASH OLYMPIC INSTRUMENTS INC 3471 S LACIENEGA BLVD LOS ANGELES 16 CALIF OLYMPIC PRODUCTS CO INC 3 AVF ALPHA NJ OLYMPIC RADIO & TV DIV SIEGLER CORP 34-01 38 AVE LONG ISLAND CITY 1 NY OMCO 3 AVF ALPMA NJ OLYMPIC RADIO 6 TV DIV SIEGLER CORP 3A-01 38 AVE LONG ISLAND CITY 1 NY OMCO BOX 1110 US 93 6 LAS PALMS ST KINGMAN ARIZ OMEGA LABS INC HAVERNILL ST ROWLEY MASS OMNITRONICS INC 511 N BROAD ST PHILA PA OMTRONICS MFG INC PO BOX 1419 PEONY PARK ST OMAHA NEBR ONAN DV OF STUDEBAKER PACKARD CORP 2515 UNIVERSITY AVE S E MINN MINN ON MARK COUPLINGS INC 4440 YORK BLVD LOS ANGELES 41 CALIF ONONDAG ELECTRONICS DIV SPEER CARBON CO 1810 W FAYETTE ST SYRACUSE 1 N Y ONSRUD MACHINE WORKS INC 7720 N LEHIGH AVE MILES 48 ILL OPAD ELECTRIC CO 43 WALKER ST NEW YORK 13 N Y OPTICAL COATING LAB INC 977 SEBASTOPOL RD SANTA ROSA CALIF OPTIMED RD SINC 246 MARBOR BLVD BELMONT CALIF 071 ICS TECHNOLOGY INC 246 MARBOR BLVD BELMONT CALIF 071 CAL GAGING PRODUCTS INC 246 MARBOR BLVD BELMONT CALIF 071 CAL GASING PRODUCTS INC 246 MARBOR BLVD BELMONT CALIF 071 CAL GASING PRODUCTS INC 246 MARBOR BLVD BELMONT CALIF 071 MLED DEVICES INC 216 E 2ND ST MINEOLA N Y 071 CALER BEARINGS CO INC 557 MAIN ST ORANGE NJ 078 ITT ELECTRONICS IND 336 N ALBANY AVE N MASSAPEOUE L I N Y 081 TI NDUSTRIES BOX 666 RESIDA CALIF 078 TI NDUSTRIES BOX 666 RESIDA CALIF 078 TI NDUSTRIES BOX 666 RESIDA CALIF 078 TI NDUSTRIES BOX 666 RESTDA CALIF 078 TI NDUSTRIES BOX 666 RESTDA CALIF 078 TI NDUSTRIES BOX 666 RESTDA CALIF 078 TI NDUSTRIES BOX 660 RESTDA CALIF 078 TI NDUSTRIES BOX 660 RESTDA CALIF 078 TI NDUSTRIES BOX 606 RESTDA CALIF 078 TI NDUSTRIES CO 2105 SE 6 AVE PORTLAND 14 ORE 0710 RECONTACE OPERATION ELECT ON SUCKAHOE N Y 07 DATERSON ST PATERSON 1 N J 07 THOLOG DIV P 0 BOX 37 PRINCETON JUNCTION N J 07 THOLDG DIV GUITON INDUST

- PACO ELECTRONICS CO INC 70-31 84TH ST GLENDALE 27 LI NY PACO PRECISION 70-31 84TH ST GLENDALE 27 LI NY PAGE FOGWELL CORP 3014 N COOLIDGE AVE LOS ANGELES CALIF PAKTRON DIV ILL TOOL WORKS 1321 LESLIF AV ALEXANDRIA VA PALCO ENG CO 355 COLUMBIA ST P O BOX 291 FRANKFORT IND PALNUT CO 25 GLEN RD MOUNTAINSIDE NY PALO ALTO ENG CO 620 PAGE MILL RD PALO ALTO CALIF PALOMATO ENG CO 4254 NIAGRA AVE SAN DIEGO 7 CALIF PAMPA ELECT CORP 21 ROCK HILL RD BALA-CYNWYD PA PANDUIT CO 22 AU HURON ST CHICAGO ILL PANFLERT CORP 17301 RIDGELAND AVE TINLEY PARK ILL PANFLECTRONICS CORP 222 W HURON ST CHICAGO ILL PANELLIT INC DIV INFORMATION SYS INC 7401 HAMLIN AVE SKOKIE ILL PANELLIT LTD MEMBER OF ELLIOTT AUTOMATION GROUP ELSTREE WAY BOREHAMWOOD HERTS ENGLAND PANELST DIV ST REGIS PAPER CO ENTERPRISE AVE TRENTDN 4 NEW JERSEY PAN FAX INC 401 OLD COAST HWY SANTA BARBARA CALI
- AN FAX INC 401 OLD COAST HWY SANTA BARBARA CALI PANOB CORP 49 BEECH PORT CHESTER N Y

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108 COLUMBUS AVE TUCKAHOE N Y ORTHO FILTER CORP 7 PATERSON ST PATERSON 1 N J ORTHOLOG DIV P 0 BOX 37 PRINCETON JUNCTION N J DRTHOLDG DIV GULTON INDUST 4054 GUAKER BRIDGE RD TRENTON NJ ORTHO MAGNETICS INC BOX 240 KUTZTOWN PENNA ORTHO PRECISION RESISTORS INC 7 PATTERSON ST PATERSON N J ORTHAN-MILLER MACHINE CO INC 19 143RD ST HAHMOND IND 0500RME ELECTRONIC CORP 712 SE HAWTHORNE BLVD PORTLAND 14 ORE 050BRME TRANSFORMER CORP 3834 MITCHELL AVE DETROIT 7 MICH 05CAR A SCHOTT CO 500-11TH AVE SO MINNEAPOLIS 4 MINN 0 6 5 RESEARCH INC 1811 BANNARD ST RIVERTON N J 05TER MEG CO JOHN AVIONIC DIV 1 MAIN ST RACINE WISC 07ARION LISTENER CORP SCARRONUGH PK OSSINING N Y 0715 ELEVATOR CO DEFENSE 6 INDUSTRIAL DIV 35 RYERSON ST DROKLYN 5 N Y 0VENAIRE INC 706 FOREST ST CHARLOTTESVILLE VA DVERHEAD DOOR CORP PO BOX 188 MARTFORD CITY IND 0VERLAD COMTROL CO 151 PENNA AVE N LONG BEACH ISLAND PARK N Y 0VENAIRE INC 35 RFACON PL PASAOFNA CALIF 0XFORD COMPONENTS DIV OXFORD ELECT CORP 3911 S MICHIGAN CHICAGO 15 ILL 0XFORD COMPONENTS DIV OXFORD SILL 0XFORD COLTRIC CORP 9113 S MICHIGAN CHICAGO 15 ILL 0XFORD CLECTRIC CORP 9113 S MICHIGAN CHICAGO 15 ILL 0XFORD CLECTRIC CORP 9113 S MICHIGAN AVE CHICAGO 15 ILL 0XFORD CLECTRIC CORP 9113 S MICHIGAN CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN AVE CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN AVE CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN AVE CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN AVE CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN AVE CHICAGO 15 ILL 0XFORD ELECTRIC CORP 9113 S MICHIGAN AVE CHICAGO 15 ILL 0XFOR ELECTRIC CORP 9114 S MICHIGAN AVE ALL AND 20 ILL 0ZONE METAL PRODUCTS CORP

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PACE ELECTRICAL INSTRUMENTS CO 70-31 84 ST GLENDALE 27 L I N Y PACE ENGINEERING CO 13035 SATICOY ST N HOLLYWOOD CALIF PACIFIC AUTOMATION PRODUCTS 1200 AIR WAY GLENDALE 1 CALIF PACIFIC ELECTRO MAGNETIC CD INC 942 COMMERCIAL ST PALO ALTO CALIF

World Radio History

ELECTRONIC MANUFACTURERS-A TO Z

PCA ELECTRONICS INC 16799 SCHOENBORN ST SEPULVEDA CALIF PICKERING CO INC SUNNYSIDE BLVD PLAINVIEW N Y PEARCE SIMPSON INC MARINE & COMM DIVISION 2295 NW 14TH ST MIAMI 35 FLA PEARCE SIMPSON INC MARINE & COMM DIVISION 8040 S W 69TH AVE S MIAMI FLA PEARSON ELECTRONICS INC 707 URBAN LA PALO ALTO CALIF PECK SPRING CO 89 WHITING ST PLAINVILLE CONM PECK STOW WILCOX CO 217 274 CENTER ST SOUTHINGTON CONN PEE WEE MOLDING CO 1720 ATLANTIC AVE BROOKLYN N Y PEEBLES & CO LTD BRUCE EAST PLITON EDINBURGH 5 SCOTLAND PEER INC PEE WEE MOLDING CO 1720 ATLANTIC AVE BROOKLYN N Y PEEBLES & CO LID BRUCE EAST PILTON EDINBURGH 5 SCOTLAND EER INC 1200 MILTON ST BENTON HARBOR MICH 1200 MILTON ST DENTON 2424 SHFLRY ST DALLAS TEXAS PEERLESS ELECT PRODS DIV ALTEC LANSING CORP 1515 S MANCHESTER AVE ANAHEIM CALL PEERLESS ELECT PRODS DIV ALTEC LANSING CORP 1515 S MANCHESTER AVENUE ANAHEIM CALL PEERLESS FRODUCTS INDUSTRIES 812 N PULASKI RD CHICAGO 51 ILL PEGLEY CO 3000 W ELEVEN MILE RD BERKLEY MICH 94024 TRANSPORT ST PALO ALTO CALIF PELLEY CO 37 HURLEY ST CAMBRIDGE MASS PELTON DIV BALDWIN LIMA HAMILTON CORP 2329 19TH ST SAN FRAN CALIF PENG DIV ALAN WOOD STEEL CO 0AKS PENNA PENDAR INC 14744 ARMINTA ST VAN NUYS CALIF PENG FENNA PENDAR INC 14744 ARMINTA ST VAN NUYS CALIF PENG FENNA PENN FIBRE SPECIALTY CO 2020 WESTMORELAND ST PHILA PA PENN FIBRE SPECIALTY CO 2020 WESTMORELAND ST PHILA PA PENN KEYSTÔNE CORP P O BOX 350 DERBY CONN PENN TRANSFORMER CORP P N BOX 350 DERBY CONN PENN TRANSFORMER CORP PENNIMOD NUMECHRON CO 7249 FRANKSTOWN AVE PHIA PA PENNIMOD NUMECHRON CO 7240 FRANK ASAS ST EL SEGUNDO CALIF PERKIN ENGG CO EMERALD ST NORWALK CONN PERXIN ENGG CORP 345 KANSAS ST EL SEGUNDO CALIF PERMAG CORP 88 06 VAN WYCK EXPRESSMAY JAMAICA N Y PERMALI INC P O BOX 718 MT PLEASANT PA PERMA-POWER CO 3102 N ELSTON AVE CHICAGD 18 ILL PERMOFLUX LORP PERMA-POWER CO 3102 N ELSTON AVE CHICAGD 18 ILL PERMOFLUX LORP 4101 SAN FERNANDO RD GLENDALE CALIF PERMOFLUX DIV 2300 W ARMITAGE AVE CHICAGO 47 ILL PERMOFILE NEG CO 910 JACKSON BLVD CHICAGO ILL PERMUTIT CO DIV PFAUDLER PERMUTIT INC 30 W 44 ST NEW YORK N Y PESCHEL ELECTRONICS INC TOWNERS RT 216 PATTERSON NJ PESCO PRODUCTS DIV WESTERN BRANCH 310 VANOWEN ST BURBANK CALIF PESCO PRODUCTS DIV WESTERN BRANCH 310 VANOWEN ST BURBANK CALIF PESCO PRODUCTS DIV WESTERN BRANCH 16 VANOWEN ST BURBANK CALIF PESCO PRODUCTS DIV WESTERN BRANCH 17 DWNES RT 216 PATTERSON NJ PESCO PRODUCTS DIV WESTERN BRANCH 1310 VANOWEN ST BURBANK CALIF PESCO PRODUCTS DIV WESTERN BRANCH 14 LAKE VIEW AVE WAUKEGAN ILL PFI PROJUCTS FOR INDUSTRY INC PENNDEL PA PHALO PLASTICS CORP 30 BOSTON TWEK SHREWSBURY MASS PHAOSTRON INSTRUMENT 6 ELECTRONIC CO 151 PASADENA AVF S PASADENA CALIF P 6 H SALES CORP 5650 N WESTERN AVE CHICAGO 45 ILL PHEDLS DOGGE CORPER PRODUCTS CORP 300 PARK AVE NEW YORK 22 N Y PHEOLIM FG CO 5700 W ROOSEVELT RD CHICAGO 50 ILL PHELES DOGGE CORPER PRONCTS SOM NJ PHILA INSULATED WIRE CO 333 NFW ALBANY RD MORRESTOWN NJ PHILASCIENTIFIC GLASS CO RIDGE AVF PFRANST PENNA PHILBRICK RESEARCHES INC GEORGE A 127 CLARENDON ST BOSTON MASS

PANDB CORP 49 BEECH PORT CHESTER N Y PANDRAMIC ELECTRONICS 520 S FULTON AVE MT VERNON NY PANTRAK CO P 0 BOX 212 EL SEGUNDO CALIF PANTHER ELECTRONICS INC 901 S MAIN ST BURBANK CALIF PAPER PRODUCTS MINNESDTA MINING 6 MFGING CO HARTFORD CITY INDIANA PAPESCH 6 KOLSTAD INC BOX 3726 10703 CAPITAL AV OAK PARK 37 MICH PARABAM INC 12822 YUKON HAWTHORNE CALIF PARAGON ELECTRIC CO 1600 12 ST TWO RIVFRS WISC PARAGON REVOLUTE DIV CHARLES BRUNING CO INC 77 SOUTH AVE ROCHESTER 4 N Y PARAMOUNT PAPER TUBE CORP 614 S LAFAYETTE ST FORT WAYNE 2 IND PARK NAMEPLATE CO 34-10 LINDEN PL FLUSHING 54 N Y PARKRE ELECTRICAL INSTRUMENT CORP 200 HARVARD AVE STAMFORD CONN PARKER KALON GENERAL AMER TRAN CO 1 PEEKAY DR CLIFTON N J PARKER METAL GOODS CO 86 DEECCTY 5 WORDECTED MACE PARKER KALON GENERAL AMER TRAN CO 1 PEEKAY DR CLIFTON N J PARKER METAL GOODS CO 85 PRESCOTT ST WORCESTER MASS PARKER SEAL CO DIV PARKER-HANNIFIN CORP 10567 JEFFERSON BLVD CULVER CITY CALIF PARKER SEAL CO DIV PARKER-HANNIFIN CORP 10567 JEFFERSON BLVD CULVER CITY CALIF PARKER LAB HENRY FRANCIS P O BOX 1665 LARE CITY STA SEATLE 55 WASH PARMENTER 6 BULLOCH MFG CO LTD GANANOQUE ONTARIO CANADA PAR-HETAL PRODUCTS CORP 32-62 49 ST LONG ISLAND CITY 3 NY PAR PRODUCTS CORP 602 COLORADO AVE SANTA MONICA CALIF PARTDOUCTS CORP 602 COLORADO AVE SANTA MONICA CALIF PARTLOW CORP 211 CAMPION RD NEW HARTFORD N Y PARTICK 6 WILKINS CO 51 N 7 ST PHILA PA PARTRICK 6 WILKINS CO 51 N 7 ST PHILA PA PARTRIDGE TRANSFORMERS LTD ROEBUCK RD TOLWORTH SURREY ENGLAND PASTORIZA ELECT INC 285 COLUMBUS AVE BOSTON MASS PATTERSON MOOS RESEARCH DIV LEESONA CORP 90 28 VAN WYCK EXPRESSMAY JAMAICA N Y PATWIN DIV PATENT BUTTON WATERBURY CONN PAUL F H 6 STEIN BROS INC 235 COLUMENT AWHITE PLAINS N Y

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ELECTRONIC INDUSTRIES

RACAL ELFCTRONICS LTD WESTERN RD BRACKNELL BERKS ENG RACINE HYDRAULICS & NACH INC 2000 ALBERT FACINE WISC RACON ELECTRIC CO 67 HANFORD ST MIDDLETOWN N Y RADA PRODUCTS CO 2911 CARROLL AVE CHICAGO ILL PADAP OFFICIE COP 2911 CARROLL AVE CHICAGO ILL RADAR DESIGN COPP PICKARD DR SYRACUSE N Y RADAR ENGINEERS 4719 BROOKLYN SEATTLE 5 WASH RADAR MEASUREMENTS CORP 190 DUFFY AVE HICKSVILLE LI N Y RADAR RELAY INC 1631 TENTH ST SANTA MONICA CALIF RADFX CORP RADAR RELAY INC 1631 TENTH ST SANTA MONICA CALIF RADEX CORP 2076 ELSTON AVE CHICAGO ILL RADIANT LAMP CORP 300 JELLIFF AVE NEWARK 8 NJ RADIAPHONE CO 600 E EVERGREEN AVE MONROVIA CALIF RADIATION AT STANFORD 3180 HANOVER ST PALO ALTO CALIF RADIATION COUNTER LABS INC 5121 W GROVE ST SKOKIE ILL RADIATION ELECT CO DIV COMPOMETER CORP 5600 JARVIS AVE CHICAGO ILL RADIATION ELECT CO DIV COMPOMETER CORP 5600 JARVIS AVE CHICAGO ILL RADIATION INC PRODUCTION DIV 501 COMMONNEALTH AVE ORLANDO FLA RADIATION INC PRODUCTION DIV 501 COMMONNEALTH AVE ORLANDO FLA RADIATION INC PRODUCTION DIV 501 COMMONNEALTH AVE ORLANDO FLA RADIATION INC PRODUCTION DIV 501 COMMONNEALTH AVE ORLANDO FLA RADIATION INST WAYNARD RADIATION INC PRODUCTION DIV 501 COMMONNEALTH AVE ORLANDO FLA RADIATION INST WAYNARD MASS RADIATION INST WAYNARD MASS RADIATION INST WAYNARD MASS RADIATION INC PRODUCTION DIV 501 COMMONNEALTH AVE ORLANDO FLA RADIATION INST WAYNARD MASS RADIATION NYS SALL RADIATION RESEARCH CORP 314 FLORIDA AVE WELROSE PARK ILL RADIATION RESEARCH CORP 1150 SHAMES DIR WESTBURY N Y RADIATRONICS INC 119 DANSON AVE BDONTON N J RADIO CANDENSER CO LITO 5 BERMONDSEY RD TORONTO CANADA RADIO CONDENSER CO WESTERN CONDENSER DV WATSEKKA LL RADIO CONDENSER CO WESTERN CONDENSER DIV HOOPESION ILL RADEX CORP RADIO CONDENSER CO LID & DERMONDSEY RO TORONID CANADA RADIO CONDENSER CO WESTERN CONDENSER DV WATSEKA ILL RADIO CONENSER CO WESTERN CONDENSER DIV HOOPESION ILL RADIO CORES INC 9540 S TULLEY AVE OAK LAWN ILL RADIO CORP OF AMERICA OFFENSE ELECT PRODUCTS 11819 W OLYMPIC BLVO LOS ANGELES 64 CALIF RADIO CORP OF AMERICA DEFENSE ELECT PRODUCTS 8500 BALBOA RIVD VAN NUYS CALIF RADIO CORP OF AMERICA ELECT DATA FROC DIV 3900 MONET ROAD WEST PALM BEACH FLA RADIO CORP OF AMERICA ELECT DATA FROC DIV 3900 MONET ROAD WEST PALM BEACH FLA RADIO CORP OF AMERICA HOME INSTRS OIV 1300 SOUTH ROGEPS STREET BLOOMINGTON IND RADIO CORP OF AMERICA HOME INSTRS OIV 501 N LASALLE ST INDIANAPOLIS IND RADIO CORP OF AMERICA CELECTRN TUBE DIV 501 N LASALLE ST INDIANAPOLIS IND RADIO CORP OF AMERICA CELECTRN TUBE DIV 501 N LASALLE ST INDIANAPOLIS IND RADIO CORP OF AMERICA CELECTRN TUBE DIV 501 N LASALLE ST INDIANAPOLIS IND RADIO CORP OF AMERICA OFFENSE ELECT PRODUCTS BURLINGTON MASS RADIO CORP OF AMERICA OFFENSE ELECT PRODUCTS BURLINGTON MASS RADIO CORP OF AMERICA DIV 64 A STREET NEEDHAM HEIGHTS MASS PADIO CORP OF AMERICA SHICONDUCTOR 5 MATERIA DIV SOMERVILLE NJ RADIO CORP OF AMERICA SHICONDUCTOR 5 MATERIA DIV SOMERVILLE NJ RADIO CORP OF AMERICA SHICONDUCTOR 5 MATERIAL DIV SOMERVILLE NJ RADIO CORP OF AMERICA SHICONDUCTOR 5 MATERIAL DIV SOMERVILLE NJ RADIO CORP OF AMERICA SHICONDUCTOR 5 MATERIAL DIV SOMERVILLE NJ RADIO CORP OF AMERICA STRO ELCTS DIV FRONT 6 COOPER STS CAMDEN NJ RADIO CORP OF AMERICA STRO ELCTS DIV FRONT 6 COOPER STS CAMDEN NJ RADIO CORP OF AMERICA STRO ELCTS DIV SUNDING ROAD LOCUST CORMESTON NJ RADIO CORP OF AMERICA SELECT TUBE DIV 1550 ST GEORGE AVE WOODBRIDGE NJ RADIO CORP OF AMERICA ELECT TUBE DIV SADIO CORP OF AMERICA ELECT TUBE DIV SADIO CORP OF AMERICA ELECT TUBE DIV SADIO CORP OF AMERICA SEMI CNOCTR 6 MTRS DIV FINDLAY OHIO RADIO CORP OF AMERICA DEFNS ELECT PRODS COVENTRY 6 LAKESJOE AVES CROYDON PA RADIO CORP OF AMERICA SEMI CNOCTR & MTRS DIV FINDLAY OHIO RADIO CORP OF AMERICA DENS ELECT PRODS COVENTRY & LAKESIDE AVES CROYDON PA RADIO CORP OF AMERICA ELECTRY TUBE OIV NEW HOLLAND PIKE LANCASTER PA RADIO CORP OF AMERICA ELECTRY TUBE NEW HOLLAND PIKE LANCASTER PA RADIO CORP OF AMERICA SEMI CNOCTRS 6 MTRS DV CRESTWOCD ROAD MOUNTAINTOP PA PADIO ENGG CO & STATE ST NEW YORK & N Y

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June 1962

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PADIO ENG LABS INC 2001 BDRDEN AVE LONG IS CITY N Y RADIO ENGG PRODUCTS 1080 UNIVERSITY ST MONTREAL 3 QUE CANADA RADIO FREQUENCY CO 44 PARK ST MEDFIELD MASS RADIO FREQUENCY LABS INC RADIO FREQUENCY CO 44 PARK ST MEDFIELD MASS RADIO FREQUENCY LABS INC BOONTON N J RADIO INDUSTRIES INC 666 GARLAND PL DES PLAINES ILL FADIO MFG ENGG INC 501 WALNUT ST WASHINGTON ILL RADIO MATERIALS CO DIV PM MALLORY " CO INC 4242 W BRYMMARR AVE CHICAGO 46 ILL RADIO MATEC OF AMERICAN INC 1550 SPRINGFIELD AVEMAPLEWOOD N J RADIO MERCHANDISE SALES INC 2016 BRONXDALE AVE BRONX 62 N Y RADIO MERCHANDISE SALES INC 2016 BRONXDALE AVE BRONX 62 N Y RADIO RECEPTOR CO INC SELENIUM DIV 240 WYTHE AVE BROOKLYN 11 N Y RADIO RECEPTOR CO GEN INST CORP SEMICK DIV 120 WYTHE AVE BROOKLYN NY RADIO SPECIALTY MFG CO 2023 S F 6 AVE PORTLANO ORE RADION CORP 345 TERRA COTTA AVE CRYSTAL LAKE ILL RADIONICS INC P 0 BOX 86 COCKEYSVILLE MD RADIONICS INC P 0 BOX 85 COCKEYSVILLE MD RADION LAKE ST GRASS LAKE MICH RADION LAKE ST GRASS LAKE MICH RADION LAKE LAND BLVD CLEVELANO 32 OHIO 245260 LAKELAND BLVD CLEVELANO 32 OHIO RADIO ST IND PAST DENDES INDIANAPOLIS 3 IND 26260 LAKELAND BLVD CLEVELAND 32 OH RAECO 1331 DELOSS INDIANAPOLIS 3 IND RAE MOTOR CORP BOX 518 MCHENRY ILL RAILWAY COMMUNICATIONS INC 9351 E 59 ST RAYTHOWN MO RAM CHEMICALS INC 210 E OLIVE ST GARDENA CALIF RAM METER INC 1100 HILTON RD FERNDALE MICH RAMSEY ENG CO 1853 COUNTY RD ST PAUL MINN RAMYE MFG CO 1779 N MAIN LOS ANGELTS 31 CALIF RANDOLPH FRODUCTS CO CARLSTADT N J RANGERTONE INC 73 WINTHROP ST NEWARK N J RANGERTONE INC 73 WINTHROP ST NEWARK N J RANSCH REASEARCH BOX 269 SAN PEDRO CALIF RANDOLPH ERODUCTS CO CARLSTADT N J RANGERTONE INC 30 WINTHROP ST NEWARK N J RANSCH REASEARCH BOX 269 SAN PEDRO CALIF RAPID ELECTRIC CO 2881 MIDDLETOWN RD BRONX 61 N Y RAPID ELECTRIC CO WASSLEY BR RD LWR SYDENHAAM ENGLAMD RANSOM REASEARCH BOY 269 SAM PEDRO CALIF RAPID ELECTRIC CO 281 MIDDLETOWN RD BRONX 61 N Y RAPID ELECTROPLATING PROCESS INC 1416 SPECIALTIES CO 37 W HURON ST CHICAGO 50 LLL RAPID SIANDARD CO INC RAPIDS STANDARD CO INC RAPIDS STANDARD CO INC CAPIDS STANDARD CO INC CAPIDS STANDARD CO INC RAPISTAN BLOG GRAND RAPIDS MICH RARITAN IND CORP SCHMELING ELECT DIV 20 1ST ST KEYPORT NJ RATEN I EL CAMINO RATEL GOLETA CALIF RA COMP SCHMELING ELECT DIV 20 1ST ST KEYPORT NJ RATONE ELECTRONIC SALES CO 1840 CAMPSELI AVE PHOENIX ARIZ RAU FASTENER CO 10 20 STSTELES TOVIDENCE RI RAUGA FASTERE CO 10 20 STSTELES INC 20 4 EATHSC CO INC 14 CHRISTIES SINC 20 5 E ST ST SOUY FALLS 5 D RAMAD BORS MITH ASSOC INC 135 20 ST N W MASHINGTON D C ARASON ELECTRICAL INSTRUMENT CO 16 DOTTER ST CAMBRIDGE 22 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 DITER ST CAMBRIDGE 22 MASS RAMSON SHITH ASSOC INC 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 DOTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 DITER ST CAMBRIDGE 24 MASS RAMSON SHITH ASSOC INC 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON SHITH ASSOC INC 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 16 JUTTER ST CAMBRIDGE 24 MASS RAMSON ELECTRICAL INSTRUMENT CO 175 ZO ST NA WASSHIDTER EDWOOD CITY CALIF RATESTOS-MANNATIAN INC 0 NG ID21 BAR SALES SI RAMSENDS-MANNATIAN INC 170 MASS AVE REDWOOD CITY CALIF RATESTOS-MANNATIAN INC 170 MASS AVE REDWOOD CITY CALIF RAUGHEN CORP 270 ALLAVE VE NOLLYWOOD CALIF RAUGANC COR 270 ALLAVE NOLLYWOOD CALIF RAUGANC ENGLINER PA RAUCHEN CORP 271 FAIR OAKS AVE REDWOOD CITY CALIF RAUGANC ENGLINER PA RAUCHEN CORP 272 FAIR OAKS AVE REDWOOD CITY CALIF RAUCAD ENGLINER PA RAUCHEN CORP 274 E WASSHINGTON AS CHICAGO 34 ILL RAUSENDE NOLLYWOOD CALIF RAUGANC ENGLINE

RAYTHEON COMPANY INDUSTRIAL OPERATION KEELER AVE S NORWALK CONN RAYTHEON COMPANY INDUSTRIAL COMPONENTS DIV NORTH WINDHAM MAINE RAYTHEON CO MICROWAVE & POWER TUBE DIVISION SPENCER LABORATORY BURLINGTON MASS RAYTHEON CO MICROWAVE & POWER TUBE DIVISION CORPORATE GOVT MKTG LEXINGTON MASS RAYTHEON CO SEMICONDUCTOR DIV CHELMSFORD ST LOWELL MASS RAYTHEON CO INDUSTRIAL COMPONENTS DIV 55 CHAPEL ST NEWTON MASS RAYTHEON CO MAS & DATA PROC OPER 1415 BOSTON & PROVIDENCE TPK NORWOOD MASS RAYTHEON CO LOWER(IAL APPARATUS SYS 225 CRESCENT ST WALTHAM MASS RAYTHEON CO DIST PROD DIV PROVIDENCE TURNPIKE WESTWOOD MASS RAYTHEON CO DIV PROVIDENCE TURNPIKE WESTWOOD CITY CALIF RAYTHEON COMPANY INDUSTRIAL OPERATION RAYTHERM CORP OAKSIDE AT NORTHSIDE REDWOOD CITY CALIF R B M CONTROLS DIV ESSEX WIRE CORP 131 GODFREY ST LOGANSPORT IND R B M DIV ESSEX WIRE CORP 131 GODFREY ST LOGANSPORT IND RCL MFG CO NEW JERSEY AVE RIVERSIDE N J RDF CORP RDF COMP HUDSON N H REA MAGNET WIRE CO 3610 E PONTIAC ST FT WAYNE IND READY POWER CO 11231 FREUD AVE DETROIT 14 MICH READY POWER CO 11231 FREUD AVE DETROIT 14 MICH READY POWER CO 3826 GRAND RIVER AVE DETROIT MICH RECORA CO POWIS RD BOX 68 ST CHARLES 'ILL RECORAC CO POWIS RD BOX 68 ST CHARLES 'ILL RECORDED TAPE OF THE MONTH CLUB 76 W 47 ST NEW YORK N Y RECORDIO CORP 600 SEMINARY ST CHARLOTTE MICH RECOTON CORP 5235 BARNETT AVE LONG ISLAND CITY N Y RECTICO INC 20 FACTORY ST CEDAR GROVE N J RECTIFIER CORP 1521 E GRAND AVE EL SEGUNDO CALIF RECTIFIER CORP 5235 BARNETT AVE LONG ISLAND CITY N Y RECTIFIER CORP 1521 E GRAND AVE EL SEGUNDO CALIF RECTIFIER OR SANTA ANA CALIF RED DEVIL MFG CO 1412 N OGDEN AVE CHICAGO 10 ILL REDFORD CORP INSTRUMENT DIV 33 CRANE ST STATION SCHENECTADY 3 NY REDMAN ELECTRONICS CORP 92 PROSPECT ST THOMPSONVILLE CONN REDMOND CO MONROE ST OWOSSO MICH REDMOND CO INC REDMAN ELECTRONICS CORP 92 PROSPECT ST THOMPSONVILLE CONN REDMOND CO MONROE ST OWOSSO MICH REDMOND CO INC ITHACA MICH REDMONT CORP 105 W SPAZIER AVE BURBANK CALIF RED SEARCH INC 10307 DETROIT AVE CLEVELAND 2 OHIO REEDER 6 CO CMARLES M 173 VICTOR AVE DETROIT MICH RED RESEARCH INC 1048 POTOMACST MASHINGTON D C REED RESEARCH INC 048 POTOMACST MASHINGTON D C REED RESEARCH INC 1048 POTOMACST MASHINGTON D C REED RESEARCH INC 050 W LAKE ST CHICAGO 6 ILL REEVES INSTRUMENT CORP 105 REAT PASTURE ROAD DANBURY CONN REF MFG CORP 303 JERICHO TURNPIKE MINEOLA N Y REGOTINC 3025 W MISSION RD ALHAMBRA CALIF REGENT CONTROLS INC MARARD AVE STAMFORD CONN REF MFG CORP 303 JERICHO TURNPIKE MINEOLA N Y REGOTINCUSTIC MARVARD AVE STAMFORD CONN REF MFG CORP 3025 W MISSION RD ALHAMBRA CALIF REGENT CONTROLS INC MARVARD AVE STAMFORD CONN REF MFG CORP 3025 W MISSION RD ALHAMBRA CALIF REGENT CONTROLS INC MARVARD AVE STAMFORD CONN REF MFG CORP 3025 W MISSION RD ALHAMBRA CALIF REGENT CONTROLS INC MARVARD AVE STAMFORD CONN REID ENTERPRISES 3010 E OT ST LONG BEACH S CALIF REIGMONDE ST ST HOBOREN N J REICHOOL CHEMICAL SINC 320 BRONNE HILL DR HOLLYWOOD 28 CALIF REIGNE RECORDING LIBRARY 3401BROOK RD RICHMOND 27 VA REID ENTERPRISES 3401 BOONNE HILL DR HOLLYWOOD 28 CALIF REIANCE NET CONTROLS INC 3401 BONNE HILL DR HOLLYWOOD 28 CALIF REIANCE TIME CONTROLS INC 3401 BONNE HILL DR HOLLYWOOD 28 CALIF REIANCE TIME CONTROLS INC 3401 BONNE HILL DR HOLLYWOOD 28 CALIF REIANCE TIME CONTROLS INC 3401 BONNE HILL DR HOLLYWOOD 28 CALIF REIANCE TIME CONTROLS INC 3401 BONNE HILL DR HOLLYWOOD 28 CALIF REIANCE TIME CONTROLS INC 3401 BONNE HILL DR HOLLYWOOD 28 CALIF REIANCE HICCON TOLS INC 3401

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RICHMOND ENGINEERING CO INC 19 CONCORD ST S NORWALK CONN RIEGEL PAPER CORP 1143 E FOURTH ST CHARLDTTE N C RIESTER 6 THESMACHER CO 1526 W 25 ST CLEVELAND OHIO RIGGS NUCLEONICS CORP 177 W MAGNOLIA BLYD BURBANK CALIF RIMAK FLECT INC 10929 VANOWEN ST N HOLLYWDOD CALIF RIPLEY CO 1 FACTORY ST MIDDLETOWN CONN RISCO 1086 FOLSOM ST SAN FRAN CALIF I TACTOTT ST MIDDLETOWN CAUN RISCO 1086 FOLSOM ST SAN FRAN CALIF RI TONE PRODS INC 157 LIVINGSTON ST BROOKLYN N Y RIVERBANK LABS ENGG DEPT P O BOX 65 GENEVA ILL RIVERSIDE ALLOY METAL DIV 1 PAVILION AVE RIVERSIDE N J RIVETT LATHE 6 GRINDER INC P O POX 7 BOSTON 35 MASS RIXON ELECTRONICS INC 2121 INDUSTRIAL PKWY SILVER SP MD R M E DIV ELECTRO VOICE INC BUCHANAN MICH R M SASSOCIATES INC BUCHANAM MICH R M S ASSOCIATES INC 112 W BOSTON POST RD MAMARONECK NY RM S ENG INC 95 BENNETT ST N W ATLANTA GA ROAMWELL COPP 180 VARICK ST NEW YORK 14 N Y ROBBINS 6 MYERS INC 1345 LAGONDA AVE SPRINGFIELD OHIO ROBERT J MARCY ASSOC 80 8TH AVE NEW YORK N Y ROBERTS ELECTRONICS INC 1028 LABREA AVE HOLLYMOOD CALIF ROBERTSHAW-FULTON CONTROLS CO SANTA ANA FRWY PUCLID AVE ANAHEIM CALIF ROBERTSHAW-FULTON CO ACRO DIV COLUMBUS 16 OHIO ROBERTSHAW-FULTON CO ACRO DIV COLUMBUS 16 OHIO ROBERTSHAW-FULTON CO ACRO DIV COLUMBUS 16 OHIO ROBERTSHAW-FULTON CO ACRO IN ROBERTSON ELEC CO INC 124 S ELMNOOD AVE BUFFALO N Y ROBERTSON INSTRUMENT CO 240 MOTOR AVE BOX 834 AZUSA CALIF ROBERTS TOLEDO RUBBER CO 4143 MONROE ST TOLEDO 6 OHIO ROBINSI NUSTRUES CORP 1224 S E AVE MONTPELIER OHIO ROBINSON MACHINE CO INC 286 PREAKNESS AVE PATERSON N J ROBINSON MACHINE CO INC 286 PREAKNESS AVE PATERSON N J ROBINSON MACHINE CO INC 285 ST PHILA PA ROBINSON TECHNICAL PRODUCTS INC TETERROR N J ROBOTONICS ENTERPRISES INC 2130 W 8 MILE RD DETROIT 19 MICH ROCKMEL MARCH AVE DARBORN MICH ROCKRESTOS WIRE & CABLE CO NICOLL & CANNER STS NEW HAVEN CONN ROCKER SOLENDID CO 140 MARINE ST WILMINGTON CALIF ROCKWELL ENGINEERING 2133 E 45 ST INDIANAPOLIS 5 IND ROCKERSTOS WIRE SCORP 146 CENTRAL AVE NEWARK N J RODEL MAGG O A 6 MINOR STS EMMAUS PA RODE IND STREET NEW TULSA OKLA RODE INC 377 SN FERNANDOR DLOSA OKLA RODE INC 377 SN FERNANDOR DLOSA OKLA RODE INC 377 SN FERNANDOR DLOSA OKLA RODE INC 370 SONS JOHN A DIV 40 S BROAD ST ARENTON N J ROECER ST WOBURN MASS RODDLY METALS INC 1337 CAMERT TRENTON N J ROECEN TRAL AVE NEWARK N J RODAL ENFG CO INC 4739 WONTROSE AVE CHICAGO A1 ILL ROM AIRCRAFT CORP FOOT OF H ST VISTA CALIF ROHOE 18 F M S ASSOCIATES INC 112 W BOSTON POST RD MAMARONECK N Y M S ASSOCIATES INC 805 MAMARONECK AVE MAMARONECK NY FOOT OF H ST VISTA CALIF ROLA CO ROUTE 28 HAWTHORNE PA ROLA CO 2330 SUPERIOR AVE CLEVELAND OHIO ROLLAN ELECTRIC CO 8233 S PRINCETON AVE CHICAGO 20 ILL ROLOCK INC 1350 KINGS HWY FAIRFIELD CONN ROMAC PRODUCTS CO 48-01 25 AVE LONG ISLAND CITY 3 N Y ROME CABLE DIV ALCOA RIDGE ST ROME N Y

ROME TURNEY RADIATOR CO BOX 32 ROME N Y ROMAN & KUNZL INC 502 SKALAMAZOO AVE MARSHALL MICH RONDO OF AMERICA INC 100 SANFORD ST HAMDEN CONN RON ELECTRONICS CORP 150 FINE ST NONTCLAIR NJ ROMETTE ACOUSTICAL CORP 190 EARLE AVE LYNBROOK N Y ROSCO LABS INC 29 NOORE ST BROOKLYN & N Y ROSCO LABS INC 29 NOORE ST BROOKLYN & N Y ROSCO LABS INC 29 NOORE ST BROOKLYN & N Y ROSCO LABS INC 29 NOORE ST BROOKLYN & N Y ROSCO LABS INC 29 NOORE ST BROOKLYN & N Y ROSCO LABS INC 29 NOARL & CHEM CO 16 HUDSON ST NY 13 NY ROSTANE COP 101 VARICK AVE BROOKLYN N Y ROSTANE COP 31 JUARICK AVE BROOKLYN N Y ROSTONE COP 31 JUARICK AVE BROOKLYN N Y ROSTONE COP 31 JUARICK AVE BROOKLYN N Y ROTATNY LIFT CORP DIV DOVER CORP 1054 KANSAS ST MEMPHIS TENN ROTATNY LIFT CORP DIV DOVER CORP 1054 KANSAS ST MEMPHIS TENN ROTATNY LIFT CORP DIV DOVER CORP 1054 KANSAS ST MEMPHIS TENN ROTATNY LAST MUMENTS DIVISION BUDD CO 9 D BOX 245 PHOENIXVILLE PA ROTOST LABS INC 2800 LOS FLORES BLVD LYNWOOD CALIF ROTRON MFG CO 448500LYL LABS INC 2010 BUDSTRIES 1702 WAYNE ST TOLEDO ONIO 30 BRIDGE AVE RED BANK N J ROWAN CONTROLLER CO 315 ROMENOOD AVE BALTIMORE 18 MD ROWE ENGRAVERS INC 65 UNION AVE CLIFTON N J ROWE INDUSTRIES 1702 WAYNE ST TOLEDO ONIO ROY CO MILITON 1300 WERMAID LANE PHILA PA ROYAL COMMUNICATION SYSTEMS 4501 PROSPECT AVE CLEVELAND 3 ONIO ROYAL ELECTRIC CORP 99 G RAM DAYF PANTUCKET RI ROYAL MCHEE INST DEVELOP LAB 67 MECHANIC ST ATTLEBORO MASS ROYCO INSTRUMENTS INC 4440 OLIVE ST PALO ALTO CALIF R SELECTRONICS CORP 223 BELLEVILLE AVE BLOOMFIELD N J RUBBERCARFT CORP OF CALIFORNIA 1900 W 220TH ST TORRANCE CALIF RUBER FCK INC 1913 S HAMILTON ST GARDENA CALIF RUBER FCK INC 1913 S HAMILTON ST GARDENA CALIF RUBERCEART CO 192 ROARSON RD LOS ANG CALIF RUBERCEART CO 7426 BESSENER AVE CLEVELAND 27 OHIO RUSCEL CORD & WADDISON NJ RUCKER CO 4727 MORTOSES T CHICAGO ILL 7335 LANKERSHIM BLVD HOLLWHOOD CALIF RUBSELL BINGDSALL 6 WARD BOLT 6 NUT CO P S110 PORT CHESTER N Y RUSSELL 6 STOLL CO INC 125 BAACLAY ST NEW YORK 7 N Y RUSSELL 6 STOLL CO INC 135 BAYE LINDENALES T CULVER CITY CALI

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ELECTRONIC INDUSTRIES

ELECTRONICS SANGAMO ELECTRIC CO 1207 N 11TM ST SPRINGFIELD ILL SONNEBORN CMEMICALS & REFINING CORP 300 PARK AVE S NEW YORK 10 NY SANTA ANITA ENGC CO OF CALIF 2451 E COLORADO ST PASADINA CALIF SARASOTA ENG CO OT CALIF 2451 E COLORADO ST PASADINA CALIF SARASOTA ENG CO INC 7010 PINE TERRACE SARASOTA FLA SARATOGA INDUSTRIES CONGRESS & BALLSTON AVES SARATOGA SPRINGS NY SARATOGA PLASTICS INC N WALPOLE NH SARGEANT & WILBUR HEAT TREATING CORP 170 YORK AVE PAWTUCKET R I SARGENT ELECTRIC CORP 23-16 40 AVE LONG ISLAND CITY NY SARKES TARZIAN INC EAST MILLSIDE DR BLOOMINGTON IND SARKES TARZIAN INC 415 N COLLEGE AVE BLOOMINGTON IND SARKES TARZIAN INC 415 N COLLEGE AVE BLOOMINGTON IND SARKES TARZIAN INC 416 MAIN ST NEWBERG ORG SATLINE CORP OF AVERICA CHEVONKI RD WISCASSET MAINE SATURN ELECTRONICS CORP 10665 MARRY HINES BLUD DALLAS TEXAS BOX 13305 DALLAS TEXAS SAUEREISON BLUD PITTSBURGH PENNA SAVGERGVE PLAITING CO INC 132 PORTAGE ST KALMAZOO MICH SAVOREFOWE PLAITING CO INC 1324 PORTAGE ST KALMAZOO MICH SAVOR ELECTRONICS INC 2152 PORTAGE ST KALMAZOO MICH SAVOR ELECTRONICS INC 9 NOX 584 GRIFFIN GA SAVOR ELECTRONICS INC 1314 NE 17 CT BOX 7127 FT LAUDERDALE FLA SAONBURG CERAMICS INC BOX 137 SANDBURG PA SATON PRODUCTS INC 4300 PARK AVE NEW YOR 57 N Y SAYOY ELECTRONICS INC 1314 N E 17TH COURT FORT LAUDERDALE FLA SATON PRODUCTS INC 1314 N E 17TH COURT FORT LAUDERDALE FLA SATON PRODUCTS INC 1314 N E 17TH COURT FORT LAUDERDALE FLA SATON PRODUCTS INC 1314 N E 17TH COURT FORT LAUDERDALE FLA SATON PRODUCTS INC 210 TAYLOR ST RIVERSIDE NJ SATON PRODUCTS INC 210 TAYLOR ST RIVERSIDE J SALAR ANDIG CO 2110 TAYLOR ST AN FRANCISCO ID CALIF 213 COLBY AVE LOS-ANGELES 64 CALIF SCALE APDIG CO 213 TAYLOR ST AN FRANCISCO ID CALIF 210 TAYLOR ST RIVERSIDE NJ SCALA RADIO CO 2814 19 ST SAN FRANCISCO 10 CALIF SCALA RADIO CO 2135 COLBY AVE LOS'ANGELES 64 CALIF SCHAEVITZ ENGG US RTE 130 & SCHAEVITZ BLVD CAMDEN NJ SCHAFER CUSTOM ENGG 235 S 3 ST BURBANK CALIF SCHAFFER AIR INDUSTRIES 290 N HENRY ST BROOKLYN 22 N Y SCHAUER MFG CORP 4501 ALPINE AVE CINCINNATI OHIO SCHENECTADY VARNISH CANADA LTD 409 COMSTOCK RD SCARSBOROUGH ONT CANADA SCHENECTADY VARNISH CAMADA LTD 409 COMSTOCK RD SCARSBOROUGH ONT CANADA SCHENECTADY VARNISH CO ROTTERDAM JCT N Y SCHERR CO GEORGE 200 LAFAYETTE ST NEW YORK 13 N Y SCHERR CO GEORGE 200 LAFAYETTE ST NEW YORK 12 N Y SCHENE CO GEORGE 200 LAFAYETTE ST NEW YORK 12 N Y SCHIRDLERS 195 GREENFIELD AVE LOS ANGELES 49 CALIF SCHIRME-NATIONA LALAR CORP 20 WESTSIDE AVE BERGENFIELD N J SCHJELDAHL CO G T BOX 170 NORTHFIELD MINN SCHLIEBUS ELECTRONICS DIV RARITAN INDS CORP 20 187 ST KEYPORT NJ SCHMELING ELECTRONICS DIV RARITAN INDS CORP 20 187 ST KEYPORT NJ SCHOT LONG XULLE RD SILVER SPRING MD SCHOT CO OSCAR A 500 11TH AVE ST INLE SPRING MD SCHOT CO OSCAR A 500 11TH AVE ST NINEAPOLIS 4 MINN SCHUMERER ELECTRONICS LABORATORY 915 WASHINGTON AVE EVANSVILLE 13 IND SCHOT CO OSCAR A 500 11TH AVE SMINNEAPOLIS 4 MINN SCHUMERER FINGECO 9170 BROKVILLE RD SILVER SPRING MD SCHOTE ELECTRONICS LABORATORY 915 WASHINGTON AVE EVANSVILLE 13 IND SCHUMERER RIDGEFIELD INSTRUMENTS RIDGEFIELD CONN SCHUMERER RIDGEFIELD INSTRUMENTS RIDGEFIELD CONN SCHUMERER NIS BUCKS CO PA SCHUMBERGER RIDGEFIELD INSTRUMENTS RIDGEFIELD CONN SCHWEILTER DIV P J KIMBERLY CLARK CORP MT HOLLY SPRINGS PA SCHUMERT RINC POTER J DIVN LEF MASS SCIAY BROS 4915 W 67 ST CHICAGO 38 ILL SCHWEITZER INC PETER J DIVN LEE MASS SCIAKY BROS 4915 W 67 ST CHICAGO 38 ILL SCIENCE-ELECTRONICS INC 195 MASSACHUSETTS AVE CAMBRIDGE MASS SCIENTIFIC ATLANTA INC 2162 PIEDMONT RD NE ATLANTA 9 GA SCIENTIFIC ELECTRIC INC 105 119 MONROE ST GARFIELD N J SCIENTIFIC ELECTRONIC LABS INC 24 WOODSIDE AVE LITTLE FALLS NJ SCIENTIFIC GLASS APPARATUS CO 100 LAKEWOOD TERRACE BLOOMFIELD N J SCIENTIFIC RADIO PRODS INC 2303 W 8TH ST LOVELAND COLORADO SCIENTIFIC RADIO SERVICE 4301 SHERIDAN ST UNIV PARK HYATTSVILLE MD SCINTILLA DIV BENDIX CORP DELAWARE AVE SIDNEY NY SCIOTO SIGN CO 370 VINE ST KENTDN OHIO SCOPES CO INC PO BOX 36 MONSEY NY

SCOTT INC H H 111 POWOFR MILL RD MAYNARD MASS SCOTT INSTRUMENT LAB 17 EAST 48TH ST NEW YORK 17 N Y SEABOARD ELECTRONIC CORP 417-421 CANAL STREET NEW YORK 13 NY SEABORD PACIFIC DIV ASSOC SPRING 15001 S BROADWAY PO BX 231 GARCENA CALIF SEAGER STANDARD CARBON CO 291 CHURCH ST NEW YORK 13 N Y SEAL-A-METIC CO DIV OF FILTORS INC 1 JOHN ST MALFORN N J SEALECTRIC SWITCH 6 RELAY CORP 6025 N KEYSTONE AVE CHICAGD 3 ILLINOIS SEALECTRIC SWITCH 6 RELAY CORP 610 FAYETTE AVE MAMARONECK NY SFALOL INC WARWICK INDUSTRIAL PARK PROVIDENCE 5 RI SEAL PEEL INC 775 STEPHENSON HWY ROYAL OAK MICH SEALTRON CORP READING RD AT AMITY CINCINNATI 15 OHIO SECOPE CORP SEALTRON CORP READING RD AT AMITY CINCINNATI 15 OHIO SECODE CORP 535 MINNESOTA ST SAN FRANCISCO 7 CALIF SECO ELECTRONICS INC 5015 PENN AVE S. MINN MINN SECO ELECTRONICS INC 5015 PENN AVE SO MINNEAPOLIS MINN SECON METALS CORP 7 INTERVALE ST WHITE PLAINS NY SECURITY CONTROLS INC 503 FRANKLIN ST BUFFALO 2 N Y SECURITY DEVICES INC 518 SC HOCTAW AVE EL RENO OKLAHOMA SEEBURG CORP 1500 N DAYTON ST CHICAGO 22 ILL SEELY INSTRUMENT CO INC 377 4TH ST PO BOX 387 NIAGARA FALLS NY SEGAL EDWARD INC 132 LAFAYETTE ST NEW YORK 13 NY SEG ELECTRONICS CO INC 12 MINSDALE ST BROOKLYN 7 NY SEISCOR MFG CO DIV SEISMOGRAPH SERVICE CORP P0 BOX 1590 TULSA OKLAHOMA SEKONIC INC SEKONIC INC 130 WEST 42ND ST NEW YORK 36 NY SELAS CORP OF AMERICA DRESHER PENNA SELECTRONS LTD 520 FIFTH AVE NEW YORK 36 NY SEL REX CORP 75 RIVER RD NUTLEY 10 N J SEMCOM 262 E 16 ST PATERSON 4 NJ 75 RIVER RD NUTLEY 10 N J SEMCOR 262 E 16 ST PATERSON 4 NJ SEMCOR 3536 W OSBORN RD PHOENIX ARIZ SEMI-ALLOYS INC 50 S FULTON AVE MOUNT VERNON N Y SEMICON ASSOCIATES INC PO BOX 832 LEXINGTON KY SEMICON ASSOCIATES INC DO BOX 832 LEXINGTON KY SEMICON ASSOCIATES INC TO BOX 832 LEXINGTON KY SEMICON INC SWETMATER RD PO BOX 328 BEDFORD MASS SEMI-ELEMENTS INC 3 SXONBURG BLVD SAXONBURG PENNA SEMICON ST WINCHESTER MASS SEMICON TO STATESTOR 310 MAIN ST WINCHESTER MASS SEMOW PRODUCTS CO 314 FALL ST SENCEA FALLS NY SENSITIVE RESCH INSTRUMENTS CORP 310 MAIN ST NEW ROCHELLE N Y SENSITIVE RESCH INSTRUMENTS CORP 310 MAIN ST NEW ROCHELLE N Y SENSORY INC 7 MAPLE AVE MORRISTOWN N J SCOUGIA WIRE 2201 BAY RD REDWOOD CITY CALIF SERCO ELECT RESEARCH CORP 15735 AMBAUM BLVD SEATTLE WASH SERDEX INC 12 ROMOIN SG BOSTON MASS SERVICE ASSOCIATED INC 9236 S VINCEMENTS CORP 426 S WESTGATE DR ADDISON ILL SERVICE INSTRUMENTS CORP 131 OFFICIAL RD ADDISON ILL SERVICE INSTRUMENT SCORP 131 OFFICIAL RD ADDISON ILL SERVICE INSTRUMENT CORP 131 OFFICIAL RD ADDISON ILL SERVICE INSTRUMENT CORP 131 OFFICIAL RD ADDISON ILL SERVICE ONSULTANTS LID 70 STATE ST WESTBURY NY SERVO CONSULTANTS LID 70 STATE ST WESTBURY NY SERVO CONSULTANTS LID 70 STATE ST WESTBURY NY SERVO CONSULTANTS NC VACUUM FILM PROD DIV 200 NO AVIATION EL SEGUNDO CALIF SERVO CONSULTANTS NC VACUUM FILM PROD DIV 200 NO AVIATION EL SEGUNDO CALIF SERVO CONTAMICS CORP MAIN ST SOMERSWORTH NH SERVO SYSTEMS CO 164 CARMER AVE BELLEVILLE N J SERVO CONTAMIS INC VACUUM FILM PROD DIV 200 NO AVIATION EL SEGUNDO CALIF SERVOMECHANISMS INC 200 AVIATION BLVD EL SEGUNDO CALIF SERVOMECHANISMS INC 200 AVIATION BLVD EL SEGUNDO CALIF SERVOMECHANISMS INC 200 AVIATION DEL SEGUNDO CALIF SERVOMECHANISMS INC 200 AVIATION BLVD EL SEGUNDO CALIF SERVOMECHANISMS INC 200 AVIATION SENDERUM FILM STA MESTAWENTS SERVO TENTRUMENTS INC 200 AVIATION SENDERUM AVJ SERVORE ANN ST WESTBURY NY SERVOMEL AND SENDERUM STA MESTBURY NY SERVOMEL AND SENDERUMENTS INC 200 AVIATION SELVERUM FILM FILM SEND 200 AVIATION SENDERUM AVIA SELVELLEVILLE C

June 1962

SETCHELL-CARLSON INC NEW BRIGHION ST PAUL 12 MINN SETHCO NEG CO 2284 BABYLON TPKE MERRICK N Y SETTER BROS INC SETHCO MFG CO 2264 DABYLON TPKE MERRICK N Y SETTER BROS INC CATTARANGUS N Y SEYMOUP MFG CO 200 FRANKLIN ST SEYMOUR CONN SMALLCPOSS MFG CO PRESTON ST SELMA NC SHALLITE INC 12A W FIRSI AVF ROSELLE N J SHAMBAN 6 CO W S 11617 W JEFFERSON BLVD CULVER CITY CALIF SHAMBAN 6 CO W S 2001 BERMEK DRIVE FT WAYNE 8 IND SHAND 6 JUPS CO 2000 ETH ST REKRELEY 10 CALIF SHAW INSULATOR CO 211 ST ST STROUDSBURG PENNA SHAW INSULATOR CO 276 SNYDER AVE BERLELEY MEIGHTS N J SNEFFER OMFG CORP FAIRVIEW N J SWEFFER FLO CORP SHEFFIC MFG CONF FAIRVITW N J SHEFFIELD COPR SUB THE BENDIX CDRP BOX 893 MU SPRINGFIELD ST DAYTON DHIO SHELL ELFEIRONIC MFG CORP 112 STATE ST WESTRURY N Y SHELTERED WORKSHOPS INC SHELTERED WORKSHOPS INC SHELTERED WORKSHOPS INC SWELTERED WORKSHOPS INC 2619 MAIN ST SANTA MONICA CALIF SHEPARD LABS INC 400 MORRIS AVE SUMMIT NJ SHEPHERD INDUSTRIES INC 103 PARK AVE NUTLEY IO NJ SHEPHARD CO R H 101 PHILADELPHIA ST HANOVER PA SHERIDAN GRAY INC 20000 C HURDRUNDLE JODGANCE CLIM <text> SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO BOX 249 LAC DU FLAMBEAU WISC SIMPSON ELECTRIC CD MERCER WISC SIMS CASTING CORP 2174 E ERIE BLVD SYRACUSE SINCLAIR WEG CO S WORCESTER ST CHARTLEY MASS SINGER MEG FINDERNE NJ FINDERNE NJ FINDERNE NJ SINGLETON CO 11770 BEREA RD CLEVE OHIO SITTLER CORP 18 N ADA ST CHICAGO 7 ILL SIVERS LAB BOX 42018 STOCKHOLM SWEDEN SJOSTROW MACH CO N N 16TH ST 6 IST AVE BOCA RATON FLA C SJOBERG & SON 415 STATION ST CRANSTON 10 R I SKF INDUSTRIES INC 5 W AYLESRURY ROAD TIMONIUM MD SKF INDUSTRIES TULIP 6 KENNEDY ST PHILA PA S W AYLESBURY ROAD TIMONIUM HD SKF INDUSTRIES TUL1P 6 KENNEDY ST PHILA PA SKIATRON ELECTRONICS TV CORP 180 VARICK ST NEW YORK 14 NY SKIDWORE-WILHELM NFG CO 482 CREEM RC LEVELAND 21 OHIO SKIL CORP 5033 ELSTON AVE CHICAGO 30 ILL SKOTTIE ELECTRONICS INC 204 BRIDGE ST PECKVILLE PA SKYDWNE INC RIVER RD PORT JERVIS NY SKYSWEEPER INC PO BOX 92 MCHENRY ILL SKYTRON ELECTRONICS 2032 SCOTT ST HOLLYWOOD FLA SLATER ELECTRIC INC 45 SEA CLIFF AVE GLEN COVE NY SLAUGHTER CO YOUNG AND COLLEGE SIS PIOLA 9 0 SLATER ELECTRIC INC 49 SEA CLIFF AVE GLEN COVE NY SLAUGHTER CO YOUNG AND COLLEGE STS PIOUA 9 OHIO SLIP RING CO DF AMERICA 3622 W JEFFERSON BLVD LOS ANGELES 16 CAL SMALL WOOD LTD S G 391-397 KING ST E KITCHENER ONTARID CANADA SMITH CORP A 0 531 N 4 ST TIPP CITY OHIO A 0 SMITH CO ELEKORN WIS SMITH CO ELEKORN WIS SMITH ELECTRONIC INC 8200 SNOWYILLE RD BRECKSVILLE OHIO SMITH-FLORENCE INC 0 VERLAKE IND PARK BOX 717 REDMOND WASH SMITM FLORENCE INC 4228 23RD AVE W SEATTLE 99 WASH SMITH MC MERMAN H 2326 NOSTRAND AVE BROOKLYN IO NY SMITH THERMOTRONICS INC FOREST HECTOR STS CONSHOHOCKEN PA SMOTH-ON MFG CO 572 COMUNIPAW AVE JERSEY CITY 4 N J SMAP-ON TOOLS CORP KEMOSTA WISC SMAP TITE INC 201 TITUSVILLE RD UNION CITY PENNA SMC MFG CO 22 6 ORTARIO STS PHILADELPHIA 40 PA SODERBER MEG CO 22 8 PALM AVE ALHAMBRA CALIF 22 6 ONTARIO STS PHILADELPHIA 40 PA SODERBERG MFG CO 620 5 PALM AVE ALHAMBRA CALIF SOLA ELECT CO SOLA TRANSFORMER DY BUSSE RD AT LUMT AVE ELK GROVE ILL SOLAR MFG CORP 4553 SEVILLE AVE LOS ANGELES 58 CALIF THE SOLARTRON ELECTRONIC GROUP LTD VICTORIA ROAD FARNBOROUGH MANTS ENGLAND SOLAR VOLT CO INC SOLIN BEND IND VICTORIA ROAD FARMBOROUGH MANTS ENGLAND SOLAR VOLT CO INC SOLUT STATE PRODUCTS INC I PINGREE ST SALEM MASS SOLITISTATE PRODUCTS INC SOULTSINGSTON ST NORWOOD N J SOMERS BRASS CO 94 BALOWIN AVE WATERBURY CDNN SONAR RADIO CORP 3050 W 21 ST BROKLYN 24 NY SONEK INC 20 E MEPMAN ST PHILA 44 PA SONIC INDUSTRIES 13 WILBUR ST LYMBROCK N Y SONOBONG CORP SUD OF AEROPROJECTS INC 202 W MARKET WEST CHESTER PA SONOTONE CORP PO BOX 200-SAW MILL RIVER RD ELMSFORD MY SONOTONE CORP COLD SPRING NY SONY CORP 514 BROADWAY NEW YORK N Y SUL SUL SILE BROADWAY NEW YORK N Y SORENSEN & CO RICHARDS AVE MORMALK CONN SORENSEN INDUSTRIAL ELECTRONIC CO ROUTE 10 DOVER NJ SORENSEN-UNIT OF RAYTHEON CO RICHARDS AVENUE SOUTH NORWALK CONN SOROBAM ENGG INC PO BOX 1717 MELBOURNE FLA SD S CIMENA SUPPLY CORP 602 W 32 ST NEW YORK 19 N Y SOUND SCREEN SUPPLIERS INC 732 BROADWAY NEW YORK 3 N Y SOUNDSCRIBER CORP 6 MIDDLETOWN AVE NEW HAVEN CONN

SOUTH BEND LATHE WORKS 425 E MADISOW ST SOUTH BEND 22 IND SOUTHCO DIV SOUTH CHESTER CORP LESTER PA SOUTHERN ELECTRONICS CORP 150 W CYPRESS AVE BURBAAK CALIF SOUTHERN ELECTRONICS CO INC MOSHELM TENN SOUTHERN INSTRUMENTS COMPUTER DIV FRIMLEY RD CAMBERLEY SURREY ENGLAND SOUTHERN SCREW CO PO BOX 1340 E I D STATESVILLE NC SOUTHERN SCREW CO PO BOX 1340 E I D STATESVILLE NC SOUTHERN TOOL & MACH CO N BIRMINGHAM WHY ANNISTON ALA SOUTHESTERN INDUSTRIAL ELECT CO 10201 W HEIMER RD HOUSTON TEXAS SOUTHWEST PRODUCTS INC RI 4 BOX 90 SAN ANTONIA TEXAS SOUTHWER CO FERTILLA ST CARROLLTON GA SOUTHWORTH MACH CO 30 WARREN AVE PORTLAND MAINE SPACE COMTROL CORP 1416 W 165TH ST GARDENA CALIF SPARTA WFG CO DOVER OMIC SPANDA STATES CONSCI JACKSON MICH SPAULONG FIERE CO INC SPATA NEG CO DOVER OHIO SPARTON ELECTRONICS JACKSON HICH SPAULDING FIBRE CO INC 1325 SAN JULIAN ST LOS ANGELES 15 CALIF SPAULDING FIBRE CO 310 WHEELER ST TONAWANDA N Y SPAULDING FIBRE CO N ROCHESTER NH SPAULDING FIBRE CO INC MILTON N H SPAULDING FRODUCTS CO 550 W BARRER ST FRANKFORT IND SPEC TOOL CO 9626 E BEVERLY RD PICO RIVERA CALIF SPEC-HATING INC 13942 SATICOY ST VAN NUYS CALIF SPEC-HATING INC 13901 SATICOY ST VAN NUYS CALIF SPEC-HATING INC 13901 SATICOY ST VAN NUYS CALIF SPEC-TROMICS 13901 SATICOY ST VAN NUYS CALIF SPEC-TROMICS 13901 SATICOY ST VAN NUYS CALIF SPECTALING INC 13901 SATICOY ST VAN NUYS CALIF SPECTALING ST OSSINING N Y SPECIAL INSTRUMENTS LABORATORY INC 312 W VIRE AVE KNOXVILLE 2 TEAM SPECIALTIES INC SKUMKS MISERY RD SYOSSET LI N Y SPECIALTIES INC SPECIALTIES ST DUSTANGTON MASS SPECIALTIES TON COMPLAND MASS SPECIALTIES TON COMPLOAND SOULAND SPECIALTIES ST DUST SOULAND SPECIALTIES ST DUST SPECIALTS ST MAYNARD MASS SPECIALTS ST MAYNARD MASS SPECTROM COMPARENT ST MAYNARD MASS SPECTROM ALLEAR ST MAYNARD MASS SPECTROM ST MAYNARD MASS SPECTROM ST MAYNARD CALIF SPECTRAN ELECTRONICS CORP 146 WAIN ST MAYNARD MASS SPECTRO MAGNETIC INDUST PO BOX 3306 HAYWARD CALIF SPECTROL ELECTRONICS CORP AMES CT PLAINVIEW NY SPECTROL ELECTRONICS CORP 1704 S DEL MAR AVE SAN GABRIEL CALIF SPEER RESISTOR DIV SPEER CARBON CO BRADFORD PA 1704 S DEL MAR AVE SAN GABRIEL CALIF SPEER RESISTOR DIV SPEER CARBON CO BRADFORD PA SPELLMAN MIGH VOLTAGE CO 1930 ADEE AVE NEW YORK 69 NY SPENCER-KENNEDY LABS INC 1320 SOLDIERS FIELD RD BOSTON 35 MASS SPERRY ELECTRONIC TUBE DIV SPERRY RAND CORP GAINESVILLE FLA SPERRY FARRAGUT CO DIV SPERRY RAND CORP FARRAGUT RD BRISTOL TENN SPERRY GYROSCOPE CO SUMNYVALE CALIF SPERRY GYROSCOPE CO DIV SPERRY RAND CORP GREAT NECK NY SPERRY GYROSCOPE CO ELECTRONIC TUBE DIV SPERRY RAND CORP GREAT NECK NY SPERRY GYROSCOPE CO ELECTRONIC TUBE DIV GREAT NECK NY SPERRY GYROSCOPE CO ELECTRONIC TUBE DIV GREAT NECK NY SPERRY MICROWAVE ELECT INC BOX 1828 CLEAWATER FLA SPERRY PHOENIX CO DV 19TH 6 DEER VALLEY RD PHOENIX ARIZ SPERRY PHOENIX CO DV SPERRY RADOCTS CO DIV SPERRY RAND CORP CHARLOTTESVILLE VA SPERRY RADOCTS CO DIV SPERRY RAND CORP CHARLOTTESVILLE VA CHARLOTIESVILLE VA SPERRY PRODUCTS CO DIV HOWE SOUND CO SHELTER ROCK RD DANBURY CONN SPERRY RAND REMINGTON RAND DIV 311 TURNER ST UTICA N Y SPERRY RAND REMINGTON RAND DIV 7 SPRUCE ST ILION N Y SPERRY SEMICONDUCTOR DIV SPERRY RAND CORP NORWALK CONN SPERRY SYROSCOPE CO DIV SPERRY RAND CORP GREAT NECK NY SPEPRY UTAH CO DV SPERRY RAND CORP 322 N 21ST WEST SALT GAKE CITY UTAH

SPERTI FARADAY INC 1322 E CHURCH ST ADRIAN MICHIGAN THE SPHERE CD INC 25 AMITY ST LITTLE FALLS N J SPICO ELECTRONICS INC MENRIETTA & DUFFY HICKSVILLE N Y SPINCRAFT INC 4122 W STATE ST MILWAUKEE 8 WISC SPIRLING PRODUCTS CO MERRIETTA ST & DUFFY AVE MICKSVILLE LI NY SPIVEY INC JAMES S 4908 HAMPDEN LANE WASHINGTON 14 DC SPLIT BALLBEARING DIV INC LEBANON NEW HAMPSHIRE SPRAUGUE ELECT CO PEMBROKE RD CONCORD N H SPRAUGUE ELECTRIC CO NORTH ADAMS MASS SPRÄGUE ELECTRIC CO NORTH ADAMS MASS SPRAGUE OF WISCONSIN INC 6 6 BEECH STS GRAFTON WISC SPRAYLAT CORP 1 PARK AVE NEW YORK 16 N Y SPRINGER AIRCRAFT RADIO CORP ROUTE 11 BOX 330 INDIAMAPOLIS IND SPRINGER AIRCRAFT RADIO CORP SPRINGER AIRCRAFT RADIO CORP ROUTE 11 BOX 330 INDIANAPOLIS IND SPRINGER AIRCRAFT RADIO CORP IND IND SPRUCE PINE MICA CO PO BOX 436 SPRUCE PINE N CAROLINA SPS WESTERN 5625 CENTURY BLVD LOS ANG CALIF SOUARE D EC 6 M DIV 4500 LEE RD CLEVELAND OHIO S RIVER METAL PRODUCTS CO 377 TURMPIKE S RIVER N J 5 6 S MACHINERY CO 140 53RD ST BOOKLYN 32 N Y ST CROIX PLASTICS CORP PRODUCTION DIV UNITED FAB 6 ELECT DRESSER WIS ST JOE MACHINES INC ST JOSEPM MICH ST JOSEPM MICH ST JOSEPM MICH ST JOSEPM ROUT CALIFON NJ ST REGIS PAPER CO ENTERPRISE AVE TRENTON B N J ST REGIS PAPER CO 150 E 42 ST NEW YORK 17 NY STACKPOLE CARBON CO XAMPE ST AFLED AND SINC STANDE ENN ST ANDY PA STACKPOLE CARBON CO ST MARYS PA STACKPOLE CARBON CO KAME PENNA STAMLIN BROS INC SOM MAPLE ST RELDING MICH STAINLESS INC 3 ST NORTH WALES PA STAL LIT LIGHTER CO ELECTRO LAB DIV 647 NORTH ST DAYTON BEACH FLA STAMFOR STAND YORK N Y STAND METAL SPECIALITY CO 427 W BROADWAY NEW YORK N Y STANCON CONN STANAT WE CONN STANAT WE CONN STANAT MEG CO 523 SHAMES DR WESTBURY NY STANCING HETAL SPECIALITY CO 427 W BROADWAY NEW YORK N Y STANCON STAMPINGS CO WOODBURY CONN STANAT WEG CO 523 SHAMES DR WESTBURY NY STANCOR ELECTRONICS INC 530 MADUS ST WANDOTE MICH STANDARD AUTO CORP 333 CEDAR ST WYANDOTE MICH STANDARD COL PRODUCTS CO 2005 N MAWTHORRE AVE MELROSE PARK 1LL STANDARD COL PRODUCTS CO 3501 W ADDISON ST CHICAGO 18 ILL STANDARD AUTO CORP 333 CEDAR ST WYANDOTTE MICH STANDARD COIL PRODUCTS CO 2005 N HAWTHORNE AVE MELROSE PARK ILL STANDARD COMPONENTS CORP 780 S 3RD AVE MOUNT VERNON N Y STANDARD CONTROLS INC 1130 POPLAR PLACE SEATTLE WASHINGTON STANDARD ELECTRIC MEG CO HADDON AVE W BERLIN NJ STANDARD ELECTRIC TIME CO 89 LOGAN ST SPRINGFIELD 2 MASS STANDARD ELECTRIC TO CORP 657 RROADWAY NEW YORK 12 NY STANDARD INSTRUMENT CORP 657 RROADWAY NEW YORK 12 NY STANDARD INSTRUMENT CORP 657 RROADWAY NEW YORK 12 NY STANDARD KOLLSMAN INGUSTRIES INC TUNER OIV 920 RATHBONE AURORA ILL STANDARD KOLLSMAN INGUSTRIES INC TUNER OIV MELROSF PARR ILL STANDARD COKNUT & LOCKWASHER INC 2250 VALLEY AVE INDIANAPOLIS 18 IND STANDARD NSTRUMENT CORP 657 RROADWAY NEW YORK 12 NY STANDARD KOLLSMAN INGUSTRIES INC TUNER OIV MELROSF PARR ILL STANDARD KOLLSMAN INGUSTRIES INC TUNER OIV MELROSF PARR ILL STANDARD PLASTICS CO INC 62 WATER ST ATTLEBORO MASS STANDARD PLASTICS CO INC 62 WATER ST ATTLEBORO MASS STANDARD PLASTICS CO INC 62 WATER ST ATTLEBORO MASS STANDARD RESED STEL CO BOX 799 JENKINTOWN PA THE STANDARD PROBULTS CO FORT LAUDERDALE FLA STANDARD REGISTER CO 626 ALBANY ST DAYTON 1 ONIO STANDARD REGISTER CO 626 ALBANY ST DAYTON 1 ONIO STANDARD TELEPHORES & CABLES LTD BRIXHAM RD PAIGNTON OEVON ENGLAND STANDARD TELEPHORES 6 CABLES LTD BRIXHAM RD PAIGNTON OEVON ENGLAND STANDARD TELEPHORES 6 CABLES LTD BRIXHAM RD PAIGNTON OEVON ENGLANS 12 LA STANDARD TELEPHORES 6 CABLES LTD BRIXHAM RD PAIGNTON OEVON ENGLANS 12 LA STANDARD TELEPHORES 6 CABLES NEY DAYTON 1 ONIO STANDARD TELEPHORES 6 CABLES NEY DAYTON 1 ON ORY STANDARD TELEPHORES 6 CABLES NEY DAYTON 100 ORYADES ST NEW ORLEANS 12 LA STANDARD TELEPHORES 5T NEW ORLEANS 12 LA STANDARD THE CORP 700 DRVADES ST NEW ORLEANS 12 LA STANDARD WINDING CD DIV OF OVITRON CORP 44-62 JOHNES ST NEWBURGH NY

STANLEY TRANSFORMER CD 31-23 VERNON BLVD LDNG ISLAND CITY N Y STANPAT CD 150 42 12TH RD WHITESTONE N Y STANWAYCK WINDING CO 137-151 WALSH AVE NEWBURGH N Y STAPLEX CO 775 5 AVE BROOKLYN 32 NY STAR-A ELECTRIC MFG CO INC 41 VARICK AVE BROOKLYN 37 NY STAR ENGRAVING 6 NAME PLATE CO 3222 E OLYMPIC BLVD LOS ANG CALIF STAR ENGRAVING 6 NAME PLATE CO 3222 E OLYMPIC BLVD LOS ANG CALIF STAR ENGRAVING 6 NAME PLATE CO 3222 E OLYMPIC BLVD LOS ANG CALIF STAR ENGRAVING 6 NAME PLATE CO 3222 B ANN HARBOR MICH STAR FORCELAIN CO ED X 288 ANN HARBOR MICH STAR FORCELAIN CO 21 MUIRHEAD AVE TRENTON 9 NJ STAR-TRONICS INC MOULTON ST GEORGETOWN MASS STATE LABS CO 649 BROADWAY NEW YORK 12 NY STATES CO MOULTON ST GEORGETOWN MASS STATE LARS CO 649 BROADWAY NEW YORK 12 NY STATES CO 19 NEW PARK AVE MARTFORD 6 CONN STATES ELECTRONICS CORP BLUDWORTH MARINE DIV 96 GOLD ST NEW YORK 38 NEW YORK STATHAM INSTRUMENTS INC OF PUERTO RICO MATO REY PUERTO RICO STATHAM INSTRUMENTS INC OF PUERTO RICO 12401 W OLYMPIC BLVD LOS ANGELES 64 CALIF STATIAM INSTRUMENTS INC 12401 W OLYMPIC BLVD LOS ANGELES 64 CALIF STATIAM INSTRUMENTS INC 12401 W OLYMPIC BLVD LOS ANGELES 64 CALIF STATIAM INSTRUMENTS INC 12401 W OLYMPIC BLVD LOS ANGELES 64 CALIF STATIAM INSTRUMENTS INC 12402 W 6TH ST CLEVELAND OHIO STAVARM ELECTRIC CO 222 CHESTNUT ST RAVENNA OHIO STEAMAR MAGNETIC PRODUCTS 635 S 28 ST MILWAUKEE 46 WISC STEEL CO MERMAN D LAFAYETTE BLOG PHILADELPHIA 6 PA STEINEY MFG CO WM 43 BRUEN ST NEWARK 5 N J STELMA INC 200 MENRY ST STAMFORD CONN STEPHENS ADAMSON MFG CO SEAL MASTER BEARING RIDGEWAY AVE AURORA ILL STEPMENS TRU-SONIC INC 8538 WARKER DR CULVER CITY CALIF STEPHEN STRU-SONIC INC 16226 BROADWAY GARDENA CALIF STEPLEN MOTOR DIV LAND AIR INC 16226 BROADWAY GARDENA CALIF STERLING ELECTRIC MOTORS INC 4510 WITH RD NORWOOD CINN OHIO STERLING RECISION CORP 17 MATIMECOCK E DORT MASHINGTON NY STERLING FRECISION CORP 17 MATIMECOCK E DORT MASHINGTON NY STEVENS MFG CO PO BOX 1007 ANNEX MANSFIELD OHIO STEVENS PAPER MILLS INC PO BOX 1007 ANNEX MANSFIELD OHIO STEVENS PAPER MILLS INC BOZZ N KOGEKS AVE CHICAGO 30 ILL STEVENS MEG CO PO BOX 1007 ANNEX MANSFIELD OHIO STEVENS PAPER MILLS INC PO BOX 347 WINDSOR CONN STEVENS PAPER MILLS INC 77 MILL ST WESTFIELD MASS STEVENS PRODUCTS INC 86 MAIN ST E ORANGE N J STEWARD MEG CO D M CHATTANOOGA TENN STEWART ENGG CO 467 BEAN CREEK RD SANTA CRUZ CALIF STEWART ENGG CO 467 BEAN CREEK RD SANTA CRUZ CALIF STEWART FASS-LUX 1111 W SEPULVEDA BLVD HOUSTON 1 TEXAS STEWART TRANS-LUX 1111 W SEPULVEDA BLVD TORRANCE CALIF STEWART WARKER ELECTRONICS DIV 1826 DIVERSEY PKWY CHICAGO 1LL STEWART WARKER ELECT 1300 KOSTNER AVE CHICAGO 1LL STEWART WARKER ELECT 1300 KOSTNER AVE CHICAGO 1LL STODDART AIRCRAFT RADIO CO 6644 SANTA MONICA BLVD HOLLYWOOD 38 CALIF STOLING CO C M 424 N HOMAN AVE CHICAGO 24 ILL STOKES CORP F J 5500 TABOR RD PHILADELPHIA 20 PA STONE CITY PRODUCTS CO 1206 7 ST BEDFORO INO STONE PAPER TUBE CO OIV OF STONE STRAW CORP 900 FRANKLIN ST NE WASHINGTON 17 OC STONE 6 SMITH INC 905 ALCOA AVE LOS ANGELES CALIF STONARD CO INC 401 N BROAD ST PHILADELPHIA B PA STONE FORG LABS INC 1001 S ELM ST GREENSDORD N CAROLINA STRATOCON CORP BOX 10 MORRISTOWN NJ STRATOCON CORP BOX 10 MORRISTOWN NJ STRATOCON CORP STRATOCON CORP BOX 10 MORRISTOWN NJ STRAT-O-SEAL MFG CO 3039 W FULLERTON AVE CHICAGO 47 ILL STREETER AMET GRAYS LAKE ILL STROBLITE CO INC 75 W 45 ST NEW YORK 36 NY STROMBERG-CARLSON-SAN DIEGO SAN DIEGO 12 CALIF STROMBERG DIV GENERAL TIME CORP 135 S MAIN ST THOMASTON CONN

STRONG ELECTRIC CORP 87 CITY PARK AVE TOLEDD 1 DHIO STRUTHERS-DUNN INC LAMPS RD PITMAN NJ STUCKER & YALE INC GREEN ST MARBLEMEAD MASS STUDEBAKER HYDRAULIC PRODUCTS CO 2511 ST CHARLES ROAD BELLWOOD ILLINOIS STUDIO TV PRODUCTS SALES 356 W 40TH ST NEW 18 NY STUECK INC W WHITNEY BOX 35EI OLD SAYBROOK CONN STURRUP INC 50 SILVER ST MIDDLETOWN CONN STURTEVANT CO P A ADDISON ILL STYROFORMICS 17 HAWKINS ST SOMERVILLE MASS SUBMINIATURE INST CORP 3236 KANSAS AVE RIVERSIDE CALIF SUCKLE ELECTRONICS CO SUBMINIATURE INST COPP 3236 KANSAS AVE RIVERSIDE CALIF SUCKLE ELECTRONICS CO 22.6 HAYES AVE CAMDEN 5 N J SULLIVAN LTD H W 70 STATE ST WESTBURY NY SUMMERS 6 MILLS INC 1511 LEVEE ST DALLAS TEX SUMMIT GOIL CO 4 CLAREMONT RD BERNARDSVILLE NJ SUMMIT INDUSTRIES INC 2104 W ROSECRANS AVE GARDENA CALIF SUNAIR DYNAMICS CORP 4415 E TENTH LANE HIALEAH FLA SUNAIR ELECT INC 3101 S W 3RD AVE FT LAUDERDALE FLA SUNAIR ELECTRONICS INC 2516 N ONTARIO ST BURBANK CALIF SUNCAST INSTRUMENTS DIV HILTON ROY CO 6301 A9TH ST ST PETERSBURG FLA SUNDSTRAND CORP 2531 IS ST ROCKFORD ILL SUNDSTRAND CORP 2339 26 AVE ST PETERSBURG FLA SUNSTRAND DENVER 2480 W 70TH AVE DENVER COLO SUN ELECTRIC CORP MARLEM 6 AVONDALE AVE CHICAGO ILL SUNDSTRAND CORP 2339 26 AVE ST PETERSBURG FLA SUNSTRAND CORP 2480 W TOTH AVE DENVER COLO SUN ELECTRIC CORP MARLEM 6 AVONDALE AVE CHICAGO ILL SUNDSTRAND CORP 2440 MOTH AVE DENVER COLO SUN ELECTRIC CORP MARLEM 6 AVONDALE AVE CHICAGO ILL SUNDSTRAND CORP 2440 MOTH AVE DENVER COLO SUN ELECTRIC CORP MARLEM 6 AVONDALE AVE CHICAGO ILL SUNDSTRAND INC RTE 301 A NORTH ROCKY MOUNT NC SUPERIOR ELECTRONICS CORP 4-6-RAPFORD PLY YONKERS NY SUPERIOR ELECTRONICS CORP 208 PIAGET AVE CLIFTON N J SUPERIOR ELECTRONICS CORP 208 PIAGET AVE CLIFTON N J SUPERIOR ELECTRONICS CORP 208 PIAGET AVE CLIFTON N J SUPERIOR ELECTRONICS CORP 208 PIAGET AVE CLIFTON N J SUPERIOR ELECTRONICS CORP 208 PIAGET AVE CLIFTON N J SUPERIOR ELECTRONICS CORP 208 PIAGET AVE CLIFTON N J SUPERIOR FLUX & MFG CO 1336 ST CLAIR AVE CLEVELAND OHID 208 PIAGET AVE CLIFTON N J SUPERIOR FLEUX & MFG CO 1011 S FIFTM ST MINN MINN SUPERIOR FLUX & MFG CO 1336 ST CLAIR AVE CLEVELAND OHID SUPERIOR INSULATED WIRE CO WASHBURNS LAME STONY POINT N Y SUPERIOR RESISTOR & ELECTRONICS CORP 333 W SUPERIOR PL BOX 274 FRANKFORT IND SUPERIOR SEATITE & CERAMIC CORP 331 W SUPERIOR PL BOX 274 FRANKFORT IND SUPERIOR STEATITE & CERAMIC CORP 83 91 W FOREST ST ENGLEWOOD NJ SUPERIOR TUBE CO BOX 191 NORRISTOWN PA SUPERIOR TUBE CO WAPAKONETA OHIO SUPREME ELECTRONICS CORP 1714 CARROLLTON AVE GREENWOOD MISS SUPREME TRANFORMER CORP PO BOX 237 HERRIN ILL OXFORD ELECTRIC CORP DIV SUPREME TRANSFORMER 4308 W ARMITAGE CHICAGO ILL SURFACE COMBUSTION CORP 2375 DORR ST TOLEDO OHIO SUFACE CONDUCTION INC PARAMOUNT BLDG 1501 BROADWAY NEW YORK N Y SUPERMANT MFG CO 172 STERLING ST CLINTON MASS SWID-CONTROL LABORATORIES INC 5251 W IMPERIAL HWY LOS ANGELES 45 CALIF SWEOLOW PLASTICS CO 394 N MERIDIAN RD YOUNGSTOWN OHIO SWEET MFG CO 10 LOVE LANE MARTFORO 1 CONN SWITC CONTROL LABORATORIES INC 5555 N ELSTON AVENUE CHICAGO ILL SWEIT TEXTILE METALLIZING 6 LAMIMATING CORP 10 LOVE LANE MARTFORO 1 CONN SWITG O LITE INC 5555 N ELSTON AVENUE CHICAGO ILL STLVANIA ELECTRIC PRODUCTS INC MICROWAVE DEVICF DIVISION EAST 3RD ST WILLIAMSPORT PENNSYLVANIA ESTES ST IPSWICH MASS SYLVANIA ELECTRIC PRODUCTS INC MICROWAVE DEVICF DIVISION EAST STON CALIF SYLVANIA ELECTRIC PRODUCTS SYLVANIA ELECTRIC PRODUC DATA STSTEMS OPERATIONS 189 R ST NEEDHAM MASS SYLVANIA ELECTRIC PRODUCTS 60 BOSTON ST SALEM MASS SYLVANIA ELECTRIC PRODS INC WALTHAM LABS 100 FIRST AVE WALTHAM MASS

ELECTRONIC INDUSTRIES

June 1962

ELECTRONIC MANUFACT BUFALD OPER ELECTR SYSTEMS 175 GREAT ARROW BUFFALD NY SYLVANIA ELECTRIC PRODUCTS INC SENECA FALLS NY SYLVANIA ELECTRIC PRODUCTS INC EMPORIUM PENNA SYLVANIA ELECTRIC PRODS INC COMPUTER PROD PLANT PO BDX 360 MUNCY PA SYLVANIA ELECTRIC PRODUCTS INC CHEM 6 METALLUNGICL DIV TOWANDA PA SYLVANIA ELECTRIC PROD INC PARTS DIV 12 2ND AVE WARREN PA SYNARRONICS INC PO BOX 2566 ORLANDU FLA SYNCRO CORP ELECT DIV MEUSSE ARGONNE AVE MICKSVILLE OMIO SYNTAME CORP MONTGOMERY AVE OAKS PA SYNTORQUE INC PO BOX 75 BEARSVILLE STA WOODSTOCK N MONTGOMERY AVE OAKS PA SYNTORQUE INC PO BOX 75 BEARSVILLE STA WOODSTOCK N Y SYNTRON CO 263 LEXINGTON AVE HOMER CITY PA SYNTRONIC INSTRUMENTS INC 100 INDUSTRIAL RD ADDISON ILL SYSTEMSTICS OF MO INC 2222 DLIVE ST ST LOUIS MO SYSTEMS DEVELOPMENT INC 307 WATER ST BINGHAMTON NY SYSTEMS INC 2400 DIVERSIFIED WAY ORLAND FLA SYSTRON DONNER CORP CONCORD CALIF т <text>

TECHNICAL APPLIANCE CDRP SHERBURNE NY TECHNICAL ASSOCIATES 140 W PROVIDENCIA AVE BURBANK CALIF TECHNICAL ASSOCIATES OF NEW ORLEANS INC 511 S CARROLLTON AVE NEW DRLEANS LA TECHNICAL CERAMICS & LAVA CORP 85 5TH AVE PATERSON NJ TECHNICAL DEVICES CO 11242 PLAYA COURT CULVER CITY CALIF TECHNICAL DEVICES CO 11242 PLAYA COURT CULVER CITY CALIF TECHNICAL ALBS BERGEN & EDSALL BLVD PALISADES PK N J THE TECHNICAL MATERIEL CORPORATION 700 FENIMDRE RD MAMAROMECK N Y TECHNICAL MATERIEL CORPORATION 700 FENIMDRE RD MAMAROMECK N Y TECHNICAL MASHINGTON AVE NORTH HAVEN CONN 1ECHNICAL SERVICE CORP 411 WASHINGTON AVE NORTH HAVEN CONN 1ECHNICAL SERVICE CORP 917-19 S THIRD LOUISVILLE 3 KY TECHNICAL WIRE PRODUCTS INC 129 DERMDOY ST CRANFORD NJ TECHNICAL WIRE PRODUCTS INC 129 DERMODY ST CRANFORD NJ TECHNICAL WIRE PRODUCTS INC 129 DERMODY ST CRANFORD NJ TECHNICAST CORP 11455 CHECK AVE LYNWOOD CALIF TECHNICAST CORP 88 SPECTACLE ST CRANSTON R I TECHNICRAFT CO 1136 COMMONWEALTH AVE BOSTON 34 MASS TECHICRAFT OIV THOMASTON CONN TECHNIQUE ASSOCIATES 1413 N CORNELL AVE INDIANAPOLIS 2 IND TECHNIQUES INC 40 JAY STREET ENGLEWOOD N J TECHNIT SALES CO 48 BROWN AVE SPRINGFIELD N J TECHNOGRAPH PRINTED ELECTRONICS INC 920 NORTHWEST BLVD WINSTON-SALEM N C TECHNOLOGY INSTRUMENT CORP ACTON MASS TECHNOLOGY INSTRUMENT CORP ACTON MASS TECH-OHM RESISTOR CORP 36-11 33 ST LONG ISLAND CITY 6 N Y TECH PAREL CO INC PD BOX 293 37 MILFORD STREET BINGHAMTON NY TECHRON CORP 20 SIMMONS ST BOSTON 20 MASS TECT INC 20 SIMMONS ST BUSION 20 MASS TECT INC LIVINGSTON 6 PEGASUS ST NORTHVALE N J TECHTRDMATIC N WALPOLE NJ TED MFG CORP 11415 JOHNSON DR SHAWNEE KANSAS TEKTRON ELECT GENERAL CEMENT CO 400 S WTMAN ST ROCKFORD ILL TEKTRONIX INC PO BOX 500 BEAVERTON OREGON TELCO ELECTRONICS MFG COMPANY 400 S WTMAN ST ROCKFORD ILL TELCON METALS TELCON WORKS MANOR ROYAL CRAWLEY SUSSEX ENGLAND TELE BROADCASTERS OF CALIF INC 756 E COLORADO ST PASADENA CALIF TELE-COIL CD INC MANOR ROYAL CRAWLEY SUSSEX ENGLAND TELE BROACCASTERS OF CALIF INC 758 E COLORADO ST PASADENA CALIF TELEFCOLL CD INC 2733 SAUNDERS ST CAMDEN 5 NJ TELE COMMUNICATIONS CORP 50 DRUMM ST SAN FRAN CALIF TELECHROME MFG CORP 28 RANICK DR ANITYVILLE LI NY TELECOMPUTING CORP 1288 SATICOY ST N HOLLYWOOD CALIF TELECOMPUTING SERVICES INC 8949 RESEDA BLVD MORTHRIDGE CALIF TELECOMTROL CORPORATION 20 DILLER AVE NEWTON N J TELECTRO INDUSTRIES CORP 35-18 37 ST LONG ISLAND CITY 1 N Y TELECTRO CO 4050 SW 14TH AVE FT LAUDEROALF FLA TELECTROSONIC CORP 3516 37TH ST LONG ISLAND CITY N Y TELECTROSONIC CORP 3155 WST EL SEGUNDO HAWTHORRE CALIF TELEGAPH CONDENSER CO N ACTON LONDON W 3 ENGLAND TELEGRAPH CONSTRUCTION & MAINTENANCE CO LTD MERCURY HOUSE THEOBALDS RD LONDON WC 1 ENG 140 W BROADWAY NEW YORK 13 N Y TELEMATED MOTION PICTURES 70 E 45 ST NEW YORK 17 N Y TELEMETERING CORP OF AMER 3110 GODDARD WAY SAN DIEGO CALIF TELEMETER MAGNETICS INC 9937 JEFFERSON BLVO CULVER CITY CALIF TELEMANTICS ORP OF AMER 3110 GODDARD WAY SAN DIEGO CALIF TELEMETER MAGNETICS INC 9937 JEFFERSON BLVO CULVER CITY CALIF TELEMANT ON NUTINGTON L I N Y TELEMANT ON NUTINGTON L I N Y TELEPIX CORP Y97 JEPFENSON BLVG CULVER CITY CAL TELEPHONICS CORP PARK AVE HUNTINGTON L I N Y TELEPIX CORP 1515 N WESTERN HOLLYWODD 27 CAL TELEPROMPTER CO 300 W 43RD ST NEW YORK N Y TELERAD DIV OF THE LIONEL CORP 1440 BROADWAY NEW YORK 18 NY TELEFAD MFG CORP FLEMINGTON N J TELEFSIONAL CORP 196 MILLER PLACE HICKSVILLE LI N Y TELEFSI INSTRUMENT CORP 136-10 31 RD FLUSMING 54 N Y TELEFTAY ELECT SYSTEMS INC 3462 3RD ST N E WASH D C

TECHNICAL APPLIANCE CORP

TELETRONIC LABS INC 1835 W ROSECRANS AVE GARDENA CALIF TELETRONICS CORP 12786 WESTERN AVE GARDEN GROVE CALIF TELETRONIX ENG CO 4688 EAGLE ROCK BLVD LOS ANGELES CALIF TELETYPE CORP 4000 W 65TH ST LITTLE ROCK ARK TELEVISON LABS INC 333 MILL STREET WAUCONDA ILL TELEVISION SPECIALTY CO DIV F M E 1035 STEWART AVE GARDEN CITY LI NY TELEVISION AVE NEW HYDE PARK L I N Y TELEVISION AVE NEW HYDE PARK L I N Y TELEVISION ZODMAR CORP 500 FIFTH AVE NEW HYDE PARK L I N Y TELEWISION ZODMAR CORP 500 FIFTH AVE NEW YDRK N Y TELEWAVE LABS INC DIV POLARAD ELECT 43 20 34TH ST LDNG ISLAND CITY N Y TELEX TELEWAVE LASS INC DIV POLANAD EL A3 20 34TH ST LDNG ISLAND CITY TELEX 1633 EUSTIS ST ST PAUL 1 MINN TELEX INC 1633 EUSTIS ST ST PAUL MINN TELEX INC COMM ACC DIV 1633 EUSTIS AVE ST PAUL MINN TEL-INSTRUMENT ELECTRONICS CORP 728 GARDEN ST CARLSTADT N J TELKOR INC BOX 186 ELYRIA OHIO TEL-LASS INC 1030 2 ST MANCHESTER N H TELONIC ENGINEERING CORP 738 BROADWAY LAGUNA BEACH CALL 1050 2 ST MANCHESTER N H TELONIC ENGINEERING CORP 773 BROADWAY LAGUNA BEACH CALIF JELONIC INDUSTRIES INC 60 N FIRST AVE BEECK GROVE IND TELVISION LABS INC 333 MILL ST WAUCONDA ILL TEMCO ELECTRONICS DIV TEMCO AIRCRAFT CORP P 0 BOX 6191 DALLAS 22 TEX TEMESCAL METALLURGICAL CORP 2850 TTH ST BERKELEY CALIF TEMPCO TV PROD CO 21341 ROSCOE BLVD CAMOGA PK CALIF TEMPCA STEEL CO 1939 BRYN MAWR AVE CHICAGO 26 ILL TEMPERATURE ENGG CORP 1600 UNION LANDING ROAD RIVERTON N J TEMPIL CORP 132 W 22 ST NEW YORK 11 N Y TEMPLET INDUSTRIES INC 701 ATKINS AVE BROOKLYN N Y TEMPLET INDUSTRIES INC 701 ATKINS AVE BROOKLYN N Y TEMPAGE RD PLAINVIEW NY TENTAGER D PLAINVIEW NY TENTAGEN DY LEVELAND 14 OHIO TEN BOSCH INC M PLEASANTVILLE NY TENNALAB 417 5 10 ST GUINCY ILL PLEASANIVILLE NY TENNALAB 417 5 10 ST QUINCY ILL TENNA MEG CO 7380 GARFIELD BLVO CLEVELAND 25 OHIO TENNEY ENGG INC 1090 SPRINGFIELD RD UNION N J 7360 GARFIELD BLVO CLEVELAND 25 OHIO TENNEY ENGG INC 1090 SPRINGFIELD RD UNION N J TENSITROM INC PIN HILL MARVARD MASS TENSOLITE INSULATED WIRE CO INC W MAIN ST TARRYTOWN N Y TENSOR ELECT DEVELOP CO 1873 EASTERN PKWY BROCKLYN 33 NY TEPRO ELECTRIC CORP 5 ST PAUL ST ROCHESTER 4 NY TEPRO FLOETRIC CORP 3 ST PATRICIA AVENUE DUNEOIN FLORIDA TERADO CO 1066 RAYMONO AVE ST PAUL MINN TERY CO GEORGE A 356 S ELMWOOD AVE SUFFALG 1 NY TEVCO INSULATED WIRE 108 E PROSPECT AVE BUFFALG 1 NY TEVCO INSULATED WIRE 108 E PROSPECT AVE BUFFALG 1 NY TEXAS CAPACITOR CO DIV K-C-K CORP 4310 LANGLEY RD MOUSTON 16 TEXAS 1000 CRYSTAL DR FORT MYERS FLA TEXAS CRYSTAL S 1000 CRYSTAL DR FORT MYERS FLA TEXAS INSTRUMENTS INC METALS & CONTROLS 300 N MAIN ST VERSAILLES KY TEXAS ENST INC SEMICONDUCTOR COM DIV DALLAS TEXAS TEXAS INSTRUMENT SEMICONDENTS OIV 135000 CENTRAL EXPRESSWAY DALLAS TEX TEXTRAN CORP PO BOX 9207 AUSTIN 17 TEXAS TEXTRAN CORP 6112 HUFF ST DUBUGUE IOWA THEMADOR ELECTRICAL MEG CO 715 S RAYMOND AVE ALAMBRA CALIF THEMACLYNE CORP 6112 HUFF ST DUBUGUE IOWA 6112 HUFF ST DUBUGUE IOWA THERMADOR ELECTER CAN HAMBRA CALIF THEMACLYNE CORP 6113 NYNMENT CORP LEBANON MH THERMAL WIRE DF AMERICA KEELERS RAY SOUTH HERO YT THERMAL DYNAMICS CORP LEBANDN NH THERMAL WIRE DF AMERICA KEELERS RAY SOUTH HERO VT THERMATRON DIV WILCOX & GIBBS 214 W 39TH ST NEW YORK N Y THERMARW WIRE CORP 304 E 45TH ST NEW YORK 17 N Y THERMECH ENGG CORP 1773 LINCOLN AVE ANAMEIM CALIF THERMOCAL DIV OF JAMIESON LABORATORIES 7900 MASKELL AVE VAN NUYS CALIFORNIA THERM-DJISC INC

ELECTRONIC MANUFACTURERS-A TO Z TRACERLAR INC 2030 WRIGHT AVE RICHMOND CALIF TRACERLAB INC 1601 TRAPELO RD WALTHAM 54 MASS TRADE WINDS WFG CO 5718 N 25 AVE OMAHA NEBR TRAK ELECTRONICS COMPANY INC 59 DANBURY ROAD ROUTE 7 WILTON CONN TRANCDA CHEMICAL CDRP 312-326 ASH ST READING MASS TRANE CO CAMERON 6 2 ST LA CROSSE WISC TRANSCO PRODUCTS INC 12210 NEBPASKA AVE LOS ANGELES 25 CALIF TRANSCO PRODUCTS INC 12210 NEBPASKA AVE LOS ANGELES 25 CALIF TRANSCO INCOLTS DIV 0 80 COUNTY ST ATTLEBORD MASS TRANS LECTRONICS DIV BURTON MFG CD 98 COUNTY ST ATTLEBORD MASS TRANSE LECTRONICS DIV BURTON MFG CD 9910 WINNETKA AVE NORTHRIDGE CALIF TRANSFORMER 6 6 LECTRONIC SPECIALTIES 3824 28 TERRACE ST PHILA 28 PA TRANSFORMER GENIERS 1039 E VALLEY BUVD SAN GABRIEL CALIF TRANSFORMER TECHNICIANS INC 2608 N CICERO AVE CHICAGO 39 ILL TRANSFORMERS MFG INC

THERMO ELECTRIC CO 109 5 ST SADDLE BROOK N J THERMOSEN INC 375 FAIRFIELD AVE STAMFORD CONN 375 FAIRFIELD AVE STANFORD CONN THETA INSTRUMENT CORP 520 VICTOR STREET SADDLE BROOK NJ 1713 KALARAWA RD NW WASHINGTON 9 DC 1713 KALARAWA RD NW WASHINGTON 9 DC 1713 KALARAWA RD NW WASHINGTON 9 DC 1816 9TH ST PASSAIC N J THOMAS LECTRONICS INC 1118 9TH ST PASSAIC N J THOMAS INSTRUMENT CO RDX 41 OSWEGO RD PHOENIX N Y RDX 41 OSWEGO RD PHOENIX N Y 1100 S 100 L 0 DIF CO 2449 W WENRY ST WOOSTER OHID 1100 E SJ ST INDIANPOLLIS T IND 1100 SJ ST INDIANPOLLIS T IND 1100 AVE RIDGEFIELD NJ THOMAS 6 SONS INC WILLIAM SLOCUM AVE RIDGEFIELD NJ THOMPSON LIGHTNING PROTECTION INC 616 4151 AVE HINN 0 PROTECTION INC 616 4151 AVE HINN 12 MINN THOMPSON MACHINE 6 TOOL CORP PD BOX LIGHTNING PROTECTION INC 616 4151 AVE HINN 12 MINN THOMPSON MACHINE 6 TOOL CORP DD BOX BLEVOITH MAINE THIG BELLIPOIT HT CAMPEL ILL THORSEN CORP L S BOX 60 DELLSWORTH MAINE THIG BELLIPOIT HT CAMPEL ILL THORSEN CORP L S BOX 60 DELLSWORTH MAINE THIG E CORPORT 6 NY 38 BROOKLYN AVE PREEPORT 6 NY 38 BROOKLYN AVE PREEPORT 6 NY 38 BROOKLYN AVE STREEDY 10 BOX 859 110B BAHLS ST DAVYILLE ILL 11 DELAYAM ST BROOKLYN 31 N Y 11 MEECTRONIC SALES 373 BROADWAY NEW YORK 13 N Y 11 MEECHTOP INC 38 BROOKLYN AVE WALLINGFORD CONN 11 NWRENAM PRODUCTS INC DEDT 16 P 0 BOX 6588 CLEVELAND 1 OHIO 11 PPTRONIC INC 1200 INN ST SANFA MONICA CALIF 11 MAN NT SANFA MONICA CALIF 11 MAN NT SANFA MONICA CALIF 11 MAN SLOY WE GLU NATL LEAD CO 11 BROADWAY NEW YORK 6 N Y 11 THEFLEX INC 11 MERCHTE ANFG CD DIY CERRO DE PASCO CORP 120 TICHTON ST BINGHAATON NY 11 THEFLEX INC 11 MAN BLOY WE ROCHTEST INC 1200 INANA ST SANFA FALLS MIC 11 MAN ALLOY WE DIY NATL LEAD CO 11 BROADWAY NEW YORK 6 N Y 11 TOPTING CONTROL TO MASSO MICH 10 DED SALE AVE GARGEN FALLS N Y 11 THEFLEX INC 10 MORD BEDPODED OHIO 10 TORON THE SINGFI CONTROL TO NITARIO CALIF 10 TOPTING TON THE SINGFI CONTROL TO NITARIO CALIF 10 MANBEL AVE ORDANT CALIF 10 PARE CONTROL TO Y SING 2700 HAWKEYE DR SIOUX CITY 2 10 Townsend Co PO BOX 71 ELLWOOD CITY PA Townsend Co (Herry Rivet Div 1224 E DELHI RD SANTA ANA CALIF Townsend MFG CO H P BROOK ST W HARTFORD 10 CONN

IKANSFORMER TECHNICIANS INC 2608 N CICERO AVE CHICAGO 39 ILL TRANSFORMERS MFG INC NORRIDGE ILL TRANSFORMERS INC 200 STAGE RD VESTAL NY TRANSICOLL CORP CHURCH RD WORCHESTER PA CHURCH RD WORCHESTER PA CHURCH RD WORCHESTER PA 40 FACTORY ST CEDAR GROVE NJ TRANSISTOR ELECTRONICS CD 3357 REPUBLIC AVE MINNEAPOLIS 26 MINN TRANSITOR ELECTRONICS INC WEST RD BENNINGTON YT TRANSITOR ELECTRONIC CORP WAKEFIFLD MASS TRANSITRON ELECTRONIC CORP WAKEFIFLD MASS TRANSITNE LECT COMMUNICATIONS CO 503 MCCARTER MWY NEWARK N J TRANSLINE ELECT COMMUNICATIONS CO 503 MCCARTER HWY NEWARK N J TRANSLUX CORP 625 MODISON AVE NEW YORK 22 N Y TRANS-LUX CORP 626 MADISON AVE NEW YORK 22 N Y TRANS-LUX CORP 55 MONECK ST ENGLEWOOD NJ TRANSONIC INC 700 161M ST BAKERSFIELD CALIF TRANSONIC INC P 0 BOX 328 LEXINGTON 73 MASS TRANSONICS MIDDLESEK TURNIPIKE BURLINGTON MASS TRANSVAL ENGG MIDDLESEK TURNIPIKE BURLINGTON MASS TRANSVAL ENGG 10401 W JEFFERSON CULVER CITY CALIF TRANSVISION INC 460 NORTH AVE NEW ROCHELLE NY TRANSVAL ENGO 10401 W JEFFERSON CULVER CITY CALIF TRANSVISION INC 400 NORTH AVE NEW ROCHELLE NY TRASONIC INC 808 SIXTEENTH ST BOX 39 BAKERSFIELD CALIF TRENTINC 211 LEVERINGTON AVE PHILA PA TRENTON TRANSFORMER CORP P 0 BOX 568 B22 E STATE ST TRENTON N J TRESCO INC 304 HAMILTON AVE ENGLEWOOD N J TRESCO INC 3054 TERRACE ST PHILADELPHIA 28 PA TRC INC 2 4EFAL WAY SYOSSETT LI N Y TRG INCORPORATED 400 RONDER ST FAST ROSTON 28 MASS TRIAD TRANSFORMER CORP 4055 REDWOOD AVE VENICE CALIF TRI ACRE ELECTRONICS EAST PINE ST PLAISTOW N H TRICME ST PLAISTOW N H TRICMARE AVE CLEVELAND OHIO TRICOM ARBLE AVE CLEVELAND OHIO TRICOM ARBLE AVE CLEVELAND OHIO TRICOM ARBLE AVE CLEVELAND OHIO TRICOM TAULA ALTHAM MASS TRICRAFT PRODUCTS CORP 1224 W NEWPORT AVE CHICAGO 22 ILL TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER ST PLAISTOW N H TRIGNAFT PRODUCTS CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER ST LINDSAY CALIF TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER ST LINDSAY CALIF TRI-FX TOWER ST LINDSAY CALIF TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER CORP 127 E INVG ST TULARE CALIF TRI-FX TOWER ST LIBERTYVILLE ILL TRIMOUNT INSTRUMENT DIV GENERAL CONTROLS CO 800 MCCORMICK BLVD SKOKIE ILLINDIS TRIMM INC 400 W ALAKE ST LIBERTYVILLE ILL TRINOUNT PLASTIC CO INDUSTALL PARK NEW BEDFORD MASS TRINDL PRODUCTS LTD 1807-113 SCLAKK ST CHICAGO 16 ILL TRINDU PRODUCTS LTD 1807-113 SCLAK ST CHICAGO 16 ILL TRINDY PLASTIC CO PLAINVIEW LI NY TRID MRG CO GRIGGSYILLE ILL TRION INC 1000 ISLAND AVE MCKEES ROCKS PA **TIO 1962** June 1962 **World Radio History**

TRIONICS CORP 4600 BELTLINE HWY MADISON-WISC TRIPLETT ELECTRICAL INSTRUMENT CO HARMON RD BLUFFTON OHIO TRIPLETT ELECTRICAL INSTRUMENT CO BLUFFTON OHIO TRIPLETT ELECTRICAL INSTRUMENT CO BLUFFTON OHIO TRIPLEX RUBBER 6 SUPPLY CO 5019 ARMOUR HOUSTON TEXAS TRI-POINT FLASTICS INC 175 I U WILLETS RD ALBERTSON L I N Y TRI-R INSTRUMENTS 144-13 JAMAICA AVE JAMAICA 35 N Y TRI-TEC 11780 W PICO RLVD LOS ANGELES 64 CALIF TRITON MFG CO 4000 TOWNE ST E HADDAM CONN TRI-TRONICS CO 2607 ST CHARLES RD BELLWOOD 13 ILL TRONEX INC G STREET MILLVILLE NJ TROPICA SCREW PRODUCTS 3275 N W 28TH ST MIAMI FLA TRDT ELECTRONICS INC 412 SMITH ST ROCHESTER 6 N Y TRU BEAM PROD 412 SMITH ST ROCHESTER 6 N Y TRU BEAM PROD 4141 BROADWAY OAKLAND CALIF TRU-CONNECTOR CORP 416 UNION ST LYNN MASS TRUTONE ELECTRONICS INC 14660 RAYMER ST VAN NUYS CALIF T ELECTRONICS INC - P O BOX 180 CULVER CITY CALIF TUBULAR RIVET 6 STUD CO WESTON AVE WOLLASTON TO MASS TUCK MFG CO 10 ELLIS AVE W BRIDGEWATER MASS TUCOR INC 59 DANBURY RD WILTON CONN TUNG SOL ELECTRIC INC ONE SUMMER AVE NEWARK 4 NJ TURG SOL ELECTRIC INC 545 ARLINGTON AVE ORANGE N J TURD JET PRODUCTS INC 424 S SAN GABRIEL BLVD SAN GABRIEL CALIF TUROM MACHINE CO LANSDALE PA TURNER CO LANSDALE PA TURNER CO 909 17 ST N E CEDAR RAPIDS IOWA TUTTLE ELECTRIC PRODUCTS INC KIRKLAND ILL TV DEVELOPMENT CORP TV DEVELOPMENT CORP 469 JERICHO TURNPIKE MINEREA NY TV UTILITIES CORP DIV NORD PHOTOCOPY CO 300 DENTON AVE NEW HYDE PARK NY TWEEZER WELD CORP 4820 PARK BLVD PINELLAS PARK FLA TYCO INCORP 585 BOYLSTON ST BOSTON MASS U

U B S CHEMICAL CORP 491 MAIN ST CAMBRIDGE 42 MASS U S CAPACITOR CORPORATION 8917 MEROSE AVE LOS ANGELES 69 CALIF U S CHEMICAL MILLING CORP 1700 ROSECRANS AVE MANHATTAN BEACH CALIF U S CONDUMENTS U S CHEMICAL MILLING CORP 1700 ROSECRANS AVE MANHATTAN BEACH CALI U S COMPONENTS 1320 ZEREGA AVE NY 62 NY 1320 ZEREGA AVE NY 62 NY 161 GRAND ST NEW YORK N Y US CONTROLS INC 410 4TH AVE BROCKLYN 15 N Y U S DIELECTRIC INC 181 GREENWOOD ST WORCESTER 6 MASS U S DYNAMICS CORP 1250 COLUMBUS AVE BOSTON MASS US ELECTRICAL MOTORS INC 200 E SLAUSON AVE LOS ANGELES 54 CALIF U S ELECTRICAL MOTORS INC MILFORD CONN THE U S ELECTRIC MOTOR CO CADIZ OHIO U S ELECTRONICS CORP 278 WAREN ST LYNDHURST N J U S ELECTRONICS CORP 278 WAREN ST LYNDHURST N J U S ELECTRONICS CORP 278 WAREN ST LYNDHURST N J U S ELECTRONICS CORP 278 WAREN ST LYNDHURST N J U S ELECTRONICS CORP U S ELECTRONICS CORP 800 SLATERS LANE ALEXANDRIA VA U S ENG CO 8473 RODEO RD LDS ANG CALIF U S GEAR CORP 81 BAY STATE RD WAKEFIELD MASS U S GRAPHITE CO DIV WICKLES CORP 1621 HOLLAND AVE SAGINAW MICH U S INSTRUMENT CORP PO BOX 1288 CHARLOTTESVILLE VA U S PLASTIC MOLDING CORP 150 CARLTON ST WALLINGFORD CCNN U S PLYWOOD CORP 55 W 44 ST NEW YORK 36 N Y U S RADIUM CORP U S RAOIUM CORP 5420 VINELAND AVE N HOLLYWOOD CALIF U S RADIUM CORP BLOOMSBURG PENNA U S RECORDING CO 1347 S CAPITOL ST WASHINGTON 5 D C U S RELAY ELECTRONICS 717 N CONEY AZUSA CALIF U S RUBBER CO 1230 AVE OF THE AMERICAS NEW YORK 20, N Y

LECTRONIC MAINUFACTORE U S SCIENCE CORP 5221 W 102ND ST LOS ANGELES 45 CALIF US SEMICONDUCTOR PRODUCTS 35400 W OSBORN RD PO BOX 11098 PHOENIX ARIZ U S STEEL AMER STEEL & WIRE DIV 767 MILLBURY ST WORCESTER MASS U S STEEL CORP 525 WILLIAM PENN PL PITTSBURGH 30 PA U S TAXIMETER CORP 516 W 54 ST NEW YORK 19 N Y U S TAINETER CORP 149 ELEEN WAY SHORE STEN US TIME CORP WATERBURY 20 CONN US TRANSISTOR CORP 149 ELEEN WAY SYOSSET NY UCINITE CO DIV UNITED CARR FASTENER CORP 459 WATERTOWN ST NEWTONVILLE 60 MASS ULANET CO GEORGE 413 MARKET ST NEWARK 5 NJ ULTRA ELECTROFORMING MFG CO 110 CEDAR AVE PITMAN 15 NJ ULTRASONIC ENGE CO 618 LAKE ST MAYWOOD ILL ULTRASONIC ENGE CO 618 LAKE ST MAYWOOD ILL ULTRASONIC ENGE CO 605 RAHWAY AVE UNION NJ ULTRASONIC THOUSTRIES INC AMES COURT PLAINVIEW L I N Y ULTRASONIC MACHINING CO 1015 ASRUPY AVF ASRUPY PARK NJ ULTRASONIC BLYD LOS ANGELES CALIF ULTRASONIC BLYD LOS ANGBRIEL CALIF ULTRASONIC BLYD LOS AN GABRIEL CALIF ULTRAVUOLET PRODUCTS INC 5114 WALNUT GROVE AVE SAN GABRIEL CALIF ULTRAVIOLET PRODUCTS INC 5114 WALNUT GROVE AVE SAN MATEO CALIF ULTRAVIOLET PRODUCTS INC 5114 WALNUT GROVE AVE SAN GABRIEL CALIF ULTRAVIOLET PRODUCTS INC 5114 WALNUT GROVE AVE SAN MATEO CALIF ULTRAVIOLET PRODUCTS INC 5114 WALNUT GROVE AVE SAN GABRIEL CALIF ULTRAVIOLET SCREW CO LTD MURAKO SOCKET SCREW CO LTD MURAKO SOCKET SCREW CO LTD MURAKA SOCKET SCREW CO LTD MURAK UN AIR ELECTRONICS INC 3101 SW 3RD AVE FT LAUDERDALE FLA UNBRAKO SOCKET SCREW CO LTD RURNARY RD COVENTRY FNGLAND UNDERWOOD CORP CANGGA DIV 736 BEAL ST WALTON BRACH FLA UNDERWOOD ELECTRIC 6 WFG CO INC 148 SO ATH AVE MAYWOOD ILL UNDYNAMICS DIV 472 PAUL AVE ST LOUIS MO UNGAR ELECT TOOLS INC 1475 E EL SEGUNDO BLVD HAWTHORNE CALIF UNGAR ELECT TOOLS INC 4101 REDWOOD AVE LOS ANGELES 66 CALIF UNHERSOLL PRODUCTS 1000 W 120TH ST CHICAGO 43 ILL UNHOLTZ DICKIE CORP 2994 WHITNEY AVE HAMDEN CONN UNI SEAL INC NORTH AVE 6 MAPLE ST GARWOOD N J UNIFORM TUBES INC LEVEL DC OLLEGEVILLE 2 PA UNIMAX SWITCH MAXSON ELECT CORP IVES RO WALLINGFORD CONN UNION CARBIDE CONSUMER PRODUCTS CO 270 PARK AVE NEW YORK 17 N Y UNION CARBIDE CONSUMER PRODUCTS CO 270 PARK AVE NEW YORK N Y UNION CARBIDE CONSUMER PROD CO 80X 749 CHARLOTTE N C UNION CARBIDE CONSUMER PROD CO 501 GAGE ST BENNINGTON VT UNION CARBIDE CONSUMER PROD CO 80X 749 CHARLOTTE N C UNION CARBIDE VISIE CO 270 PARK AVE NEW YORK N Y UNION CARBIDE PLASTICS CO 270 PARK AVE NEW YORK N Y UNION CITY FILAMENT CORP 540 39TH ST UNION CITY NJ UNION CITY FILAMENT CORP 540 39TH ST UNION CITY NJ UNION CITY FILAMENT CORP 540 39TH ST UNION CITY NJ UNION CITY FILAMENT CORP 540 39TH ST UNION CITY NJ UNION CLECTRONICS 0NGUE WERE WAVING CO INC 540 39TH ST UNION CITY NJ UNION CLITA-SONICS CORP 540 39TH ST UNION CITY NJ UNION CLITA-SONICS CORP 540 39TH ST UNION CITY NJ UNION CLECTRONICS CORP 540 39TH ST UNION CITY NJ UNION SUTCH 6 SIGNAL OIV 1769 CARAFEY AVE HILLSIDE NJ UNION ULTRA-SONICS CORP 540 39TH ST UNION CITY NJ UNION SULTAR-SONICS CORP 540 39TH ST UNION CITY NJ UNITON SULTAR-SONICS CORP 540 39TH ST UNION CITY NJ UNITON SULTRA-SONICS CORP 540 39TH ST UNION CITY NJ UNITA SON ELECTRONICS CORP 541 ANFIN ST GRAND HAVEN MICH UNITSON ELECTRONICS INC 342 42N ST NASH YORK 17 N Y UNITED AIRCRAFT PRODUCTS INC 137 W 137TH ST GARDENA CALIF UNITED AIRCRAFT PRODUCTS INC 137 W 137TH ST GARDENA CALIF UNITED AIRCRAFT PRODUCTS INC 137 W 137TH ST FOREST OHIO UNITED AUDIO PRODUCTS INC 202 E 19 ST NEW YORK 3 N Y ANTIED AUDIO PRODUCTS INC 202 E 19 ST NEW YORK 3 N Y UNITED CARBON PRODUCTS CO 1310 N MADISON ST BAY CITY MICH UNITED CONDENSER CORP 3400 PARK AVE NEW YORK N Y UNITED CONTROL CORP OVERLAKE INDUSTRIAL PK PO BOX 3104 SEATTLE 14 WASH UNITED DATA CONTROL INC 380 N HALSTEAD ST PASADENA CALIF UNITED ELECTROITOLS CO 85 SCHOOL ST WATERTOWN 72 MASS 200 ALLENDALE RD PASADENA CALIF UNITED ELECTRODYNAMICS 200 ALLENDALE RD PASADENA CALIF UNITED ELECTRONIC MFG CORP 542 SPSING ST NEWARK N J UNITED ELECTRONICS 42 SPBING ST NEWARK N J UNITED MIG CO DIV UMC ELECTRONICS 41 HAIG ST HAMDEN 14 CONN UNITED MINERAL 6 CHEMICAL CORP 16.HUDSON ST NEW YORK 13 N Y

S-A TO Z UNITED SENSOR 6 CONTROL CORP BOX 127 GLASTONBURY CONM UNITED SHOE MACHINERY CORP SHELTON CONM UNITED STATES GASKET CO P 0 ROX 93 CAMBEN N J UNITED STATES GASKET CO P 0 ROX 93 CAMBEN N J UNITED TESTING LABS "573 MONTEREY PASS RD MONTFREY INK CALIF UNITED TEANSFORMER CORP PACIFIC IV 4008 JEFFENSON BLVD LOS ANG CALIF UNITED TRANSFORMER CORP PACIFIC IV 4008 JEFFENSON BLVD LOS ANG CALIF UNITED TRANSFORMER CORP PACIFIC IV 4008 JEFFENSON BLVD LOS ANG CALIF UNITED TRANSFORMER CORP PACIFIC IV 4008 JEFFENSON BLVD LOS ANG CALIF UNITED TRANSFORMER CORP PACIFIC IV 4008 JEFFENSON BLVD LOS ANG CALIF UNITERSAL CIRCUIT CONTROLS 3610 OAKTON ST SKOKIE ILL UNIVERSAL CONDENSER CO 9435 N KIMBALL AVE CHICAGO ILL UNIVERSAL ELECTRIC CO 300 F MAIN ST OWOSSO MICH UNIVERSAL ELECTRONICS CO 1720 22 ST SANTA MONICA CALIF UNIVERSAL ELECTRONICS CO 1720 22 ST SANTA MONICA CALIF UNIVERSAL ELECTRONICS CO 1720 23 ST SANTA MONICA CALIF UNIVERSAL ELECTRONICS CO 1720 25 ST SANTA MONICA CALIF UNIVERSAL MATCH COUNDAWAICS DIV 472 PAUL AVE ST LOUIS 13 MISOURI UNIVERSAL MICROPHONE CO BOX 51 INGLEMOD CALIF UNIVERSAL MICROPHONE CO 1522 HARRISON ST INSTINGTON 11 N J UNIVERSAL MICROPHONE CO 1525 INGLEMOD CALIF UNIVERSAL PRODUCTS ENGG CO 4100 TAYLOR AVE RACINE WISC UNIVERSAL PRODUCTS ENGG CO 4100 TAYLOR AVE BROOKLYN NY UNIVERSAL STIFIELCO INC 1102 SHELBY ST VINCENNES IND UNIVERSAL STUFFIE CO INC 1102 SHELBY ST VINCENNES IND UNIVERSAL STUFFIE CO INC 1102 SHELBY ST VINCENNES IND UNIVERSAL STUFFIE IRVINGTON 11 N J UNIVERSAL STUFFIE IRVINGTON 11 NJ UNIVERSAL STOPIAGUEN NY UNIVERSAL STOPIAGUEN Y UNIVERSAL STEPERSON BLVD LOS ANGELES CALIF UNIVERSAL ST RAWINGDALE N Y UNIVERSAL TRANSISTOR PRODE CORP 300 OAK ST COPIAGUEN Y UNIVERSAL TRANSISTOR PRODE CORP 300 OAK ST COPIAGUEN Y UNIVERSAL UTAH RADIO CORP 1124 E FRANKLIN ST HUNTINGTON IND UTILITIES SERVICE CO PO BOX 627 ALLENTOWN PA UTILITY ROOY CO 1530 WOOD ST DAKLAND CALIF UTILITY METAL PRODUCTS CO INC 117 ELLIOTT ST BEVERLY MASS UTRAD CORP DIV LITTON IND 305 N BRIANT ST HUNTINGTON IND VACAP CORP 1905 SUMMIT AVE UNION CITY N J VACO PRODUCTS CO 317 E ONTARIO ST CHICAGO 11 ILL VACTRONIC LAB EQUIPMENT INC 21 MONNOUTH CT E NORTHPORT N Y VACUDENT MFG CO 975 E 5 ST SALT LAKE CITY UTAH VACUUM APPARATUS CO 906 INDUSTRIAL AVE PALO ALTO CALIF VACUUM SPEC INC 34 LINDEN ST SOMERVILLE MASS VALCO AMPHFIERS INC 4701 GRAND AVE CHICAGO ILL VALCOR ENG CORP 365 CARNEGIE AVE KENILWORTH N J VALOR ELECTRONICS CO 13214 CRENSHAW BLVD GARDENIA CALIF VALUE ENG PROD INC 890 MONTEREY PASS RD MONTEREY PARK CALIF VALVERDE LABS 252 LAFAYETTE ST NEW YORK 12 N Y VANGUARD ELECTRONICS CO 3364 MOTRO AVE LOS ANGELES 34 CALIF VANGUARD ELECTRONICS CO 3194 MOTRO AVE LOS ANGELES 34 CALIF VANGUARD ELECTRONIC LOBS 190 48 99TH AVE HOLLIS N Y VANISOR MFG DIV WESTON ELEC INST CORP UNION N J VANIST FAIR ELECTRONICS

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VANISTOR MEG DIV WESTON ELEC INST UNION N J VANITY FAIR ELECTRONICS 50 S 45T BROOKLYN N Y VANTON PUMP & EQUIPMENT CORP 201 SWEETLAND AVE HILLSIDE 5 N J VAP AIR DIV VAPOR CORP 6444 HOWARD ST CHICAGO ILL VARD INC

VARD INC 2981 E COLORADO PASADENA 8 CALIF

- VDRAC CO 147 MEADOW RD RUTHERFORD N J VDRON ELECTRONICS CDRP 1230 E MERMAID LANE PHILA 18 PA VOTRON PRODUCTS 1020 APROYO PARKWAY PASADENA CALIF VUE TRONICS INC OV OF PRESCOTT CD 920 CITRUS AVE LDS ANGELES 38 CALIF VULCAN ELECTRIC CO
- 88 HDLTEN ST DANVERS MASS VULCAN-TV MAST & TOWER CO INC PO BOX 6537 BIRMINGHAM 7 ALA

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WAAGE ELECTRIC INC 720 COLFAX AVE KENILWORTH N J WABASH METAL PRODUCTS CD ' 1569 MORRIS ST WABASH IND WABASSO PRODUCTS INC WABASSO FLA WABER ELECTRONICS INC MANGKK & SOMERSET STS PHILA 33 PA WACLINE INC 35 S ST CLAIR ST DAYTON OHIO WADDELL DYNAMICS INC 5015 WEEKS AVE SAN DIEGO CALIF WADE ELECTRIC PRODUCTS CO BOX 271 STURGIS MICH WALCE TAIC PRODUCTS CO 3190 WALKER AVE MONROVIA CALIF WAIME GREW MAGNETICS 1900 WALKER AVE MONROVIA CALIF WAIHET ALLOYS CO 5370 OAKMAN BLYD DEARBORN 2 MICH WALCO ELECT CO INC 60 FRANKLIN ST E ORANGE N J WALD ELECTRONICS 3395 RESERVOIR OVAL NEW YORK N Y WALDOS KOHINOGY INC 47 16 AUSTEL PL LONG ISLAND CITY N Y WALDOM ELECTRONICS INC 4625 W 33 ST CHICAGO 32 ILL WALES STRIPPIT INC 47 16 AUSTEL PL LONG ISLAND CITT N 1 WALDOM ELECTRONICS INC 4625 W 53 ST CHICAGO 32 ILL WALES STRIPPIT INC UNIT OF HOUDAILLE IND INC AKRON N Y WALES STRIPPIT INC AKRON NFW YORK WALKER CO GEORGE 118 AMSTERDAM AVE PASSAIC NJ WALKIRT CO 10321 S LA CIENAGA BLVD LOS ANGELES 45 CAL WALLINGFORD STEEL CO VALLEY ST WALLINGFORD CONN WALLIN OPTICAL SYSTEMS INC 18670 VENTURA BLVD TARZANA CALIF WALL MFG CO P ERIE ST GROVE CITY PA WALSON ASSOC INC 35 E RUNYON ST NEWARK N J WALSCO ELECTRONICS MFG CO 100 W GREEN ST ROCKFORD ILL WALTER J HYATT CO PO BOX 943 BEVERLY HILLS CALIF WALTHAM ELECTRONICS CORP 351 LYNNWAY LYNN MASS WALTHAM SCREW CO 77 PUMFORD AYF WALTHAM MASS WALTHAM SCREW CO 12 HURON DRIVE NATICK MASS WALTHAM SCREW CO 12 HURON DRIVE NATICK MASS WALTHAM SCREW CO 35 LYNNWAY LYNN MASS WALTHAM SCREW CO 37 PUMFORD AYF WALTHAM S4 MASS WALTHAM SCREW CO 37 PUMFORD AYF WALTHAM S4 MASS WALTHAM SCREW CO 39 LYNNWAY LYNN MASS WARD LECARD ELECTRIC CO MAR MARINE PRODUCTS INC 47 ONDUCTS CORP EDSON ST AMSTERDAM N Y WARD PRODUCTS CORP EDSON ST AMSTERDAM N Y WARD PRODUCTS CORP 23 16 DDWNING ST FLUSHING N Y WARDER LECTRIC BRAKE S CLUTCH CD 10 NURRIAL DIV BELOIT WISC WARNER 6 SWASEY CO 32 16 DDWNING ST FLUSHING N Y WARNER COMPONENTS DIV EL-TRONICS INC 32 16 DDWNING ST FLUSHING N Y WARNER 6 SWASEY CO 32 16 DDWNING ST FLUSHING N Y WARNER 6 SWASEY CO NEWTOWN RD LITTLETON MASS WARTER A SING ST JUSTING NARMEN NIRE CO POWNAL YT WARNER COMPONENTS DIV ELTRONICS INC S IRVINE ST WARREN PA WARNER MIRE CO POWNAL YT WARNER COMPONENTS DIV ELTRONICS INC S WARDEN AND SCIENTIFIC INDUST 1045HINGTON N J WASHINGTON N J WASHINGTON N J WASHINGTON N J WASHINGTON N SCIENTIFIC INDUST 13111 WAYZATA BLVO MINN MINN WANDAL CHANCOLOGICAL ASSOC INC ASHINGTON PORCELAIN CO WASHINGTON PORCELAIN CO WASHINGTON NJ WASHINGTON SCIENTIFIC INDUST 13111 WAYZATA BLVD MINN MINN WASHINGTON TECHNOLOGICAL ASSOC INC 979 ROLLINS AVE ROCKVILLE MD WATERBURY COS INC 835 S MAIN ST P O BOX 1032 WATERBURY CONN WATERBURY PRESSED METAL CO 300 CHASE AVE WATERBURY 14 CONN WATERMAN PRODUCTS CO 2445 EMERALD ST PHILADELPHIA 25 PA WATERS CONLEY CO INC ROCHESTER MINN THE WATERS CORP 18 S W 14TM ST ROCHESTER MINN WATERS MFG INC BOSTON POST RD WAYLAND MASS ELECTRONIC INDUSTRIES

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ELECTRONIC MANUFACTURERS_A TO Z

WATLOW ELECTRIC MFG CD 12001 LARKLAND RD ST LDUIS MD WATSON MFG CD 63 TAYLOR ST JAMESTOWN NY MAVEFORNS INC 333 6 AVE NEW YORK N Y WAVEGORDE INC 851 W 18 ST COSTA MESA CALIF WAVELINE INC P 0 BOX 718 CALDWELL N J WAYEK GEORGE CORP 322 NEEDHAM ST NEWTON MASS WAYNE KERR CORP 1633 RACE ST PHILA 3 PA WEATHERS INDUSTRIES DIV ADVANCE INDS 66 E GLOUCESTER PIKE BARINGTON NJ WEBBER ENGINEERING CORP P 0 BDX 217 INDIANAPOLIS 1ND WEBBER ENGINEERING CORP P 0 BDX 217 INDIANAPOLIS 6 IND WEBCOR ELECTRONICS 2431 WOLCOTT CHICAGD ILL WEDOR ELECTRONICS 3912 W MCLEAN AVE CHICAGD 47 ILL WEBCOR ELECTRONICS 3912 W MCLEAN AVE CHICAGD 47 ILL WEBCOR ELECTRONICS 1516 WABASH CHICAGO ILL WEBCOR INC 5610 BLOOMINGDALE AVE CHICAGO ILL WEBCDR INC-ELECTRONICS DIV 816 N KEDZIE CHICAGO 51 ILL WEBER AIRCRAFT CORP 2820 ONTARIO ST BURBANK CALIF WEBER LIFCT DIV 2020 UNIARIO SI BURBANK CALIF WEBER ELECT DIV 3050 CALIF ST BURBANK CALIF WEBSTER MFG 317 POEBLING RD S SAN FRANCISCO CALIF WECKESSER *ECKESSER 5701 NORTHWEST HWY CHICAGO ILL WEDGELOCK CORP OF CALIF 11323 HARTLAND ST N HOLLYWOOD CALIF WEIDNHOFF CORP WEIDNHOFF CORP ALGONA IOWA WEIGHING & CONTROL DIAGONAL TRANS-WIGH KING OF PRUSSIA PA WEINSCHELENGG 10503 METROPOLITAN AVE KENSINGTON MD WEKSLER INSTRUMENTS CORP 1955 E MERRICK RD FREEPORT L I N Y WELCH SCIENTIFIC CO W M 1515 SEDGWICK ST CHICAGO ILL WELDEX DIVISION 23361 TELEGRAPH SOUTHFIELD MICH <code-block>Nessee instruction to compare to in y in the second se</code>

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Product Finding Index

Here's How To Use This Index:

• Find the product in the alphabetical list below.

Products one listed by their basic description (i.e. a wheatstone bridge will be found listed as "bridge, wheatstone"). Cross-referencing is also pravided where a product may be known by a number of different names—for instance, volume control; resistor, variable; and potentiometer will be found listed separately in alphabetical order but all indicating poge_sewhere their manufacturers are listed

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Competitors, vacuum, nikedLisiCoils, antenaLisiConceptors, ponographLisiCorpetLisiCapacitors, vacuum, variableLisiCoils, centeringLisiConceptors, ponographLisiCorpetCoils, centeringLisiCapacitors, valagevariableLisiCoils, centeringLisiConceptors, ponetaris, printed circuitLisiCords, dialLisiCarbidesLisiCoils, centeringLisiConceptors, printed circuitLisiCords, dialLisiCarbidesLisiCoils, centeringLisiConceptors, printed circuitLisiCords, resistanceLisiCarlions, electionicLisiCoils, dielaction voleLisiConceptors, nock SponelLisiCores, cermicLisiCarrier current systemsLioiCoils, fieldLisiConceptors, submittaiceLioiCores, curlLisiCarser sourceLioiCoils, foll woundLisiConceptors, submittaiceLioiCores, curlLisiCastersLioiCoils, foll woundLisiConceptors, submittaiceLioiCores, for theLisiCathode roy shledingLioiCoils, fieldLisiConceptors, submittaiceLioiCores, submittaiceLioiCathode roy shledingLioiCoils, fieldLisiLisiCores, submittaiceLisiCores, submittaiceLisiCathode roy shledingLioiCoils, fieldLisiLioiCoils, fieldLisiLisiCathode r				
Carpacitors, vacuum, variableL54Coils, audio cressoverL73Connectors, powerL60Cords, attochmentL112CaPACITORS, VARIABLECoils, conteringL73Connectors, presutedL60Cords, inteL112CarbidesL120Coils, conteringL73Connectors, printed circuitL60Cords, inteL119CarbidesL103Coils, deflection v/oceL73Connectors, printed circuitL60Cords, resistanceL119Carlions, electronicL103Coils, ifeldL73Connectors, attributed scennetL60Cords, cessitanceL179Cartier current comunicationsL56Coils, fieldL73Connectors, attributed scennetL60Cores, ceruitL79CartersL70Coils, focusingL73Connectors, stripL60Cores, ceruitL79CartersL70Coils, focusingL73Connectors, stripL60Cores, feriteL79CartersL70Coils, ibertingL73Connectors, stripL60Cores, feriteL79CartersL70Coils, ibertingL73Connectors, stripCores, ceruitL79CartersL70Coils, inearityL73Connectors, stripCores, ceruitL79CartersL70Coils, ibertingL73Connectors, stripCores, ceruitL79CartersL70Coils, illeL73Connectors, stripCores, ceruitL79CartersL70Coils, illeL73C	Capacitors, vacuum, fixed L53	Coils, antenna L73		
CAPACITORS, VARIABLECouls, CenteringL73Connectors, pressuttzedL60Cords, lineL160Carditors, voltage-vriableL120Colls, color purityL73Connectors, printed circuitL60Cords, lineL119Cartilons, electronicL103Colls, feld diaL73Connectors, printed circuitL60Cores, ceramicL179Cartier current systemsL103Colls, fild diaL73Connectors, rack & panelL60Cores, ceramicL79Carter current systemsL70Colls, foll woundL73Connectors, rack & panelL60Cores, ceramicL79Carter current systemsL70Colls, foll woundL73Connectors, stripL60Cores, lawL79CastersL70Colls, foll woundL73Connectors, stripL60Cores, lawL79CastersL70Colls, likeringL73Connectors, tubL60Cores, lawCores, lawL79Cathede ray shleldingL102Colls, likeringL73Connectors, utwin lineL60Cores, lawL79CathedesL118Colls, likeringL73Connectors, unin lineL60Cores, lawL79CathedesL118Colls, likeringL73Connectors, waterroofL60Cores, lawL79CathedesL118Colls, likeringL73Connectors, uningL79Cores, lawCores, lawL79Cathede sL112Colls, pinted circuitL73Connectors, uningL79 <td></td> <td></td> <td>Connectors, power L60</td> <td></td>			Connectors, power L60	
Carpicitors, voltage-variable L99 Coils, color puily L19 Coils, coverprece L73 Connectors, printed circuit L60 Cords, inse				
Carrillons, electronicL103Colls, deflection yokeL73Connectors, quick disconnectL60Cores, cerumicL73Carrier current communicationsL56Coils, fieldL73Connectors, R-FL60Cores, cerumicL79Carrier current systemsL70Coils, foll youndL73Connectors, R-FL60Cores, cerumicL79Carses, portableL70Coils, foll youndL73Connectors, stripL60Cores, cerumicL79Carses, portableL70Coils, foll youndL73Connectors, subminictureL60Cores, ferriteL79Carses, portableL70Coils, foll youndL73Connectors, twh lineL60Cores, ferriteL79Cartos, subcinicalL102Coils, klystonL73Connectors, twh lineL60Cores, slaminatedL79CartodesL118Coils, linearityL73Connectors, twh lineL60Cores, slaminatedL79Cartodes, indicavaveL80Coils, pickupL73Connectors, whilicalL60Cores, slaw tuningL79Cartotes, wavemeterL40Coils, pickupL73Conneoles, controlL60Cores, trape woundL79Cartotes, wavemeterL40Coils, pickupL73Conneoles, controlL104Cores, trape woundL79Cartotes, wavemeterL40Coils, pickupL73Conneoles, control, studioL104Cores, trape woundL79Cartotes, wavemeterL40Coils, pickupL73 <td></td> <td></td> <td></td> <td>Cords, line L119</td>				Cords, line L119
Carrier current communications L56 Coils, field L73 Connectors, rack & panel L60 Cores, C-type L73 carrier current systems L70 Coils, field L73 Connectors, rack & panel L60 Cores, C-type L79 Carrier current systems L70 Coils, focusing L73 Connectors, subminiature L60 Cores, C-type L79 Casters L70 Coils, heating L73 Connectors, subminiature L60 Cores, Fertype L79 Casters L70 Coils, heating L73 Connectors, subminiature L60 Cores, laminatel L79 Casters L70 Coils, literity L73 Connectors, unbiled L60 Cores, lang natel L79 Cathedes L118 Coils, linearity L73 Connectors, unbiled L60 Cores, lang natel L79 Carvites, tuned, wavemeter L80 Coils, peickup L73 Consoles, control L74 Cores, lang natel L79 Carvites, tuned, wavemeter L80 Coils, peickup				
systemsL103Coils, flybackL73Connectors, R-FL60Cores, citrL73Cartler current systemsL70Coils, focusingL73Connectors, solderlessL60Cores, citrL73Carses, portableL70Coils, foll woundL73Connectors, subminiatureL60Cores, fullL73CarstersL70Coils, I-FL73Connectors, subminiatureL60Cores, fullL73CattersL70Coils, I-FL73Connectors, subminiatureL60Cores, fullL73Cattode ray shieldingL102Coils, klystranL73Connectors, subminiatureL60Cores, powderedL79Cattode ray shieldingL102Coils, klystranL73Connectors, waterpoolL60Cores, powderedL79Cattos, ferrite, microwaveL80Coils, pictureL73Consoles, controlL79Cores, toroidalL79Cavities, wavemeterL80Coils, printed circuitL73Consoles, control, studioL79Cores, toroidalL79Cavities, suifon solarL90Coils, printed circuitL73Consoles, control, studioL104CorkCores, furtherL76CementL55Coils, R+F chokeL73Control consoles, transmitterL107Counters, electronic digitalL107Contoris, suiprentureL55Coils, R+F chokeL73Control consoles, transmitterL117Ceramics, high temperatureL55Coils, R+F chokeL73Control cont				
Carrier current systemsL70Coils, facusingL73Connectors solderlessL60Cores, E-typeL79CastersL70Coils, falw andL73Connectors, subminiatureL60Cores, fertiteL79CastersL70Coils, heatingL73Connectors, subminiatureL60Cores, fertiteL79Cathode ray shleldingL102Coils, klystonL73Connectors, tubeL60Cores, bype periodL79Cathode sL118Coils, klystonL73Connectors, tub lineL60Cores, byge periodL79Cathode sL118Coils, klystonL73Connectors, wateproofL60Cores, tage turingL79CathodesCoils, scillatorL73ConsolesL79Cores, tage turingL79Cavities, tuned, wavemeterL80Coils, pickupL73Consoles, controlL78Cores, toroidalL79Cavities, wavemeterL80Coils, pickupL73Consoles, controlL104Cores, toroidalL79Cavities, wavemeterL80Coils, relayL73Consoles, control, studioL104CountersL58CeramicL96Coils, R-F chokeL73Control consoles, transmitterL107Counters, directionalL107Chambers, alphaL87Coils, R-F transmittingL73Control, alarm systemL66Counters, electronicCounters, electronicL107Chambers, alphaL35Coils, R-F transmittingL73Controls, alarm system <td></td> <td></td> <td>Connectors, B-F</td> <td></td>			Connectors, B-F	
Cases, portableL70Coils, foll woundL73Connectors, stripL60Cores, high permetbilityL79CastersL70Coils, heatingL73Connectors, subminiatureL60Cores, high permetbilityL79Cathode ray shieldingL102Coils, klystronL73Connectors, twin lineL60Cores, high permetbilityL79Cathode soL118Coils, klystronL73Connectors, twin lineL60Cores, high permetbilityL79CathodesL118Coils, linearityL73Connectors, whilicalL60Cores, slug tringL79Cathodes, microwaveL80Colls, magneticL73Connectors, werptroofL60Cores, slug tringL79Cavities, microwaveL80Colls, pinted droutL73Consoles, controlL70Cores, slug tringL79Cavities, wavemeterL48Colls, pinted droutL73Consoles, controlL104Cores, U-typeCores, U-ty			Connectors solderless	
CastersL70Coils, heatingL73Connectors, subminiatureL60Cores, high remechilityL73CastersL70Coils, I-FL73Connectors, tubeL60Cores, high remechilityL79Cathode ray shieldingL102Coils, kilystronL73Connectors, twin lineL60Cores, high remechilityL79CathodesL118Coils, linearityL73Connectors, twin lineL60Cores, slug tuningL79CathodesL118Coils, gargeticL73Connectors, with lineL60Cores, slug tuningL79Carvities, ferrite, microwaveL80Coils, oscillatorL73ConsolesL70Cores, slug tuningL79Carvities, tuned, wavemeterL80Coils, printed circuitL73Consoles, controlL70Cores, U-typeL75Carvities, suilcon solarL99Coils, relayL73Consoles, remote switching, remoteL104Cores, U-typeL76Cells, silicon solarL99Coils, R-F chokeL73Contracts, motor & generatorL84Counters, liceCtonalL107CeramicsL76Coils, R-F transmittingL73Controls, aircraft navigationL60Counters, electronicL107Chambers, alphaL87Coils, toroidalL73Controls, aircraft navigationL62Counters, electronicL107Chambers, alphaL13Coils, toroidalL73Controls, automatic tuningL62Counters, electronicL107Chambers, temperature &				
CastersL70Coils, I-FL73Connectors, tubeL60Cores, laminatedL79Cathode roy sheldingL102Coils, klystonL73Connectors, twin lineL60Cores, powderedL79CathodesCoils, linearityL73Connectors, twin lineL60Cores, powderedL79Cavities, microwaveL80Coils, occiliatorL73Connectors, waterproofL60Cores, sing turingL79Cavities, uned, wavemeterL80Coils, occiliatorL73Consoles, controlL60Cores, toroidalL79Cavities, uned, wavemeterL80Coils, printed circuitL73Consoles, controlL104Cores, toroidalL79Cavities, uned, wavemeterL80Coils, printed circuitL73Consoles, control, studioL104Cores, toroidalL79Cavities, uned, wavemeterL80Coils, relayL73Consoles, control, studioL104Cores, toroidalL79CenterL55Coils, R-F chokeL73Control consoles, transmitterL107Conters, adjuedCounters, directionalL107Ceramics, high temperatureL55Coils, R-F transmittingL73Controls, autor wavemeterL80Counters, electronic digitalL107Chambers, environmental testL113Coils, toroidalL73Controls, autor wavemeterL107Counters, electronic digitalL107Chambers, temperature & hundidtyL113Coils, transformerL73Controls, autor transingL62Count			Connectors, subminiature L60	
Cathode ray shieldingL102Cails, klystronL73Connectors, twin lineL60Cares, powderedL79CathodesL118Coils, linearityL73Connectors, unbilledL60Cares, speededL79Catrolies, microwaveL80Coils, oscillatorL73Connectors, waterproofL60Cares, tape woundL79Circulators, ferrite, microwaveL80Coils, oscillatorL73Connectors, waterproofL60Cares, tape woundL79Cavities, wavemeterL48Coils, pickupL73Consoles, controlL78Cares, tape woundL79Cavities, wavemeterL80Coils, pickupL73Consoles, controlL78Cores, U-typeCares, U-typeL79Cavities, wavemeterL80Coils, relayL73Consoles, control, studioL104Cores, U-typeL79Cores, U-typeCares, U-typeL79Careantics, high temperatureL55Coils, R-F chokeL73Contracts, motor & generatorL84Counters, electronicCounters, electronicL107Chambers, alphaL76Coils, R-F transmittingL73Control consoles, transmitterL107Counters, electronicCounters, electronicL107Chambers, alphaL87Coils, transducerL73Controls, aidmany systemL62Counters, electronicL107Chambers, vibrationL113Coils, transformerL73Controls, automatic tunningL62Counters, fequereyL107Chambers, vibrationL113 <td></td> <td>Coils, I-F L73</td> <td>Connectors, tube L60</td> <td></td>		Coils, I-F L73	Connectors, tube L60	
CathodesL118Coils, intentityL73Connectors, unbilledL60Cares, slug tuningL79Cavities, microwaveL80Coils, magneticL73Connectors, waterproofL60Cares, tape woundL79Circulators, ferrite, microwaveL80Coils, oscillatorL73Consoles, controlL70Cares, tape woundL79Cavities, uned, wavemeterL48Coils, pickupL73Consoles, controlL78Cares, toroidalL79Cavities, wavemeterL80Coils, pinted circuitL73Consoles, control, studioL104Cores, tuppeCares, tuppeL79Cavities, wavemeterL55Coils, relayL73Consoles, control, studioL104Counter measuresL80CementL55Coils, R-F cokeL73Control consoles, transmitterL107Counters, electromogneticL107Ceramics, high temperatureL55Coils, R-F transmittingL73Controls, aircraft navigationL62Counters, electronic digitalL107Chambers, alphaL113Coils, toroidalL73Controls, aircraft navigationL62Counters, electronic cliptalL107Chambers, temperature & humidityL113Coils, transformerL73Controls, automatic tunningL62Counters, electronic cliptalL107Chambers, radiac detectorL87Coils, transformerL73Controls, automatic tunningL62Counters, fequencyL107Chambers, radiac detectorL87Coils, transformerL73 </td <td></td> <td></td> <td>Connectors, twin line L60</td> <td></td>			Connectors, twin line L60	
Cavities, microwaveL80Coils, magneticL73Connectors, waterproofL60Cores, tape woundL79Cavities, tuned, wavemeterL80Coils, pickupL73Consoles, controlL70Cares, taroidalL79Cavities, tuned, wavemeterL80Coils, pickupL73Consoles, controlL70Cares, taroidalL79Cavities, silicon solarL99Coils, pickupL73Consoles, control, studioL104Cores, taroidalL76Cells, silicon solarL99Coils, R-F cookeL73Consoles, metors watching, remoteL104Counter measuresL81CeramicL76Coils, R-F receivingL73Control consoles, transmitterL117Counters, electronalCounters, electronalL107Chambers, alphaL13Coils, toroidalL73Controls, aircraft navigationL62Counters, electronicL107Chambers, temperature & L113Coils, toroidalL73Controls, aidam systemL62Counters, electronicL107Chambers, temperature & fundidityL113Coils, transformerL73Controls, automatic tanningL62Counters, electronicCounters, electronicL107Chambers, temperature & L147Coils, transformerL73Controls, automatic tanningL62Counters, electronicL107Chambers, temperature & L113Coils, transformerL73Controls, audomatic tanningL62Counters, fequereyL107Chambers, temperature & L113Coils, transformerL73C				
Chronites, territe, microwave.L80Colls, scillatorL73Consoles.Consoles.L70Cores, travidalL79Cavities, tuned, wavemeterL80Colls, printed circuit.L73Consoles, control.L78Cores, U-typeL79Cavities, tuned, wavemeterL80Colls, printed circuit.L73Consoles, control.L104Cores, U-typeL79Cavities, tuned, wavemeterL99Colls, relayL73Consoles, control, studioL104Counter measuresL76CementL55Colls, R-F transmittingL73Controls, motor & generatorL84Counters, directionalL107Ceramics, high temperatureL55Colls, R-F transmittingL73Control consoles, transmitterL107Counters, electronic digitalL107Chambers, alphaL87Colls, toroidalL73Controls, alraraft novigationL62Counters, electronic digitalL107Chambers, temperature & humidityL113Colls, toroidalL73Controls, alam systemL62Counters, electronicL107Chambers, radiac detectorL87Colls, transformerL73Controls, automatic tunningL62Counters, frequencyL107Chanses, radiac detectorL87Colls, transformerL73Controls, cameraL104Chassis, cabinetL70Colls, transformerL73Controls, cameraL104Chassis, cabinetL70Colls, virableL73Controls, cameraL107Chastis, socialetL70 <td< td=""><td></td><td></td><td></td><td></td></td<>				
Cavities, hund, wavemeter L48 Coils, pickup L73 Consoles, control L78 Cores, U-type L79 Cavities, wavemeter L80 Coils, pinted circuit L73 Consoles, control L104 Cores, U-type L79 Cavities, wavemeter L90 Coils, relay L73 Consoles, control L104 Cores, U-type L76 Cement L55 Coils, R-F choke L73 Controls, motor & generator L84 Counters, directional L107 Ceramics, high temperature L55 Coils, R-F transmitting L73 Control consoles, transmitter L111 Counters, electronic digital L107 Chambers, alpha L87 Coils, telephone L73 Controls, aircraft navigation L62 Counters, electronic digital L107 Chambers, environmental test L113 Coils, transducer L73 Controls, aidro recording L62 Counters, electronic digital L107 Chambers, vibration L113 Coils, transformer L73 Controls, automatic tunning L62 Counters, electronic L107 Chambers, vibration L113 Coils, transformer <td< td=""><td></td><td></td><td></td><td></td></td<>				
Cells, silicon solarL99Coils, relayL73Consoles, temote switching, remoteL104Counter measuresL61CementL55Coils, R-F chokeL73Contracts, moto & generatorL64Counters, directionalL107Ceramics, high temperatureL55Coils, R-F transmittingL73Control consoles, transmitterL117Counters, directionalL107Ceramics, high temperatureL55Coils, R-F transmittingL73Control consoles, transmitterL117Counters, directionalL107Chambers, alphaL87Coils, telephoneL73Control equipment, remoteL104Counters, electronic digitalL107Chambers, environmental testL113Coils, toroidalL73Controls, aidrordf navigationL62Counters, electronicL107Chambers, vibrationL113Coils, transducerL73Controls, audio recordingL56Counters, electronicL107Charges, radiac detectorL87Coils, transducerL73Controls, audio recordingL56Counters, geigerL107Charges, radiac detectorL87Coils, transformerL73Controls, cameraL104Counters, ieguercyCounters, ieguercyL107Chassis, cabinetL70Coils, virabelL73Controls, conductivityL62Counters, mechanicalL107Chassis, cabinetL54Coils, virabelL73Controls, conductivityL62Counters, mechanicalL107Chassis, metalL54Coils, voice <t< td=""><td></td><td></td><td></td><td></td></t<>				
CementL55Colls, R-F chokeL73Contacts, motor & generatorL84Counters, metadaesL51CeramicL76Colls, R-F receivingL73Control consoles, transmitterL117Counters, directionalL107Ceramics, high temperatureL55Coils, R-F transmittingL73CONTROL EQUIPMENTL62Counters, electromometicL107Chambers, alphaL87Coils, telephoneL73Controls, aircraft navigationL62Counters, electronic digitalL107Chambers, environmental testL113Coils, toroidalL73Controls, aircraft navigationL66Counters, electronic digitalL107Chambers, vibrationL113Coils, transducerL73Controls, audor recordingL62Counters, events-per-unit timeL107Chambers, vibrationL113Coils, transformerL73Controls, automatic tunningL62Counters, fequercyL107Chamsers, radiac detectorL87Coils, transformerL73Controls, cameraL104Counters, fequercyL107Chassis, cabinetL70Coils, uranabitingL73Controls, cameraL104Counters, mechanicalL107Chassis, cabinetL54Coils, video peakingL73Controls, conductivityL62Counters, mechanicalL107Chassis, metalL54Coils, video peakingL73Controls, conductivityL62Counters, photoelectricL107Chassis, metalL54Coils, variableL73Controls, conductivit				Cork L76
CeramicL76Coils, R-F receivingL73Control consoles, transmitterL117Counters, directionalL107Ceramics, high temperatureL55Coils, R-F transmittingL73Control consoles, transmitterL117Counters, directionalL107Chambers, alphaL87Coils, R-F transmittingL73Control consoles, transmitterL107Chambers, environmental testL113Coils, toroidalL73Controls, aircraft navigationL62Counters, electronic digitalL107Chambers, temperature & humidityL113Coils, toroidal variableL73Controls, aircraft navigationL62Counters, electronic digitalL107Chambers, temperature & humidityL113Coils, toroidal variableL73Controls, aidm systemL62Counters, electronic digitalL107Chambers, radiac detectorL87Coils, transformerL73Controls, audoraccordingL96Counters, frequencyL107Charges, radiac detectorL87Coils, transformerL73Controls, cameraL104Counters, inpulseL107Charges, radiac detectorL54Coils, valueL73Controls, conductivityL62Counters, impulseL107Charges, tadiac detectorL54Coils, valueL73Controls, conductivityL62Counters, impulseL107Charges, radiac detectorL54Coils, valueL73Controls, conductivityL62Counters, mechanicalL107Charges, radiac detectorL54Coils, value <td></td> <td></td> <td></td> <td></td>				
Ceramics, high temperature L55 Coils, R-F transmitting L73 CONTROL EQUIPMENT L62 Counters, diction of the transmitting L107 Chambers, alpha L87 Coils, telephone L73 Control equipment, remote L104 Counters, electronognetic L107 Chambers, environmental test L113 Coils, toroidal L73 Controls, aircraft navigation L86 Counters, electronic digital L107 Chambers, temperature & humdity L113 Coils, toroidal L73 Controls, alarm system L62 Counters, electronic L107 Chombers, vibration L113 Coils, transducer L73 Controls, audio recording L96 Counters, electronic L107 Counters, requerche chamit L107 Counters, requerche chamit L107 Counters, requerche chamit L107 Counters, requerche chamit Counters, restriction chamit L107 Counters, requerche chamit Counters, requerche chamit Counters, requerche chamit Counters, restriction chamit L107 Counters, requerche chamit Counters, restriction chamit<				
Chambers, alpha L87 Coils, telephone L73 Control equipment, remote L104 Counters, effectionic digital L107 Chambers, environmental test L113 Coils, toroidal L73 Controls, aircraft navigation L86 Counters, electronic digital L107 Chambers, environmental test L113 Coils, toroidal variable L73 Controls, aircraft navigation L86 Counters, electronic digital L107 Chambers, vibration L113 Coils, transducer L73 Controls, audio recording L95 Counters, electronic digital L107 Chassis, cabinet L70 Coils, transformer L73 Controls, automatic tunning L62 Counters, frequency L107 Chassis, cabinet L70 Coils, transformer L73 Controls, camera L104 Counters, geiger Counters, impulse L107 Chassis, cabinet L54 Coils, video peaking L73 Controls, conductivity L62 Counters, mechanical L107 Chassis, metal L54 Coils, voice L73 Controls, conductivity L62 Counters, preset Counters, photoelectric L107 <t< td=""><td></td><td></td><td></td><td></td></t<>				
Chambers, environmental test L113 Colls, toroidal L73 Controls, aircraft navigation L66 Counters, electronic argital Counters, electronic argital L107 Chambers, temperature & humidity L113 Coils, toroidal variable L73 Controls, aircraft navigation L66 Counters, electronic argital Counters, electronic argital L107 Chambers, temperature & humidity L113 Coils, transducer L73 Controls, audo recording L62 Counters, electronic argital Counters, electronic argital L107 Charges, radiac detector L87 Coils, transformer L73 Controls, automatic tunning L62 Counters, fequency L107 Chassis, cabinet L70 Coils, transformer L73 Controls, camera L104 Counters, mechanical L107 Chassis, cabinet L70 Coils, video peaking L73 Controls, conductivity L62 Counters, mechanical L107 Chassis, metal L54 Coils, voice L73 Controls, conductivity L62 Counters, preset Counters, preset Counters, preset L107 Chassis, metal L54 Coils, voice L73 </td <td></td> <td></td> <td></td> <td></td>				
Chambers, temperature & humidity. L113 Coils, toroidal variable L73 Controls, alarm system L62 Counters, events-per-unit time L107 Chombers, vibration L113 Coils, transformer L73 Controls, alarm system L62 Counters, events-per-unit time L107 Charges, radia detector L87 Coils, transformer L73 Controls, automatic tunning L62 Counters, frequency L107 Chassis, acbinet L70 Coils, transmitting L73 Controls, camera L104 Counters, impulse L107 CHASSIS, ACCESSORIES, L54 Coils, video peaking L73 Controls, conductivity L62 Counters, impulse L107 Charses, metal L54 Coils, voice L73 Controls, counting L62 Counters, peiger Counters, impulse Charses, metal L54 Coils, voice L73 Controls, counting L62 Counters, photoelectric L107 Charses, non-matul L54 Coils, voice Cortrols, counting L52 Counters, preset L107		Coils, toroidal L73		
Chombers, vibration L113 Coils, transducer L73 Controls, audio recording L96 Counters, or frequency Charges, radiac detector L87 Coils, transformer L73 Controls, audio recording L96 Counters, or frequency L107 Charges, radiac detector L87 Coils, transformer L73 Controls, automatic tunning L62 Counters, geiger L107 Charsis, cabinet L70 Coils, transmitting L73 Controls, camera L104 Counters, impulse L107 CHASSIS, ACCESSORIES, L54 Coils, variable L73 Controls, conductivity L62 Counters, mechanical L107 Chassis, metal L54 Coils, voice L73 Controls, counting L62 Counters, photoelectric L107 Chassis, metal L54 Coils, voice L73 Controls, counting L62 Counters, photoelectric L107 Chassis, metal L54 Coils, width L73 Controls, counting L62 Counters, preset L107 Chassis, metal L54 Coils, width L73 Controls, counting L62 Counter		Coils, toroidal variable L73		
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PRODUCTS & MANUFACTURERS

This is a comprehensive listing of equipment, test and measuring instruments, and components manufactured by the electronic industries. Also listed are supplemen-tary items such as cabinets, chemicals, hardware, raw materials and services related to the electronic field. Names and addresses of manufacturers are given for over 1,500 product categories. Companies making these products or offering services in the field are arranged alphabetically. Addresses of the companies are contained in the alphabetical listing of manufacturers at the beginning of the directory. Num-ber actived at the vield of active alphabetically. bers printed at the right of each column indicate the products each firm manufactures.

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DIEHL MFG CO 24-3 DIETZ CO S J 5-20-23-3 DIGITROL SYSTEMS INC 5-20 DJOTRON INC 10 DJECD DIV DJORDJEVIC ENGG CO 4-12-14-15-1 DON BOSCO ELECT SUB OF HOWELL ELECT MOTORS 7-2 DOTY ACOUSTICAL ELECTRONIC LABS 7-21-3 DOTY ACOUSTICAL ELECTRONIC LABS 7-21-2 DOTY ACOUSTICAL ELECTRONIC LABS 7-21-2 DATS RESER ELECT SIE DIV 7-2 DRESSER ELECT SIE DIV 7-2 DYNANER TICS CORP 14-21-3 DYNANERTICS CORP 14-24-3 DYNAMICS INST CO 22-24-28-3 EDO CORP 31-3 EASTERN INDUSTRIES DIV OF LIFE INC 22-24-28-3 EDO CORP 31-3 ELECT NC SCIENTIFIC CORP 2-3 ELECTRA N MFG CO 5-20-24-3 ELECTRO NISTUMENT INC 5-20-24-3 <	10066 39116416141297936114680
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DIEHL MFG CO 24-3 DIETZ CO S J 5-20-23-3 DIGTRON INC 1 DJECD DIV DJORDJEVIC ENGG CO 4-12-14-15-1 DON BOSCO ELECT SUB OF HOWELL ELECT MOTORS 7-2 DOTY ACOUSTICAL ELECTRONIC LABS 7-21-3 DOTS ELECT SUB OF HOWELL ELECT MOTORS 7 DOTS ACOUSTICAL ELECTRONIC LABS 7-21-3 DRESSER ELECT SIE DIV 1 DRESSER ELECT SUB OF HOWELL 14-21-3 DRESSER ELECT SUB OF HOWELD 14-21-3 DRESSER ELECT SUB OF HOWELD 14-21-3 DRESSER ELECT SUB OF HOWELD 14-21-3 DYNAIR ELECTRONICS INC 22-24-28-3 EDO CORPORATION 22-24-28-3 ELCOR INC CORP 2-3-31-3	100066 391164161412979361114680140
DIEHL MFG CO 24-3 DIETZ CO S J 5-20-23-3 DIGITROL SYSTEMS INC 5-20 DJOTADN INC 10 DJECD DIV DJORDJEVIC ENGG CO 4-12-14-15-11 DON BOSCO ELECT SUB OF HOWELL ELECT MOTORS 7-2 DOTY ACOUSTICAL ELECTRONIC LABS 7-21-3 DRESSER ELECT SIE DIV 7-2 DRESSER ELECT HST DIV 1 DYNAMERTICS CORP 14-21-3 DYNAMERTICS CORP 14-21-3 DYNAMERTICS CORP 18-24-2 DYNAMICS INST CO 2-4-6-7-9-12-14-15-26-3 EDO CANADA LTD 22-24-28-3 EDO CORP 31-3 ELECT RIC ELECTRONICA RES INC 2-3-31-3 ELECT MC CORP 31-3 ELECTR ASCIENTIFIC CORP 2-3-31-3 ELECTRA MFG CO 11 ELECTRA MFG CO 14 ELECTR MEDICAL RES INC 5-20-24-3 ELECTRA NEGE CO 14 ELECTRA SCIENTIFIC CORP 2-3 ELECTRA MFG CO 14 ELECTRA SCIENTIFIC CORP 2-3-3-3 ELECTRANTON CO	10066 3911641614129793611468014049
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DIEHL MFG CO 24-3 DIETZ CO S J 5-20-23-3 DIGITROL SYSTEMS INC 5-20 DIOTRON INC 1 DON BOSCO ELECT SUB OF HOWELL ELECT MOTORS 7-2 DOTY ACOUSTICAL ELECTRONIC LABS 7-2-1-3 DOTY ACOUSTICAL ELECTRONIC LABS 7-2-1-3 DRESSER ELECT SIE DIV 1 DREXEL DYNAMICS CORP 14-21-3 DYNANETRICS CORP 14-21-3 DYNANETRICS CORP 18-24-2 DYNANETRICS CORP 31-3 EDO CANADA LTD 22-24-28-3 EDO CORPORATION 21-2-14-15-26-3 EDO CORPORATION 21-2-24-3 ELECT MICS INST CO 2-4-2-2-28-3 EDO CORPORATION 21-2-24-28-3 ELECT MECHANICAL RES INC 29-31-3 ELECTR MINDUSTRIC CO 2-2-24-28-3 ELECTR MED CO 11 ELECT NECHANICAL RES INC 2-31-3 ELECTR MINDUSTRIC CORP 2-31-3 ELECTR MINDUSTRIC NEGO 2-2-2-2-24-3 ELECT NONSTRUMENT INC 6-7-9-26-3 ELECTROMIC CONTROL CORP 2-2-2-3-3	10066 39116416141297936114680140490115-31
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DIEHL MFG CO 24-3 DIETZ CO S J 5-20-23-3 DIGITROL SYSTEMS INC 5-20 DJECD DIV DJORDJEVIC ENGG CO 4-12-14-15-15 DON BOSCO ELECT SUB OF HOWELL ELECT MOTORS 7-2 DOTY ACOUSTICAL ELECTRONIC LABS 7-21-3 DRESSER ELECT SIE DIV 7-2 DRESSER ELECT MST DIV 1 DYNAMERTICS CORP 14-21-3 DYNAMERTICS CORP 14-21-3 DYNAMERTICS CORP 18-24-2 DYNAMICS INST CO 2-4-6-7-9-12-14-15-26-3 EDO CANADA LTD 22-24-28-3 EDO CORPORATION 31-3 ELECTR KEE SDIV OF LIFE INC 2 EDO CORPORATION 2-2-24-28-3 ELECT MECHANICAL RES INC 2-9-31-3 ELECTR MINDUSTRIES DIV OF LIFE INC 2-3-31-3 ELECTR MAG CO 14 ELECTR MECHANICAL RES INC 2-9-31-3 ELECTR MEDI CONPENT CO 5-20-24-3 ELECTR MINDUSTRIEMENT INC 6-7-9-26-3 ELECTR MEDI CAL RES INC 2-2-24-3 ELECTR MEDICAL ENG CO 2-2-24-3 ELECTR MINC CONFERS INC 5-20-24-3 ELECTRONIC COMMUNICATION	10066 39116416141297936114680140490115-317-1 432
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For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

FEDERAL MEG & ENG CORP TV SPECIALTY DIV 31LIBRASCOPE DIV GENERAL PRECISION INC GLENDA3FEEDBACK CONTROLS INC4-16-24FIDELITY AMPLIFIER CO20-21-23-90-31FISHER RADIO CORP21FISHER RADIO CORP21LING TEMCO VOUGHT INC ELECT DIV29-21-22-24LING TEMCO VOUGHT INC ELECT DIV29FORVAY INDUSTRIES INC20-21-23-90-31FORVAY INDUSTRIES INC20-21-23-90-31FORVAY INDUSTRIES INC2-6-7-16-24-29-31LITION SYSTEMS INC COP12-14-15-21-22-24-26-31LITION SYSTEMS INC CAPPLIED SCIENCE DIVISIONFREED TRANSFORMER CO16-18FYR-FYTER ELECTRONICS 6 ALARM CORP21-31GAI-TRONICS CORP31GAI-TRONICS CORP31GENCRAL COMPUTERS INC4-5-6-7-8-9-12MACHINERY ELECTRIFICATION INC20GENERAL COMPUTERS INC4-6-21-22-24-26-31MACHINERY ELECTRIFICATION INC20GENERAL COMPUTERS INC4-6-21-22-24-26-31MAGNATYNE CORP2-4-5-7-10-12-14-15-16-18-21-22-24-26-3-31GENERAL COMPUTERS INC4-5-6-7-8-9-12MAGNATYNE CORP2-4-5-7-10-12-14-15-16-18-21-22-24-26-3-31GENERAL COMPUTERS INC4-5-6-7-8-9-12MAGNATYNE CORP2-4-5-7-10-12-14-15-16-18-21-22-23-24-27-29-31GENERAL ELECTRONICS CORP<math>31GENERAL ELECTRONICS (ALARM CORP)2-4-5-7-10-12-14-15-16-18-21-22-24-26-3-31MACHINERY ELECTRIFICATION INC<math>20MAGNATYNE CORP2-4-5-7-10-12-12-24-26-31MAGNETIC CIRCUIT ELEMENTS
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 GC ELECTRONICS CO DIV TEXTRON ELECTRONICS
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For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

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 MULTRONICS INC
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MA	JDWIG JHRS & JESTI ARCH D	HONO CO IC EX	NDUS ENTZE STRIE LD ME C H TRUDE ICS I	TRIES EN IN ES MA FG CO ERS I INC	INC CHI RYLAN	K LORE	ENTZEI V	S OIV 4 9 DIV 5-10-	13- -6-1 -13-1 16- -21- 16-	-14 2 -8 19 4- -5 -26 2 23
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 15-16-18-20-26-27-28 ELECTRA MFG CO 26 ELECTRICAL SPECIALTY CO 6-16 ELECTRICAL UTILITIES CO 1-9-13-15-16-17-27 ELECTRO-CERAMICS INC 3 ELECTRO MOTIVE MFG CO INC 9-12-13-14-15-18-ELECTRO SCIENTIFIC IND INC 12-13-14-19-25-28-30 18-27 ENFLO CORP 18-27 EPIC INC 11 ERIE ELECTRONICS DIV 2-3-4-5-8-9-12-13-14 13 22-25-26-28 ERIE RESISTOR OF CANADA LTD 2-3-5-8-14-22-25-28 ERIE RESISTOR CORP 2-3-5-8-12-13-14-22-25-26-28 ESPEY MFG & ELECTRONICS CDRP 9-12-13-15-16-26-28 ESPEY MFG & ELECTRONICS CORP 9-12-13-15-16-17-20-23-27 FARADYNE ELECT CORP 6-7-8-12-26 FILTRON CO 1-8-9-12-13-15-16-17-18-20-23-FILTRON CO 1-8-9-12-13-15-16-17-18-20-23-24-27 FILTRON CO INC WESTERN DIV 8-13-16-23 FRYLING ELECT PROD INC 3-5-8-18-28 GENERAL ELECTRIC CAPACITOR DEPT 6-7-26 GENERAL INSTRUMENT CO 6-7-14-15-17-26 GENERAL INSTRUMENT CO 6-7-14-15-17-26 GENERAL INSTRUMENT CO 6-7-14-15-17-26 GENERAL INSTRUMENT CO 6-7-14-15-17-26 GENERAL INSTRUMENT CO 14-15-17-18-19-20-22-24-25-26-27-29 GENERAL RADIO CO 14-15-17-19-20-23 GENERAL RADIO CO 14-15-17-19-20-23 GODD ALL ELECTRIC MFG CO 3-9-9-11-11-5 15-18-18-26-26 THE GUDEMAN CO 1-8-9-12-13-15-16-17-18-20-2 GUDEMAN CO OF CALIF 9-12-13-15-16-17-18-20-2 CADDING CO FALIF 9-12-13-15-16-17-18-20-2 CADDING CO FAL 23-24-27-28 GUDEMAN CO OF CALIF 9-15-17-18-24 GULTON INDUSTRIES INC METUCHEN 3-11-12-26-
 HALLETT MFG CO
 28

 HALLETT MFG CO
 8

 12900 FOOTHILL BLVD SANFERNANDO CAL96
 1

 8-9-12-13-15-16-17-18-20-22

 21LLINOIS CONDENSER CO
 1-6-12-19-22

 INTL ELECTRÓNIC INDUSTRIES
 6-7-6-26

 ITT CENECTRÓNIC INDUSTRIES
 6-7-6-26

 ITT FEDERAL LABORATORIES DIV INTL TEL * TELH
 3-0-12-22-26
 28 ITT COMPONENTS CT. ITT FEDERAL LABORATORIES DIV INTL TEL * TELH 3-9-12-22-26 JARVIS ELECTRONICS CORP JEFFERS ELECTRONICS DIV SPEER CARBON CO 4 JENNINGS RADIO MFG CORP JOHNSTON FOIL MFG CO LAPP INSULATOR CO RADIO SPECIALTIES DIV 10-13 8 LA ROSE'S ASSOC INC W T LECLANCHE S A 2-3-5-6-7-8-9-13-15-16-17-18-
 LEEDS & NORTHRUP CO
 20-20

 LINE MATERIAL INDUSTRIES
 25

 MAIDA DEVELOPMENT CO
 3-5-8-12-13-22-28

 P R MALLORY & CO INC
 1-6-7-12-13
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Capacitors, Variable

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MALLORY CAPACITOR CO GREENCASTLE	16 26
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METAVAC INC METROPOLITAN TELECOMMUNICATIONS CORP	9-25
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NATIONAL VACUUM PLATERS INC NEPTUNE ELECTRONICS CO 15- NUCLEAR CORP DF AMER PHOENIX	16-17 26
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NYTRONICS INC KY 2	-7-13
OHIO BRASS CO OHMITE MEG CO	13 7-26
ONONDAGA ELECTRONICS DIV SPEER CARBON CO	3- 5-28
PLANET MFG CORP PLASTIC CAPACITORS INC 1-8-9-12-13-1	6-22
18-20+22-23-	24+27
THE POTTER CO 1-8-9-12-13-15-16-17-18- PRECISION CAPACITORS INC 1-9-12-13-1	24-27
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RADIATION RESEARCH CORP WESTBURY 9-15-	
22-	22~26
RADIO CORP OF AMERICA SOMERVILLE RADIO CORP OF AMERICA SEMI CNDCTR & MTRS	26 DIV
RADIO FREQUENCY CO	26
RADIO MATERIALS CO DIV PR MALLORY & CO I	NC
3-5-13-19-	22-28
SAFE-T-MIKE CDRP SAN FERNANDO ELECTRIC MFG CO 1-3-7-8-	9-12-
13-15-16-17-18-19-20-22- SANGAMO ELECTRIC CO 1-2-4-5-6-7-8-9-1	24-27
14-15-16-17-18-19-20-21-2	2-23-
SCINTILLA DIV BENDIX CORP 3-12-	14-25
SEMICON INC SKOTTIE ELECTRONICS INC 3-5-12-13-	9 22-28
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22-23-24-25-26-27- SPRAGUE OF WISCONSIN INC	3-22
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10-11+12-13-14-15-16-17-1 20-21-22-23-24-25-26-27-2	8-29-
	30 9-12-
13-15-16-18-22-23- TEXAS INSTRUMENT SEMICON-COMPONENTS DIV	
TI TAL INC 6-7-	12-26
U S CAPACITOR CORPORATION US SEMICONDUCTOR PRODUCTS	3 6-7-8
UNDERWOOD ELECTRIC & MFG CD INC UNITED ELECTRONIC MFG CORP	0 6-22
UNIVERSAL CONDENSER CO 1-8-9-11-12-1 16-17-18-20-22-23-24-	3-15-
VITRAMON INC 2-3	-8-21
WESCO ELECTRIC & MFG CO 1-9-12-13-15-1 18-19-20-22-23-24-27-	28-29
WESTINGHOUSE ELECT CORP APPARATUS DIV	7-12-13
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Capacitors, high temperature	5
Capacitors, mica trimmer	6
Capacitors, minature	7
Capacitors, oil filled	8
Capacitors, piston	9
Capacitors, plastic	10
Capacitors asisted strength	
Capacitors, printed circuit	11
Capacitors, semiconductor	12
Capacitors, temperature	
compensated	13

Capacitors, transmitter tuning 14 Capacitors, trimmer
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ATLEE CORP 4 AUTOMATION COMPONENTS INC 2 BARKER 6 WILLIAMSON INC 14 BENDIX CORP SEMICONDUCTORS DIV 12 BIRD 6 SONS LTD SYDNEY S 1-6-14
BRITISH RADIO ELECTRONICS LTD 1-13 BUD RADIO INC 1-14 CAMBRIDGE THERMIONIC CORP 2-11 CENTRALAB DIV GLOBE UNION 2-7-11-12 COLUMBUS ELECTRONICS CORP 2-30 COMPONENT RESEARCH CO INC 1-2-4-5-7-8-9-13
CONTINENTAL DEVICE CORP 12 CONTINENTAL ELECTRONIC MFG CO 8-14 CORNING GLASS WORKS 4-5-7 DIEHL MFG CO 28 DITTMORE FREIMUTH CORP 1 ELECTRON RESEARCH INC 12 ELPAC INC 7-8-10-11 ERIE ELECTRONICS DIV 2-4-5-7-11-12-13
ELPAC INC 7-8-10-11 ERIE ELECTRONICS DIV 2-4-5-7-11-12-13 ERIE RESISTOR OF CANADA LTD 2-10-13 ERIE RESISTOR CORP 2-4-5-9-10-11-13 FRYLING ELECT PROD INC 2-10-13 GARY WELLS CO 1
GENERAL ELECTRIC CO CAPACITOR DEPT 7-8-10- 12 GENERAL INSTRUMENT CORP 1-8-12-14 GENERAL INSTRUMENT CORP F W SOCKLES DIV 1 GENERAL RADIO CO GENISTROM INC 7-8-10-13
GLADDING MCBEAM 6 CO GOMBOS INC CO JOHN AMMARLUND MFG CO INC INTERNATIONAL RECTIFIER CORP ITT FEDERAL LABORATORIES DIV INTL TEL * TELM 7-12
JACKSON BROS LONDON LTD 1-7-9-10-11-14 JARVIS ELECTRONICS CORP 7 JENNINGS RADIO MFG CORP 15 JFD ELECTRONIC CORP 2-3-4-5-7-9-10-11-13-14 JOHANSON MFG CO 1-2-4-5-7-9-11-14 JOHANSON CO E F 1-7-9-11-13-14
LAPP INSULATOR CO RADIO SPECIALTIES DIV 3- 14 LA POINTE INDUSTRIES INC 14 LEEDS 6 NORTHRUP CO 11 MAIDA DEVELOPMENT CO 2 MASUREMENTS DIV MC GRAW-EDISON CO 11 MASUREMENTS DIV MC GRAW-EDISON CO 11
M E C INC 7 METAL SPECIALTY PRODUCTS CORP 1 MICROMOLD PRODUCTS CORP 10 MILLEN MFG CO JAMES 1-2 MILLER CO J W 1-6 MUIRHEAD 5 CO LTD 1 MUIRHEAD INSTRUMENTS INC 1
MUIRHEAD INSTRUMENTS INC 1 NATL RADIO CO INC 1-14 OAK MFG CO 1-1 THE POTTER CO 5-7-8-10-11 PRECISION CAPACITORS INC 10 RADIO COND CO SUB THOMPSON RAMO WOOLDRIDGE 10
1-5-7-11-13-14 RADIO CONDENSER CO LTD 1-7-10-11 RADIO CUNDENSER CO WESTERN CONDENSER DV 1- 10 10
RADIO CONDENSER CO HOOPESTON 1-10 RADIO FREQUENCY CO 14 SARKES TARZIAN INC 1-7 SICKLES F W DIV GIC 1 TAFFET ELECTRONICS INC 1 TELECHROME MFG CORP 1-2-4-7-9-14
TELEGRAPH CONDENSER CO 2 TRANSITRON ELECTRONIC CORP 12 VACAP CORP 15 WESTINGHOUSE ELECT CORP APPARATUS DIV 8
CHASSIS_ACCESSORIES_ FUSES_ Adapter granted

LOSE2	
Adapters, crystal	1
Adapters, lamp socket	2
Adapters, plug	3
Adapters, test	4
Adapters, tube socket	5
Binding posts	6
Chassis, metal	7
Chossis, non-metal	8
Fuse clips	9
Fuse holders	10
Fuses, cartridge	11
Fuses, indicating	12
Fuses, instrument	13
Panels, fuse	14
Fuses, plug	15
Fuses, special-purpose	16
Jocks	17

Jumpers	18 1
Lugs	19
Sockets, adapter	20
Sockets, coil	21
Sockets, relay	23
Sockets, subminiature	24
Sockets transistor	25
Sockets, tube	26
Sockets, turret	27
Spaghetti	28
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ACME MODEL ENGG CO ADC PRODUCTS DV OF MAGNETIC CONTROLS AEROVOC CORP	17 26
AEROVOC CORP AIRCRAFT & ELECT SPEC 4- AIR O TRONICS ENG CO	
ALCON METAL PRODUCTS INC 5-6-18-	19-26-29
ALDEN SYSTEMS CO	10
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AMCO ENG CO	7.14
AMERICAN ALUMINUM CO AMERICAN ELECTRIC CABLE CO AMERICAN ELECT INC TALLER & COOPER DIN AMERICAN ELECTING CULLER & COOPER DIN	7
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ARTISAN METAL WORKS CO ASSOCIATED ENG CORP	7
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AUTO PRODUCTS MFG BARNES DEVELOPMENT CO 3-4-5-23-2	13
W A BEAUCHAINE & SONS INC	7
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BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERNARU FRANKLIN CO INC BOW SULUER PRODUCTS CO	3-14-16 31 7 31
BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERNARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC	.3-14-16 31 7 31 23 9
BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERNARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC	3-14-16 31 7 31 23 9 7-14
BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC BROOK BC PERKINS INC BUD RADIO INC BUJSMANN MFG CO DIV MCGRAW EDISDN 9	3-14-16 31 7 31 23 9 7-14 7 -10-11-
BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAUN TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC BROWN ENG CO INC BUSSMANN MFG CO DIV MCGRAW EDISDN 9 BUSSMANN MFG CO DIV MCGRAW EDISDN 9 BUSSMANN MFG CO	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 30
BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAUN TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC BROOK ENG CO INC BUD RADIO INC BUSSMANN MFG CO DIV MCGRAW EDISUN 12-13-1 BY-BUK CO CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 30 7 7
BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERNARD FRANKLIN GO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAUN TOOL 6 INSTRUMENT CO INC BROWS 60 PERKINS INC BROWN ENG CO INC BUD RADIO INC BUSSMANN MFG CO DIV MCGRAW EDISDN 9 12-13-1 BY-BUK CO CALCOR SPACE FACILITY INC CALIFORNIA CHASSIS CO CAMBRIDGE THERMIONIC CORP CANNON ELECTRIC CO PHOENIX	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 30 7 7 17
BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC BUD RADIO INC BUJSMANN MFG CO DIV MCGRAW EDISDN 9 BUSSMANN MFG CO DIV MCGRAW EDISDN 9 12-13-1 BUSSMANN MFG CO DIV MCGRAW EDISDN 9 BY-BUK CO CALCOR SPACE FACILITY INC CALIFORNIA CHASSIS CO CAMBRIDGE THERMIONIC CORP CANDON ELECTRIC CO PHOENIX CARTER PARTS CO	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 30 7 7 17 20-23 17
BELFUSE INC 9-10-11-12-1 BELMONT SMELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BROOKS & PERKINS INC BROOKN ENG CO INC BUD RADIO INC BUSSMANN MFG CO DIV MCGRAW EDISDN 9 12-13-1 BUSSMANN MFG CO DIV MCGRAW EDISDN 9 12-13-1 BUSSMANN MFG CO DIV MCGRAW EDISDN 9 CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CALFORNIA CHASSIS CO CAMBRIDGE THERMIONIC CORP CANDON ELECTRIC CO PHOENIX CARTER PARTS CO C B C ELECTRONICS CO C B C ELECTRONICS CO	$\begin{array}{c} 3-14-16\\ 31\\ 7\\ 31\\ 23\\ 9\\ 7-14\\ \end{array}$
BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BROOKS & PERRINS INC BROOKS & PERRINS INC BUD RADIO INC BUD RADIO INC BUD RADIO INC BUD RADIO INC BUSSMANN MFG CO DIV MCGRAW EDISDN 9 12-13-1 BY-BUK CO CALIFORNIA CHASSIS CO CANNON ELECTRIC CO PHOENIX CARNON ELECTRIC CO C & C ELECTRONICS CO CENTURY LIGHTING INC CHEMALOY ELECTRONICS CORP CHEMALOY ELECTRONICS CORP	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 30 7 7 7 7 7 17 20-23 17 3-5-20 7-17-18 31 28 9 7-14 9 7 10 10 10 10 10 10 10 10 10 10
BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BELMONT SHELTING & REFINING WORKS BERNARD FRANKLIN CO INC BOWN SOLDER PRODUCTS CO BRAND REXE DIY AMER ENKA CORP BRAND REXE DIY AMER ENKA CORP BROKS & PERKINS INC BUSSMANN MFG CO DIV MCGRAW EDISUN BUSSMANN MFG CO DIV MCGRAW EDISUN BY-BUK CO CALCOR SPACE FACILITY INC CAMBRIDGE THERMIONIC CORP CAMBRIDGE THERMIONIC CORP CANNON ELECTRIC CO PHOENIX CARTER PARTS CO C B C ELECTRONICS CORP CHEMALOY ELECTRONICS CORP CHEMLAST INC CHEMLAST INC CHEMLAST INC CHISHOLM INDUST LTD CINCH MFG CO CINCH JONES DIV 9-10-17	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 30 7 7 7 7 7 7 7 -10-11- 4-15-16 30 7 7 7 7 -1 4 -15-16 7 7 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BELMONT SHELTING & REFINING WORKS BERNARU FRANKLIN CO INC BOWN SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BROKS 6 PERKINS INC BUSSMANN MFG CO INC BUSSMANN MFG CO DIV MCGRAW EDISDN BY-BUK CO CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CANBRIDGE THERMIONIC CORP CANBRIDGE THERMIONIC CORP CANTRY LIGHTING INC C B C ELECTRONICS CO CHEMALOW ELECTRONICS CORP CHEMALOW ELECTRONICS CORP CHEMALOW ELECTRONICS CORP CHEMALOW ELECTRONICS CORP CHEMALOW FLOC CINCH MFG CO CINCH JONES DIV 9-10-17 23-24-2 COLUMBIA METAL BOX CO	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 37 7 7 7 7 7 7 7 7 7 7 7 7 7
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BELFUSE INC 9-10-11-12-1 BELFONT SHELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BROOKS & PERKINS INC BROOKS & PERKINS INC BROOK SE PERKINS INC BUSSMANN MFG CO DIV MCGRAW EDISUN BUSSMANN MFG CO DIV MCGRAW EDISUN CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CALFORNIC CORP CANDON ELECTRONICS CO C B C ELECTRONICS CO CHEMPLAST INC CHEMPLAST INC CINCH MFG CO CINCH JONES DIV 21-21-21 23-24-2 COLUMBIA METAL BOX CO CONN HARD RUBBER CO CONNECTOR CORP CONSIDATED MOLDED PRODUCTS CORP 10 CRAIG SYSTEMS INC CRONAME INC	3-14-16 7 31 23 9 7-14 7 7 7 7 7 7 7 7 7 7 7 7 7
BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERMONT SHELTING & REFINING WORKS BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BROKS & PERKINS INC BROKS & CO INC BUSSMANN MFG CO DIV MCGRAW EDISDN 9 BY-BUK CO CALLFORNIA CHASSIS CO CALIFORNIA CHASSIS CO CANNON ELECTRIC CO PHOENIX CANNON ELECTRIC CO PHOENIX CANNON ELECTRIC CO PHOENIX CANNON ELECTRIC CO CORP CHEMPLAST INC CINCH MFG CO CINCH JONES DIV 9-10-17 COLUMBIA METAL BOX CO CONNECTOR CORP 00NSOLIDATED MOLDED PRODUCTS CORP 10 CRAIG SYSTEMS INC CROWN CONTROLS CORP	3-14-16 31 7 31 23 9 7-14 7 -10-11- 4-15-16 37 7 7 7 7 7 7 7 7 7 7 7 7 7
BELFUSE INC 9-10-11-12-1 BELFONT SHELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC BROOKS 6 PERKINS INC BUSSMANN MFG CO DIV MCGRAW EDISDN 9 BUSSMANN MFG CO DIV MCGRAW EDISDN 9 CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CANDON ELECTRONICS CO C B C ELECTRONICS CO C B C ELECTRONICS CO CHEMLAST INC CINCH MFG CO CINCH JONES DIV 9-10-17 23-24-2 COLUMBIA METAL BOX CO CONN MARD RUBBER CO CONNE TOR CORP CONSOLIDATED MOLDED PRODUCTS CORP 10 CROIMS INC	3-14-16 31 7 31 23 9 7-14 17 4-15-16 30 7 7 17 3-5-20 7-17-18 31 28 7 1-5-20 7-17-18 31 28 9 9-23-26 -17-18- 23-20 7 7 1-10-11- 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 7 7 1-10-11 8 8 8 7 1-10-11 8 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-11 1-10-
BELFUSE INC 9-10-11-12-1 BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERNARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BROKS 6 PERKINS INC BROKS 6 PERKINS INC CALCOR SPACE FACILITY INC CALFORNIC COP CANNON ELECTRONICS COP CANNON ELECTRONICS CORP CHEMPLAST INC CINCH MFG CO CINCH JONES DIV 9-10-17 23-24-2 COLUMBIA METAL BOX CO CONN ERT RUBBER CO CONNECTOR CORP CONNECTOR CORP CROAME INC CROAME INC COUTER METAL PRODUCTS CO DAHLSTROM METALLIC DOOR CO DAISLEY CO INC RAY	3-14-16 31 7 31 23 9 7-14 4-15-16 30 7 7 7 17 20-23 17 20-23 17 3-5-20 7-17-18- 23-20 9-23-26 -17-18- 23-22- 7 7 1-10- 7 7 7 7 7 7 7 7 7 7 7 7 7
BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BROKS & PERKINS INC BROKS & DERKINS INC CALCOR SPACE FACILITY INC CALFORNIC CORP CANNON ELECTRONICS CO C & C ELECTRONICS CO C & C ELECTRONICS CORP CHEMPLAST INC CINCH MFG CO CINCH JONES DIV 9-10-17 23-24-2 COLUMBIA METAL BOX CO CONN EARD RUBBER CO CONNECTOR CORP CONNECTOR CORP CROAME INC CROAME CO DATE ELECTRONICS INC DIV OF LIONEL CORI DALWELD CO INC	$\begin{array}{c} 3-14-16\\ 31\\ 7\\ 7\\ 31\\ 23\\ 9\\ 7-14\\ 4-15-16\\ 30\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\$
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BELFUSE INC 9-10-11-12-1 BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERNARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAUN TOOL 6 INSTRUMENT CO INC BROOKS 6 PERKINS INC BROOKS 6 PERKINS INC BROOK 9 PERKINS INC BUD RADIO INC BUSSMANN MFG CO DIV MCGRAW EDISDN 9 12-13-1 BY-BUK CO CALCOR SPACE FACILITY INC CALCOR SPACE FACILITY INC CALLFORNIA CHASSIS CO CAMBRIDGE THERMIONIC CORP CANNON ELECTRIC CO PHOENIX CARTER PARTS CO C CANELECTRIC CO COP CEMTURY LIGHTING INC C 2- CHEMALLOY ELECTRONICS CORP CHEMPLAST INC CINCH MFG CO CINCH JONES DIV 9-10-17 23-24-2 COLUMBIA METAL BOX CO CONNECTOR CORP CONSOLIDATED MOLDED PRODUCTS CORP ID CRAIG SYSTEMS INC CROWA CONTROLS CORP CUTLER METAL PRODUCTS CO DAHLSTROM METALLIC DOOR CO DAHLSTROM METALLIC DOOR CO DAHLSTROM METALLIC DOOR CO DAHLSTCON INC MICTOR DIV OF LIONEL CORP DALE ELECTRONICS INC DIV OF LIONEL CORP DALE ELECTRONICS INC DIV OF LIONEL CORP DATSTROM INC MILLITARY ELECTRONICS DIV DELTA ELECTRO TO THOR CO DATSTROM INC MILLITARY ELECTRONICS DIV DELTA ELECTRONICS INC DIV OF LIONEL CORP DATSTROM INC MILLITARY ELECTRONICS DIV DELTA ELECTRONICS INC DIV OF LIONEL CORP DATSTROM INC MILLITARY ELECTRONICS DIV DELTA ELECTRONICS INC DIV OF LIONEL CORP DATSTROM INC MILLITARY ELECTRONICS DIV DELTA ELECTRONICS INC DIV OF LIONEL CORP DATSTROM INC MILLITARY ELECTRONICS DIV DELTA ELECTRONICS INC DIV OF LIONEL CORP DATSTROM INC MILLITARY ELECTRONICS DIV DELTA ELECTRONICS INC DIV OF LIONEL CORP DATSTROM INC MILLITARY ELECTRONICS DIV	3-14-16 31 7 31 23 9 7-14 4-15-16 30 7 7 17 3-5-20 7-17-18 23 28 31 28 7-17-18- 23-23 9 9-23-26 7 7 7 1-10- 7 7 7 7 9 9-23-26 23-23 23-23 7 7 7 1-10- 7 7 7 7 7 7 7 7 7 7 7 7 7
BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BROKS 6 PERKINS INC BROKS 6 PERKINS INC CALCOR SPACE FACILITY INC CALFORNIC COP CANNON ELECTRIC CO PHOENIX CARTER PARTS CO C B C ELECTRONICS CO C B C ELECTRONICS CORP CHEMPLAST INC CINCH MFG CO CINCH JONES DIV 9-10-17 23-24-2 COLUMBIA METAL BOX CO CONN EARD RUBBER CO CONNECTOR CORP CONNECTOR CONNECTOR CONNECTOR CONNECTOR CONNECTOR CONNECTOR CONNECTOR CONNECTOR CONNECTOR CONNECTOR	3-14-16 31 7 31 23 9 7-14 4-15-16 30 7 7 7 7 7 7 7 7 7 7 7 7 7
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BELFUSE INC 9-10-11-12-1 BELMONT SHELTING & REFINING WORKS BERMARD FRANKLIN CO INC BOW SOLDER PRODUCTS CO BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BRAND REX DIV AMER ENKA CORP BROKS & PERKINS INC BROKS & PERKINS INC BUSSMANN MFG CO DIV MCGRAW EDISDN SUSSMANN MFG CO DIV MCGRAW EDISDN CALIFORNIA CHASSIS CO CALIFORNIA CHASSIS CO CANBRIDGE THERMIONIC CORP CANTER LECTRONICS CO CARTER PARTS CO COLMBIA MIDUST LTD CINCH MFG CO CINCH JONES DIV CONN BARD RUBBER CO CONNECTOR CORP CONNECTOR CORP CONNECTOR CORP COLMBIA METAL BOX CO CONNECTOR CORP CONNECTOR	3-14-16 31 7 31 23 9 7-14 4-15-16 30 7 7 7 7 7 3-5-20 7-17-18 31 28 7-17-18 31 28 7-17-18 31 28 7-17-18 31 28 7-17-18 30 9-23-26 7 7 7 7 7 7 7 7
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For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

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5	HALLETT MFG CO HAMNER ELECTRONICS CO INC	18
2	HANDEE HOUSEHOLD PRODUCTS	7
3	HELDOR MFG CORP HELLER CO GERALD K	7-17
	HI-SPEED EQUIPMENT CO	7-8
	HOBSON BROS HOFFMAN ENG CORP	19
2	HUGHES AIRCRAFT CO ELECT PROD DIV	14 23
'	HUGHES TREITLER MEG CORP IDEAL INDUSTRIES INC SYCAMORE	7
	IE MFG 3-4-7-9-1	7-8 0-17-18
	INSO ELECT PROD INC INSTRUMENTS FOR INDUSTRY INC	28
	INTERLAKE STAMPING CORP	26 7
	INTERNATIONAL ELECTRIC INDUSTRIES INC	3-4-
	JETTRON PRODUCTS 2-5-20-2	18-29
	JOCLIN MEG CO	30
		7-22-26
	KEYSTONE ELECTRONICS CORP 6-14-1	7-18-19
	KOLTON ELECTRIC MEG CO	7-18-19
	KORRY MANUF CO	24
	LABELLE INDUSTRIES INC	3-19-29
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC	7 5-7-8
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAI I & E DIV	7 5-7-8 7-8
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAI I 6 E DIV LAND AIR INSTRUMENT 6 ELECT DIV LEACH 6 GARNER CO INDUSTRIAL DIVISION	7 5-7-8 7-8 7
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAI I 6 E DIV LAND AIR INSTRUMENT 6 ELECT DIV LEACH 6 GARNER CO INDUSTRIAL DIVISION	7 5-7-8 7-8 7
	LABERLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAI I & E DIV LAND AIR INSTRUMENT & ELECT DIV LEACH & GARRER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISIO	7 5-7-8 7-8 7 31 7-8 NN 21-26
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAI I & E DIV LAND AIR INSTRUMENT & ELECT DIV LEACH & GARRER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISIO LIVINGSTON ELECT CORP LMB	7 5-7-8 7-8 7 31 7-8 21-26 24-26 7
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAID AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LIVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TRON INC	7 5-7-8 7-8 7 31 7-8 21-26 24-26 7 7-14
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAID AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISIO LIVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYNCH COMMUNICATION SYSTEMS INC	7 5-7-8 7-8 7-8 21-26 24-26 7 7-14 19-24 7
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAI I & E DIV LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISIO LIVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TRON INC LYNCH MFG CO R H MADIGAN CORP	7 5-7-8 7-8 7 31 7-8 21-26 24-26 24-26 7 7-14 19-24 7 7
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LADORAIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GEMERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LIVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TRON INC LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO	7 5-7-8 7-8 7-8 21-26 24-26 7 7-14 19-24 7
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAI I 6 E DIV LAND AIR INSTRUMENT 6 ELECT DIV LEACH 6 GARRER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISIO LIVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYNC MEG CO R H MADIGAN CORP MALLIN-ILLION CO MARCONI INSTRUMENTS MARVLAND CERAMIC 6 STEATITE CO INC	7 5-7-8 7 31 7-8 21-26 24-26 24-26 24-26 24-26 7 7-14 19-24 7 7-18
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LADORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LIVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TRON INC LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MARYLAND CERAMIC & STEATITE CO INC MASTERITE INDUSTRIES INC	7 5-7-8 7-8 7 31 7-8 21-26 24-26 24-26 7 7-14 19-24 7 7 7-8 7 7-8 7 94 19 9
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LADORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GEMERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LVINGSTON ELECT CORP LMB LUDWIG HONOLD HFG CO LYNC COMMUNICATION SYSTEMS INC LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MARYLAND CERAMIC & STEATITE CO INC MASTERITE INDUSTRIES INC MAYSTEEL PRODUCT INC METAL CRAFT INC	7 5-7-8 7-8 7 31 7-8 21-26 24-26 7 7-14 19-24 7 7-8 7 7-8 7 94 19
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LAID AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISIO LIVINGSTON ELECT CORP LMB LUDHIG HONOLD MFG CO LYN TRON INC LYNCH COMMUNICATION SYSTEMS INC LYNCH OGMUNICATION SYSTEMS INC LYNCH MFG CO R MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MARTYLAND CERAMIC & STEATITE CO INC MASTERITE INDUSTRIES INC MAYSTELL PRODUCT INC METAL CRAFT INC METAL CRAFT INC	7 5-7-8 7-8 7-8 7-8 7 8 19-26 24-26 24-26 24-26 24-26 7 7-14 19-24 7 7 7-14 19-24 7 7 7-8 7 7 -8 7 7 7 7 7 7 7 7 7 7 7 7
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	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LADORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LUVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MASTRIFE INDUSTRIES INC MAYSTEEL PRODUCT INC METAL CRAFT INC METAL CRAFT INC METAL CRAFT PRODUCTS CORP METAL SPECIALTY PRODUCTS CORP	7 5-7-8 7-8 7-8 7-8 21-26 24-26 24-26 24-26 7 7-14 19-24 7 7-8 7 9 9 7 7 5-7-20 -25-26 7
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LADORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LUVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MASTRIFE INDUSTRIES INC MAYSTEEL PRODUCT INC METAL CRAFT INC METAL CRAFT INC METAL CRAFT PRODUCTS CORP METAL SPECIALTY PRODUCTS CORP	7 5-7-8 7-8 7-8 7-8 N 21-26 24-26 24-26 24-26 7 7 7-14 19-24 7 7 7 -7 9 9 7 7 -5 -7-20 -25-20 -25-27 7 -24-26
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LABORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LUVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TROM INC LYNCH COMMUNICATION SYSTEMS INC LYNCH COMMUNICATION SYSTEMS INC LYNCH COMMUNICATION SYSTEMS INC LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MARYLAND CERAMIC & STEATITE CO INC MASTERIE INDUSTRIES INC MASTERIE INDUSTRIES INC MASTERIE INDUSTRIES INC METAL FABRICATORS CORP METAL FABRICATORS CORP METAL SPECIALTY PRODUCTS CORP METHODE MFG CORP MIDUEST METAL PRODUCTS INC MIDUEST METAL PRODUCTS INC MILLITEST CORP	7 5-7-8 7-8 7-8 7-8 7-8 21-26 24-26 24-26 24-26 24-26 7-7 7-14 19-24 7 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7-8 7 7 5-7-20 7 7 7-2-226 7 7 7-24-26 4
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LABORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GEMERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LUVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TROM INC LYNCH COMMUNICATION SYSTEMS INC LYNCH COMMUNICATION SYSTEMS INC LYNCH COMMUNICATION SYSTEMS INC LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MARYLAND CERAMIC & STEATITE CO INC MASTERITE INDUSTRIES INC MASTERITE INDUSTRIES INC METAL CRAFT INC METAL FABRICATORS CORP METALSECLALTY PRODUCTS CORP METALSECLIALTY PRODUCTS CORP METALSECLIALTY PRODUCTS INC MID-CONTINENT ENGINEERING MIDWEST METAL PRODUCTS INC MIDEST METAL PRODUCTS INC MINEAPONENTIAL PRODUCTS INC MINEAPONENTIA	7 5-7-8 7-8 7-8 7-8 21-26 24-26 24-26 7 7-14 19-24 19-24 7 7 7-8 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-16 7 7-26 7 7-26 7 7-26 7 7-26 7 7-26 7 7-26 7 7-26 7 7-26 7 7-26 7 7 7-26 7 7 7-26 7 7 7 7-26 7 7 7 7 7-2-26 7 7 7 7-2-26 7 7 7-2-26 7 7 7-2-26 7 7 7-2-26 7 7 7-26-26 7 7-26-26 7 7-26-26 7 7-26-26 7 7-26-26 7-25-26 7 7-26-26 7-25-26 7 7-26-26 7-25-26 7-26-26 7-25-26 7-26-26 7-25-26 7-26-26 7-25-26 7-26-26 7-25-26 7-26-26 7-25-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26-26 7-26 7-26-26 7-26 7-26 7-26-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-26 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76 7-76
	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LABORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT 6 ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GENERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISIO LIVINGSTON ELECT CORP LMB LUDHIG HONOLD MFG CO LYN TRON INC LYNCH MFG CO R H MADIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MARYLAND CERAMIC & STEATITE CO INC MASTERITE INDUSTRIES INC MASTERITE INDUSTRIES INC MASTERITE INDUSTRIES INC MASTERITE INDUSTRIES INC MASTERL PRODUCT INC METAL CRAFT INC METAL SPECIALTY PRODUCTS CORP METALS OF PRODUCT INC MIDWEST METAL PRODUCTS INC MIDUEST METAL PRODUCTS INC MIDUEST METAL PRODUCTS INC MILLITEST CORP MINI-MOLD INC MINNEAPOLIS-HONEYWELL AERO DIV MINNESOTA MINING & MFG CO	7 5-7-8 7-8 7-8 7-8 21-26 24-26 24-26 7 7-14 19-24 7 7 94 19 9 9 7 7 -25-26 7 7 -25-26 7 7 -25-26 25 7-8 30
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	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LABORATORY FOR ELECTRONICS INC LAND AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GEMERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LUVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TRON INC LYNCH COMMUNICATION SYSTEMS INC LYNCH COMMUNICATION SYSTEMS INC LYNCH MFG CO R H MADLIGAN CORP MALKIN-ILLION CO MARCONI INSTRUMENTS MATYLAND CERAMIC & STEATITE CO INC MASTERITE INDUSTRIES INC MASTERITE INDUSTRIES INC MASTERITE INDUSTRIES INC METAL CRAFT INC METAL CAFT INC METAL FABRICATORS CORP METHODE MFG CO JAMES 1-6-20-21-22-23 MILLIEST CORP MINLEND ISC MFG CO MILLEN MFG CO JAMES 1-6-20-21-22-23 MILLIEST CORP MINLAPOLIS-HONEYWELL AERO DIV MINNEAPOLIS-HONEYWELL AERO DIV MINNEAPOLIS-HONEYWELL AERO DIV MINNEAPOLIS METAL CORP MUCKLE MFG CO MUCKICR SOLDERS LTD MULTICORE SOLDERS LTD MULTICORE SOLDERS LTD MULTICORE SOLDERS LTD MULTICORE SOLDERS CO NEVADA AIR PRODUCTS CO NEWYORK SOLDER CO NICHOLS PRODUCTS CO NEWYORK SOLDER CO NICHOLS PRODUCTS CO	$\begin{array}{c} 7\\ 5-7-8\\ 7-8\\ 7-8\\ 7-8\\ 7-8\\ 7-8\\ 7-14\\ 19-26\\ 24-26\\ 24-26\\ 7\\ 7-14\\ 19-26\\ 7\\ 7\\ 7-14\\ 19-29\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\$
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	LABELLE INDUSTRIES INC LABORATORY FOR ELECTRONICS INC LADO AIR INSTRUMENT & ELECT DIV LEACH & GARNER CO INDUSTRIAL DIVISION LINK DIV GEMERAL PRECISION INC LITTON INDUSTRIES ELECTRON TUBE DIVISION LIVINGSTON ELECT CORP LMB LUDWIG HONOLD MFG CO LYN TRON INC LYNCH COMMUNICATION SYSTEMS INC LYNCH COMMUNICATION SYSTEMS INC LYNCH MFG CO R H MADLIAN-ILLION CO MARCONI INSTRUMENTS MARYLAND CERAMIC & STEATITE CO INC MASTERITE INDUSTRIES INC MID-CONTINENT ENGINEERING MIDEST METAL PRODUCTS CORP METAL CAFT INC MILLIEST CORP MINNEAPOLIS-HONEYWELL AERO DIV MINNESOTA MINING & MFG CO MORSE CO FRANK W MUCTLOCE SOLDERS LTD NATIONAL TEL TRONICS CORP MEVADIS PRODUCTS CO NEVADA AIR PRODUCTS CO NEVADA AIR PRODUCTS CO NEVADA AIR PRODUCTS CO NEW YORK SOLDER CO NICHOLS PRODUCTS CO NOREICH PLASTICS CORP PLUMIC RODUCTS CO NORE LECTRONICS CO NEW YORK SOLDER CO NICHOLS PRODUCTS CO NOR LECTRONICS COP PEBLES 6 CO LTD BRUCE PEBLES 6 CO LTD BRUCE PEBLES 7 CO PLUMIN INSTRUMENTS INC PUCHANTING CO ROJECTS UNLIMITED INC PTLE-NATIONAL CO RADIO SPECIALTY MFG CO	$\begin{array}{c} 7\\ 5-7-8\\ 7-8\\ 7-8\\ 7-8\\ 7-8\\ 7-8\\ 19-26\\ 24-26\\ 24-26\\ 7\\ 7-14\\ 19-26\\ 7\\ 7\\ 7-8\\ 7\\ 7\\ 7-8\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 19-29\\ 7\\ 7\\ 7\\ 7\\ 10-18\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\ 7\\$
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Switches, cooxial	2
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Switches, crossbar	4
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Switches, hermetically seoled	9
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	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMÉR DIV GIANNINI CONTROLS CORP CRYOGENICS INC CUNINGHAM SONS & JAMES CUTLER HAMMER INC DALES CO FRANKLIN DANLY MACHINE SPEC INC DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIALIGHT CORP DIAMOND ANTENNA & MICROWAVE CORP DIAMOND ANTENNA & MICROWAVE CORP DIAMOND ANTENNA & MICROWAVE CORP DIAMOND ANTENNA & MICROWAVE CORP DIALIGHT CORP DIALOFT CREMUTY G INC DITIMORE FREIMUTH CORP DITIMORE FREIMUTH CORP DON LAN ELECTRONICS CORP SUB QUANTATRO DOUGLAS MICROWAVE CO DOW KEY CO INC DUYER MFG COF W	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4 39 31 25-27 39 31 39 4-19-30 8-29-30 8-29-30 9-26-33 32 2-38 19-32 2-38 9-28-35 1-12-25 IN INC 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-3
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMÉR DIV GIANNINI CONTROLS CORP CRYOGENICS INC CUNINGHAM SONS & JAMES CUTLER HAMMER INC DALES CO FRANKLIN DANLY MACHINE SPEC INC DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIALIGHT CORP DIAMOND ANTENNA & MICROWAVE CORP DIALOHT CORP DON LAN ELECTRONICS CORP SUB QUANTATRO DOUGLAS MICROWAVE CO DOW KEY CO INC DWYER WIG COFP	L-22-23- 27-29-33 19-31 32 31 25-27 4 39 31 25-27 4 39 31 25-27 4 39 31 25-27 38 32 2-38 9-26-33 38 32 2-38 9-26-33 19-32 2-38 9-26-33 19-32 2-38 19-32 2-38 2-38 19-32 19-32 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-31 12-27 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 19-32 2-38 2-38 19-32 2-77-33 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19-32 19
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONAL ENGG SERVICE CRAMER DIV GIANNINI CONTROLS CORP CROYOGENICS INC CUNNINGHAM SONS & JAMES CUTLER HAMMER INC DALES CO FRANKLIN DALES CO FRANKLIN DALES CO FRANKLIN DALES CO FRANKLIN DALES CO FRANKLIN DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26- DELTA ELECT CO 3-59-19-20-23-25-26- DELTA ELECT CO 3-5-9-19-20-23-25-26- DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIALIGHT CORP DIAMOND ANTENNA & MICROWAVE CORP DIAMOND ANTENNA & MICROWAVE CORP DIAMOND ANTENNA & MICROWAVE CORP DILECCTRIC PRODUCTS ENGG CO DIELECTRIC PRODUCTS CORP SUB QUANTATRO DON LAN ELECTRONICS CORP SUB QUANTATRO DOU LAN ELECTRONICS CORP SUB QUANTATRO DOUGLAS MICROWAVE CO DOW LEN ELECTRIC MFG CO 6-11-12-14-2 EALIMAM PRECISION INST CO INC 20-2	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4 39 4-19-30 8-29-30 8-29-30 9-26-33 36 9-28-35 1-12-25 NI NIC 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-37 3-35 3-35 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-3
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAVGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALS CO FRANKLIN DAALS CO FRANKLIN DAALS CO FRANKLIN DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIALIGHT CORP DIALOND ANTENNA 6 MICROWAVE CORP DIALNE CO FRANKLIN CORP DOW LEY CO INC DOW KEY CO INC DOW KEY CO INC DAVER MEG COF # EAGLE ELECTRIC MEG CO 6-11-12-14-2 CALIMA PRECISION INST CO INC 20-2 EASTERN SPECIALTY CO	L-22-23- 27-29-33 19-31 32 31 25-27 39 31 4-19-30 82-29-30 82-23 30 9-26-33 32 222 2-36 19-32 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-27 2-38 2-38 2-38 2-38 2-38 2-27 2-38 2-38 2-38 2-38 2-27 2-28 2-38 2-38 2-38 2-28-35 2-27 2-28 2-28-35 2-28-35 2-28-35 2-27 2-28-35 2-28-35 2-28-35 2-27 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-3
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAYOGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALS CO FRANKLIN DAALS CO FRANKLIN DAALS CO FRANKLIN DATAMETRICS INC DAYEN CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIALIGHT CORP DIALOND ANTENNA 6 MICROWAVE CORP DIALNE CO FA DON LAN ELECTRONICS CORP SUB QUANTATER DOUGLAS MICROWAVE CO DOW KEY CO INC DOW KEY CO INC ELECTRIC MFG CO 6-11-12-14-2 EALIMA PRECISION INST CO INC 20-2 EASTERN SPECIALTY CO EBY SALES CO ECLIPSE-PIONEER DIV BENDIX CORP	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4 39 31 25-27 4 39 31 39 4-19-30 8-29-30 9-26-33 38 9-28-35 1-12-25 NI NI NC 2-38 2-38 2-38 2-38 2-38 2-31 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-58 2-
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMÉR DIV GIANNINI CONTROLS CORP CRYOGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DANLY MACHINE SPEC INC DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DIALIGHT CORP DIALECTRIC PRODUCTS ENGG CO DIELECTRIC PRODUCTS ENGG CO DIELECTRIC PRODUCTS CORP SUB QUANTATRO DOUGLAS MICROWAVE CO DOW LAN ELECTRONICS CORP SUB QUANTATRO DOUGLAS MICROWAVE CO DOW LEY CO INC DUYER MFG CO F W EALING CORP EALING	L-22-23- 27-29-33 19-31 32 31 25-27 39 31 4-19-30 82-29-30 82-23 30 9-26-33 32 222 2-36 19-32 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-27 2-38 2-38 2-38 2-38 2-38 2-27 2-38 2-38 2-38 2-38 2-27 2-28 2-38 2-38 2-38 2-28-35 2-27 2-28 2-28-35 2-28-35 2-28-35 2-27 2-28-35 2-28-35 2-28-35 2-27 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-35 2-28-3
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	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMÉR DIV GIANNINI CONTROLS CORP CRYOGENICS INC CITS CORP CUNNINGHAM SONS 6 JAMES CUTLER HAMMER INC DALES CO FRANKLIN DANLY MACHINE SPEC INC DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-2 DAVEN CO 3-5-9-19-20-23-25-26-2 DAVEN CO 3-5-9-19-20-23-25-26-2 DAVEN CO 3-5-9-19-20-23-25-26-2 DAVEN CO 3-18-1 DECTARLANTE SINC DAVEN CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALECTRIC PRODUCTS ENGG CO DIELECTRIC PRODUCTS ENGG CO DIELECTRIC PRODUCTS CORP SUB QUANTATER DON LAN ELECTRONICS CORP SUB QUANTATER DON LAN ELECTRONICS CORP SUB QUANTATER DOUGLAS MICROWAVE CO DOW KEY CO INC DUYER MFG CO F W EALING CORP EALING CORP EALING CORP EALING CORP EALING CORP EALING CORP ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED ELECTRALAB PRINTED ELECTRALAB PRINTED ELECTRALAB PRINTED ELECTRALAB PRINTED ELECTRALAB P	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4 39 31 25-27 4 39 31 25-27 39 31 32 2-38 9-26-33 36 9-26-33 36 9-26-33 36 9-26-33 36 9-26-33 36 9-26-35 1-12-25 NI NI NC 2-38 9-28-35 1-12-25 2-38 9-28-35 1-12-25 2-38 9-28-35 1-12-25 2-38 9-28-35 1-12-25 2-38 9-28-35 1-12-25 2-38 9-28-35 1-12-25 2-38 9-28-35 1-12-25 2-38 31-35 2-27 31-35 2-27 2-27 31-35 2-27 2-27 2-28 31-35 2-27 2-27 2-28 31-35 2-27 2-27 2-28 31-35 2-27 2-27 2-28 31-35 2-27 2-27 2-28 31-35 2-27 2-27 2-27 2-27 2-28 31-35 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAYOGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALY MACHINE SPEC INC DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-1 DAVEN CO 3-5-9-19-20-23-25-26-1 DELTA ELECT CO DAVEN CO 3-5-9-19-20-23-25-26-1 DELTA ELECT CO DELTA ELECT CO DIAJENT CORP DIAJENT CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIALO ELECTRONICS CORP SUB QUANTATRO DOUGAS MICROWAVE CO DOUGAS CO INC DOUGAS CO INC DOUGAS CO INC DOUGAS MICROWAVE CO DOUGAS CO INC DOUGAS CO	L=22-23- 27-29-33 19-31 3 14-32 31 25-27 39 4-19-30 8-29-30 8-29-30 8-29-30 9-26-33 36 9-26-33 32 2-23 9-28-35 1-12-25 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-27 2-38 2-38 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-28 2-38 2-27 2-27 2-38 2-27 2-38 2-27 2-27 2-38 2-27 2-27 2-38 2-27 2-28 2-27 2-28 2-27 2-27 2-27 2-23 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28
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	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMÉR DIV GIANNINI CONTROLS CORP CRAYOGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALES CO FRANKLIN DALES CO FRANKLIN DESTRON CO DIALIGHT CORP DIALOND ANTENNA & MICROWAVE CORP DIALOND ANTENNA & MICROWAVE CORP DIALOND ANTENNA & MICROWAVE CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUG LAS MICROWAVE CO DOUG LAS MICROWAVE CO DOUG LAS MICROWAVE CO DOUG LAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUG LAS MICROWAVE CO DUELECTRIC THE DIV BENDIX CORP ELECTROINDUST THOMAS A INST DIV ELECTRO DOUGEN CO ELECTRO SOLID CONTROLS INC ELECTRO SOLID CONTROLS INC ELECTRO SULT CORP INCO ELECTRO SULT CORP INCOS INC ELECTRO SULT CORP INCOS INC ELECTRO THE CORP INCOS INC ELECTRO SULT CORP INCOS INC ELECTRO TO CORP INCOS INC ELECTRO SULT CORP INCOS INC ELECTRO SULT CORP INCOS INC ELECTRO SULT CORP INCOS INC ELECTRO SULT CORP INCOS INC	L=22-23- 27-29-33 19-31 3 14-32 31 25-27 39 4-19-30 8-29-30 8-29-30 8-29-30 9-26-33 36 9-26-33 32 2-23 9-28-35 1-12-25 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-27 2-38 2-38 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-38 2-27 2-28 2-38 2-27 2-27 2-38 2-27 2-38 2-27 2-27 2-38 2-27 2-27 2-38 2-27 2-28 2-27 2-28 2-27 2-27 2-27 2-23 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBLIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMER DIV GIANNINI CONTROLS CORP CROYOGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DALLS CO FANKLIN DALLS CO FANKLIN DALLS CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO DATAMETRICS INC DAVEN CO 3-18-1 DEMORNAY BONARDI CORP DEMORNAY BONARDI CORP DIALIGHT CORP DIAL CON DUGLAS MICROWAVE CO DOW LAN ELECTRONICS CORP SUB QUANTATED EALING COP EALING COP EALING COP EALING COP EALING COP EALING COP EALING COP EALING COP EALING COP EALING COP ELECTRALS PRINTED ELECT CORP ELECTRALS PRINTED	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4 39 4-19-30 8-29-30 8-29-30 9-26-33 32 2-38 9-28-35 1-12-25 31-35 2-38 2-38 2-27-33 31-35 31-35 31-35 2-27-33 31-35 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-33 31-35 2-27-27-33 31-32 2-27-27-33 31-32 2-27-28-29- 30 1-22-27-33 31-32 2-28-29- 30 1-22-27-33 31-32 2-28-29- 30 1-22-27-33 31-32 2-28-29- 30 1-22-27-33 31-32 2-28-29- 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 30 1-27-25-30 1-27-25-30 30 1-27-27-30 30 1-27-25-27-30 30 1-27-25-27-30 30 1-27-25-27-25-27-27-27-27-27-27-27-27-27-27-27-27-27-
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAYOGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALY MACHINE SPEC INC DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-1 DAVEN CO 3-5-9-19-20-23-25-26-1 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIADHEX DIV DIALIGHT CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIADHLEX DIV DIELECTRIC PRODUCTS ENGG CO DIETI CON FREIMUTH CORP DON LAN ELECTRONICS CORP SUB QUANTATRO DOUGAS MICROWAVE CO DOUGAS MICROWAVE CO DOUGAS MICROWAVE CO DOW KEY CO INC DOWYER MFG CO F W EAJING CORP EALING CORP EALI	L=22-23- 27-29-33 19-31 3 14 32 31 25-27 4 39 31 3-14 4 32 31 32 2-27 2-38 2-28 2-38 2-28 2-38 2-27 2-38 2-28 2-38 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 31-35 2-27 30 31-35 2-27 30 31-35 2-27 30 31-35 2-27 30 31-35 2-27 30 31-35 2-27 30 31-35 2-27 30 31-35 2-27 30 31-35 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-27 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 2-28 30 31-32 30 31-32 30 31-32 30 31-32 30 31-32 30 31-32 30 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-32 31-
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNAL ENGS SERVICE CRAMER DIV GIANNINI CONTROLS DIV CORONA ENGS SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAVGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALS CO FRANKLIN DALES CO FRANKLIN DOUGLAS MICROWAVE CORP DIAIDENT CORP DISTRON CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUG KEY CO INC DOUG KEY CO INC DOUG KEY CO INC DOUG KEY CO INC DOUG KEY CO INC DOUGLAS MICROWAVE CO DOUG KEY CO INC DOUG SALES CO ECLIPSE-PIONEER DIV BENDIX CORP ELECTRO SUITHOMAS A INST DIV ELECTRO SUITHOMAS A INST DIV ELECTRAMATIC INC SUBLECTRO SUITHOMAS A INST DIV ELECTRO SUITHORMS A INST DIV ELECTRO SUITHORMS A INST DIV ELECTRO SUITH CORP LECTRAMATIC INC LECTRO SUITH CORP I-16-23-24-25-27 LECTRO SUITH CORP I-16-23-24-25-27 LECTRO TEC CORP VIRGINIA OIV ELECTROPOT INC ELECTRO TEC CORP VIRGINIA OIV ELECTROPOT INC ELESTRON THOMAS A CO DIVER SOLUCTOR CONTROLS INC ELECTROPOT INC ELECTRO TEC CORP VIRGINIA OIV ELECTROPOT INC ELESTRON THOMAS CO DIVELEDIN THOMAS CO DIVER SOLUCTOR CONTROLS INC ELECTROPOT INC ELESTRON SUITH CORP I-16-23-24-25-27 ELECTROPOT INC ELESTRON THOMAS CO DIVER SOLUCTOR CONTROLS INC ELECTROPOT INC ELESTRON THOMAS CO DIVER SOLUCTOR CONTROLS INC ELECTROPOT INC ELESTRON CONTROLS DIV ELGIN NAT WATCH CO 20-25-25-27 ELESTRON CONTROLS DIV ELGIN NAT WATCH CO 20-25-25-27 ELESTRON CONTROLS DIV ELGIN NAT WATCH CO 20-25-27 ELESTRON	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4-19-30 8-29-30 9-26-33 32 2-38 19-32 2-38 19-32 2-38 9-28-35 1-12-25 N INC 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-29 2-38 2-29 2-38 2-29 2-38 2-29 2-29 2-29 2-28 2-28 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-29 2-28 2-27 2-29 2-28 2-27 2-29 2-28 2-27 2-29 2-28 2-28 2-27 2-29 2-28 2-27 2-29 2-28 2-29 3-28 2-28 2-29 -29 -29 -29 -29 -29 -29 -2
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNELL-DUBILIER ELECTRONICS DIV CORONA ENGG SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRYOGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DANLY MACHINE SPEC INC DATAMETRICS INC DAVEN CO 3-5-9-19-20-23-25-26-2 DELTA ELECT CO 3-18-1 DEMORNAY BONARDI CORP DESTRON CO DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALOND ANTENNA & MICROWAVE CORP DIALOND ANTENNA C MICROWAVE CO DOW LAN ELECTRONICS CORP SUB QUANTATRO DOUGLAS MICROWAVE CO DOW LEY CO INC DUYER WFG COF F EALING CORP EALING CORP EALING CORP EALING CORP ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED CLECT CORP ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED CLECT CORP ELECTRALAB PRINTED CLECT CORP ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED ELECT CORP ELECTRON SUID CONTROLS INC ELECTRO SUID CONTROLS INC EL	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4 39 31 25-27 39 31 25-27 31 30 2-22 2-38 32 2-38 32 2-38 2-28 2-38 2-28 2-38 2-28 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-27 2-39 2-38 2-38 2-27 2-39 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-2
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNAL ENGS SERVICE CRAMER DIV GIANNINI CONTROLS DIV CORONA ENGS SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAVGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALW MACHINE SPEC INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS ORP DIALGENCO 3-5-9-19-20-23-25-26-1 DELTA ELECT CO DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIALOND ANTENNA 6 MICROWAVE CORP DIAPHLEX DIV DIELECTRIC PRODUCTS ENGG CO DIETZ CO MENRY G INC DOUGLAS MICROWAVE CO DOUG KEY CO INC DOUG SA MICROWAVE CO DOUG KEY CO INC DOUG KEY CO INC DOUG SA MICROWAVE CO DOUG KEY CO INC DOUG SA MICROWAVE CO DOUG KEY CO INC DELECTRIC MFG CO 6-11-12-14-2 CALIMA PRECISION INST CO INC 20-2 ELECTRO SOLID CONTROLS INC ELECTRO SOLID CONTROLS INC ELECTRO SOLID CONTROLS INC ELECTRO SOLID CONTROLS INC ELECTRO TEC CORP VIRGINIA OIV ELECTRO TO CORP VIRGINIA OIV ELECTROPOT INC LISON DRAFT GAGE CO ELY SALES CO ENARCO CORP PSCO INC	L=22-23- 27-29-33 19-31 3 14-32 31 25-27 39 4-19-30 8-29-30 8-29-30 8-29-30 9-26-33 30 9-26-33 32 2-23 9-28-35 1-12-25 2-38 2-38 2-238 2-38 2-238 2-38 2-238 2-38 2-238 2-38 2-38 2-38 2-238 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-27 2-38 2-38 2-38 2-27 2-38 2-38 2-27 2-38 2-38 2-27 2-38 2-27 2-38 2-38 2-27 2-38 2-27 2-27 2-38 2-28 2-38 2-27 2-27 2-27 2-38 2-27 2-27 2-27 2-38 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2-27 2
	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNAL ENGS SERVICE CRAMER DIV GIANNINI CONTROLS DIV CORONA ENGS SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAVGENICS INC CITS CORP CUTLER HAMMER INC DALES CO FRANKLIN DAALW MACHINE SPEC INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS ORP DIALGENCO 3-5-9-19-20-23-25-26-1 DELTA ELECT CO DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DATAMETRICS INC DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIALIGHT CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIALOND ANTENNA 6 MICROWAVE CORP DIAPHLEX DIV DIELECTRIC PRODUCTS ENGG CO DIETZ CO MENRY G INC DOUGLAS MICROWAVE CO DOUG KEY CO INC DOUG SA MICROWAVE CO DOUG KEY CO INC DOUG KEY CO INC DOUG SA MICROWAVE CO DOUG KEY CO INC DOUG SA MICROWAVE CO DOUG KEY CO INC DELECTRIC MFG CO 6-11-12-14-2 CALIMA PRECISION INST CO INC 20-2 ELECTRO SOLID CONTROLS INC ELECTRO SOLID CONTROLS INC ELECTRO SOLID CONTROLS INC ELECTRO SOLID CONTROLS INC ELECTRO TEC CORP VIRGINIA OIV ELECTRO TO CORP VIRGINIA OIV ELECTROPOT INC LISON DRAFT GAGE CO ELY SALES CO ENARCO CORP PSCO INC	L-22-23- 27-29-33 19-31 3 14 32 311 25-27 4 39 31 25-27 39 31 25-27 31 30 2-22 2-38 32 2-38 32 2-38 2-28 2-38 2-28 2-38 2-28 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-27 2-39 2-38 2-38 2-27 2-39 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-27 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-2
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	3-5-9-13-16-18-19-20-2 COOK ELECT CO WIRECOM DIV CORNAL ENGS SERVICE CRAMER DIV GIANNINI CONTROLS DIV CORONA ENGS SERVICE CRAMER DIV GIANNINI CONTROLS CORP CRAVGENICS INC CIS CORP CUTLER MAMMER INC DALES CO FRANKLIN DAALES CO FRANKLIN DALES CO FRANKLIN DIALIGHT CORP DISTON CO DIALIGHT CORP DIAMOND ANTENNA 6 MICROWAVE CORP DIAPHLEX DIV DIELECTRIC PRODUCTS ENGG CO DIFIZ CO HENRY G INC DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUGLAS MICROWAVE CO DOUG KEY CO INC DUYER MEG CO F # EAGLE ELECTRIC MFG CO 6-11-12-14-2 EALIMAM PRECISION INST CO INC 20-2 EALIMM PRECISION INST CO INC 20-2 EALIMM PRECISION INST CO INC 20-2 ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED ELECT CORP ELECTRALAB PRINTED ELECT CORP ELECTRANTIC INC ELECTRO SWITCH CORP 1-16-23-24-25-27 ELECTRAMIC CORP 1-16-23-24-25-27 ELECTRON SUIC CORP 1-16-23-24-25-27 ELECTRON SUICH CORP 1-17 ELECTRON SUICH CORP 1-16-23-24-25-27	L-22-23- 27-29-33 19-31 3 14 32 31 25-27 4-19-30 8-29-30 9-26-33 32 2-38 19-32 2-38 19-32 2-38 19-32 2-38 9-28-35 1-12-25 10 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-38 2-28 2-38 2-28 2-38 2-28 2-28 2-38 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-28 2-2
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PRD ELECTRONICS INC PRECISION LINE INC PRECISION METAL PRODUCTS CO PRECISION THERMOMETER 6 INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDNAL CO OUALITY STAMPING CO OUALITY STAMPING CO OUALITY STAMPING CO COUNTATERN INC RECORD OF AM BROADCAST 6 COM PROD D RECORA C/ RED RESEARCH INC RESITRON LABS INC REVERE CORP OF AMERICA RHODES INC M H ROANWELL CORP	38 25 25 31 1NC 30 20 1-12 -32-33 -23-33 -23-33 -23-33 1V 2 -19-29 -26-27 35 25 7-9 32 25 7-9 32 25 7-9
PRD ELECTRONICS INC PRECISION LINE INC PRECISION METAL PRODUCTS CO PRECISION THERMOMETER & INST CO PRINCETON DIV ELECTRO MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDNAL CO OUALITY STAMPING CO OUALITY STAMPING CO DUALITY STAMPING CO DECORA C/ 16 RED RESEARCH INC REUTRE INC REVERE CORP OF AMERICA RHODES INC M H RODALE MEG CD 12-14-22	38 25 20 31 1NC 30 20 1-12 -32-33 -23-33 21 22 -19-29 -26-27 35 25 7-9 32 15-22 -27-33
PRD ELECTRONICS INC PRECISION LINE INC PRECISION METAL PRODUCTS CO PRECISION THERMOMETER & INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINCETON DIV ELECTRD MECHANICAL RESCH PRINCETON DIV ELECTRD MECHANICAL RESCH OUALITY STAMPING CO 100 GUANTATRON INC 20 RADID CORP DF AM BROADCAST & CDM PROD D RECORA C/ 16 REUTER INC 9-13-23 RESITRON LABS INC REUTER INC H RODARS INC MH ROANWELL CORP RODALE MEG CD 12-14-22 RONAN & KUNZL INC 100	38 25 20 31 30 20 1-12 -32-33 -23-38 1V 2 -19-29 -26-27 35 25 7-9 32 15-22 -27-33 3-9
PRD ELECTRONICS INC PRECISION LINE INC PRECISION METAL PRODUCTS CO PRECISION THERMOMETER & INST CO PRINCEDTO DIV ELECTRO MECHANICAL RESCH PRINCED CORP PYLE-NATIDNAL CO OUANTATRON INC DALITY STAMPING CO DALOR PARAMETER / COMPANY PRECORA C/ RESITRON LABS INC REUTR INC REVERE CORP OF AMERICA RHODES INC M H ROANWELL CORP ROANLE MEG CD 12-14-22 RONAN & KUNZL INC ROSENTHAL ISOLATOREN GMBH DF SELB W GER	38 25 20 31 30 20 1-12 -32-33 8 IV 2 -19-29 -26-27 -35 25 25 7-9 32 15-22 -27-33 3-9 MANY 25
PRD ELECTRONICS INC PRECISION LINE INC PRECISION METAL PRODUCTS CO PRECISION THERMOMETER 6 INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDNAL CO OUALITY STAMPING CO OUALITY STAMPING CO DIV ELECTRO BROADCAST 6 CDM PROD D RECORA C/ RED RESEARCH INC PEVIER CORP OF AMERICA REVERE CORP OF AMERICA RODALE MFG CD RODALE MFG CD 12-14-22 RODALE MFG CD ROSENTHAL ISOLATOREN GMBH DF SELB W GER ROWAN CONTROLLER CO N J 1	38 25 20 31 31 30 20 1-12 -32-33 1V 2 -19-29 -26-27 35 25 7-9 35 25 7-9 35 25 7-9 3-9 3-9 40 25 25 7-9 35 25 25 25 25 25 25 25 25 20 20 1-12 -32-38 1V 20 1-12 -32-38 1V 20 1-12 -32-38 1V 20 1-15 -25 20 20 1-15 20 20 1-15 20 20 1-15 20 20 1-15 20 20 1-15 20 20 1-15 20 20 1-15 20 20 20 1-15 20 20 20 20 20 20 20 20 20 20 20 20 20
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PRD ELECTRONICS INC PRECISION LINE INC PRECISION HERAL PRODUCTS CO PRECISION THERMOMETER & INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDMAL CO OUALITY STAMPING CO OUALITY STAMPING CO DANTATRON INC 22 RADID CORP DF AM BROADCAST & COM PROD D RECORA C/ RED RESERCH INC PUTER INC REVERE CORP OF AMERICA REVERE CORP OF AMERICA RHODES INC M H ROANELL CORP RODALE MFG CD 12-14-22 RONAN & KUNZI INC ROSENTHAL ISOLATOREN GMBH DF SELB W GER ROWAN CONTROLLER CO N J 1 ROYAL MEBEE INST DEVELOP LAB RUCKELSHAUS LABORATORIES INC JOHN G	38 25 20 31 31 1NC 30 20 1-12 2-32-33 1V 2-32-33 1V 2-19-29 -26-27 32 15-22 -27-33 3-9 MANY 25 -17-22 25 20-25 20-25
PRD ELECTRONICS INC PRECISION LINE INC PRECISION HEAL PRODUCTS CO PRECISION THERMOMETER & INST CO PRINCETON DIV ELECTRO MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDNAL CO QUALITY STAMPING CO QUANTATRON INC RADID CORP DF AM BROADCAST & CDM PROD D DECORA C/ 16 RED RESEARCH INC REUTR INC REVERE CORP OF AMERICA RHODES INC M H RODALE MEG CD RODALE MEG CD 12-14-22 RONAN & KUNZL INC ROSENTHAL ISOLATOREN GMBH DF SELB W GER ROWAN CONTROLLER CO N J 1 ROYAL MEBE INST DEVELOP LAB 1 RUXELSAUS LABORATORIES INC JOHN G	38 25 20 31 INC 30 20 1-12 2-32-33 -23-38 IV 2 -19-29 -26-25 25 7-9 32 15-22 -27-33 3-9 MANY -17-225 20 20 20 20 20 20 20 20 20 20 20 20 20
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PRD ELECTRONICS INC PRECISION LINE INC PRECISION HERAL PRODUCTS CO PRECISION THERMOMETER & INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDMAL CO OUALITY STAMPING CO OUALITY STAMPING CO PRECORA C/ RED RESERCH INC PEVERE CORP OF AMERICA REVERE CORP OF AMERICA REVERE CORP OF AMERICA REVERE CORP OF AMERICA RODALE MFG CD 12-14-22 RONAN GAUTARL SINC REVERE CORP OF AMERICA REVERE CORP OF AMERICA REVERE CORP OF AMERICA RODALE MFG CD 12-14-22 RONAN GAUTORIES INC 1 ROSENTHAL ISOLATOREN GMBH DF SELB W GER ROWAN CONTROLLER CO N J 1 ROVAL MEBEE INST DEVELOP LAB 1 ROVAL MEBEE INST DEVELOP LAB 1 ROVALES ASSOCIATES NOG SANDERS ASSOCIATES	36 25 20 31 INC 20 20 20 20 20 20 21 20 21 22 23 35 22 23 23 25 7-9 26 25 7-9 26 27 23 3-9 32 15-22 25 20 25 7-9 26 25 7-29 32 15-22 25 20 20 20 20 20 20 20 20 20 20 20 20 20
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PRD ELECTRONICS INC PRECISION LINE INC PRECISION HEAL PRODUCTS CO PRECISION THERMOMETER 6 INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDNAL CO OUALITY STAMPING CO OUALITY STAMPING CO DANTATRON INC 2 RADID CORP DF AM BROADCAST 6 CDM PROD D RECORA C/ RESTRON LABS INC REVERE CORP OF AMERICA RODALE MFG CD RODALE MFG CD RODALE MFG CD RODALE MFG CD ROMAN CONTROLLER CO N J ROWAN CONTROLLER CO N J ROWAN CONTROLLER CO N J ROVAL MEBEE INST DEVELOP LAB RUCKELSHAUS LABORATORIES INC JOHN G SANDERS ASSOCIATES SANDERS ASSOCIATES SANDERS ASSOCIATES SANDERS ASSOCIATES SCHENTIFIC ELECTRICAL SALES CORP 16-22 SCHENTIFIC ELECTRICAL SALES CORP 16-22 SCHENTIFIC ELECTRICAL SALES CORP	36 25 20 31 INC 30 20 1-12 -32-33 1V 2-32-33 1V 2-19-29 7-9 2-6-27 3-2 25 7-9 3-2 15-22 2-27-33 3-9 MANY -15-22 2-27-33 3-9 MANY -15-22 20 20 2-27-33 3-9 15-22 20 20 20 20 20 20 20 20 20 20 20 20 2
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PRD ELECTRONICS INC PRECISION LINE INC PRECISION HERAL PRODUCTS CO PRECISION THERMOMETER 6 INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDMAL CO OUALITY STAMPING CO OUALITY STAMPING CO PRECORD CORP DF AM BROADCAST 6 COM PROD D RECORA C/ RED RESEARCH INC PESTRON LABS INC REVERE CORP OF AMERICA REVERE CORP OF AMERICA RHODES INC M H ROANELL CORP RODALE MFG CD 12-14-22 RONAN CONTROLLER CO N J ROVAL MEBEE INST DEVELOP LAB RUCKELSHAUS LABORATORIES INC JOHN G SANGAMO ELECTRIC CO SCHMACK ELECTRICLAL SALES CORP SCHATEFIC ELECTRONIC LABS INC SECUPITFIC ELECTRONIC LABS INC SECUPITFIC ELECTRONICL ABS INC SCHOTFIFIC ELECTRONIC LABS INC SCHOTFIFIC ELECTRONIC LABS INC SECUPITFY CONTROLS INC SECUPITY CONTROLS INC SERVONIC INSTRUMENTS CORP SERVONIC INSTRUMENTS CORP SERVONIC INSTRUMENTS MENTS CORP <td>36 25 20 31 INC 20 20 20 20 20 20 20 20 20 20 20 20 20</td>	36 25 20 31 INC 20 20 20 20 20 20 20 20 20 20 20 20 20
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PRD ELECTRONICS INC PRECISION LINE INC PRECISION METAL PRODUCTS CO PRECISION THERMOMETER 6 INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDNAL CO OUALITY STAMPING CO OUALITY STAMPING CO DUALITY STAMPING CO PRECORA C/ LECTRO LABS INC RECORA C/ RESITRON LABS INC REVERE CORP OF AMERICA RODALE MEG CD RODALE MEG CD RODALE MEG CD RONAN & KUNZL INC ROSENTHAL ISOLATOREN GMBH DF SELB W GER ROWAN CONTROLLER CO N J ROYAL MCBEE INST DEVELOP LAB RUCKELSHAUS LABORATORIES INC JOHN G SANDERS ASSOCIATES SANDERS ASSOCIATES SANGAMO ELECTRIC COALES CORP SCHARCK LECTRICAL SALES CORP SECURITY CONTROLS INC SECURITY CONTROLS INC SECURITY CONTROLS INC SENSITIVE RESCH INSTRUMENTS CORP SERVONIC INSTRUMENTS INC SHALLCROSS MEG CO 5-9-16-20-25 SIGMTMASTER CORP SIGMA INSTRUMENTS INC	36 25 20 31 INC 20 20 20 20 20 20 20 20 20 21 22 32 3 22 3 2
PRD ELECTRONICS INC PRECISION LINE INC PRECISION METAL PRODUCTS CO PRECISION THERMOMETER 6 INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDNAL CO OUALITY STAMPING CO OUALITY STAMPING CO DUALITY STAMPING CO PRECORA C/ LECTRO LABS INC RECORA C/ RESITRON LABS INC REVERE CORP OF AMERICA RODALE MEG CD RODALE MEG CD RODALE MEG CD RONAN & KUNZL INC ROSENTHAL ISOLATOREN GMBH DF SELB W GER ROWAN CONTROLLER CO N J ROYAL MCBEE INST DEVELOP LAB RUCKELSHAUS LABORATORIES INC JOHN G SANDERS ASSOCIATES SANDERS ASSOCIATES SANGAMO ELECTRIC COALES CORP SCHARCK LECTRICAL SALES CORP SECURITY CONTROLS INC SECURITY CONTROLS INC SECURITY CONTROLS INC SENSITIVE RESCH INSTRUMENTS CORP SERVONIC INSTRUMENTS INC SHALLCROSS MEG CO 5-9-16-20-25 SIGMTMASTER CORP SIGMA INSTRUMENTS INC	36 20 20 20 20 20 20 20 20 20 20 20 20 20
PRD ELECTRONICS INC PRECISION LINE INC PRECISION HERAL PRODUCTS CO PRECISION THERMOMETER 6 INST CO PRINCETON DIV ELECTRD MECHANICAL RESCH PRINTED ELECT CORP PYLE-NATIDMAL CO OUALITY STAMPING CO OUALITY STAMPING CO DOUALITY STAMPING CO PRECORA C/ RED CORP DF AM BROADCAST & COM PROD D RECORA C/ RESITRON LABS INC REVERE CORP OF AMERICA RHODES INC M H ROANEL CORP RODALE MFG CD 12-14-22 RONAN & KUNZL INC ROSENTHAL ISOLATOREN GMBH DF SELB W GER ROWAN CONTROLLER CO N J ROYAL MEBEE INST DEVELOP LAB RUCKELSHAUS LABORATORIES INC JOHN G SANGAMO ELECTRIC CO SCHATFIFIC ELECTRONIC LABS INC SECURITY CONTROLS INC SECURITY CONTROLS INC SECUDE CORP SECUDE CORP SECUDE CORP SECUDE CORP SECUNTIFY CONTROLS INC SECUDE CORP SECUDE CORP SECUDE CORP SECUDE CORP SECUDE CORP	36 25 20 31 INC 30 20 2-2-33 2-23-38 IV 2 2-2-38 IV 2 2-2-27 3 2 2-27-33 3-9 3-9 15-22 2 2-27-33 3-9 MANY -15-22 20-25 20-25 20-25 1-31 -27-33 3-9 MANY -17-28 20-27 -33 3-9 12-27 -28 -27 -33 3-9 12-27 -28 -27 -33 3-9 3-9 12-27 -28 -27 -28 -27 -27 -28 -27 -27 -28 -29 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -26 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -28 -27 -27 -27 -27 -28 -27 -27 -27 -27 -27 -27 -27 -27 -27 -27
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TECHNICAL LABS 1-2-3-5-9-20-2	
TELECTRO INDUSTRIES CORP	32 9 C
TELEX INC TELONIC INDUSTRIES INC	22 0
TENSOR ELECT DEVELOP CO	3 C ATORIES 9-18 C
THERMOCAL DIV OF JAMIESON LABOR THERMO ELECTRIC CO TORRES ENGG CO INC 9-13-15-1	11-22-25
TORSION BALANCE CO	33 C 29-33 C
TOUCH-PLATE MFG CORP	22-23
TRANSISTOR ELECTRONICS CO MINN TRIMM INC	10-11-22
TUNG SOL ELECTRIC ELECTRIC INC. TURBO MACHINE CO	38 0
UCINITE CO DIV UNITED CARR FAST 5-10-15-16-18-2	ENER CORP 3- 0 0-22-25-26-27- 0
ULANET CD GEORGE	29-30
UNIMAX SWITCH MAXSON ELECT CORP	13-22-27-
UNISON ELECTRONICS	25 0
UNITED ELECTRIC CONTROLS CO	35 0
	28-31
UNIVERSAL MATCH CO UNDYNAMICS D UNIV MATCH CORP ARMA DIV AVNC &	IV 9 6 ELECT DEPT
	9 19-27-28-31-32
UNIVDX CORP CALIF VALVERDE LABS	2 31
WABER ELECTRONICS INC	1
WADE ELECTRIC PRODUCTS CO WALSCD ELECTRONICS MFG CO WALTHAM PRECISION INSTR CO INC	
WAVELINE INC	38
WESTERN DIV PENN CONTROLS INC WESTINGHDUSE ELECT CORP APPARAT	US DIV 17
WESTINGHOUSE ELECTRIC CORP STAN	DARD CONTROL
WILCOLATOR CO WILSON & CO G C	31 32
WINTERBURN MFG CD	3-23
WOOD ELEC CDRP	
BRIDGES & DECADE BO	(ES
Attenuators, decade	
Bridges, audio	
Bridges, bolometer	3
Bridges, capacitance	
Bridges, canductivity Bridges impedance	
Bridges, impedance Bridges, inductance	
Bridges, megohm	8
Bridges, resistance	9
Bridges, R-F	
Bridges, standing wave Bridges, strain gage	
Bridges, synchro	
Bridges, temperature	
Bridges, thermistor	
Bridges, VHF Bridges, wein	
Bridges, wheatstone	
Decade boxes, capacitance	
Decade boxes, inductonce	
Decade boxes, resistance	41
AIRBORNE INSTRS LAB DIV CUTLER	
ALFORD MEG CO	10-11
AMERICAN ASTRO-SYSTEMS 1-2	6-9-18-19-40-41
10-11-12-13-14- 20-21-22-23-24-	15-16-17-18-19-
30-31-32-33-34-	35-36-37-38-39- 40-41
ANADEX INSTRUMENT S INC ARRA RESEARCH ASSOCIATES	12
ASSOCIATED RESEARCH INC ELECTRONICS DIV BALDWIN MAMILT	8
	5-6-7-8-9-18-41
BELL INC F W	4-9 9
BENSON LEHNER G B LTD B & F INSTRUMENTS INC	9
BIDDLE CD JAMES G BLACKBURN ELECTRONIC CORP	9 41
BON DE ELECTRONIC LABS INC BOONTON ELECTRONICS CORP	4-6-7-7-10
BODNTON RADIO CDRP BRUNO NEW YORK INDUST CORP	
BUI OUT HATCH OF FLOOD CONF	6-10-16
BULOVA WATCH CO ELECT DIV	10-15 40
BURNELL & CO INC	10-15 40
BURNELL & CO INC CALIF TECHNICAL INDUST DIV TEX CAMBRIDGE INSTRUMENT CO INC	10-15 40 40 TRON INC 6-8 4-7-9-18-19-40- 41
BURNELL & CO INC CALIF TECHNICAL INDUST DIV TEX CAMBRIDGE INSTRUMENT CO INC CANADIAN RESEARCH INSTITUTE CARMA MANUFACTURING CO	10-15 40 40 TRON INC 6-8 4-7-9-18-19-40- 41 8-9 5
BURNELL & CO INC CALIF TECHNICAL INDUST DIV TEX CAMBRIDGE INSTRUMENT CO INC CANADIAN RESEARCH INSTITUTE CARMA MANUFACTURING CO CENTRAL COIL CORP CENTRAY ELECT INST INC	10-15 40 40 TRON INC 6-8 4-7-9-18-19-40- 41 8-9
BURNELL & CO INC CALIF TECHNICAL INDUST DIV TEX CAMBRIDGE INSTRUMENT CO INC CANADIAN RESEARCH INSTITUTE	10-15 40 TRON INC 6-8 4-7-9-18-19-40- 41 8-9 5 9-18-19-40-41 12 2 4

CINEMA ENGINEERING DIV AEROVOX CORP	1-19-
CLAROSTAT MEG CO	40-41-41 41
CLEGG LABS DIV CLEGG INC CLOUGH BRENGLE CO	6 2-4-7-9
COAST COIL CO	40
CAMPAGNIE GENERALE DE METROLOGIE CHEMIN DE LA CROIX ROUGE BOX 30	6
COMPUTER ENGG ASSOC	6-7 1-9-14
CONSOLIDATED RESISTANCE CO DE AMERIC.	41
CONTROL INDICATING CORP CURTISS-WRIGHT CORP ELECTRONICS DIV	9-14
DATASCAN INC	4-8
DAVEN CO DAWE INSTRUMENTS LTD	19-41
DAYSTROM INCORPORATED WESTON INSTRUM	3
DECKER CDRP DIAMDND ANTENNA & MICRDWAVE CDRP	4 1
DICE CO J W DMETER MFG CD	9 1-9-18-41
DYNAMICS INST CC DYTRONICS CD	8-9-18 4-6-17
EALING CORP 1-6-9	-18-19-41
	-6-7-9-19 -9-13-18-
ELECTRONIC INSTRUMENT CO INC	19-41 4-9
ELECTRONIC MEASUREMENTS CDRP EPIC INC	4 4-7-9-41
EPPLEY LAB INC ERDCD ENGG CDRP	14-18
ESPEY MEG & ELECTRONICS CORP	7-9
FLUIDYNE ENG CORP	12
FIDELITY AMPLIFIER CD FLUIDYNE ENG CORP FLUKE MFG CO INC JOHN FREED TRANSFORMER CO	6 6-7-19-40
FURZEHILL LABS LTD GENERAL MICROWAVE CORP	4 3-10-15
GENERAL RADID CO 1-2-3-4-6-7-8-9-	10-16-17-
GERTSCH PRODUCTS IN.	1-2-6-13
GREINER CO EMIL	9-14-18
GULTON INDUSTRIES INC METUCHEN HEATH CD SUB OF DAYSTROM INC 4-6-7	4-9-11-18-
HELLIGE INC	19-41
HEWLETT PACKARD CD 1- HEYER INDUSTRIES INCORPORATED	-3-6-15-16 18
HOLLAND ELECTRONICS HOWELL INSTRUMENTS INC	10-16 14
INDIKON CD	4
INDUSTRIAL CONTROL CO INDUSTRIAL DEVELOPMENT LABS INC	4-9
INDUSTRIAL TEST EQUIPMENT CO INDUSTRIAL TRANSFORMER CDRP	13 7-11
INSTRON ENGG CORP JACKSON ELECTRICAL INSTRUMENT CO	12
JACKSON ELECTRICAL INSTRUMENT CO JARVIS ELECTRONICS CORP JONES ELECTRONIC CO INC	6-7-9 10-11
KAY ELECTRIC CD KEITHLEY INSTRUMENTS INC	1-41
KURTSTON ELECTRONICS	41
LABLINE INC LANGEVIN DIV OF SONOTEC INCORP	14-15
LEEDS & NORTHRUP CD 4-5-6-7-8-9-14 LEHIGH VALLEY ELECT ENGG & MFG CO	
LENION VALLET ELECT ENGO 6 MFO CO	15
LIQUIDDMETER CDRP N Y	15 4 4
LIQUIDMETER CORP N Y MACLEOD 6 HANDPOL MAGNETIC METALS CD MANSON LABORATORIES INC	15 4
MACLEOD & HANDPOL MAGNETIC METALS CD MANSDN LABORATORIES INC	15 4 4 7
AGLEOD & HANDPOL MAGLEOD & HANDPOL MAGNETIC METALS CD MANSON LABORATORIES INC MARCONI INSTRUMENTS	15 4 7 1 1-2-6-7-10 41 1-3-4-6-
LIGUIDUMETER CORP N Y MACLEOD & HANDPOL MAGNETIC METALS CD MANSON LABORATORIES INC MARCONI INSTRUMENTS MARMA ELECTRONICS CO	15 4 7 1 1-2-6-7-10 41
LIGUIDDMETER CORP N Y MACLEOD 6 HANDPOL MASDRTIC METALS CD MANSON LABORATORIES INC MARCONI INSTRUMENTS MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP	$ \begin{array}{r} 15 \\ 4 \\ 7 \\ 1 \\ 1 - 2 - 6 - 7 - 10 \\ 41 \\ 1 - 3 - 4 - 6 - \\ 7 - 10 \end{array} $
LIGUIDDMETER CORP N Y MACLEOD 6 HANDPOL MASDRTIC METALS CD MANSDN LABORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN MEG CO JAMES	15 4 7 1-2-6-7-10 41 1-3-4-6- 7-10 10-11-16 17
LIGUIDDMETER CORP N Y MACLEOD 6 HANDPOL MANSON LABORATORIES INC MANSON LABORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MIDLEN MEG CO JAMES MILLEN MEG CO JAMES MILLEN MEDUCTS INC MINCO PRODUCTS INC	$ \begin{array}{r} 15\\ 4\\ 7\\ 1-2-6-7-10\\ 41\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 17\\ 8-9-41\\ 6-11\\ 9\\ 14 \end{array} $
LIGUIDUMETER CORP N Y MACLEOD 6 HANDPOL MANSON LABORATORIES INC MANSON LABORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MIDLEN MEG CO JAMES MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINNEAPOLIS-HONEYWELL RUBICON DIV	$15 \\ 4 \\ 7 \\ 1 \\ 1 - 2 - 6 - 7 - 10 \\ 1 \\ 1 - 3 - 4 - 6 \\ - 7 - 10 \\ 10 - 11 - 16 \\ 17 \\ 8 - 9 - 41 \\ 6 - 11 \\ 9 \\ 14 \\ 8 - 9 - 13 - 14 - 18 - 41$
LIGUIDUMETER CORP N Y MACLEOD 6 HANDPOL MANSON LABORATORIES INC MANSON LABORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MIDLEN MEG CO JAMES MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINNEAPOLIS-HONEYWELL RUBICON DIV	$ \begin{array}{r} 15\\ 4\\ 7\\ 1-2-6-7-10\\ 41\\ 1-3-4-6-\\ 10-11-16\\ 17\\ 8-9-41\\ 6-11\\ 9\\ 14-18-41\\ 4-9-13-\\ 14-18-41\\ 6-1-19-40-41 \end{array} $
LIGUIDDMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MARNA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC MILLEN METALCRAFT INC MILLEN METALCRAFT INC MILLEN METALCRAFT INC MILLEN METALCRAFT INC MILLEN METALCRAFT INC MILLING INSTRUMENTS INC MINNEAPOLIS-HONEYWELL RUBICON DIV MODEL ENGS 6 MFG INC MUIRHEAD 6 CO LTD MUIRHEAD 6 CO LTD 1-4-7-9-10 MUIRHEAD INSTRUMENTS INC	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ 1-2-6-7-10\\ 10-11-16\\ 17\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 6\\ 3-19-40-41\\ 3-9-12-13-\\ 3-19-40-41\\ 3-19-40-41\\ \end{array}$
LIGUIDDMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MARNSDN LABORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINNEAPOLIS-HONEYWELL RUBICON DIV MODEL ENGG 6 MFG INC MUIRHEAD INSTRUMENTS INC 1-4-6-7-11 MUIRHEAD INSTRUMENTS INC 1-4-6-7-11 NEPTUNE ELECTRONICS CO NETWORK INDUSTRIES INC	$ \begin{array}{r} 15\\ 4\\ 7\\ 1-2-6-7-10\\ 11\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 17\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 6\\ 3-19-40-41\\ 6\\ 3-9-12-13-\\ \end{array} $
LIGUIDDMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MARNSDN LEGETRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MIDLEN METALCRAFT INC MILLEN METALCRAFT INC MILLEN METALCRAFT INC MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINNEAPOLIS-HONEYWELL RUBICON DIV MODEL ENGG 6 MEG INC MUIRHEAD 6 CO LTD MUIRHEAD 6 CO LTD MUIRHEAD INSTRUMENTS INC 1-4-7-9-11 MUIRHEAD INSTRUMENTS INC 1-4-7-0-11 NEPTUNE ELECTRONICS CO NETWORK INDUSTRIES INC METALSON	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ 1-2-6-7-10\\ 41\\ 1-3-4-6-\\ 10\\ 10-11-16\\ 17\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 3-19-40-41\\ 3-9-12-13-\\ 3-19-40-41\\ 19-40\end{array}$
LIGUIDUMETER CORP NT MACLEOD 6 HANDPOL MASDETIC METALS CO MANSDN LABORATORIES INC MARNSDN LABORATORIES INC MARMA ELECTRONICS CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN MFG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINREAPOLIS-HONEYWELL RUBICON DIV MODEL ENGG 6 MFG INC MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD INSTRUMENTS INC 1-4-6-7-4 IV MOREL ELECTRONICS CO NETWORK INDUSTRIES INC NETWORK INDUSTRIES INC NEW LONDON INST CD INC NORTH ATLANTIC INDUST INC NORTHEAST ELECT CORP	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ 1-2-6-7-10\\ 1\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 17\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 4-9-13-\\ 14-18-41\\ 6\\ 3-9-12-13-\\ 3-19-40-41\\ 19-41\\ 19-41\\ 12-13-40\\ 6\end{array}$
LIGUIDUMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MANSDN LEGTRANTICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MIDLEN METALCRAFT INC MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINCAPOLIS-HONEYWELL RUBICON DIV MODEL ENGS 6 MFG INC MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 SO LTD 1-4-7-9-11 MUIRHEAD 6 SO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 7 SINC 1000 NORTHATANTICS INC NETWORK INDUSTRIES INC NETWORK INDUSTRIES INC NORTHATLANTIC INDUST INC NORTHATLANTIC INDUST INC NORTHEAST ELECT CORP OMMITE MEG CO	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ 1\\ -2-6-7-10\\ 1\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 6\\ 3-9-2-13-\\ 14-18-41\\ 8-9-13-\\ 19-40-41\\ 19-41\\ 19-41\\ 19-41\\ 12-13-40\\ 6\\ 4\\ 1\\ 4-6-9-17- \end{array}$
LIGUIDUMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MANSDN LABORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN METALCRAFT INC MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINNEAPOLIS-HOMEYWELL RUBICON DIV MODEL ENGS 6 MFG INC MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD INSTRUMENTS INC 1-4-6-7-1 INEPTUNE ELECTRONICS CO NETWORK INDUSTRIES INC NET LANTIC INDUST INC NORTH ATLANTIC INDUST INC NORTHEAST ELECT CORP OHMITE MFG CO ORTHO PRECISION RESISTORS INC 1- PACO ELECTRONICS CO INC	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ 1\\ -2-6-7-10\\ 1\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 6\\ 3-9-2-13-\\ 14-18-41\\ 8-9-13-\\ 19-40-41\\ 19-41\\ 4\\ 12-13-40\\ 6\\ 1\\ 4-6-9-17-\\ 18-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-$
LIGUIDUMETER CORP NT MACLEOD 6 HANDPOL MASDETIC METALS CD MANSON LABORATORIES INC MANSON LABORATORIES INC MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN METALCRAFT INC MINCO PRODUCTS INC MINCO PRODUCTS INC MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 7 CO NOTH ATLANTIC INDUST INC NORTH ATLANTIC INDUST INC NORTHAST ELECT CORP OMMITE MEG CO ORTHO PRECISION RESISTORS INC 1- PACO ELECTRONICS CO INC POLYTECHNICS CD 9-1	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ -2-6-7-10\\ 11\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 6-11\\ 9\\ 14\\ 8-9-41\\ 14-18-41\\ 19-40-41\\ 19-40-41\\ 12-13-40\\ 6\\ 41\\ -4-6-9-17-\\ 18-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 20\\ -14-18-41\end{array}$
LIGUIDUMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MANSDN LEBORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCAPOLIS-HONEYWELL RUBICON DIV MODEL ENGS 6 MFG INC MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-6-7-1 INC MUIRHEAD 6 CO LTD 1-4-6-7-1 MUIRHEAD 1NSTRUMENTS INC 10 NETWORK INDUSTRIES INC NETWORK INDUSTRIES INC NORTH ATLANTIC INDUST INC NORTHATLANTIC INDUST INC NORTHATLANTIC INDUST INC NORTHATLANTIC INDUST INC POLYTECHNIC RESEARCH 6 DEVELOPMENT POLYTECHNICS CO 9-1 PRO ELECTRONICS INC 905THEOM METALCHITUS INC 2	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ 1-2-6-7-10\\ 41\\ 1-3-4-6-\\ 17\\ 10-11-16\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 19-40-41\\ 19-40-41\\ 12-13-40\\ 6\\ 1\\ 12-13-40\\ 6\\ 1\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-40-42\\ 1\\ 19-$
LIGUIDUMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CO MANSDN LABORATORIES INC MANSDN LABORATORIES INC MARMA ELECTRONICS CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN MFG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-6-7-4 10 MODEL ENGG 6 MFG INC MUIRHEAD INSTRUMENTS INC 14 MODEL ENGG 6 MFG INC MORTHE ELECTRONICS CO NETWORK INDUSTRIES INC NORTH ATLANTIC INDUST INC NORTHEAST ELECT CORP OMMITE MFG CO ORTHO PRECISION RESISTORS INC PACO ELECTRONICS CO INC POLYTECHNIC RESEARCH 6 DEVELOPMENT POLYTRONICS CD PROJECTS UNLIMITED INC 2	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ -2-6-7-10\\ 10\\ 10-11-16\\ 7-10\\ 10-11-16\\ 7\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 6\\ 3-19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 19-40-41\\ 20\\ 6\\ 1\\ -4-6-9-17-\\ 18-41\\ 19-40-41\\ 20\\ -3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-15\\ 3-1$
LIGUIDUMETER CORP NT MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MANSDN LECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCAPOLIS-HONEYWELL RUBICON DIV MODEL ENGG 6 MFG INC MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-7-9-11 MUIRHEAD 6 CO LTD 1-4-6-7-1 INEPTUNE ELECTRONICS CO NETWORK INDUSTRIES INC NORTH ATLANTIC INDUST INC NORTHA TLANTIC INDUST INC NORTHA TLANTIC INDUST INC NORTHA TLANTIC INDUST INC NORTHAST ELECT CORP OMMITE MFG CO ORTHO PRECISION RESISTORS INC 1- POLYTECHNICS CO POLYTECHNICS CO POLYTECHNICS INC POLYTECHNICS INC POLYTECNICS INC PRECISION METALSMITHS INC 2 PROJECTS UNLIMITED INC PULSE ENG INC OUANTATON INC	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ -2-6-7-10\\ 1\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 7\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 8-9-13-\\ 14-18-41\\ 3-9-12-13-\\ 3-19-40-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-$
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LIGUIDUMETER CORP NY MACLEOD 6 HANDPOL MAGNETIC METALS CD MANSON LABORATORIES INC MANSON LABORATORIES INC MARMA ELECTRONICS CO MERIDIAN METALCRAFT INC METAL SPECIALTY PRODUCTS CORP MID-EASTERN ELECTRONICS INC MID.EASTERN ELECTRONICS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MUTHEAD 6 CO LTD 1-4-7-9-11 MUTHEAD INSTRUMENTS INC MUTHEAD INSTRUMENTS INC MUTHEAD INSTRUMENTS INC MUTHEAD INSTRUMENTS INC NOTHEAS INC NOTH ALLANTIC INDUST INC NORTHEAS LECT CORP OHMITE MFG CO ORTHO PRECISION RESISTORS INC PACO ELECTRONICS CO INC POLYTECHNIC RESEARCH 6 DEVELOPMENT POLYTECHNIC RESEARCH 6 DEVELOPMENT POLYTECTRONICS INC PRECISION METALSMITHS INC 2 PROJECTS UNLIMITED INC PULSE ENG INC GUANTATRON INC RADAR MEASUREMENTS CDRP RCMANCO INC ROBDE 6 SCHWARZ 1-2-4-6-7-8-9-10 ROSEMOUNT ENG CO SENSITIVE RESCH INSTRUMENTS CORP SMALLCROSS WEG CO	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ -2-6-7-10\\ 10\\ 10-11-16\\ 7-10\\ 10-11-16\\ 7\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 4-9-13-\\ 14-18-41\\ 6\\ 3-9-13-14-18-41\\ 6\\ 3-9-13-12-13-\\ 3-19-40-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ -4-6-9-17-\\ 18-41\\ 19-40-41\\ 20\\ -4-6-9-17-\\ 18-41\\ 19-40-41\\ 20\\ -4-6-9-17-\\ 18-41\\ 19-40-41\\ 20\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40-41\\ 10\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-40\\ -17-19-19-10\\ -17-19-19-10\\ -17-19-10\\ -17-19-10\\ -17-19-10\\ -17-19-10\\ -17-19-10\\ -17-19-10\\ -17-19-10\\ -1$
LIGUIDUMETER CORP NY MACLEOD 6 HANDPOL MASDETIC METALS CD MANSDN LABORATORIES INC MANSDN LABORATORIES INC MARMA ELECTRONICS CO MEASUREMENTS DIV MC GRAW-EDISON CO MERIDIAN METALCRAFT INC MILLEN METALCRAFT INC MIDLEASTERN ELECTRONICS CORP MILLEN MEG CO JAMES MILLIVAC INSTRUMENTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MINCO PRODUCTS INC MUIRHEAD & CO LTD MUIRHEAD & CO LTD MUIRHEAD & CO LTD MUIRHEAD & CO LTD MUIRHEAD & CO LTD MORTH ATLANTIC INDUST INC NORTH ATLANTIC INDUST INC PACO ELECTRONICS CO INC POLYTECHNIC RESEARCH & DEVELOPMENT POLYTECHNIC RESEARCH & DEVELOPMENT POLYTECTNICS INC PRECISION METALSMITHS INC 2 PROJECTS UNLIMITED INC PULSE ENG INC QUANTATRON INC RADAR MEASUREMENTS CDRP ROF CORP REMANCO INC ROMED 6 SCHWARZ 1-2-4-6-7-8-9-10 ROSEMOUNT ENG CO	$\begin{array}{c} 15\\ 4\\ 7\\ 1\\ 1\\ -2-6-7-10\\ 1\\ 1-3-4-6-\\ 7-10\\ 10-11-16\\ 7\\ 8-9-41\\ 6-11\\ 9\\ 14\\ 8-9-13-\\ 14-18-41\\ 6\\ 3-9-12-13-\\ 19-40-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 19-41\\ 10\\ 10\\ 17-19-40-\\ 41\\ 9\\ 9-18\\ \end{array}$

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For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

SPECIAL INSTRUMENTS LABORATORY INCBSPERAUGUE ELECTRIC CONTROL CONTROL CONTROL CONTROLSPERAUGUE ELECTRIC CONTROL CONTROL CONTROL CONTROLSPRAUGUE ELECTRIC CON ADAMS4-19STDDDART AIRCRAFT RADIO CO1STDDDART AIRCRAFT RADIO CO1SYSTEMS INC4SYSTEMS INC1SYSTEMS INC1TECHNICAL LABS1-2-0-18TECHNICAL LABS1-2-0-18TECHNICAL LABS1-2-0-18THETA INSTRUMENT CORP14-18THETA INSTRUMENT CORP13TOROTRON CORP10UNIVERSAL TOROID COIL WINDING INC40UNIVERSAL TOROID COIL WINDING INC40UNIVERSAL TOROID COIL WINDING INC40WELCH SCIENTIFIC CO W M19-40-41WELCH SCIENTIFIC CO W M19-40-41WILTRON CO11GENERAL ELECTRIC WKS INC4 6-7-9-18-19-41GENERAL ELECTRIC WKS INC4 6-7-9-18-19-41GENERAL CONTROL CO14GENERAL RADIO CO14GENERAL RADIO CO14

COUNTING DEVICES Counters, directional Counters, electromognetic Counters, electronic Counters, electronic digital Counters, events-per-unit-time Counters, frequency Counters, geiger 7 Counters, impulse Counters, mechanical 8 9 Counters, photoelectric 10 Counters, preset 11 Counters, proportional 12 Counters, radiation 13 Counters, revolution 14

1

2

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4

5

6

 ABACUS INC
 1-3-4-6-16

 ACCURATE INSTRUMENT CO
 3

 AMERACINC
 6-9-14

 AMERACINC
 6-9-14

 AMERICAN ASTRO-SYSTEMS
 1-2-3-4-5-6-7-8-9

 IO-11-12-13-14-15-16
 10

 AMERICAN MISSILE PROD CO INC
 1-3-4-5-6-11

 ANADEX INSTRUMENTS INC
 4-5-6-6-11

 ANATON ELECTRONICS LABS
 3-7-11-12

 APPLIED DEVELOPMENT CORP
 3-4-8-16

 ASSOCIATED ELECTRICAL INDUSTRIES LTD
 3-4-10

 ATOMIC ACESSDRIES INC
 7-12-13-15-16

 AUTOMATIC TIMING & CONTROLS INC
 8-14

 AUTOMATIC NAMAGEMENT INC
 3-4-5-5-6-6

 AUTORON INC
 10

 ANTON KEG INC
 3-3-6-16

 BALLARD CO IRVING
 16

 BARKER & WILLIAMSON INC
 9

 BECKMAN INST INC BERKELEY DIV
 1-3-4-5-6-11-16

 BENSON LEHNER CORP
 1-3-10-14

 BECKMANN INST INC DERRELET OTV
 12-14-16

 BENSON LEHNER CORP
 1-3-10-14

 BIDDLE CO JAMES 6
 8-9-11

 BOWAR INSTRUMENT CORP
 1-2-8-9-14

 BOY-MAR ELECTRICAL SERVICE CO
 3-10

 BROWN ENG CO INC
 16

 CALCULAGRAPH CORP INC
 16

 CALCULAGRAPH CORP INC
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INDUSTRIAL CONTROL CO 8	SY
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INDUSTRIAL WINDING MACHINERY CORP 15 INSTRUMENT ELECTRONICS CORP 16	TE
INSTRUMENT MASTERS INC 4-8-9-10-17-20 INSTRUMENTS INC 2	TH
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IRWIN LABS INC 5. ITI ELECTRONICS INC 20	TR
JACKSON ELECTRICAL INSTRUMENT CD 16 JETRONIC INDUSTRIES 6-10-16-20-21	TR
JONES ELECTRONIC CO INC 18	TR
KEITHLEY INSTRUMENTS INC 10-16-17-22	VA VE
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LANDSVERK ELECTROMETER CO 1-17 LANSDALE ELECTROMETER CO 1-22	VO
LAVDIE LABS INC 6 LEEDS & NDRTHRUP CO 5-8-10-17	WA WA
LEYGHTON PAIGE CORP 4-12-17 LINK DIV GENERAL PRECISION INC 2:	WA WE
LUMEN INC 6-18	WE
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MARINE ELECTRIC CORP 3 MASTERCRAFT INSTRUMENT CD 4-8-17 MAXSON ELECTRONICS CORP N Y 11	YD
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MEASUREMENTS DIV MC GRAW-EDISDN CO 6-10-16- 17-20	Г
MEDISTOR INST CD 1-16 MELABS 6	
MERIDIAN METALCRAFT INC 6 MESUR MATIC ELECTRONICS CORP 16-17 METAL SPECIALTY PRODUCTS CDRP 6	
METER MAKERS INC 20	
METERS INC 4-8-10-17-20 METRONIX INC 16	
MICROWAVE ASSOCIATES INC 6 MID-EASTERN ELECTRONICS INC 1	
MILLEN MFG CO JAMES 6 MILLER CO M C 4-8-17-20-22	
MILLIVAC INSTRUMENTS INC 8-10-16-17-20 MINNEAPOLIS-HONEYWELL PRECISION METER DIV	
8-17 MINNEAPOLIS-HONEYWELL BROWN INST DIV 1	
MODEL ENGG 6 MFG INC 7-10-12-17-18-20 MOSELEY CO F L 17	
MOTOROLA COMMUNICATIONS & ELECT INC 6-17 MUIRHEAD INSTRUMENTS INC 11-16	
NEW LONDDN INST CO INC 6 NON LINEAR SYSTEMS INC 20-21	
NDRTH ATLANTIC INDUST INC 11-16-18-21 NORTHEAST ELECT CORP 16	L
NORTHERN RADIO MFG CO 6 NUCLEAR-CHICAGD CORP]	AD
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SAVOY ELECTRONICS INC	16.20
SCDPES CD INC SECD ELECTRONICS INC	16-20
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SHURITE METERS SIMMONDS PRECISION PRODUCTS INC	4-17
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WAVELINE INC WEIDNHOFF CORP WEIDCH SCIENTIFIC CO W M 4-10- WESTERN APPARATUS WILTRON CO WINTRONICS INC YDKDGAMA ELECTRIC WKS INC 11- ZACHARIAS ELECTRONICS CORP ZINN INSTRUMENTS METERS RF Ammeters, RF Meters, ditenuation	4-1 11-17-14 1 1 13-17-14 2 1 2 3 4
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WAVELINE INC WEIDNHOFF CORP WEICH SCIENTIFIC CO W M 4-10- WESTERN APPARATUS WILTRON CD WINTRONICS INC 11- ZACHARIAS ELECTRONICS CORP ZINN INSTRUMENTS	4-1 11-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 1
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AVELINE INC WEIDNHOFF CORP WEIDCH SCIENTIFIC CO W M 4-10- WESTERN APPARATUS WILTRON CO VINTRONICS INC YDKDGAWA ELECTRIC WKS INC 11- ZACHARIAS ELECTRONICS CORP ZINN INSTRUMENTS METERS. RF Ammeters, RF. Meters, distortion Meters, field strength Meters, field strength Meters, FM Deviation Meters, Grid dip Meters, Grid dip Meters, Grid dip Meters, RF frequency Meters, RF frequency Meters, RF frequency Meters, Stonding wave ratio Meters, Not Meters, Not Meters, volt Meters, wave Meters, wave Meters, wave Meters, wave Meters, Not INST INC AD-YU ELECTRONICS LAB INC AIRBORNE INSTRS LAB. DIV CUTLER HAMMER ALCD ELECTRONIC PRODUCTS INC AMERICAN ASTRO-SYSTEMS 1-2-3-4-5- MERICAN MACH & FOUNDRY CO AMERICAN MACH & FOUNDRY CO	4-1 11-17-11 11-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 1
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WAVELINE INC WEIDNHOFF CORP WEICH SCIENTIFIC CO W M 4-10- WESTERN APPARATUS WILTRON CD WINTRONICS INC 11- ZACHARIAS ELECTRONICS CORP ZINN INSTRUMENTS	4-1 11-17-11 11-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 13-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 11-17-11 1
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L	EMPIRE DEVICES PRODUCTS CORP	4
L.	ENGELHARD INDUSTRIES ENGERLAND INDUSTRIES INC	12
L	ENGERLAND INDUSTRIES INC	1
L	ENGINEERING ASSOCIATES 4-6-	
L.	FERRIS INDUSTRUMENT CORP	4
E.	FREQUENCY ENGG LABS	9-13
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	KAY ELECTRIC CO	12
	LAMPKIN LABS INC	5-9
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For Company Addresses, See Alphabetical Listing of Electronic Mirs.

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Meters, vibrating reed	25
Meters, vibration	26
Meters, X-ray intensity	27
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AD-YU ELECTRONICS LAB INC 6
AIRPAX ELECT INC SEMINOLE DIV 21
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ALWAC COMPUTER DIV EL-TRONICS INC 6
AMERAC INC 1
AMERICAN GYRO DIV TAMAR ELECT INC 22
ANNIS CO R B 4-10-20-23
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ATOMIC ACESSORIES INC 7-10-19
AUTOMATION DYNAMICS CORP 1-6
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BECKMAN INST INC BERKELEY DIV 10-12-20
BELL INC F W 3
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TRANSFORMERS	1000
Brighteners, TV tube	1
Transformers, antenna	
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Transformers II	
Transformers, audio	3
Transformers, autotransformer	4
Tronsformers, bias	5
	6
Transformers, current	
Transformers, filament	7
	8
Transformers, flyback	8
Transformers, 400 cycle	9
Transformers, HV	10
Transformers, instrument	11
Transformers, isolation	12
Transformers, microwave	13
	13
Transformers, modulation	14
Transformers, plate	15
Transformers, power	16
Transformers and tot	
Transformers, precision	
matched	17
T is	
Transformers, voltage	
dividing	18
Transformers, pulse	19
Transformers, RF-IF	20
Transformers, toroidal	21
Transformers transforme	
Transformers, transistor	22
Transformers, ultrasonic	23
Transformers, variable	24
Transformers, vibrator	25
Transformers voltage regulating	26
Transformer, velocity	27
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BTRONICS INC	1
CDC ELECTRONICS INC 2-3-4-5-6-7	-9-10-11-
12-14-15-16-17-19-20	-21-22-20
12-14-15-16-17-19-20- C ELECTRONICS INC 3-4-5-6-7-9-11-	12-14-16
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16-17-18-19-20	-21-22-20
CF ELECTRONICS DIV ACF INDUSTRIES IN	NC 13-
CME ELECTRIC CORP 4-7-9-10-11-12-	-19-21-20
CHE ELECTRIC LURP 4-7-9-10-11-12-	15-16-24-
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CRO ELECTRONIC PRODUCTS CO 1-2-3	-4-5-6-7-
CRO ELECTRONIC PRODUCTS CO 1-2-3	-4-5-6-7-
CRO ELECTRONIC PRODUCTS CO 1-2-3	-4-5-6-7-
CRO ELECTRONIC PRODUCTS CO 1-2-3	-4-5-6-7-
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CR0 ELECTRONIC PRODUCTS C0 1-2-3. 8-9-10-11-12-13-14-15. CR0MAG INC CR0 PRODUCTS C0 3-7-12-15. CR0 FRODUCTS C0 3-7-10-12-15. DC PRODUCTS DV OF MAGNETIC CONTROLS C TRANSFORMER CORP 4-7-10-12-15. DC PRODUCTS DV OF MAGNETIC CONTROLS DVANCE ROSS ELECT CORP CHICAGO DVANCE ROSS ELECT CORP CHICAGO DVANCE ROSS ELECT CORP BURLINGTON DVANCE CLECT INC SEMINOLE DIV IRPAX ELECTRONICS INC JRPAX ELECT INC SEMINOLE DIV IRPAX ELECTRONICS CO LADDIN ELECTRONICS CO LADDIN ELECTRONICS CO MERICAN CAPITRON OIV 7-9-10-12-14-15-16. MERICAN CAPITRON OIV 7-9-10-19 INCORPORATED 10-14-40 MP INCCAPTORATED 10-14-40 MP INCORPORATED 10-14-40 MOLERSON CONTROLS INC	22 -4-5-6-7-7- -16-17-11 -16-19-22 -16-24-22 -3-4-5- -23-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-
CR0 ELECTRONIC PRODUCTS C0 1-2-3: 8-9-10-11-12-13-14-15: CR0MAG INC CR0 PRODUCTS C0 3-7-12-15: C TRANSFORMER CORP 4-7-10-12-15: DC PRODUCTS DV OF MAGNETIC CONTROLS 7-9-10-11-12-14-15: DVANCE ROSS ELECT CORP CHICAGO DVANCE ROSS ELECT CORP CHICAGO DVANCE ROSS ELECT CORP CHICAGO DVANCE CROSS ELECT CORP BURLINGTON DVANCE DELECTRONICS INC 3-4-7-9-11-1 IRPAX ELECT INC SEMINOLE DIV IRPAX ELECTRONICS INC LADDIN ELECTRONICS DIV ALADDIN INDUS LLIS CHALMERS MERICAN MAGNETICS COP 3-4-5-6-7. RERICAN MAGNETICS COP 3-4-5-6-1. MERICAN MAGNETICS COP 3-4-5-6-1. MERICAN MAGNETICS COP 3-4-5-6-1. MERICAN MAGNETICS COP 3-4-5-6-1. MERICAN MISSILE PROD CO INC MP INCORPORATED MP INCORPORATED 10-14- MP INCORPORATES 10-14- MOERSON CONTROLS INC NOERSON CONTROLS INC NOERSON CONTROLS INC NOERSON CONTROLS INC	22 -4-5-6-7-7- -16-17-11 -16-19-22 -16-24-22 -3-4-5- -16-17-18- -23-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-25-25 -22
CR0 ELECTRONIC PRODUCTS C0 1-2-3: 8-9-10-11-12-13-14-15: CR0MAG INC 3-7-12-15: CR0PRODUCTS C0 3-7-12-15: CTRANSTORMER CORP 4-7-10-12-15: DC PRODUCTS DV OF MAGNETIC CONTROLS 7-9-10-11-12-14-15- DVANCE ROSS ELECT CORP CHICAGO 19-21-22: DVANCE ROSS ELECT CORP CHICAGO DVANCER COSS BLECT CORP BURLINGTON DVANCE ROSS ELECT CORP BURLINGTON DVANCED ELECTRONICS INC TRPAX ELECT INC SEMINOLE DIV IRPAX ELECT INC SEMINOLE DIV IRPAX ELECT NONICS DIV ALADDIN INDUS LLIS CMALMERS MERICAN ELECTRONICS CO 4-4-9-9-11-12 IRPAX ELECTRONICS CONSTRUCTION 3-4-5-9-5-7- IRPAX ELECTRONICS CONSTRUCTION 3-4-5-9-11-12 MERICAN ELECTRONICS CONSTRUCTION 3-4-5-9-10-14-15-16-16-16-16-16-16-16-16-16-16-16-16-16-	22 -4-5-6-7-7- -16-17-11 -16-19-22 -16-24-24 -3-4-5- -16-24-24 -3-4-5- -23-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22
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CRO ELECTRONIC PRODUCTS C0 1-2-3: 8-9-10-11-12-13-14-15: 2 CROMAG INC 3-7-12-15: CROMAG INC CO CRONDUCTS CO 3-7-12-15: DC PRODUCTS DV OF MAGNETIC CONTROLS 19-21-22: DVANCE ROSS ELECT CORP CHICAGO 19-21-22: DVANCE ROSS ELECT CORP CHICAGO DVANCE CORSON ELECT CORP BURLINGTON DVANCE DELECTRONICS INC 3-4-7-9-11-1 IRPAX ELECT ING SEMINOLE DIV IRPAX ELECTRONICS OL LADDIN ELECTRONICS DIV ALADDIN INDUS LLIS CHALMERS MERICAN ELECTRONICS CORP 3-4-5-6-7: IRPAX PRODUCTS CO 3-4-5-6-7: LLIS CHALMERS MERICAN ELECTRONICS CORP MERICAN ELECTRONICS CORP 3-4-5-6-7: MERICAN MISSILE PROD CO INC MP 10-14-15-16: MP INCORPORATED 10-14-14-15-16: MP INCORPORATES A KING NOBERSIN LAP INC NOBERSIN LAP INC NOBERSIN LAP INC NOBERSIN LAP INC NOBERSIN LAP INC NOBERSIN LAP INC NOBERSIN CONTROLS INC VKO MFG CO NNIS COR B VEX COLL TANASFORMER CORP 3-4-5-5 <	22 -4-5-6-7-7- -16-17-11 -16-19-22 -16-24-22 -3-4-5- -23-25-22 8-22 8-22 8-22 8-22 8-22 11-16 -3-4-5- 19-22 -22-55-22 4-7-16 19-22 -22-55-22 4-7-16-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-55-22 -22-5
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CRO ELECTRONIC PRODUCTS CO 1-2-3: 8-9-10-11-12-13-14-15: CROMAG INC CRO PRODUCTS CO 3-7-12-15: C TRANSFORMER CORP 4-7-10-12-15: DC PRODUCTS DV OF MAGNETIC CONTROLS 7-9-10-11-12-14-15- 19-21-22: DVANCE ROSS ELECT CORP CHICAGO DVANCER SOSS ELECT CORP CHICAGO DVANCER SOSS ELECT CORP CHICAGO DVANCER COSS ELECT CORP UNLINGTON DVANCE CROSS ELECT CORP UNLINGTON DVANCE ROSS ELECT CORP UNLINGTON DVANCE ROSS ELECT CORP UNLINGTON DVANCE ROSS ELECT CORP UNLINGTON DVANCE ROSS ELECT CORP UNLINGTON DVANCE RODUCTS CO LADDIN ELECTRONICS DIV ALADDIN INDUS LLIS CHALMERS MERICAN ELECTRONICS CORP 3-4-5-6-7: 12-14-15-16- MERICAN MISSILE PROD CO INC MP INCORPORATED 10-14- MPLINCTRORORATED 10-14- MPLINCTRORORATED 10-14- MPLINCTRORORATED 10-14- MDERSON CONTROLS INC NUSESON CONTROLS INC NUSESON CONTROLS INC NUSESON CONTROLS INC NUSE CO R PEX COLL TRANSFORMER CORP 3-4-5- SW CO RNOLD MAGNETICS CORP RATE ELECTRONICS INC RATE ELECTRONICS INC RATE ELECTONICS INC RATE ELECTONICS INC RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS INC RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS INC RATE ELECTONICS CORP RATE ELECTONICS INC RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS INC RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS INC RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS CORP RATE ELECTONICS ELECT RATE ELECTONICS ELECT	22 -4-5-6-7-7- -16-17-11 -16-19-22 -16-24-24 -3-4-5- -3-4-5- -23-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-22 -22-25-25-22 -22-25-25-22 -22-25-25-22 -22-25-25-22 -22-25-25-25-22 -22-25-25-25-22 -22-25-25-25-25-25-25-25-25-25-25-25-25-
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PRODUCTS & MANUFACTURERS

Test Equipment—Testers

Tools, Hand Transformers BERKSHIRE TRANSFORMER CORP 3-4-5-6-7-9-10-11-12-13-14-15-16-17-18-22-23-BETTER COIL & TRANSFORMER CORP 3-4-7-11-12 14-15-16-17-22-2 BLACKBURN ELECTRONIC CORP 6-9-16-19-20-2 25 BLACKBURN ELECTRONIC CORP 6-9-16-19-20-21 BOGART MFG CORP 13 BRAD THOMPSON INDUST INC 10 GRIGHT RADIO LABS INC 20 NROWN ENG CO INC 13 BUDD STANLEY CO 13 BULDVA WATCH CO ELECT DIV 3-6-9-19-20-21-22 RUNDY ELECTRONICS CORP 17-19 BURANC ELECTRONICS CO 17-19 BURNEL 6 CO INC 21 BURNDUGHS CORP ELECTRONIC INSTRS DIV 19 BUSH TRANSFORMER CORP 3-4-5-6-7-9-10-11-12 14-15-16-17-18-19-20-21-22-23 14-15-16-17-18-19-20-21-22-23 25-26 CADDELL-BURNS MFG CO 2-11-20 CALEDONIA ELECTRONICS 6 TRANSFORMER CORP 3-4-5-6-7-9-10-13-15-16-17-18-19-21-22-25-26 CALIF MAGNETIC CONTROL CORP 3-4-5-6-7-9-10-11-12-14-15-16-18-19-21-22-25-2 25-26 22-23-25 22-23-25 C 6 K CDMPONENTS INC COAST COIL CO 3-4-5-6-7-9-11-12-16-17-18-21 COHU ELECTRONICS INC KIM TEL DIV COIL COMPANY OF AMERICA 3-4-5-6-7-9-10-11-12-14-15-16-17-18-19-21-22-23-COLL ENGG 6 MFG CO 2-4-7-12-15-25-26 COLLCRAFT INC 19-20-21-22-24 COLIN CAMPBELL CO INC 2-3-4-5-6-7-9-10-11-12-14-15-16-17-18-19-21-22-23 COLLINS CORP G L 18 COLUMBIA RESEARCH LABS 24 COLUMBUS PROCESS CO 3-4-6-7-9-10-12-13-14-COMPONENTS FOR RESEARCH INC 7-10-12-15-16 COMMUNICATION ACCESSORIES CO 3-45-56-7-9-10-11-12-14-15-16-17-18-19-21- COMPUTER ENGG ASSOC 11-12 CONTINENTAL X RAY CORP 10-12-16 CORNELL-DUBILIER ELECTRIC CORP 19 CRESCENT ENGG & RESEARCH CO 24 CRITTENDEN TRANSFORMER WORKS 4-6-7-9-10-11-12-15-16 22 CROWN CONTROLS CORP 12-15-16 12-15-16 1-4-7-12 CYCLE TRANSFORMER CORP 3-4-5-7-9-10-12-15 DALE ELECTRONICS INC SIOUX DV 20-21-22 DAVSTROM INCORPORATED WESTON INSTRUMENTS DIV DECOURSEY ENGG LAB 11 DELTRON CO INC 21 DENTRON CO INC 21 OERO ELECTRONICS 1 DFVELOPMENT ELECT CORP 19 DEWITT DEVELOPMENT CO 4-12 OIATRON INC 3-4-5-6-7-9-12-14-15-17-18-19-20-21-22 IB-19-20-21-22 18-19-20-21-22 01ETZ DESIGN INC 3-4-5-6-7-9-12-14-15-17-18-19-20-21-22 DITTMORE FREIMUTH CORP 11 DJECO DIV DJORDJFVIC ENGG CD 2-9-13-16 DOMGAN ELECTRIC KFG CO 00 DORMEYER INDUSTRIFS ILL 7 OORMEYER INDUSTRIFS IND 4-7-12-16 DUGLAS MICROWAVE CO 13 DRESSER ELECT SIE DIV 11-12-21-22 DRESSER ELECT MST DIV 3-4-5-7-9-10-12-14 DRESSER ELECT MST OIV 3-4-5-7-9-10-14-15-16 15-16-17-18-17-21-22-23 0X RADIO PRODUCTS CO 21-22 21-22 EAGLE ELECTRIC MFG CO EASTERN SPECIALTY CO 6 EDGERTON GERMESHAUSEN 6 GRIER 10-19 EDKO ELECTRONICS ENGG CO 3-4-5-6-7-9-10-12-14-15-16-18-22-23-25 EDO CAMADA LTD 21 EISLER TRANSFORMER CO INC 3-4-6-7-9-10-11-12-16-24

ELECTRAMATIC INC

For Company Addresses, See Alphabetical Listing of Electronic Mirs.

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ELECTRAN MEG. CO.

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HUMPPHREY INC 24 HYPERION INC 7-9-10-11-2-16-19-22 I M MFG CO 1-2-3-4-6-7-12 INDUSTRIAL ELECTRONICS OF OMAHA INC 21 INDUSTRIAL ELECTRONICS OF OMAHA INC 21 INDUSTRIAL TRANSFORMER CORP 3-11-12-14-15- 16-17-18-21-22-25-26 JAMES ELECTRONIC INC 3-4-5-6-7-90-10-11-12- JAMES ELECTRONIC INC 3-4-5-6-7-90-10-11-12- 14-16-19-22-25 JETRONIC INDUSTRIES 19-20 JFD ELECTRONIC CORP 2-0-21-22 KAPITOL MAGNETIC CORP 2-0-21-22 KAPITOL MAGNETIC CORP 2-20-21-22 KAPITOL MAGNETIC CORP 2-20-21-22 KAPITOL MAGNETIC CORP 2-20-21-22 KAPITOL MAGNETIC CORP 23-24-25-27 KELL STROM TOOL CO INC ELECT DIV 11-21 KENYON TRANSFORMER CO 3-4-5-6-7-9-10-12 KENYON TRANSFORMER CO 3-4-5-6-7-9-10-12	PHILIPS ELECTRONIC INSTRUMENTS 10 POLYPHASE INSTRUMENT CO 3-6-7-9-10-11-12- 14-15-16-17-18-19-21-22-26 POWERTRAN CORP 3-4-5-6-7-9-10-12-15-16-23- POWERTRAN CORP 3-4-5-6-7-9-10-12-15-16-23- PROTECTION EQUIP CO INC MOPKINS 3-16 PULSE ENG INC 19-21 QUTRONIC TRANSFORMER CORP 3-4-5-7-9-10-11- 12-14-15-16-17-18-21-22-25-26 13 RADAR MEASUREMENTS CORP 13 RADIATION AT STANFORD 15-16 RADIO ENG LABS INC 3-7-10-16-21-22-25-26 RADIO ENG LABS INC 3-7-10-16-21-22-25-26 RADIO FREQUENCY CO 2D RAECO 15-16 RADIO FREQUENCY CO 2D RALWAY COMMUNICATIONS INC 21 RAMWR MFG CO 6-16-24-26 RADALL INC DOUGLAS 1-3-4-5-7-9-12-14-15-16 16-21-22-23-25 RATEL INC RAPEN INC 1-2-3-4-5-6-7-8-9-12-14-15-16-22
HUMPPHREY INC 24 HYPERION INC 7-9-10-11-12-16-19-22 I M MFG CO 1-2-3-4-6-7-12 INDUSTRIAL ELECTRONICS OF OMAHA INC 21 INDUSTRIAL ELECTRONICS OF OMAHA INC 21 INDUSTRIAL ELECTRONICS OF OMAHA INC 21 INDUSTRIAL TRANSFORMER CORP 3-11-12-14-15- 16-17-18-21-22-25-26 JAMES ELECTRONIC INC JAMES ELECTRONIC INC 3-4-5-6-7-9-10-11-12- JETRONIC INDUSTRIES 19-2C JFD ELECTRONIC CORP 19-2C JOHNSON ELECTRONIC SINC 2-20-21-22 KAPITOL MAGNETIC CORP 2-9-4-5-6-7-9-10-11- 12-13-14-15-16-17-18-19-21-22-25-27 23-24-25-27 KELL STROM TOOL CO INC ELECT DIV 11-21 KELL STROM TOOL CO INC ELECT DIV 11-21 KENYON TRANSFORMER CO 3-4-5-6-7-9-10-12-12- 15-16-17-18-19-21-22-23-24-25 27 KELSTROM TOOL CO INC ELECT DIV 11-21 KENYON TRANSFORMER CO 3-4-5-6-7-9-10-12-14- 15-16-17-18-19-21-22-23-24-25-27 15-16-17-18-19-21-22-23-24-25-27	PHILIPS ELECTRONIC INSTRUMENTS 10 POLYPHASE INSTRUMENT CO 3-6-7-9-10-11-12- 14-15-16-17-18-19-21-22-26 POWERTRAN CORP 3-4-5-6-7-9-10-12-15-16-23- 25 PORTECTION EQUIP CO INC MOPKINS 3-16 PULSE ENG INC 19-21 QUTRONIC TRANSFORMER CORP 3-4-5-7-9-10-11- 12-14-15-16-17-18-21-22-25-26 RADAR MEASUREMENTS CORP 13 RADIATION AT STANFORD 15-16 RADIO FREQUENCY CO 20 RAECO 3-7-10-16-21-24-26 RAMYR MEG CO 6-16-24-26 RAMVR MEG CO 6-16-24-26 RAMVR MEG CO 6-16-24-26 RANDALL INC DOUGLAS 1-3-4-5-7-9-12-14-15-16-22 RATEL INC 2-3-20-22 RATHEON COMPANY INDUSTRIAL OPERATION 26 RATHEON COMPANY INDUSTRIAL OPERATION 20
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Tubing, non-metallic	18
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ACCURATE SPECIALTIES CO INC 2	-4-7-		
	15-1	6-17-	-20
ACME NEWPORT STEEL CO		13-	-17
ACOUSTICA ASSOCIATES			20
ADAM METAL SUPPLY INC		7-14-	-22
AIR REDUCTION SALES CO REDUCTION	CO		20
ALAN WOOD STEEL CO		13-	-17
ALLIED CHEMICAL DIV GENERAL CHEM	CORP		10-
		16.	-17
ALL-STATE WELDING ALLOYS CO			20
AMERICAN BRASS CO		17	-22

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AMERICAN METAL CLIMAX INC 10-14-17 AMERICAN PERFIT CRYSTAL CORP 11 IMERICAN SILVER CO 6 MMERICAN TUBE RENNING CO 22 NACONDA ALUMINUM CO 7 3ACHE & CO SEMON 18 BETHLEMEM STEEL CO 13-17-22 SIRNBACH RADIO CO 18 SREZEZ CORPS 22 CARLSTEDT RESEARCH INC 17 TENTRALAB DIV GLOBE UNION 18 LENTRAL SCIENTIFIC CO OF CANADA LTO 14	FLEXAUST CD 22 FLEXROCK CD 19. GENERAL ELECTRIC CO CLEVELAO 2-4-17 GENERAL ELECT CO METALLURIGICAL PROD 21	
AMERICAN PERFIT CRYSTAL CORP 11	FLEXPOCK CO	PENCO DIV ALAN WOOD STELL CO 17
MERICAN SILVER CD	GENERAL ELECTRIC CO CLEVELAD	PHELPS DODGE COPPER PRODUCTS CORP 1-10-14-
MERICAN TURE BENDING CD	GENERAL ELECTRIC CO CLEVELAD 2-4-17	22
NACONDA ALUMINUM CO	GENERAL ELECT CO METALLURIGICAL PROD 21	P M DIV CRANE CO 8-13-14-16
SARCOCK & WILCOX CO	GOODRICH AVIATION PRODUCTS DIV B F GOODRICH	RADIUM CHEMICAL CO
ACHE & CD SEMON	HAMILTON WATCH CO SUSCE DIN	P M DIV CRANE CO 8-13-14-16 RADIUM CHEMICAL CO 16 RAY PROOF CORP 7-14
RETHLENEN STEEL CO	HAMILTON WATCH CO ELECT DIV 8-13-14	REPUBLIC FOIL & METAL MILLS INC
	HANDY & HARMAN 7-15-16-17-18-20	RESEARCH CHEMICALS
	HARMON LICHTENSTEIN & CD 14	RESISTOFLEX CORP
APLICTEDT DESEADOU INC	HARVEY ALUMINUM 14-16	RIMAK ELECT INC
TARESTEDT RESEARCH INC 17	HERCULES CHEMICAL CO INC' 20	RODNEY METALS INC
LATRALAD DIV GLUBE UNION 18	HUDSON TOOL & DIE CO	SEMCOM
ENTRAL SCIENTIFIC CO OF CANADA LTO 14	ILLUMITRONIC ENGG CO	SEMICON ASSOCIATES INC.
RONSON METALS CORP CERIUM METALS & ALLOYS DI	INTERNATIONAL NICKEL CO. R-14-17-22	SEYMOUR MEG CO
14	IDDEE PLASTIC INC	SHIFLDALLOV CORD 1-13-14-17
HROMALLOY CORP 14	JOHNS MANUTLE NEUVORK	REPUBLIC FOIL 6 METAL MILLS INC 7-14 REFUBLIC FOIL 6 METAL MILLS INC 7 RESISTOFLEX CORP 16 RESISTOFLEX CORP 16 RIMAK ELECT INC 17 RODNEY METALS INC 6-7 SEWCON 17 SEWTCON ASSOCIATES INC 2-3-4-5 SEVMOUR WFG CO 1-13-14-17 SHIELDALLOY CORP 1-13-14-17
HROMALLOY CORP 14 LEVELAND CONTAINER CO 18 OULONIAL ALLOYS CO 17	JONESVILLE PAPER TUBE CORP.	S RIVER METAL PRODUCTS CO 22 SUN ENG INC DF ST PETERSBURG 17 SUPREMANT MFG CO 18
OLONIAL ALLOYS CO 17	KAVECKI CHEWICAL CO	SUPPENANT MEG CO
ONSOLIDATED MINING SMELTING OF CANADA LTD	KENT LIGHTING CORP	TELECRAPH CONSTRUCTION & MANAGEMENT
ORNING GLASS WORKS ELECTRICAL PRODUCTS DIV	HAMILTON WATCH CO ELECT DIV 8-13-14 HANDY & HARMAN 7-15-16-17-18-20 HARWON LICHTENSTEIN & CD 14 HARVEY ALUMINUM 14-16 HERCULES CHEMICAL CO INC' 20 HUDSON TOOL & DIE CO 17 ILLUMITRONIC ENGE CO 18 INTERNATIONAL NICKEL CO 8-14-17-22 JOBEE PLASTIC INC 18 JOMES MANVILE NEWYORK 18 JOMESVILL PAPER TUBE CORP 18 KAWECKI CHEMICAL CO 0-3 KENT LIGHTING CORP 17 LETRONICS INC 17 LETRONICS INC 2-3-4-7-8-9-10-13-14-15-16-	TELEGRAPH CONSTRUCTION & MAINTENANCE CO LTD
10	LEETPONICE INC	14-17-18 14-17-18
10 10 RVGIBLE STEEL CO OF AMERICA 13-18 DEMUTH GLASS WORKS INC 18 DUNTON CC MW 20 DU PONT DE NEMOURS & CO E I 16 AGLE-PICHER CC AMERICAN BLDG 14 NGLD CORP 18	"ACKAY INC A D 2-3-4-7-8-9-10-13-14-15-16-	TITAN METAL MEG CO DIV CERRO DE PASCO CORP
NUCIDLE STEEL CO OF AMERICA 12-19		
EMUTH GLASS WORKS INC	17-20-21-22-1	U S GRAPHITE CO DIV WICKLES CORP 17-21
UNTON CO MW 20	HIGH SHO CO	UNIFORM TUBES INC 18 UNION CARBIDE METALS CO 2-3-14
U PONT DE NEMOURS & CO F T	MICA FAR CO 18	UNION CARBIDE METALS CO 2-3-14
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NGLO CORP	MODRE CO HOWARD J 18	20-22
		UNITED STATES GASKET CO 19
	18-22	UNITED STATES GASKET CO VAR-LAC-DID CHEMICAL CO 2-3-4-7-8-9-10-13-
ARADAY INC	NATIONAL CARBON CO DIV UNION CARBIDE CORP	14-15-16-20-21
EDERAL TOOL & MES CO	21	WAIMET ALLOYS CO 8-13-14-16-21 WALLINGFORD STEEL CO 13
MERICAN SAFETING REEINING CO	NEW JERSEY WOOD FINISHING CO 18	WALLINGFORD STEEL CO
FEDERATED WETALS DIV	OHIO SEAMLESS TUBE DIV COPPERWELD STEEL CO	WHITEHEAD METALS INC 1-7-8-13-14-15-17-18-
IBEE GLASS EVERCOAT CO	22	20-22
19	PARKER VETAL GOODS CO 22	ZIRCONIUM CORP OF AMER 20-22 14-17
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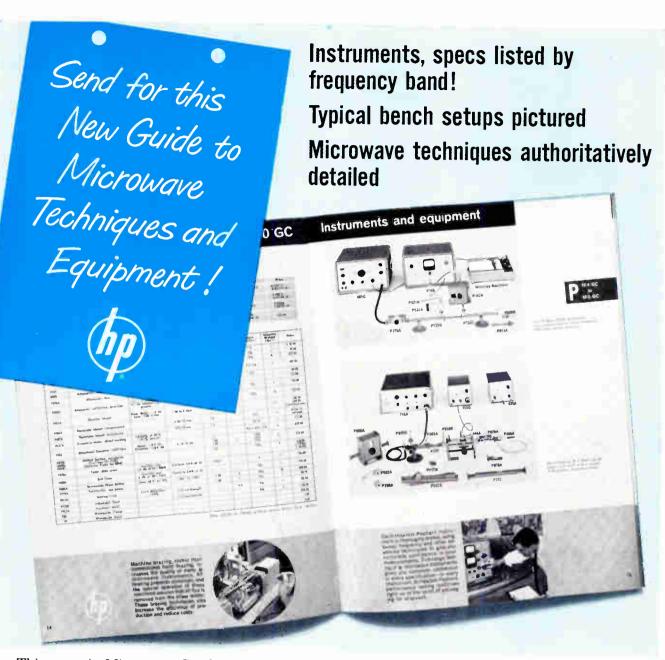
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