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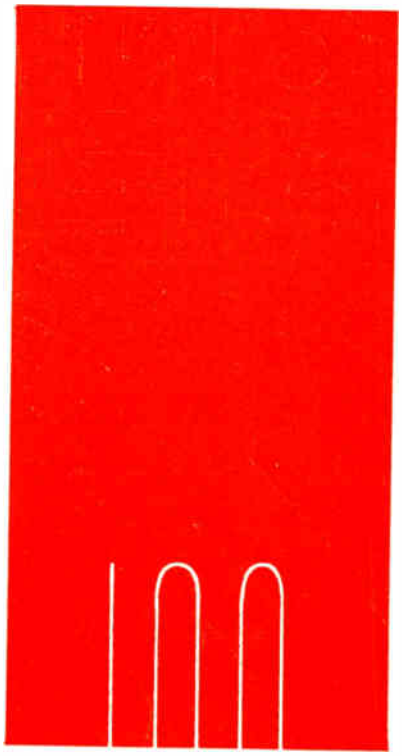

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FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

ELECTRONIC INDUSTRIES
& TELE-TECH

Vol. 16, No. 4 **April, 1957**

FRONT COVER: This year the Institute of Rodio Engineers Annual Show moves into a brand new home, New York's sparkling new Coliseum. Visitors to the show will find themselves in the heart of down town New York City, close by hundreds of other activities that should add a great deal of color to the proceedings. For details on the show and the technical sessions that will be held during the week, turn to page 61.

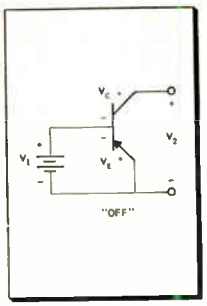
MONTHLY NEWS ROUND-UP

NEW ELECTRONIC EQUIPMENT

DEPARTMENTS

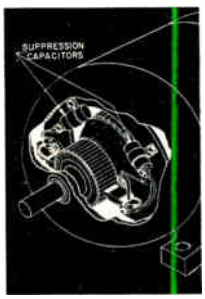
BPA NBP

The Real Transistor 52



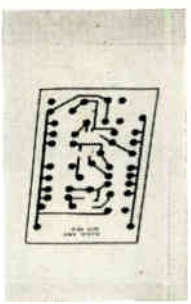
Transistors have been treated until now only on a theoretical and mathematical basis. Here is a practical explanation of them as physical components.

Marine Interference 56



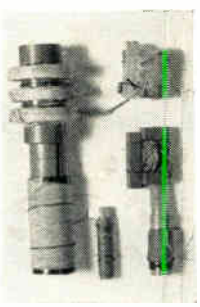
The military finds that altogether too much effort is going into filtering of marine equipment. Here are their recommendations for adequate, economical filtering.

$100 Printed Circuit 72



Labs and small volume printed circuit producers can set up "printing" operations for less than $100 using the "Ozalid" method.

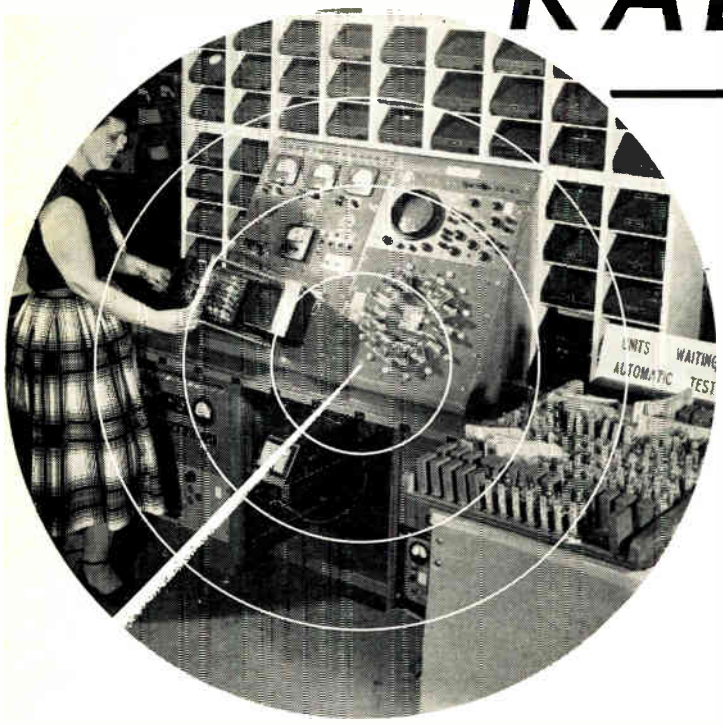
New Look At Inductors 78



For the first time the inductor losses are treated separately. Iron loss is examined and found negligible compared with "insertion loss."

ELECTRONIC INDUSTRIES & Tele-Tech, Apr., 1957, Vol. 16, No. 4. A monthly publication of Chilton Co. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila., Pa. Accepted as controlled circulation publication at Phila., Pa. 75¢ a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $5.00; 2 yrs. $8.00; 3 yrs. $10.00. Canada 1 yr. $7.00; 2 yrs. $11.00; 3 yrs. $14.00. All other countries 1 yr. $10.00; 2 yrs. $16.00.

RADARSCOPE



AUTOMATIC TESTING

This elaborate test panel at Westinghouse's Air Arm Div. runs complete dynamic tests on complex equipment in a matter of seconds. For more details, see page 55.

THE AIRCRAFT INDUSTRY is plowing back 65% of their earnings into research and development programs. This figure is higher than that of any other industry and is necessary because of the startling advances in aviation technology which are being made under the pressure of military necessity.

THE ENGINEER SHORTAGE is "greatly overrated," says Dr. Frederick E. Terman, of Stanford University School of Engineering. He cited figures from the National Science Foundation that about 25% of college graduates went into engineering or the sciences. Dr. Terman agreed that there are shortages of engineers, but, he pointed out, there are shortages in other fields, too. Many engineers have left to go into sales, service, and administrative positions and that their loss is naturally being felt.

TRANSISTOR MANUFACTURERS are looking to the automotive industry as a tremendous potential market. Electronic ignition using transistors is already on the way, and fuel injection units designed by Bendix and using five transistors are being introduced this spring in the Nash Rambler. The next target is a transistorized voltage regulator. Transistor powered electronic clocks for cars, busses and planes are just around the corner and transistorized electronic controlled traffic lights is another almost certain development.

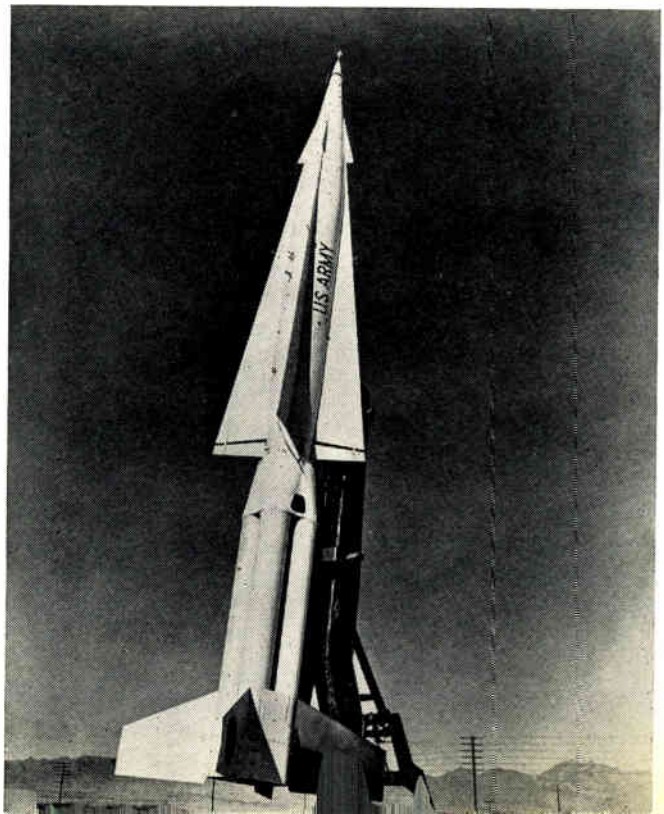
STEREOSCOPIC TELEVISION is finding application in nuclear research where ordinary closed-circuit television makes it difficult for the operator to judge the distance of remote manipulating equipment used to handle dangerous radio-active materials.

THE SELENIUM SHORTAGE has lessened to the point where certain selenium commodities are available for export. The Bureau of Foreign Commerce reports a supplementary quota of 10,000 lbs. (selenium content) has been established by the first quarter, and a total of 30,000 lbs. (selenium content) for the second quarter.

ENGINEER RECRUITING comes into its own as a full fledged exposition on June 8 to 12 in Chicago. The "Technical Personnel Recruiting Exposition" to be presented in conjunction with the National Technical Carrer Conference will feature exhibits by leading research and manufacturing organizations, and panel discussions to provide registrants with a yardstick to measure their professional progress. A preview of this show says "more information will be available at this exposition about the job and the company behind it than has ever been given to prospective technical employees."

ATOMIC-AGE NIKE

NIKE-Hercules, newest version of the NIKE, has many times the destructive power and is much faster than the original. It will reportedly carry nuclear heads.



Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation

GENERAL PRICE INCREASE seems imminent. Fiscal statements of the top firms in the industry all show the same trend—sales are up, but profits are down, compared with 1955. Industry officials seem to agree that a general 10% increase in prices will be in force by the end of 1957.

A PESSIMISTIC NOTE was sounded by Tung-Sol Electric Co. in announcing that they are discontinuing for the present all further activities in color TV picture tubes.

MANUFACTURING

THE TV OUTLOOK, as the first quarter of 1957 ends, is not bright. The low-cost portable TV set which had given the industry such a shot in the arm in 1956 has now become the last line of resistance for the manufacturer. The warehouses are bulging with more than 2,000,000 unsold TV's. The profit margins have been shaved to the point where TV manufacturing has become unprofitable to all but the largest manufacturers. Throughout the industry, groups of company executives are being harassed by exasperated stockholders who can not or will not face the fact that TV sales have reached a temporary saturation. Completely impossible situations seemed to be in the making, as the manufacturers on the one hand insist that TV receiver prices must be raised 10% and on the other hand dealers are refusing to accept any but the low-priced portable models because the public has become accustomed to the $100 price and refuses to go any higher. There is only one solution—prices must be raised.

LABOR RELATIONS

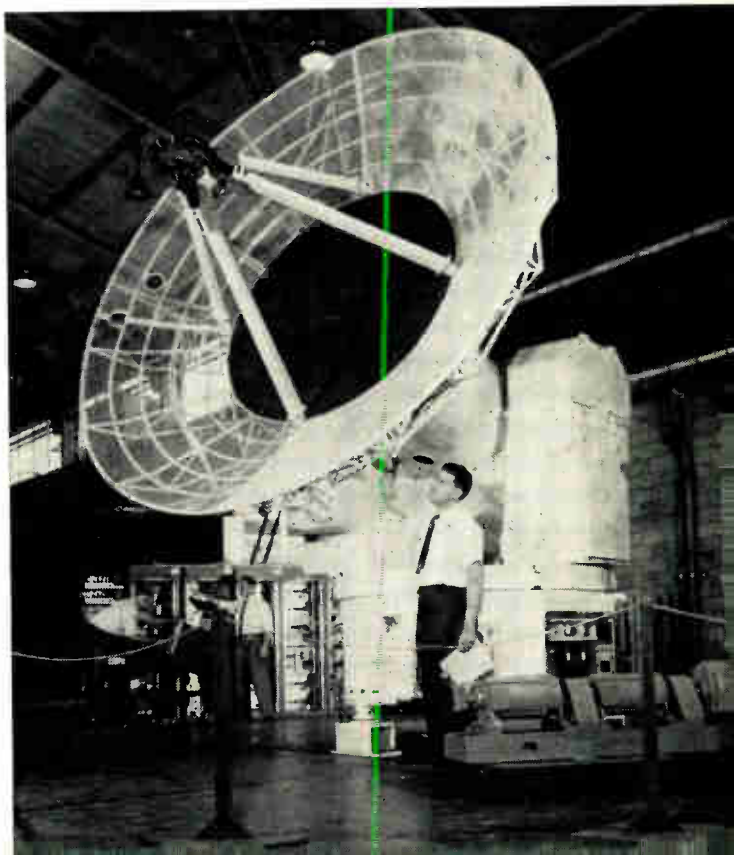
SERIOUS CLASH seems inevitable between the IUE, representing workers in the radio-TV industry and the radio-television manufacturers. As the manufacturers pulled in their belts to weather the most serious setback they have encountered in the post-war years, the union was announcing their intention to ask for a guaranteed annual wage and a shorter work week in the radio-TV industry. The suggestion for a shorter work week came after a report to the conference that the productivity in the industry had soared in the last few years. The union also warned manufacturers who were planning out-of-the-country operations in cheaper labor markets, notably Puerto Rico, that they could expect to deal with organized labor in those areas as well. The IUE, they said, already has organizers in Puerto Rico where several large electronics manufacturers have recently set up plants. These organizers have been able to raise wages substantially in a number of plants on the island.

COMMUNICATIONS

AT THE N.A.R.T.B. SHOW a great deal of interest will be shown in a paper to be presented on the single side band system by Leonard R. Kahn of Kahn Research Laboratories, Freeport, New York. Mr. Kahn will be explaining his compatible single side band system to the broadcasters, after having had remarkable success in taking his case to the military and air lines. Mr. Kahn has already had some success in applying the system to the Voice of America broadcast. Arinc has already stated flatly that the compatible single side band system will eventually be adopted for all air navigation communication. At a meeting in Washington of the Aircraft Electronics Engineering Committee of Aeronautical Radio, three competing systems were examined—Kahn's, Collins, and General Electric. The Kahn system was adopted mainly because of its compatibility, an extremely important feature to the airlines. Following its adaption by Arinc, the Kahn system was purchased from the Kahn organization by Kaiser Aircraft & Electronics Corp., an affiliate of Kaiser Industries Corp. Kaiser now has full rights for manufacturing and sale of this system to military and owns the necessary patents.

TRACKING GUIDED MISSILES

Instrumentation radar system developed by RCA makes possible for the first time direct calibration and immediate evaluation of the performance and behavior pattern of guided missiles. Designated the AN/FPS-16, is now in production for the Army, Navy and A. F.



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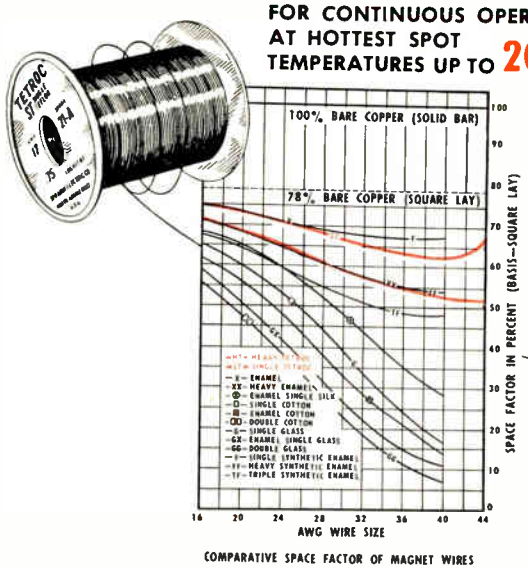
HIGH-TEMPERATURE MAGNET WIRES

FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO **200°C**



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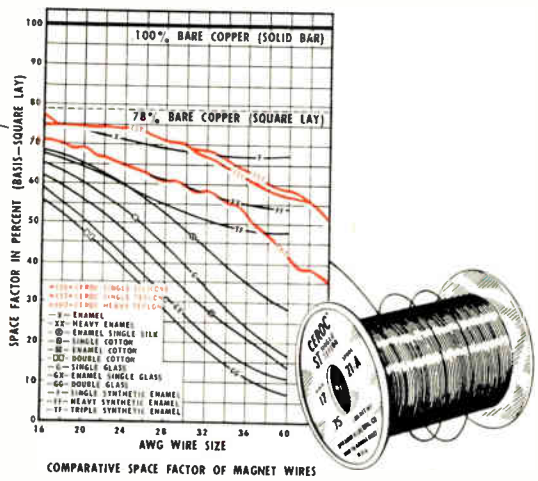
FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO **250°C**



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TETROC is recommended for continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time. Tetroc, a teflon-insulated wire is available in both single and heavy coatings.

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Both Tetroc and Ceroc Magnet Wires provide extremely high space factors.

FOR COMPLETE DATA WRITE FOR ENGINEERING BULLETIN 405 (TETROC WIRES) 400A (CEROC WIRES).

SPRAGUE ELECTRIC COMPANY • 233 MARSHALL ST. • NORTH ADAMS, MASS.

As We Go To Press . . .

Atomic Heads For New NIKE Missile

An improved version of the NIKE guided missile, recently designated as Nike Hercules, with many times the destructive power of the original Nike, is undergoing final tests at White Sands.

Although longer, heavier and more than double the diameter of Nike Ajax, the Hercules model will have extreme maneuverability at altitudes far in excess of those capable of being reached by Ajax. Its higher velocity will permit swifter interception of the most advanced types of aircraft and its increased lethality will make Nike Hercules one of the most effective weapons in America's defense arsenal.

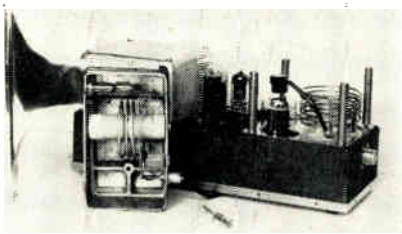
According to a special announcement by Secretary of Defense Charles E. Wilson, nuclear capability will be incorporated into the Nike Hercules surface-to-air guided missile system.

The ground guidance and control equipment and missile guidance are being manufactured by the Western Electric Company at its Burlington and Winston-Salem plants in North Carolina.

Miniature Computer

The first model of a general-purpose, all-transistor digital computer, the CP-266, has been produced and delivered to the U. S. Air Force Rome Air Development Center. The rugged 200 pound unit requires no installation or set-up time, features self-refrigeration, etched-circuit plug-in boards, self-contained test console and self-checking circuits. The unit is a product of Autonetics, a division of North American Aviation.

WIDE-RANGE ULTRASONICS



This is the new Ionovac speaker. The tiny quartz cell shown beside the speaker generates a pulsating ionic cloud which replaces the diaphragm of ordinary speakers. The unit is being developed primarily for the range 1 kc to 1 mc, and is not limited to a single frequency as are most conventional ultrasonic transducers. Ionovac was recently placed in production by Dukane Corp., St. Charles, Ill.

Storm R-F to Aid Propagation Studies

Scientists plan to use nature-operated broadcasting stations during the International Geophysical Year (IGY) to learn more about radio interference and how radio waves travel through the atmosphere. They will record radio signals sent out by some 50,000 thunderstorms that occur daily on earth.

NBS Boulder Laboratories have designed special radio noise recording equipment for the study. These atmospheric noise recorders, operating continuously, will chart the intensity and behavior of thunderstorm signals broadcast at 15 kc to 20 mc.

Some interfering noises made by man will also be recorded and studied. Mostly, however, the scientists will try to choose sites as far removed from the din of man and machines as possible. One station is being installed at Marie Byrd Base in the Antarctic which is about as far as it is earthly possible to get from the belt of high thunderstorm activity around the equator. Here information will be gained on how radio waves travel long distances through the atmosphere.

FCC Orders 4 Areas To Use UHF-TV Only

The FCC took the first step last month toward alleviating the financial troubles of the UHF TV stations. The Commission ordered all television broadcasting in four areas — Albany, Schenectady-Troy, N. Y.; Elmira, N. Y.; Springfield, Ill. and Peoria, Ill. — to be confined to the UHF band. At the same time the Commission moved to switch broadcasting in St. Louis predominantly to the very-high-frequency band.

Only two stations will be required to change. General Electric's station WRGB, Schenectady, N. Y., has been directed by the Commission to show cause why it should not change from its present Channel 6 to Channel 47. First reports said that a WRGB spokesman had called the decision "obviously not in the public interest" and that GE would contest the decision.

In St. Louis station KTVI will be switched temporarily from Channel 36 to Channel 2, pending the outcome of FCC proceedings on applications for "regular operation" of a TV station on Channel 2.

The decision also affected two other stations, authorized but not yet constructed. Station WIRL-TV, Peoria, which had been temporarily assigned Channel 8, and WMAY-TV which had been assigned Channel 2 in Springfield. Both will be given UHF channels.

Army Builds Solar Furnace

Solar energy will be used to produce exceedingly high temperatures at the Army Quartermaster Center, Natick, Massachusetts. The system will be used to test protective equipment for military personnel and equipment. The giant reflecting mirror will automatically track the sun.

MORE NEWS ON PAGE 8

ELECTRONIC INDUSTRIES
& Tele-Tech

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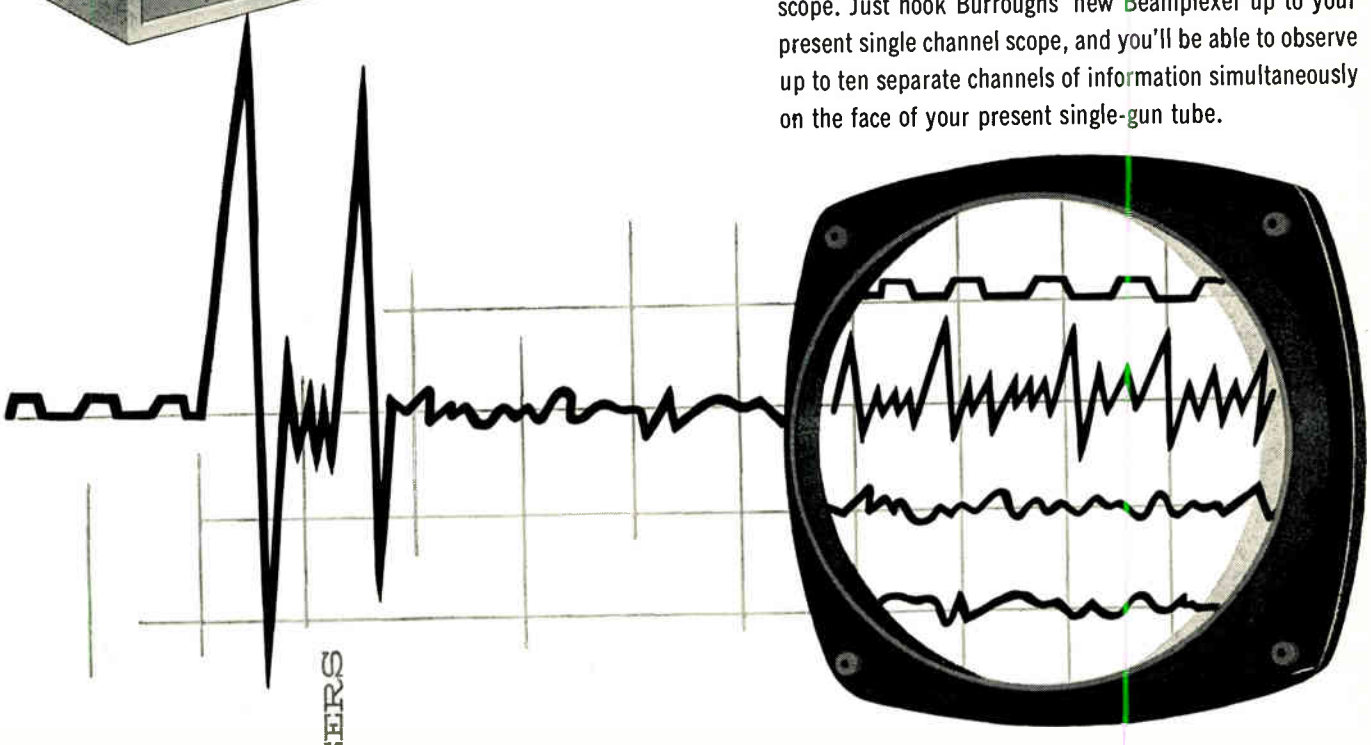
NEW BURROUGHS BEAMPLEXER

displays up to 10 separate signals on a single-channel scope simultaneously

Now you can have the advantages of multi-channel oscillography at a fraction of the cost of a multi-channel oscilloscope. Just hook Burroughs' new Beamplexer up to your present single channel scope, and you'll be able to observe up to ten separate channels of information simultaneously on the face of your present single-gun tube.



TOOLS FOR ENGINEERS

The Beamplexer is actually a fast electronic switch. Its heart is the Burroughs Beam Switching Tube which acts as a gate, picking the ten parallel input signals off in sequence, at adjustable speeds ranging from push button to 100 kc, and putting them out on one line. Each signal can be located on the scope as desired, and even superimposed on one another through individual positioning pedestal controls for each channel. Other controls include separate amplification for each channel.

Power consumption is 120 volts a-c, 60 cps, single phase, 0.73 amps, with the entire unit self-contained for cabinet or standard relay rack mounting.

Full details on how the Beamplexer can make your scope more useful . . . make your time more efficient . . . are given in Technical Bulletin 346 available for the asking. Write for your copy.

Burroughs

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Circle 4 on Inquiry Card. page 97

TASO Begins Study Of TV Allocations

The important Television Allocations Study Organization (TASO) has begun functioning with Dr. George R. Town serving as Executive Director. Dr. Town is on leave of absence from Iowa State College where he is Associate Director of the Engineering Experiment Station. He was formerly Manager of Engineering and Research at Stromberg-Carlson and is a Fellow of the IRE and AIEE.

The formation of TASO resulted from a request by the FCC in September, 1956, to five major elements of the television industry to cooperate in conducting a study program into the technical aspects of UHF and VHF TV broadcasting. Together, the parent organizations of TASO represent every phase of the TV industry in this country — VHF and UHF stations, stations in both large and small markets, the educational broadcasters, and the manufacturers.

Five technical panels have already been formed to begin the work of TASO: Transmitting Equipment, Receiving Equipment, Field Tests, Propagation Data, and Analysis and Theory.

In an exclusive report to ELECTRONIC INDUSTRIES on the present status of TASO, Dr. Town emphasized that,

"It is our sincere wish that any representative of a broadcast station or a television manufacturing company, whether or not his employer is a member of one of the parent organizations of TASO, shall notify us of his interest and capabilities so that we may truly represent the industry as a whole. We might add that tentative lists as of this date already include such representation, and we are anxious that this industry-wide participation shall continue. The only qualifications for membership are technical competence, plus the desire and time to serve on the panels."

MORE NEWS ON PAGE 12

ELECTRONIC SHORTS

Air pollution experts will welcome the news from Hanford atomic plant that dirt-free, sootless, smogless heating may result from atomic heating. Use of reactor waste heat has been proved technically feasible in the Hanford buildings. Unlike many development projects, the Hanford installation has proved remarkably sound and trouble-free — and will result in a net saving of about $60,000 a year after a three to seven year amortization.

The newly developed Bell Labs type M1789 traveling-wave tube may be the forerunner of a popular class of tubes. It is a medium power tube capable of amplifying a 500 mc band at a center frequency of about 6000 mc, with a gain of approximately 33 db at its nominal output of 5 watts. Current-consuming focusing solenoids have been eliminated, and other improvements are introduced to give an average life in early models which exceeds 10,000 hours.

British manufacturers are now producing marine radar sets at a rate to equip more than 5 vessels a day. More than 1800 British-made marine radar sets per year are being supplied to ships of all nations throughout the world. Mr. C. H. T. Johnson, Chairman of the Radio Communication and Electronic Engineering Association, speaking of Britain's stringent Marine Radar Performance Specification: "It is right that Britain, where radar was invented, should set and keep the world standard for this type of equipment."

Choking traffic problems, now faced by most American cities, may be answered by effective use of closed-circuit TV. Cameras would be strategically located along busy cross-city intersections or other important traffic arteries. A traffic coordinator, seated in front of a bank of monitors, at a central traffic bureau, could view conditions and control traffic by radio-controlled lights. A few cities are already using radio-controlled lights, but no concerted effort has been made to test traffic control by closed-circuit TV and radio-coordinated traffic systems.

The National Bureau of Standards (NBS) has developed a punched card transcriber which makes possible more rapid feeding of data into an automatic computer. Numbers and instructions recorded on punched cards are converted into a binary serial code. The system is about 150 times faster than the present paper tape inscriber and can handle up to 600 cards/min.

Great Britain has announced that it will begin forming its first guided missiles regiment. The regiment to be known as the 47th Guided Weapons Regiment (field), Royal Artillery, is to be equipped with United States made Corporal missiles that have a range of about 50 miles. It will be stationed in Hampshire, in the south of England, but it will have a training range on South Uist, one of the outer Hebrides, off Scotland. Patterned more after the U. S. missile battalion than ordinary British artillery regiments, it will comprise about 500 men, including 30 officers, organized in two batteries and a maintenance unit.

Jamming radio programs from the west is costing the Soviet Union between $3- and $4-billion a year according to an estimate by the former Supreme Allied Commander in Europe, General Alfred M. Gruenther. The U. S. informational program costs about $125-million a year. So much money is spent on jamming radio programs that it exceeds the amount of all the cultural and informational activities of the entire western world. The Soviets are spending the tremendous sums in the form of pure propaganda—radio, pamphlets, and others. The propaganda is very clever and almost imperceptible as such.

The Federal Communications Commission has directed AT&T and Bell Systems subsidiaries to permit phone subscribers to use the Hush-a-Phone and similar devices. The Hush-a-Phone is a cup-like device that can be snapped on the telephone mouthpiece to give privacy to conversations and shut out surrounding noise. The New York manufacturers of the device have challenged, in the courts, the telephone company regulations prohibiting "foreign attachments" on telephones. The court held that a telephone subscriber had a right to use his telephone "in ways which are privately beneficial without being publicly detrimental."

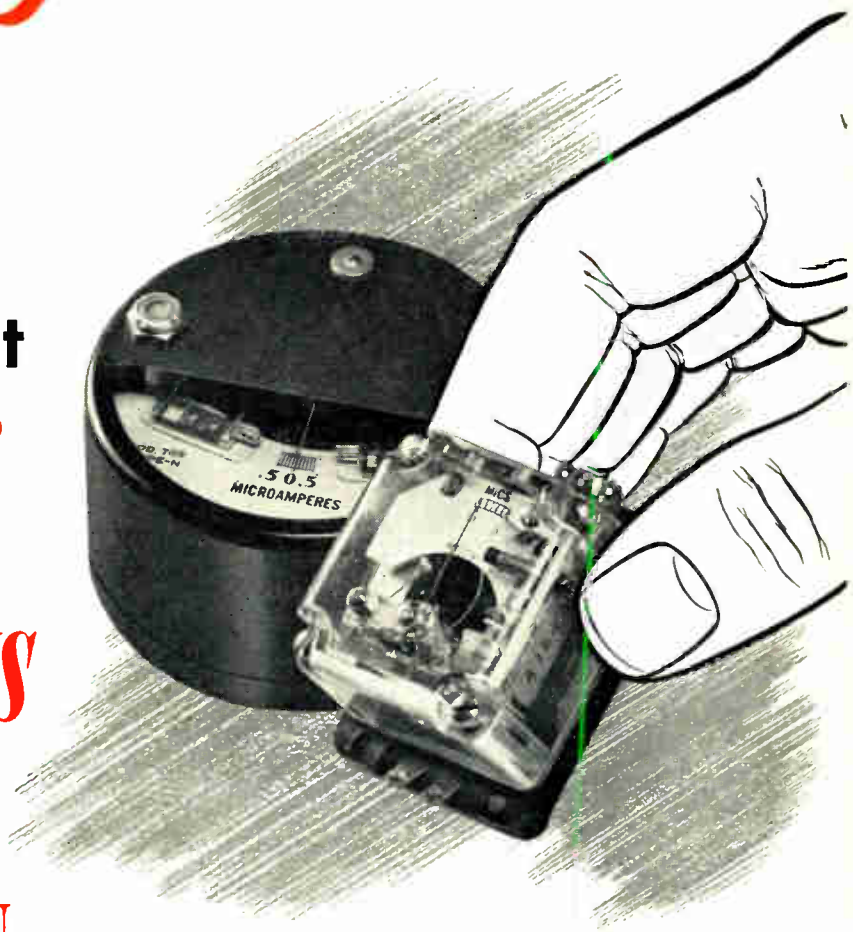
Forget the Amplifier

If your design utilizes an amplifier to boost a minute signal for relay operation – or, if you have 'shelved' some new product idea because the cost, space requirement and other drawbacks of amplifiers made the design impractical – *Sensitrol relays are for you.* For these tiny, ultra-sensitive relays, which operate direct on input signals as slight as *1 millivolt* or *½ microampere,* and handle substantial wattage at *110 volts,* entirely replace amplifiers, vacuum tubes and auxiliary power supplies. They are available with single or double contacts, fixed or adjustable, manual or solenoid reset. For engineering assistance in adapting Sensitrol relays to present products, or new problems you have in mind, call your nearest Weston representative, or write for the Sensitrol bulletin B-25-B . . . *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.*

Boost feeble input signals with compact

Sensitrol®

ultra-sensitive relays



WESTON Instruments

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Circle 5 on Inquiry Card, page 97

6 NEW ANSWERS TO TODAY'S

New IRC Dual Diodes

New answer to the bulk, higher cast, and assembly problems of vacuum tube diodes in law current applicatians.

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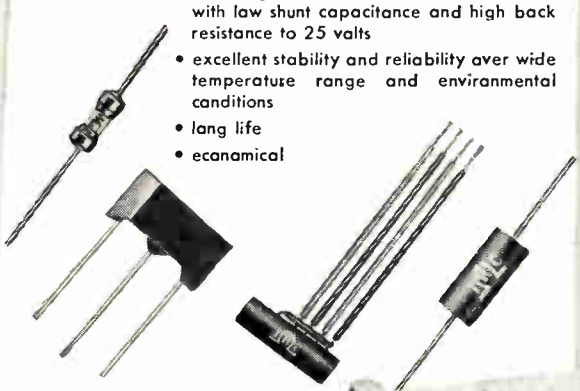

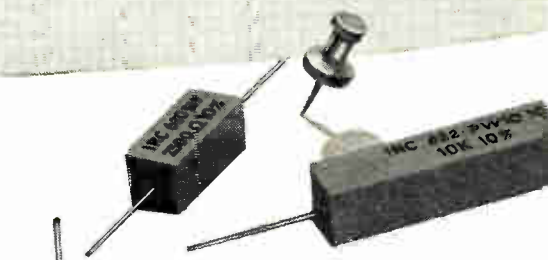

Expanded line af axial lead resistors offering wider ranges, higher aperating temperatures and easier assembly at lawer cast.

- now available in 5, 7 and 10 watt ratings
- leads autamatically secured ta elemeant far maximum terminal security
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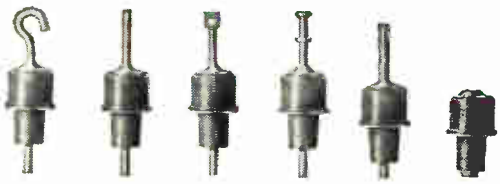
- featuring high stability and uniform characteristics
- ecanamical

New IRC Hermetic Sealing Terminals



Superiar hermetic sealing and insulating perfarmance in miniature units meeting a wide variety af space, electrical, and terminatian requirements.

- faur bady designs and six lead types
- excellent resistance ta thermal shack, zera water absarptian, physically taugh, will not crack or craze.
- special fluoracarban plastic bady with superiar electrical and mechanical characteristics

DESIGN AND COST PROBLEMS

Deposited Carbon Resistors

New molded resistor line providing a means of obtaining long-term stability up to 100 megohms with savings in cost and bulk.

- ⅛, ¼, ½, 1 and 2 watt ratings
- excellent load life characteristics and resistance to aging
- conservatively rated at 70° C. ambient

Low Range BW Wire Wound Resistors

Now mass produced at low cost for transistor applications where the low value and stability of a wire wound resistor is an important factor. Ruggedized unit to withstand rigors of modern installation techniques.

- fully insulated
- values from 0.24 ohm to 10 ohms

VISIT BOOTHS 2821—2823—2825

Components Floor
RADIO ENGINEERING SHOW
March 18 to 21

Insulated Composition Resistors • Deposited and Boron Carbon Precistors • Power Resistors • Voltmeter Multipliers • Ultra HF and Hi-Voltage Resistors

Wherever the Circuit Says

Low Wattage Wire Wounds • Resistance Strips and Discs • Selenium Rectifiers and Diodes • Hermetic Sealing Terminals • Insulated Chokes • Precision Wire Wounds • Potentiometers

IRC®

IRC PLANTS—Asheville, N.C. • Boone, N.C.
Burlington, Iowa • Philadelphia, Pa.
Hycor Division, Sylmar, California
Circuit Instruments Inc., St. Petersburg, Fla. (subsidiary)
Hycor Company, Inc., Vega Baja, P.R. (subsidiary)

INTERNATIONAL RESISTANCE COMPANY

Dept. 230, 401 N. Broad St., Philadelphia 8, Pa.
In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send complete information on ☐ Selenium Dual Diodes, ☐ Delay Lines, ☐ Hermetic Sealing Terminals, ☐ Power Resistors, ☐ Molded Deposited Carbon Resistors, ☐ BW Wire Wound Resistors

Name _____

Company _____

Address _____

City _____ State _____

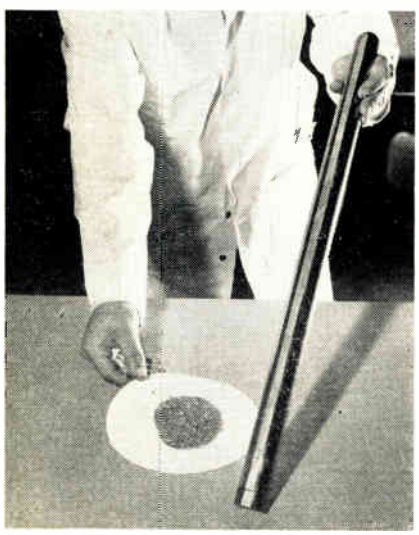
As We Go To Press . . .

Interface Impedance Test Established

At its last meeting, ASTM Committee F-1 on Materials for Electron Tubes and Semiconductor Devices reported progress in improving the method of test for interface impedance. The data from extensive interlaboratory tests have been recorded on punched cards and will be analyzed at the Bell Telephone Laboratories. The committee is concentrating its efforts in measuring time constants below 1 microsecond as it is this range which is most critical in measurement of low values of interface impedance. Tubes which develop an appreciable interface impedance lose their ability to handle high frequencies, especially pulses, and thus may be rendered inoperative in such applications as computers.

Long experience has indicated that measurement of physical, electrical and chemical properties of materials outside an electron tube does not always indicate performance of the materials in a tube. Therefore, the committee is developing reference tubes, both diodes and triodes, in which the quality of materials and details of construction are carefully specified. These reference devices are useful for evaluating properties of tube materials.

CRYSTAL INGOT



Bar of pure germanium, after processing by Hughes Aircraft Co.'s semi-conductor division in Los Angeles, is converted into the small pile of crystals shown—80,000 of them. Each forms the heart of a germanium diode.

Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period April and May, that are of special interest to electronic engineers

Apr. 7-11: 35th Annual Convention, sponsored by NARTB; at the Conrad Hilton Hotel, Chicago.

Apr. 8-10: Techniques of Supervisory Training (Pt. 2), sponsored by the American Management Association; at the Sheraton-Astor Hotel, N. Y.

Apr. 8-11: National Electrical Industries Show, sponsored by Eastern Electrical Wholesalers Assn., at 71st Reg. Armory, New York.

Apr. 8-12: Annual Welding Show, sponsored by American Welding Society and AIEE; at Hotel Sheraton and Convention Hall, Philadelphia.

Apr. 9-10: Annual Industrial Electronic Educational Conf., sponsored ble IRE Industrial Electronics Grp. and Armour Found.; at Ill. Inst. of Tech., Chicago.

April 9-11: 14th Annual British Radio Component Show (incl. TV, electronic and telecommunication equipment); Radio & Electronic Component Mfrs. Federation, 21 Tothill St., London S. W. 1; in London.

Apr. 10: Annual Meeting & Dinner, sponsored by the Radio Pioneers; at Conrad Hilton Hotel, Chicago.

April 11-13: 9th Southwestern Regional Conf. & Electronics Show, sponsored by Houston Section, IRE; at Shamrock Hotel, Houston.

April 11-13: Nat'l Simulation Council sponsored by IRE-PGEC, Houston Section, (as part of S. W. Reg, Conf.); Shamrock Hotel, Houston.

April 14-27: U. S. World Trade Fair (incl. electronic equipment and scientific instruments); at The Coliseum, New York.

April 15-16: Meeting of the Radio Technical Commission for Marine Service; at the Shoreham Hotel, Washington, D. C.

April 15-17: National Symposium on Telemetering. sponsored by IRE; at the New Sheraton Hotel, Phila.

April 15-17: Symposium on Systems for Information Retrieval, sponsored by Western Reserve Univ., at the Western Reserve Univ., Cleveland.

April 16-18: Symp. on Nondestructive Tests Developed in the Field of Nuclear Energy, sponsored by the AICE, American Nuclear Society, ASTM, and Society for Nondestructive Testing; at the Morrison Hotel, Chicago, Ill.

April 23-25: 5th National Electromagnetic Relay Conf., sponsored by Oklahoma Inst. of Tech., Oklahoma A & M and National Assn. of Relay Mfg.; at Oklahoma A & M, Stillwater.

April 23-25: Symp. on Role of Solid State Devices in Electric Circuits, sponsored by IRE and Dept. of Defense; at Engineering Society Bldg., New York.

April 23-25: International Symp. on the Role of Solid State Phenomena, sponsored by the Polytechnic Institute of Brooklyn, Microwave Research Institute; at the Auditorium of Engineering Societies Bldg., N. Y.

April 24-25: National Industrial Research Conf., sponsored by Armour Research Foundation; at Conrad Hilton Hotel, Chicago.

April 25-26: Annual Technical Meeting of the Institute of Environmental Engineers; at the LaSalle Hotel, Chicago, Ill.

April 26-27: 11th Annual Spring TV Conf., sponsored by IRE; at Eng'g. Society Bldg., Cincinnati.

April 27-May 2: SAMA Annual Meeting, sponsored by SAMA; White Sulphur Springs, W. Virginia.

April 29-May 3: 81st Semi-Annual Conv., sponsored by Society of Motion Picture & TV Engineers; at Shoreham Hotel, Wash., D. C.

May 1-3: Electronic Components Symp., sponsored by IRE, AIEE, RETMA, WCEMA; at Morrison Hotel, Chicago.

May 9-10: Annual Meeting, Covering Ferrites Devices, sponsored by IRE Microwave Theory & Techniques Grp.; at the Western Union Auditorium, N. Y.

May 12-16: 111th Annual Meeting: sponsored by the Electrochemical Society; at the Hotel Statler, Washington, D. C.

May 13-15: National Aeronautical & Navigational Conf., sponsored by IRE; at the Dayton-Biltmore Hotel, Dayton, Ohio.

May 14-15: Industrial Nuclear Technology Conf., sponsored by Armour Research Found.; at Museum of Science and Industry, Chicago.

(Continued on page 130)

Abbreviations:

AICE: American Inst. of Chemical Engrs.
AIEE: American Inst. of Electrical Engrs.
ASTM: American Society for Testing Materials
IAS: Inst. of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
NARTB: National Assn. of Radio & TV Broadcasters
NEDA: National Electronic Distributors Assoc.
RETMA: Radio-Electronic-Television Manufacturers Assoc.
SAMA: Scientific Apparatus Makers Assoc.
WCEMA: West Coast Electronic Manufacturers Assoc.

LOOK TO LORAL for CREATIVE ELECTRONICS

Imprint of Integrity

Something NEW in AIRBORNE PLOTTERS

Another LORAL development for use in...

Weapons Systems

THE LORAL GROUND TRACK PLOTTER provides an instantaneous and permanent record of the ground track of the aircraft. The position of a target relative to the present position of the aircraft may be automatically set into the unit.

LORAL has consistently and successfully followed a forward looking progressive policy of creative development from problem recognition and functional requirement through research, development and production engineering.

During the past decade LORAL has established a solid record of accomplishment in the development and production of complex precision electronic and electro-mechanical equipments.

We welcome any opportunity to assist in your engineering problems.

Among recent developments are:

● The LORAL AIRBORNE NAVIGATIONAL COMPUTER. A compact and accurate system computes and indicates ground displacement of aircraft.

● The LORAL Automatic Short Range GROUND POSITION INDICATOR—on 18 lb. navigational computer automatically indicating ground position.

LORAL ELECTRONICS CORPORATION

NEW YORK 54, NEW YORK

Serving in AVIONICS • AIRBORNE NAVIGATIONAL EQUIPMENT • COMMUNICATION SYSTEMS • RADAR EQUIPMENT • TEST EQUIPMENT

Another First...

FROM TRANSISTOR CENTER, U.S.A.

SB101
For general high frequency use, the SB101 offers a narrow, controlled Beta range—plus medium gain characteristics. Here is a good wide-band video or IF amplifier.

SB102
SB102 is a higher gain transistor, with controlled Beta range. Performs extremely well in oscillators, converters, mixers and narrow-band video.

SB103
SB103 features hi-frequency (min. f max. = 60 MC). This transistor is ideally suited to higher frequency oscillators and converters, or wherever high frequency operation is the most important consideration.

NOW... *High Frequency Transistors* for easier circuit design—unequalled reliability

New PHILCO SBT Family Simplifies Transistorization for Communications Engineers

For the first time—anywhere—Philco offers a complete line of Surface Barrier Transistors for low voltage communications circuitry (1-5 volts). Now you can select the best general purpose, high-frequency transistor for each application . . . RF . . . IF . . . video amplifiers, converters, oscillators . . . and for high-speed switching circuits.

The low cost of Philco Surface Barrier Transistors extends their usefulness to every type application. Low collector capacitance and low leakage current make them highly desirable for critical circuitry. Performance of hermetically sealed Philco SBT's is precise and dependable. Circuit specification is simple . . . accurate!

Get the facts on the Philco SBT Family
Test . . . compare . . . specify Philco

Other Philco Surface Barrier Transistor types are available for military applications (2N128, 2N129) and for high speed switching (2N240).

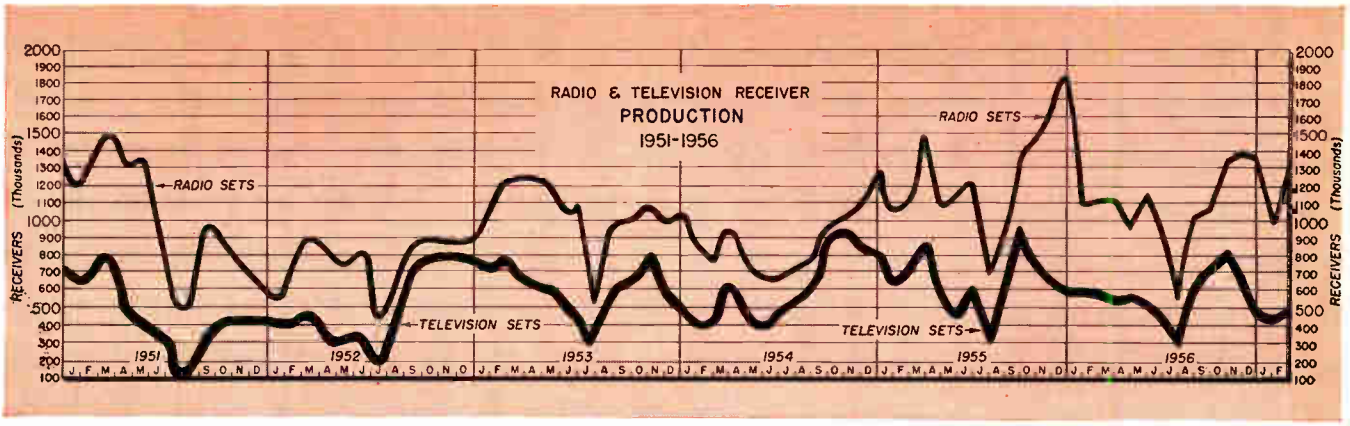
	SB101			SB102			SB103		
	Min	Typ	Max	Min	Typ	Max	Min	Typ	
Current Amplification Factor, h_{fe}	11		33	25		110	10		
Maximum Frequency of Oscillation, f_{os} max	30	50		30	50		60	75	mc

Max. Ratings (SB101, 102, 103) $V_{CE} = -5v.$, $I_C = -5$ ma., P_C @ 40°C = 20 mw.

Write for complete data and prices. *Make Philco your prime source of information for high-frequency transistor applications!*

PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA

TOTALS



ENGINEERING DEGREES

Degree	1954-55	1955-56
B.S.	22,589	26,306
M.S.	4,379	4,705
Ph.D.	599	610
Enrollments	**1955-56**	**1956-57**
1st Year	72,825	77,738
2nd Year	50,841	55,767
3rd Year	39,377	44,610
4th Year	31,300	37,571
5th Year regular	1,358	1,387
5th Year cooperative	1,450	1,838
Other	24,297	32,210
Subtotal	221,448	251,121
M.S. graduate students	18,482	22,529
Ph.D. graduate students	3,163	3,402
Total	243,093	277,052

—Engineers Joint Council & Scientific Manpower Commission

TRANSISTOR PRODUCTION

Year	Quantity	$ Value
1956	12,840,000	37,352,000
1955	3,646,802	9,860,062
1954	1,317,327	5,122,266

—Retma

MILITARY EXPENDITURES

Budget Category	Fiscal year 1956	1st quarter FY 1957
Aircraft	$ 925.0	$213.0
Ships and Harbor Craft	80.0	17.0
Combat Vehicles	9.5	1.0
Support Vehicles	5.8	.2
Guided Missiles	630.0	205.0
Electronics and Communications	770.2	130.0
Research and Development	265.0	66.0
Miscellaneous	47.5	.4
TOTAL	$2,733.0	$632.6

Millions of Dollars *—Retma*

HOUSEHOLDS WITH TV SETS

Sets in household	Aug. 1956	Feb. 1956	June 1955
All households	100%	100%	100%
With one set or more	76%	73%	67%
One set	72%	69%	65%
Two sets or more	4%	4%	2%
No set	24%	27%	33%

—Dept. of Commerce

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government procurement agencies in February, 1957.

Amplifiers	331,497	Inverters	174,779	Relay Components	48,857
Amplifier Parts	1,198,547	Kit Radar Installation	120,999	Relays	221,087
Antennas & Components	286,743	Kits, Modification	928,172	Resistors	28,325
Battery Chargers	89,600	Meters	25,935	Servo Positioning Mechanisms	104,990
Batteries, Dry	400,791	Meters, Frequency	58,713	Signal Comparators	45,194
Batteries, Storage	768,606	Meters, Ohm	63,526	Simulators, Target	214,176
Cable Assemblies	235,013	Meters, Volt	49,510	Spare Parts	26,430
Capacitors	113,565	Multimeters	212,593	Speakers	113,044
Circuit Breakers	37,748	Networks	95,570	Stroboscopes	39,058
Coils	138,599	Oscilloscopes	42,722	Switches	173,307
Computers & Accessories	80,173	Power Supplies	802,202	Syncros	66,536
Computers, Airborne	6,736,102	Radar Components & Spares	214,127	Tape, Recording	27,500
Connectors	41,970	Radar Equipment	51,419	Television Equipment	289,705
Co-ordinate Data Sets	741,168	Radio Receivers	32,000	Testers	65,687
Dummy Loads	60,458	Radio Set Controls	25,600	Test Sets	27,437
Echo Boxes	122,035	Radio Transmitters	374,220	Transformers	109,842
Generators, Signal	278,829	Radomes	343,492	Transponder Set	35,599
Handsets & Headsets	581,580	Receivers-Transmitters & Acces.	5,451,974	Tubes, Electron	2,253,647
Indicators	2,925,336	Recorders-Reproducers	41,958	Vibrators	25,800
Insulators	45,650	Rectifiers	45,377	Wavemeters	27,869
Intercom Racks	54,307	Relay Assemblies	130,588	Wire & Cable	1,377,856

Electronic Industries' News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

INTERNATIONAL BUSINESS MACHINES CORP. has revealed plans to establish the new manufacturing unit for the company's recently formed Data Processing Div. in the village of Essex Junction, 6 mi. east of Burlington, Vt.

SANGAMO ELECTRIC CO. is now operating its newest factory, located at Pickins, S. C., a short distance from Greenville. This completely air-conditioned bldg. provides approx. 200,000 sq. ft. of floor space.

GULTON-SPEIDEL, INC., is the name of the recently formed, jointly owned corporation of Speidel Corp. and Gulton Industries, Inc. The new firm has been formed for the purpose of marketing a series of new electronic products.

X-RAY AND INDUSTRIAL ELECTRONCS DIV., a recently formed new division of the Westinghouse Electric Corp., will be headed by W. J. Delaney, Jr.

RETMA HEADQUARTERS is now in its new building at 1721 DeSales St., N. W. Washington 6, D. C.

FISCHER & PORTER CO has purchased 2 tracts in central Bucks County, Pa. Both tracts, 8 mi. from the present Hatboro location, are tied in with plans for company expansion.

SPERRY RAND CORP. has selected Clearwater, Fla., as the site of a $2,000,000 electronics plant for research in microwave physics and development of advanced radar and missile instrumentation. Eugene J. Venaglia will be manager of this new division.

DATA & DISPLAY DEPT. is a newly formed group of A. B. DuMont Labs. Inc. This new group is in the circuit research div. Its formation was prompted by increased activity in research and development work on data pick-up, processing, and display techniques.

GE'S LIGHT MILITARY ELECTRONIC EQUIPMENT DEPT. has received a letter contract totaling $20 million from the USAF for production of airborne electronic countermeasures equipment (radar jammers).

CONSOLIDATED ELECTRONICS INDUSTRIES CORP. directors have authorized the company to negotiate an agreement to supply overall management assistance to the Sessions Clock Co., Forestville, Conn.

BOGUE ELECTRIC MFG. CO. has been awarded a contract totaling $2.5 million for control systems for the long range bomber missiles. Production originally scheduled over a 2 yr. period has been accelerated in a crash program to provide for completion of the work in approx. 9 months.

NEW YORK UNIV., COLLEGE OF ENGINEERING, has placed into operation an IBM 650 high speed electronic computer. The ¼ million dollar medium-sized "mechanical brain" will be used for research and in a new educational program.

RESIN INDUSTRIES, Santa Barbara, Calif., has acquired a Leominster, Mass., plant of 21,000 sq. ft. At the same time, an eastern sales office was opened at Stamford, Conn.

WHITEHEAD METAL PRODUCTS CO., INC., laid the cornerstone for their new 35,000 sq. ft. office and warehouse at Windsor, Conn.

SIGHTMASTER, CORP., manufacturers of fuses, has announced that it has acquired Mutual Electronic Industries Corp., a producer of patented cable and panel equipment and triaxial connectors. Both companies have manufacturing facilities at New Rochelle, N. Y.

AMERICAN ELECTRONIC LABORATORIES, INC., announces the removal of its main administrative offices to the Copeland Bldg., 121 N. 7th St., Philadelphia 6.

MID-WEST

UNIV. OF MICHIGAN, COLLEGE OF ENGINEERING, has announced 2 summer Intensive Courses in Automatic Control. The first is scheduled for June 17 to 22 incl.; the second, June 24 to 26, 1957, incl. The courses are intended for engineers who find it necessary or who wish to obtain a basic understanding of the field, or who cannot spare more than a few days for this purpose.

ADMIRAL CREDIT CORP., a wholly owned subsidary of Admiral Corp., has been formed to handle the financing of dealer purchases throughout the country. The organization will ultimately finance consumer purchases as well.

BENDIX AVIATION CORP. has entered into a contract to acquire the business and assets of the Sheffield Corp., Dayton, O., a privately owned company, which is one of the major manufacturers of precision, gauging and measuring instruments.

PHOTO CRYSTALS, INC., opened management offices at 1974 E. 61st St., Cleveland, O. The company factory will presently remain at Geneva, Ill. The company manufacturers a line of miniature light, heat, and humidity sensing elements.

FIELDEN INSTRUMENT DIV., ROBERTSHAW-FULTON CONTROLS CO., has moved to larger quarters at 6116 St. Clair Ave., Cleveland. Harold N. Gilmore has been named to head the Cleveland office.

FOREIGN

CONTROLS CO. OF AMERICA has announced an expansion program to increase assembly and fabrication operations at the Nijmegen, Holland, plant of its subsidiary, Controls Maatschappij Europa N.V.

AMF ATOMICS INC., American Machine & Foundry Co. subsidiary has been awarded a contract by the Greek Govt. to design and build a nuclear research reactor near Athens as the center of a new Greek National Atomic Energy Laboratory which will be named for Democritus, acknowledged discoverer of the atom.

G-V CONTROLS, INC., East Orange, N. J., has negotiated an agreement for the manufacture and sale, under license, of its products in Europe through Societe Intertechnique, a French firm active in the aeronautical and electronic fields.

HUMPHREY INC., San Diego manufacturer of electro-mechanical instruments, has appointed Industrial Imports Ltd., Tokyo, as its representative in Japan.

WEST

ALBUQUERQUE, N. M., CHAMBER OF COMMERCE, INDUSTRIAL COMMITTEE has announced the appointment of an Electronics Advisory Board to advise electronics firms that indicate interest in locating there. Joe Hegge, manager of the Sandia Corp. Electromechanical Development Dept. was named chairman of the new board.

ALWAC CORP. is the new name for Logistics Research. The new title will provide better identification with the company's products and services which all bear the Alwac name.

CALIFORNIA TECHNICAL INDUSTRIES has moved to 1421 Old County Rd., Belmont, Calif. The company has recently changed its name from Color Television Inc.

SYSTRON CORP. has been formed to design and manufacture electronic control systems and data processing equipment. G. H. Bruns, Jr., is president and director of the company. The firm is located in Concord, Calif., about 20 miles east of San Francisco Bay.

BEHLMAN ENGINEERING CO., 114-116 South Hollywood Way, Burbank, has recently expanded. The move doubles the firm's previous floor space.

LOCKHEED'S MISSILE SYSTEMS DIV. has established two new weapon system organizations. The managers of the new organizations are John H. Carter and Stanley W. Burriss.

C. P. CLARE & CO., Chicago relay manufacturer, opened a new field engineering and sales office at 6047 Hollywood Blvd., Los Angeles 28. Jesse R. Stone will be in charge of the new office.

SCIENTIFIC INSTRUMENTS DIV., BECKMAN INSTRUMENTS INC., Fullerton, Calif., has received an order for a 200-channel Beckman 112, completely transistorized data-processing system, from Douglas Aircraft. The system will be used to speed research on the "Thor," an intermediate range ballistic missile now being developed for the Air Force.

BECKMAN & WHITLEY, INC., San Carlos, Calif., manufacturer of high-speed research cameras, meteorological instruments, and explosive-actuated devices, more than doubles its floor space in assimilation of the building adjoining its present plant.

DATAIRE CO. is the new subsidiary of West Coast Research Corp. It will handle data reduction, analysis, and computer work. Martin Seldon, will function as General Manager of the company.

MINNEAPOLIS-HONEYWELL'S AERONAUTICAL DIV.'S Missile Controls Lab. at Los Angeles will carry out work on a half-million dollar study contract concerned with the development of a new type of air-to-ground rocket.

AUTONETICS, DIV. OF NORTH AMERICAN AVIATION CORP., has been elected to membership in the Radio Technical Commission for Aeronautics.

TEXAS INSTRUMENTS, INC., announced that two wholly-owned subsidiaries have become operating divisions. Houston Technical Laboratories, geophysical and industrial instrument manufacturer, has become the Industrial Instrumentation Div. W. I. Mann Co., precision optics manufacturer, located in Monrovia, Calif., is now the Optics Div.

Dick Sounds like a real improvement Jim

BOST CHI DET LA NY PHILA OFC KLG

NEW RAYTHEON RECORDING STORAGE TUBE. CAN STORE A PICTURE OR DATA IN LESS THAN 1/60 SECOND. READ OUT 30,000 TIMES. NOW WITH OVER 600 LINES RESOLUTION AT HALF-AMPLITUDE MODULATION. CAN BE USED FOR FREQUENCY OR SCAN CONVERSION. A SUPERIOR TUBE IN WRITING-ERASING, STEEDXXXX SPEED, DYNAMIC RANGE AND CAPACITY.

AMONG ITS USES ARE 1. DATA STORAGE FOR ANALOGUE COMPUTERS. 2. STOP MOTION OF TV SIGNALS. 3. STORAGE OF SIGNALS TO BAND COMPRESS. 4. EXPANSION OF TV SIGNALS FOR NARROW BAND TRANSMISSION. 5. STORAGE OF REPETITIVE SIGNALS TO IMPROVE SIGNAL-TO-NOISE RATIO. MANY NEW PRODUCT USES BEING DEVELOPED.

DATA SHEETS ON THE RK-6835/QK-464 ARE JUST OFF THE PRESS. WRITE FOR YOURS NOW. NO OBLIGATION. TUBES ARE AVAILABLE FOR IMMEDIATE DELIVERY ON SMALL QUANTITY ORDERS.

RAYTHEON

Excellence in Electronics

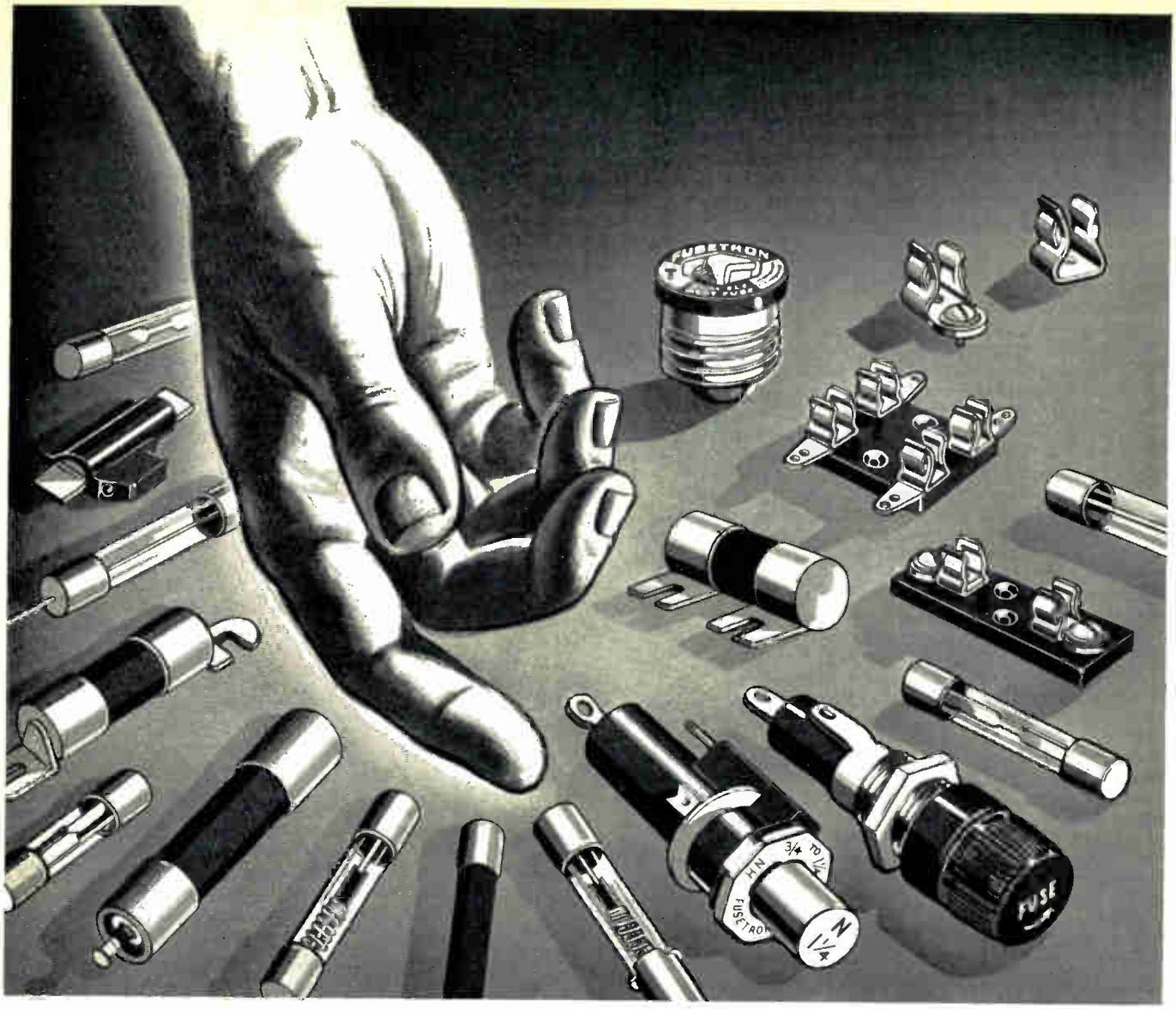
RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-96, Waltham 54, Mass.

Regional Sales Offices: 9501 W. Grand Avenue, Franklin Park, Illinois; 622 S. LaBrea Avenue, Los Angeles 36, California

Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Picture Tubes, Transistors

Circle 9 on Inquiry Card, page 97



BUSS FUSES provide maximum protection against damage due to electrical faults

Protection against damage due to electrical faults can be no better than the device used to protect the equipment. The safest, most dependable protection you can get is with BUSS fuses.

To make sure BUSS fuses will clear the circuit should an electrical fault occur,—BUSS fuses are electronically tested. A sensitive testing device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

This careful testing is also your assurance BUSS fuses won't give a false alarm by blowing needlessly. Shutdowns due to faulty fuses blowing without cause are eliminated.

With a complete line of "trouble-free" BUSS fuses available in all sizes and types,—it is just good business to standardize on BUSS fuses.

If your protection problem is unusual, you can save engineering time by letting the BUSS fuse engineers help you select the fuse or fuseholder best suited to your needs.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders . . . Write for bulletin TT. Bussmann Mfg. Co. (Div. of McGraw-Edison Co.) University at Jefferson, St. Louis 7, Mo.

BUSS fuses are made to protect—not to blow, needlessly

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

457

MILLIONS of crystals made to ANY specifications but only ONE standard quality

Midland frequency control units are on the job in two-way communications on land, sea and in the air throughout the world. Now they're playing a leading role in color television. The range of applications Midland serves is wide, but every Midland crystal has one thing in common: a single level of quality.

That one quality is simply the highest that modern methods and machines can produce. It's assured by Midland's system of critical quality control—exacting inspection and test procedures through every step of processing.

Result: Your Midland crystal is going to give you the best possible service in frequency control—with stability, accuracy, and uniformity you can stake your life on . . . as our men in the armed forces and law enforcement do every day.

Whatever your Crystal need, conventional or highly specialized. When it has to be exactly right, contact

Midland
MANUFACTURING COMPANY, INC.
3155 Fiberglas Road, Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS

Tele-Tips

TV SERVICE INDUSTRY last month unloosed a bitter blast at the manufacturers planning factory service operations, and in the process put their finger on one of the paradoxes of the times. Automobile radios, as new equipment, are holding an average price of $90.38, and range up to $135.00 per set. Television sets, even the most anemic, have three times as many components, plus CRT and expensive cabinet. Yet dealers are finding it difficult to get more than $100.00 apiece for them.

OUR ELECTRONIC TIMES: Pope Pius XII transmitted his Apostolic blessing by radio to 3,000 Cardinals, Archbishops, Bishops, other clergymen and laymen.

FIRST COLOR TV OUTLET, Station WNBQ, Chicago cut back their programming from 44 to 38¼ hrs. per week. Reason: no sponsors.

FIRST CRYSTAL-CONTROLLED all-weather radar has gone into operation at London Airport. The new system operates on the 50 cm band and is almost impervious to weather conditions. It incorporates a moving target indicator system to eliminate permanent echoes. High operational stability is ensured through complete crystal control.

MOBILE RADIO has found a new application, tying together cemetery operations. Groups of workmen can be at work at widely spaced locations yet be available in a few moments for any needed duties.

NEW "RADAR RULER" surveying tool developed by Motorola and the U. S. Signal Corps is accurate to within a few feet over a distance of 50 miles.

GRAND PRIZE in Pyramid Electric's Twist Mount Capacitor Contest will be a weekend for two at the Waldorf-Astoria Hotel, N. Y. plus $100 cash.

(*Continued on page* 24)

No Dimensional change

part
after part
after part

NEW GE Textolite®
COLD PUNCH 11572

New General Electric Textolite 11572 is an outstanding XXX-P high IR laminate designed to provide extremely close tolerance punching at normal room temperature, with no cracking or delamination.

The cold fabricating quality, plus outstanding product uniformity, eliminates dimensional variations from piece to piece . . . permitting the use of automatic assembly equipment.

Common degreasing solvents have no effect on G-E Textolite 11572 in standard etching practices. For example G-E 11572 withstood exposure to hot trichloroethylene up to 15 minutes.

This new cold punch laminate is recommended for electronic applications using high voltage at radio frequencies. G-E Textolite 11572 exceeds NEMA XXX-P standards and meets military specifications MIL-P-3115-PBE-P. 11572 is available in unclad or copper-clad form with 1 or 2 oz. copper on one or both sides for precision printed wiring.

Progress Is Our Most Important Product

GENERAL ELECTRIC

General Electric Company
Laminated Products Dept.
Sec. EI-37, Coshocton, O.

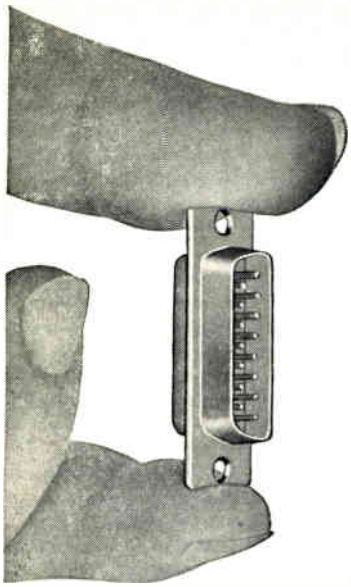
☐ *Please have your representative call.*

☐ *Please send me complete information on G-E Textolite® 11572 Cold Punch Laminate.*

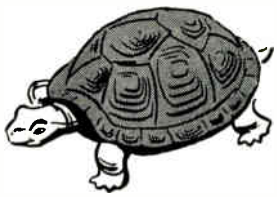
Name .....
Title .....
Firm .....
Street .....
City ..... Zone ..... State .....

When the properties have to be right . . . Specify G-E Textolite®

Circle 13 on Inquiry Card, page 97



TINY like a beetle
RUGGED like a turtle
..because they both have a SHELL

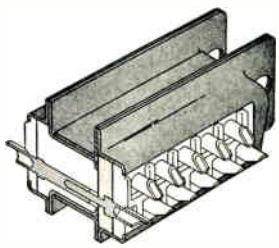


TYPE D *SUBMINIATURES*

...light, but strong steel shells give maximum support to Cannon "D" Sub-Miniature Plugs. And... ***mounting depth is actually less than on conventional shell-less connectors.***

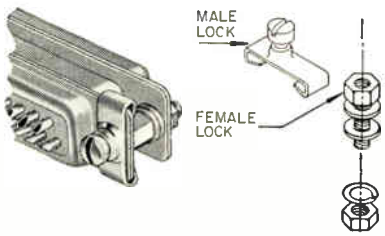
Zytel 101 insulators allow a greater number of contacts within a smaller area in standard units. Four DH Connectors are now made for hermetic seal applications. And, junction shells specially adaptable for potting. The DF Sub-Miniature Series feature new floating mounting holes for ease of alignment; screw locking assemblies, miniature coaxial contact combinations, and straight and angle 90° junction shells with cable clamps. Five shell sizes. 9, 15, 25, 37, and 50 five ampere contact insert arrangements; gold plated brass contacts in plastic inserts; cadmium plated steel contacts in fused glass insulators. Keystone polarization. And... most important of all... Cannon Electric assured quality.

NOW... Available in Diall plastic.



Cutaway of standard "D" sub-miniature connector

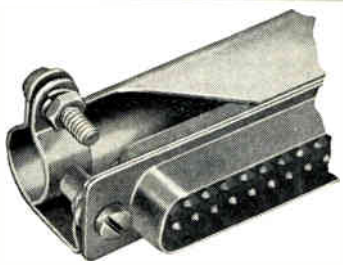
Standard D available in Zytel or Diall. DH hermetic seal units have vitreous insulators; solderpot shown; eyelet also available.



Screw locking mechanism is simple, positive.

Each miniature coaxial replaces five 5-amp. contacts in "D" layout.

Floating mounting holes aid alignment in multiple mount rack-and-panel applications.



Junction shell with 90° cable clamp.

Look for this Display Box of Cannon "D" Sub-Miniatures

Write for 8-page Bulletin D-6.
"D" Connectors Are Stocked by More than 200 Jobbers, Coast-to-Coast—and by Cannon Service Stores.

Please refer to Dept. 201

CANNON PLUGS

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif.

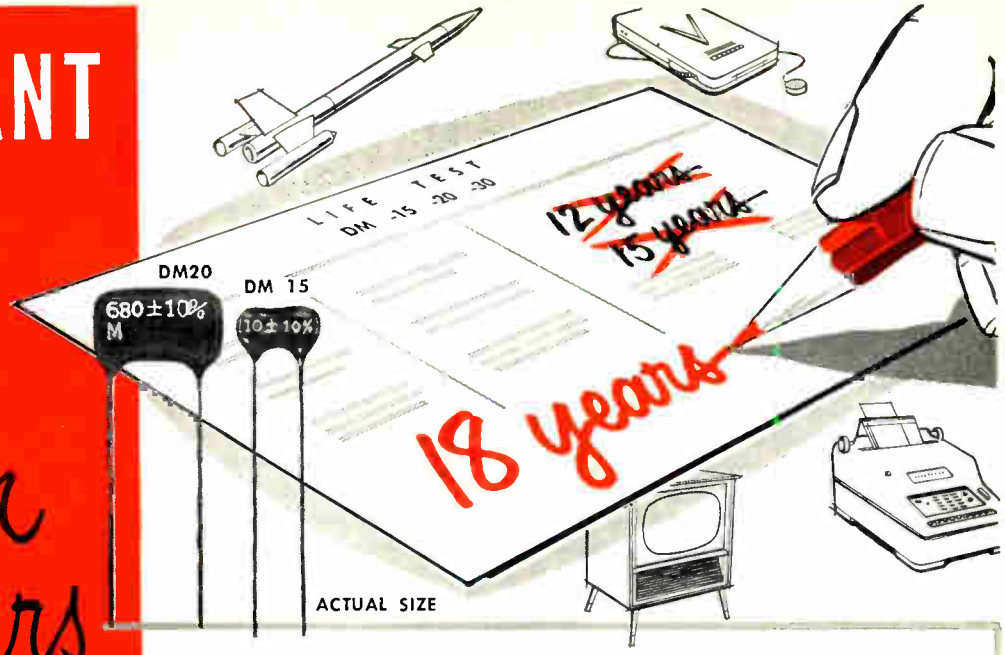
IMPORTANT NEWS

for design engineers

WHAT IS YOUR CAPACITOR APPLICATION PROBLEM?

We'll be glad to advise you.

Make your own test of El-Menco Dur-Mica Capacitors



El-Menco Dur-Micas

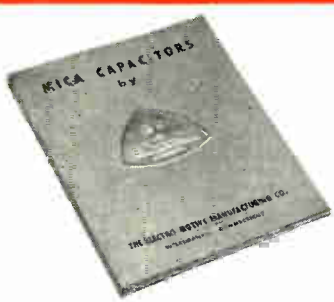
now rated for even

LONGER LIFE!

El-Menco Dur-Mica Capacitors Can Now Assure You Of Dependable Performance Up To 18 Years!

Not An Extravagant Claim, But A Tested Fact. The latest series of rugged trials by El-Menco engineers found El-Menco DM15, DM20 and DM30 Dur-Mica Capacitors outlive and outperform all others. Under accelerated conditions of 1½ times rated voltage at 125°C ambient temperature; El-Menco capacitors continued to perform reliably after 12,000 hours. Translated into normal conditions, this indicates a lifetime of from 15 to 20 years!

MEET ALL ENVIRONMENTAL AND ELECTRICAL REQUIREMENTS OF BOTH CIVILIAN AND MILITARY SPECIFICATIONS.



Write for FREE samples and catalog on your firm's letterhead.

El-Menco Dur-Mica DM15, DM20 and DM30 Capacitors Mean:

1. LONGER LIFE
2. POTENT POWER
3. SMALLER SIZE
4. EXCELLENT STABILITY — SILVERED MICA
5. PEAK PERFORMANCE

In addition to longer life, El-Menco Dur-Mica Capacitors with tougher phenolic casing assure greater stability over wide temperature range.

WITH NEW CRIMPED LEADS.

Crimped, parallel leads simplify application in television, printed circuits, electronic brains, computors, guided missiles and other civilian and military uses.

El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

WILLIMANTIC CONNECTICUT

• molded mica • mica trimmer

• tubular paper • ceramic • silvered mica films.

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

Tele-Tips

(*Continued from Page* 20)

INTERFERENCE from electrical and electronic equipment is impairing the operation of America's modern defense systems, declared a Signal Corps spokesman at the two-day Radio Interference Reduction Conference, conducted by the Armour Research Foundation of Illinois Inst. of Technology. Brig. Gen. E. F. Cook said that many new equipments are on the drawing boards but before they can become practical something must be done to decrease the high interference already existing around present equipment.

THE WORLD now has 845 TV stations and 56,000,000 TV sets. The U. S. alone has 496 TV stations and 42,000,000 receivers.

NUCLEAR POWER PLANTS are finding it difficult to sell the installation of reactors to nearby residents because of the public's apprehension over the radiation problem. Now a special PR course has been designed expressly to instruct company personnel in soothing the public's objections.

MICROWAVE LINKS now constitute about half of the Bell System's national coaxial network.

SKIP HAPPY. Squad car 1 called in, "I need some anti-freeze, sarge. Any there in the station?" The sergeant in a N. J. station called back, "Yeah, five cans. Come in and get it." After a few moments squad car 2 broke in, "Don't wait for him, sarge. That's a car out in Denver, Colorado." Explanation: sunspots.

THE ELECTRONIC AGE has finally caught up with the Army. The Signal Corps announces that some 1,000 carrier pigeons they have been training at Ft. Monmouth, N. J., will soon be offered for sale, marking the end of these colorful couriers in Army service. The Army started using pigeons back in 1897 as carriers of messages, map overlays and photographic film. During WW II, approximately 40,000 racing pigeons were supplied the Army without cost by pigeon fanciers.

Eliminates costly, wasteful baking operation . . .

PRINTS DRY!

Semi-Automatic

MARK III-A PRESS

REVOLUTIONIZES etched circuit Production

D.S.P.'s new Mark III-A press means greater production as well as high quality printed etched circuits . . . with rejection practically nil.

Like other D.S.P. presses, Mark III-A *prints dry*, delivers 600-800 perfectly dry impressions per hour, each one of which is ready to etch. And, since it prints *dry*, the resist can't run — it stays fast in the exact pattern of the stencil design. Not only that, but baking or other drying steps are completely eliminated, cutting the time cycle from blank stock to etched panel to a minimum. Add 5-6 seconds to the time it now takes you to etch each piece and that's the total time involved with Dry Screen Process.

Mark III-A prints on single or double copperclad laminate up to ⅛ inch in thickness. Effective impression size up to 22" x 28" allows maximum number of designs per impression.

Equally fine results may be obtained in electroplating the blanks with reverse printing design.

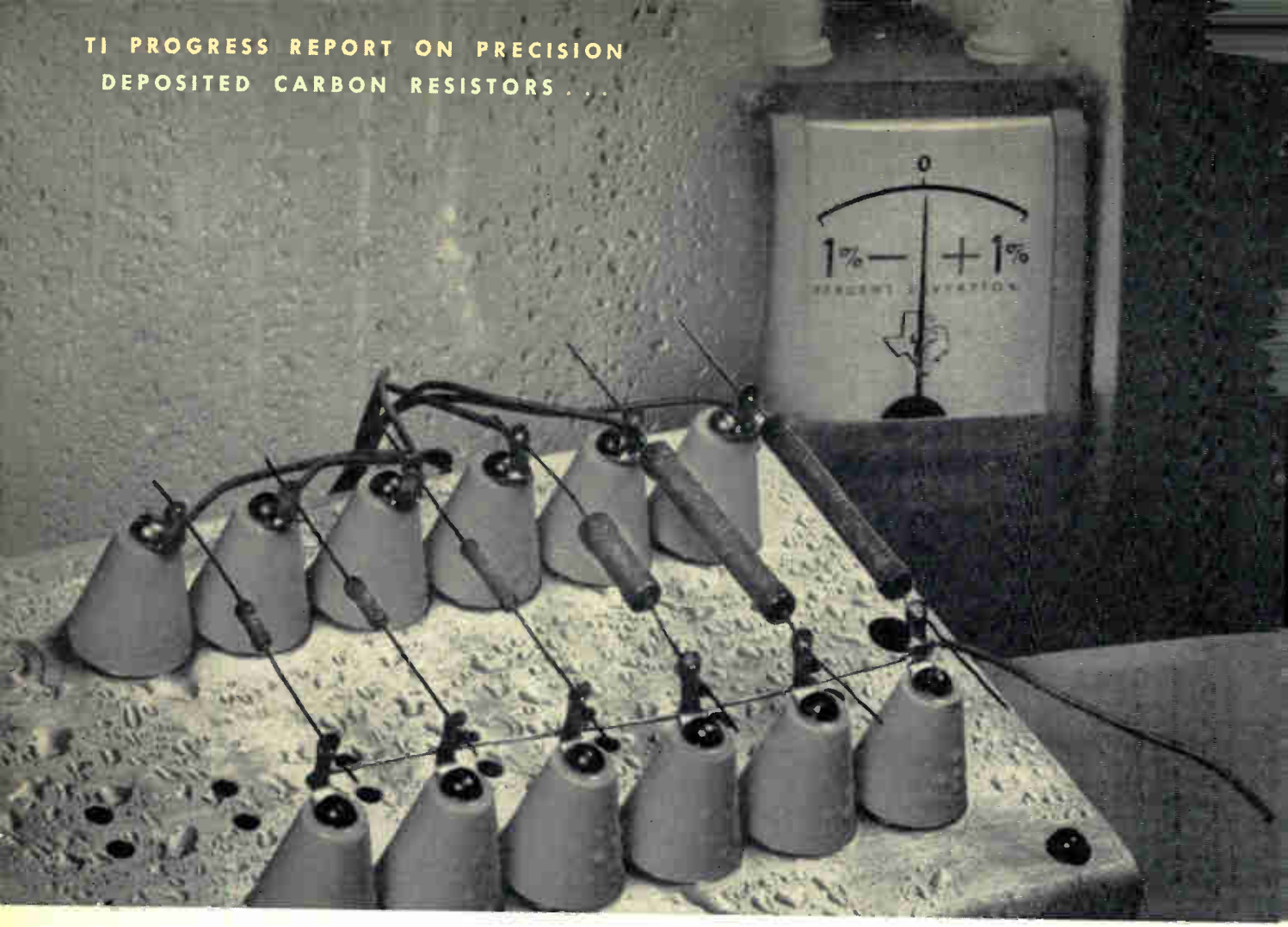
Besides this high volume press, two other models are available with capacities of 200 impressions per hour. All models *print dry*, cut production time, lower costs, give excellent results.

Write today for full information and literature

DRY SCREEN PROCESS, INC.

1016 MADISON AVE. • PITTSBURGH 12, PA.

Mfgrs. of Dry Screen Printing Equipment
Dry Screen Process Colors



TI MIL-Line Precision Resistors

HOLD TOLERANCE...EVEN WHEN DRIPPING WET!

Soaking wet, dried out, or 'shook up' – TI MIL-Line deposited carbon resistors still far exceed MIL-R 10509B . . . emerge from one acceptance test after another – by major electronics manufacturers – with performance records that have not been equalled. *It's the seal that makes the difference* . . . an exclusive Texas Instruments process that snugly wraps these precision resistors in tough jackets of a special coating with high dielectric strength.

For ease in design, production, and maintenance . . . for improving the reliability and saleability of your products, the moisture resistance of TI deposited carbon MIL-Line resistors is just *one* field-proven factor. You also get a choice of 1, 2, or 5% tolerances . . . high stability over wide temperature ranges and under full load . . . low negative temperature coefficients . . . negligible voltage coefficient and noise levels . . . long shelf-life . . . wide selection of sizes and resistance values . . . reasonable prices . . . and, if desired, reel-type packaging for automation.

Here is a typical TI reel pack designed to speed production. TI precision deposited carbon resistors are mass produced and packaged in five sizes from ½ watt to 2 watts with resistance values from 25 ohms to 30 megohms.

For complete data, write for Bulletin DL-C 539.

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

Industry News

Col. Forrest W. Donkin, USAF (Ret.) has joined Page Communications Engineers, Inc., as Vice-President and Dir. of Operations, Western Div. Colonel Donkin was closely associated with the building of the first Ionospheric-Scatter Communications System.

John K. McDonough has been promoted to Vice President and General Sales Manager of General Instruments Corp. His experience of more than 15 years in the radio and TV industry has encompassed all phases of manufacturing, engineering, and purchasing, as well as sales.

J. K. McDonough

W. M. Pierce

Wayne M. Pierce, Jr. has been appointed Vice President for Engineering and Manufacturing at Norden-Ketay. He planned the layouts of operations for several of their plants. Mr. Pierce's offices are at Norden-Ketay's headquarters in Stamford, Conn.

Russel A. Schlegel is now General Sales Manager of the Weston Electrical Instrument Corp.

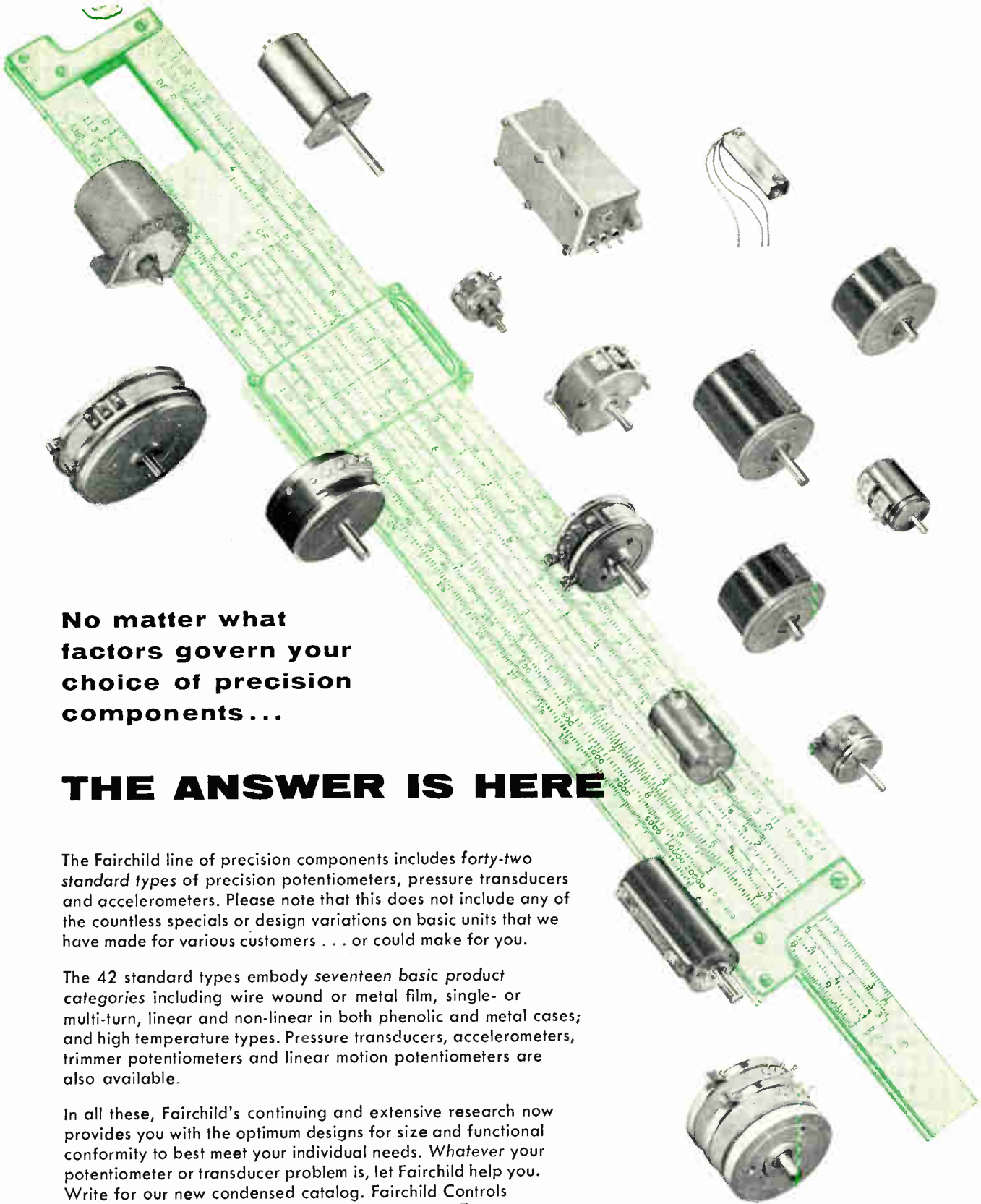
William W. Bumpus has joined Hycon Eastern, Inc. as General Manager of the Sales Div. Mr. Bumpus brings with him a broad background in electronics having been affiliated with the USAF Nuclear Weapons Program for 6 years.

Irving I. Ser has been named General Sales Manager of Astron Corp., East Newark, N. J.

J. R. Wolff is now Director of Research at Radiation Instrument Development Laboratory. He will correlate engineering and development between RIDL, Chicago, and the manufacture of their equipment by Intertechnique of Versailles, France.

Thomas Teigen has been made Manager of Sangamo's Advertising Dept. with full charge of its administration and direction.

(*Continued on page* 32)



No matter what factors govern your choice of precision components...

THE ANSWER IS HERE

The Fairchild line of precision components includes *forty-two standard types* of precision potentiometers, pressure transducers and accelerometers. Please note that this does not include any of the countless specials or design variations on basic units that we have made for various customers . . . or could make for you.

The 42 standard types embody *seventeen basic product categories* including wire wound or metal film, single- or multi-turn, linear and non-linear in both phenolic and metal cases; and high temperature types. Pressure transducers, accelerometers, trimmer potentiometers and linear motion potentiometers are also available.

In all these, Fairchild's continuing and extensive research now provides you with the optimum designs for size and functional conformity to best meet your individual needs. *Whatever* your potentiometer or transducer problem is, let Fairchild help you. Write for our new condensed catalog. Fairchild Controls Corporation, Components Division, Dept. 140-82E.

EAST COAST
225 Park Avenue
Hicksville, L. I., N. Y.

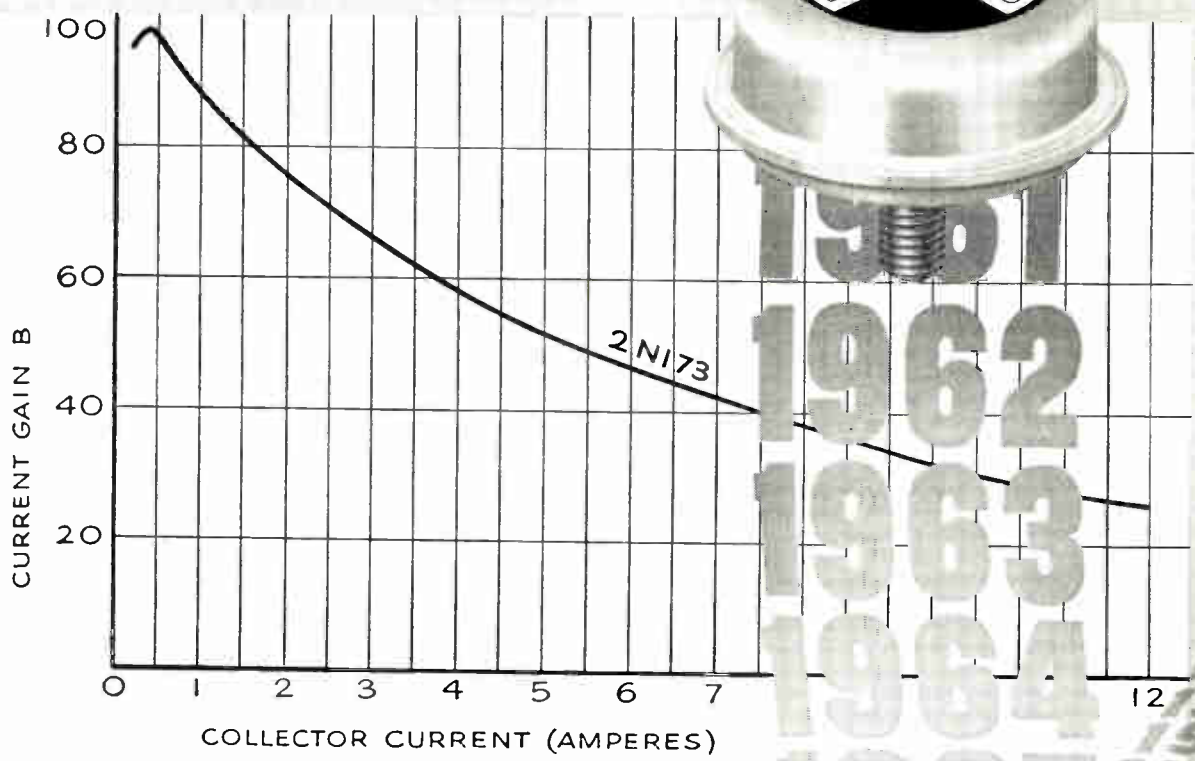
WEST COAST
6111 E. Washington Blvd.
Los Angeles, Calif.

FAIRCHILD
PRECISION POTENTIOMETERS and COMPONENTS

Circle 21 on Inquiry Card, page 97

Industry's Highest Power Transistors

Combine stability with long life



1957
1958
1961
1962
1963
1964
1965
1966

Delco Radio's 2N173 and 2N174 alloy junction germanium PNP transistors have unusual stability and reliability. These superior characteristics are retained by hermetic seal and proper internal atmosphere.

In addition, normalizing processes contribute to the high output power, high gain and low distortion characteristics that were designed into them. Delco Radio High Power transistors, ideal for your audio as well as general power applications, are produced by the thousands every day. Write for information and engineering data.

TYPICAL CHARACTERISTICS

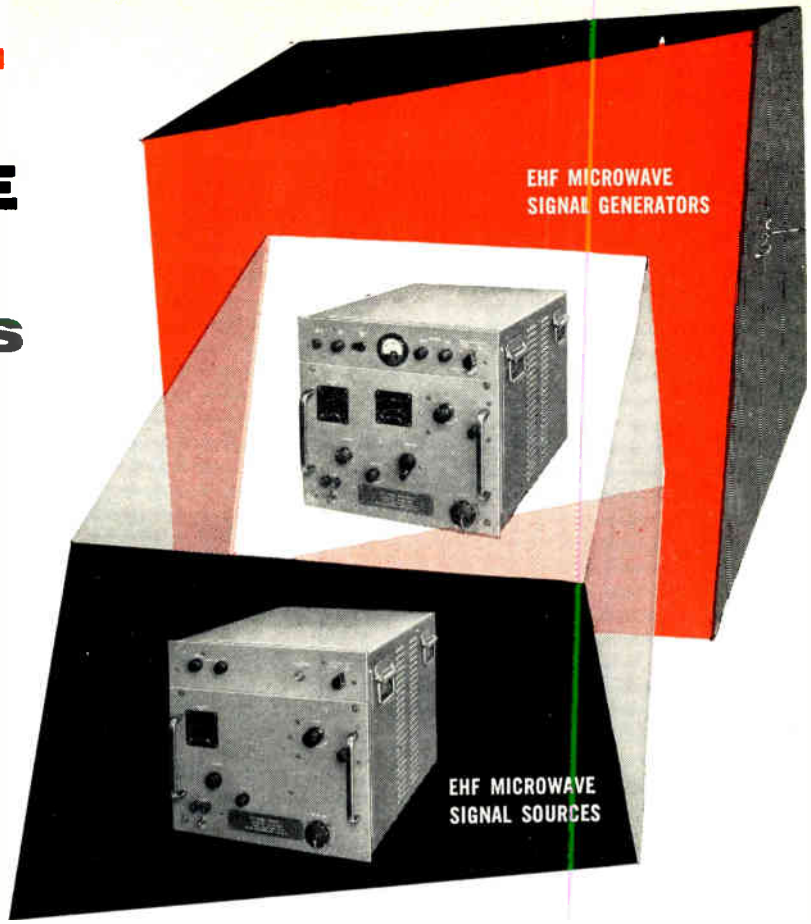
	2N173	2N174	2N277
Properties (25°C)	12 Volts	28 Volts	12 Volts
Maximum current	12	12	12 amps
Maximum collector voltage	60	80	40 volts
Saturation voltage (12 amp.)	0.7	0.7	0.7 volts
Power gain (Class A, 10 watts)	38	38	38 db
Alpha cutoff frequency	0.4	0.4	0.4 mc
Power dissipation	55	55	55 watts
Thermal gradient from junction to mounting base	1.2°	1.2°	1.2° °C/watt
Distortion (Class A, 10 watts)	5%	5%	5%

DELCO RADIO DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

Circle 22 on Inquiry Card, page 97

EHF MICROWAVE GENERATORS AND SOURCES

18,000 to 50,000 mc with PLUG-IN TUNING UNITS



Now, with the Polarad plug-in interchangeable tuning unit feature you can equip your laboratory with Extremely High Frequency generators and sources covering 18,000 to 50,000 mc permitting wide flexibility of operation at minimum cost. Each of the various tuning units requires no further adjustment after plug-in — all voltages and controls are automatically set for proposed operation.

These new Polarad self-contained instruments operate simply with direct reading, wavemeter dials. They provide cw or modulated signals of known frequency for field, production line and laboratory testing of microwave equipment, components and systems.

Write to Polarad or your nearest representative for complete information.

EHF Microwave Signal GENERATORS

- 7 plug-in r-f tuning units cover the frequency range from 18,000 to 39,700 mc.
- Direct-reading calibrated attenuator output, accuracy ±2 db.
- Frequency calibration accomplished by a ±0.1% direct-reading wavemeter.
- Internal 1000 cps square-wave modulation.
- Capable of external modulation, both pulse and fm.
- Equipped with integral electronically-regulated power supplies.

EHF Microwave Signal SOURCES

- 9 plug-in r-f tuning units cover the frequency range from 18,000 to 50,000 mc.
- Internal 1000 cps square-wave modulation.
- Capable of external modulation, both pulse and fm.
- Equipped with integral electronically-regulated power supplies.
- Frequency calibration accomplished by a ±0.1% direct-reading wavemeter.

SIGNAL GENERATORS Basic Unit Model HU-2		FREQUENCY RANGE	SIGNAL SOURCES Basic Unit Model HU-1	
Plug-In Tuning Unit Model No.	Power Output Calibrated		Plug-In Tuning Unit Model No.	Power Output Average
G1822	—10 to —90 dbm	18,000 — 22,000 mc	S1822	10 mw
G2225		22,000 — 25,000 mc	S2225	10 mw
G2427		24,700 — 27,500 mc	S2427	10 mw
G2730		27,270 — 30,000 mc	S2730	10 mw
G3033		29,700 — 33,520 mc	S3033	10 mw
G3336		33,520 — 36,250 mc	S3336	9 mw
G3540		35,100 — 39,700 mc	S3540	5 mw
		37,100 — 42,600 mc	S3742	Approx. 3 mw
		41,700 — 50,000 mc	S4150	Approx. 3 mw

Model SG-1218, Signal Generator and Model SS-1218 Signal Source are available to cover the frequency range 12,400 to 17,500 mc.

MODULATION:

Internal modulating:
Frequency ..... 1000 cps square wave.

Requirements for external pulse modulation:
Pulse repetition frequency.... 100 to 10,000 pps.
Pulse width rate..... 0.5 to 10 microseconds.
Pulse amplitude..... 10 volts peak, minimum.
Pulse polarity..... Positive.

Requirements for external frequency modulation:
Waveform ..... Sawtooth or sine wave.
Frequency ..... 50 to 10,000 cps.
Amplitude ..... Approx. 10 volts rms, to produce 40 mc deviation.

Reliable maintenance service throughout the country is an important part of the Polarad instrument.

For private demonstration without obligation ask for the

to stop at your plant

POLARAD
PROVEN RELIABILITY

ELECTRONICS CORPORATION
43-20 34th Street, Long Island City 1, N. Y.

REPRESENTATIVES: Albany, Albuquerque, Atlanta, Baltimore, Boston, Chicago, Cleveland, Dayton, Denver, Englewood, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, Rochester, St. Louis, San Francisco, Schenectady, Stamford, Syracuse, Washington, D. C., Winston-Salem, Canada: Arnprior, Ontario.
Resident Representatives in Principal Foreign Cities

Industry News

(*Continued from page* 28)

Keeton Arnett has submitted his resignation as a Vice-President of the Allen B. DuMont Laboratories, Inc. in order to accept the Executive Vice-Presidency of the Chamber of Commerce of Greater Phila.

Walter C. Byrne, Jr. has been promoted to the position of Sales Manager, for Motorola Microwave and Industrial Control Dept. Mr. Byrne joined the company as a Senior Engineer in 1950 and then became a specialist in microwave and industrial control products.

W. C. Byrne

P. J. Teich

P. J. Teich has been appointed Manager of Marine and Ordnance Radar Systems Engineering for General Electric's Heavy Military Electronic Equipment Dept. His engineering responsibilities have been related exclusively to military electronics systems.

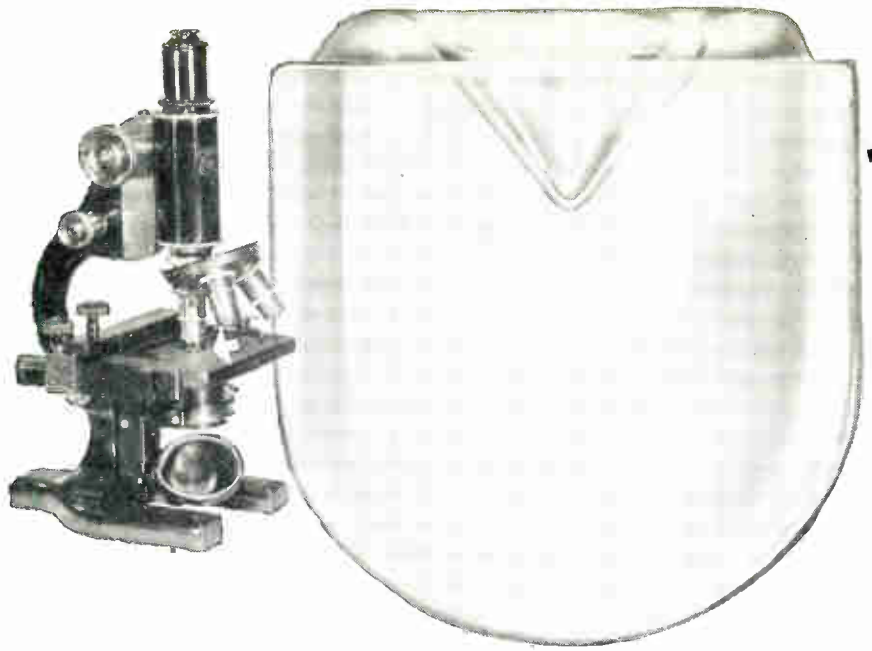
Dr. Lee L. Davenport will become President of Sylvania-Corning Nuclear Corp. upon its formation in the near future. He also has been appointed to an executive post with Sylvania Electric Products Inc. The new corporation is being formed as a jointly owned company by Sylvania and Corning Glass for expanded research, development and production activities in the atomic energy field.

Robert L. Colfax and **Otho C. Lindsey** are now Sales Managers of IRC, Hycor Div., Sylmar, Calif. and IRC's subsidiary, Circuit Instruments, Inc., St. Petersburg, Florida, respectively.

Dr. Harvard L. Hull, Vice-President of Litton Industries, Inc. has been named General Manager of the College Park, Md. subsidiary of the company, formerly the Ahrendt Instrument Co.

Donald C. Wagner was promoted from Production Manager to Plant Manager of Magnetic Research Corp., El Segundo, Calif.

(*Continued on page* 34)

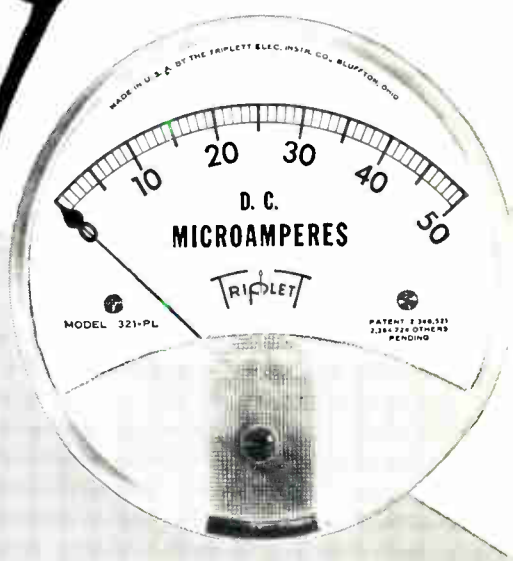


one important little detail 100 times enlarged!

Typical of the scientific technology that is behind Triplett's world wide reputation for reliability—these jewel pivot bearings are so minute that 1000 do not even half-fill this one-half inch bottle and every jewel is perfectly balanced with more painstaking care than the watchmakers' art.

Triplett current catalog offers more than 15,000 available types and ranges of clear plastic front and conventional design black plastic panel meters.

The identical careful accuracy and high reliability is available in the complete Triplett line of VOMs, VTVMs, scopes and other test equipment.



TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
Bluffton, Ohio

Over half a century of experience

Industry News

(Continued from page 32)

Dr. Robert P. Petersen, former Director of Nuclear research for Republic Steel Corp., was elected President of Applied Research Inc. He has played a prominent part in the development of the nations atomic energy program.

Andrew T. Fischer has been named Marketing Director for Alwac Corp. (formerly Logistics Research, Inc.). Mr. Fischer has been Sales Manager of RCA Computer Div. before joining Alwac.

A. T. Fischer

M. J. Volcansek

Brig. Gen. Max J. Volcansek, Jr. USMC (Ret.) has joined Texas Instruments Inc. in the Apparatus Div. Engineering Dept. He will be head of the Administrative Branch and will be responsible for all planning of an administrative nature.

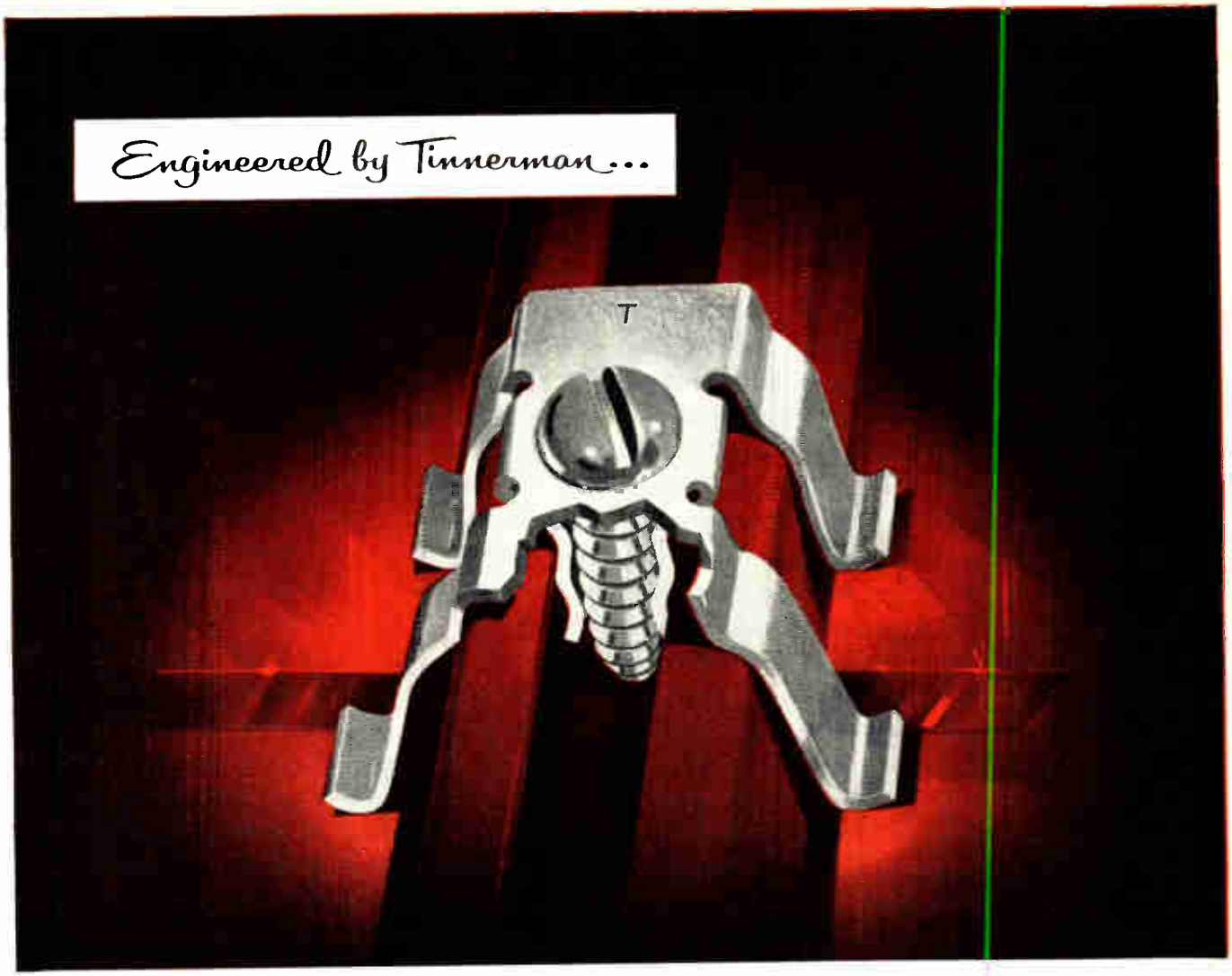
E. Philo Davis, formerly of Hughes Products, has joined the staff at Hoffman Labs.

Leslie A. Skinner, nationally known missile and rocket specialist has joined as Manager, RCA Missile Operations at the White Sands Proving Grounds.

E. V. Space for the newly created position as Manager, Equipment and Production Development, RCA Semi-Conductor Div.

Harold Hechtman will now serve as Director of Public Relations of Airborne Instrument Laboratory, Inc., Mineola, N. Y.

Harry E. Pinkerton has been named president of the Intercontinental Electronics Corp. (INTEC). Mr. Pinkerton's experience is particularly suited to the overall objective for which INTEC was created — the application of French Scientific Discoveries for the American market.



6-fingered **SPEED CLIP**®
holds glass panels tight, saves 46%!

This special SPEED CLIP fastens glass panels to aluminum extrusions with a grip that prevents slippage. Heat stays in, rain stays out of greenhouses and similar glass structures. Working closely with engineers of the Metropolitan Greenhouse Mfg. Corp., Brooklyn, Tinnerman developed this unique fastener that saves almost one-half the cost of former less effective assembly methods!

Installation is fast and simple. Two overlapping glass panels are positioned against the extrusion. A screw driven into the spring-steel SPEED CLIP spreads the two center fingers outward to grip the inner walls of the extrusion. No secondary fastening devices required—SPEED CLIPS hold tight, yet are easily removed to permit replacement of glass.

This is another example of a fastener engineered by Tinnerman to satisfy special, complicated fastening problems. A Fastening Analysis of your products may produce a similar cost-cutting solution. See your Tinnerman representative soon.

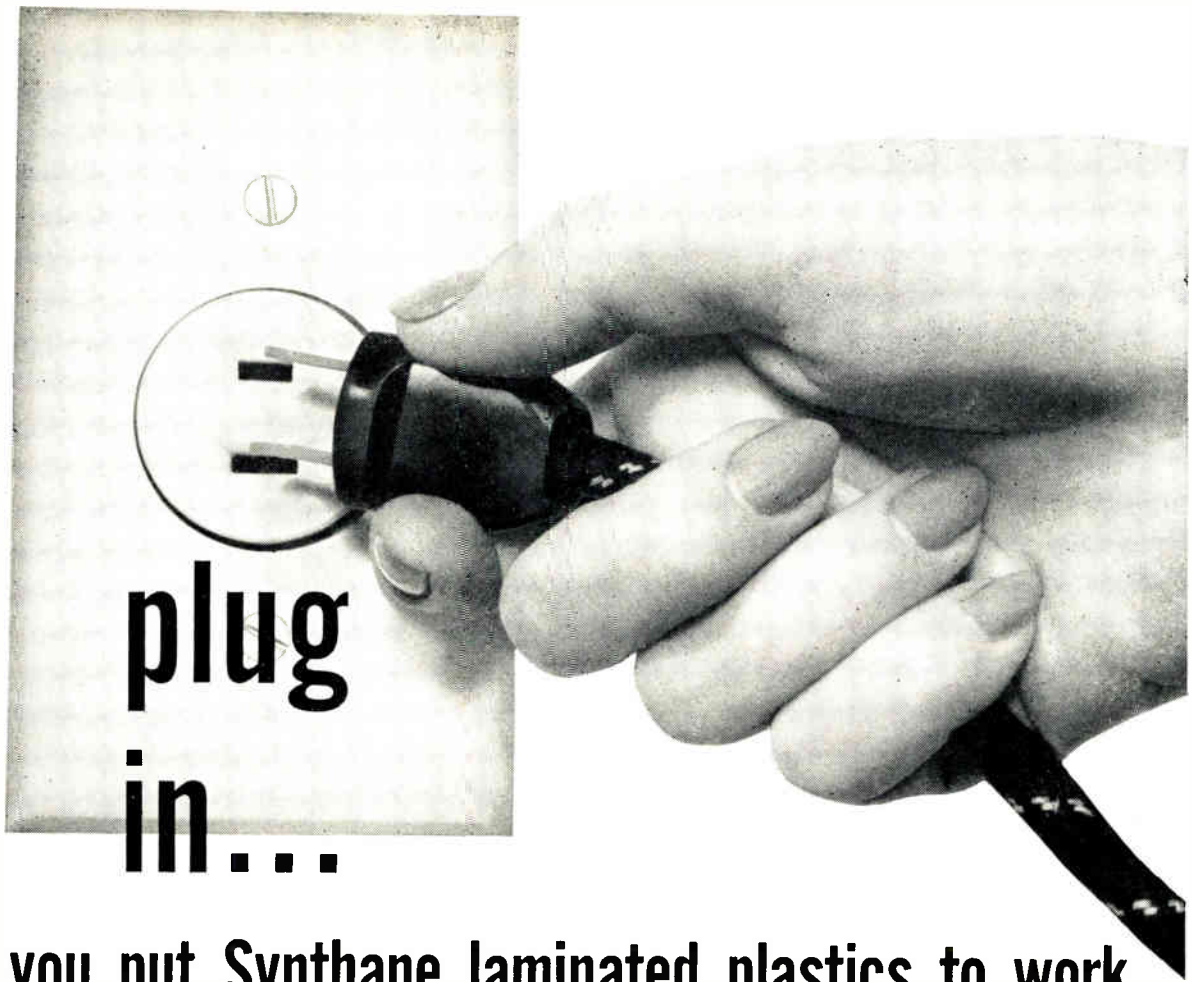
TINNERMAN PRODUCTS, INC.
BOX 6688 • DEPT. 12 • CLEVELAND 1, OHIO

TINNERMAN

Speed Nuts®

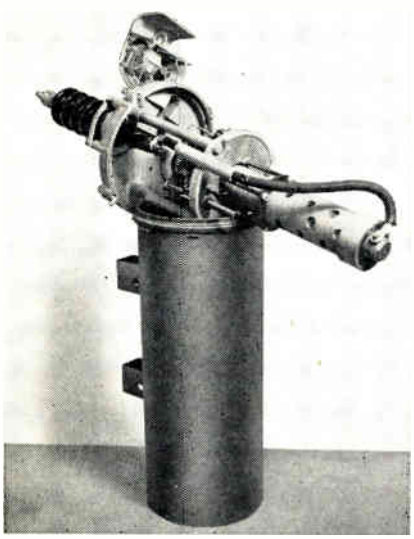
FASTEST THING IN FASTENINGS®

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. Great Britain: Simmonds Aerocessories, Limited, Treforest, Wales. France: Simmonds, S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). Germany: Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.



plug in...

and you put Synthane laminated plastics to work



Automatic Circuit Recloser Parts made from Synthane sheet and tube provide insulation for high voltages.

Think of the many conveniences available simply by plugging into an electrical outlet.

On both sides of the outlet Synthane laminated plastics are at work in power generation and distribution, home appliances and other electrical equipment.

You find Synthane laminated plastics in circuit breakers, buss bar coverings, transformers. Synthane laminated plastics are important insulators in toasters, ranges, food mixers. Synthane is at work in thermostats, voltage regulators, power tools.

Synthane is valued in electrical applications chiefly for its high dielectric strength, low moisture absorption and low dissipation factor plus its additional properties of dimensional stability, machinability and mechanical strength. Synthane is available in over 30 standard grades in sheet, rods, tubes or you can avail yourself of our complete fabricating services.

For more information about the many properties of Synthane and how you can benefit by using Synthane materials and fabricating services, write for our product catalog. Synthane Corporation, 11 River Road, Oaks, Pennsylvania.

DIELECTRIC STRENGTH

IMPACT STRENGTH

HEAT RESISTANCE

LIGHT WEIGHT

SYNTHANE ... industry's unseen essential

SYNTHANE CORPORATION, 11 RIVER ROAD, OAKS, PA.

build reliability into your product with OHMITE® COMPONENTS

close-control RHEOSTATS

All-ceramic and metal, close-control rheostats for unsurpassed dependability and smoothness of operation. Ten stock sizes, 25 to 1,000 watts.

wire-wound RESISTORS

A wide range of dependable, fixed, adjustable, tapped, and noninductive power wire-wound resistors. Also a wide range of precision resistors.

general-purpose RELAYS

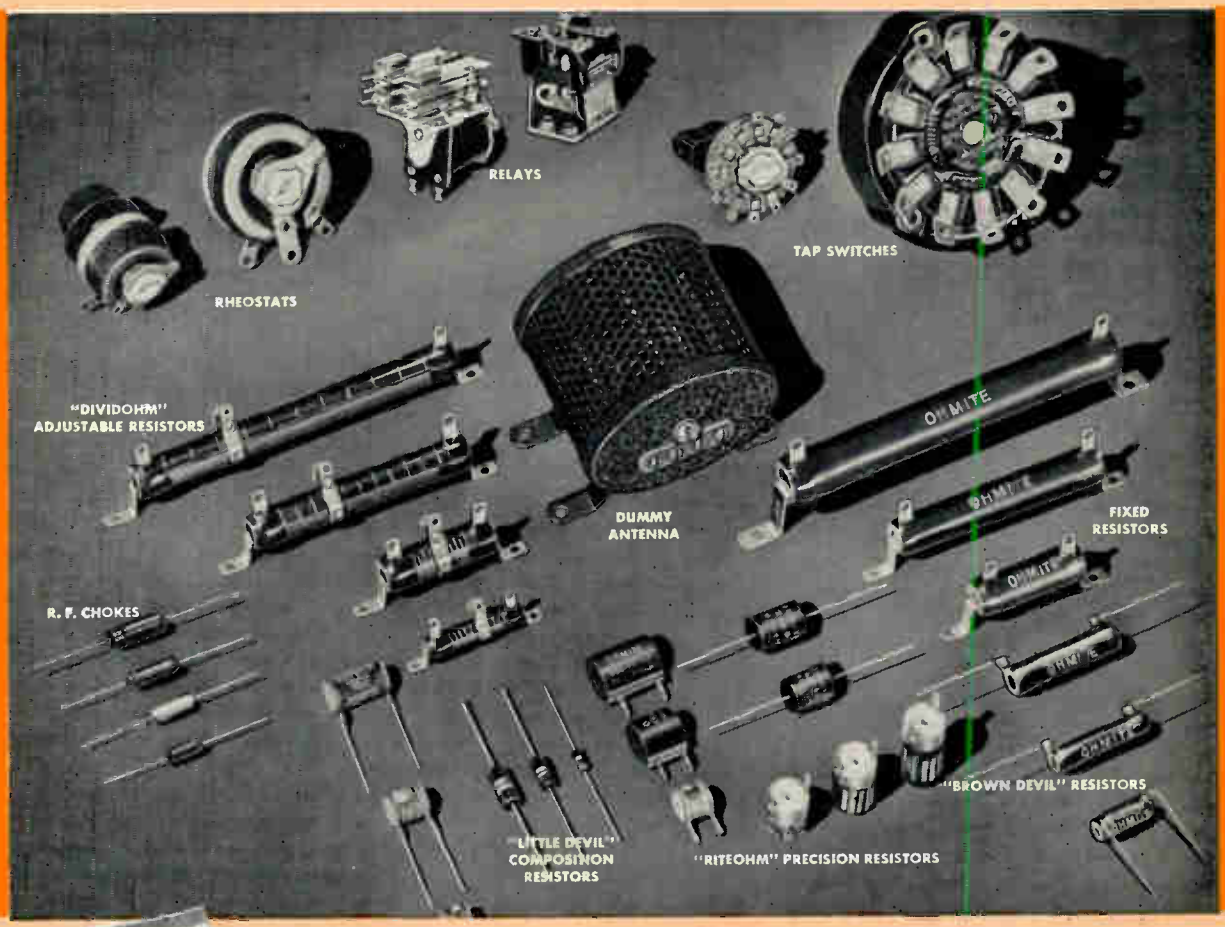
65 Types in four stock models. Good delivery on made-to-order relays. Contact current ratings up to 25 amps, AC or DC. Wide variety of contact arrangements. Hermetically sealed or dust-protective enclosures available.

high-current TAP SWITCHES

Five compact models, up to 100 amperes, AC, up to 12 taps. All-ceramic and metal construction. Silver-to-silver contacts, with self-cleaning rotor contact.

radio-frequency CHOKES

Single layer R.F. plate chokes and power line chokes on steatite or plastic cores. Protected by a special moisture-resistant coating.

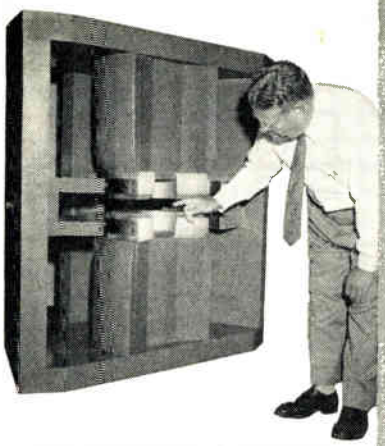


WRITE on Company Letterhead for Catalog and Engineering Manual.

Be Right with OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

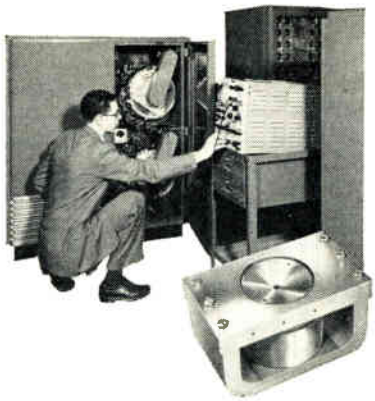
OHMITE MANUFACTURING COMPANY • 3662 Howard Street, Skokie, Illinois



MASS SPECTROMETER SEPARATES ELECTRON PARTICLES

This mass spectrometer for basic research in the petroleum industry required an extremely stable, high-intensity field which could be varied.

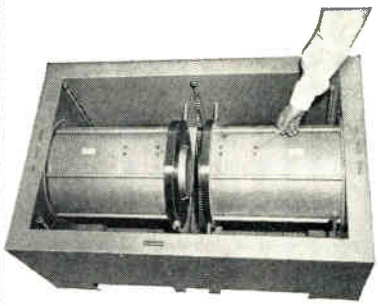
This assembly, which incorporates a massive 1,300-pound Indiana Alnico permanent magnet, provided the answer. It has a maximum field strength of 6,000 gauss, and stability is maintained without the use of complex control equipment normally associated with electromagnets.



ELECTRONIC "BRAIN" SENSITIVITY DEPENDS ON ALNICO

This electronic computer manufacturer required a permanent magnet housing for the magnetic tape reader and recorder unit of the processing machine in order to improve sensitivity.

Using Alnico for this housing brought on immediate improvement in signal strength . . . and better sensitivity because of the magnet's high efficiency.



NUCLEAR RESONANCE RESEARCH UNIT USES 1,000-LB. MAGNET

The University of Chicago, renown in the field of basic research, required a high intensity magnetic field to extend their research in nuclear resonance.

This huge permanent magnet assembly, containing over 1,000 pounds of Indiana Alnico, produces a field of 6,750 gauss. The stability — an inherent quality of permanent magnets — is maintained without the use of costly controls.

How three unusual products use Alnico permanent magnets plus creative design ... by Indiana

These dramatic examples of the use of Alnico permanent magnets illustrate how the creative engineering and manufacturing skill of The Indiana Steel Products Company have combined to meet the critical requirements of three unusual products.

This same experience can be put to work for you, too . . . regardless of application. Indiana offers the largest staff of magnet engineers and the most complete research and production facilities in the world to assist in the development of permanent magnets for use in your products.

Be sure your new designs incorporate the most efficient and economical magnet! Contact Indiana, today, for engineering assistance and recommendations—without cost or obligation, of course!

You can expect from Indiana:

- Uniform, high energy magnets
- 24-hour service on "stocked" Alnico V magnets for your product development work
- Engineering assistance with new magnet designs—no cost or obligation
- World's most complete magnet production and research facilities

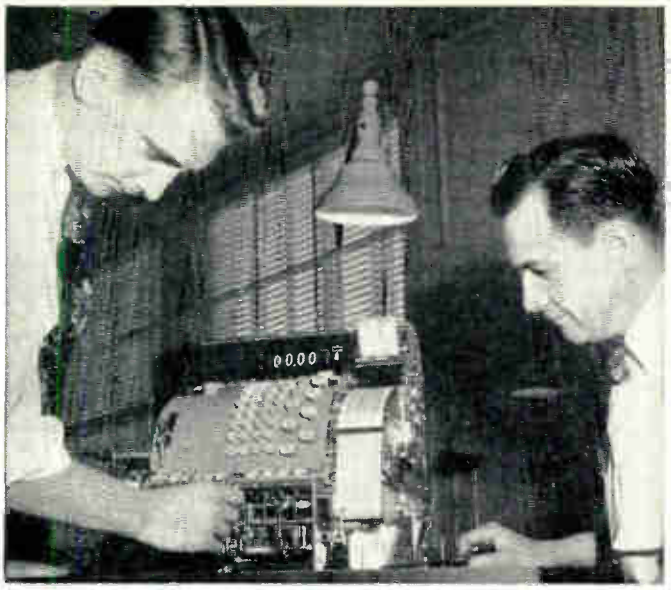
For your product development work, Indiana stocks a wide variety of standard Alnico V magnets—available immediately in experimental quantities. Write for Catalog 11-N4

THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

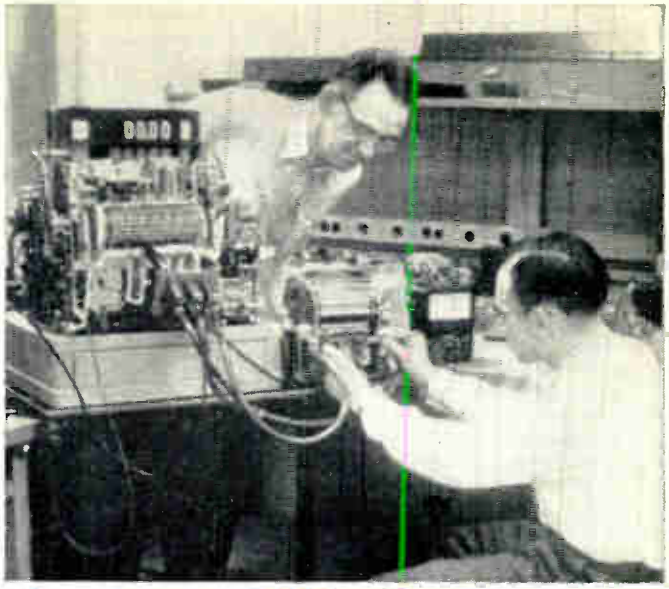
World's largest manufacturer of permanent magnets

IN CANADA: The Indiana Steel Products Company of Canada Limited • Kitchener, Ontario

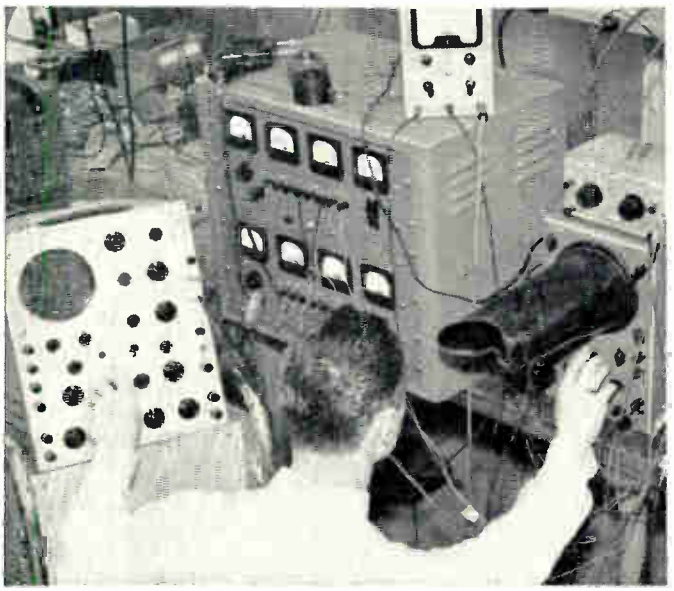
INDIANA PERMANENT MAGNETS



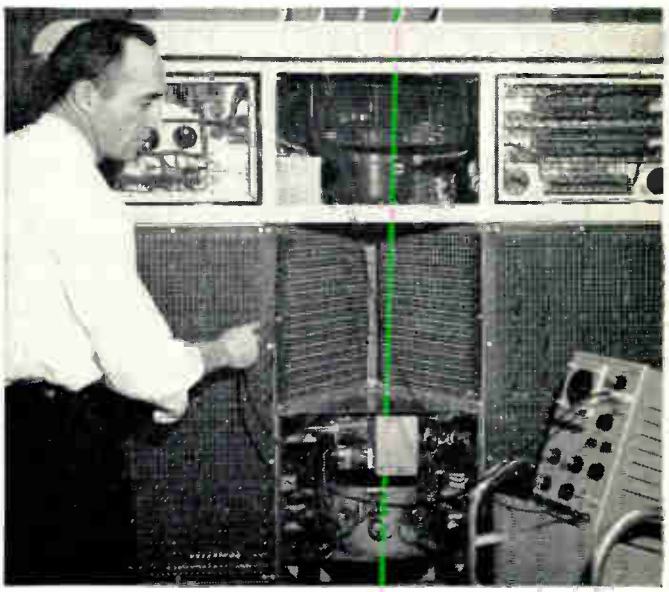
MECHANICAL ENGINEERS are using their skills in the design and development of new mechanisms required for business machines and for those mechanical products which are associated with electronic data processing equipment.



ELECTRO-MECHANICAL ENGINEERS are constantly faced with the problems of capturing information from the various input devices and converting this information into a usable form for subsequent use in data-handling equipment.



ELECTRONIC ENGINEERS enjoy an unparalleled freedom in the development of new types of circuitry and components which are necessary to maintain leadership in the competitive field of record-keeping automation.



COMPUTER ENGINEERS backed by the company's computer research since 1938 are developing an economical, flexible digital computer to meet the requirements of all record-keeping applications.

ENGINEERING UNLIMITED

AT ONE OF THE WORLD'S MOST SUCCESSFUL CORPORATIONS

If you are looking for a challenging opportunity with an established company which has tripled its sales in ten years—one that offers excellent starting salaries as well as permanent positions . . .

Act at once! Send resumé of your education and experience to Employment Department, Technical Procurement Sec. L, The National Cash Register Company, Dayton 9, Ohio.

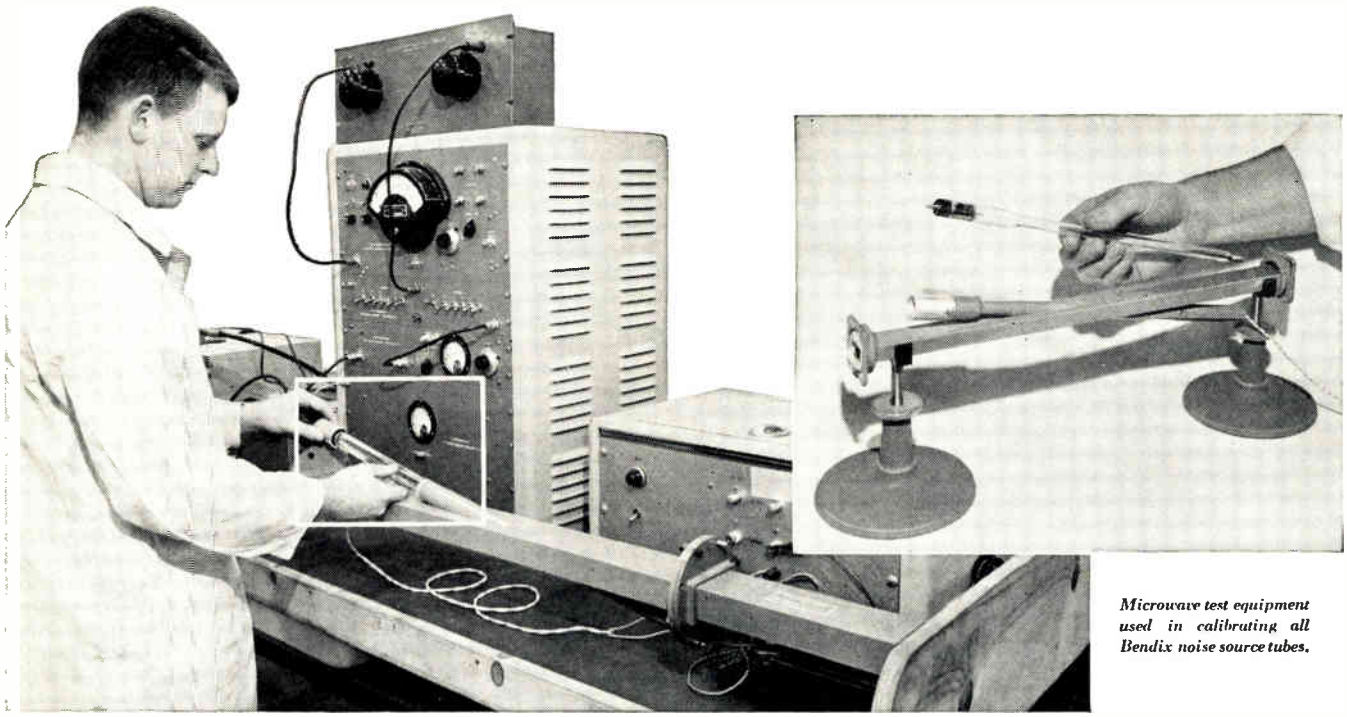
NCR

THE NATIONAL CASH REGISTER COMPANY

Bendix Red Bank

NOISE SOURCE TUBES

Offer unusual stability plus freedom from ambient temperature corrections



Microwave test equipment used in calibrating all Bendix noise source tubes.

As measured sources of noise power in microwave equipment, Bendix Red Bank noise source tubes offer several distinct advantages.

First, temperature changes and fluctuations in noise output present no problems with these tubes, because we make them so that no correction in noise figures is necessary over the range from −55°C. to +85°C. Next, our precise quality control works to close tolerances that produce unusual stability and long life—far beyond that usually found in noise source measuring equipment.

Finally, as can be seen in the table at right, Bendix Red Bank noise source tubes cover an extremely wide range of frequencies, so that there is no difficulty in finding a type to meet any specific need.

If you have any sort of application in measuring noise and sensitivity in microwave receiving equipment, check with us for the most efficient answer. Write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

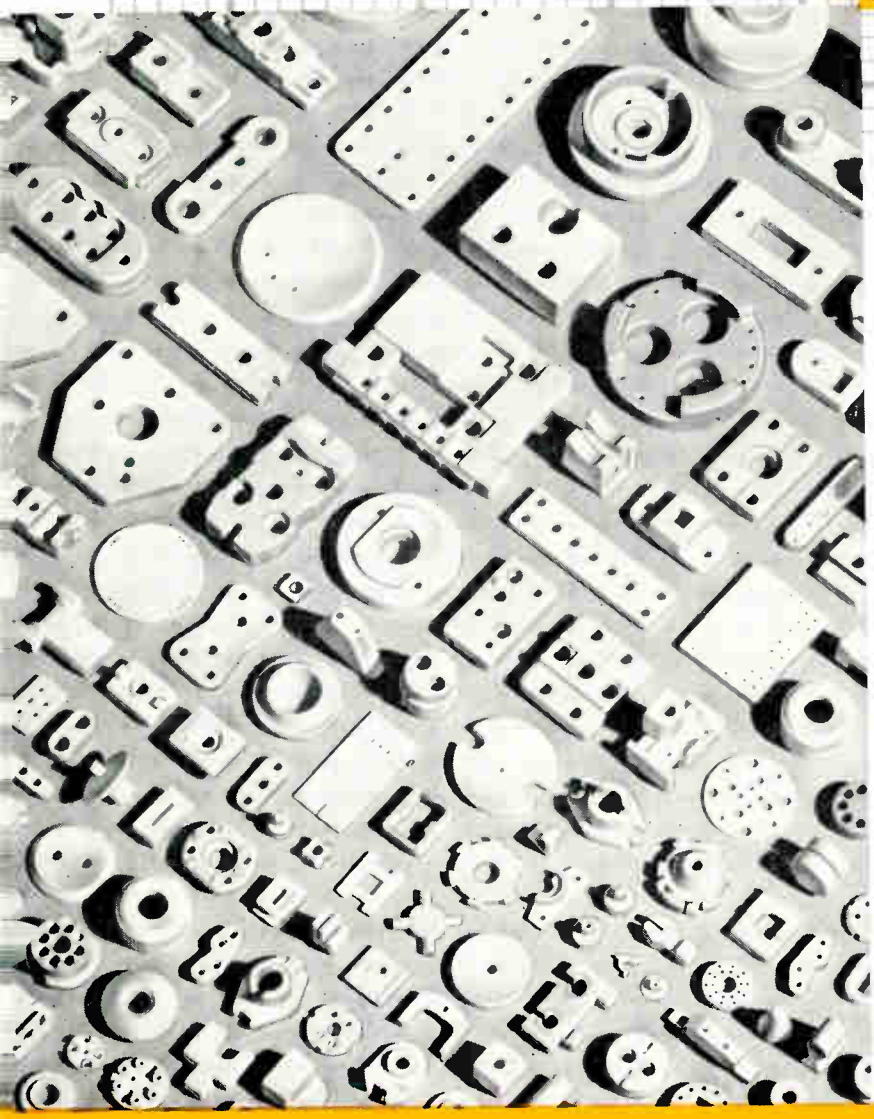
Bendix Type	RETMA No.	Waveguide No.	Frequency KMC	Anode Current MA	Nom. Tube Drop Volts	Nom. Noise Rating db	Mount Type
TD-10	6356	RG49/U	3.95-5.85	250	70	15.2	10°E
		RG50/U	5.85-8.20				
TD-11	6357	RG25/U	8.20-12.40	200	75	15.2	10°E
TD-12	6358	RG48/U	2.60-3.95	250	80	15.2	10°E
TD-13	6359	RG53/U	18.00-26.50	200	65	15.2	10°E
TD-18	6684	RG91/U	12.40-18.00	200	70	15.2	10°E
TD-21	—	RG69/U	1.12-1.70	250	65	15.2	90°H
TD-22	—	RG48/U	2.60-3.95	250	45	15.2	90°H
TD-23	—	RG52/U	8.20-12.40	200	115	18.0	10°E
TD-24	—	WR 229	3.30-4.90	250	65	15.2	10°E

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif.
Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
Canadian Distributor: Aviation Electric Ltd., P.O. Box 6102, Montreal, Quebec

Red Bank DIVISION — Bendix AVIATION CORPORATION

Improves your product. Lowers your costs...

ALSIMAG®
die pressed ceramics



If you need a strong, low cost component . . . custom made for your application . . . with superior electrical characteristics . . . great thermal shock resistance . . . produced to close dimensional tolerances . . . available in volume . . . it will pay you to investigate the "plus" values of AlSiMag pressed ceramics.

Most complete choice of special characteristic materials in the industry, including new and rugged AlSiMag Alumina "super ceramics." Wide latitude in design. Strict Quality Control. Dependable uniformity. Fast deliveries. Batteries of high speed presses. Complete equipment for the most efficient and economical production of parts to specification in any quantity. Ample facilities for volume raw material preparation, firing and machining.

Prototype service available. Check performance under actual operating conditions **before** placing orders for tooling, quantity lots.

Send sketch with detailed specifications for prices and suggestions from our highly specialized Engineering Department on material and design. No obligation.

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

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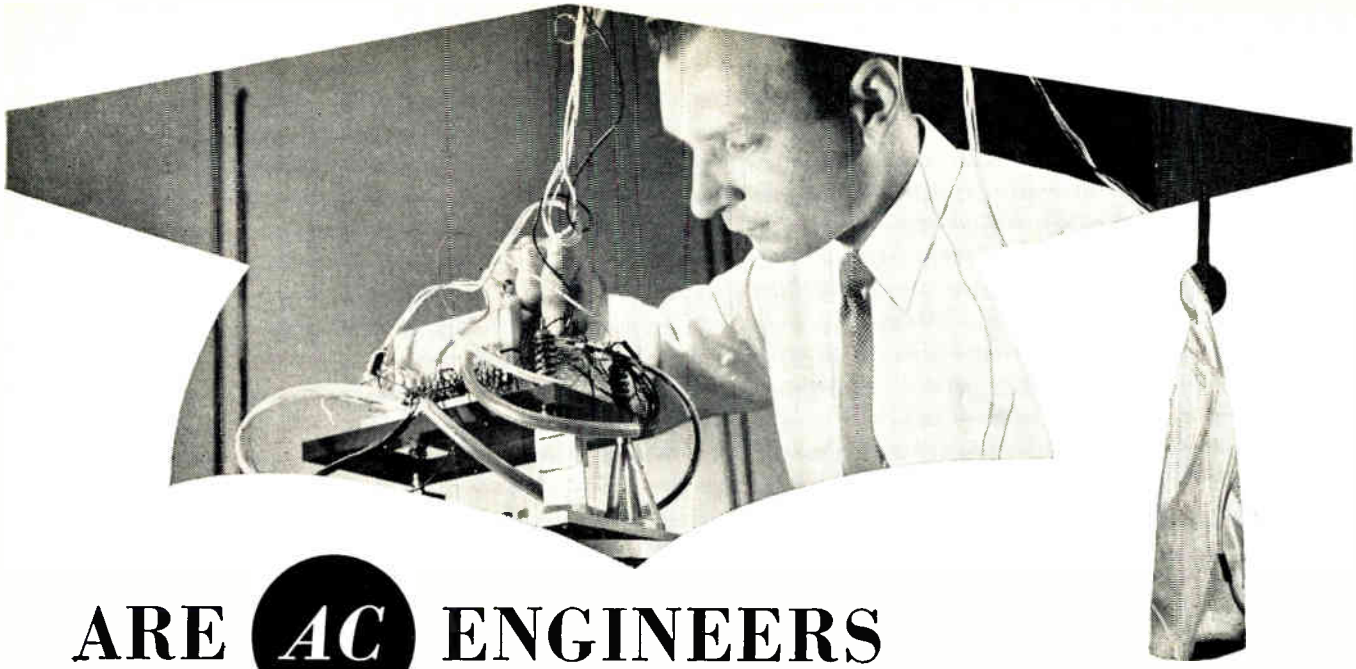
55TH YEAR OF CERAMIC LEADERSHIP

For service, contact Minnesota Mining & Manufacturing Co. Offices in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Calif. • New York: Ridgefield, N. J. • Philadelphia, Pa. • Pittsburgh, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Calif. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ont. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.



ARE AC ENGINEERS really smarter?

Many are the absolute top men in their respective fields.

Currently, we are actively engaged in the fields of Avionics, Missile Guidance, (IRBM), Computers (Digital and Analog), Jet Engine Fuel Controls, Land to Air—Shore-to-Ship Communication Equipment, etc.

We are permanently dedicated to RESEARCH and DEVELOPMENT in every conceivable field of ELECTRONICS.

Opportunities for your personal development are unlimited. G.M.'s policy of decentralization creates exceptional opportunity for individual advancement. Starting wages are high, you work with the finest of equipment on challenging problems. Construction is already under way for an additional plant (225,000 square feet) in an exclusive Milwaukee suburb.

MASTER'S DEGREE GRADUATE PROGRAM

AC has worked out a Master's Degree Graduate Program (evenings) at the University of Wisconsin, Milwaukee. AC pays all tuition fees for this program.

Undergraduate programs are also available at Wisconsin, Marquette and Milwaukee School of Engineering.

For your future's sake, you too be smart—send for complete facts and employment application form to Mr. Cecil E. Sundeen, Supervisor of Technical Employment.

AC THE ELECTRONICS DIVISION
GENERAL MOTORS CORP.

Milwaukee 2, Wis. Flint 2, Mich.

Now...an accomplishment so far reaching it will change the sights of all rectifier users

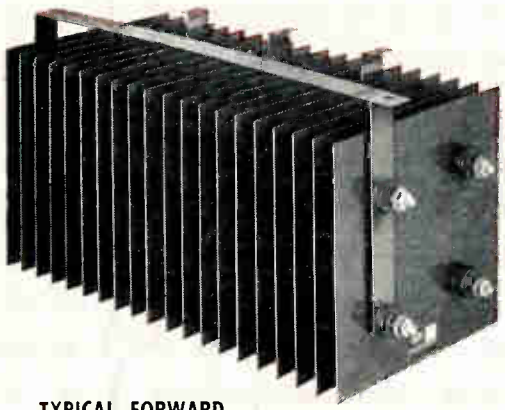
RADIO RECEPTOR'S improved new vacuum process

* PETTI-SEL

** High Current Density*

Industrial type SELENIUM RECTIFIERS

Developed by the famous Siemens Organization of West Germany and now manufactured by Radio Receptor Co. in the U. S. A.



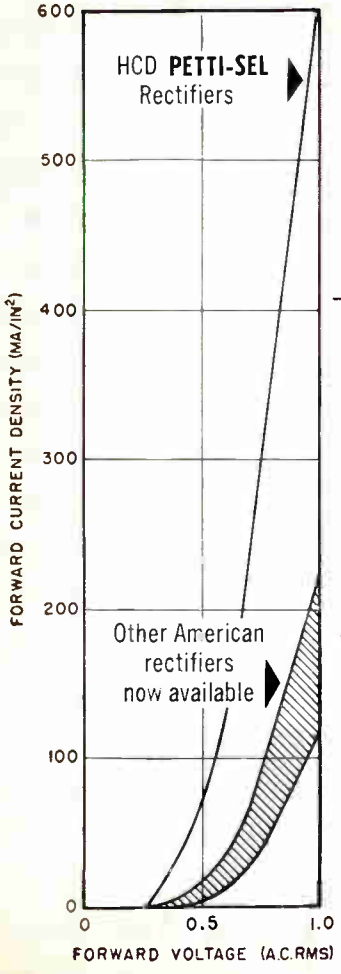
Estimated life 100,000 hours

Much smaller cell sizes than conventional units of the same ratings

Lower forward voltage drop

Suitable for high temperature applications

TYPICAL FORWARD CHARACTERISTICS

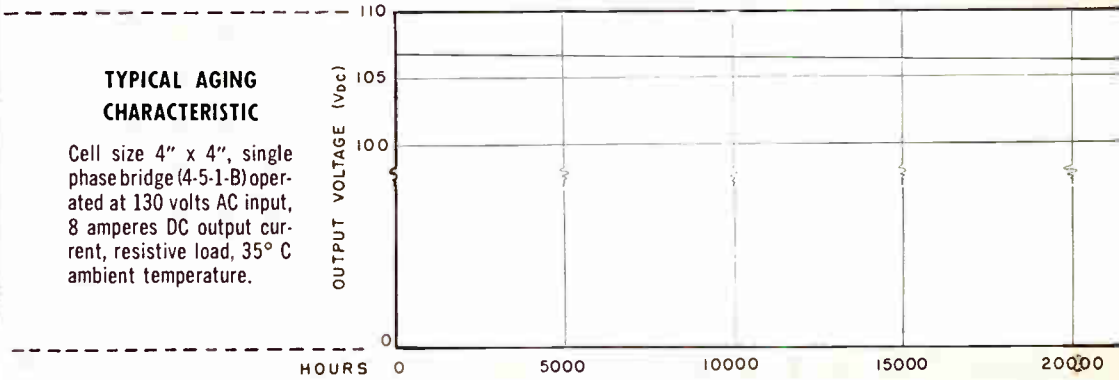


Far smaller in size than other rectifiers of the same current ratings, the new Radio Receptor HCD Petti-Sel units are manufactured under laboratory controlled conditions with fully automatic machinery, assuring new standards of product uniformity.

Field experience extending over several years with these rectifiers indicates an estimated life of 100,000 hours. This is largely attributable to the special process requiring no artificial barrier layer. Low forward voltage drop and low aging rate make the new Petti-Sel Rectifiers applicable to magnetic amplifiers and other control applications.

TYPICAL AGING CHARACTERISTIC

Cell size 4" x 4", single phase bridge (4-5-1-B) operated at 130 volts AC input, 8 amperes DC output current, resistive load, 35° C ambient temperature.



Watch for further announcements of unique developments on these history-making rectifiers. If you would like our new bulletin as soon as it is available, write today to Section T-3-R.

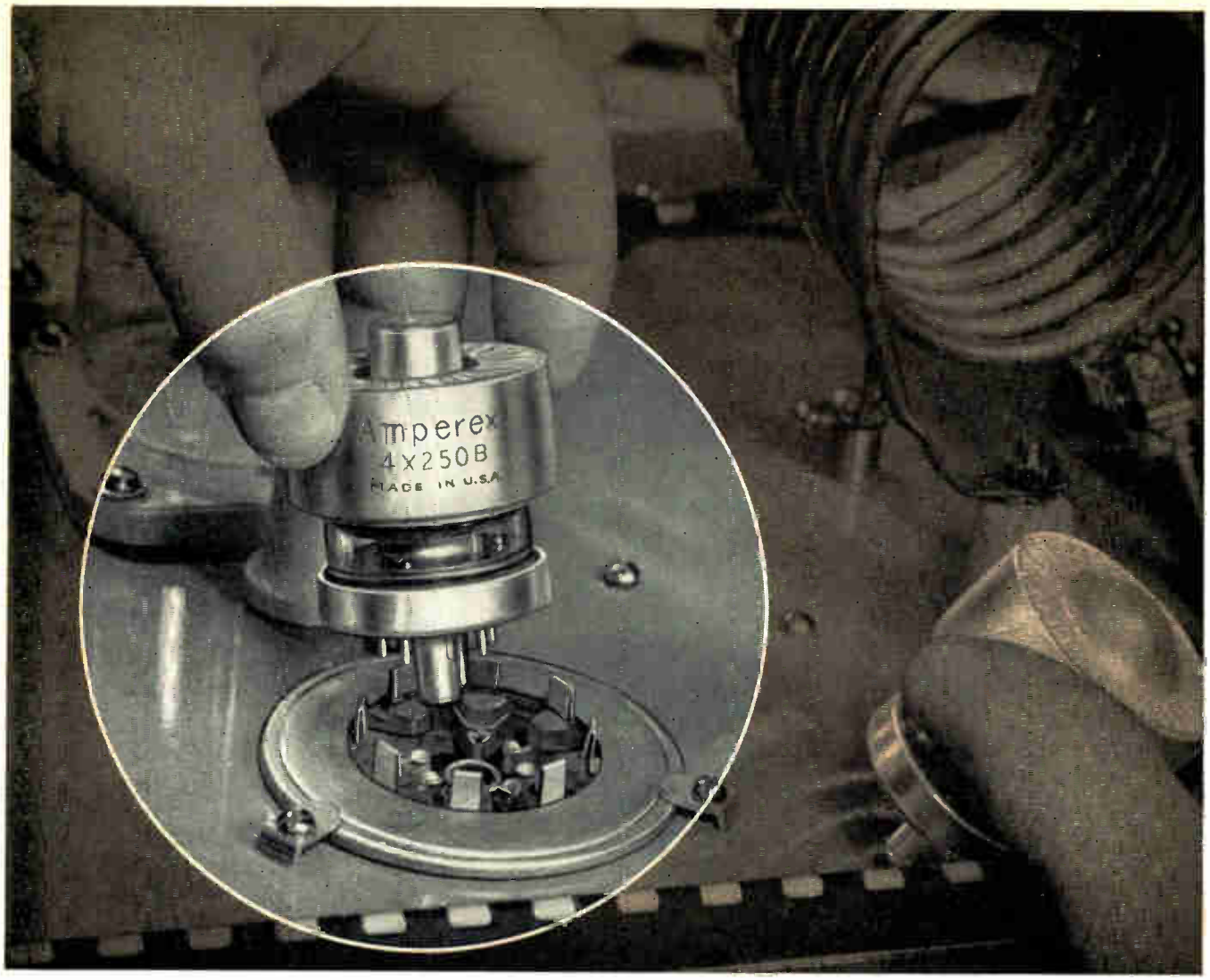
Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

Radio and Electronic Products Since 1922

240 Wythe Avenue, Brooklyn 11, N. Y. • EVergreen 8-6000

Radio Receptor Products for Industry and Government: Selenium Rectifiers • Germanium Diodes Thermotron Dielectric Heating Generators & Presses • Communications, Radar & Navigation Equipment



If it's a 4X250B by **Amperex**...*you know it's*

interchangeable

electrically and physically with the 4X150A!

Amperex TYPE 4X250B AS R-F POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(key-down conditions, per tube)

MAXIMUM RATINGS

DC Plate Voltage	2000 volts
DC Screen Voltage	300 volts
DC Grid Voltage	—250 volts
DC Plate Current	250 ma
Plate Dissipation	250 watts
Screen Dissipation	12 watts
Grid Dissipation	2 watts

TYPICAL OPERATION

DC Plate Voltage	500	1000	1500	2000 volts
DC Screen Voltage	250	250	250	250 volts
DC Grid Voltage	—90	—90	—90	—90 volts
DC Plate Current	250	250	250	250 ma
DC Screen Current	45	35	30	25 ma
DC Grid Current	32	28	28	27 ma
Peak RF Grid Voltage (approx.)	118	116	116	115 volts
Driving Power	3.6	3.2	3.2	2.8 watts
Plate Power Input	125	250	375	500 watts
Plate Power Output	85	195	300	410 watts

The 4X250B has numerous applications as a replacement, in existing circuits, for the 4X150A, where longer life and additional plate dissipation up to 500 Mc are required. It is therefore imperative that the brand of 4X250B you choose be an *exact* plug-in replacement for the 4X150A – meaning the identical base, identical dimensions, identical electrode inductances and identical interelectrode capacitances. With the AMPEREX 4X250B you can be certain of getting just that – *total* electrical and physical interchangeability!

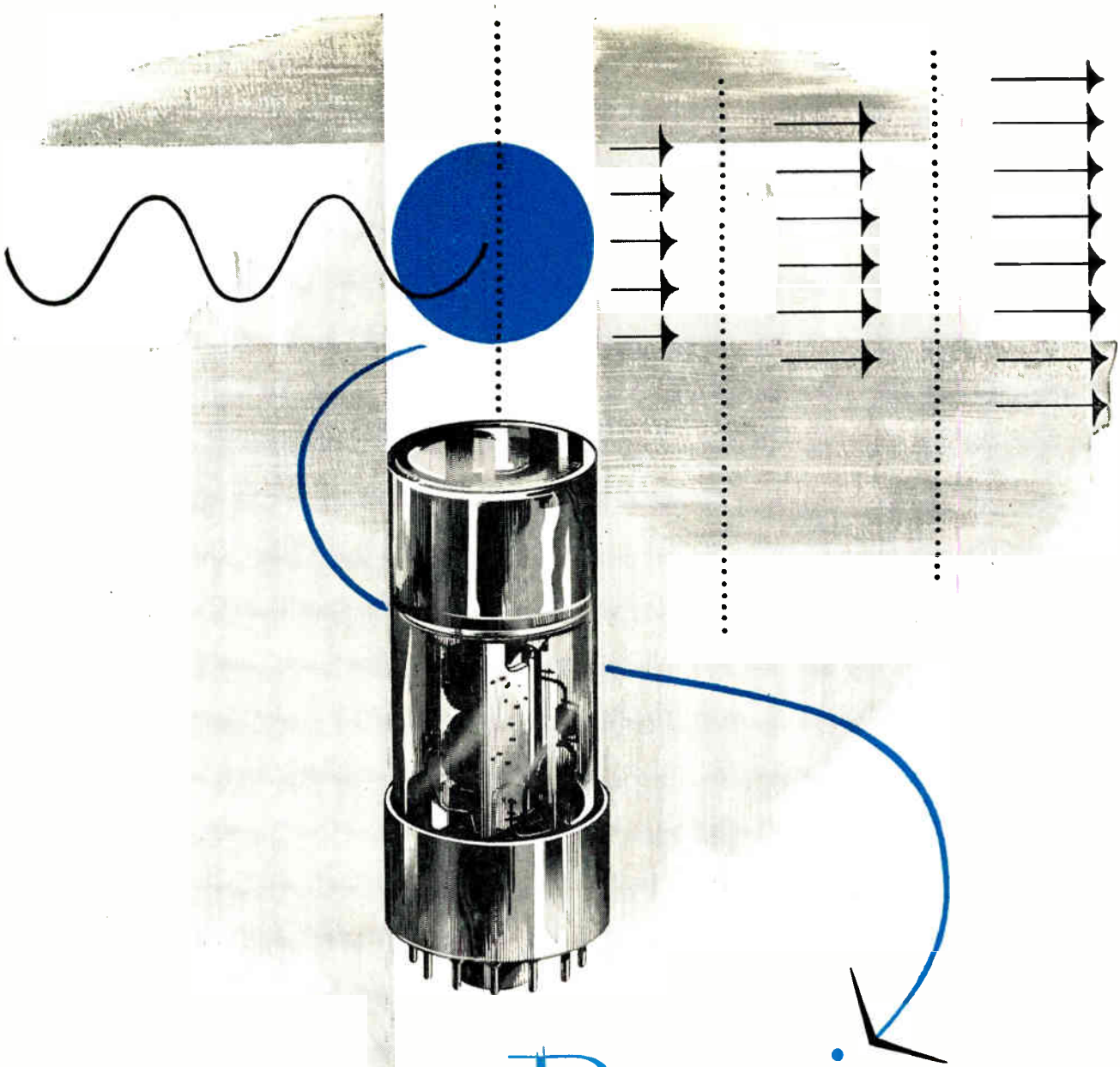
Write for Detailed Data Sheets

Amperex ELECTRONIC CORP.

230 Duffy Avenue, Hicksville, Long Island, N.Y.

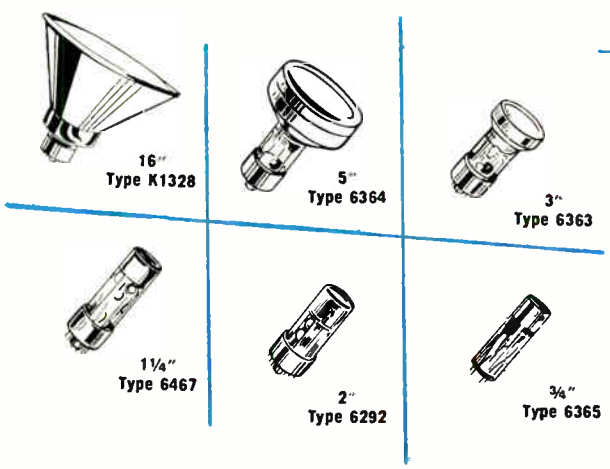
In Canada: Rogers Electronic Tubes and Components
11-19 Brentcliffe Road, Leoside, Toronto 17, Ont.

Circle 36 on Inquiry Card, page 97



Precise

PHOTOELECTRONICS*



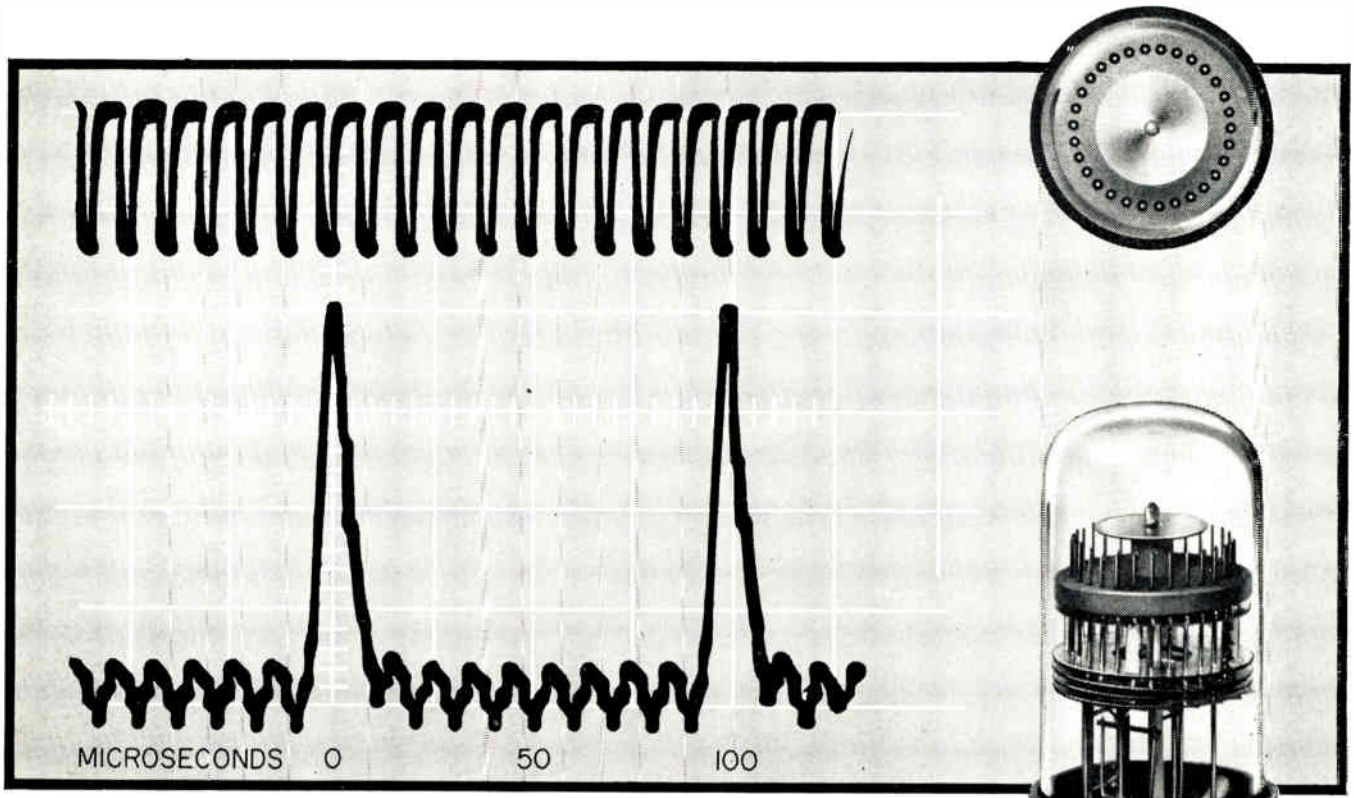
* The conversion of light input to highly magnified electrical output in a dependable, precise relationship.

Depend on Du Mont Multiplier Phototubes for precise quantitative and qualitative measurements. Available in a wide selection of sizes and electrical characteristics for every photoelectronic need.

DU MONT®

Industrial Tube Sales, ALLEN B. DU MONT LABORATORIES, INC. 2 Main Ave., Passaic, N. J.

Now—only from Sylvania



Zero cathode output at 100 KC. Short recovery time makes it possible to achieve 100 KC counting speed and respond reliably to random pulses such as those received from radiation detection devices.

NEW *HIGH SPEED* COUNTER TUBES

—wrap 100 KC counting circuits into a single envelope

Sylvania answers the designer's biggest need for high speed bi-directional counting. Now with these 100 KC tubes designers can minimize circuitry in counters requiring multiple stages and re-setting functions, work previously done with numerous vacuum tubes and neon-indicators.

These high speed counter tubes exhibit the same neon glow characteristics as the lower speed types. Thus it is possible to design a 100 KC stage into a counter and retain readout color uniformity on the instrument panel.

And they make it possible to design smaller, lighter, counter instruments at lower cost. Write for complete details. Address Department D40R.

Now, Sylvania is your leading source for both medium and high speed counter tubes

Type	Freq.	Output Cathodes	Base	Min. D.C. Supply Voltage	Max. Anode Current
6909	100KC	4(0,5,8,9)	Octal	400 V.	1.2 ma
6802	4KC	4(0,5,8,9)	Octal	400 V.	0.6 ma
6910	100KC	10	Duo Decal	400 V.	1.2 ma
6476	4KC	10	Duo Decal	400 V.	0.6 ma
6879	5KC	3(0,8,9)	7-pin	320 V.	0.8 ma

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Building, Montreal

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

Letters

to the Editor

"Crystal Ball"

Editor, ELECTRONIC INDUSTRIES:

As a result of the article on my "Crystal Ball" which you published in the February issue of "ELECTRONIC INDUSTRIES AND TELE-TECH," the response has been something more than astounding, including telephone calls and flying visits from all over the country. Already there have been many hundreds of inquiries, and interest appears to be snow-balling. A pattern of interest has begun to take shape.

James R. Alburger
President
Shannon Luminous Materials Co.

Editor's note:

Mr. Alburger has summarized the number of new applications of "Electroflors" which have come to mind as a result of the above inquiries. Copies may be obtained by writing to the Editor, ELECTRONIC INDUSTRIES & Tele-Tech, Chestnut and 56th Sts., Philadelphia 39, Pa.

"New Look"

Editors,
ELECTRONIC INDUSTRIES:

I certainly have been favorably impressed by the "new look" displayed by the last dozen or so editions of Tele-Tech. I think you are doing an excellent job; kindly accept my congratulations.

Irving Gottlieb
Calif. Registered Electrical Engineer #3207
1592 Waxwing Ave.
Sunnyvale, Calif.

Editor, ELECTRONIC INDUSTRIES:

The expanded format of ELECTRONIC INDUSTRIES has constantly caught my eye and I am quite pleased with the development of your publication.

R. T. Silberman
Kin Tel (Kay Lab)
5725 Kearney Villa Rd.,
San Diego, Calif.

Editor, ELECTRONIC INDUSTRIES:

Keep up the good work on the wide variety of articles of general interest as well as those for specific segments of the field of electronics. It helps us keep up with what is going on. The January, 1957 issue is an excellent illustration of this.

Harold I. Peters
Chief Engineer
Radio Station WOMI
Owensboro, Ky.

Westinghouse **IGNITRON TUBES** still the industry standard.

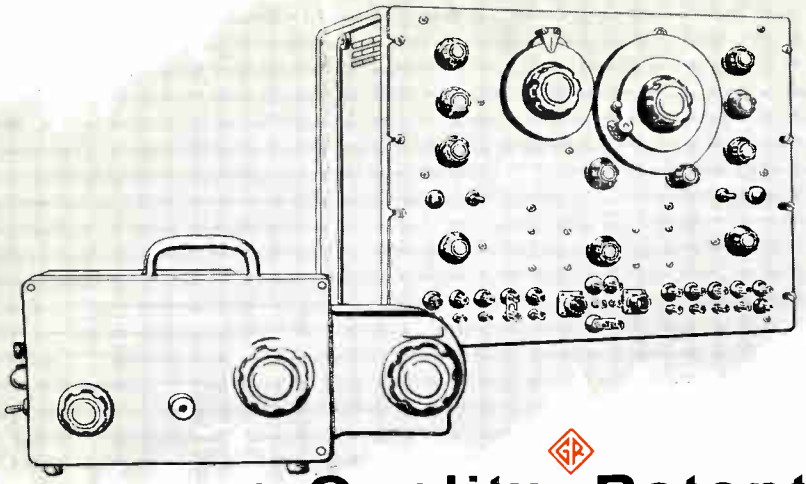
Westinghouse invented the Ignitron tube and has maintained a record of improvements that are today the accepted industry standards:

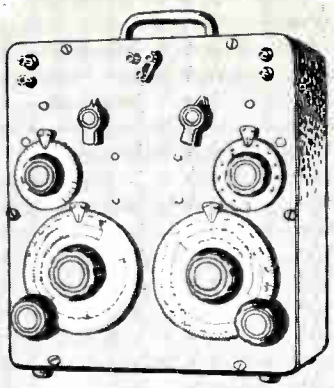
- kovar seals to permit use of steel envelopes
- improved ignitors to assure accurate ignition.
- thermostatic control for overload protection and water savings.

For highest quality Industrial and Special Purpose tubes—always specify Westinghouse.

7ET-4103-B

YOU CAN BE SURE...IF IT'S Westinghouse





a Quality Potentiometer for a Quality Product

The General Radio Type 970 Potentiometer serves as a basic element in a variety of electronic and electro-mechanical apparatus. But, perhaps the greatest recommendation that can be given this Potentiometer is that it is used in precision laboratory measuring equipment of all kinds, including G-R instruments, requiring the utmost in component performance and reliability.

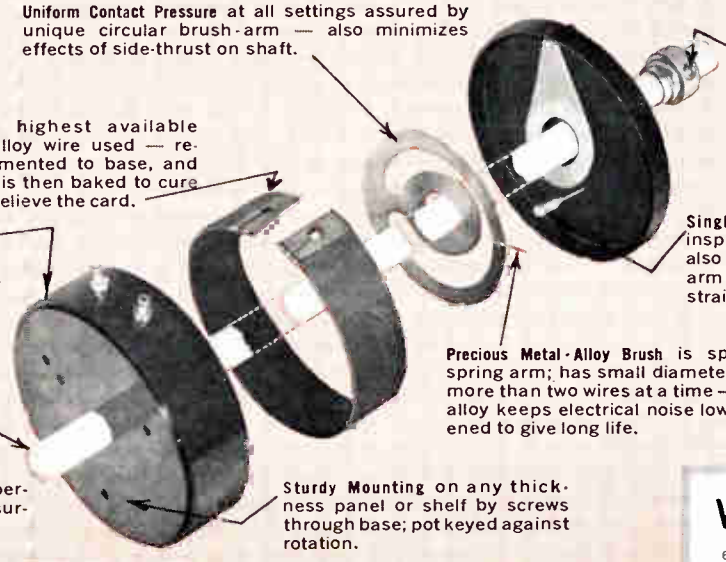
The new General Radio Types 1391-A Pulse and Time-Delay Generator, 1603-A Universal Impedance Bridge, and 1750-A Sweep Drive — the finest instruments of their kind — use 970 Potentiometers. Mechanical and electrical performance approaching the best available has been obtained at low cost through a unique simplicity of design and utilization of the latest in materials and manufacturing techniques. Individual inspection for conformance with linearity and noise specifications insures that *every* unit shipped is up to these high standards.

Write For The G-R Potentiometer Bulletin For Complete Specifications

Type 970 Series Potentiometers

- ✓Linearity Better Than ±0.2% for larger units, graded to ±2% for smaller sizes (stable with age and over wide range of environmental conditions).
- ✓17 Sizes from 2 to 500,000 ohms — 2- to 20-watt ratings at 40°C ambient — 1¼" to 4¼" diameters.
- ✓Ganged units available with no loss of excellent low-capacity characteristic offered by individual units.

Low Cost — **$3.50 to $10.00**



Uniform Contact Pressure at all settings assured by unique circular brush-arm — also minimizes effects of side-thrust on shaft.

External Phasing — screws in projecting hub secure the shaft, permitting convenient shaft orientation without opening case.

Track Durability — highest available grades resistance-alloy wire used — resistance card is cemented to base, and complete assembly is then baked to cure cement and stress-relieve the card.

Single Cover Retaining Screw permits easy inspection even when pot is mounted — also serves as brush stop; strikes brush arm 180° from brush so as not to bend or strain spring.

All Phenolic Case for minimum capacitance to ground — no unequal curing or aging stresses, insuring uniformly concentric surface for wound-wire card — cleanliness resulting from complete enclosure keeps noise low.

Precious Metal-Alloy Brush is spot welded to spring arm; has small diameter to contact no more than two wires at a time — noncorrosive alloy keeps electrical noise low, is heat hardened to give long life.

Glass-Reinforced Polyester provides superior electrical performance, strength, and insurance against warpage.

Sturdy Mounting on any thickness panel or shelf by screws through base; pot keyed against rotation.

Versatility

In addition to potentiometers normally stocked, units will be provided on special order with: 360° mechanical rotation — taps as close as ¼" apart along entire winding — special all-metal or metal-filled shafts — resistance values other than standard — resistance functions other than linear — resistance and linearity tolerances better than standard.

Attractive prices can be offered when quantities are sufficient to warrant special production.

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ELECTRONIC INDUSTRIES
& TELE-TECH

M. CLEMENTS, Publisher • O. H. CALDWELL, Editorial Consultant • B. F. OSBAHR, Editor

GAW & Unionization

In the past month there have been two important announcements by labor that have a direct bearing on the electronic industries. The first is that the IUE (International Union of Electrical, Radio & Machine Workers of America) will seek to introduce GAW (guaranteed annual wage). The second is that attempts will be made to unionize electronic engineers.

Both of these efforts can have serious consequences. GAW in the radio and television industry for example, can spell the difference as to whether medium sized or smaller organizations can remain in business. There appears little doubt that its introduction will cause higher prices and add more fuel to the inflationary spiral.

At the present time the unions claim to represent about 10% of the engineers in the U. S. and this membership appears to be confined to firms that hire engineers by hundreds or thousands. Thus the union inroad into the professional sphere has been comparatively small and this is probably because of the creative ability of engineers and their desire to be individualistic. There is a feeling among many that unionization is not the answer but there is also the admission that there is no workable organization standing between unions and the professional engineering societies.

In any event, the months ahead will be important. We should be aware of the circumstances and take pains to acquaint ourselves with all the details in order to properly evaluate conditions. Two important booklets have been issued in recent months that deserve individual review. The first is "Unionization Among American Engineers" (Studies in Personnel Policy No. 155), published by the National Industrial Conference Board, Inc., 460 Park Avenue, New York 22, N. Y. The second is "Monopoly Power As Exercised by Labor Unions" issued by the National Association of Manufacturers, 2 East 48th Street, New York 17, N. Y.

The Bubble Can Burst

Government contracts provide each contractor with a reasonable expense allowance for help wanted advertising.

All of us have been aware during recent years of the tremendous demand for electrical and electronic engineers. All of us have heard of the excellent salaries and large number of fringe benefits that suitably trained and experienced engineers can acquire. Perhaps some of us have taken this advantageous time to "job-hop" and in a few short years arrive at an income that would normally have taken two or three times longer to achieve.

While expenditures for military electronics have risen over the last six years, the rise no-where-near parallels the rise in help wanted advertising lineage. In 1950 the Chicago Tribune reported approximately 161,000 display lines. In 1956 this figure comes to more than 600,000. So the question arises . . . What is a reasonable allowance for help wanted advertising? And who pays for the increase in lineage?

There are signs on the Washington horizon now that "reasonableness" will be more critically watched. It would be well to evaluate personnel requirements and personnel status now. If the "help-wanted bubble" does burst there could be difficult times ahead for both the electronic manufacturers and the engineers.

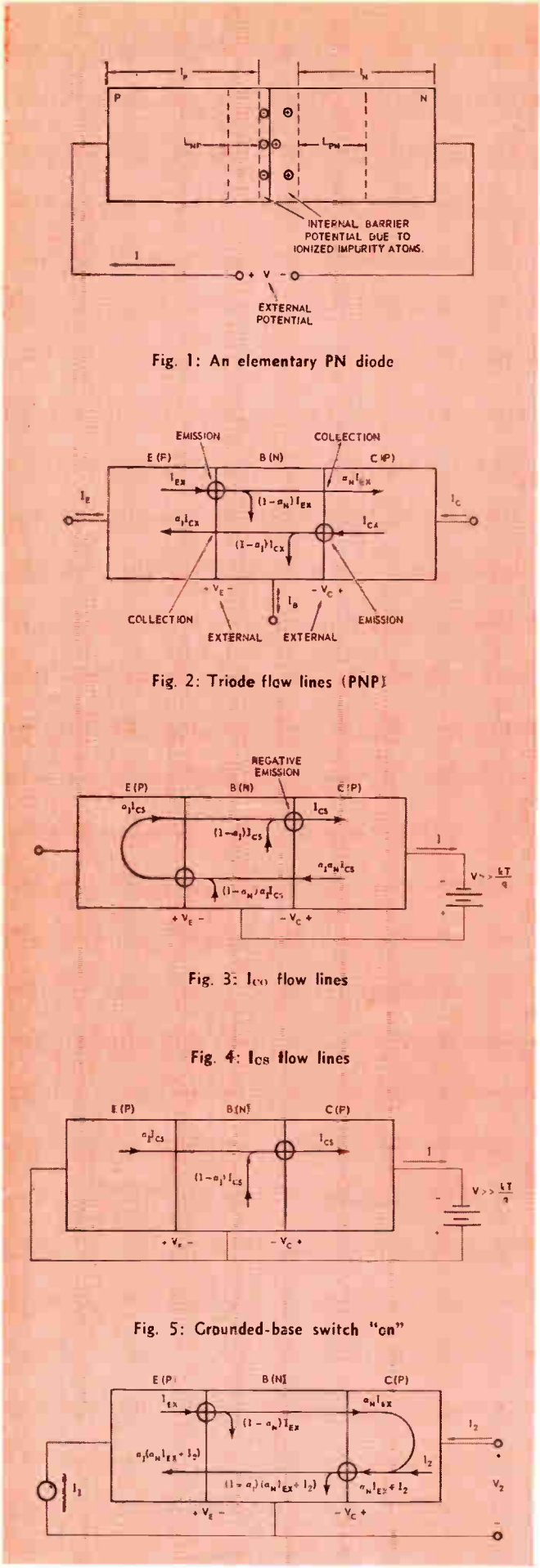


Fig. 1: An elementary PN diode

Fig. 2: Triode flow lines (PNP)

Fig. 3: I_{co} flow lines

Fig. 4: I_{cs} flow lines

Fig. 5: Grounded-base switch "on"

Flow Line Analysis

Practical engineers will welcome this pictorial analysis of transistor switching circuits—it gives an intuitive check on design calculations.

By RICHARD B. HURLEY

Senior Research Engineer
Convair, Pomona, Calif.

R. B. HURLEY

Limiting potentials and currents are of concern in switching circuits and in the biasing of transistors. The large-signal analyses of Ebers and Moll[1], the switching studies of Bright[2], and the floating potentials derived by Bell[3] combine the more significant interactions within a transistor to yield a good approximation of its external performance. Quite often, however, the results are not intuitively obvious. "Flow line analysis" is presented as an intuitive check on the results of calculations.

This method of analysis employs no new relationships. It is a pictorial expression of equations developed by Ebers and Moll, and gives an intuitive correlation between internal and external transistor behavior.

Preliminary

The PN diode represented by Fig. 1 should obey the conventional diode equation[4] (below) at small applied voltages and resulting currents, if body ohmic drops and surface leakages are ignored.

$I = I_S (\epsilon^{qV/kT} - 1)$, where (1)

I_S = body saturation current,

q = electronic charge,

k = Boltzmann's constant,

T = absolute temperature,

$\frac{kT}{q}$ = 0.026 volts @ 300°K,

V = applied forward voltage, and

I = forward current.

Furthermore, if the P-side is heavily doped relative to the N-side, the saturation current should be[4]

$$I_S = \frac{1}{L_{PN}} (q\, P_N\, D_P\, A), \text{ where} \quad (2)$$

P_N = density of "free" holes on the N-side,

D_P = diffusion constant for holes,

A = cross-sectional area,

$L_{PN} = \sqrt{D_P \tau_{PN}}$ = diffusion length of holes on the N-side, and

τ_{PN} = lifetime of holes on the N-side.

A small germanium diode might be fabricated by creating a heavily doped P-region on an N-type crystal chip with an effective junction area of, say 0.01 square centimeters. The N-type crystal might have a resistivity of 5 ohm-cm. and lifetimes of 100 micro-seconds. Thus a calculation of the saturation current would yield—

$$I_S \cong 2\ \mu a.$$

Should the length of the N-region now be cut to where it is much less than the original diffusion length, the length of the N-region would become approximately the new diffusion length, and the lifetimes would be appropriately reduced. If the length of the N-region is reduced to, say 0.0025 cm., and this length is substituted for the diffusion length in equation (2),—

$$I_S \cong 50\ \mu a.$$

Now consider a PNP triode in which both P-regions are heavily doped relative to the base N-region, e.g., a conventional alloyed PNP transistor. In addition, assume that the collector-base diode has the properties of the preceding diode example with a base thickness of 0.0025 cm. Now if this transistor is symmetrical and has alphas of about 0.95, the measured collector-base current under a few-tenths of a volt reverse bias might register about 5 μa. That is, if the emitter is left open, and voltages are applied between the collector and base terminals, the resulting device acts externally like an ordinary diode, but with a saturation current of about 5 μa rather than the anticipated saturation current of about 50μa. Such a situation is as it should be, but a degree of confusion could exist without a clear picture of the internal actions of a transistor. A satisfactory insight to such transistor action can be gleaned from a "flow line analysis."

Basic Method

The basic ingredients (ignoring surface leakages and body ohmic drops) of "flow line analysis" are illustrated in Fig. 2. The barrier potentials shown are the net external voltages and not the internal barrier potentials. Due to the thermally generated barrier (not "seen" externally), the actual internal barrier potentials are assumed always to be negative on the P-side and positive on the N-side as illustrated in Fig. 1. Thus an applied forward voltage simply reduces the size but does not reverse the polarity of the internal barrier potential. Therefore both junctions in a transistor are always "collecting" junctions. That is, both barriers have a net internal electrostatic potential of proper polarity for collecting minority carriers from the base region.

"Emission" by a junction (as used herein) refers to a current flow through a junction by virtue of its own diode action as governed by eq. (1). "Collection" by a junction refers to a current flow across a junction by the process of collecting minority carriers in the base region that are due to emissive action on the part of the other junction. Therefore a given junction is always in a collecting state, but its emission may be positive, zero, or negative depending on whether the net external voltage is forward (positive on P-side), zero, or reverse. The basic rules employed here for flow line analysis are as follows:

1. Flow lines are given arrowhead directions in the direction of conventional positive current flow.
2. The emission of a given junction is assumed positive if its external junction voltage is assumed forward.
3. The emission of a given junction is assumed negative if its external junction voltage is assumed reverse.
4. The "chain of events" along a flow line follow the direction of the arrowheads for assumed positive emission, but they go against the arrowhead directions for assumed negative emission in a PNP transistor. The converse is true in an NPN transistor.

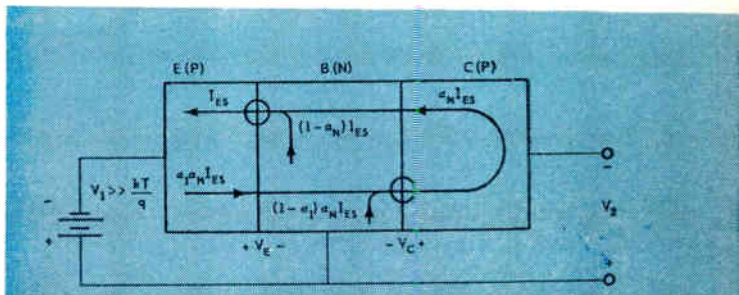


Fig. 6: Grounded-base "off" switch

The equations representing the flow line action in Fig. 2 are—

$$I_{EX} = I_{ES}(\epsilon^{qV_E/kT} - 1) \text{ and} \quad (3)$$

$$I_{CX} = I_{CS}(\epsilon^{qV_C/kT} - 1) \text{ where} \quad (4)$$

I_{EX} = current emitted by the emitter,

I_{CX} = current emitted by the collector,

I_{ES} = internal body saturation current of the emitter-base diode, and

I_{CS} = internal body saturation current of the collector-base diode, and

$$I_E = I_{EX} - \alpha_I I_{CX}, \text{ and} \quad (5)$$

$$I_C = I_{CX} - \alpha_N I_{EX}, \text{ where} \quad (6)$$

α_I = inverted alpha (emitter collecting), and

α_N = normal alpha (collector collecting),

Before applying the flow line analysis to particular problems, the alphas will be restricted. It will be

Flow Line Analysis *(Continued)*

assumed that the alphas are constants of the transistor and are therefore independent of the level of the various voltages and currents. Thus it will be assumed that there are no induced fields in the base region[5], no space-charge layer widening effects[6], and no avalanche multiplication action at the collecting junctions[7]. The flow line technique of analysis is not, in general, dependent upon constant alphas, but such a limitation does allow for simple equations, easy calculations, and yet frequently useful results. Obviously the restricted alphas will give most reliable performance data when the transistors are used in low-level applications[1] such as millivolt choppers[2] or low-power multivibrators. However, Ebers and Moll[1] have illustrated good agreement between analysis and experiment even at higher levels in an example where measured high-level alphas were employed in the equations.

Collector Saturation

A good example of flow line analysis is found in the case cited earlier where a reverse voltage is applied to the collector-base diode and the emitter is left open (Fig. 3). With a few tenths of a volt reverse potential applied to the collector-base diode, the body saturation current will be exposed, amounting to a negative emission at the collector junction of I_{cs}. Since the emission is negative and the device is PNP, flow line events are against the arrowhead direction. Of the current emitted at the collector, the emitter collects a fraction, α_I, and the rest is lost to the base region. Since the emitter terminal is open, the α_I fraction cannot leave the emitter but must be emitted back into the base region. In turn, the collector will collect its fraction, α_N, and the difference is lost to the base region. The flow diagram is now complete since all flow lines terminate in regions conected externally. The external current is—

$$I = I_{CS} - \alpha_I \alpha_N I_{CS} = (1 - \alpha_I \alpha_N) I_{CS}. \quad (7)$$

By conventional definition, however, $I = I_{CO}$. Therefore—

$$I_{CS} = \frac{I_{CO}}{1 - \alpha_I \alpha_N}, \text{ and similarly} \quad (8)$$

$$I_{ES} = \frac{I_{EO}}{1 - \alpha_I \alpha_N}, \text{ where} \quad (9)$$

I_{CO} = collector saturation current, emitter open, and

I_{EO} = emitter saturation current, collector open.

Hence, if $I_{CO} = 5\mu a$, and $\alpha_I = \alpha_N = 0.95$,

$$I_{CS} = \frac{5}{1 - (0.95)^2} \cong 50\mu a,$$

and the previously mentioned point of confusion is resolved. In other words, even though the emitter is open, transistor action is still taking place. The net result is that the transistor action significantly reduces the saturation currents as "seen" externally.

The complete collector saturation current can be obtained by shorting the emitter to the base (Fig. 4). In this case the emitter cannot emit since its external potential is zero. Therefore all of its collected current goes out its terminal connection. Thus,—

$$I = I_{CS} = \frac{I_{CO}}{1 - \alpha_I \alpha_N} \quad (10)$$

as shown previously by Ebers and Moll.[1]

Floating Potentials

Floating potentials, as developed by N. W. Bell[3] can also be obtained by flow line analysis. Before proceeding, a very convenient relationship proved by Ebers and Moll[1] for restricted alphas will be added to the list of equations.

$$\alpha_I I_{CO} = \alpha_N I_{EO}, \text{ and, hence,} \quad (11)$$

$$\alpha_I I_{CS} = \alpha_N I_{ES}. \quad (12)$$

In addition, a particular reference symmetrical transistor (RST), operating at room temperature will be considered for use in numerical examples.

$$\alpha_I = \alpha_N = 0.95, \text{ and}$$

$$I_{EO} = I_{CO} = 5\mu a,$$

The governing equations for the grounded-base "on" switch as obtained from flows in Fig. 5, are, assuming $V_E >> \frac{kT}{q}$ ——

$$I_{EX} = I_{ES}\, \epsilon^{qV_E/kT} = \text{emitter emission}, \quad (13)$$

$$\alpha_N I_{EX} + I_2 = I_{CS} (\epsilon^{qV_C/kT} - 1) = \text{collector emission}, \quad (14)$$

$$I_1 = I_{EX} (1 - \alpha_I \alpha_N) - \alpha_I I_2, \text{ and} \quad (15)$$

$$V_2 = V_C. \quad (16)$$

Solving the above equations and making free use of eqs. (8), (9), and (11)—

(Continued on page 136)

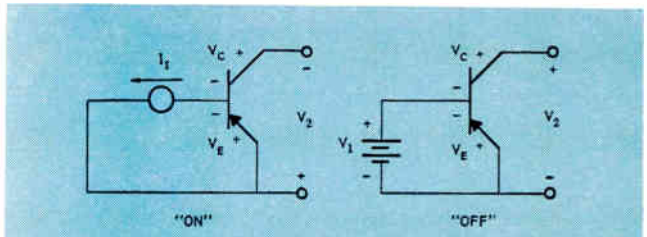


Fig. 7: Grounded-emitter switches

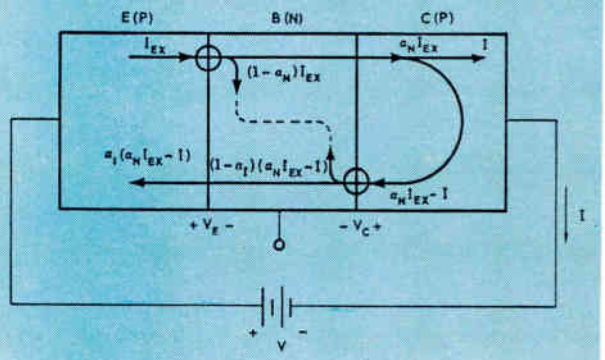
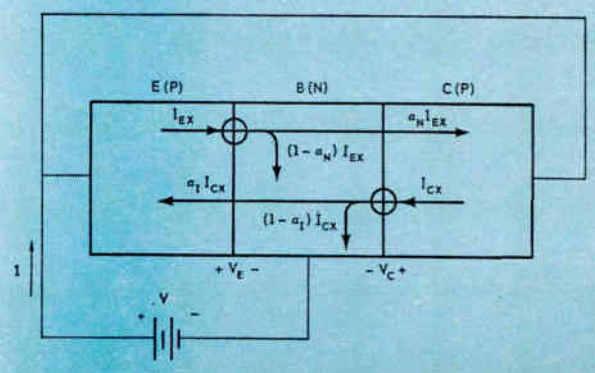


Fig. 8: Grounded-emitter saturation current

Fig. 9: Emitter and collector tied together



Automatic Test Station

At Westinghouse, complete dynamic test equipment takes a fraction of the time consumed by conventional methods.

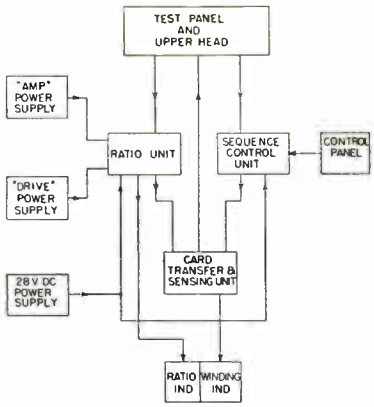


Fig. 1: Diagram of an automatic transformer primary vs. secondary turns-ratio tester. Heart of system is a null-seeking bridge circuit.

Fig. 2: Pot checker measures resistance, function, hi-pot, and noise. Accuracy: mechanical, ±2' of arc; electrical ±.015% of the full scale.

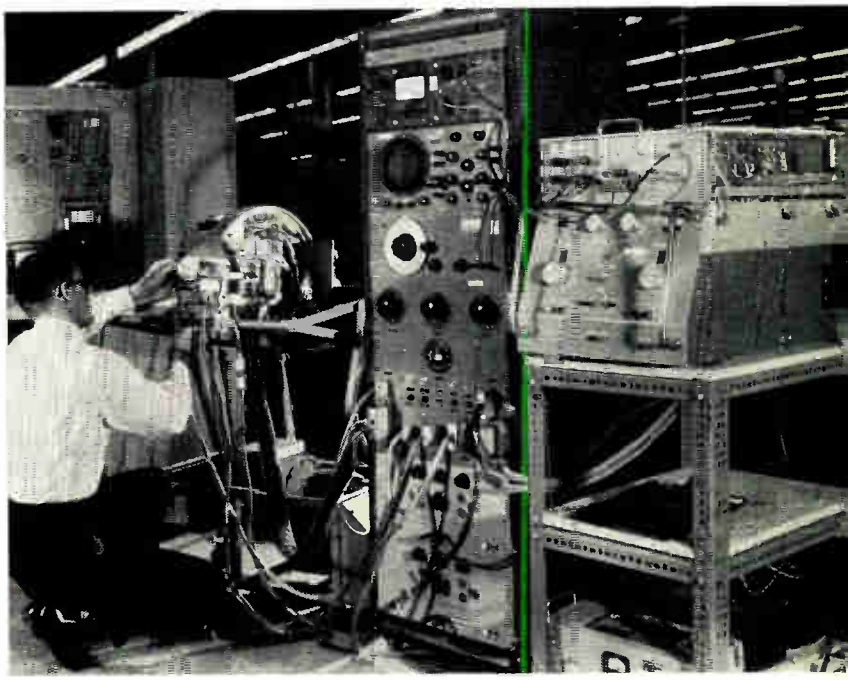


Fig. 3: Automatic function tester measures impedance or voltage of components in circuits and does functional tests. Typical application: airborne radar power supply check.

Fig. 4 (above): The automatic cable harness checker is used chiefly for circuit testing chassis and cable harness.

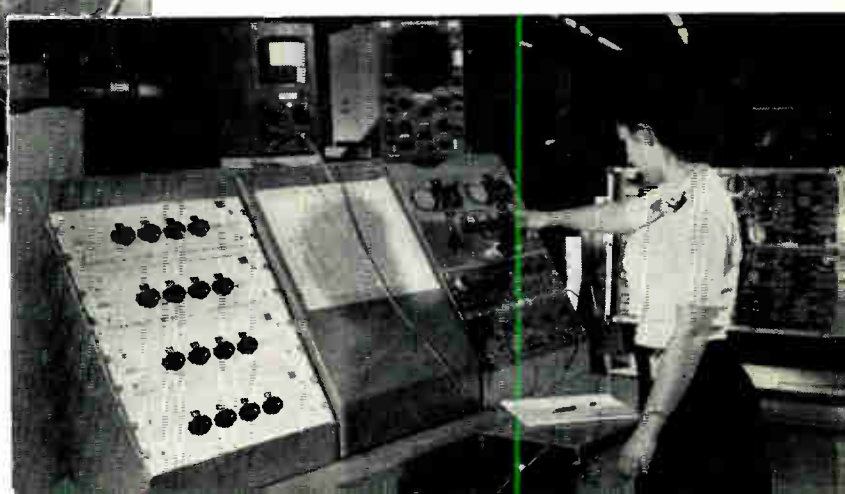


Fig. 5 (right): Forty-eight test problems can be provided for analog computers by the semi-automatic test stand.

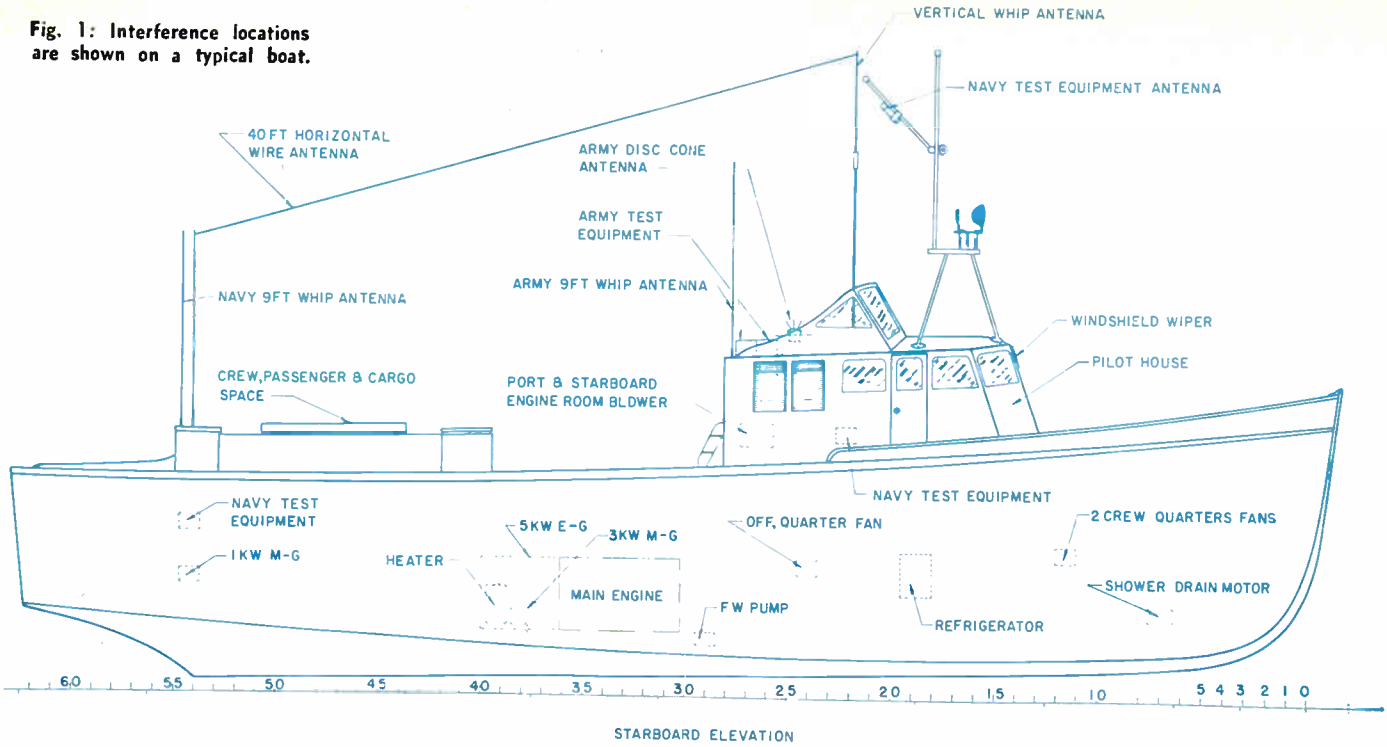


Fig. 1: Interference locations are shown on a typical boat.

The Military Says That

Marine Equipment is Over-Filtered

By JOHN J. O'NEIL,
Chief, Suppression Systems Sec., Signal Corps Eng'g Labs., For Monmouth, N. J.

JAN tests indicate that simpler methods of filtering can be just as efficient and considerably less expensive. Reviewed here are their findings and recommendations.

Included among the interference reduction responsibilties of the Signal Corps is the design and test of radio interference suppression sytsems for watercraft procured by the Transportation Corps. These craft range in size and type from an 18-foot Utility Boat to a 210-foot Floating Repair Shop. Wood, Steel, and plastic hulls are used and as many as 67 devices capable of producing interference are installed for various functions aboard the boats. During the past four years, the Signal Corps Engineering Laboratories have completed more than 100 separate investigations of design, development, application engineering and testing of suppression systems for various types of watercraft.

J. J. O'NEIL

Suppression Specifications

During early suppression investigations of watercraft, SCEL noted that the contractors were not aware of the many engineering advances made in the art of interference reduction, but were applying costly suppression components. Consequently, based upon previous experience with other Army equipments, Military Specification MIL-S-13237 entitled "Suppression, Radio Interference, Requirements for Watercraft" which reflected these advances, was immediately prepared and referenced as the governing suppression document for all watercraft procurements.

The principal features of the specification include the following:

a. The reduction of interference over the frequency range of 0.15 MC to 1000.0 MC to a degree which assured optimum operation of all Army communication equipment.

b. Design of the watercraft to achieve the maximum interference reduction with a minimum of suppression measures.

c. An outline of a minimum suppression system consisting principally of the application of 0.1 μf capacitors of the proper voltage rating at the brushes of the motors of the various equipments.

d. The availability of technical assistance and guidance by SCEL.

e. The requirement that capacitors be used unless tests definitely proved that filters were required to achieve the required interference reduction.

It is of interest to note that the grounding of the metallic sheath electrical wiring with which all craft are equipped, is ignored as a specification requirement. This was done purposely as it was believed that to insist on satisfactory r-f grounding for all cable shielding would be too expensive as well as unnecessary, except in specialized cases. Furthermore, where necessary, those cables which were radiating or reradiating interference could be grounded at the time of test.

Effectiveness of Capacitors

In practically all instances, the tests performed over the last four years proved that the application of by-pass capacitors (Fig. 3) to the many motor-driven equipments, attenuated radio interference to the levels specified in MIL-S-13237 and assured optimum use of all communication and electronic equipment operating in the frequency range of 0.15 to 1000.0 MC. In those rare instances where further interference reduction was necessary, the application of feed-thru type capacitors to items such as electric windshield wipers as shown in Fig. 2, furnished the required degree of noise reduction. These tests have also revealed that insofar as Army requirements were concerned, no serious attention to grounding of the metallic sheathing of the electrical wiring was necessary on either wooden or steel hull boats.

Costly brute force filtering has always been considered by interference reduction engineers a necessity for adequate interference reduction below 150 KC/sec. Consequently, when the use of by-pass and feed-thru type capacitors proved successful on Army watercraft, it raised the questions "How effective in practical application are such capacitors at frequencies lower than 150 KC? Would these capacitors furnish sufficient interference reduction, for example, at 14 KC/sec. which the Navy utilizes, or are filters always necessary at this frequency? Is power cable shielding really necessary or justifiable for interference reduction purposes?" In an effort to obtain the answers to these questions, JAN tests were recently conducted on an Army Patrol Boat. The purpose of these tests was to determine, by actual installation of standard Navy communication receivers covering the major portion of the frequency range of 14 KC to 400 MC, whether the type of radio interference suppression system used by the Army would be satisfactory for Navy use aboard a watercraft that was equipped with power cable shielding.

JAN Test

Arrangements were completed with the Transportation Research and Development Command, Fort Eustis, Virginia, for a 63 ft. wooden hull patrol boat on which the investigation was to be performed. This boat had been in service for approximately one year. It had been equipped, during its construction, with an Army suppression system. Standard power cable shielding, the grounding of which had been ignored as a suppression measure during the initial suppression investigation, was also existing.

A wooden hull watercraft was selected to assure maximum interference conditions as no shielding effect would be provided between the sources of interference and the test equipment antennas as would be the case with a steel hull watercraft. No inspection was conducted to determine if the suppression system designed for this type of craft had been properly applied or maintained.

Upon locating a site which was free of man-made interference, the Army test equipments and Navy communcition receivers were installed as shown in Fig. 1. It will be noted that 3 locations were used to assure that all possible interference would be recorded.

The Navy's standardized installation test procedure, which requires the use of an audio output meter at

(*Continued on page* 12)

Fig. 2: Feed-thru type capacitors are used as suppressors on electric windshield wipers.

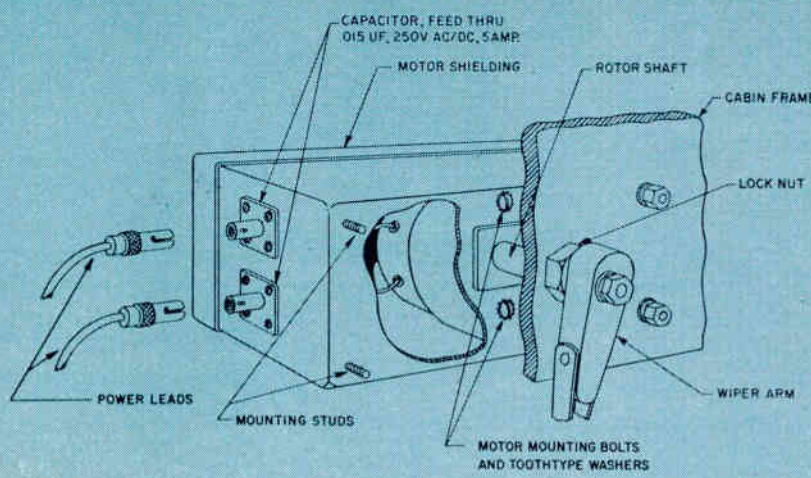
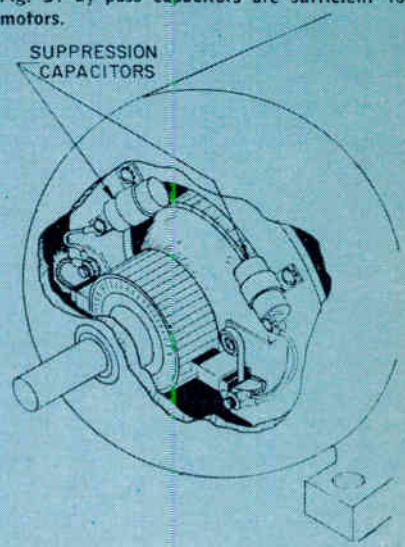
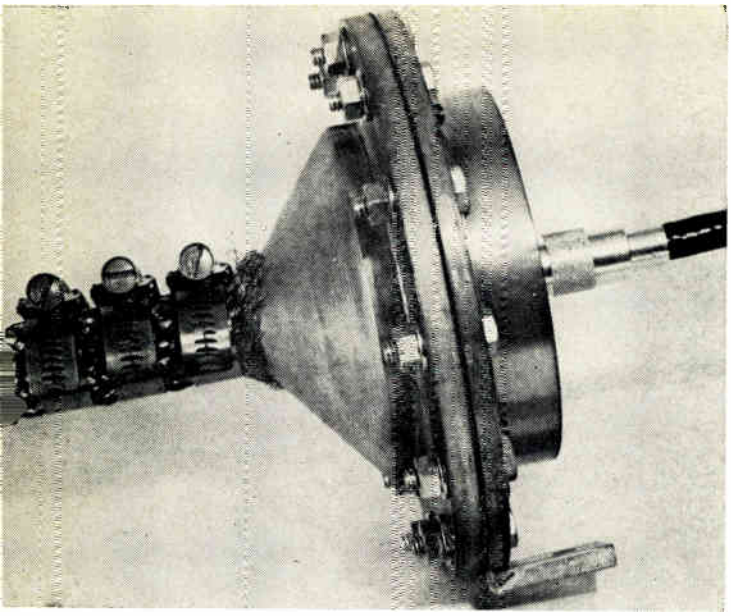


Fig. 3: By-pass capacitors are sufficient for motors.





Radial Shunt Is Used For

Measuring 100,000-Ampere Pulses

Large, high-frequency, short-pulse currents normally beyond the capabilities of a measuring instrument are measured to an average error of 2½% with a noninductive radial shunt in conjunction with an oscilloscope.

By H. BRUCE McFARLANE
University of California
Radiation Laboratory
Livermore, Calif.

THE measurement of high currents at frequencies much greater than 60 cps is complicated by inductance, stray magnetic fields, and by magnetic forces that tend to disassemble the device.

The radial shunt shown in Fig. 1, when used with an oscilloscope, measures currents having amplitudes of 100,000 amperes, a frequency range of from dc to 500,000 cps, and pulse lengths up to 0.001 second, with an average error of 2½%. The accuracy of the measurements made with the device is well within the limits of experimental error.

The shunt is about 4 in. diameter, 6⅝ in. long, and weighs 2¼ lb. From the cross section, Fig. 1, and the schematic diagram, Fig. 2, it can be seen that the shunt is essentially a noninductive device, since the current flow through the measuring element is at right angles to the field produced by the current supply.

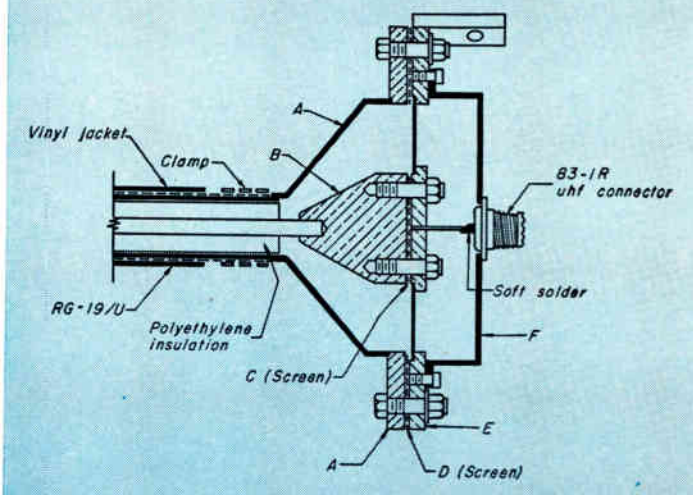
Isolation of the shunt from regions of high field intensity is accomplished by attaching it to the end of a length of RG-19/U coaxial cable. To avoid measurement errors from voltages generated by ground loops, it is desirable to ground the circuit at one point only. A grounding lug on the shunt serves this purpose.

A skin-effect correction factor should be applied to measurements at frequencies higher than 100 cps. Fig. 3 shows the skin-effect correction factor, and also the phase angle, plotted against the frequency.

Skin-Effect Correction

I_{ac} = total current flowing at frequency under consideration
I_{dc} = total current flowing under d-c condition
V_{ac} = a-c voltage measured across shunt in x = t plane
V_{dc} = d-c voltage measured across shunt in x = t plane
K = skin effect correction factor
i_{rx} = current density at any point r, x
i_{r0} = current density at point r in plane of x = 0
i_{2t} = current density at r = r_2 in plane of x = t
i_{20} = current density at r = r_2 in plane of x = 0
v_{rx} = radial voltage gradient at the point r in plane x

Fig. 1: Cross section of radial current shunt



v_{rt} = radial voltage gradient at the point r in plane t
f = frequency in cycles per second
μ = permeability of shunt material in henries per meter
σ = conductance of shunt material in mhos per meter
r_2 = major radius of shunt
r_1 = minor radius of shunt
δ = skin depth in meters

Calibration of the shunt is accomplished with direct current. A constant, I_{dc}/V_{dc} is obtained. At a frequency other than 0, the calibration constant will be different from the d-c constant due to skin effect.

$$I_{ac}/V_{ac} = K\, I_{dc}/V_{dc}$$
$$K = I_{ac}\, V_{dc}/I_{dc}\, V_{ac} \quad (1)$$

Current density at any point (r, x) can be expressed in terms of the current density at the point (r, 0).

$$i_{rx} = i_{r0}\, e^{-\tau x} \quad (2)$$

where $$\tau = 1 + j/\delta \quad (3)$$

and the skin depth $$\delta = 1/(\pi f \mu \sigma)^{1/2} \quad (4)$$

The total current flow for any value of r is:

$$I_{total} = 2\pi r_2 \int_0^t i_{20}\, e^{-\tau x}\, dx\; i_{20} 2\pi r_2/\tau\, (1 - e^{-\tau t}) \quad (5)$$

The radial voltage gradient at any point is:

$$v_{rx} = i_{rx}/\sigma$$

And the plane x = t the radial voltage gradient is:

$$v_{rt} = i_{rt}/\sigma$$

From the geometry of the shunt element it can be said that:

$$2\pi r_2 i_{2x} = 2\pi r i_{rx}$$

And $$i_{rx} = i_{2x}\, r_2/r$$

Then in the plane x = t:

$$i_{rt} = i_{2t}\, r_2/r$$

The radial voltage drop across the plane x = t is:

$$V_t = \int_{r_1}^{r_2} v_{rt}\, dr = \int_{r_1}^{r_2} \frac{i_{rt}}{\sigma}\, dr = \frac{i_{2t}\, r_2}{\sigma} \ln \frac{r_2}{r_1} \quad (6)$$

And substituting Eq. (2) in the above:

$$V_t = \frac{i_{20}\, e^{-\tau t}}{\sigma} \ln \frac{r_2}{r_1} \quad (7)$$

Referring to Eqs. (3) and (4):

When $f = 0,\ \delta = \infty$, and $\tau = 0$.

Then $$V_t(dc) = \frac{i_{20}}{\sigma} \ln \frac{r_2}{r_1}$$

Substitution of the above in Eq. (5) shows that in the exponential form I_{total} becomes indeterminate for $\tau = 0$. Expanding the exponential portion of Eq. (5) in an exponential series:

$$\frac{1}{\tau}(1 - e^{\tau t-}) = \frac{1}{\tau}\left[1 - 1 + \tau t - \frac{^2\tau t^2}{2} + \frac{\tau^3 t^3}{6} - \frac{\tau^4 t^4}{24} \cdots\right] \quad (8)$$

And substituting $\tau = 0$ in the whole expression,

$$I_{dc} = i_{20}\, 2\pi\, r_2 t$$

From Eqs. (1), (5), (6), and (8), we can say that:

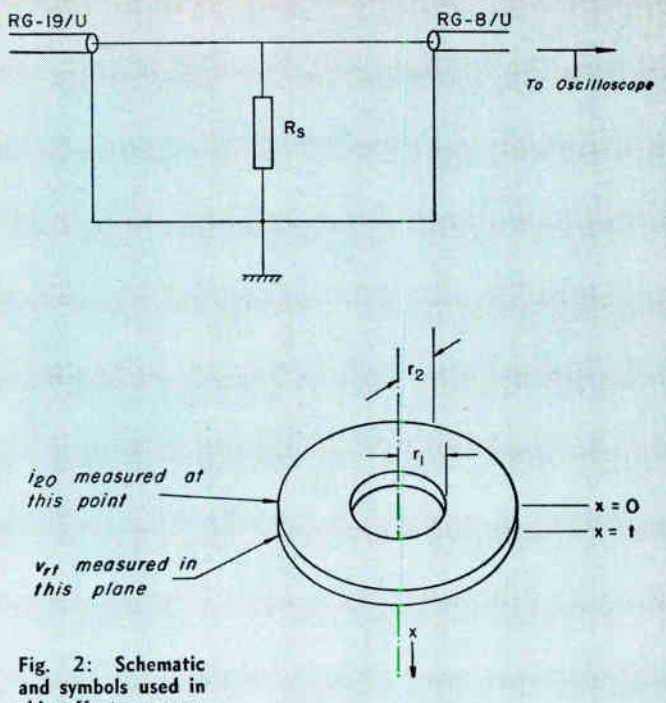


Fig. 2: Schematic and symbols used in skin-effect correction

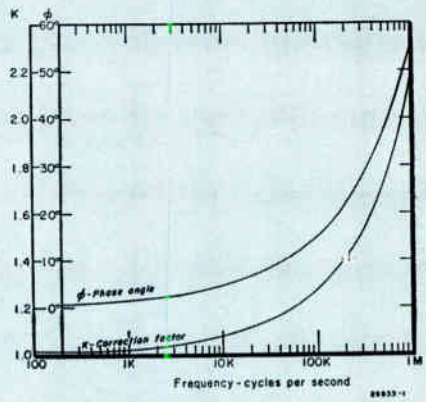


Fig. 3: Skin-effect factor and phase angle vs. frequency

$$K = \frac{\left[i_{20} 2\pi r_2\, (1 - e^{-\tau t})\right]\left[\frac{i_{20}}{\sigma} \ln \frac{r_2}{r_1}\right]}{\tau\left[i_{20} 2\pi r_2 t\right]\left[\frac{i_{20} e^{-\tau t}}{\sigma} \ln \frac{r_2}{r_1}\right]} = \frac{1 - e^{-\tau t}}{\tau t e^{-\tau t}}$$

$$K = \frac{1}{\tau t}(e^{\tau t} - 1) \quad (9)$$

In order to yield accurate results at low frequencies, this expression must be converted to the form of an exponential series.

$$K = 1 + \frac{\tau t}{2!} + \frac{(\tau t)^2}{3!} + \frac{(\tau t)^3}{4!} + \frac{(\tau t)^4}{5!} + \cdots + \frac{(\tau t)^{n-1}}{n!} \quad (10)$$

$$= \left[1 + \frac{t}{2\delta} - \frac{t^3}{12\delta^3} - \frac{t^4}{30\delta^4} - \frac{t^5}{180\delta^5} \cdots\right]$$
$$+ j\left[\frac{t}{2\delta} + \frac{t^2}{3\delta^2} + \frac{t^3}{12\delta^3} - \frac{t^5}{180\delta^5} \cdots\right] \quad (11)$$

The last expression was obtained by substituting $\tau = I + j/\delta$ from Eq. (3) into Eq. (10).

A graph of the magnitude and phase relationship of K is plotted in Fig. 3.

Pulse Measurement *(Continued)*

Current Measurements

In an LCR circuit the current flowing at any time is:

$$I = (E/L\beta)e^{-\alpha t} \sin \beta t$$

where $\alpha = R/2L$, the decrement factor in second^{-1}

$\beta = (1/2)\,[(4/LC) - (R/L)^2]^{1/2} = [(1/LC) - \alpha^2]^{1/2}$

$= $ natural frequency in radians/second

If $\alpha^2 << 1/LC$, then $\beta = 1/(LC)^{1/2}$ and $L = 1/\beta^2 C$ (12)

From a photograph of a current waveform (Fig. 4), the following were determined:

Time of 1 cycle, $\tau = 1.15 \times 10^{-4}$ second.

The first peak occurring at $t = \pi/2\beta$ was 3.2 cm high $= A_1$.

A second peak occurring at $t = 3\pi/2\beta$ was 2.5 cm high $= A_2$.

The current at a peak is given by:

$$I_n = A_n K = (E/L\beta)\, e^{-\alpha t_n}$$

$$I_{n+1} = A_{n+1} K = (E/L\beta)\, e^{-\alpha t}\, n + 1$$

Solving:

$$\alpha = 1/(t_{n+1} - t_n) \ln (A_n/A_{n+1}) = (\beta/\pi) \ln (A_n/A_{n+1}) \quad (13)$$

$$\beta = 2\pi/\tau = \frac{2\pi \times 10^4}{1.15} = 5.46 \times 10^4 \text{ radian/second} \quad (14)$$

From (13): $\alpha = (5.46 \times 10^4/\pi) \ln (3.2/2.5) = 4.29 \times 10^3$ sec^{-1}

From (12): $C = 2.08 \times 10^{-4}$ farad as measured.

$L = 1/\beta^2 C = 1/(5.46)^2 \times 10^8 \times 2.08 \times 10^{-4} = 1.61 \times 10^{-6}$ henry.

Peak current occurs at $n = 1$ where $t = \pi/2\beta$

$\sin \beta t = \sin (\pi/2) = 1.0$

$I_p = (E/L\beta)\, e^{-\alpha t} = 1.5 \times 10^4/1.61 \times 10^{-6} \times 5.46$

$$\times 10^4\, e^{-4.29 \times 10^3} = 1.71 \times 10^5\, e^{-0.123}$$

$$= 1.52 \times 10^5 \text{ amperes} \quad (15)$$

This may be considered as the theoretical current based upon calculations and the parameters of the system L, C, R, and E.

Direct-current calibration of the shunt in use gave a sensitivity of 8.62×10^3 amperes per volt.

Skin depth $\delta = 1/(\pi f \mu \sigma)^{1/2}$

From (14) $f = \beta/2\pi = 5.46 \times 10^4/2\pi = 8.68 \times 10^3$

$\mu = 4\pi \times 10^{-7}$ henries/meter

$\sigma = 9.25 \times 10^5$ mhos/meter

$\delta = 1/(\pi \times 8.68 \times 10^3 \times 4\pi \times 10^{-7} \times 9.25 \times 10^5)^{1/2}$

$= 5.64 \times 10^{-3}$ meter

Skin-Effect Correction (Eq. 11)

$t = 7.95 \times 10^{-4}$

$\delta = 5.64 \times 10^{-3}$

$t/\delta = 1.41 \times 10^{-1} = 0.141$

$K = [1 + 0.141/2 - (0.141)^{3/12} - (0.141)^{4/30}]$

$+ j\,[0.141/2 + (0.141)^{2/3} + (0.141)^{3/12} - (0.141)^{5/180}]$

$= 1.069 + 0.077j = |\,1.072\,|$

Peak measurement on oscilloscope was 3.2 cm; oscilloscope sensitivity, 5 volts/cm.

Rearranging Eq. (1)

$$I_{ac} = K \frac{I_{dc}}{V_{dc}} V_{ac} = 1.072 \times 8.62 \times 10^3 \times 3.2 \times 5.0$$

$$= 1.48 \times 10^5 \text{ amperes} \quad (16)$$

Error $= (1.52 - 1.48)/1.52 = 2.6\%$

The figures given in Eqs. (15) and (16) are, coincidentally, closer than one would expect, considering the accuracy to which oscilloscope traces can be read. This demonstrates, however, that the radial current shunt can be used to measure currents and that it performs well within the limits of experimental error.

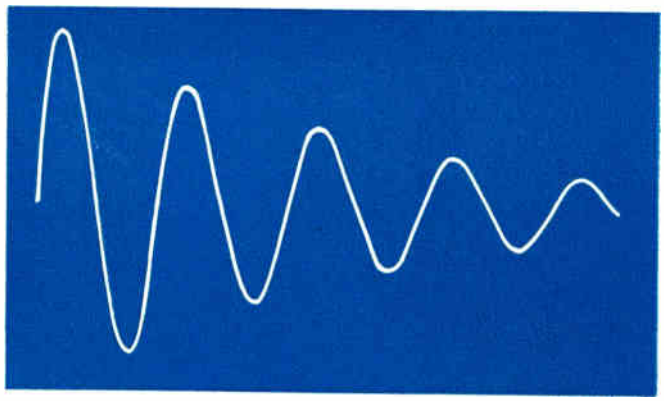
Construction Notes

Refer to Fig. 1. Remove the outer vinyl jacket of the RG-19/U coaxial cable for a distance of about 4 inches from the end of the cable. Remove the polyethylene insulation for a distance of about ¾ in. from the end.

Slide the slotted end of Part A over the polyethylene insulation and under the outer braid. (Part A has 8 slots in its cylindrical end to facilitate the insertion operation and to assure good contact with the outer braid.)

Hard-solder Part B to the copper center conductor of the cable. When Part B has cooled, place copper screen, part C, over studs in Part B, and place copper screen, Part D, on the flanged portion of Part A, lining up the holes in the screen with those in the flange.

Fig. 4: 140,000 amp pulse; period about 110 μsec.



Place Part E over the studs in Part B, attach nuts to studs and tighten. Align outer holes in Parts A, D, and E; assemble bolts, lockwashers, and nuts in the outer holes of Parts A, D, and E, and tighten the nuts.

Tin the end of the No. 16 wire protruding from the center of Part E. Attach Part F to Part E with screws. Apply solder to center conductor of 83-1R connector. Place connector in position and melt solder by means of heat applied to center conductor of 83-1R connector from outside. Install screws to hold the 83-1R connector in place.

Stainless steel hose clamps are used to clamp the outer braid of the RG-19/U cable to Part A.

Calibration

The radial shunt is calibrated with a 1.5-volt, lead-acid storage cell, a known d-c shunt, and a millivoltmeter. The value of I_{dc}/V_{dc} (amperes per volt) is obtained by calculation. The ratio of I_{ac}/I_{dc} can be computed from the above ratio and from the skin-effect correction factor, K_1, read from the graph, Fig. 3, for any given frequency.

Technical Sessions Highlight IRE Show

Particularly high level of interest will be focussed on this year's technical program. Latest developments in semiconductors, electronic controls and a compatible single-sideband system will be the highspots.

A comprehensive program of 55 technical sessions is expected to attract at least 50,000 Radio Engineers and Scientists. Thirty-three sessions are scheduled for the Waldorf-Astoria Hotel and 22 will be held at the Coliseum. Approximately 250 papers will be presented at these sessions.

One of the opening sessions on Monday afternoon will discuss how pilot errors on jet aircraft may be reduced. The application of human engineering principles to electronics controls has resulted in vastly improved performance and corresponding error reduction. A paper titled "The New Look In Electronic Controls" by R. J. Meyer of Collins Radio Co., Cedar Rapids, Iowa, explains these thoughts fully. Also on Monday a paper titled "A New Semi-Conducter Device," by C. A. Aldridge, General Electric Co., Syracuse, N. Y., will discuss how significant circuit economies are achieved with a new semiconducter amplifying device that will be introduced. The mechanical and electrical characteristics will be described fully at this session.

The ratio of assigned channel bandwidths to intelligence bandwidths has been gradually reduced from about 60:1 to 10:1 in the past 10 years. The question arises will equipment manufacturers 10 years hence approach a ratio of 1:1? "How Far Can We Go In Narrowing Channels in the Land Mobile Radio Services?" by C. B. Plummer, FCC, Washington, D. C., answers these questions.

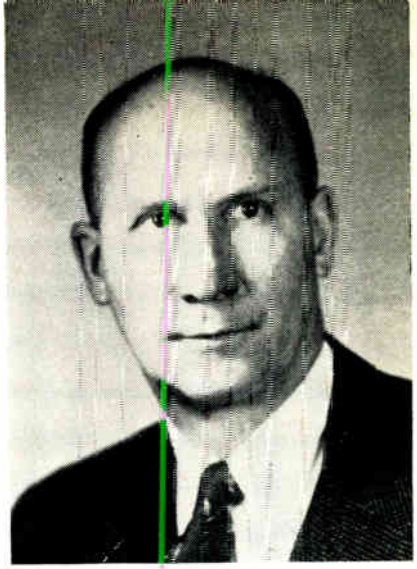
"Single-Sideband Broadcast Developments," being presented by L. Kahn, Kahn Research Lab., Freeport, N. Y., will be of great interest to broadcasters. This paper describes a new system which will permit a greater number of broadcast channels. The transmitter will only require an adapter while home receivers do not necessitate any change.

Management is a most important factor in security analysis. Who is behind a balance sheet is usually more important than what. The quality of a company's management is reflected in the price of its securities. A paper being presented Tuesday morning titled "Finance: Wall Street Looks at Engineering Management," by O. C. Roehl, Keystone Custodian Funds, Boston, Mass., covers this area of management thoroughly.

Aircraft and telemetering designers should find great interest in the paper "High Altitude Breakdown Phenomena" being presented by J. Ashwell, E. B. Cole, A. Pratt, and D. Sartorio, all of the Glenn L. Martin Co., Baltimore, Md., on Tuesday morning. Breakdown problems associated with the operation of antennas at high altitude and high speeds will be the focal point of this discussion.

The cry, "Make it smaller—make it lighter," has been ringing in the radio electronics engineer's ears since before World War I. It seems that the more he accomplishes along this line the louder and more insistant the cry becomes. Added to this cry is the modifier, "but make it more reliable." A session titled "Micro-

(*Continued on page* 113)

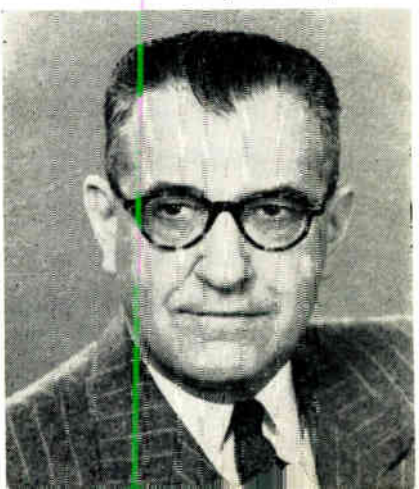


J. T. Henderson, IRE Pres.

Yasujiro Niwa, IRE Vice-Pres.

Haraden Pratt, IRE Secy.

W. R. C. Baker, IRE Treas.



IRE's 1957 Fellows Predict . . .

Exclusive statements from the nation's leading electronic engineers summarize the future for the electronic industries.

ACOUSTICS

Laurence Batchelder, Raytheon Mfg. Co.—". . . Sonar remains the primary means of depth sounding and the indispensable means of detecting submarines. By intensive effort, detection ranges are increasing to meet the threat of improved submarines, and this progress must continue despite the difficulties of accoustic propagation in the ocean."

L. Batchelder

D. W. Martin

D. W. Martin, The Baldwin Piano Co.—"Before World War II an eminent scientist advised, 'Acoustics as a field of research is dead'. However, just as in other branches of science and technology, new knowledge has raised new questions in acoustics—particularly in voice communication, recording and reproduction, electroacoustic transducers, musical acoustics, and noise control. As long as there are receptive listeners and creative producers of new and better sounds, there will be new horizons of research and engineering in this steadily expanding field"

AIR NAVIGATION

Dr. Carl A. Frische, Sperry Gyroscope—"Problems of air traffic control, inertial navigation, missiles, radar and radio devices and industrial automation dictate that progress be made more rapidly in all facets of electronics. From improved components, such as semi-conductor devices, to increased efficiencies in the management of large weapon systems programs, our industry has plenty of challenges to meet all along the line."

C. A. Frische

M. H. Schrenk

M. H. Schrenk, Dept. of the Navy—"The state of development of solid state devices and associated circuitry offers the possibility of designing computers and automatic control devices of small size and weight having small power requirements and high reliability. Their use in aircraft and on the ground in applying modern techniques of storage and processing of flight information will permit more nearly optimum flight paths and more precise traffic control and materially reduce the increasing burden imposed on air crews and traffic controllers by high speed high density air traffic."

Paul G. Hansel, Servo Corp. of America—"In the area of air navigation we will see many devices and systems now regarded as competitive, integrated into an overall system in which these devices have complementary rather than competitive roles. Ground-based direction finders will be improved radically in sensitivity, accuracy, speed of operation and reliability and will ultimately have great importance in such cooperative techniques as terminal area navigation and traffic control, meteorological balloon tracking and rescue operations.

P. G. Hansel

G. F. Wolcott

G. Frederick Wolcott, Gilfillan Bros., Inc.—". . . the density of air traffic is increasing at a very rapid rate. I see the use of color phosphors in radar display tubes as a potent means of quickly and positively distinguishing various types of targets by color identification."

Leslie E. Flory, RCA Laboratories—"Really mass application of television to everyday problems has awaited simple low-cost equipment. Transistorized circuits with miniature pickup tubes may provide the answer. Electronics in medicine has a particularly promising future. Nowhere in our field are the problems more challenging or their solution more rewarding."

L. E. Flory

J. Hillier

COMMUNICATION SYSTEMS

Dr. James Hillier, RCA Laboratories—"The electron microscope has so fully achieved its place in science today that we accept as a matter of course the delivery of a score or more each month for various research tasks in the fields of chemistry, metallurgy and biology. Looking into the future, we can anticipate the further simplification rather than radical improvements of the microscope, as well as the development and application of other devices employing many of its principles. Among these will be novel electronic probing instruments to detect and measure phenomena in the submicroscopic range, leading us to greater understanding of the atomic and chemical structures of microscopic particles."

James C. W. Scott, Defence Research Board, Canada—"In the coming years research into radio propagation will be increasingly concerned with atmos-

pheric phenomena which are at present only of marginal importance for practical communications and radar systems. Consequently increasing emphasis must be placed, not only on measuring and understanding such phenomena as cosmic and solar noise, meteor and auroral scatter and special modes of propagation but also on using these phenomena to our advantage"

J. C. W. Scott

R. A. Sykes

R. A. Sykes, Bell Telephone Laboratories—"Recent advances in the development of high frequency plated crystal units having substantially a single resonance will play an important part in the future of radio communication. This will allow present crystal filter theory to be applied to the design of very selective filters in the frequency range from 5 to 20 megacycles resulting in only a single step of conversion for the VHF and UHF regions. The increased precision and stability of quartz crystal units will permit even single sideband transmission at these frequencies."

Ernest H. Schreiber, Pacific Telephone & Telegraph Co.—"An extensive network of monochrome and color TV, teletype-writer, integrated data, telephotograph, facsimile and other channels are in daily use over the entire nation. These facilities range from the older voice frequency open wire and cable conductors to many of the newer systems which include coaxial cables and broad band microwave systems which can handle literally thousands of individual message channels. With the development and growth of these new communications systems and those foreseeable in the next decade telephone companies will be in an excellent position to continue to meet the increasing demands of industry."

E. H. Schreiber

G. S. Turner

George S. Turner, F.C.C.—"The F.C.C. is now sponsoring Cooperative Interference Committees which bring together the many radio services within a community in the form of "User Committees" whose purpose it is to help each other in the prompt detection and elimination of routine interference. A year's operation has already proven the effectiveness of the idea. The next step is to extend the plan nationwide."

S. G. L. Horner, Hudson's Bay Co.—"The Canadian North is going through one of the greatest development stages in its history, due to the intense search for minerals, iron ore, uranium, copper, etc Hand in hand with these great developments goes radio communication and over the next five years the Northern part of this continent will become a network of communication systems ranging from Microwave and "Scatter Systems" to auxiliary systems using SSB in the VHF and HF frequency spectrums."

S. G. L. Horner

R. E. Samuelson

BROADCAST

Dr. R. E. Samuelson, Motorola, Inc.—"Our high speed age is requiring us to communicate information using the narrowest share of the spectrum and the least amount of time. I foresee greatly increased use of SSB and other narrow-band techniques for VHF and UHF communications. This is particularly true in the case of military and civil aviation where I further expect to see such improved voice communication methods supplemented by automatic data links."

COMPUTERS

R. M. Ryder, Bell Telephone Laboratories — "The electronic revolution, foreshadowed by the invention of transistors, is now well underway both in transmission of information, in development of new knowledge through electronic computation, and in use of information to control machine operations. We look forward to the day when all routine operations in manufacturing will be taken care of by automatic equipment of high reliability. People will be freed of deadening drudgery and will be able to have a better standard of living since automatic manufacture is both better and cheaper. No end is in sight to the opportunities for people with high skills and capabilities."

R. M. Ryder

E. Mittlemann

Eugene Mittelmann, Consulting Engineer—"The future machine shop will see perhaps as a routine matter, electronic units which will correctly prescribe the proper sequence of operations, carry out these operations with maximum accuracy, check the final product and even classify the rejects into salvagable groups One of the by-products of electronically programmed and operated machine tools will be perhaps the universal replacement of the fractional system by the decimal system, thus saving additional thousands and thousands of engineering man-hours for more useful purposes."

Dr. John W. Mauchly, Remington Rand Univac—"The field of applications for digital computers should expand rapidly for many years to come for at least two basic reasons. First, new components and manufacturing economies are bound to reduce the cost of using such equipment, and make very profitable many applications which cannot today find economic justification. Second, and just as important, will be the effect of improved techniques of programming and the exploration and development of new procedures and methods for the application of such devices to fields not presently regarded as falling within the scope of automatic data processing."

J. W. Mauchly

H. R. Hegbar

Dr. H. R. Hegbar, Goodyear Aircraft—"The explosive growth of electronics will project the analog computer into a new growth pattern embracing, on the surface, paradoxical features —(1) simpler operation, (2) more

IRE "Fellows Predict .... *(Continued)*

complex applications, and (3) smaller size. The combination of digital and analog techniques, along with new circuit elements, will reduce the size of the installations and at the same time broaden the fields of applications. The future will see the operator's tasks simplified by completely automatic insertion of prepared, "packaged" problem statements, and automatic readout of the problem setup for checking and record storage."

Burgess Dempster, Electronic Engineering Co.—"One of the most urgent and difficult problems is to find how to adapt developments in the data handling field to industrial applications. If we can find how to do an effective job of applying our knowledge of data handling to commercial uses, we can look forward to industrial electronics soon becoming as large a part of our electronics industry as entertainment or military."

B. Dempster

F. C. Williams

Dr. F. C. Williams, Manchester University, England—"I am currently concerned with the development of brushless variable speed induction motors, and I foresee a considerable future for them since they combine the ruggedness and simplicity of the squirrel cage motor with the variable speed features which have hitherto only been obtainable by using either commutators or sliprings."

COMPONENTS

Jesse Marsten, International Resistance Co.—"Major advances will result from research and development leading to new and improved materials. In the next few years, maximum effort will be directed towards a search for new resistor and dielectric materials. Bulk metals used as resistor materials will gradually and partly be replaced by films of one kind or another. New dielectric materials will enable resistors to be operated at much higher temperatures and humidities."

J. Marsten

L. Podolsky

Leon Podolsky, Sprague Electric Co.—". . . basic research on materials in the solid state, on ultra pure metals, and on vacuum refining methods will open new fields for revolutionary components both in performance and in ability to meet severe environments. These components will in many cases be far different in structure and function from the present lumped constant items with which we are familiar today."

ELECTRON DEVICES

G. Ross Kilgore, Signal Corp.—"I look forward to more and more breakthrough in the electron device area, which inevitably will expand all of electronics. With use of solid state devices just starting, even now research in atomic and molecular resonance is forecasting a new era in frequency stabilization and microwave receiver sensitivity"

G. R. Kilgore

J. O. McNally

J. O. McNally, Bell Telephone Labs.—"Reliability in electronic equipment will be more important in the future, and the job of developing, producing and applying electron tubes to obtain long life and high operating reliability has hardly been started. Future work in this direction might remove a very large percentage of tubes used from the lists of expendable items."

A. K. Wing, Jr., Federal Telecommunication Laboratories—"During the past two decades intensive work has been carried on in the electron tube field. I anticipate that this level of activity will be increased in the years just ahead, particularly on special devices for handling and processing large quantities of information for various purposes. These new devices will be designed to perform a wide variety of operations which will push out the boundaries of what can now be accomplished by electronic systems."

A. K. Wing

W. T. Born

MAGNETIC TAPE

W. T. Born, Geophysical Research Corp.—"The recent application of magnetic tape recording to the techniques of geophysical prospecting is giving great impetus to experimentation looking toward new and improved methods of data processing and interpretation. The availability of original data in easily produceable form makes possible many investigations which were previously impossible or impractical. Although I do not expect any revolutionary developments, it seems certain that work now going on will lead to much more effective use of existing field techniques."

MICROWAVE

Leland E. Thompson, Engineering Products Div.—"Developments in microwave communication, using both line-of-sight and scatter propagation, will play an increasingly important part in supplying the ever-growing need for communication."

L. E. Thompson

L. D. Smullin

L. D. Smullin, M.I.T.—"I believe that the next few years will see marked increases in the operating efficiencies of high power microwave tubes. With the generation of 10's and 100's of kilowatts of average power, efficien-

cies of 20-30 per cent are no longer tolerable, and even 50 per cent seems too low "In the low-noise field, we still have to learn what limits the theoretical noise figure of traveling wave tubes We now know how to get the lowests noise figure from a given beam. The next problem is to learn how to reduce noise injected into the beam."

Dr. Georg Goubau, Signal Corps.—"The Surface Wave Transmission Line (nick-named "G-String") is presently applied in the commercial field in lieu of coaxial cable in community TV systems The trend to UHF television will soon extend the range of applications to TV transmitter and receiver antenna installations I believe that the time will come when this line will be used to transmit television to moving trains"

G. Goubau

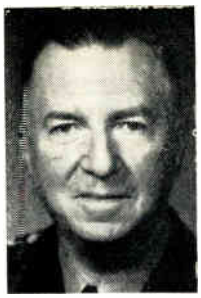
W. A. Edson

W A. Edson General Electric Co.—"The MASER opened the door to an entirely new area of microwave generation and amplification. Recent work indicates that the same general results may be obtained from solid state devices. I believe the development of this new class of microwave devices substitutes one of the exciting and important trends in the electronic industry."

MILITARY

Maj. Gen. J. D. O'Connell, U. S. Army—"In the future the overall combat capability of the United States Army will more and more depend upon the effectiveness of its communication and electronic systems. These systems for gathering information and disseminating decisions are needed to develop maximum results from the Army's increased firepower and mobility. Our present capability for reliable and flexible means of command control must be greatly increased. This will be done as rapidly as scientific advances in communication and electronics permit."

W. S. Hinman, Jr., Diamond Ordnance Fuze Laboratories—"The advent of electronics in ordnance ammunition, first in proximity fuzes, and then in guided missiles, increased weapon performance by adding intelligence in the missile to the intelligence at the firing line. It is a new specialization in electronics. As in all new fields, much needs to be done, and there are many opportunities for exceptional contributions and inventions."



J. D. O'Connell

W. S. Hinman

NETWORK THEORY

Sidney Darlington, Bell Labs.—". . . there are still many unsolved problems in network theory, the solution of which will facilitate further developments. Currently, the trend appears to be toward design techniques which apply to more general circuit components and configurations. The object is to arrive at an ever closer correspondence between theoretical results and practical needs."

S. Darlington

H. Q. North

SEMICONDUCTORS

Harper Q. North, Pacific Semiconductors—"Such familiar semiconductor devices as the copper oxide and selenium rectifier for power applications are being outstripped in performance by newer gemanium and silicon devices Estimates of the national market for semiconductor devices in 1965 center around $500,000,000, while those for 1975 range between 1 billion and 1.5 billion dollars These figures, large as they are, ignore solar cells, infrared detectors, microwave amplifiers such as the solid state maser, and a wealth of probable devices not yet invented. In short, the field of solid state electronics is coming into its own and shows every evidence of becoming one of the most important, if not the most important branch of the electronic component industry."

James E. Keister, General Electric Co.—"Although the semiconductor infant has barely been born, its future is breath-taking The diode, rectifier, and transistor are in the first glimmerings of its potential. Understanding and exploitation of its small size, low power consumption, indefinite life, and unique characteristics will change the whole complexion of the electronics field. Equipments and appliances will occupy volumes and consume powers in the order of 1/100 or less of their tube counterparts and new applications not feasible or practical before will become commonplace. Just as the electron tube gave us the 12-billion dollar electronics industry, so the semiconductor may give us another such industry."

J. E. Keister

T. H. Kinman

T. H. Kinman, British Thomson-Houston Co.—"After more than fifty years of constant change it is reasonable to expect that the technique of power conversion will soon be stabilized by using the unique properties of semiconductors which, apart from their greater conversion efficiency, are inherently more stable and adaptable than older devices to a wide field of application. This process of conversion is already under way and will reach full flood in the coming years."

L. G. Abraham, Bell Labs.—"As I see it, the greatest changes in radio systems of the future will be due to the general introduction of solid state devices, including the maser. Size, reliability, power requirements and complexity should be greatly improved. Data transmission in various forms for defense purposes, and for many general business uses, should expand tremendously in the next few years. Some of this will be over considerable distances."

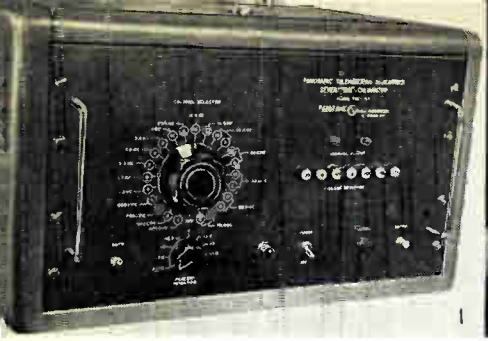
L. G. Abraham

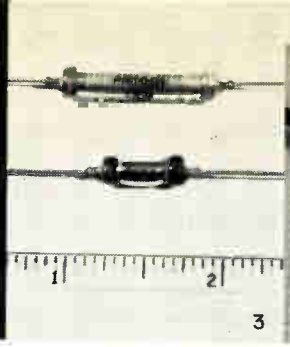
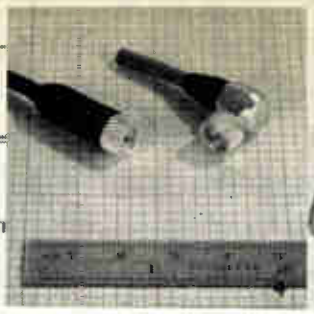
W. J. Morlock

TELEVISION

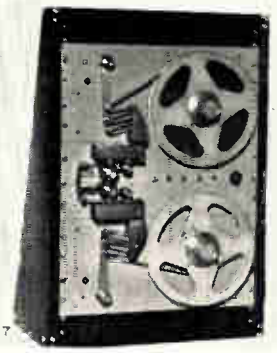
William J. Morlock, General Electric Co.—"The application of closed circuit industrial television will change the methods and procedures of industrial

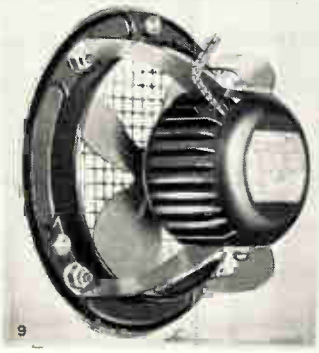
(Continued on Page 160)



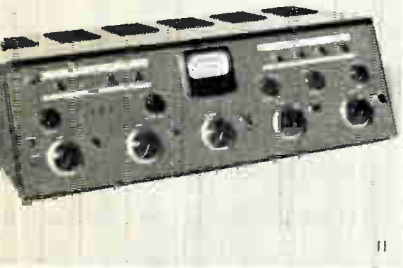
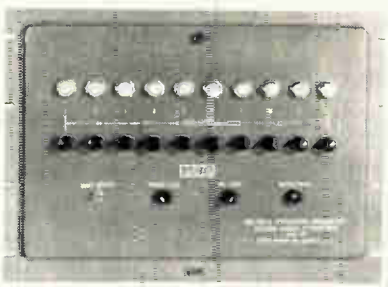
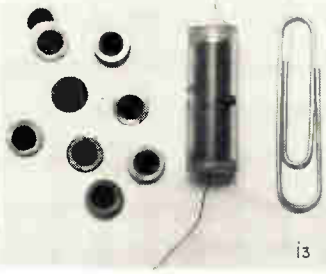
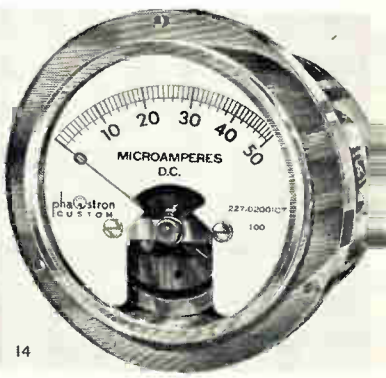





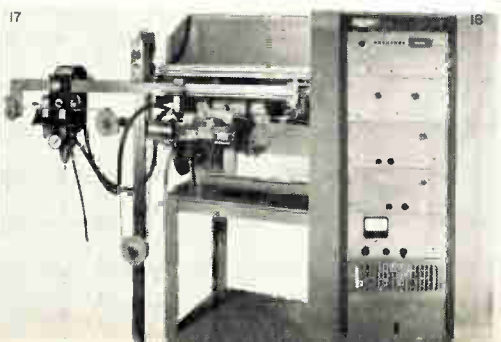





See these Products at IRE





1—Panoramic Radio Products, Inc.

Specifically designed for telemetering applications, the TMC-307 sequentially furnishes 7 equally spaced frequencies/channel.

2—Raytheon Mfg. Co.

A complete line of special purpose tubes including the reliable subminiature tubes which are widely used in guided missile. Booth 2611.

3—Pyrofilm Resistor Co.

PT 501, ½ w. nominal rating, and PT 1001, 1 w. nominal rating, are usable to ambient temperatures of at least 400°C. Booth 3938.

4—Microdot, Inc.

Two new miniature coaxial plugs, 32-66 and 32-68, were designed for the new all "Teflon" RG-195/U miniature coax, of .155 in.

5—Norden-Ketay Corp.

A new binary coded decimal analog digital converter. Using the 1, 2, 4, 8 pattern, output is presented in parallel form on 12 terminals.

6—Precision Scientific Co.

A new Thelco Model 18 Mechanical Convection Oven will be displayed. This cabinet has been completely redesigned. Booth 1521.

7—Key Electric Corp.

Model 101 Digital Magnetic-Tape Handler will feature a new magnetic head making available 10 tracks on ½-inch tape. Booth 1730.

8—Syntorque, Inc.

Four distinctive motor types for servos: hysteresis and induction motors; ac permanent magnet and sine wave generators. Booth 4415.

9—Rotron Mfg. Co.

DFE dual frequency fan operates on either a ground 50-60 cps power supply or the 320 to 1000 cps encountered on aircraft. Booth 2234.

10—American Machine & Foundry Co.

The new "PFM" meters consist of a 3-in. D'Arsnoval galvanometer and a case containing potted circuit components. Booth 1506.

11—Collins Radio Co.

Entire exhibit will be devoted to SSB developmental achievements. Displayed will be the SC-101 Station Control for SSB service.

12—Gates Radio Co.

The MO-3815 totalizer is a precision unit used to record the time a signal is at or above a pre-selected value. Booth 1302.

13—GE Electronic Components Div.

A new sub-miniature, solid electrolyte 95 v. battery which has a projected shelf life of over 20 years. Booth 2904.

14—Phaostron Instr. & Electronic Co.

New core magnet design assures good linearity for 100° of scale arc. Simplified design provides many structural advantages. Booth 3116.

15—Industrial Instruments, Inc.

A new line of type PG Voltage Breakdown Testers. These units range in output from 3 KV to 30 KV with output capacity of 5 KVA.

16—Branson Ultrasonic Corp.

Exactly 10 ft. long, this ultrasonic cleaning tank will be a production item. The stainless steel tank is 9 in. wide x 18 in. deep.

17—Artos Engineering Co.

CS-6 Machine measures, cuts, strips, and marks wire leads automatically in 1 operation at speeds up to 3000 finished pieces/hr.

18—Hamner Electronics Co., Inc.

A complete Gamma Ray Scintillation Spectrometer. Also included in the exhibit will be a line of regulated power supplies and chassis.

19—G. Felsenthal & Sons, Inc.

Edge-lighted control panels are featured similar to those used in the SAGE project. Acrylic plastic will transmit light most efficiently.

20—Balco Research Labs.

Metallized teflon capacitors have miniature dimensions and give exceptional performance at 200° C without derating. Booth 2123.

21—Gardner-Denver Co.

The 14E Component "Wire-Wrap" Machine has 2 laterally adjustable wrapping tools mounted side by side. Booth 4126.

22—Craig Systems, Inc.

The HELICOP-HUT accommodates countless equipment layouts. A wall of displayed radio relay station will be plexiglas. Booth 1325.

23—Assembly Products, Inc.

A three-position controller offers certain advantages previously unattainable with controls incorporating contact meter-relays.

24—G. M. Giannini & Co., Inc.

A high temperature, infinite-resolution potentiometer has been added to the line of slidewire type precision potentiometers.

25—Cubic Corporation

Model 504 Transistor Curve Tracer presents parameters as a single curve or a simultaneous presentation of a family. Booth 1723.

26—Radio Frequency Laboratories, Inc.

Model 1051 C-R-A-M Unit provides a precise frequency standard at modest cost for laboratory, communications or production line use.

27—LEL, Inc.

Embodying crystal band pass filters and a discriminator, this new i-f amplifier provides extreme skirt selectivity. Booth 2108.

28—Eclipse-Pioneer.

Size 10 and 15 precision induction generators and size 23 generators will be shown. Particularly adaptable as computer components.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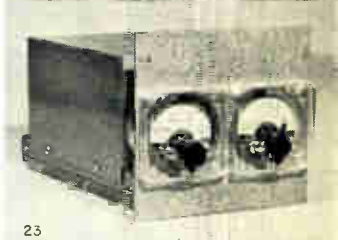
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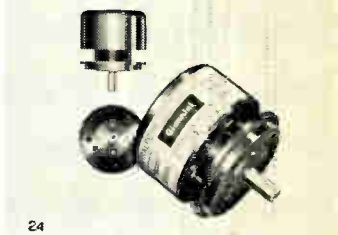
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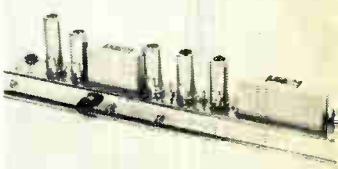
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Page from an Engineer's Notebook

#39—Transistor Formulas

By **PAUL PENFIELD JR.**, *Consulting Engineer, 752 Lakeside, Birmingham, Mich.*

(Fig. 1)

$R_{IN} = e_1/i_1$

$R_{OUT} = e_2/i_2$ when output is excited, input dead

$A_v = e_2/e_1$

$A_i = i_2/i_1$

$g_s = i_2/v$

$G = e_2 i_2/e_1 i_1 = A_v A_i$

$G_t = e_2 i_2 4R_g/v^2 = 4(g_s)^2 R_g R_L$

(Figs. 2, 3, and 4)

$e_{be} = h_{11} i_e + h_{12} e_{bc} = r_h i_e + \mu e_{bc}$

$i_c = h_{21} i_e + h_{22} e_{bc} = -\alpha i_e + y_c e_{bc}$

$\beta = \alpha/(1 - \alpha)$

Low-frequency small-signal transistor amplifier formulas are tabulated, using 2 popular parameter sets, defined by their equivalent circuits, Figs. 3 and 4. The h-parameters are easily measured; the other set has an intuitive appeal. To relate the 2 sets, use the conversion formulas. The approximations $r_e + r_b << r_e(1 - a)$ or $y_c r_h + \mu\alpha << (1 - \alpha)$ were made in all formulas. System transconductance g_s, useful for input stages, is the ratio of output current to source voltage. Power gain G is the ratio of output power to input power; transducer gain G_t is the ratio of output power to available source power.

Parameter Set Relations

$r_h = r_e + r_b(1 - a)$

$\mu = r_b/r_e$

$\alpha = a$

$y_e = 1/r_e$

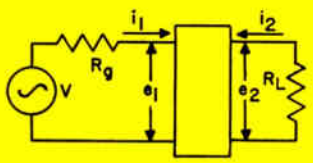
$\beta = a/(1 - a)$

$r_e = 1/y_e$

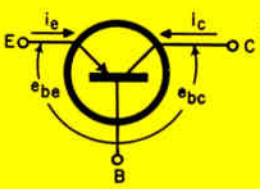
$r_b = \mu/y_e$

$a = \alpha = \beta/(1 + \beta)$

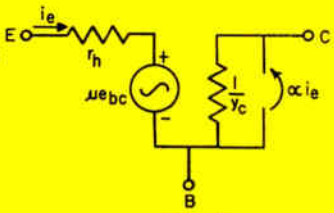
$r_e = r_h - (1 - \alpha)\mu/y_e$



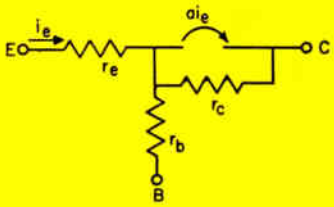
(Fig. 1)



(Fig. 2)

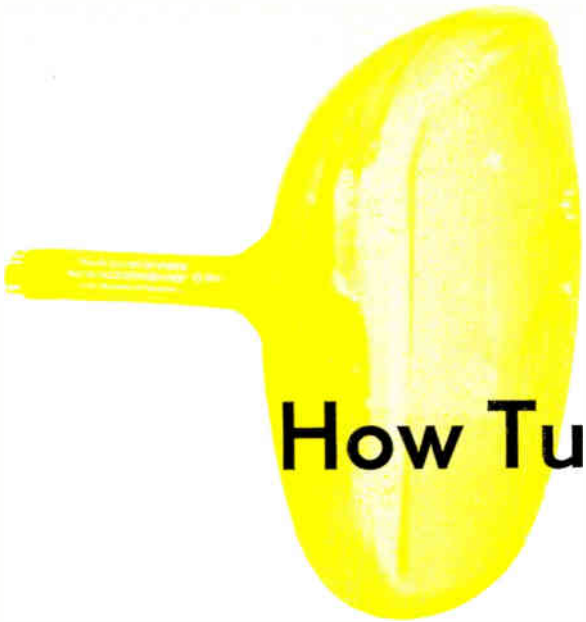


(Fig. 3)



(Fig. 4)

	Common-Emitter	Common-Base	Common-Collector
R_{IN}	$\frac{r_h(1+\beta)(1+R_L y_c)+R_L\beta\mu}{1+R_L y_c(1+\beta)}$	$r_h + \frac{\alpha\mu R_L}{1+R_L y_c}$	$\frac{(1+\beta)(r_h+R_L)}{1+R_L y_c(1+\beta)}$
R_{OUT}	$\frac{r_h(1+\beta)+R_g}{y_c(1+\beta)(r_h+R_g)+\mu\beta}$	$\frac{1}{y_c+\alpha\mu/(R_g+r_h)}$	$\frac{r_h(1+\beta)+R_g}{(1+\beta)(1+R_g y_c)}$
A_v	$\frac{-\beta R_L}{r_h(1+\beta)(1+R_L y_c)+R_L\beta\mu}$	$\frac{\alpha R_L}{r_h+R_L(y_c r_h+\alpha\mu)}$	$\frac{R_L}{R_L+r_h}$
A_i	$\frac{\beta}{1+R_L y_c(1+\beta)}$	$\frac{-\alpha}{1+R_L y_c}$	$-\frac{(1+\beta)}{1+R_L y_c(1+\beta)}$
g_s	$\frac{\beta}{(r_h+R_g)[1+R_L y_c(1+\beta)]+r_h\beta+R_L\mu\beta}$	$\frac{-\alpha}{r_h+R_g(1+R_L y_c)+R_L(y_c r_h+\mu\alpha)}$	$\frac{-(1+\beta)}{r_h(1+\beta)+R_g+R_L(1+\beta)(1+R_g y_c)}$
R_{IN}	$r_b + r_e\left[\frac{r_e+R_L}{r_e(1-a)+R_L}\right]$	$r_e + r_b\cdot\left[\frac{R_L+r_e(1-a)}{R_L+r_e}\right]$	$\frac{r_e+r_b(1-a)+R_L}{1-a+(R_L/r_e)}$
R_{OUT}	$r_c\left[1 - a\frac{r_b+R_g}{r_e+r_b+R_g}\right]$	$r_c\cdot\left[1 - \frac{ar_b}{R_g+r_e+r_b}\right]$	$\frac{r_c}{r_c+R_g}[r_e+(r_b+R_g)(1-a)]$
A_v	$\frac{-aR_L r_c}{(R_L+r_c)(r_e+r_b)-ar_c r_b}$	$\frac{aR_L}{r_e+r_b(1-a)+(r_e+r_b)(R_L/r_c)}$	$\frac{R_L}{R_L+r_c+r_b(1-a)}$
A_i	$\frac{a}{1-a+(R_L/r_c)}$	$\frac{-a}{1+(R_L/r_c)}$	$\frac{-1}{1-a+(R_L/r_c)}$
g_s	$\frac{ar_c}{(R_L+r_c)(r_e+r_b+R_g)-ar_c(r_b+R_g)}$	$\frac{-ar_c}{(r_e+r_b+R_g)(r_c+R_L)-ar_c r_b}$	$\frac{-1}{r_e+r_b(1-a)+R_L+R_g[1-a+(R_L/r_c)]}$



How Tubes Are Named

Centralized agency (JETEC) ensures that tubes are designated in a precise pattern, and that all manufacturers meet the specifications described for the tube.

By DAVID KAUFMAN

D. Kaufman. Staff Engineer. RETMA Eng'g Dept., 11 W. 42nd St., New York.

Although most people are familiar with the fact that electron devices[1] can be "identified" by type designations, we often get inquiries as to how these designations are assigned, or who handles these assignments, or, in general, what constitutes this phase of the standardization program both in the United States and the rest of the world.

Before going into the mechanics of the type designations systems, it would be well to mention the standardizing organizations concerned.

RETMA, the Radio-Electronics-Television Manufacturers Association, is a national trade association which represents all major manufacturing segments of the electronics industry.

NEMA, the National Electrical Manufacturers Association, is the counterpart of RETMA as a national trade association of electrical manufacturing companies.

In 1944, RETMA and NEMA established the Joint Electron Tube Engineering Council to serve the electron tube industry. JETEC is composed of Product Committees (i.e. receiving tubes, cathode ray tubes, transmitting tubes, semiconductors, etc.) and Service Committees (i.e. mechanical standardization, type designations, packaging, etc.). The activities of these Committees are coordinated by the JETEC Council, which is comprised of top-level representatives from the tube industry.

Administration

The type designation systems are administered by the RETMA Engineering Office on behalf of JETEC. In making type assignments, the administrator has 4 RETMA-NEMA Standards to work with:

1. Designation System for Receiving Tubes — (Primarily for Home Entertainment)—RETMA Standard ET-110A, NEMA Publication No. 506A.
2. Tube Type Designations—(Principally for Industrial Applications—5500 Series)—RETMA Standard ET-108A, NEMA Publication No. 504-A.
3. Designation System for Cathode Ray Tubes—RETMA Standard ET-111A, NEMA Publication No. 507-A.
4. Designation System for Solid-State Devices—RETMA Standard ET-115, NEMA Publication No. 512.

In addition to these standards, the various JETEC Product Committees, along with the Committee on Type Designations, have formulated rules for the use of the type administrator.

In order to follow the mechanics of type assignments, let us examine the steps both the manufacturer and the type administrator take in the process. Any manufacturer of an electron device, whether a member of the standardizing associations or not, may request a designation for a developmental type.

How Tubes Are Named *(Continued)*

This request must be in writing and accompanied by sufficient data, both mechanical and electrical, to enable the administrator to adequately search the records to determine the uniqueness of the device.

Type Designation

On receipt of a request for a type in the Home Entertainment Series, an arbitrary number is assigned to conform to the RETMA-NEMA (JETEC) Standard. This standard states that the type designation shall consist of (1) a first number symbol; (2) a first letter symbol; (3) a second number symbol; and, (4) one or more suffix letters as required. Therefore, looking at the submitted data we may find that the type has a filament or heater voltage of 6.3 v. This establishes the first number symbol as "6," since the standard lists the first number symbol as being an integer "n" where n is in excess of (n-0.4) and up to and including (n + 0.6). Skipping over the first letter symbol, we assign a second number symbol which is determined by the number of useful elements for which terminals are provided. Now say the device is a diode-pentode with terminals provided for:

1. Diode Plate
2. Diode Cathode
3. Pentode Plate
4. Pentode Grid #3 and Cathode
5. Pentode Grid #2
6. Pentode Grid #1
7. Heater (both terminals)

Even though the tube may be a 9-pin miniature with either 2 pins listed as "no connection" or having multiple terminals of any of those listed, the second number symbol "7" is assigned. So we have our tentative type designation of 6—7. On comparing the mechanical and electrical data of 6—7 with all other diode-pentodes listed in this category, we determine the uniqueness of the device. If it is sufficiently different, we fill in the blanks with the first letter symbol and now may have 6BV7. The "BV" is assigned in sequence starting with single letter "A" and progressing through single and then double letter combinations, except that the letters "I," "O" and "P" are not used, nor are identical double letters used.

We may find that the type designation request is for a variation of an existing type. In this instance, if the new type can be used as a direct replacement for the existing type, a suffix letter "A, B, C, D, E, or F" is assigned. Thus we have a 6CB5A which is the equivalent of the 6CB5 but for overall length, or the 6DQ6A which has higher maximum ratings than the 6DQ6, or the 6AN8A which features controlled heater warm-up time that is not a part of the 6AN8 data.

Type designation requests for devices covered by the three remaining standards are handled in a similar manner. For tubes "Principally for Industrial Applications," the designation will consist of a pure numeric starting with "5500" and is assigned consecutively and chronologically in the order of type requests. The 5500 Series, while designated as types "Principally for Industrial Applications," covers a wide variety of electron devices. We find ruggedized receiving tubes, magnetrons, klystrons, traveling wave tubes, thyratrons, storage tubes, phototubes, and miscellaneous types, that for some reason or other do not fit into the Receiving Tube for Home Entertainment category. As was indicated, assignments of type numbers in the 5500 Series are made as the requests are received, in chronological order. Thus we may have 6500 as a traveling wave tube, 6501 may be a hydrogen thyratron, while 6502 may be a magnetron.

Cathode Ray Tubes

For Cathode Ray Tubes, the designation consists of three groups of symbols, such as assigned to the Home Entertainment Types, except for CRT the first symbol number shall be a measurement in inches, of the largest bulb diameter. The second symbol is a letter or letters, other than I, O, P, or combinations of identical letters, to distinguish those types having the same bulb diameter. The third symbol consists of the letter "P" and a number to designate the screen characteristics. Thus our type assignment may be 17AVP4, which would indicate a tube having a 17 inch diagonal dimension and a "P4" type phosphor on its screen.

At the present time, the Engineering Office has reached P27 in the phosphor designation system. A peculiarity of the CRT designation system is that a basic tube type such as 17AV—may be assigned any number of phosphors. So that it is feasible to have anything from 17AVP1 to 17AVP27. Of course, the phosphor type is limited to the use of the tube, so that for television applications the phosphor "P4" is commonly used for monochrome, while the "P22" is for color. Types used for radar may have several phosphor designations, as will tubes used in oscilloscopes.

Suffix letters are assigned to CRT designations to indicate later modified versions which may be unilaterally interchanged with the prototype. So that 17AVP4A may indicate a higher anode voltage rating, while the 17AVP4B may have a filter glass as opposed to the clear glass of the prototype. Then, the 17AVP4C may have an aluminized screen, and so forth.

Solid-State Devices

In making assignments for solid-state devices (diode and transistors), we find that the type designation consists of (1) a first number symbol; (2) a letter symbol; (3) a second number symbol; and (4) a suffix letter if required. The first number symbol indicates the number of useful electrical connections, less one. That is, a diode having two useful connections will be started with the number 1. A transistor having three useful connections would be assigned 2, and so forth. The letter symbol is always "N." The second number symbol consists of a numeric starting with 21 and assigned consecutively in the class as indicated by the first number symbol.

(*Continued on page* 144)

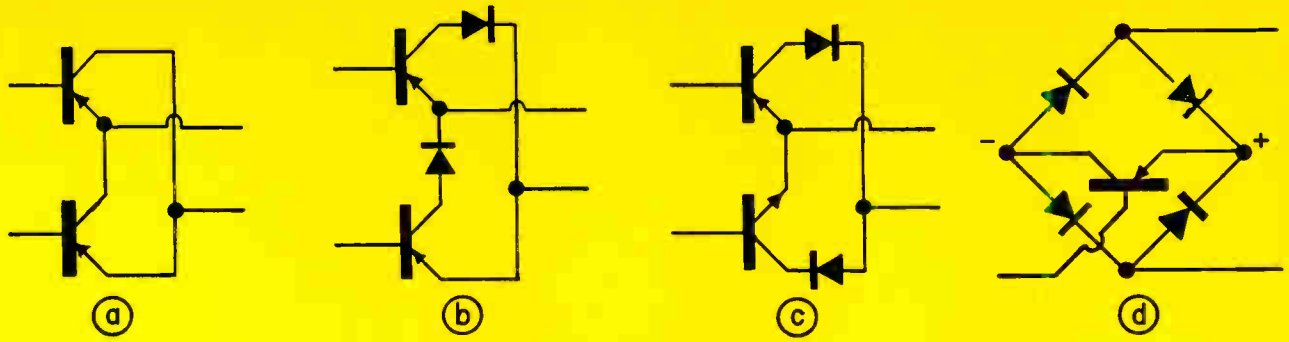


Fig. 1: Some methods for protecting transistors against application of incorrect voltage polarity

Eliminate Transistor Burnout

Incorrect battery insertion can ruin sensitive transistors. Here are design techniques for eliminating this problem.

By DR. HANS E. HOLLMANN

Consultant Physicist
Los Angeles, California

POLARITY is a problem with transistor circuits. Unlike vacuum tubes, transistors can be destroyed by reversing battery polarity. The miniature electrolytic capacitors used with transistors are also sensitive to incorrect polarity.

Point-Contact Symmetry

An interesting feature of transistors is the dual nature of their electrodes and junctions. In a point-contact transistor, either cat-whisker can be used as emitter or collector depending upon their electrical formation and whether they are biased in the reverse, or high impedance, direction or in the forward, or low-impedance, direction. Energy transmission is substantially the same in both directions regardless of which cat-whisker is utilized as emitter or collector, at comparable values of emitter and collector currents.

Junction Symmetry

A similar philosophy holds for the junction types but is complicated by asymmetry. Since transistor action is based upon a more efficient collecting ability of one junction as compared to that of the other, the collectors of standard junction transistors have larger areas than the emitters so that a favorable angle exists for the charge carriers to be collected before recombination occurs. Symmetrical junction transistors with equal collector and emitter geometry do not exhibit the necessary collecting efficiency. In other words, symmetrical junction transistors generally are obtained at the expense of current gain and efficiency.

(*Continued on page* 162)

Fig. 2: The symmetrical transistor (b) has low gain; the circuits of (a) and (b) are suitable for protection of a complete transistor circuit

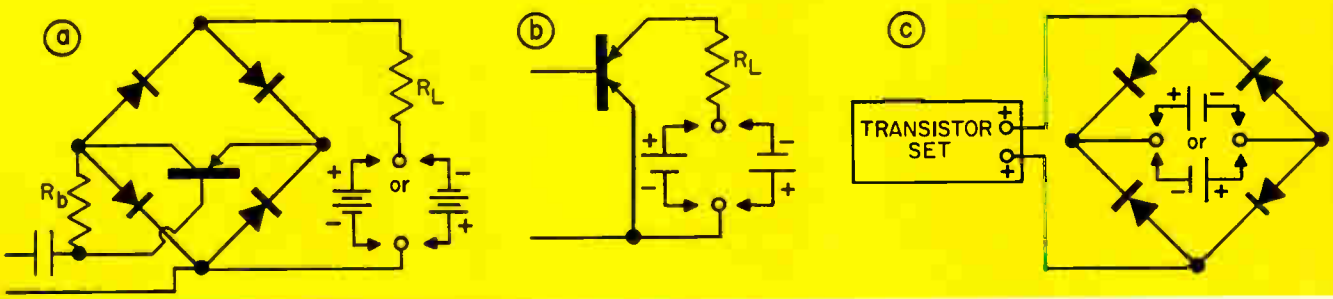


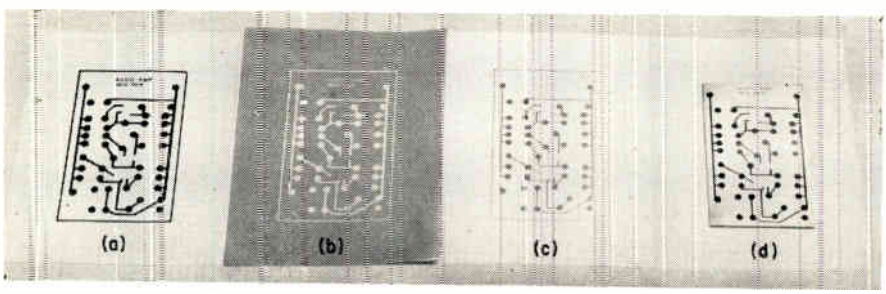
Fig. 1: Shown is all the equipment required to make good printed circuits.

$100 Starts This Printed Circuit Business

With the Ozalid method, anyone can make good quality printed circuits that are ideal for model labs and low volume production.

By NORRIS C. HEKIMIAN and ROBERT E. ROBINSON

Fig. 2: (a) Original drawing. (b) Foil exposed. (c) Foil developed. (d) Laminate exposed.



In the usual printed circuit process, a thin sheet of copper backed with plastic and covered with a light sensitive chemical is masked with a photographic negative made from a scaled drawing of the wiring pattern required and exposed to the light of an arc lamp. The light penetrates the negative along the lines representing wires, and affects the chemical coating. The sensitized surface is then developed. This process leaves the plate with a coating resistant to the etching solution at the points where it was previously exposed to light. Finally, the plate is immersed in a suitable etching solution (i.e., Ferric Chloride) which eats away the copper not protected by the coating, leaving only the wiring "printed" on the plastic backing.

The cost and complexity of the usual printed circuit process are considerably reduced by introducing 3 improvements: the arc light is replaced by an ordinary sun lamp radiating through a dark blue filter; the photographic negative is replaced with Ozalid reversal foil; and the process of etching is speeded up by an electrolytic technique which removes a large part of the undesired copper in ionic form.

Light Source

The light source employed is a conventional sun lamp available in many drug and department stores at a relatively low price. It is to be observed that a true sun lamp is used instead of the simple incandescent lamp. However, it has been found that the direct radiation from the lamp is generally excessive and will deteriorate the optical qualities of the resist coating on the copper clad laminate.[1] To avoid this it was found necessary to use a dark blue filter placed between the light and the sensitized surface of the laminate. A blue Du Mont oscilloscope filter was used, although any similarly tinted filter would do. By spacing the sun lamp approximately 10 in. from the sensitized surface and exposing the surface to the light for 4 to 6 minutes (after the lamp arc has struck) an exposure equivalent to 2 to 3 minutes of the usual carbon arc is obtained.

It is desirable to protect the exposed surface from the initial

light of the sun lamp until the arc strikes. This is because prior to the striking of the arc, the light radiated by the sun lamp is rich in visible light and heat which only deteriorates the surface and does not produce the desired photographic effect. As contrasted to the carbon arc, the sun lamp does not require special equipment, holders, or unusual techniques in its operation. Maintenance consists of simple replacement in case of failure.

Ozalid Process

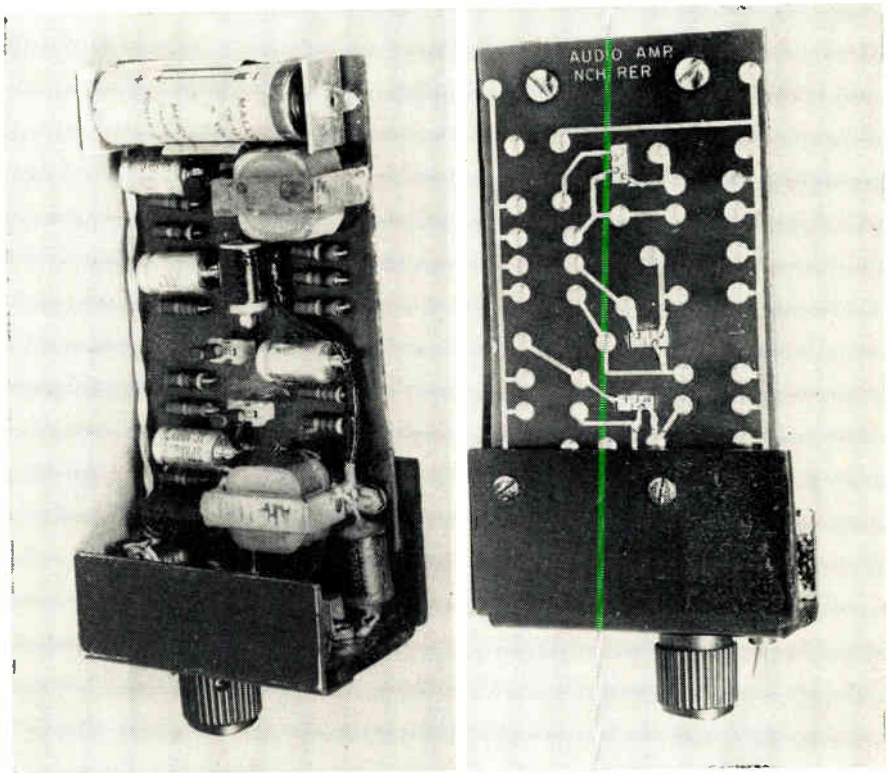
In the process described, the major difference from the conventional procedure is in the substitution of an Ozalid reversal foil for the photographic negative usually required. Ozalid foil is inexpensive and can be processed by conventional Ozalid machines, which are readily available in many offices and laboratories. Trained personnel (as contrasted with the photographic technician) are not required. The use of Ozalid foil results in a considerable saving in processing time, personnel and equipment.

As in the usual process, an original drawing is required and it is preferable that this be done in India ink on some high contrast medium such as tracing cloth or vellum. The drawing is made in a 1:1 ratio since there is no photographic reduction involved. Next a contact print using Ozalid reversal foil is made. This is done by feeding the Ozalid foil and the circuit drawing into the machine in the usual manner. The reversal foil as it comes out of the Ozalid machine must be washed in water to fix the image and to prevent deterioration by normal room light. (Fig. 2a-2c).

If a machine is unavailable, an equivalent process can be performed by exposing the reversal foil through the ink drawing for several minutes. The light source may again be the sun lamp but without a filter. After exposure, the foil is developed in ammonia solution or vapor and is then rinsed in tap water. The entire process is noncritical and can be performed in normal room light.

Sensitizing the plate is accomplished by cleaning the copper surface, flowing the photo resist on it, and then drying and insuring an even coat by spinning the plate at 60 to 100 RPM in a whirler. (a suitable whirler can easily be made from an old phonograph turntable.) This method does have a disadvantage, the coat becomes slightly thicker at the plate edges. This usually has no harmful effects and the whirler appears to be the simplest way of obtaining a satisfactory result. Eastman Kodak recommends this, as well as spray gun and quick-dip application techniques. Baking of the dried plates by the use of hot air, strip heaters or infra-red lamps has not been found necessary.

Fig. 3: Completed printed circuit chassis. Note sharpness of printed wiring.



The processed Ozalid foil is placed in contact with the sensitized surface and exposure is made under the sun lamp and filter as discussed above. Care must be taken that the foil is in complete contact with the sensitized surface of the copper clad laminate or there may be loss of definition because of light leakage around the edges of the lines on the Ozalid foil. After exposure, the plate is immersed in photo resist developer for approximately 3 minutes. Agitation of the developer bath is helpful.

Next the developed plate is flushed with photo resist dye, which is then retained on the surface for approximately 30 seconds, to allow time for it to set in the exposed areas. Finally the excess dye is washed off under a jet of lukewarm water. The dyeing step is not essential in the process, but it affords a simple and accurate check to the operator so that he can observe any defects which may exist in the plate. The dye will stain the exposed area (which will be resisted by the etching solution) to a deep black. The area that will be etched away in the bath will be unstained, and appears copper colored (Fig. 2d).

Should a faulty image occur, the plate can be stripped down to the original copper simply by scrubbing with developer solution. It is then ready to be reprocessed. If full confidence is developed in the process of the exposure and developing, the dyeing step may be omitted. At this point the plate is now ready to be etched.[2]

One of the most popular etching solutions is a highly concentrated solution of ferric chloride. The plate may be immersed in a tray of ferric chloride and simply allowed to etch at a normal rate. In this case etching time may be of

(*Continued on page* 114)

TV Compares Photographic Data

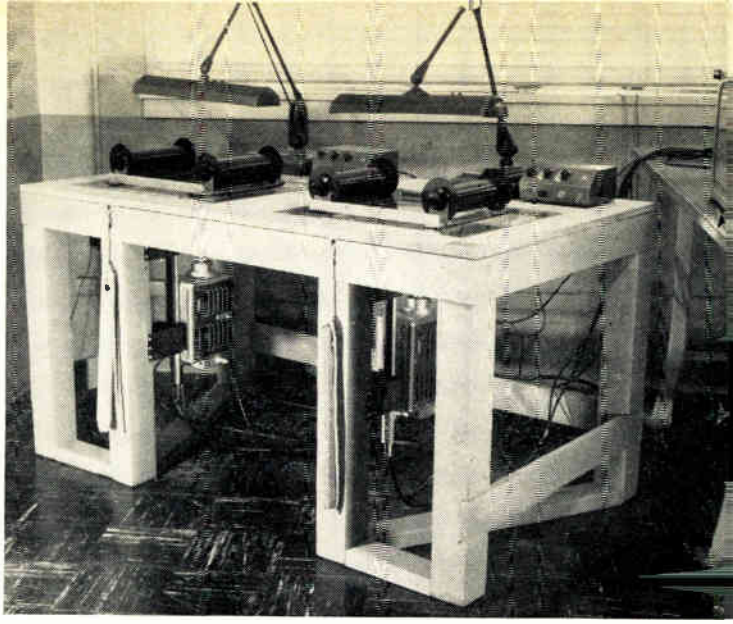


Fig. 1: TV comparator. Vertical motion of camera affects scaling.

Two films, differing widely in size, can be compared by superimposition on a TV monitor. Error is as low as 1%, making the method ideal for aerial survey interpretation.

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In recent years, photographic recording has become one of the most importatnt techniques for collecting data on various transient phenomena which cannot, because of bandwidth or response time, be studied on other types of recording equipment.

In many cases, the engineer and scientist must compare film records of electrical waveforms and other photographic data which have not been corrected for scale differences. The film is often too small to be examined without magnification. In other instances, such as the case with larger photographs, film comparison is impeded somewhat by the lack of a simple means for transforming the data.

The present article describes a technique for studying 2 rolls of film data by means of 2 vidicon type television cameras, a resistive mixer circuit, a difference amplifier and a video monitor.

The experimental equipment shown in Fig. 1 has been used for the comparison of 2 rolls of 9-in. film such as that used in aerial survey work. The film is mounted in 2 aluminum film holders which may be moved manually in x, y, and θ on the transparent working surface of a comparator table. Scale change is provided by vertical movement of the TV cameras which have been modified to focus on objects as near as 1 in. and as far as 1 ft. away from the lens. Illumination is provided by 2 dazor lamps with light diffusing screens.

Advantages

For certain purposes, a TV comparator such as that shown in Fig. 1 has advantages over a flying spot scanner which is very often used for scanning film data. Several of these advantages are as follows:

1. The TV scanner can yield a better signal to noise ratio because of the relatively unlimited

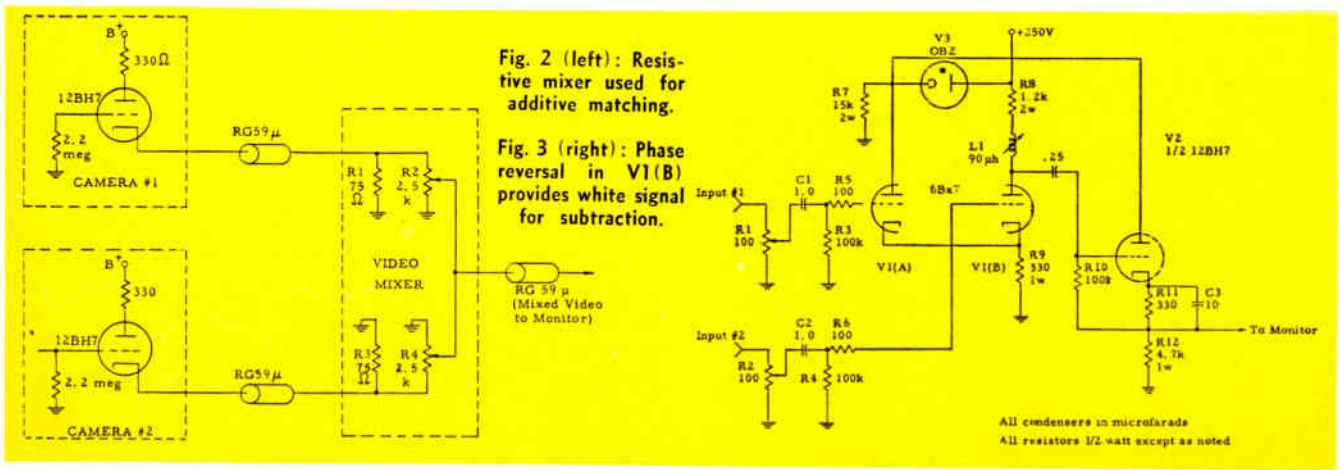


Fig. 2 (left): Resistive mixer used for additive matching.

Fig. 3 (right): Phase reversal in V1(B) provides white signal for subtraction.

amount of illumination which can be used on the photograph.

2. The TV scanner is a "single-ended" device which allows more freedom of movement on the operator's side of the photograph.

3. Although a flying spot scanner generally has better resolution than a closed circuit TV system, fewer variables in the optical system of the latter device generally make it easier to produce scale transformations.

4. Photographic data can be transmitted to remote locations more easily and more economically on the TV system.

Several simple matching experiments have been conducted using the photographic data comparator. The resistive mixer circuit shown in Fig. 2 has been used for additive matching, and the difference amplifier in Fig. 3 has been used for matching by subtraction.

Matching

For purposes of illustration, 2 coins were placed on separate sheets of paper on each side of the alignment table. Fig. 4a is a photograph of the mixed or added signals obtained on the monitor screen when the images of the 2 coins were superimposed through the resistive mixer. Note that the apparent density of either coin can be varied at will by adjustment of R2 and R4 in the mixer circuit. The dense overlap region, represents the added video signals. As the coins are pushed closer together the eclipsed area will increase until a single dark area appears on the monitor. It is possible by means of scale change to align and compare objects of different size and to observe the differences between 2 patterns which fail to match.

Difference matching is illustrated in a similar manner in Fig. 4b which was produced when the images of the 2 coins were mixed or superimposed in the difference amplifier. In this case, the white signal is produced by phase reversal of input No. 1 in V1(B), Fig. 3. As the coins are pushed closer together a difference overlap region shown in Fig. 4c appears. The null signal in Fig. 4d is obtained when the images are almost completely overlapped.

Data matching by TV techniques is limited at present to either simple pattern matching of large data or small area matching of more complex data. With a simple optical system, the alignment table has been used for reading microfilm and for comparing printed materials. This technique may also be used for editing 8mm, 16mm, or 32mm movie film.

The television equipment used in this investigation consisted of 2 Dage Model 65A2 driven sweep TV cameras, 1 Model 420A synchronizing generator, and a Dage Model 602-A 14-in. monitor. The accuracy of the matching technique was limited to 3% error using the present equipment. It is estimated that the error could be reduced to 1% by using matched deflection yokes and common sweep voltages for the vidicon cameras.

Acknowledgments

The techniques described in this article were developed under Air Force Contract AF 30(602)-1404 in conjunction with the Intelligence Laboratory, Rome Air Development Center.

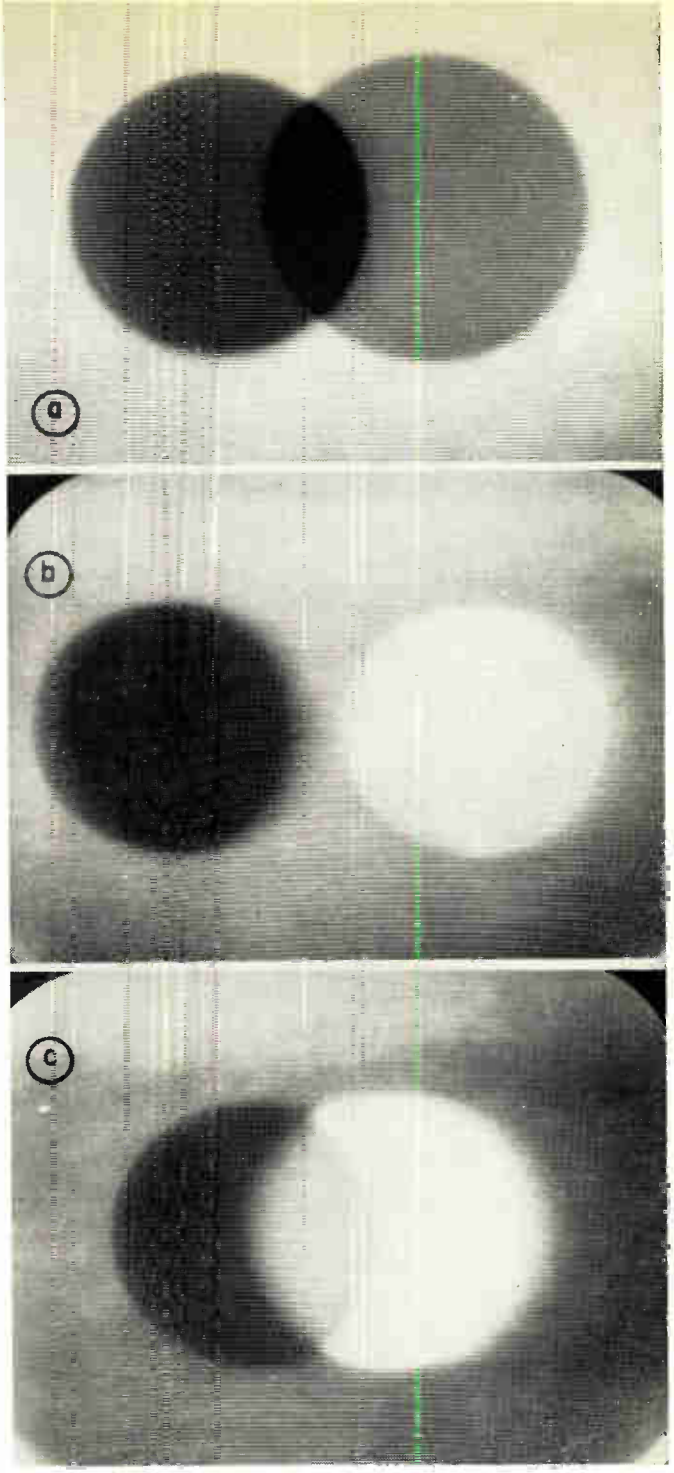


Fig. 4: Two coins are shown (a) as added signals partly overlapped, when superimposed through the resistive mixer. Mixed in the difference amplifier, they are represented as (b) separated, (c) partly overlapped, and (d) as a null signal when almost completely overlapped.

What's New . . .

NBS Designs Improved R-F Power Bridge

An improved rf-power-measuring bridge has been developed by the High Frequency Electrical Standards Section at the Boulder Laboratories of the National Bureau of Standards. Unlike conventional bridges, the present design measures the power effects of the rf current directly and eliminates measurements of large currents and then obtaining the difference.

The operation of a power-measuring bridge is based on the equivalent heating effect of dc power and rf power when both are dissipated in a purely resistive load. A temperature-sensitive resistor such as a thermistor or a Wallaston wire forms one arm of a Wheatstone bridge circuit which is biased with dc power until the bridge is balanced. When rf power is fed into the thermistor simultaneously with the dc bias power, the bridge becomes unbalanced and a quantity of dc power must be withdrawn to effect a rebalance.

Usually direct measurements of I_1 and I_2, the dc bias currents before and after rf power is fed into the thermistor, are made. This results in large errors when the rf power level is small because the measurement involves the difference between two large quantities. To alleviate this problem, it is the usual practice (an inconvenient one) to use several bolometer or thermistor elements with various sensitivities to cover the power range from microwatts to milliwatts.

Design

The approach used in the present improved design eliminates the difficulty by measuring the differences, ΔI, directly, and at the same time making available a very simple and relatively foolproof circuit arrangement.

The basic principle is to use o fixed total amount of direct current, furnished by a constant current source, and to divert the necessary part of this current from the bolometer bridge into a shunt resistor, where it can be measured directly. The more constant the current source, the greater the accuracy, especially at low power levels, and thus the overall usable range is increased.

Current Source

A simple constant-current source can be improvised from a regulated laboratory dc power supply and a series resistor whose value is about 100 times that of the bridge resistance. The maximum change in the total current due to load impedance changes will then be only about 1%. Accuracies of the order of 5% or better can be obtained with such a source and a 50-ohm single-thermistor bridge at power levels of about 1 to 100 mw.

Stability

Much better current regulation as well as stability can be obtained by using a well designed constant-current source. The source in use at the Bureau (a special electronically regulated power supply) has a regulation of 1 part in 10^5 for load variation from zero to 100 ohms while the stability is $\pm$ 1 part in 10^6 per hour. Stabilities of $\pm$ 1 part in 10^6 have been observed over periods of from 5 to 10 minutes. With this source, RF power levels at the thermistor from 100 mw down to 100 mμ were measured with respective accuracies of 0.05 to 5%.

The design of this bridge circuit readily permits incorporating a self-balancing feature by having the amplified output of the bridge control the amount of shunt current. The improvement over present-day commercial bridges is about ten to one in the power range and as much as 100 to 1 in percentage accuracy, with the greatest improvement at low levels.

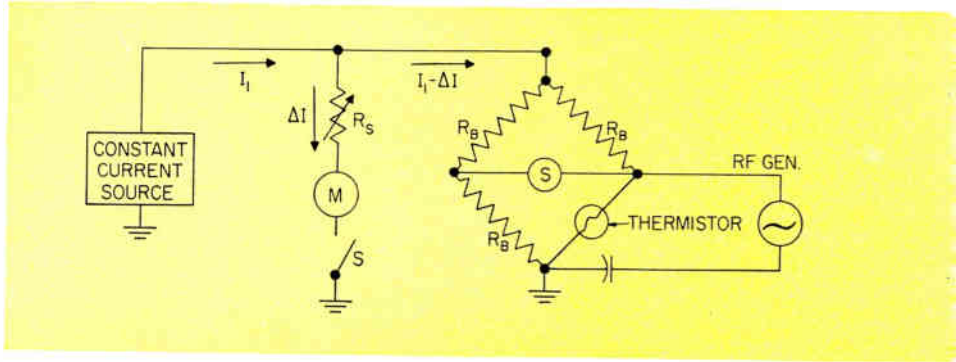
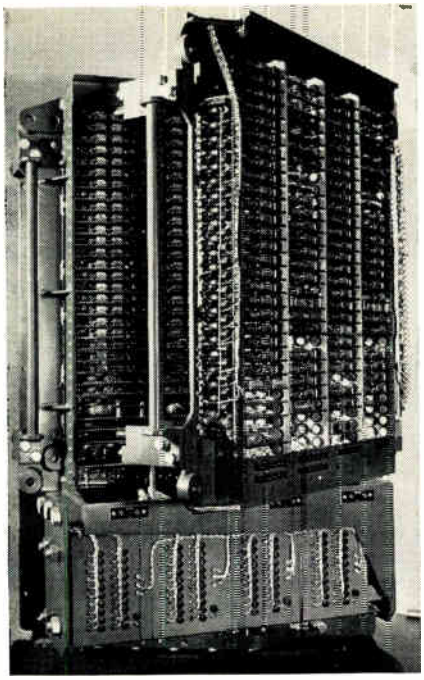


Fig. 1 (Above): Circuit diagram of the NBS rf bridge.

Fig. 2: The simple, reliable, single thermistor rf-power measuring bridge developed at NBS employs a constant-dc (or constant-af) current source and a shunt branch (R) to make direct measurements of the rf power equivalent.

French Electronic Exchange



This 20-line, fully electronic telephone exchange requires no mechanical or electrical adjustments after installation. This unit was designed for use by the French Navy

Basic components of the new French telephone switching center are silicon junction diodes and ferro-resonant circuits composed of a saturable self-inductance coil in series with a capacitance. Speech currents pass through gates formed by the diodes and are controlled by the magnetic trippers. Each gate consists of two diodes inserted in the subscriber line circuits. In the blocking condition they present a resistance of 1000 megohms; in the passing position, a resistance of about 4 ohms.

The new equipment has no moving parts and no vacuum tubes, thus possessing great inherent resistance to shock and vibration. At a later stage of development, it is intended to design a subscriber station to meet the same test conditions. This will mean, in particular, replacing the present dial with a push-button call sender, and replacing the ringer with an electro-acoustic transducer supplied from a transistor amplifier contained in the subscriber station. This will eliminate the magnetic amplifier now included in the line equipment and reduce its weight considerably.

The new equipment was developed by Laboratoire Central de Telecommunications, French research associate of IT&T. The 20-line exchange is a first step toward complete replacement of electro-mechanical devices with all-electronic systems.

Ionovac Super-Sonic Speaker

Exciting new possibilities in audio and super-sonic engineering are opened up by announcement of a speaker which has no moving coil, no cone, diaphragm, or vibrating crystal. All these components are replaced by a pulsating cloud of highly ionized air. As an example of the performance of the new "Ionovac" speaker, tests on an early model showed a response of ± 4 db at a 94 db level from 1800 to 20,000 cps.

While the product is being offered initially to the high-fidelity market as a loudspeaker for the more expensive record players and radios, its applications as a generator of ultra-sonic waves for use by a wide variety of industries is considered of even greater importance.

Heart of the new invention is a small open-ended quartz cell the size of a peanut shell. Air is cupped in a chamber which narrows down to an aperture about the size of an automatic pencil lead. Within this small space, air molecules are bombarded with a high frequency, high voltage current which ionizes the air. The resulting ionized cloud, which glows with a violet hue, functions in place of the traditional diaphragm.

How It Works

The ionized particles, when exposed to an intense electric field, become highly agitated. When the strength of the field is changed, the breadth of the oscillations of each of the particles is also changed. Each variation causes an expansion of the "cloud," followed by a contraction, thereby producing sound waves in any strength, form and frequency needed.

Moving parts in loud speakers —the coils and diaphragms—are at present the weakest links in high fidelity sound reproduction. Within the receiver and amplifier we have learned how to design with extremely low distortion, only to destroy the fidelity by the

(*Continued on page* 151)

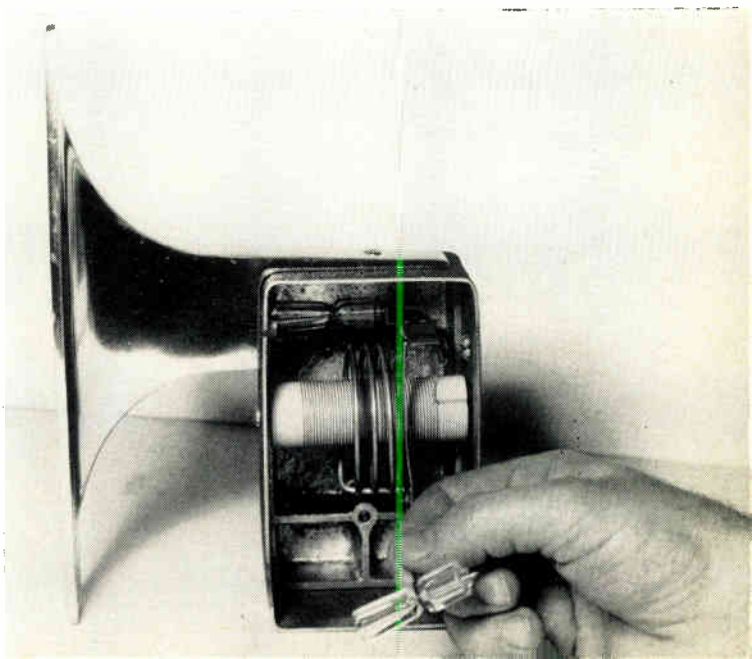


Fig. 1: The small quartz cell shown beside this Ionovac speaker is the electronic heart of the new device. Unlike conventional speakers with their moving coils and vibrating cones, or conventional ultra-sonic transducers with their piezoelectric or magnetostrictive elements, the new cell creates a tiny cloud of ions which is made to expand or contract in response to audio or ultra-sonic signals. The transducer is broad-band, enabling use of one unit to cover a wide range of ultra-sonic frequencies.

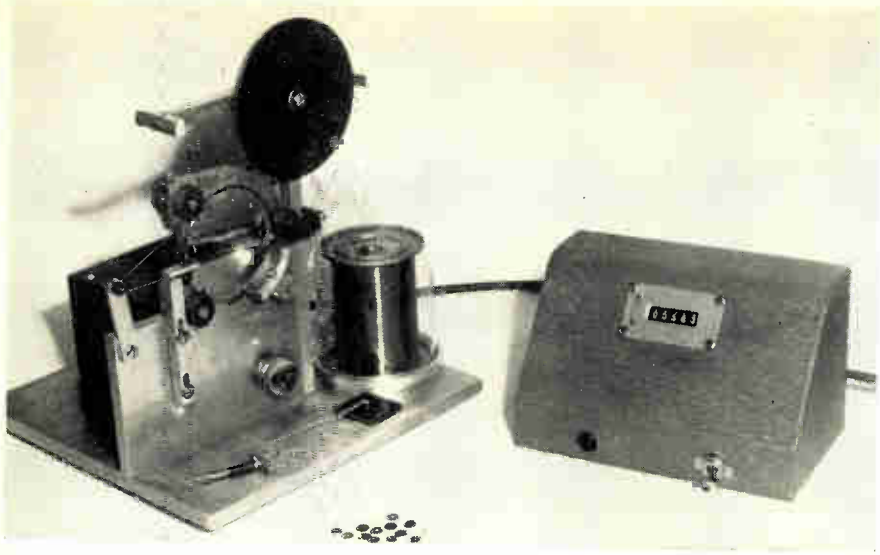


Fig. 1: View of typical machinery, winder & counter, used in manufacturing miniature toroids.

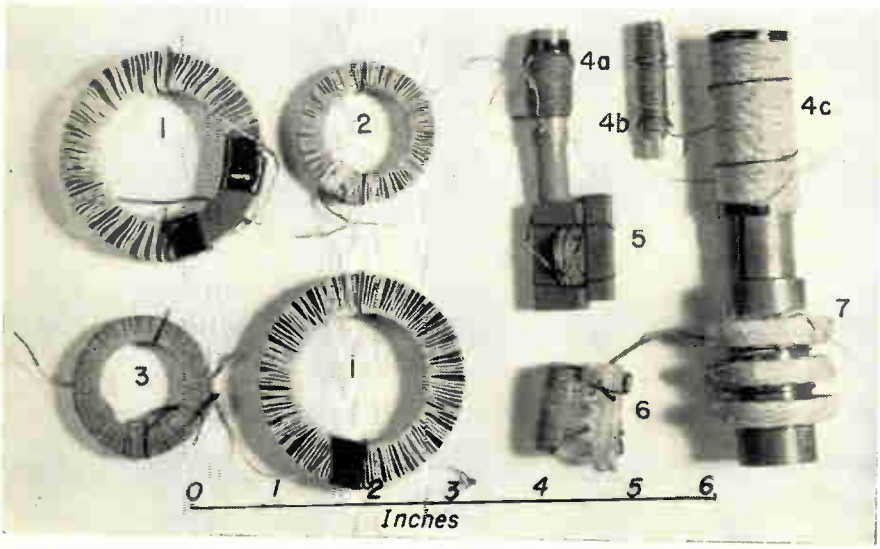
New Method of

Evaluating Ferro-Inductors

For the first time, the iron loss is treated as a separate entity—negligible compared to the insertion loss. Formulas for measuring the insertion loss are derived and applied to typical cases.

By W. J. POLYDOROFF

Fig. 2: Toroids 1, 2, & 3 produce Q of 450 to 300; 4a, b, & c show optimum Q vs. permeability; 5 & 6, min. insertion loss; and 7, cannot be improved by iron core.



A good number of articles nave been dealing with iron core coils. Even the very recent ones treat the insertion of the core as "the iron loss," or equivalent resistance. This article will show how misleading this practice may be in the design of inductors, testing the cores in the usual solenoidal coils. It is hoped, that it will lead to the design of better coils with optimum utilization of wire and core material.

Iron Losses

We start with the general expression of iron losses as shown by Legg[1]:

$R_i = L_l \mu\, f\, (aB + c + ef + gf^2)$

in which the fourth term gf^2 was observed some time ago by the writer, when noticing behavior of inductors at higher frequencies, and confirmed by other investigators.

Knowing the inductance, permeability, frequency and values of a, c, e and g, one can easily calculate the iron loss resistance (ohms) which will be added to the coil's resistance to get the loss resistance of the combination. In actual practice, we may safely omit hysteresis loss resistance for h-f work (aB) as this loss in normal circumstances will not exceed 2% of the R_i. We may, therefore, deal with the other 3 terms as a "package" and knowing the coefficients c, e, and g, make tables vs. frequency.

We note now that R_i is proportional to μ and L_l, or to μ^2 and L_o, where L_o would be an inductance of the coil as such. While Legg's formula was primarily designed for toroidal inductance, where μ is the full permeability of the material, we may extend the same to any other application utilizing permeability. Bearing in mind that the loss resistance of the iron is proportional to the degree of utilization of its magnetic properties.

This has been proven time and time again. In a majority of recent measurements, increment of permeability is compared with increment of loss. If we accept this principle, we may extend Legg's equation to any shape and form of inductor. Also, take for μ its "effective" value, μ_e, as can be measured from the ratio L_i/L_o of in-

ductances with, and without, magnetic material. Further, in this investigation, it will appear that the above principle holds true.

Magnetic Losses

Now consider the magnetic losses. Coefficient e denotes eddy current loss which, according to the laws on induction, must be proportional to f^2, the total in ohms being $R_e = L_i\mu f^2 c$. This loss, in powdered cores, is proportional to the conductivity of iron or alloy, to the (diameter of particles)^2, and to the ("packing factor")—⅓. Also, it will depend on the overall conductivity of a core

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or on the degree of insulation between the particles.

The second term of the "package" may be attributed to frictional losses within the material and is usually called "residual." The term c and the loss, $R_c = L_i\mu fc$, is more pronounced at the lower frequency of the range, while the last term of gf^2 or the loss, $R_g = L_i\mu f^3 g$, because of its frequency dependence, is evidenced at higher frequencies and acts as a brake for the use of any iron at a certain "limiting" frequency. (This is especially true for the ferrities, both powdered and solid, where eddy current loss, because of very low internal conductivity, is practically absent, yet every material has a definite upper frequency limit because of g-loss.)

When Legg's method was applied to a series of measurements of toroidal coils at several low (telephone) frequencies and plotted vs. frequency, we were able to determine the coefficients c and e. Unfortunately, the same method applied to high frequencies produced most confusing and conflicting figures, indicating the influence of the windings. The author, therefore, as early as 1940, replaced toroids by coaxial lines loaded with specimen of iron and obtained some consistent figures. They were far from being accurate because of two limitations: very high frequencies at which the measurements could be made and inadequacy of measuring tools.

Recently, the same methods were applied by NBS employing long lines, low enough frequency and a precision bridge. The figures for coefficients c and e, thus obtained, are extremely low for carbonyl iron powders of standard grades and are in conformity with those recently published in England.

Table 1 gives the values of loss coefficients recently determined from the NBS measurements on several grades of carbonyl iron specimen cores. As it is customary to express coils in terms of their Q, the values of Q_i at different μ are calculated:

From Legg's equation, it follows that

$$\mu Q_i = \frac{2\pi}{c + ef + gf^2}$$

Note the values of Q_i of the order of thousands as compared with the same of the coil proper. Also interesting to note that Q_i, after a certain high frequency, rapidly declines due to term g which is proportional to f^3.

Table 1

Q_i AND LOSS COEFFICIENTS
for "hard" carbonyl iron powdered cores.

	"E"		"TH"	"SF"		"J"		"W"
Loss coeff c	1.9×10^{-4}		1.25×10^{-4}	1.0×10^{-4}		9.2×10^{-4}		15.0×10^{-4}
Loss coeff e	1.9×10^{-10}		0.8×10^{-10}	0.25×10^{-10}		0.2×10^{-10}		0.1×10^{-10}
Loss coeff g	1.9×10^{-18}		1.6×10^{-18}	1.2×10^{-18}		1.25×10^{-18}		0.9×10^{-18}
freq. mc	at $\mu=10$	$\mu=8$	$\mu=8$	$\mu=8$	$\mu=6$	$\mu=7.6$	$\mu=6$	$\mu=6$
0.5	2,200	2,700	4,800	—	—	—	—	—
1.0	1,700	2,200	3,800	6,250	8,300	900	1,000	—
2.0	1,100	1,400	2,800	5,200	7,000	870	1,000	—
5.0	550	700	1,350	3,400	4,400	800	920	—
10.0	270	340	725	1,650	2,200	670	850	670
20.0	—	—	330	710	950	470	600	500
50.0	—	—	—	180	240	130	160	250
100.0	—	—	—	55	74	55	70	110
150.0	—	—	—	—	—	—	—	50

Table 2

Item	Core	Turns	$L\mu H$	μ_o	Q 0.8 mc	1.0 mc	1.2 mc	1.5 mc	1.7 mc	2.0 mc
1	AIR	125	13.1	1.0	—	150	155	185	180	170
2	"E"	127	95.0	7.0	440	410	390	330	300	230
3	"E"	114	85.0	6.9	470	460	430	400	360	330
4	"TH"	127	85.1	6.4	460	430	410	380	360	330
5	"E"	125	42.5	3.3	190	225	230	225	220	215
6	"TH"	111	64.0	6.4	460	480	470	410	445	400

With the coefficients now given, we may calculate R_i resistance increase due to iron. Or for those mostly interested in Q of an inductor, knowing Q of the coil, Q_i of the iron, and resistance of the coil proper at a given frequency, R_{rf}, to arrive at the Q of the combination we have a simple expression:

$$Q = \frac{Q_o R_{rf} + Q_i R_i}{R_{rf} + R_i}$$

or

$$Q = \frac{WL_o + WL_o(\mu - 1)}{R_{rf} + R_i}$$

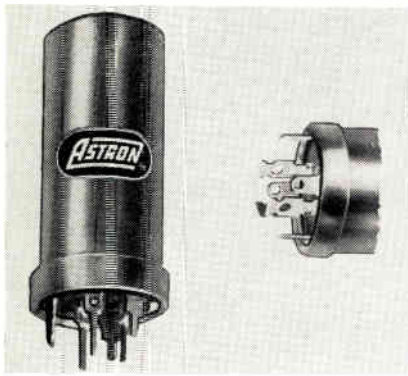
In actual practice, such calculations do not agree with the

(*Continued on page* 147)

New Products . . . for the Design Engineer

ELECTROLYTIC CAPACITORS

Style EX and EZ feature superior quality materials, specially anodized, 99.99% pure aluminum foil, and scientifically compounded electrolytic formulas. They have been specially

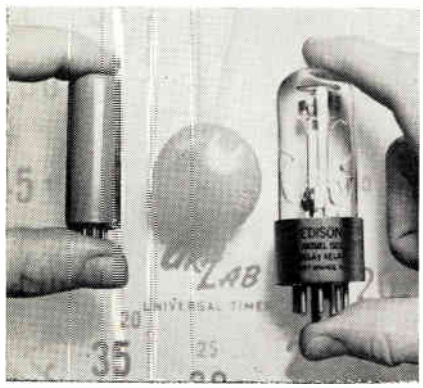


designed to meet exacting requirements of small size, extremely low leakage and long idling or shelf life. Ideal for printed and transistorized circuitry. These rugged, hermetically sealed capacitors supply dependable performance over wide temperature ranges. EX has standard twist prong mtg.; EZ is for printed circuit mtg. Astron Corp., 255 Grant Ave., East Newark, N. J.

Circle 43 on Inquiry Card, page 97

DELAY RELAY

A new miniature thermal delay relay (shown at the left) has just been announced. This vibration resistant unit is specifically designed for applications in both missiles and jet aircraft. Among its many design features are: virtual elimination of contact chatter up to 1500 cps at 10 g's; no resonance to 500 cps; good ambient compensation between —65°C



and +85°C—contacts rated for 1 a. at 27.5 vdc. or 3 a. at 115 vac.; and extra-rigid construction for exceptionally high contact pressure. Instrument Division, Thomas A. Edison Industries, West Orange, N. J.

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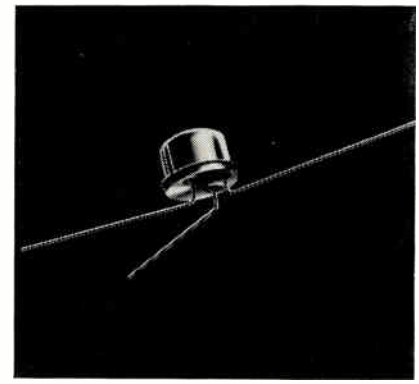
SWITCHING TRANSISTOR

These new pnp computer transistors, the 2N-315, 2N-316 and 2N-317 are the germanium alloy type intended primarily for applications where high speed, high current switch-

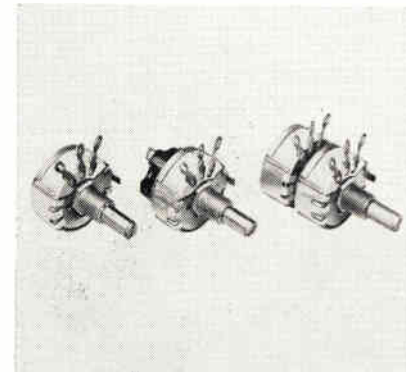


ing is of paramount importance. The 2N-317 has, with only a minimum of drive current, a typical switching speed of 0.3 msec. at 400 ma. of collector current. Series resistance when conducting is ½ ohm; nonconducting series resistance is as high as 10 Megs with a result that approaches optimum efficiency at high current levels. General Transistor Corp., 91-27 138th Place, Jamaica, N. Y.

Circle 45 on Inquiry Card, page 97

VARIABLE CONTROL

A new variable composition control for the RV4 style under MIL R-94A using a molded composition resistance track, employs a radial resistance element, filling the entire inner perimeter of the resistor barrel. Wattage dissipation is higher and localized hot spots are reduced. Model "R" offers a 3 w. std. rating; 2 w. under RV4 style. After moisture resistance

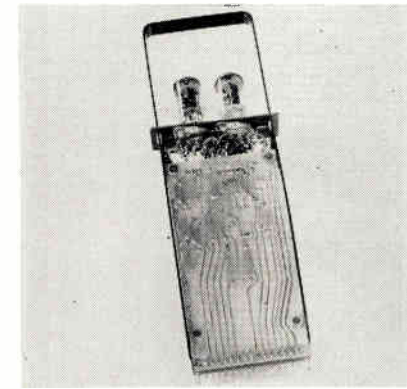


type testing the resistors will exceed the "Y" environmental characteristic, with an average change of 2%. Linear, cw, and ccw tapers provided. Reon Resistor Corp., 117 Stanley Ave., Yonkers, N. Y.

Circle 46 on Inquiry Card, page 97

PLUG-IN CIRCUITS

A new "Computer-Series" of plug-ins, said to represent a refinement of the building-block concept to a degree hitherto unknown, has been announced. Performance of the new

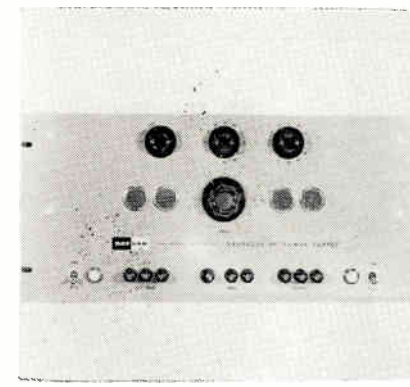


plug-ins has been engineered for application where ultra-conservative design at the component level is essential because of system complexity. A full line of circuits is available, including Flip-Flops, Shift Register Elements, DC "Not" Circuits, Delay Units, Pulse Mixer Amplifiers, and One-Digit Subtractor Matrixes. Engineered Electronics Co., 506 East First St., Santa Ana, Calif.

Circle 47 on Inquiry Card, page 97

DC POWER SUPPLY

Model 30B-25 Power Supply provides dc from 1.02 to 302 v. at up to 250 ma. with ±100 ppm long time stability, 0.01% load regulation factor, 0.002% line regulation factor, and less than 0.5 mv. hum and noise. Calibrated dials select desired output voltage to an accuracy of 0.02% or 5 mv. DC output impedance is less than 0.01 ohm, and ac output impedance is less



than 0.5 ohm to 200 KC. Response time is less than 0.2 mecs. Varible bias from 0 to —150 v. at 10 ma. and 6.3 v. ac filament voltage at 5 a. KINTEL (formerly Kay Lab), 5725 Kearny Villa Rd., San Diego 11.

Circle 48 on Inquiry Card, page 97

New Products ... for the Design Engineer

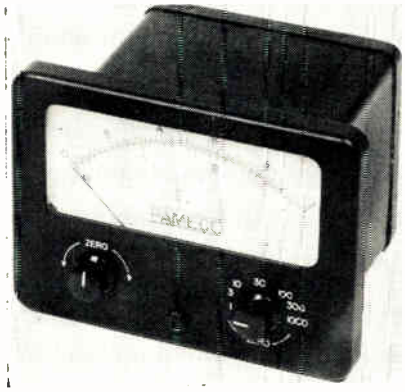
STEPPING SYNCHRO

Precision stepping synchros utilizing an electro-mechanical positioner to drive the rotor of a differential synchro in fixed increments of 1° produce an ac output that is synchronous with rotor position. Rotation of the mechanism is unlimited in both directions, and is operated by an electrical input pulse at any speed up to 60°/sec. The Model 89161A-1 Stepping Synchro will fit a multitude of applications such as often found in complex directional or guidance systems where the need exists for servo actuation. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1.

Circle 49 on Inquiry Card, page 97

ELECTRONIC VOLTMETER

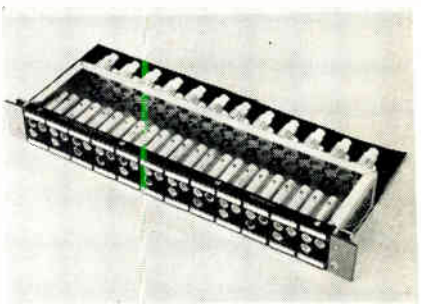
One of a series of miniature, panel-mounted electronic instruments, the Model 310 DC Electronic Voltmeter has been especially designed for incorporation into equipment where compactness and dependability are important considerations. The instrument is a completely self-contained, multirange voltmeter possessed of good electrical characteristics which include high input impedance, good accuracy and the ability to effect voltage measurements up to 1000 vdc. It offers a large scale with 7 voltage ranges, 0-1/3/10/30/100/300/1000 v. Pameco, Mill Lane, Waterford, Conn.



Circle 51 on Inquiry Card, page 97

JACK PANEL

These video jack panels are designed to provide co-axial patching facilities for television installations or other applications where 70 ohm lines are used. These panels are available with jacks for both the RCA and Western Electric size. Individual jacks, plugs, patchcords and looping plugs are also available. Panels may also be obtained with 12 groups of either 2, 3 or 4 jacks. A sub-chassis is included providing 24 Amphenol connectors and plugs to allow disconnection of long lines. Perfect shielding guaranteed. Nems-Clarke, Inc., 919 Jesup-Blair, Silver Spring, Md.



Circle 53 on Inquiry Card, page 97

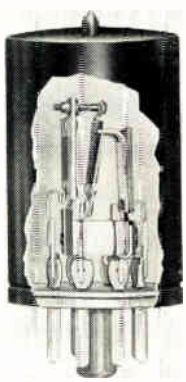
READ-OUT TUBE

The first mass-produced all-electronic "read-out" tube is now in volume production. The NIXIE, a small, low-cost electron device, converts electronic signals directly to readable characters. It contains all the numeric digits, any one of which can be selected and displayed. It can be triggered by beam switching tubes or any suitable voltage source requiring approx. ¼ w. Applications include computer read-out, industrial control, electronic instrumentation, military electronic control, and channel selectors. Burroughs Corp., Electronic Tube Div., Plainfield, N. J.

Circle 50 on Inquiry Card, page 97

MEMORY RELAY

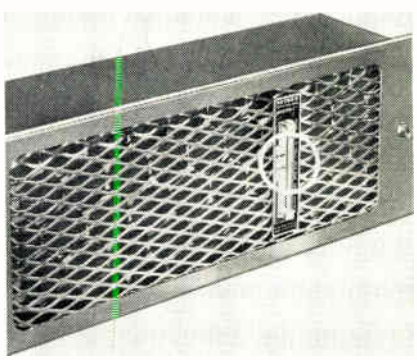
This device is a bistable time relay with SPDT snap action contacts. The relay is thermally operated, having two separate heater circuits. Each heater serves to transfer a movable arm from one contact to the other. The relay being bistable remains in either of the two contact positions until operated by means of the appropriate heater circuit. Because of the thermal actuating characteristics, a time delay is associated with each operation. The bimetal strips are perfectly matched, Curtiss-Wright Corp., Electronics Div., 631 Central Ave., Carlstadt, N. J.



Circle 52 on Inquiry Card, page 97

COOLING PANEL

A new cooling panel for flushing clean, cooling air through standard 19-in. enclosed relay racks has been announced. A built-in fan pulls air through a 2-in. thick fiberglass dust-filter on which there is a novel Filter Pilot (white circle), which automatically indicates when filter replacement is due. The Model RF Cooling Panel is capable of handling 2000 w. dissipation with a 40° F. temp. rise and can operate continuously in 125° F. ambients. Height is only 7 in. and total weight 7 lbs. Rotron Manufacturing Company, Schoonmaker Lane, Woodstock, N. Y.



Circle 54 on Inquiry Card, page 97

WASHINGTON News Letter

MICROWAVE OVERHAUL—The FCC is commencing its all-important hearings the latter part of April or early May to determine the future uses of the frequency spectrum above 890 MC. Full written cases by the participants in the proceeding were submitted to the Commission during the latter part of March, but they will not be made available to all participants "for competitive reasons" until a short time before the hearings are under way.

DATA ON RECORD—The objective of this procedure is to get most of the data, particularly statistical information, on record at the FCC before the oral sessions start. This will allow more time for the parties to emphasize special points during the oral hearings. The hearings will run two or three days a week. While more than 200 organizations have filed notices of appearance or comments, a number have indicated that they do not intend to testify and numerous others have simply endorsed the position of other participants.

PROCEDURE TO BE FOLLOWED—Cross-examination during the microwave hearings will be done exclusively by the FCC Commissioners or staff attorneys. The parties in the case will be given an opportunity to submit for Commission consideration any questions they may want to ask of another party. There will be no "round-robin" cross-examination of witnesses by the FCC staff, it was emphasized. Some method of rebuttal by the different parties is being formulated by the FCC legal staff in charge of the microwave hearings' planning and this will be allowed after the conclusion of the oral sessions.

FIVE-YEAR LICENSES—Strong support for 5-year license periods for broadcasting and television stations instead of the present three-year renewal requirement came recently from two top-ranking governmental sources. Senator John Pastore (D., R. I.) who heads the communications-radio subcommittee of the Senate Interstate and Foreign Commerce Committee and FCC Chairman George C. McConnaughey advocated the longer license periods on the premise that renewals of broadcast-TV stations should only be refused for violation of the Communications Act. In fact, Senator Pastore indicated that he favored permanent licenses for the broadcasting field. FCC Commissioner John C. Doerfer in an address several months ago had also proposed that the licenses be awarded "in perpetuity."

SCATTER READY—At a conference of federal government and armed services officials under the sponsorship of the Telecommunications Planning Committee it was recently disclosed to ELECTRONIC INDUSTRIES' Washington Bureau that radio communication by ionospheric scatter has now progressed where it is ready for routine operational application. The objective of the conference, attended by government and military officials who are or may be in the future responsible for operational use of ionospheric scatter, was a comprehensive review of the theoretical, experimental and operational state of scatter communication. Besides the government and military participants at the classified conference, speakers included representatives from Aeronautical Radio, Inc., Collins Radio Co., Lincoln Laboratories, and Page Communications Engineers.

SINGLE SIDEBAND FOR AVIATION—Endorsement of single sideband for civil aeronautical communications service as "still the right conclusion" was the determination of the Airlines Electronic Engineering Committee, affiliated with Aeronautical Radio, Inc., following a recent all-day symposium on single sideband and double sideband attended by around 350 aviation radio engineers at which representatives from Collins Radio, General Electric, Hoffman Laboratories and Kahn Research Laboratories presented their views on different systems for ground-air communications. The AEEC concurred in the previous findings of the International Air Transport Association resulting from its analysis of SSB potentialities at Montreal last November.

SSB DATA TRANSMISSION—Both speech processing and data transmission can be accomplished on SSB, the AEEC concluded, although for data transmission more "sophisticated" techniques are required. The ARINC technical agency cited "it is clear there is a relative spectrum advantage in SSB systems over DSB systems," and single sideband is "the logical replacement" for the present AM communications system.

DEFENSE SPENDING—During the first half of the government fiscal year 1957 which ended last Dec. 31, the Department of Defense spent $455,176,000 out of a total $2,938,145,000 available for communications and electronics requirements for both military functions and the military assistance program. For military functions alone $366,689,000 out of a fund of $2,554,281,000 available. Spending by departments with amounts available in parentheses included: Army, $72,292,000 ($579,771,000); Navy, $56,483,000 ($444,614,000); and Air Force, $230,914,000 ($1,529,896,000). For the military assistance program $88,487,000 was spent in the last half of 1956 out of $383,864,000 available.

National Press Building
Washington 4

ROLAND C. DAVIES
Washington Editor

☆ Visual Alignment Unnecessary...Ribbon Spring Contacts...


36-4200-8S

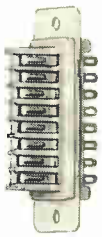

36-4100-8P

Floating Bushings

BLUE RIBBON CONNECTORS BY CINCH

☆ The ribbon contact principle, with dielectric guide and support eliminates the possibilities of damaged or bent contacts and prevents difficulties of plug-in. No dependence on contact arrangement or visual alignment is necessary.


36-4200-16S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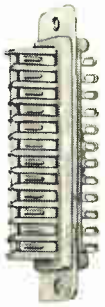
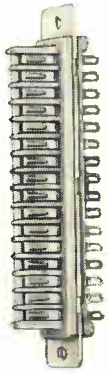
36-4200-24S


36-4100-24P


36-4200-32S


36-4100-32P

For your connector requirements — you can depend on CINCH.

BARRIER POLARIZATION TYPE INSURE QUICK POSITIVE CONTACT WITH EASE

The Wedge principle with the strong spring action of the contacts holds the connector in positive contact, and provides ease of insertion and withdrawal. The protective barriers between ribbon contacts insure the spacing. The entire length of the contacts are supported by quality dielectric. Multiple mounting makes it possible to make or break any number of circuits simultaneously. The high tensile strength of blue dielectric provides positive polarization. Molded-in mounting plates are of corrosion resistant passivated stainless steel.

BLUE RIBBON CONNECTOR IMPROVED MILITARY TYPE


36-4200-24S (345)

36-4100-24P (345)

Improved design of plug ar socket casting eliminate ar possible breakag

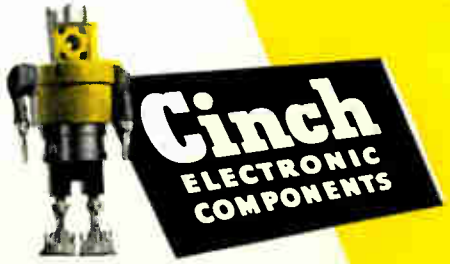
IMPROVED TYPE:

36-4100- 8P (345)
36-4100- 8S (345)
36-4100-16P (345)
36-4100-16S (345)
36-4100-24P (345)
36-4100-24S (345)
36-4100-32P (345)
36-4100-32S (345)

REGULAR TYPE:

36-4100- 8P (334)
36-4100- 8S (334)
36-4100-16P (334)
36-4100-16S (334)
36-4100-24P (334)
36-4100-24S (334)
36-4100-32P (334)
36-4100-32S (334)

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; LaPuente, California; St. Louis, Missouri.



CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

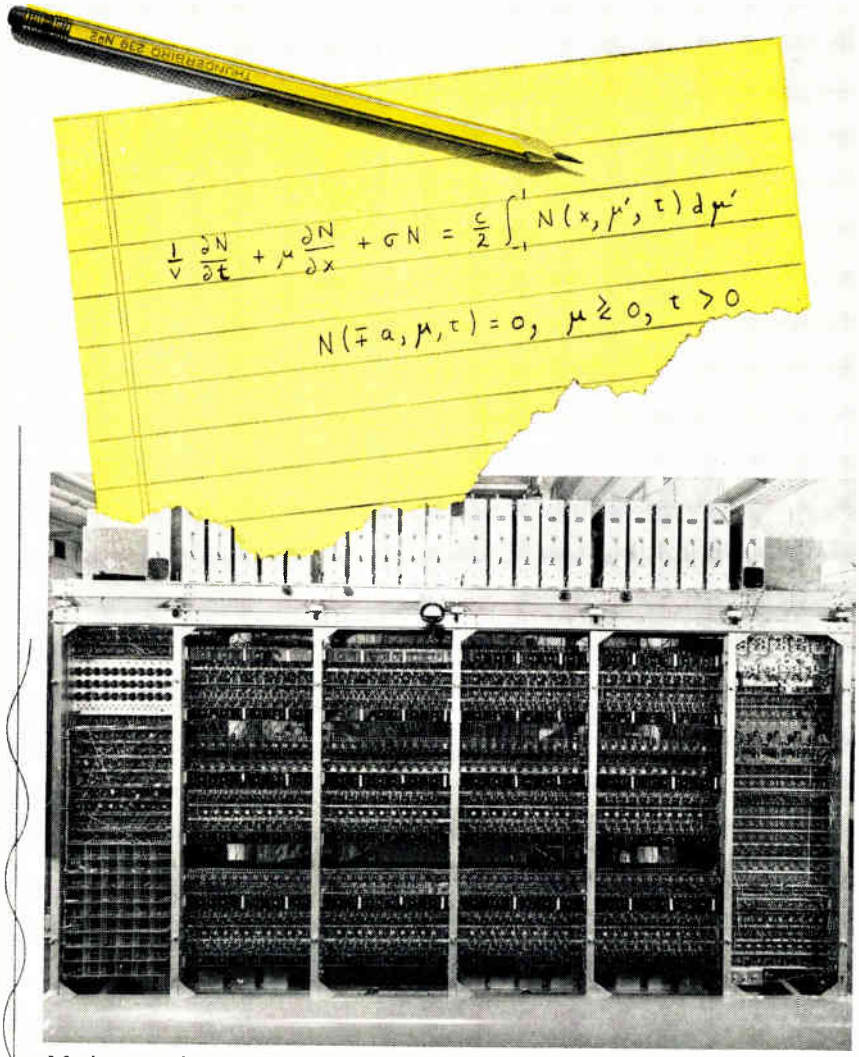
Subsidiary of United-Carr Fastener Corporation, Cambridge, Ma

another example of exciting work at los alamos...

BREAKING PROBLEM BARRIERS

The linearized Boltzmann equation shown at the right describes the transport of neutrons in a slab. Its mathematical structure was first completely worked out at Los Alamos. This is only one of the many fundamental problems in disciplines ranging from pure mathematics through biology that are yielding to newly developed methods of experimental and theoretical analysis.

The Laboratory has entered a new phase of scientific endeavor. Pioneering activities in the unexplored realms of nuclear power, nuclear rocket engines, and controlled thermonuclear power have been added to its weapons program; experiments are being planned and carried out at pressures and temperatures far beyond any previously created by man. These activities exemplify the imaginative approach by which the Laboratory maintains its preeminence in scientific achievement.



Mathematical support for many of the Laboratory's programs is given by the Theoretical Division, which also pursues its own investigations in hydrodynamics, magnetohydrodynamics, computer theory and design, and other fields. The vast amount of computation involved has brought about the creation at Los Alamos of the largest known computing center devoted exclusively to scientific work.

The "Maniac" (above) is one of the many advanced computers in use at the Laboratory.

Los Alamos Scientific Laboratory is a non-civil service operation of the University of California for the U. S. Atomic Energy Commission.

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

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International
ELECTRONIC SOURCES

ELECTRONIC INDUSTRIES' exclusive monthly digest of the world's top electronic engineering articles

ANTENNAS, PROPAGATION

Sky Waves For Short Range Transmission, by R. E. Lacy and J. J. Egli. "El. Ind. Op. Sect." April 1957. 2 pp. The authors examine the conditions affecting short range (25 miles) communication on all parts of the earth. Variables investigated are atmospheric radio-noise levels, attenuation (both free-space and ionospheric absorption), and ionospheric usable frequencies.

The Reflection of a Plane Wave from a Wire Grid when the Wave is Normally Polarized, by V. G. Iampol'sky. "Radiotek." Nov. 1956. 5 pp. The paper examines the problem of the reflection of a plane electromagnetic wave from a grid consisting of equally spaced round conductors for the case when the electric field intensity vector of the incident wave lies in the plane of the grid and perpendicular to the axes of the conductors.

A Limiting Case in the Design of an Excited Reflector Antenna, by V. A. Krishnaswamy. "J. ITE." Dec. 1956. 5 pp. The author brings together the basic theory relating to the excited reflector and the parasitic reflector, and spotlights the situation where the excited reflector breaks down. The vector diagrams help to comprehend clearly the role of the mutual impedance in altering the base impedance of the aerials to different values.

Terminated Horn Enclosures, by W. E. Glenn. "IRE Trans. PGAU." No. 6, 1956. 3 pp. The characteristics of a finite exponential horn terminated in a physically realizable impedance have been calculated on an IBM 650 computer. Some of the results of the calculations and some experimental results of tests on such a terminated horn are presented.

Radiation by Disks and Conical Structures, by A. Leitner and C. P. Wells. "IRE Trans. PGAP." Oct. 1956. 4 pp. This paper studies the use of the method of integral transforms in a class of radiation and antenna problems involving mixed boundary conditions on coordinate surfaces of the spherical system.

Foreign Publications as an Engineering Tool, by J. G. Adashko. "Ford Instrument Company Engineering Log." Jan. 1957. 2 pp. Mr. Adashko emphasizes the importance of foreign technical publications as a source of information. He points out that the Russians, Germans, and French publish more technical material than we do—the Russians have at least three magazines comparable to the IRE Proceedings. Speaking of his own work in nuclear equipment he lists as probably most valuable the very expensive "Avtomatika i Telemekhanika." Only EI's exclusive INTERNATIONAL ELECTRONIC SOURCES regularly and thoroughly abstracts this Russian journal.

Radiation Absorbers—Their Selection and Use, by D. J. Newman. "El. Des." Feb. 1, 1957. 3 pp. The article deals with electromagnetic energy absorbers to simulate free-space.

Ferrod Radiator System, by F. Reggia, E. G. Sencer, R. D. Hatcher, and J. E. Tompkins. "Proc. IRE." March 1957. 9 pp. Ferrod radiator systems for 3-cm have been developed which are especially useful in the field of portable radars and have good possibilities in the miniaturization of fire-control antenna systems requiring high-speed electrical scanning or lobing.

Simplification of Field Strength Computations for Shielded Enclosures, by R. G. Lessner and A. S. Markham. "Proc. IRE." March 1957. 1 p. The authors of this note derive a simplified formula for the method developed by Haber in "Generation of Standard Fields in Shielded Enclosures."

Military Standardization of Dummy Loads, by L. Field and A. C. Metzger. "El. Des." Feb. 1, 1957. 2 pp.

Partially Reflecting Sheet Arrays, by G. von Trentini. "IRE Trans. PGAP." Oct. 1956. 6 pp. Multiple reflections of electromagnetic waves between two planes are studied, and the increase in directivity that results by placing a partially reflecting sheet in front of an antenna with a reflecting screen is investigated at a wavelength of 3.2 cm.

Line-of-Sight Wave Propagation in a Randomly Inhomogeneous Medium, by B. M. Fannin. "IRE Trans. PGAP." Oct. 1956. 5 pp. Theoretical calculations have been made, using single-scattering approximation, for propagation in a randomly inhomogeneous medium in which the deviations of refractive index from the mean are small. The emphasis in this paper is in indicating the transition from the ray treatment results to the scattering cross section results.

Computer Predictions of LUFS and MUFS. "Research for Industry," Jan. 1957. 2 pp. Computations of lowest useful high frequency and maximum usable frequency by the Signal Corps Radio Propagation Agency at Fort Monmouth, N. J., are described in general, and applicability of computers to the task discussed.

Circulatory-Polarized Biconical Horns, by C. Goatley and F. D. Green. "IRE Trans. PGAP." Oct. 1956. 5 pp. The method of obtaining elliptical and circular polarization described here consists basically of interposing a dense array of thin, conducting elements on cylindrical plastic forms between the faces of the cones. The authors discuss polarization obtained and radiation patterns, gain, phase differences, and applications of the antenna.

Phase Centers of Microwave Antennas, by D. Carter. "IRE Trans. PGAP." Oct. 1956. 4 pp. Contrary to the prediction of aperture theory, it is shown that the phase centers of axially symmetric antennas are not in the aperture plane, but they are dispersed about it. It is pointed out that the phase centers of the reflected radiation field can be varied and even pushed behind the dish by defocusing and separating the primary feed phase centers.

REGULARLY REVIEWED

AEG Prog. AEG Progress
Aero. Eng. Rev. Aeronautical Engineering Review
Ann. de Radio. Annales de Radioelectricite
Arc. El. Uber. Archiv der elektrischen Uebertragung
ASTM Bul. ASTM Bulletin
Auto. Con. Automatic Control
Auto. El. The Automatic Electric Technical Journal
Avto. i Tel. Avtomatika i Telemekhanika
AWA Tech. Rev. AWA Technical Review
BBC Monc. BBC Engineering Monographs
Bell Rec. Bell Laboratories Record
Bell J. Bell System Technical Journal
Bul. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Comp. Computers and Automation
Con. Eng. Control Engineering
E. & R. Eng. Electronic & Radio Engineer
Elek. Elektrichestvo
El. Electronics
El. & Comm. Electronics and Communications
El. Des. Electronic Design
El. Energy. Electrical Energy
El. Eng. Electronic Engineering
El Eq. Electronic Equipment
EL. Ind. ELECTRONIC INDUSTRIES & Tele-Tech
El. Mfg. Electrical Manufacturing
El. Rund. Electronische Rundschau
Eric. Rev. Ericsson Review
Fern. Z. Fernmeldetechnische Zeitschrift
Freq. Frequenz
GE Rev. General Electric Review
Hochfreq. Hochfrequenz-technik und Elektroakustik
IBM J. IBM Journal
Insul. Insulation
IRE Trans. IRE Transactions of Prof. Groups
Iz. Akad. Izvestia Akademii Nauk SSSR
J. BIRE. Journal of the British Institution of Radio Engineers
J. ITE. Journal of The Institution of Telecommunication Engineers
J. IT&T. Electrical Communication.
J. UIT. Journal of the International Telecommunication Union
Nach. Z. Nachrichtentechnische Zeitschrift
NBS Bull. NBS Technical News Bulletin
NBS J. Journal of Research of the NBS.
Onde. L'Onde Electrique
Phil. Tech. Philips Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers
Proc. BIEE. Proceedings of the Institution of Electrical Engineers
Proc. IRE. Proceedings of the Institute of Radio Engineers
Radiotek. Radiotekhnika
Radio Rev. La Radio Revue
RCA. RCA Review
Rev. Sci. Review of Scientific Instruments
Rev. Tech. Revue Technique
Syl. Tech. The Sylvania Technologist
Tech. Haus. Technische Hausmitteilungen
Tech. Rev. Western Union Technical Review
Telonde. Telonde
Toute R. Toute la Radio
Vak. Tech. Vakuum-Technik
Vide. Le Vide
Vestnik. Vestnik Svyazy
Wire. Wld. Wireless World

For more information, contact the respective publishers directly. Names and addresses of publishers may be obtained upon request by writing to "Electronic Sources" Editors. ELECTRONIC INDUSTRIES & Tele-Tech, Chestnut & 56th Sts., Philadelphia 39.

International ELECTRONIC SOURCES

A High-Performance Conically-Scanning X-Band Antenna of Novel Design, by J. G. McCann and R. J. Stegan. "IRE Trans PGAP." Oct. 1956. 4 pp. This paper describes the techniques employed to obtain a conically-scanning antenna producing a pencil beam having equal E- and H-plane beamwidths and having polarization—changing features enabling quick change from linear to circular to vertical polarization. The problems encountered and their solutions are described.

Systematic Errors Caused by the Scanning of Antenna Arrays: Phase Shifters in the Branch Lines, by L. A. Kurtz and R. S. Elliott. "IRE Trans. PGAP." Oct. 1956. 9 pp.

History of the Directional Antenna in the Standard Broadcast Band for Purpose of Protecting Service Area of Distant Stations, by R. M. Wilmotte. "RE Trans. PGBTS." Feb. 1957. 5 pp.

The Shape of Dielectric Antennas, by G. V. Trentini. "Nach. Z." Feb. 1957. 5 pp. The radiation properties of various types of dielectric antennas are investigated by means of experiments. Rods with steps in the dimensions of their cross-sections have produced similar results as those of the usual design in the form of tapered rods with equal length. Plates of suitable dimensions exhibit a stronger beam concentration in one plane and composite systems such as parallel or crossing plates, horns, horns with tubular extensions and variations thereof have a higher gain for almost concentrically concentrated beams.

A New Method for the Measurement of the Average Dielectric Constant of the Underground Medium on Site, by Mohamed A. H. El-Said. "IRE Trans. PGAP." Oct. 1956. 5 pp. An electromagnetic interference pattern in the far-distance condition is utilized to determine the average dielectric constant of the underground propagational medium. The method depends upon the determination of the surface wave velocity by means of measuring the first self-resonance frequency of a dipole wire laid on the earth's surface.

The Image Method of Beam Shaping, by P. T. Hutchison. "IRE Trans. PGAP." Oct. 1956. 6 pp. At microwave frequencies, cosecant-squared radiation patterns are obtained with parabolic reflectors no larger than those required to give pencil beams of commensurate beam widths. A qualitative analysis of a paraboloid fed by a horn and several images is shown to agree with measured results.

Loop Antenna Measurements, by P. A. Kennedy. "IRE Trans. PGAP." Oct. 1956. 9 pp. Experimental measurements on three loop antenna configurations are presented. The technique for obtaining impedance and current distributions using a single-wire transmission line over an image plane is described with particular attention given to the form, and for loops where theoretical results are available, curves comparing theory and experiments are presented.

AUDIO

Sawtooth Testing of Audio Amplifiers, by R. C. Hitchcock. "IRE Trans. PGBTS." Feb. 1957. 4 pp. A sawtooth wave contains all harmonics, and a single oscilloscope picture shows flatness of frequency response, transient stability, and overload of an audio amplifier.

The AF Anechoic Chambers at Cherry Hill, by M. S. Corrington, R. L. Libbey, and S. V. Perry. "IRE Trans. PGAU." No. 6, 1956. 6 pp. Design features and construction details of "sound proof" rooms for acoustic measurements on TV and radio receivers, phonographs, and loudspeakers are discussed.

On the Phasing of Microphones, by B. B. Bauer. "IRE Trans. PGAU." No. 6, 1956. 7 pp. The phasing of all gradient and of some phase-shift microphones is reversed for rearwardly arriving sound waves. In this paper the phase-frequency characteristics of most common microphones are described; methods for predicting or ascertaining the phasing of microphones are given; and a system is proposed for experimentally determining the absolute phasing of an unknown microphone.

An Experimental 9000-Watt Airborne Sound System, by D. W. Martin et. al. "IRE Trans. PGAU." No. 6, 1956. 10 pp. Results of operation of the experimental sound system were poor. Important factors included turbulence and gross inhomogeneity in the medium (resulting in random fluctuations in level), the effect of source motion in speeding up the fluctuations, multipath interference, normal attenuation with distance, high-frequency absorption in the medium, and Doppler effect.

Automatic Reverberation Time Recorder, by C. R. Viswanathan. "J. ITE." Dec. 1956. 9 pp. An equipment has been constructed which can plot reverberation time vs. frequency of an enclosure under test in a relatively short time. The time taken for 40 db decay is measured and is taken as two-thirds the value of reverberation time, assuming an exponential decay of sound energy. The advantages and limitations of the equipment are discussed, taking a typical studio measurement as an example.

Audio Induction Paging Sytem, by R. Zuck. "El." Feb. 1, 1957. 2 pp. Circuits and performance of a three-transistor portable a-f receiver are discussed.

CIRCUITS

Electrostatic Generators, by N. Felici. "Onde." Jan. 1957. 16 pp. After a brief recapitulation of the historic causes which froze the development of electrostatic generators until recently, the principle of the insulated cylinder generators is briefly described and their close relation of electronic amplifiers is indicated.

The principles of electronic control of these generators is advanced. The mathematical criteria of stability are discussed as well as the transient response. This shows the excellence of the dynamic stability and the possibility of providing high current intensity points, which are used in some applications.

Stability and Power Gain of Tuned Transistor Amplifiers, by A. P. Stern. "Proc. IRE." March 1957. 9 pp. The transistor can become unstable at frequencies where its internal feedback is sufficiently large; its maximum power gain is then infinite and it may oscillate. The author discusses the maximum power gain realizable as a function of required degrees of stability.

The "Asmodulor" Process, by L. Paternault. "Onde." Dec. 1956. 9 pp. Electronic apparatus can nearly always be split into a number of homogenous sub assemblies, and this is behind the "Asmodulor" process which enables an electronic assembly to be realized by an assembly of a number of identical mechanical units carrying the components. By reason of the mechanical production and small labor cost, this leads to a reduction in price, and it favors mechanized test methods more than conventional type equipment. Big developments in this process are particularly foreseen in the military and aeronautical fields. The article describes in detail the process, its applications, and gives some information on the special components employed.

Of the Miller Integrator, by R. G. Goldman. "Proc. IRE." March 1957. 1 p. This brief note calls attention to a useful property of the Miller Integrator; it can generate a linear sweep whose peak exceeds the dc supply voltage.

Eliminate Transistor Burnout, by Dr. Hans E. Hollmann. "El. Ind." April 1957. 2 pp. Dr. Hollmann outlines circuitry for maintaining correct polarity at transistor leads regardless of battery polarity.

Better Regulation With Positive Feedback, by I. Gottlieb. "El. Ind. Op. Sect." April 1957. 2 pp. The author describes simple circuit improvements which give better output level regulation in telephone carrier frequency amplifiers. The technique involves addition of a positive feedback loop and an equal increase in negative feedback.

Computation of Certain Circuits on the Basis of Their Response to a Unit Step-Voltage, by V. V. Zgirkis. "Radiotek." Nov. 1956. 8 pp. The paper examines problems involved in the determination of the circuits of fourpoles on the basis of their response to a unit step-voltage. A method is developed for determining the elements of resonant and aperiodic fourpoles.

The Practical Elimination of "Inverse Operation" in an Amplitude-Phase Detector when Pulse Interference is Present, by Iu. S. Lezin. "Radiotek." Nov. 1956. 8 pp. The paper examines the variation of the phase angle of the grid circuit voltage in an amplitude-phase detector when that variation is caused by the interference of a single pulse. It is proven that the maximum value of this variation can be made so small that "inverse operation" will be impossible in such a detector when interference from single pulses is present.

Meter-Wave Pentode Frequency Converters, by I. I. Levenstern. "Radiotek." Nov. 1956. 7 pp. The paper examines different variants of balanced circuits for single-grid heterodyne pentode frequency converters. The following problems are analyzed: 1) the special features of single-grid heterodyne frequency converters which use a capacitive divider; 2) converters with an inductive divider; 3) experimental investigation of a balanced converter.

Band-Pass Filters with an Invariant Frequency Response, by I. M. Simontov. "Radiotek." Nov. 1956. 3 pp. The paper provides design computations for a special band-pass filter circuit which has a constant frequency response over the entire tuning range.

Graphs for the Design of Filters on the Basis of Their Characteristic Parameters, by M. M. Shenberg. "Radiotek." Nov. 1956. 6 pp. Graphs are given for the purpose of determining the parameters of matching filter elements in accordance with the specified attenuation requirements in the band of effectively passed frequencies. A nomogram is provided for plotting the frequency responses of the intrinsic attenuation of filter elements in the stop-band.

Linear Pulse-Forming Circuits, by W. C. Gore and T. Larsen. "IRE Trans. PGCT." Sept. 1956. 7 pp. The authors present a generalized method for the design of linear pulse-forming circuits—circuits which have pulse-type responses to a step-function input, which would be applicable for a variety of pulse shapes.

Retrace Driven Deflection Circuit, by W. B. Guggi. "IRE Trans. PGBTR." Oct. 1956. 4 pp. The circuit described here employs either a single transistor or a tube, operated as a switch. The switching operation is such that the inrush current upon closing the switch and the voltage build-up on opening the switch are delayed sufficiently to prevent excessive momentary dissipation in the switching device.

Phase-Adjusting Circuits, by J. W. R. Griffiths. "E. & R. Eng." Jan. 1957. 5 pp. A well-known phase-adjusting circuit is shown to be a special form of a more general type of circuit. Various other forms of this generic circuit are discussed, and shown to be of practical use under certain conditions of load, where the original circuit would not be suitable. The results are presented in a form useful for reference.

RF AND IF Amplifier Design with Conductance Curves, by K. A. Pullen, Jr. "El. Des." Feb. 1, 1957. 4 pp.

On Networks without Ideal Transformers, by I. Cederbaum. "IRE Trans. PGCT." Sept. 1956. 4 pp. Necessary conditions for a matrix to be an impedance or admittance matrix of pure resistance "n" ports are given. The results are then applied to RLC networks for real positive values of the complex frequency, and the most general linear reciprocal networks without ideal transformers at zero frequency. Some properties of the matrices fulfilling these conditions are presented.

Electrostatic Lens, by N. P. Carlton. "Rev. Sci." Jan. 1957. 2 pp. An electrostatic lens has been constructed which, by a succession of closely spaced rings at graded potentials, approximated a cylindrical surface along which the potential varies as the square of the distance from some original plane. This lens was more efficient in focusing a highly divergent beam of ions than were several combinations of conventional lenses which were also tried.

On Electrical Circuits and Switching Circuits, by S. Seshu. "IRE Trans. PGCT." Sept. 1956. 7 pp. During the past two decades switching and electrical network theories have developed more or less independently and both have developed a great deal. The purpose of the present paper is to relate the two theories from a point of view quite different from the one taken by previous workers. The two theories are related from a topological rather than an impedance point of view.

The Characteristics of Parallel-T RC Networks, by D. H. Smith. "El. Eng." Feb. 1957. 7pp. Article discusses properties of symmetrical parallel-T networks, both balanced and unbalanced. An analytical treatment of the networks leads to curves expressing the characteristics of different forms of the networks; these curves are suitable for design application. Design of oscillators and bandpass amplifiers using the networks is considered.

The Tone Ringer, by F. L. Crutchfield and J. R. Power. "Bell Rec." Feb. 1957. 5 pp. A new Transistor-operated tone ringer has been designed at Bell Telephone Laboratories as a possible replacement for the conventional telephone bell to provide equal or superior performance in supplying a pleasant but attention-attracting sound.

Periodic Sampling Logarithmic Amplifier, by J. S. Nettel. "Rev. Sci." Jan. 1957. 4 pp. The logarithmic response of the amplifier is derived by extracting an output proportional to the time required for the voltage across a parallel resistance condenser combination to decay to a small fixed value. A logarithmic response over four decades with a deviation of less than 1% of the maximum output is secured. An immediate application is the study of transients associated with photocells.

Transistor Pulse Generator, by F. Rozner. "E. & R. Eng." Jan. 1957. 3 pp. Pnp and npn transistors in combination can be used to generate pulses with short rise times. Minority carrier storage can be used to broaden the pulse. Using low-frequency medium-power transistors, rise and fall times of the order of 0.7 microseconds at 100 kc repetition frequency can be obtained with a peak power output of 1 watt.

COMMUNICATIONS

Punched Tape Handles "Break" Switching, by A. C. Angus. "El. Ind. Op. Sect." April 1957. 2 pp. Up to seven program sources can be sequentially scheduled with this new control equipment. It holds the time base to within 1 sec. Programming for 24 hours can be contained on 80 feet of tape.

Stabilized Bias for Broadcast Amplifiers, by H. G. Stratman. "El. Ind. Op. Sect." April 1957. 2 pp. Dual channel, negative, regulated power supply holds bias constant on grids of a high-power TV amplifier. Peak power output is maintained constant regardless of a light or a dark picture signal.

Marine Filtering is Over-Filtered, by J. J. O'Neil. "El. Ind." April 1957. 2 pp. Reporting a series of Signal Corps investigations, the author mentions the many engineering advances in the art of interference reduction which can reduce cost of suppression.

Radio Reception Interference which is Created by the Gas-Filled Rectifiers of the Transmitter Rectifier Unit, by G. S. Shul'man. "Radiotek." Nov. 1956. 2 pp. A brief summary of interference data which has been experimentally obtained on commercial units in actual operation. The nature of the interference and the means for its elimination are discussed.

The Determination of the Optimum Capacity Figures for Telephone Networks with Inundating Traffic, by J. Rettenberger. "Nach. Z." Feb. 1957. 7 pp. The outlay for a telephone network becomes a minimum when the basic traffic for one communication path is passed through a direct group of channels and when the remaining traffic is passed through a higher level exchange. The paper shows by means of a section of a simple network how the required network with a minimum in outlay can be determined when in individual cases the traffic units, the line costs and various types of channel grouping are taken into consideration. The paper continues describing the possible application of this method to complicated sections in networks and explains the practical application by means of one example.

UHF Communication System Interference Reduction Through the Use of Selective Filters, by M. W. Caquelin. "IRE Trans. PGVC." Dec. 1956. 5 pp.

Communication with Moving Trains in Tunnels, by N. Monk and H. S. Winbigler. "IRE Trans. PGVC." Dec. 1956. In the range of 159 to 162 mc, where the FCC assigns railroad communications systems, radio communications is impossible with ordinary methods while trains are in long tunnels. Experiments with a two mile tunnel showed satisfactory transmission in tunnels could be obtained for a distance up to approximately 6,000 feet from stationary transmitters by radiating from twin-lead cable such as RG-86/U suitably located within the tunnel.

Equalization of Military Carrier Telephone Systems, by C. L. Semmelman. "Bell Rec." Feb. 1957. 4 pp. Excellent equalization is reported for two recently developed military carrier telephone systems using a combination of fixed and adjustable equalizers and temperature-compensating regulators.

An Economical Guide to Station Planning, by D. M. Weise. "IRE Trans. PGBTS." Feb. 1957. 5 pp. A brief review with illustrations, of the operation of the Chicago Educational TV Association.

Possible Applications for Goniometers in Telecommunications, by H. Fricke. "Nach. Z." Feb. 1957. 9 pp. Goniometers, which have so far been used for the determinations of incident azimuthal angles for electro-magnetic waves, are universal circuit elements in telecommunication engineering. New possibilities for their application exist principally in radio location as well as in other fields. The present paper is by no means exhaustive but is intended to give suggestions for further applications of goniometers by way of sketched examples.

VHF Radio Coordinated Traffic Light Control System, by E. W. Hassel. "IRE Trans. PGVC." Dec. 1956. 9 pp. The author describes a VHF carrier modulated with audio-frequency control tones to permit the radio coordinated system to perform the same as ordinary cable controlled systems, without cable. The system may be used with all conventional traffic light control equipment without modification. Operating experience has been gained with several installations.

Crystal Oscillators in Communication Receivers, by A. G. Manke. "IRE Trans. PGVC." Dec. 1956. 6 pp.

First Transatlantic Telephone Cable System, by E. T. Mottram. "Bell Rec." Feb. 1957. 7 pp.

Ship Autoalarm Uses Computer Techniques, by E. R. Sarratt and H. H. Abelew. "El." Feb. 1, 1957. 4 pp. An automatic alarm for use with a receiver tuned to the international distress frequency is described. Variations in atmospherics, and interfering signals must be discriminated against. The system uses computer techniques to provide an alarm signal only in response to an international distress signal.

The BBC Radio Microphone, by F. A. Peachey and G. A. Hunt. "E. & R. Eng." Feb. 1957. 3 pp. A tiny FM transmitter is described.

A Stable FM Receiver With Preset Tuning, by G. S. Robinson. "El Eng." Feb. 1957. 4 pp. Article describes a fixed tuned receiver using a crystal-controlled reference. Design details on the inductive components are included.

The VF-telegraphy System Type WT 24/1, by H. H. Voss and J. Arnold. "Nach. Z." Feb. 1957. 7 pp. After a discussion concerning the requirements which a modern VF-telegraphy system must meet because of technical and economical reasons the paper describes the circuits and the electrical properties of the new system type WT 24/1 which has been partly fitted with transistors. The paper ends in brief descriptions of special parts of the design.

Instantaneous Speech Compressor, by C. R. Rutherford. "El." Feb. 1, 1957. 2 pp. Intelligibility of air-ground communications is increased by the use of a transistorized speech compressor which plugs into the carbon microphone jack. Unit combines advantages of clipper and agc techniques.

Frequency Allocation—A Complex Planning Task. "Wire and Radio Communications." Feb. 1957. 2 pp. A review of allocation functions of the FCC and present assignments in the radio spectrum.

Optimum Detection of Random Signals in Noise, with Application to Scatter-Multipath Communication, I, by R. Price. "IRE Trans. PGIT." Dec. 1956. 11 pp.

A Coincidence Procedure for Signal Detection, by M. Schwartz. "IRE Trans. PGIT." Dec. 1956. 5 pp. A coincidence method of detecting a signal in the presence of noise is compared to the statistically optimum Neyman-Pearson procedure utilizing signal integration and threshold detection.

International ELECTRONIC SOURCES

Near and Far-End Crosstalk in Balanced Pair Cables After Splicing, Near-end Crosstalk Compensation, by H. Pech. "Cab. & Trans." Jan. 1957. 19 pp. Formulae are given, allowing determination of the permissible values of near-end crosstalk measured during splicing tests, in order to fulfill the conditions finally required for the completed circuits.

Development Problems of Miniature Assemblies in Communication Engineering, by P. Henninger. "Freq." Jan. 1957, 15 pp. The problems arising in connection with miniature components are discussed in detail. In particular the design and materials used in capacitors, and the dimensioning of the structures involved are considered. Chemical and other associated problems are introduced.

Remote Control Receiver, by E. Bohr. "El." Feb. 1, 1957. 1 p. This is a superregenerative circuit followed by an amplifier stage, using the Philco L5108 surface barrier transistor and a 2N43. The receiver, as described, operates on the 27.255 mc Citizen Radio frequency, and is suitable for operating a control relay.

Transistorized Communications Receiver, by S. Schwartz. "IRE Trans. PGVC." Dec. 1956. 5 pp. Transistors have been used successfully in all sections following the mixer of a 500 kc to 32 kc military, vehicular-type radio receiver originally designed with all vacuum tubes. The receiver provides reception of CW, phone, and single-channel, frequency-shift radio teletype signals. This superheterodyne, multiple conversion receiver, while keeping the desirable characteristics of the vacuum tube receiver also provides for a five-fold increase of audio power and a reduction of battery power drain by one third.

New Developments in Two-Way Communications, by A. A. Macdonald. "IRE Trans. PGVC." Dec. 1956. 6 pp. Coded squelch, transistorized dynamic microphones, transistorized portable transmitter-receivers are among new developments discussed.

A Semi-Automatic Tuning High Frequency Communications Equipment, by M. C. Dettman. "IRE Trans. PGVC." Dec. 1956. 5 pp.

Automatic Programming in Small A-M Stations, by E. C. Miller. "El." Feb. 1, 1957. Subsonic tones recorded with program material on tape, and the time delay at the end of a musical selection serve to actuate an automatic control system controlling an Ampex tape recorder and a Seeburg automatic music system.

A Visual Communication System, by V. I. Weihe, B. R. Boymel, and S. C. Feild, Jr. "IRE Trans. PGAP." Dec. 1956. 5 pp. An analysis of air-traffic-control problems leads the authors to conclude that a direct viewed bright storage tube display method offers advantages over electromechanical indicators for ground-air data transmission.

Reference Generator for SSB Systems, by M. I. Jacob. "El." Feb. 1, 1957.

COMPONENTS

Selection and Application of Precision Film Resistors, by P. Nyul and C. Wellard. "El. Des." Feb. 15, 1957. 3 pp.

Relay Contact Life in Central Offices, by A. P. Goetze. "Bell Rec." Feb. 1957. 4 pp. The amount of erosion per operation is proportional to the amount of energy dissipated at the contacts. Studies of erosion characteristics of various contact metals provide data for longer life and higher reliability contacts.

Coding Tool for Translator Cards, by E. Graf. "Bell Rec." Feb. 1957. 4 pp. In direct distance dialing, automatic switching centers obtain routing information from coded cards. In larger centers, as many as 10,000 such cards may be needed. Card blanks are made from sheets of thin chromium-plated steel with 40 tabs on the lower edge and 118 holes arranged over the card face. A machine has been devised for coding these cards.

Miniaturized High-Altitude, High-Temperature Connectors, by C. H. Stuart and R. F. Dorrell. "IRE Trans. PGCP." Dec. 1956. 5 pp.

Solenoids for Airborne Applications, by A. S. Gutman. "E. & R. Eng." Feb. 1957. 4 pp. A formula is derived for the optimum dimensions of a single-turn solenoid, taking into account its own weight and that of associated power-generating equipment. Various forms of practical multi-turn solenoids are considered, and foil-wound constructions are selected, because of their greater space efficiencies than wire-wound types. Heat transfer is considered.

Printed Circuits for Military Equipment, by J. K. Scott. "El. Des." Feb. 15, 1957. 4 pp. The different layout techniques, materials, components, and packaging required for military equipment are discussed.

Multipurpose Evaporated Metal Film Resistors, by S. J. Stein. "IRE Trans. PGCP." Dec. 1956. 6 pp. Evaporated metal film resistors are described which have been prepared on ceramic bases which have properties that compare favorably with wirewound resistors.

Transducer Characteristics, by H. G. M. Spratt. "E.& R. Eng." Jan. 1957. 7 pp. The principles of transducers for vibration and strain are reviewed.

The Application of Large Capacitors for Use in Energy Storage Banks, by D. F. Warner. "IRE Trans. PGCP." Dec. 1956. 8 pp. The information presented here establishes the criteria for selection of large banks of capacitors under the most favorable economic and technical conditions, along with an assurance of reliable performance without excessive unused safety factor dollars.

Synchro and Resolver Performance Definitions, by L. A. Knox. "IRE Trans. PGCP." Dec. 1956. 11 pp. The author presents a consistent set of fundamental synchro and resolver definitions, with some application notes.

Closer Crystal Oven Temperature Control, by M. D. McFarlane and R. B. Metz. "El. Des." Feb. 15, 1957. 3 pp. The article concerns itself primarily with applications of the change-of-state principle to obtain increased temperature stability for electronic components. One example is an oven surrounded by a quantity of paradibromobenzene or paradiethoxybenzene which is capable of maintaining oven temperatures at the melting points of the salts to within plus-or-minus 0.015 degrees Centigrade.

The Impedance of Condensers as a Function of Frequency, by J. P. Mayeur. "Cab. & Trans." Jan. 1957. 10 pp. A study of the impedance variation of condensers with frequency allows determination of their natural resonance frequencies. Results of calculation are applied to the various considered types of condensers and compared with those of experience and are found in good agreement with the latter.

Automatic Interpolation with Spiral-Scale Dials, by C. D. Berger. "El. Des." Feb. 1, 1957. 4 pp.

Carrier-Frequency Transformers for PI Carrier, by D. Ribett. "Bell Rec." Feb. 1957. 3 pp. Special carrier-frequency transformers have been developed which achieve a substantial gain in miniaturization, to keep up with size reductions in other components, and yet permit wideband transmission.

Make Printed Circuits for $100, by N. C. Hekimian and R. E. Robinson. "El. Ind." April 1957. 2 pp. Using the Ozalid method, anyone can make good quality printed circuits that are ideal for model labs and low volume production.

New Method of Evaluating Ferro-Inductors, by W. J. Polydoroff. "El. Ind." April 1957. 3 pp.

The Selection of the Allowable Deviations of Parameters in Radio-Engineering Equipment Units, by N. F. Vollerner. "Radiotek." Nov. 1956. 10 pp. The paper examines the problems of the interchangeability of elements of radio-engineering units which are mass produced. Certain concepts are advanced regarding the selection of tolerances for electrical radio-engineering parameters of radio equipment. An example is given of the computation of tolerances for the electrical parameters of power and output transformers.

COMPUTERS

Generalization of the Dynamic Equations of a Complex Power System and the Utilization of an Electronic Computer for Analyzing the Stability, by L. V. Tsukernik. "Avto. i Tel." Jan. 1957. 12 pp. The equations for the perturbed motion of a complex power system are presented in matrix form, while taking into account the automatic excitation control of synchronous machines which are operating in parallel; the paper refers to application of computing units for stability analysis. A simplified method for programming the computation of the coefficients of the characteristic equation is given. A realizable logical programming system for computing the boundaries of the region of stability in the parameter plane is described. The program can be used for dynamic systems of any type if the corresponding equation of perturbed motion can be obtained.

The Design and Applications of a General-Purpose Analogue Computer, by R. J. A. Paul and E. L. Thomas. "J. BIRE." Jan. 1957. 25 pp. Various design and construction factors are considered, with particular attention to the effects of finite amplifier gain, bandwidth, and phase shift. An indication is given of the lines along which analog computers may develop in the future, and of other possible applications.

Considerations on the Principles of Universal Nnmerical Computers, by F. H. Raymond. "Onde." Jan. 1957. 11 pp. The object of the paper is to explain to the non-specialist a number of basic principles applying to the operation of universal numerical computers. The author deals, in particular, with the physical representation of numbers, with the principles on which digital computing is based and with the automatic aspects of programmed computer operation. This paper is of a purely introductory nature, and for that reason, deliberately ignores actual processes of calculation.

Ferrite Apertured Plate for Random Access Memory, by J. A. Rajchman. "Proc. IRE." March 1957. 10 pp. Multiple ferrite memory cores can be replaced by a thin ferrite plate with a regular array of round holes. Metallic plating on the surface of the ferrite plate can provide the necessary current conductors. The result is a ferrite memory plate with printed windings which requires much less time and labor for making, testing, and assembling than conventional magnetic core memories. The plates open the possibility of random access

memories with capacities of millions of bits, or lower capacity memories of extremely small size.

The Junction Transistor as a Computing element, by E. Wolfendale, L. P. Morgan, and W. I. Stephenson. "El. Eng." Feb. 1957. 5 pp. Article describes an emitter coupled bistable circuit which can be triggered or used as a source of trigger voltages with better action than the standard Eccles-Jordan circuit. A transistor blocking oscillator and several coincidence gating circuits using transistors are described.

Deriving Information from Magnetic Memories without Deletion, by A. Darré. "Freq." Jan. 1957. 9 pp. This is a detailed discussion of the "Transfluxor" on the basis of the behavior of magnetic field lines.

Thermal Circuit Simulation Practice in Nuclear Reactor Plant Control, by C.-P. Caillet. "Onde." Jan. 1957. 5 pp. Papers given on the occasion of the Brussels Journées de Calcul Analogique can be divided into four distinct sections

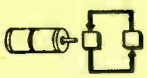
1) Description of computers by makers and users.

2) History of the development of analog methods.

3) Considerations on present methods and their future developments.

4) Reports on results obtained to date in various fields of application with simulation techniques.

M. C.-P. Caillet's report deals with this last section. It describes how simulated nuclear-reactor kinetic performance implies the simulation of thermodynamic phenomena. The report includes a study of several representations and formulations used to express the thermal exchange process over the transition periods.



CONTROLS

Investigation of the Dynamics of Pulse-Relay Automatic Control Systems, by V. P. Kazakov. "Avto. i Tel." Jan. 1957. 13 pp. Methods are given for determining the self-oscillations and transient responses which occur in pulse-relay systems; these methods are based upon the frequency and time characteristics of the continuous portion of the system. The paper describes an approximate method for determining the self-oscillations, which involves the use of the first harmonic of the output of the pulse-relay element; a method is given for taking the higher harmonics into account. Computed results are compared with experimental results.

The Stabilization of Nonlinear Servomechanisms Encountered in Antenna Instrumentation, by J. Bacon. "RE Trans. PGAC." Feb. 1957. 10 pp. An investigation of the problem of compensating the loop-gain of instrument servos to provide uniform transient response over a wide dynamic operating range.

On the Design of A-C Networks for Servo Compensation, by H. Levenstein. "IRE Trans. PGAC." Feb. 1957. 17 pp. This paper presents an analytical method for analysis and synthesis of networks for ac servo compensation. The response of a linear network to a modulated suppressed-carrier excitation is formulated in terms of in-phase and quadrature carrier components. The relationship between the modulation on these components and the exciting modulation is shown to depend upon operators simply related to the original network function.

A Survey of Techniques for the Analysis of Sampled-Data Control Systems, by G. J. Murphy. "IRE Trans. PGAC." Feb. 1957. 12 pp.

Heat Control in Electronic Equipment, part 2, by E. N. Shaw. "El. Eng." Feb. 1957. 6 pp. Article examines heat-flow problems in rack mounted equipment, plotting constant-temperature contours for various configurations of components with different arrangements for conduction, convection, and radiation of the generated heat. The importance of minimizing the removal of heat from the chassis by vertical flow, and techniques for improving the removal of heat are discussed. Diagrams of typical heat distributions are included.

Final Value Controller Synthesis, by M. V. Mathews. "IRE Trans. PGAC." Feb. 1957. 11 pp. A method is presented for synthesizing a type of control system designated as a final time controller. This device is a feedback control system that is designed to achieve a desired response at one time only, the response at earlier times being arbitrary within physical limits. The final time controller developed is a time varying, nonlinear system.

A Positioning Servomechanism With a Finite Time Delay and a Signal Limiter, by D. H. Evans. "IRE Trans. PGAC." Feb. 1957. 12 pp. The author analyzes an idealization of a servomechanism which is used in a digital positioning circuit. The loop consists of an ideal integrator, a finite time delay, and a nonlinear signal limiting element.

Digital Time and Sequency Control, by M. L. Klein, F. K. Williams, and H. C. Morgan. "Instruments and Automation." Dec. 1956. 5 pp. A binary-wired switch is used to form simple trunking of a matrix line. Four sets of such switches, with relays, control a sequency of events in the variable-interval automation controller described here.

Fundamental Equations for the Application of Statistical Techniques to Feedback-Control Systems, by G. A. Biernson. "IRE Trans. PGAC." Feb. 1957. 25 pp. The autocorrelation function of the output is computed by a transient technique which treats the input autocorrelation function as a transient input to the system. By transforming this procedure, equations are developed for relating the spectral densities of the input and output, and a means of performing the computation on an analog computer is presented.

INDUSTRIAL ELECTRONICS

Transistorized Guidance System Feeds Chickens, by S. Knight. "El." Feb. 1, 1957. 3 pp. A slow-moving battery-powered cart is guided by the magnetic field from a single conductor buried in the floor. The conductor carries about one ampere of a-c current. Error signals are developed by transistorized circuitry and control a steering motor.

The Circuit Development of a Heavy-Duty Dynamic Balancing Machine, by L. H. Vale. "J. BIRE." Jan. 1957. 18 pp.

Capacitance Pickup Measures Small Forces, by J. Dimeff and T. B. Fryer. "El." Feb. 1, 1957. 3 pp. A capacity pickup is used instead of the conventional movable contact of a potentiometer, thus eliminating the friction of a physical contact. The potentiometer resistance is energized by an a-c current.

Precision Spotwelder Handles Metal Foils, by W. W. Robinson. "El." Feb. 1, 1957. 2 pp. Carefully controlled amounts of electrical energy are stored in capacitor banks. These are discharged through a thyratron and the primary of a transformer. The transformer secondary is connected to the welding electrodes. The control of welding energy is precise and very thin materials can be handled.

A Study of Electrolysis Danger in Paris-Lyon Railwayside Cables and of Their Protection Means, by M. Vialaron. "Cab. & Trans." Jan. 1957. 10 pp. The study leads to the conclusion that insulating sleeves do not appear to afford sufficient protection. The adoption of cathodic protection devices is suggested.

MATERIALS

Microwave Ferrite Phase Shifter, by S. Sensiper. "Proc. IRE." March 1957. 1 p. This note reports some of the results of tests on a new ferrite phase shift device which appears to have promise as a sideband modulator or as part of a high speed switch.

Progress in Ferrite Materials, "E. & R. Eng." Feb. 1957. 6 pp. A survey of recent advances in ferrite technology.

Ferromagnetic Granular Structures, by P. M. Prache. "Cab. & Trans." Jan. 1957. 34 pp. Magnetic materials commonly used in telecommunications practically consist of compact granular structures, the grain diameter of which does not exceed about 10 microns. In such granular structures, there probably does not exist any systematic wall formation and it is thus possible to set up a coherent theory of ferromagnetic phenomena by admitting that the domains are constituted by the grains themselves, as was suggested in 1907 by Pierre Weiss.

Impulse Voltage Strength of Oil Immersed Insulation, by H. F. Jones. "El. Energy." Dec. 1956. 7 pp.

Some Problems of Aluminum Connexion, by C. T. Marx. "El. Energy." Dec. 1956. 4 pp. Methods and problems of connecting aluminum are discussed and attention drawn to differences in practice between copper and aluminum connection techniques.

Impregnation of Toroids for High-Temperature Service, by E. O. Deimel. "IRE Trans. PGCP." Dec. 1956. 3 pp. Two materials have been used successfully for vacuum impregnation of magnetic amplifiers and similar devices for continuous operation at 325°F or higher. Complete impregnation, even though layers of interwinding tape, has been achieved. One material discussed is an undiluted silicone rubber capable of withstanding 500°F continuously. The other is a rigid, filled epoxy resin using a nonvolatile hardener, which will withstand 325°F continuously.

Harnessing Ferrites for Electronics, by H. W. Katz and E. B. Mullen. "GE Rev." Nov. 1956. 6 pp. This is a fairly elementary general review of ferrites and their applications in computing and microwave.

Materials Used in Radio and Electronic Engineering, The Electrodeposition of Metals. "J. BIRE." Jan. 1957. 14 pp.

A CsI(Tl)-Crystal Surgical Scintillation Probe, by C. C. Harris et. al. "Nucleonics." Nov. 1956. 3 pp.

MEASURING & TESTING

Radial Shunt is Used for Measuring 100,000-Ampere Pulses, by H. Bruce McFarlane. "El. Ind." April 1957. Large, high-frequency, short-pulse currents normally beyond the capabilities of a measuring instrument are measured to an average error of 2½% with a noninductive radial shunt in conjunction with an oscilloscope.

International ELECTRONIC SOURCES

TELEVISION

From Havana to Santiago—by Microwave, by Morton L. Long. "El. Ind. Op. Sect." April 1957. 2 pp. The author describes the problems and solutions in providing a television link across Cuba.

TV Compares Photographic Data, by E. J. Oelbermann. "El. Ind." April 1957. 2 pp. Two films, differing widely in size, can be compared by superimposition on a TV monitor. Error is as low as 1%, making the method ideal for aerial survey interpretation.

Determining the Region of Stable Operation for an Inertial System of Television Synchronization, by Iu. N. Bakaev, P. I. Kuznetsov. "Radiotek." Nov. 1956. 8 pp. This paper solves the problem of the stability of the inertial synchronizing unit which was examined in a previous paper. A great deal of attention is devoted to the composition and subsequent averaging of the differential equations for the unit, since neglecting the mathematical details previously led to inaccuracies. The method of the mean is used to derive an estimate for the boundaries of the stable operating region of the system. A modified small parameter method is proposed for the purpose of investigating an aperiodic regime.

Practical Circuits for Junction Transistor Video Amplifiers, by T. M. Agakhanian, Iu. A. Volkov. "Radiotek." Nov. 1956. 7 pp. Practical circuits are given for junction transistor video amplifiers, based on tupe PIE and PII transistors. The circuits incorporate current feedback for the purpose of reducing the distortion of the pulse edges.

Properties of Very Thin Leaves of Glucinium and Their Applications to the Modulation of Light and to Television, by M. Auphan. "Onde." Dec. 1956. 6 pp. By evaporation in vacuum it is possible to obtain leaves of glucinium, with both surfaces free and having a thickness between 200 and 1 000 A. The process is to deposit the glucinium by evaporation on to a temporary support which can be sublimed, and which, after evaporation, leaves the leaf free. Gratings can be used during evaporation and interesting structures may result; in particular, a leaf of glucinium can be stretched parallel to a glass support and at a very small distance from it. This distance can be maintained constant by a number of separators. If an electron flux impinges on such a structure, it passes through the leaf, which is deformed by the electrostatic force caused by secondary emission. In this way a light modulator is obtained which can be used in monochrome or color television.

Automatic Level Control for Film Systems, by W. L. Hurford. "IRE Trans. PGBTS." Feb. 1957. 5 pp. Film-TV systems are vulnerable to sudden changes in film density. A system is described for automatic compensation for film density.

Television Receiver for Metric Waves, by V. Biggi. "Onde." Dec. 1956. 10 pp. The author examines the problem of designing a receiver intended for long distance direct reception of a television signal from a main transmitter radiating on metric waves. The quality of the signal given by the receiver, both video and sound, must be good enough to modulate a satellite transmitter.

After having given particular attention to the design of the input circuit in order to give a low noise factor, and to the selectivity requirements imposed by asymmetric sideband reception, the author suggests an original method of automatic gain control for positive modulation.

An application of this method illustrates how direct reception provides a simple means for the transmission of the signal to a point for re-radiation.

The Possibilities of Reduced Television Bandwidth, by S. Deutsch. "IRE Trans. PGBTR." Oct. 1956. 14 pp. Present TV standards evolved from efforts to make TV "as good as the movies," as economically as possible. The result was a 4 mc bandwidth. In the present article, Mr. Deutsch has approached the problem from the other end: given the 50 kc bandwidth of tape recorders at 15 ips, and the similar bandwidth of high-quality telephone lines—find TV standards for maximized entertainment value, within limits of engineering practice and economy. The result of his deliberations is a thorough analysis of the possibilities for reduced TV bandwidth.

$$\Delta G = \Delta G / e n_i \mu_p \delta$$

THEORY

Flow Line Analysis, by Richard B. Hurley. "El. Ind." April 1957. 2 pp. Flow line analysis provides a pictorial analysis of transistor switching circuits which serves as a check on calculations of circuit parameters. Practical engineers will welcome this method of visualizing what goes on inside a switching transistor.

The Problem of a Geometric Proof of the Shannon Theorem, by E. L. Blokh, A. A. Kharkevich. "Radiotek." Nov. 1956. 12 pp. In previous papers the attempt to compose a geometric proof of the theorem concerning carrying capacity has led to a divergence from the generally known result obtained by Shannon. Further investigation has shown that the cause of this divergence is the assumption of an incorrect geometric model; this present paper clarifies problems which are associated with this proof.

Transient Regimes in Contact-Relay Circuits, by Ya. I. Mekler. "Avto. i Tel." Jan. 1957. 12 pp. The paper examines the disruption of circuit operation when adding zero and when multiplying by one. A method is given which permits such disruptions to be avoided and allows reliable circuits to be constructed. This method makes it possible to easily transform circuits which require overlapping contacts, or, conversely, circuits which require non-overlap into normal circuits which are free from these requirements.

One Method of Determining Desired Logarithmic Frequency Responses, by P. S. Matveev. "Avto. i Tel." Jan. 1957. 7 pp. The paper provides a method for determining desired logarithmic frequency responses. A chart is provided for evaluating overregulation, and example are given which show that it is possible to use this method for different types of practical applications.

Solution of Algebraic Equations: Real Roots. "E. & R. Eng." Feb. 1957. 2 pp. A routine is outlined for finding the real roots of an equation—the description is intended as an aid for the engineer who "does not have to do this every day."

Survey of the Computations Concerning Filters with Losses According to the Operational-Parameter Theory, with a Particular View to Band-Pass Filters in Crossed Connection, by C. Kurth. "Freq." Jan. 1957. 6 pp. This continuation of an article published in the preceding issue of this magazine, deals with the mathematical representation of the transmission properties of four-terminal networks. Formulas are derived, and tables with coordinated filter sections and formulas are included.

Eight Network Theorems and Their Applications, by V. V. L. Rao. "J. ITE." Dec. 1956. 12 pp. This is a textbook presentation of: superposition theorem, Thevenin's theorem, Notron's theorem, compensation theorem, maximum power transfer theorem, reciprocity, theorem, Bartlett's bisection theorem, and Foster's reactance theorem.

Calculation of Capacitance, by D. Harrison. "E. & R. Eng." Jan. 1957. 5 pp. The method of geometrical inversion is applied to the determination of the capacitance between long parallel circular conductors. Formulae are derived for the capacitance between a long cylindrical conductor and an infinite plane conductor parallel to the axis of the cylinder, between parallel cylindrical conductors, and between eccentric cylinders. The application of the inversion technique to field plotting and calculation of maximum voltage gradient is described.

Molecular Amplification and Generation of Microwaves, by J. P. Wittke. "Proc. IRE." March 1957. 26 pp. The author presents a general introduction to the field of amplification and generation of microwaves using molecular rather than electronic processes.

Non-Linear Circuit Equation, by J. Irving and N. Mullineux. "E. & R. Eng." Feb. 1957. 3 pp. Details are given of a way of solving non-linear equations by a perturbation method. A numerical method is also described and employed as a check.

Graphical Method of Determining the Efficiency of Two-Port Networks, by E. F. Bolinder. "Proc. IRE." March 1957. 1 p.

On the Statistics of Individual Variations of Productivity in Research Laboratories, by W. Shockley. "Proc. IRE." March 1957. 12 pp. Dr. Shockley, writing while Deputy Director and Research Director of the Weapons Systems Evaluation Group, Dept. of Defense, has presented some facts about research productivity, and draws some important conclusions regarding the causes of variation of productivity among research workers.

TUBES

How Tubes Are Named, by D. Kaufman. "El. Ind." April 1957. 2 pp. This is a description of procedures followed in JETEC type designation.

28 MeV Electron-Accelerator Project for the C.E.N. (French Center for Nuclear Research) at Saclay, by Leboutet, Picard, Vastel. "Onde." Jan. 1957. 8 pp. The authors review the various considerations that motivated the choice of an accelerator of that type, giving basic design data. This accelerator plant consists of 3 cavity klystron HF sources, accelerator-guide consisting of a succession of $\pi/2$ cavities, external shield of concrete material providing complete radiation-proofing and supporting the focussing coils, Pierce type electron gun, mutually synchronized modulators, overall protection against radiation leakage provided by concrete work embodying lead slabs for local sheating reinforcement.

Strong Focussing in Particle Accelerators—Alternating Gradient Synchrotrons, by P. Lapostolle. "Onde." Jan. 1957. 7 pp. Alternating gradient focussing, otherwise known as strong focussing action, is a very recent invention, but it has opened up a new way of making high energy particle accelerators, and several large synchrotrons using this principle are under construction or under consideration in the world. In this article the various theoretical and practical problems which arise in setting this principle to work are considered in turn: the stability of the oscillation, transition energy, resonance, manufacturing tolerances. The article concludes with a description of a 200 meter diameter synchrotron which is under construction at CERN (Geneva).

The Stability of Oscillations of a Triode, by L. Sideriades. "Onde." Jan. 1957. 7 pp. In the 2nd order differential equation governing

the oscillations of a triode, the non-linear term due to the tube characteristic is of the first order, and the associated parameters are subject to discontinuities. The analysis depends on the topological method applied to an equivalent dynamic system, and the use of isoclines enables a complete study of the phase plan to be carried out, showing the cyclic limits where stable oscillation takes place. Finally, an experimental presentation demonstrates the integral curves on the screen of an oscilloscope.

U. S. GOVERNMENT

Research reports designated (LC) after the price are available from the Library of Congress. They are photostat (pho) or microfilm (mic.), as indicated by the notation preceding the price. Prepayment is required. Use complete title and PB number of each report ordered. Make check or money order payable to "Chief, Photoduplication Service, Library of Congress," and address to Library of Congress, Photoduplication Service, Publications Board Service, Washington 25, D. C.

Orders for reports designated (OTS) should be addressed to Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Make check or money order payable to "OTS, Department of Commerce." OTS reports may also be ordered through Department of Commerce field offices.

When an agency other than LC or OTS is the source, use the full address included in the abstract of the report. Make check or money order payable to that agency.

Complete copies of the selected patents described below may be obtained for $.25 each from the Commissioner of Patents, Washington 25, D. C.

Four-Loop VOR Antenna, by S. R. Anderson, H. F. Keary and W. L. Wright. CAA. June 1953. 14 pp. photo, drawings, diagrs., graphs, table. Mi $2.40, ph. $3.30. (LC) (PB 123578). This report presents the results of the development and operational tests conducted at TDEC on the four-loop VOR antenna system. Except for the antenna, standard VOR equipment and a 35-foot diameter counterpoise 15 feet in height were used for the tests. Results from similar tests on a standard five-loop VOR at the same site are included for comparison.

Point-Contact Transistor Life Test Under Pulse Conditions, by J. A. Di Giorgio. USAF Communications Laboratory, Bedford, Mass. Feb. 1956. 21 pp. diagrs., graphs. (OTS) 75 cents. (OTS) (PB 121560). Working data were obtained by taking periodically voltage margins of the emitter and collector supply voltages on a group of 30 high-speed nonsaturating flip-flop circuits. Three types of transistors were used for the test. Some life test results of 16 stages of regenerative pulse amplifier circuit, employing transistors which have gone over the 5000 hour mark, are also included.

Power Supply Characteristics and Standards for Transistorized Airborne Electronic Equipment, by A. B. Jacobsen. Motorola, Inc. Dec. 1955. 120 pp. diagrs., graphs, tables. (OTS) $3. (OTS) (PB 121525). In order to derive a tentative standard supply voltage for transistorized electronic equipments, this report presents the problems associated with the operation of such equipments from various sources of primary power. The result of this study is a recommendation for adoption by the Air Force of a standard power-supply output rating of 18 volts dc. A power-supply designed according to the specifications outlined in this report would function equally well from either an alternating-current (a-c) or d-c power line in an aircraft; from vehicular power sources, or from batteries.

Study of the Memory Requirements of Sequential Switching Circuits, by D. A. Huffman. MIT. Mar. 1955. 30 pp. diagrs., tables. Mi $2.70, ph $4.80. (LC) (PB 123217). The number of elementary binary memory devices necessary for the realization of an arbitrary asynchronous sequential switching circuit is considered. The least upper bound is discovered to be approximately equal to twice the greatest lower bound. The minimum conceivable interstate transition time for a sequential circuit is the reaction time of a single memory element. A solution which achieves this minimum time is derived and its relationship to the Hamming single-error correcting code is shown. The fundamental limitations of error correction schemes which compensate for malfunctioning of memory elements are discussed.

Telemetering Notch Antenna 225.0 Mc/Sec Aerobee Hi Rocket, by H. W. Haas. New Mexico College of Agriculture and Mechanic Arts. Feb. 1956. 39 pp. photos, diagrs., graphs. Mi $3, ph $6.30. (LC) (PB 122373). The design and development of a 225.0 mc notch antenna for the Aerobee Hi rocket is presented. A detailed radiation pattern study has been made of the antenna installed in a full scale size rocket mockup. The radiation patterns have been measured for linear, right circular and left circular polarization. Measured power contour plots are presented to show the distribution of power in the aft region of the missile. A number of photographs of the antenna, rocket mockup and antenna range facilities are included in this report. Electrical and mechanical details of the antenna are shown by the drawings.

Study of Type and Frequency of Communication Messages Aboard Naval Vessels, by L. Doty, T. D. Hanley and M. D. Steer. Purdue University. Apr. 1955. 37 pp. tables. Mi $3, ph $6.30. (LC) (PB 123753). To determine the efficiency of voice communications systems aboard Naval vessels, recordings of messages transmitted during actual Naval operations were analyzed. The frequency of occurrence of various types of messages was tallied and the relative contribution of each message in terms of the information transmitted was determined.

Analysis and Matching of a Trimode Turnstile Waveguide Junction, by R. S. Potter. NRL. Dec. 1955. 51 pp. diagrs., tables. $1.50. (OTS) (PB 111867). The microwave junction studied in this report is a lossless seven-port variation of a turnstile waveguide junction with a coaxial port opposite and centered on the axis of the circular waveguide. The junction's scattering matrix, the normal modes, the normal mode scattering coefficients, the equations relating the elements of the scattering matrix to each other, and the equations relating the elements of the scattering matrix to the normal mode scattering coefficients are determined.

Corrective Line Sources for Paraboloids, by C. J. Sletten, R. B. Mack, W. G. Mavroides and H. M. Johanson. USAF. Antenna Laboratory, Bedford, Mass. Dec. 1955. 53 pp. photos, diagrs., graphs. Mi $3.60, ph $9.30. (LC) (PB 122215). The notably poor wide-angle focusing characteristics of the paraboloidal reflector can be improved by corrective line sources. Studies of the caustic surfaces and focal fields of the reflector have led to the development of (1) a straight line source suitable for generating fan-shaped microwave beams, and (2) line sources that produce a pencil beam at a given acute angle with the axis of the reflector.

Detection of Separations Between Adjacent Signals on a Simulated PPI Radar Scope, by R. M. Herrick, H. E. Adler, J. E. Coulson and G. L. Howett. Columbia University. July 1955. 28 pp. diagr., graphs, tables. 75 cents. (OTS) (PB 121470). A simulated Plan Position Indicator (PPI) scope was used to evaluate the effects of a number of visual variables upon the minimum signal luminance increment required for the detection of a separation between two identical signals.

Series-Tube Core Memory, by E. J. Otis. USAF Computer Laboratory, Bedford, Mass. Sept. 1955. 44 pp. photos, diagrs., graphs. $1.25 (OTS) (PB 121558). Usefulness of magnetic cores as components of digital equipment, especially in the buffer and permanent storage sections, is evident by their incorporation in many of the existing digital data-handling systems. One of the problems in using magnetic cores for permanent high-speed storage is that of selecting the few cores representing a storage register and then providing the high currents necessary for reading out or writing information into this register. This paper solves the problem with the following assumptions; (a) the achievement of speeds comparable to those of presently available memories; (b) minimizing the number of vacuum tubes used; (c) the selection to be done external to the memory cores. This last assumption would make the memory system independent of core characteristics and would not require a matching of the cores used. This solution requires a diode to be used with each core. The resulting core memory achieves a random access time of two microseconds. It requires $3n+K$ driving tubes for n^2, K-bit storage registers.

Sensitive Method for Studying Gyromagnetic Media, by R. S. Hebbert. U. S. Nav. Ord. Lab. Aug. 1954. 14 pp. photos, drawing, diagrs., table. Mi $2.40, ph $3.30. (LC) (PB 122049). Apparatus is described sensitive to Faraday rotations as small as one one-thousandth of a degree. It was constructed to aid in the development and confirmation of a theory of the susceptibility tensor of multiple sublattice ferrites. Several such ferrites were studied but this report is concerned mainly with the experimental techniques necessary to achieve high sensitivity rather than the results of these investigations.

Starting-Current Analysis of Monotrons With a Cylindrical TM_{01n} Resonator, by H. D. Arnett and A. J. Ruhlig. NRL. Sept. 1956. 20 pp. diagrs., graphs, table. 50 cents. (OTS) (PB 121402). An electron beam, unmodulated in velocity, can excite cavity oscillations in a single-cavity resonator by converting some of its kinetic energy into electromagnetic energy. For interaction between electron beam and cavity fields, there must be an electric field component in the direction of motion of the electrons. The simplest such modes are the cylindrical TM_{01n} modes. A calculation has been made of the minimum current required for the start of oscillations in the four lowest modes of this type. This type of oscillator is especially suited to millimeter wavelengths because of the relative ease of cavity fabrication, provided currents of about an ampere can be provided.

PATENTS

Optical Scanner, #2,778,872. Inv. A. Nyman. Assigned to Alden Products Co. Issued Jan. 22, 1957. An elongated illuminating line of elemental width is focused on the original in a facsimile apparatus, defining the width of the line. A scanning aperture positioned between the original and the copy is movable lengthwise of the illuminating line so that its width defines the other dimension of the elemental scanning area. An optical system focuses an image of the illuminated line onto the moving aperture. Hence both dimensions of the elemental area may be independently focused.

Frequency Correcting Method and Apparatus, #2,778,877. Inv. R. S. Caruthers. Assigned Lenkurt Electric Co. Issued Jan. 22, 1957. A pilot signal of known frequency is incorporated in a band of message signals prior to its modulation onto a carrier whose frequency differs from its nominal value by a nominal error.

International ELECTRONIC SOURCES

The pilot frequency is separated out and combined with a locally derived carrier to shift it outside the message signal band. The pilot and message signals are then intermodulated to develop two sidebands, one with twice the unknown error, the other with cancellation of the error, which later sideband is used.

Microphone, #2,778,881. Inv. D. H. Fryklund. Assigned Gulton Industries, Inc. Issued Jan. 22, 1957. A titanate ceramic disc is supported around its edge and mechanically flexed by a wave progressing in the direction of its axis. Two annular electrodes are mounted adjacent the edge of the disc and inwardly spaced therefrom, respectively; mechanical flexing will produce a voltage due to piezoelectricity.

Parallel Ampilfying System, #2,778,883. Inv. P.S.T. Buckerfield. Assigned The British Thomson-Houston Co., Ltd. Issued Jan. 22, 1957. The amplifier for dc and ac voltages comprises a dc and an ac amplifier. The input and coupling resistance capacitance networks are arranged to form a pair of T networks and proportioned to pass substantially uniformly and with inappreciable phase-shift dc and ac voltages up to the rejection frequency of the parallel T-filter network. Uniform amplification with negligible phase-shift is accomplished.

Semiconductor Signal Translating Devices, #2,778,885. Inv. W. Shockley. Assigned Bell Tel. Laboratories, Inc. Issued Jan. 22, 1957. One end section of a semiconductor has a conductivity at least several hundred times that of the remainder; this section is connected to the load, the opposite end constitutes the base. A pair of juxtaposed zones of the opposite conductivity type, defining a pair of rectifying junctions, is arranged in a constricted region intermediate these two opposing ends. The input is applied between this pair of zones as one terminal and the base as the other terminal.

Distributed Amplifier Transmission Line Terminations, #2,778,887. Inv. E. H. Bradley. Assigned Melpar, Inc. Issued Jan. 22, 1957. A plurality of tubes have their anodes connected to points of various delay on a transmission line. A matching impedance is interposed between the transmission line and the anode supply. This impedance consists of an elongated co-axial transmission line structure having relatively small reflection, flat uhf response, and negligible dc resistance.

Color Television Camera Stabilizing Circuit, #2,779,817. Inv. R. J. Stahl. Assigned Color Television, Inc. Issued Jan. 29, 1957. In a switching circuit, two diodes are connected in series between the adjacent cathode resistors of two preceding push-pull connected tubes for alternate conduction. A gating tube having a low internal impedance compared to the push-pull connected tubes is connected in parallel thereto is responsive to the trigger pulse to simultaneously bias both diodes to cut-off.

Electronic Vulcanization of Rubber, #2,779,847. Inv. G. P. Bosomworth. Assigned The Firestone Tire & Rubber Co. Issued Jan. 29, 1957. A plurality of articles of varying thickness is continuously heated in a high frequency field. These articles move between two parallel electrodes with their top surface parallel to and equally spaced from the top electrode and with their bottom surface electrically connected to the bottom electrode.

Synchronizing System for Color Television, #2,780,668. Inv. K. E. Farr, Ch. W. Baugh, and Ch. B. Heffron. Assigned Westinghouse Electric Corp. Issued Feb. 5, 1957. A rotor positions a succession of red, green and blue filters in front of a television picture screen. A dc control winding for the rotor drive is supplied with a voltage depending on the rotor speed and a comparison voltage derived by moving a magnetic body in inductive relation to an inductor winding; this voltage is correlated with the vertical synchronizing signal.

Ultra-Sonic Wave Transducer, #2,779,880. Inv. G. Malherbe. Assigned Ateliers de Constructions Electriques Charleroi. Issued Jan. 29, 1957. Two frusto conical sections are coaxially arranged with their small ends adjoining, one end terminating in a wave-emitting section, the other end in flexible wall. The unit is filled with a wave-conducting medium. Waves from the emitting section are repeatedly reflected resulting in a highly concentrated beam and good directivity.

Dynamic Amplifier, #2,779,921. Inv. R. C. Hawes. Assigned Beckman Instruments, Inc. Issued Jan. 29, 1957. A low-current signal may be measured by applying it to a capacitor connected in series between a grid and anode of a tube. An ammeter and a capacitor are connected in series in the output circuit which also contains a switch.

Complex Pulse Communication System, #2,779,933. Inv. E. M. Bradburd. Assigned International Telephone and Telegraph Corp. Issued Jan. 29, 1957. Three pulses are being transmitted, the ratio of the spacings between two adjacent pulses being K for all such groups of three pulses. The signalling means operate to vary the pulse spacing by given amounts while always maintaining the spacing ratio K.

Noise Actuated Disabling Unit, #2,779,935. Inv. C. L. Loudon and W. E. Riker. Assigned Holmes Electric Protective Co. Issued Jan. 29, 1957. Noise within a predetermined range is amplified and used to render an alarm mechanism inoperative and for producing a control signal which, after a predetermined time delay, operates to render the alarm circuit operative again.

Phasing System, #2,780,673. Inv. J. B. Singel. Assigned Westinghouse Electric Corp. Issued Feb. 5, 1957. A master oscillator feeds a first power amplifier and a transmission circuit connected to a second power amplifier, the two amplifiers supplying a common load. The phase and amplitude of the second power-amplifier output are adjusted to match those of the first power-amplifier output.

Resonant Circuit, #2,780,727. Inv. J. F. Dreyer. Assigned Telephonics Corp. Issued Feb. 5, 1957. A cylindrical rotatable and slidable tuning member extends axially into a resonant chamber. It carries an inductive element and cooperates with the opposing chamber walls to form a tubular capacitor, simultaneously providing support for the sliding and rotating tuning motion of the member. Inductance and capacitance are simultaneously varied as the member is rotated.

Raster Centering Control. #2,780,749. Inv. L. Dietch. Assigned Radio Corp. of America. Issued Feb. 5, 1957. A potential dividing resistor is connected between a choke and a winding on an output transformer; the other choke terminal being connected to the output transformer winding. The deflection winding extends between the adjustable contact of the potential dividing resistor and the common terminal of the choke and transformer winding. Thus the potentiometer is effective to control the dc component of the deflection current.

Semi-Conductor Network, #2,780,752. Inv. R. W. Aldrich, J. S. Schaffner, and J. J. Suran. Assigned General Electric Co. Issued Feb. 5, 1957. Each end of a semi-conductor is provided with predominantly bilaterally conducting electrodes, while a unilaterally conducting junction electrode is situated therebetween. A capacitor is connected between the junction electrode and one of the bilaterally conducting electrodes and an impedance between the junction electrode and the other of the bilaterally conducing electrodes.

Solar Energy Converting Apparatus, #2,780,765. Inv. D. M. Chapin, C. S. Fuller and G. L. Pearson. Assigned Bell Telephone Laboratories, Inc. Issued Feb. 5, 1957. Several silicon bodies are connected in series across the storage battery to be kept charged. Each silicon body includes an n-type zone contiguous with a p-type zone including a concentration of boron impurities; the thickness of the p-type zone being of the order of the diffusion length of the electrons therein. A rectifier is inserted in the circuit and poled to permit only charging current to pass.

Self-Saturating Reactor Circuits, #2,780,772. Inv. B. Lee. Assigned Vickers Inc. Issued Feb. 5, 1957. The reactance winding of a saturable reactor is connected in series with a half-wave rectifier between the input and output circuits of a magnetic amplifier. A second winding on the reactor carries the ac control current. A second half-wave rectifier is connected in shunt to this second winding and so poled to permit current flow in a direction to establish a magnetic field opposed to that due to the current through the first half-wave rectifier.

Stabilized Direct Current Amplifier, #2,781,419. Inv. V. F. Ragni. Assigned International Telephone and Telegraph Corp. Issued Feb. 12, 1957. The common cathode resistor of two tubes is connected to a negative potential, while one plate is grounded, the associated grid being connected to an intermediate potential point. The other plate is connected to a positive potential. The output is derived between the two plates, the input applied between the other grid and a similar intermediate potential point. A given change in bias on both grids will cause a greater current change in the grounded-plate tube than in the other tube.

Band-Pass Filter Circuit, #2,781,422. Inv. Ch. N. Hood. Assigned General Electric Co. Issued Feb. 12, 1957. The output of a first tube is simultaneously connected to the grid of a successive tube and to one terminal of a parallel-resonant filter. The frequency-selective filter output is fed to a second control electrode of the first tube and to the cathode of the second tube in a degenerative sense in both instances.

Amplifier Gain-Stabilization, #2,781,423. Inv. Ch. G. Kuczun and P. A. Husman. Assigned Laboratory for Electronics, Inc. Issued Feb. 12, 1957. Two parallel connected amplifiers accommodate slightly overlapping portions of a wide frequency spectrum. To stabilize the gain of one amplifier channel, a pilot signal is passed through this channel, the pilot signal frequency lying within the pass band of the other channel and outside the pass band effectively passed by the channel to be controlled. A gain control signal is derived from a comparison of the initial and the output pilot signal level.

Television Receiver, #2,781,475. Inv. G. W. Fyler. Assigned Motorola Inc. Issued Feb. 12, 1957. At least one high-voltage winding is inductively coupled to the deflection winding of an electromagnetic television beam deflection system. This high voltage is rectified to secure a high dc voltage.

Semiconductors and Methods of Making Same, #2,781,481. Inv. L. D. Armstrong. Assigned Radio Corporation of America. Issued Feb. 12, 1957. A metallic electrode is fused to the surface of an N-type semiconductive germanium wafer, and a P-N rectifying junction is disposed adjacent the electrode. The electrode consists of indium in which minor proportions of germanium and either gold, silver, copper or nickel are dissolved.

Helical Antenna System, #2,781,514. Inv. W. Sichak and J. J. Nail. Assigned International Telephone and Telegraph Corp. Issued Feb. 12, 1957. A helical radiator is conductively connected to a ground plane and mounted on a hollow cylindrical dielectric structure. The effective length of the helical conductor can be varied by shorting out adjustable lengths thereof. The input is applied through a coaxial transmission line at a predetermined distance from the position of the short.

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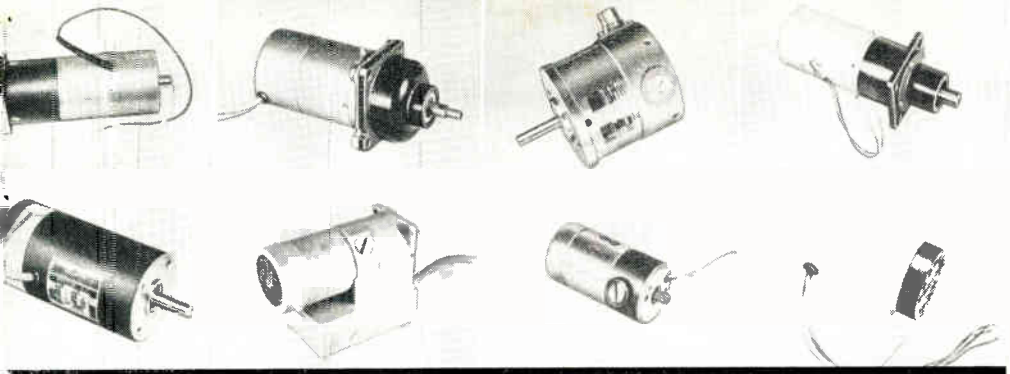

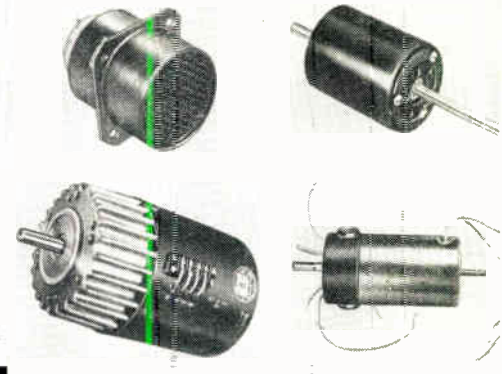

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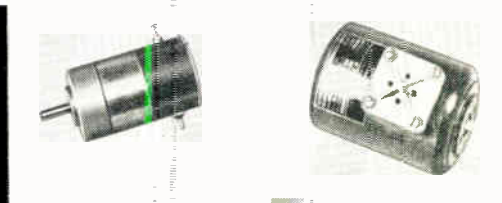
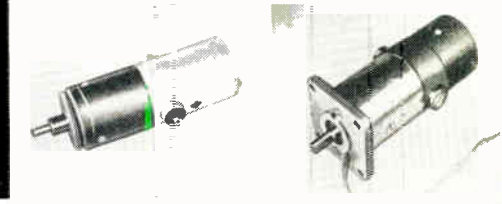
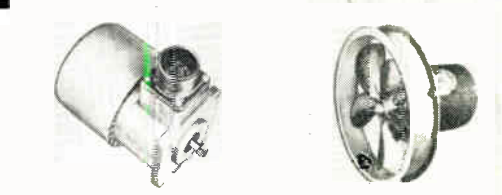
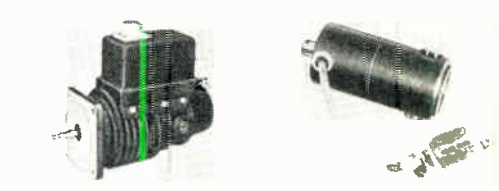








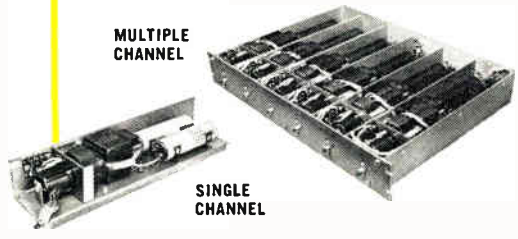
Western Gear's extensive miniature motor line ranges from 1/500th to 4 H.P., 50 to 400 cycles, any voltage required, designed and built to meet military specifications. Our engineers will gladly work with you in solving your rotary electrical problems without obligation.

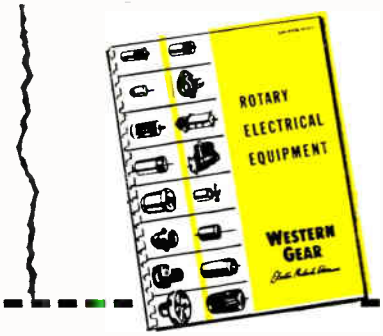
special power supply units, too!

Transistorized D.C. voltage regulator employing series power transistor and temperature compensated Zener diode reference voltage. Input voltage is 27.5 V.D.C. plus or minus 15%. Model 7VR09 output is 20 V.D.C. at 50 to 250 MA; Model 7VR08 20 V.D.C. at 10 to 150 MA. Regulation less than plus or minus .1% for combined variations of input voltage, load current, temperature, drift and vibration. Shunt loss is less than 25 MA. Temperature range from 32°F. to 150°F. Measures 2" x 2" x 2".

MODEL 7VR08-9

Model 7P01 single or multiple channel strain gage power supply, 115 V., 60 cycle input, 10 V.D.C. output, adjustable from 9-11 V.D.C. with a 10-turn potentiometer. Output voltage changes less than plus or minus .05% due to temperature change from 0 to 45°C.; output voltage changes less than .1% due to 2% change in load current. Output ripple is less than 300 microvolts RMS, isolated from ground as follows: insulation resistance to ground, 10,000 megohms; AC pickup voltage to ground, 5 microvolts peak.





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WESTERN GEAR Corporation

ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.)
SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

Western Gear Corporation
Electro Products Division
132 W. Colorado St., Pasadena 1, Calif.

- ☐ Please send me motor catalog No. 254-A
- ☐ Data sheet on voltage regulator
- ☐ Data sheet on strain gage power supply

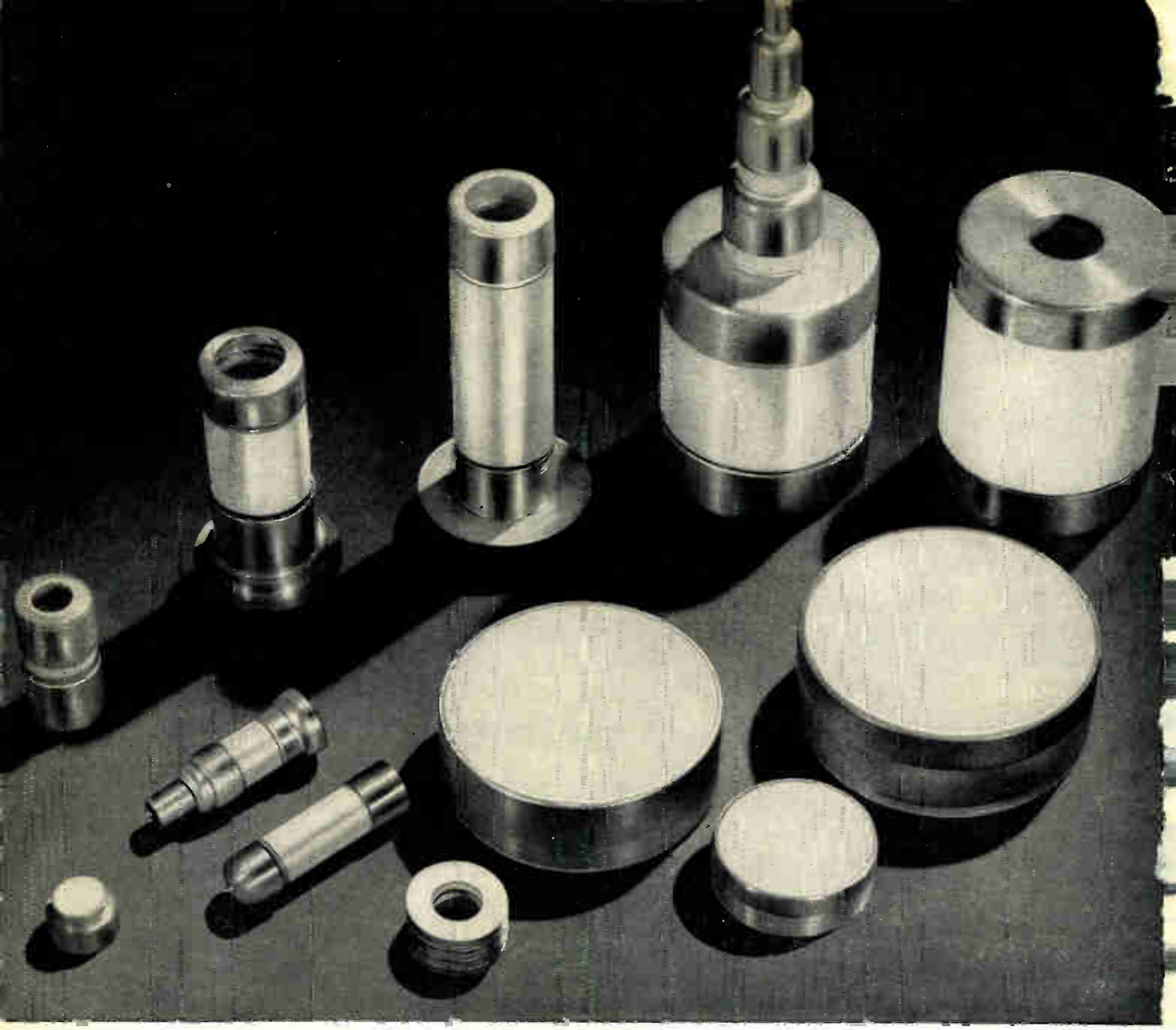
Name_____

Title_____

Company_____

Address_____

City_____ State_____



Why your ceramic-to-metal seals need RAYTHEON R-95 HIGH-ALUMINA CERAMIC

Fundamental to the problem of reliable seals is a reproducible ceramic body. And equally basic to the quality of the ceramic body are these essential characteristics:

1. Vacuum tightness
2. Sure thermal shock resistance
3. Reliable mechanical properties
4. Dependable electrical properties
5. High temperature characteristics
6. Economical fabrication
7. Uniformity—from lot to lot—in each of the above

Raytheon's R-95 ceramic meets every one of these exacting demands, consistently!

Ceramic parts manufactured from Raytheon's R-95 high-alumina are available, either alone or as hermetic ceramic-to-metal assemblies, in accordance with your specifications. The assemblies can be soldered into your production in your own plant.

Send sketches or drawings outlining dimensions and tolerances, together with operational conditions. We will be pleased to supply information and help on any of your ceramic needs.

Write for complete specification sheet. No cost or obligation, of course.

RAYTHEON MANUFACTURING COMPANY

RAYTHEON

Excellence in Electronics

Ceramic Sales **Waltham 54, Massachusetts**

Circle 58 on Inquiry Card, page 97

Oldsmobile Show Uses Steriophonic Sound

The 1957 Oldsmobile models were introduced to dealers throughout the United States by a two-and-one-half hour live presentation designed to present new car features by means of song lyrics and dialog. The show was presented in eight major cities throughout the nation.

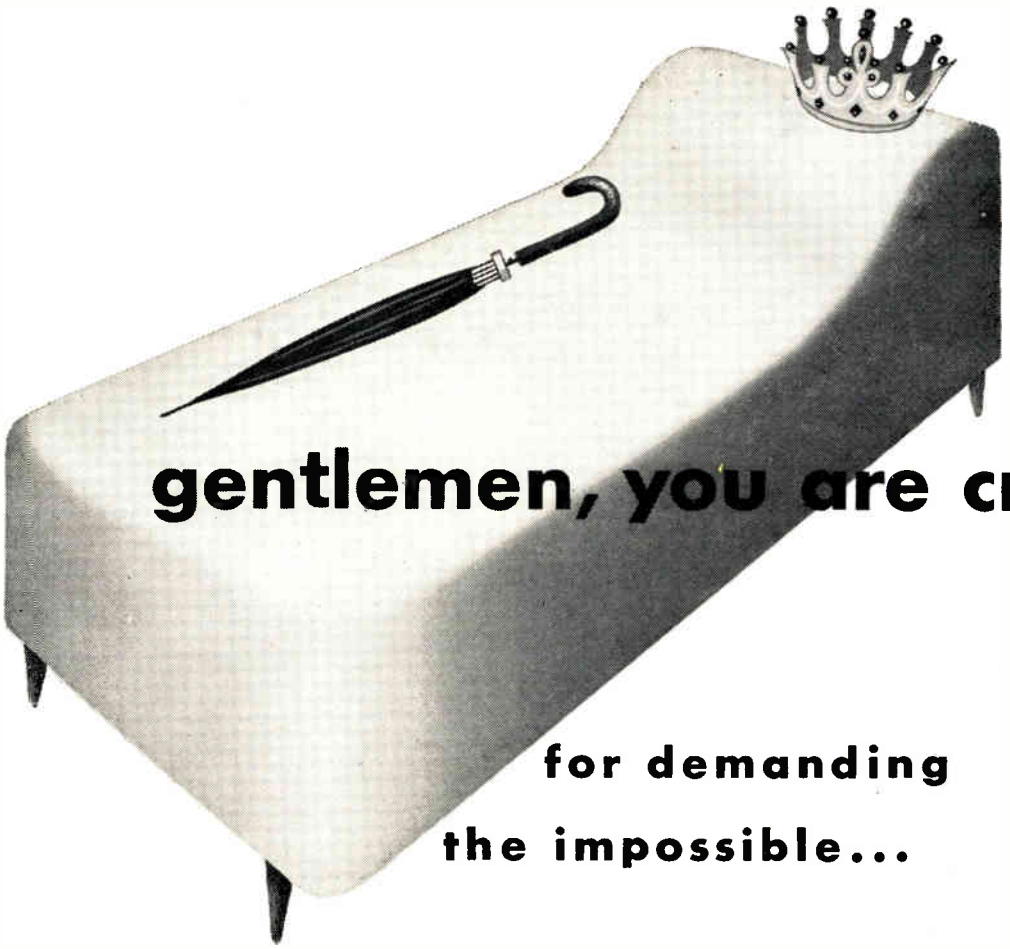
One of the unique features of the show was the elaborate stereophonic sound system including a stage sound system, an effects system, a portable hi-fi public address system, and a cueing system for dressing rooms. The system was devised by Altec's F. C. Dickely and Oldsmobile's William C. Hill as a crowning touch to the presentation.

Altec Engineers Ravzin and Dach check the stereophonic control console

A radical departure from the sound setup Altec had provided for previous shows staged by the Oldsmobile organization was a change in the mixing. Previously, this has been accomplished from an off-stage position, rendering it impossible for those at the controls to observe the action taking place on the stage. Altec designed and fabricated a special control console, the work of Mike Revzin, a member of Altec's engineering staff at New York headquarters, to be positioned in a strategic location in the auditorium, enabling the control engineer to follow the entire course of the performance, with resultant pin-point timing of the required sound effects.

Circle 59 on Inquiry Card, page 97

to our clients:



gentlemen, you are crazy

for demanding the impossible...

and we are even crazier for supplying it!

EFCON

CLOSE-TOLERANCE CAPACITORS

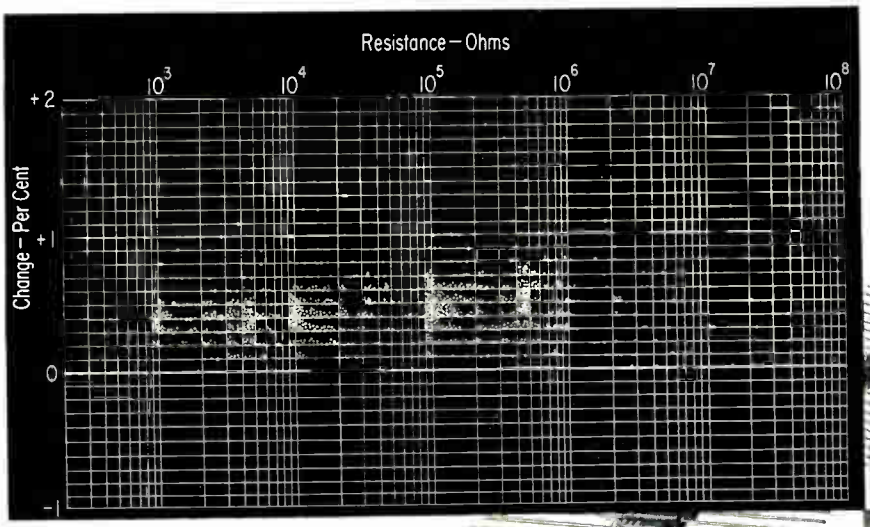
ELECTRONIC FABRICATORS, INC.

DEPT. T-3, 682 BROADWAY, N. Y. 12, N. Y.

TELEPHONE: SPRING 7-4900 CABLE: ELFACAP

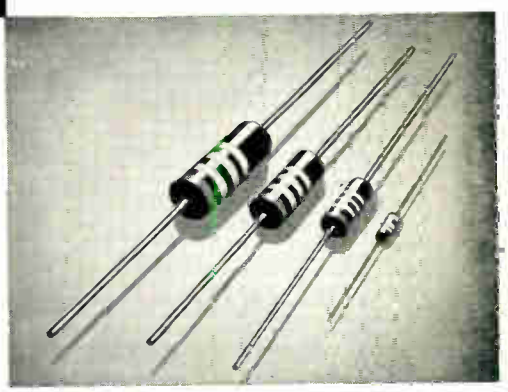
they look alike...

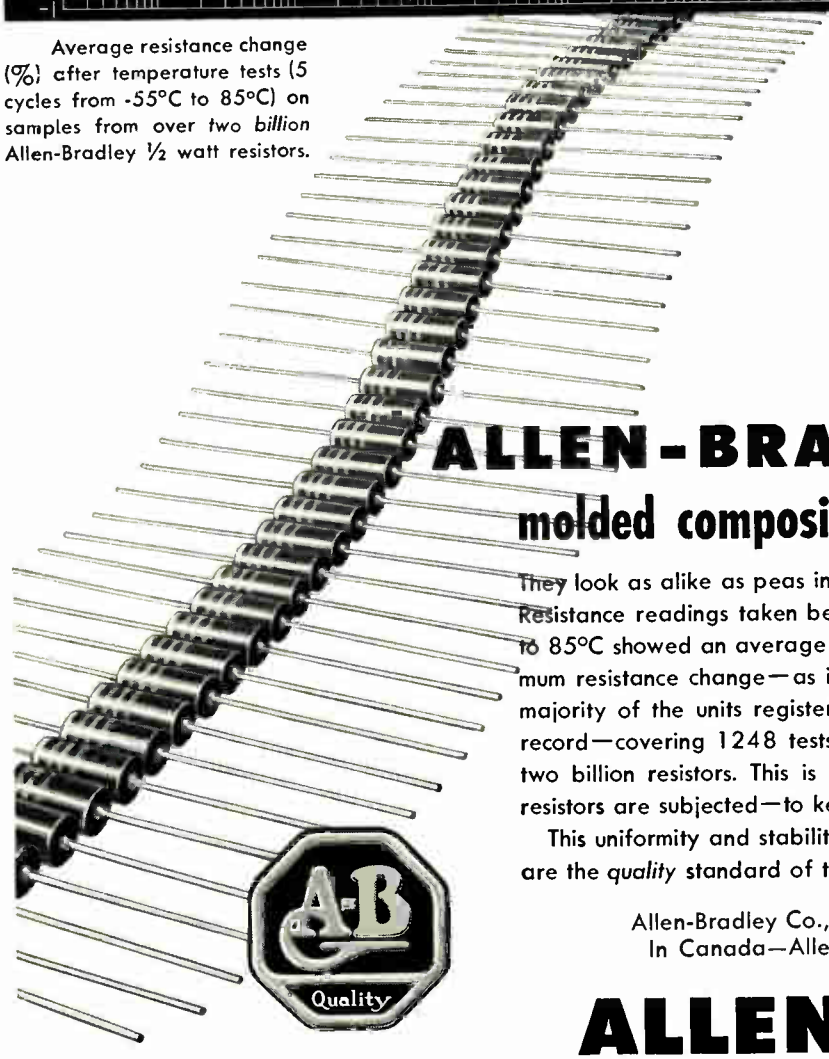
and they are alike!



Average resistance change (%) after temperature tests (5 cycles from -55°C to 85°C) on samples from over two *billion* Allen-Bradley ½ watt resistors.

Allen-Bradley fixed resistors are available in 1/10, ½, 1, and 2 watt sizes, in all standard RETMA resistance values.





ALLEN-BRADLEY
molded composition RESISTORS

They look as alike as peas in a pod—but actually they are *far more* uniform! Resistance readings taken before and after five complete cycles from -55°C to 85°C showed an average resistance change of about ½ of 1%. The maximum resistance change—as indicated on the chart—was below 2%, with the majority of the units registering below 1% change. The chart is a six year record—covering 1248 tests of samples from production runs totaling over two billion resistors. This is only one of many tests to which Allen-Bradley resistors are subjected—to keep "tab" on their quality and uniformity.

This uniformity and stability is the reason that Allen-Bradley fixed resistors are the *quality* standard of the electronics industry.

Allen-Bradley Co., 1342 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Limited, Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC, AND TELEVISION COMPONENTS

Circle 61 on Inquiry Card, page 97

Books

Television Engineering, Principles and Practice, Vol. 2

By S. W. Amos, B. Sc. (Hons.), A.M.I.E.E. and B. C. Birkinshaw, M.B.E., M.A., M.I.E.E. Published 1956 by the Philosophical Library, 15 E. 40th St., New York 16. 270 pages. Price $15.00.

This volume describes the fundamental principles of video-frequency amplifiers and examines the factors which limit their performance at the extremes of the passband. A wide variety of circuits is described and particular attention is paid to the use of feedback. There is a section reviewing the special problems of camera-head amplifiers.

Because of the nature of the subject, the text is necessarily mathematical, but whenever possible, self-contained mathematical derivations have been included as appendices at the end of chapters.

Transistor Engineering Reference Handbook

By H. E. Marrows. Published 1956 by John F. Rider Publisher, Inc., 116 W. 14th St., New York 11. 288 pages. Price $9.95.

The book is divided into five major sections. The first section deals with the discussion of transistor materials, structures, and fabrication techniques. Coverage is given on the point contact, field effect, fieldistor, analog, antianalog, filamentary, junction avalanche, surface barrier, intrinsic barrier, and diffused layer transistor types.

In broadest terms, the book is planned to be used as a source book for technical information on transistors and components designed for use with transistors, operating capabilities, performance characteristics, and sources of supply. It covers some 200 different types of transistors; components designed for transistorized equipments presented in this book are 450 capacitors, more than 100 cells and batteries, a selection of thermistors and a variety of miscellaneous components. This complete tabulation is a definite aid to the development engineer and the purchasing agent in all transistorized equipment research and production.

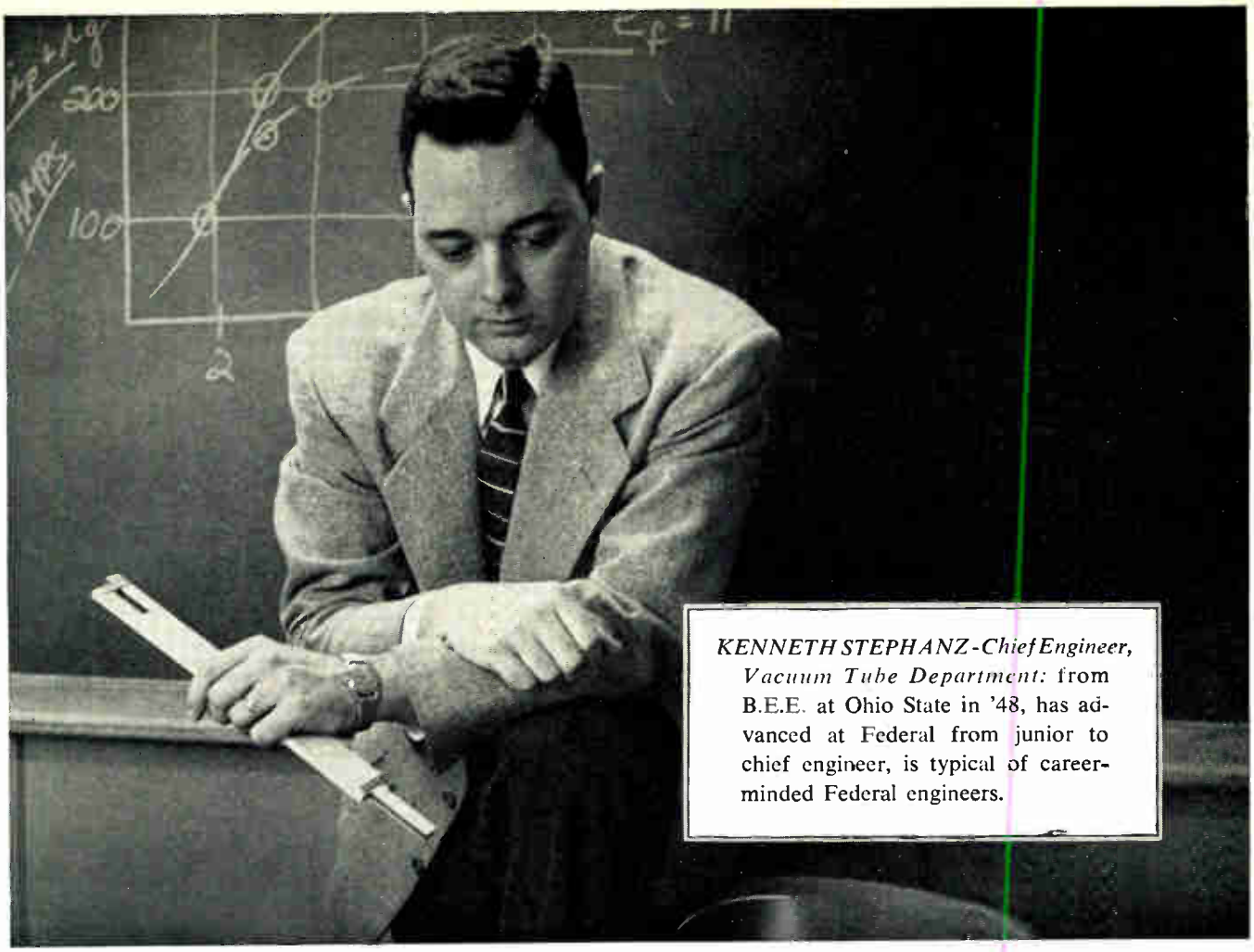
Electrical Measurements and Their Applications

By Walter C. Michels. Published 1957 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 331 pages. Price $6.75.

This work lays a solid groundwork in basic electrical measurements and techniques, and then examines applications in the measurement of quantities which are not primarily electrical.

Recently developed instruments as well as the more traditional ones, are discussed in detail. Whenever possible, physical arguments are used to

(*Continued on page* 104)



KENNETH STEPHANZ - Chief Engineer, Vacuum Tube Department: from B.E.E. at Ohio State in '48, has advanced at Federal from junior to chief engineer, is typical of career-minded Federal engineers.

Recognition, advancement, security and hard work

"In my nine years at Federal I think I have discovered the key to success — the right choice of company and hard work," says Ken Stephanz. "It takes an engineer and a company to make a career. You must know what you want to do, what direction you want to move in. Then you must answer a tough question . . . What company offers me greatest opportunity to develop my talents, to build a career and have a happy personal life? The rest is up to you. The rewards are great — recognition of your efforts and abilities, chance for advancement, and financial and job security.

"True, there are other considerations — location, work of your choice, living conditions, association with capable engineers, company prestige and growth potential. Engineers at Federal find that this company provides all these advantages. In fact, you will find that Federal, a member of the world-wide IT&T System, presents unusual opportunities for the ambitious engineer."

The markets for Federal's many products will keep the Company growing, assuring a bright future for Federal and its engineers. The broad scope of engineering projects opens to you a wide choice of assignment. When you join Federal you join a stable, dynamic organization, a leader in the electronics industry.

Join the IT&T Team

For information of engineering opportunities and assignments write to Mr. J. Connington, Technical Placement Director.

Federal Telephone and Radio Company

A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

100 Kingsland Road, Nutley, New Jersey

Books

(*Continued from page* 102)

supplement mathematical approaches.

A substantial number of specific experiments illustrate and give reality to the exposition. The author has tried to make these experiments varied enough to meet the diversed needs of engineers and scientists and to suit the facilities of any laboratory.

A highly significant chapter covers applications in nuclear physics, including the measurement of nuclear disintegration rates.

Relay Protection of Power Lines and Power Stations, 1st Volume.

By A. M. Fedossejew. Translated from Russian into German by Kourtiline and Werkmeister. Published 1955 by VEB Verlag Technik, Berlin, Germany. 329 pages.

The book is concerned with the relay protection of power lines and power stations and in particular with recent developments in Russia and the methods presently employed.

The type of mistakes and resulting disturbances, such as short-circuits, in the normal operation in over-head lines and cables are explained. Subsequently the various designs, involving relays, which operate a control circuit when the current in a line reaches a predetermined maximum, are considered.

Protective relay apparatus for parallel connected power stations and ring-connected lines are discussed in great detail. Since this type of station arrangement involves different time-delays for a pair of protective devices, depending on the position of the overload, relative phases must be taken into consideration.

A further type of protection in which the time delay depends on the distance is extensively treated. This type may be operated either in response to the voltage, the current, or the phase.

The text has been written with a view to assist in the selection of the best type of equipment in a special instance at hand.

Books Received

Basic Radio and Radio-Receiver Servicing

By P. B. Zbar & S. Schildkraut. Published 1956 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 114 pages, paper bound. Price $1.75.

AMA Management Book Shelf

Published 1956 by American Management Association, Inc., 1515 Broadway, New York 36. A catalog of AMA publications and films.

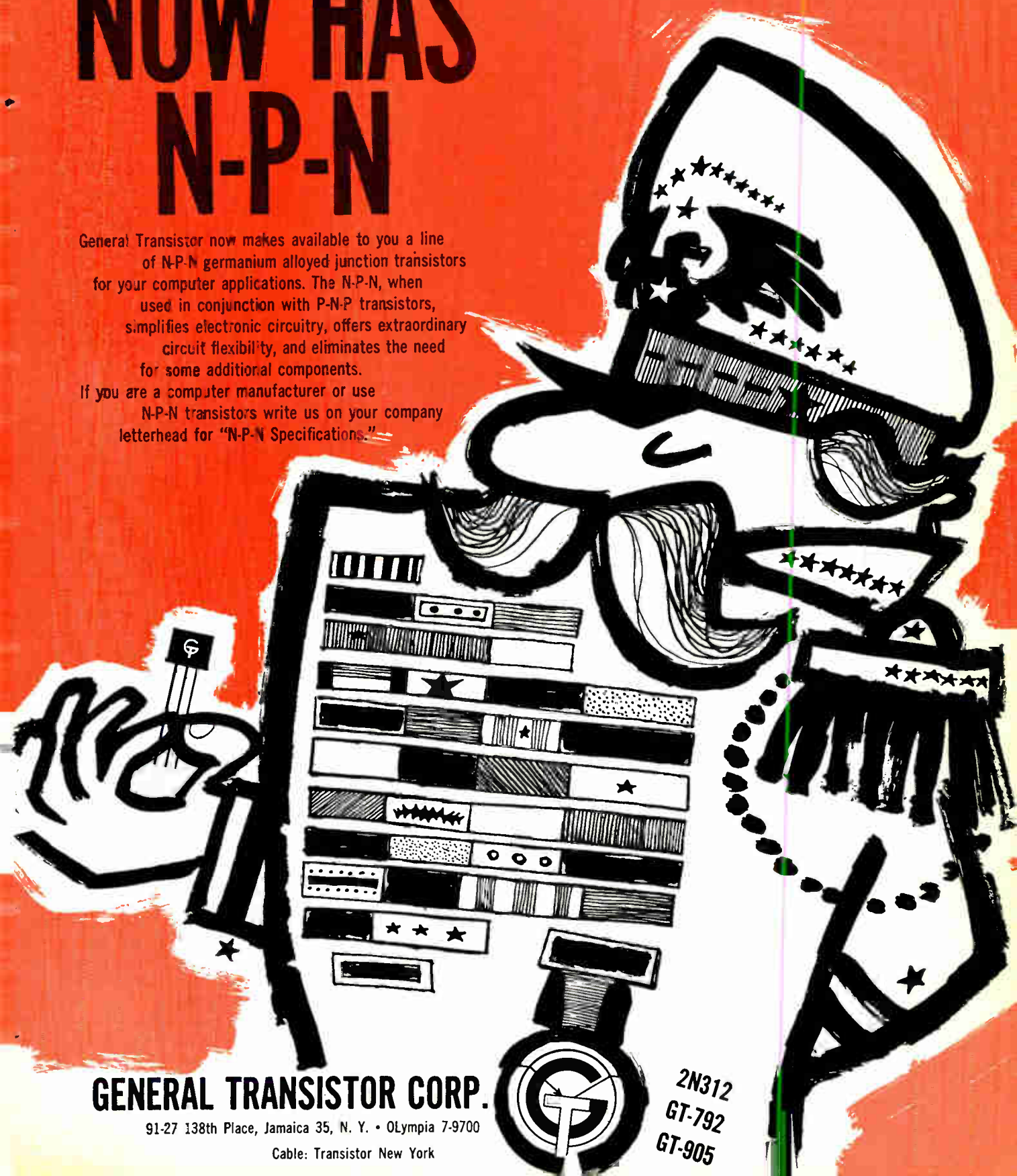
Bibliography and Abstracts on Electrical Contacts

Published 1956 by American Society for Testing Materials, 1916 Race St., Philadelphia 3. 48 pages, heavy paper cover. Price $1.00.

GENERAL NOW HAS N-P-N

General Transistor now makes available to you a line of N-P-N germanium alloyed junction transistors for your computer applications. The N-P-N, when used in conjunction with P-N-P transistors, simplifies electronic circuitry, offers extraordinary circuit flexibility, and eliminates the need for some additional components.

If you are a computer manufacturer or use N-P-N transistors write us on your company letterhead for "N-P-N Specifications."



GENERAL TRANSISTOR CORP.

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Cable: Transistor New York

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For A-N-Ything in Alnico Magnets

Specify "ARNOLD"

Materials

Cast Alnico Magnets are most commonly made in Alnico V, VI or III. Sintered Alnico Magnets usually are made in Alnico II, V or VI. Special permanent magnet materials include Vicalloy, Cunico, and Cunife.

Engineering Data

Write for your copy
BULLETIN GC-106 B

Contains useful data on Alnico Magnets, their physical and magnetic properties. Also lists stock items and standard tolerances for cast and sintered magnets.

ADDRESS DEPT. T-74

Your best bet when looking for a source of Alnico magnets and assemblies is Arnold—producer of the most complete line of magnetic materials in the industry. Arnold can supply your need for any size or shape of Alnico magnet, as illustrated by the variety pictured above. Weights range from a few ounces to 75 pounds or more. Die-cast or sand-cast aluminum jackets, Celastic covers, etc., can be supplied as required. Complete assemblies are available with Permendur, steel or aluminum bases, inserts and keepers as specified—magnetized and stabilized according to the requirements of the application.

A wide range of the more popular shapes and sizes of cast and sintered magnets are carried in stock at Arnold. Unsurpassed plant facilities make possible quick delivery of all special orders. ● *Let us handle your magnetron, traveling wave tube and wave guide permanent magnet requirements, or any other magnetic material specification you may have.*

WSW 6445

THE ARNOLD ENGINEERING COMPANY

Main Office & Plant: Marengo, Illinois

Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices: New York: 350 Fifth Ave. *Boston:* 200 Berkeley St. *Los Angeles:* 3450 Wilshire Blvd. *Washington, D. C.:* 1001—15th St., N. W.

How much should a Tape Recorder cost?

$45,000* The new **Ampex Videotape Recorder** at $45,000 achieves flawless reproduction of TV picture and sound. The system not only promises to revolutionize network telecasting but will actually reduce material costs by 99%. In hundreds of TV stations throughout the country Ampex Videotape Recording will repay its cost in less than a year.

$1,315* The **Ampex Model 350 studio console recorder** at $1,315, costs less per hour than any other similar recorder you can buy. Year after year it continues to perform within original specifications and inevitably requires fewer adjustments and parts replacements than machines of lesser quality.

$545* The **Ampex Model 601 portable recorder** at $545 gives superb performance inside and outside of the studio. This price buys both the finest portable performance available and the most hours of service per dollar.

YOU CAN PAY LESS FOR A TAPE RECORDER BUT FOR PROFESSIONAL USE YOU CAN'T AFFORD TO BUY LESS THAN THE BEST

*Net price as of August 1, 1956 and subject to change.

SIGNATURE OF PERFECTION IN MAGNETIC TAPE RECORDERS
934 Charter Street • Redwood City, California

AMPEX
CORPORATION

See all three IN ACTION *at the* **NARTB** CONVENTION

News of Reps

REPS WANTED

A leading manufacturer of general electronic test equipment such as oscillators, VTVM's pulse generators and power supplies seeks representation in the Mid-West and Southwest areas. (Ask for R4-1)

Manufacturer of precision resistors wants reps for Colorado and Washington-Oregon territories. (Ask for R4-2)

Technical sales reps desired for high quality miniature transistorized test and pulse programming equipment. In the Midwest, North West and Southern areas. Manufacturer is rapidly expanding in the electronic instrumentation field. (Ask for R4-3.)

Smith and Purdy Associates, Walpole, Mass., have been appointed to represent Teletronics Laboratory, 54 Kinkel St, Westbury, L.I., N.Y., in New England and up-state New York.

Mr. John B. DeWolf has joined the **Fred F. Bartlett Co.,** 160 Morlyn Ave., Bryn Mawr, Pa.

Kendrick H. Lippitt of Earlville, N. Y., and **Harry C. Howard, Jr.,** of Akron, O., have joined the sales force of D. S. Kennedy Co., Cohasset, Mass.

Air Supply Co. and **Aero Eng. Co.,** Divisions of the **Garrett Corp.,** have been appointed sales reps throughout the U. S. for the Mica Corp., Culver City, Calif.

Frank Malley, formerly sales manager, Fisher Radio Corp. of New York City, has formed **Frank Malley & Associates,** P. O. Box 1764, Albuquerque, New Mexico. Operating out of centrally located Albuquerque, they service the areas of Arizona, New Mexico and El Paso, Texas.

R. E. Thompson attained the one million dollar sales mark for one year as a rep with Kay Sales Co., Kansas City, Mo.

David Bogen Co., Inc., of Paramus, N. J., has appointed six new sales reps to handle Bogen and Presto Equipment. **E. C. Wharfield** and **Leon S. Bush** have been appointed as reps in the Rocky Mountain area; **E. L. Berman Co.** of San Francisco will represent Presto in Northern California; **Michael Scott Co.,** Boston, will represent Presto in New England; **Morris, Cunningham and Mitchell** of Indianapolis will handle Indiana; **W. H. Ellinger Sales Co.** of Chicago, has been appointed to handle Illinois and the Eastern half of Wisconsin; **Northwestern Agencies, Inc.,** has been appointed the Pacific Northwest.

(*Continued on page* 110)

YOU'VE GOT TO HAND IT TO ENGINEERING!

You've got to hand it to the engineering profession. The "slide-rule" boys know quality when they see it . . . and they won't be satisfied with anything less. Take solder, for example. Engineers depend on KESTER FLUX-CORE SOLDER in their work because they know Kester's reputation for quality and precision manufacturing . . . a reputation built up over more than 50 years. That's why Kester's the preferred choice of a great majority of electronic manufacturers. *Engineers know that a few pennies saved on a "second-line" solder product can waste dollars!*

KESTER SOLDER

SEND TODAY for your copy of the 78 page Kester Textbook, "Solder . . . Its Fundamentals and Usage." It's Free.

Company

4210 Wrightwood Avenue, Chicago 39, Illinois
Newark 5, New Jersey, Brantford, Canada

News of Reps

(*Continued from page* 108)

The J. Y. Schoonmaker Co. announced its move into new and bigger quarters at 5328 Redfield Ave., Dallas, Tex. The new one-story building provides 5000 sq. ft. of facilities to serve their customers and principals.

Harry P. Segel Co., Inc., has opened new ultra-modern quarters at 386 Washington St., Brookline, Mass. The completely air-conditioned building boasts an entirely new concept in manufacturers' representation.

Robert E. Fowler has been appointed a sales rep for Magnetics, Inc., of Butler, Pa. He will cover areas in upstate New York as well as Erie, Warren and McKean Counties in Pennsylvania.

Perlmuth Electronics Associates finished 1956 as one of the top three sales reps for Raytheon Mfg. Company in distributor tube sales.

Vincent Puente has become associated with **L&M Associates,** 22-02 Raphael St., Fair Lawn, N. J., as sales engineer for Camden and Eastern Pennsylvania.

Koehler-Pasmore Co., 11833 Hamilton, Detroit, has completed negotiations with BARCO, Inc., of Milwaukee,, importers of miniature electronic capacitors and rectifiers, to represent them in the lower peninsula of Michigan.

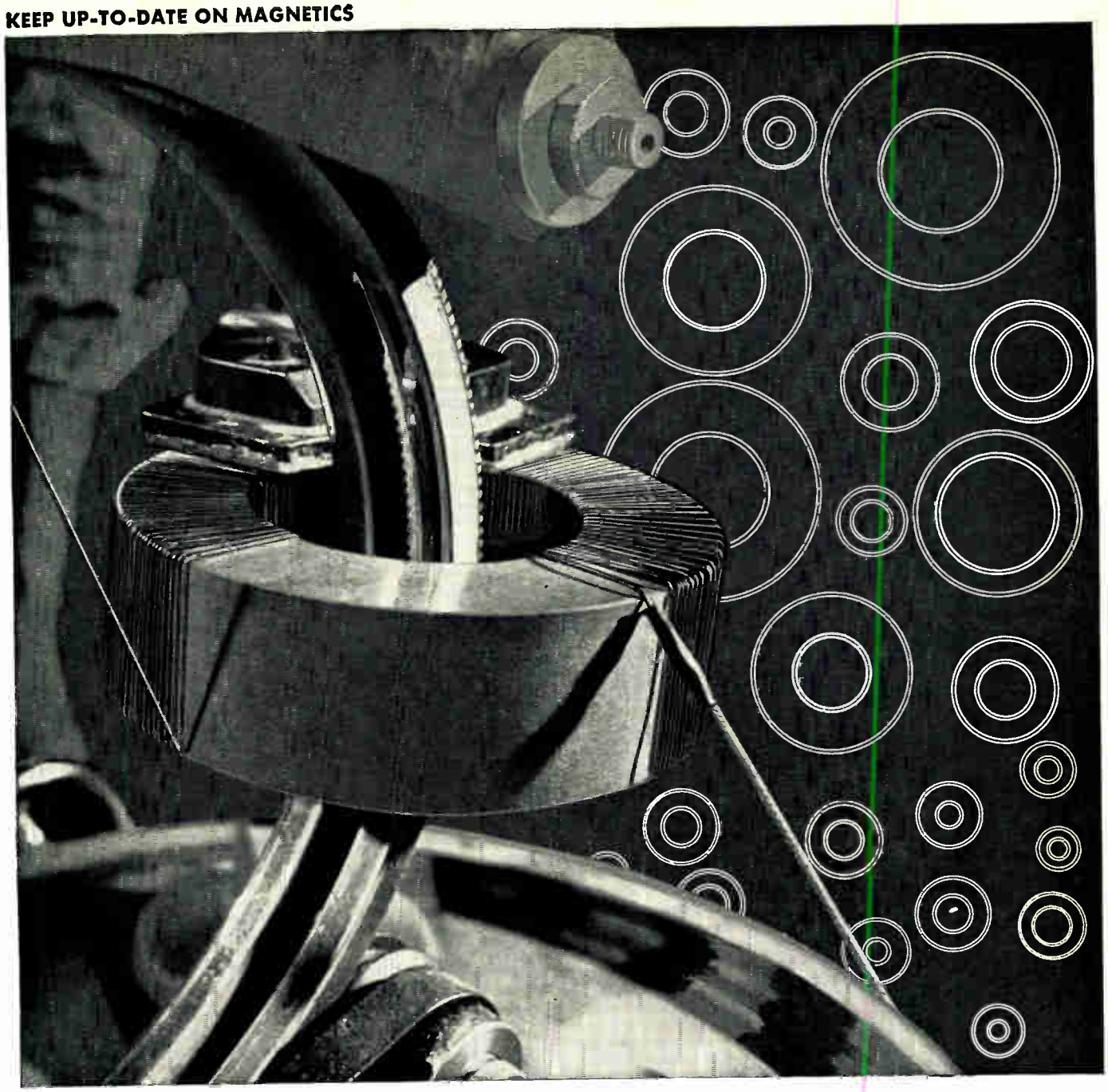
Smith & Purdy Associates of 944 Main St., Walpole, Mass., are reps for Marconi Instruments, Ltd., in the New England States.

Ben Z. Rubin, 16222 Cheyenne Ave., Detroit 35, Mich., has been appointed rep for Industrial Development Labs, Inc., Jersey City 5, N. J.

LeeMark Associates have been appointed the engineering reps for Berkeley Div., Beckman Instruments, 2500 Fuller Road, Fullerton, Calif., and Waveline, Inc., 35 S. St. Clair, Dayton 2, Ohio, operating in Colorado, Missouri, Kansas and Nebraska.

Electro Sales Associates, Inc., Cleveland, O., announce the opening of a new sales office at 512 Orangewood Dr., Dayton 9, O. **John F. Sheffs** has been appointed manager of this office.

Tel-Instrument Electronics Corp., Carlstadt, N. J., has announced the appointment of three new sales reps: **Instrument Dynamics, Inc.,** 6 Abbott Road, Wellesley Hills, Mass., will cover New England; **Brimberg Associates,** 1028 Connecticut Ave., Washington 6, D. C., will handle the territory of Delaware, Maryland, and Northern Virginia; and **Cox Sales Co.,** 51 Ogden St., Denver, Colo., will cover Montana, Idaho, Wyoming, Utah, Colorado, New Mexico, West Nebraska and El Paso, Texas.



How will tape wound core users be affected by new size standards?

If toroidal core winding is a familiar sight in your plant, you'll welcome news that standard sizes for tape wound cores have been proposed by the A.I.E.E.* You are going to benefit from a high in consistency of core performance, brought about by our being able to concentrate on your most important sizes.

Magnetics, Inc. is now stocking all of the proposed standard core sizes in both aluminum and phenolic core boxes for immediate delivery. Consistency of core performance is increased because each size is made in large lots taken from the same alloy batch and dry hydrogen anneal. They all bear our exclusive Performance-Guarantee.

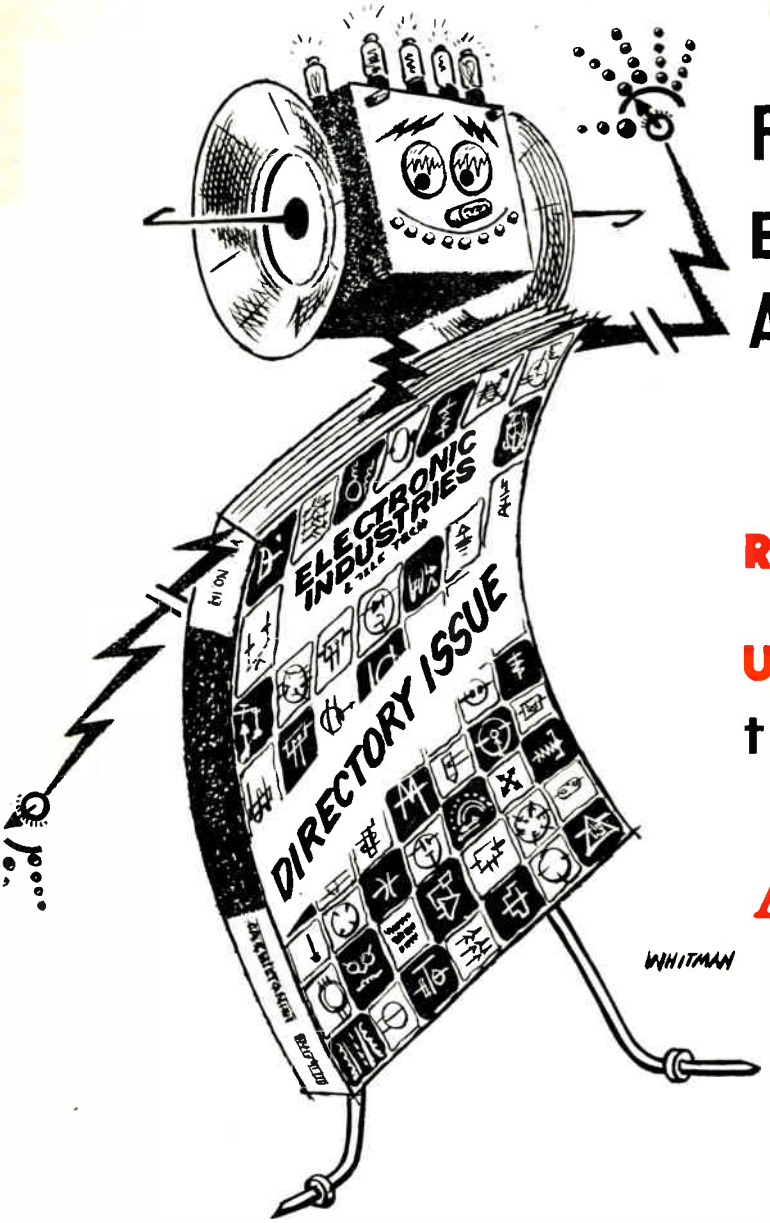
You can find all specifications for these AIEE-standardized tape wound cores in Catalog TWC-102, a new publication which, incidentally, is the most comprehensive tape wound core text published anywhere by anybody. Your copy of this Catalog-Design Manual may be obtained by writing on your letterhead to *Magnetics, Inc., Dept. TT-34, Butler, Pa.*

MAGNETICS inc.

**Paper 57-206, Proposed Size Standards for Toroidal Magnetic Tape Wound Cores. Report of the Magnetic Amplifiers Material Sub-Committee, at the 1957 Winter General Meeting, A.I.E.E.*

Circle 63 on Inquiry Card, page 97

DOUBLE IMPACT!



From your advertising in ELECTRONIC INDUSTRIES' Annual Directory Issue

READ as an issue

USED as a reference throughout the year

Assured continued sales exposures

The Electronic Industries' Directory is an integral part of a regular monthly issue. It is read by the top electronic engineers in the original equipment market as well as other design talent throughout the industry—with the same enthusiasm as all other 11 issues. THIS IS THE FIRST IMPRESSION YOUR ADVERTISING WILL MAKE. More listings . . . more complete listings . . . more practical listings make it a storehouse for electronic engineers. ELECTRONIC INDUSTRIES' Directory is in contact with these men whenever they look to buy. THIS IS THE SECOND AND LASTING IMPRESSION YOUR ADVERTISING WILL MAKE.

AD DEADLINE: MAY 1, 1957

ELECTRONIC INDUSTRIES

IRE Sessions

(*Continued from page* 61)

miniaturization — The Ultimate Technique" will discuss these problems fully Tuesday evening.

Printed circuits have been a boon to mass production of electronic equipment. New, more rapid methods of manufacturing printed circuits are being constantly sought. "An Automatic Dip Soldering Machine" is being presented by V. O'Gorman, United Shoe Machinery Corp., Beverly, Mass. This machine described fluxes, preheats, dip solders, cleans the residual flux from the boards and unloads automatically at a rate of 1,000 per hour. This discussion will take place Wednesday afternoon at the Coliseum.

Until recently, techniques for recording digital data on perforated tape had been perfected to meet the requirements of the communications industry. The recorder described in the paper "Design Considerations for Super Speed Perforate Tape Digital Recording" probably represents the first tape perforator designed for instrumentation as well as digital computer output data recording applications. Recordings of standard 5, 6, 7 or 8 whole code patterns can be reliably performed at controlled rates up to 240 codes per second. This paper should be of interest to computer engineers as well as people concerned with telemetering and remote control. The paper will be presented Thursday morning in Morse Hall at the Coliseum.

Microwave switches are the subject of 2 papers being presented Thursday morning in Faraday Hall at the Coliseum. "Fast Acting Microwave Switch" describes a novel mechanical microwave switch primarily applicable to low power circuitry. The switching time is in the order of 1 microsecond and the stop power attenuation is better than 60 db at all frequencies of the useful microwave spectrum. The other paper is "High Speed Ferrite Microwave Switches." Problems in the design of the microwave structure as well as electronic driving circuitry are discussed.

GOLD PLATED CELL

The photograph above compares the new Energizer cell with a shirt button. The tiny cell is designed to power an electric wrist watch for more than 12 months

Avionic Report

"Automatic Flight," released by The Radio Technical Commission for Aeronautics, is a report of studies on the application of automatic flight techniques in takeoff, cruise, approach, landing, and taxiing. The report describes six categories of automatic flight and defines fundamental terms as a basis for automatic flight equipment nomenclature. Of special interest to avionic engineers are the detailed analysis of the final approach problem and the criteria for adjustment of ILS localizer facilities. Standards for localizer receiver output and autopilot coupler output characteristics are recommended.

Bendix Builds Minitrack Receivers

Minitrack radio receivers, so sensitive they can "hear" invisible stars, are in production at Bendix Aviation Corporation.

The ultra-sensitive Minitrack radio was designed and built originally by the Naval Research Laboratory to track the earth satellite. The original "Minitrack" system, along with 11 other receivers under construction by the radio division of Bendix in Baltimore, will be strategically placed up and down the American continents to tune in radio beams from the man-made moon as it orbits in space.

In its orbit around the world, the satellite's 13-ounce transmitter will transmit a radio signal on a frequency of 108 mc—at the upper end of the standard FM broadcast band—with a power of from 10 to 50 milliwatts. Radio equipment sensitive enough to receive this signal reportedly, can listen to radio "noise" originating on the sun—not ordinary sun-spot "static"—and detect the presence of stars that emit no visible energy.

The complete Minitrack radio receiving system being built by Bendix Radio will occupy six racks, each about the size of a filing cabinet. Each system will be housed in an air conditioned mobile trailer and receive signals picked up from eight antennas, separated by a few feet to 500 feet, at each of the receiving stations. By measuring the minute difference in time required for the satellite's signal (traveling at the speed of light) to reach each of several antennas, the position of the 20-inch sphere whirling 200 to 1500 miles above the earth will be pinpointed.

The United States earth satellite program calls for the launching of additional small, unmanned, earth-circling satellites as part of U. S. participation in the International Geophysical Year. The satellites will be used to collect data by scientific measurements in interplanetary space. Data will be obtained by radio signals coming from the instrument-packed 20-inch sphere and also by optical observation of the tiny "moon" as it orbits at 18,000 miles an hour —circling the earth about once every 90 minutes.

The earth satellite will provide scientists with information on the outer limits of the atmosphere, the characteristics of interplanetary space, solar radiation and its effects on weather and communications, cosmic rays, the density of dust and micrometeorites in outer space and precise data never before available on the size and shape of the earth.

Printed Circuit

(*Continued from page* 73)

the order of 20 to 30 minutes. However, the process may be considerably speeded up by applying a spray or jet of ferric chloride to the plate rather than simply immersing it. Other common techniques for speeding the operation of etching are (a) heating the solution or (b) violent agitation. Both involve a certain amount of risk. The first one entails a risk of boiling and the resultant danger to personnel and equipment. The second entails the risk of splashing and spillage. To avoid these possibilities, it has been found possible to employ an electrolytic etching technique.

Electrolytic Etching

Electrolytic etching simply requires the connection of an external current source to the copper-clad plate and immersing another electrode in the etching solution. The copper-clad laminate is connected to the positive electrode and the other electrode is connected to the negative terminal. This cathode can be a carbon rod. A suitable source of power is a 12 v. storage battery. Although it is readily seen that the electrolytic etching cannot remove isolated portions of the conductor, nevertheless the saving in time achieved by etching down to a very thin residual layer is considerable.

The electrolytic action will assist in removing a large bulk of material that would otherwise have to be etched away. Once this large bulk has been removed, the normal etching procedure will go to completion and yield the desired finished product.

Care should be taken that the connection to the copper-clad laminate is made on an inconspicuous portion of the plate, where no damage will be done. Further, the copper under the connection will not be etched away. Removal of the copper that is shielded by the connection can be done in a variety of ways.

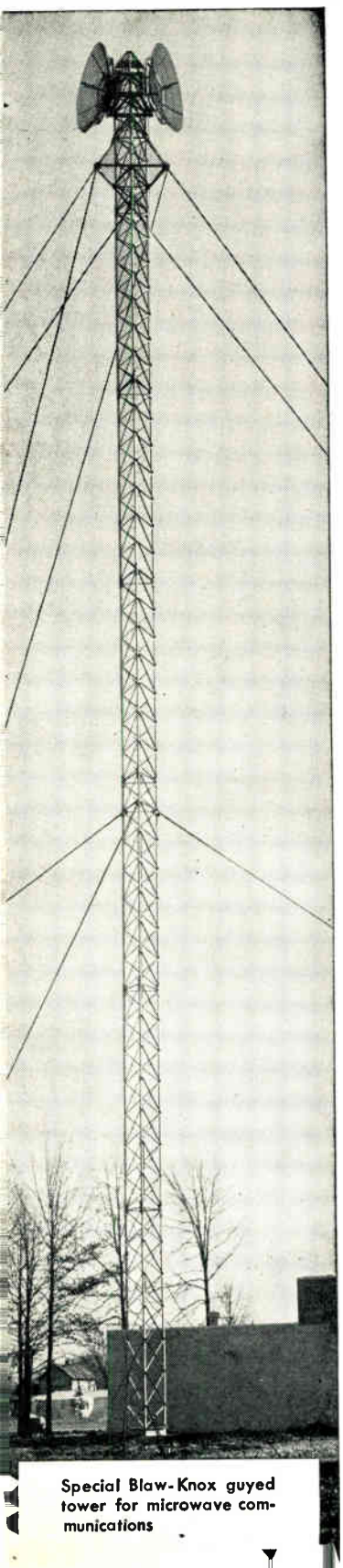
Advantages

The prime advantage of this system is in the extremely low cost

(*Continued on page* 116)

Planning better communications?

Microwave may be the answer ...and Blaw-Knox has the towers



Special Blaw-Knox guyed tower for microwave communications

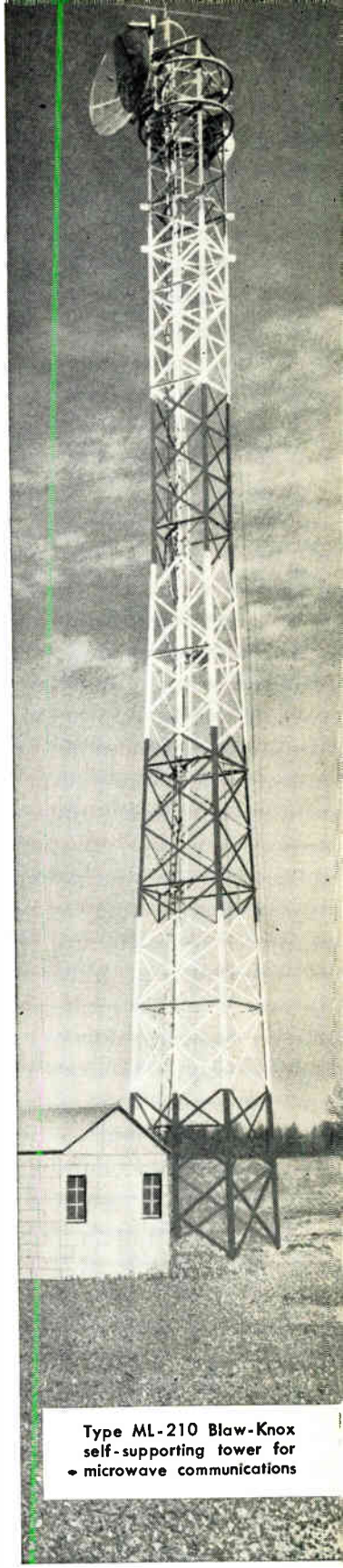
Improved service, reduced maintenance, and economy records of pioneer microwave installations are responsible for many companies planning new communications paths through the sky. Quite possibly, microwave can best answer your growth problems, and Blaw-Knox can best answer your tower questions.

Blaw-Knox Microwave Tower designs are based on more than 40 years of experience in building towers. For example:

- The first Blaw-Knox Towers, four 300′ self-supporting towers erected over 40 years ago in Alaska, still stand in good service.
- The world's first atom bomb was supported by a Blaw-Knox Tower, ushering in the Atomic Age at Alamogordo, New Mexico, in 1945.
- First electronic contact was made with outer space by a radar signal to the moon, beamed from a Blaw-Knox Tower.

From such varied experience as this, Blaw-Knox engineers are well qualified to design and engineer the type of tower system that will best meet your present and future requirements. Blaw-Knox Microwave Towers meet or surpass government standards and recommendations of the Radio-Electronics-Television Manufacturers Association for safety, wind loading and quality of construction.

Get the full story of Blaw-Knox Tower design, engineering and fabrication services. Write today for your free copy of new Bulletin 2538.



Type ML-210 Blaw-Knox self-supporting tower for microwave communications

BLAW-KNOX

BLAW-KNOX COMPANY
Equipment Division
Pittsburgh 38, Pennsylvania

MICROWAVE TOWERS
Guyed and self-supporting Microwave Towers, custom-built for each installation...and Transmission Towers...Antenna Towers—guyed and self-supporting for AM-FM-TV, Radar... parabolic antennas and other special structures

(*Continued from page* 114)

of setup and operation. Compared to photographic negatives, the Ozalid reversal foil is indeed inexpensive, costing approximately ten cents for an 8 x 10 in. sheet. The processing required may employ a conventional Ozalid machine or the manual method described.

The disadvantages of an arc-light source are avoided by using the inexpensive and safe sun lamp and filter. Four commercially available chemical compounds, a simple spinner, and a few processing trays constitute the remainder of the equipment.

All the processes involved can be easily performed in normal room light by relatively unskilled personnel. The quality of reproduction of the ink drawing is almost perfect and the overall process produces adequate results for all but the most exacting printed circuit fabrication. It is estimated that a complete setup suitable for model shop use (including about 2400 sq in. of copper clad laminate) can be obtained for less than $100. (Fig. 1)

Disadvantages

About the only disadvantages encountered in this system arise when extreme accuracy of reproduction is required. In these cases the photographic process which allows a 4:1 or greater reduction ratio from a large master drawing, may be desirable. However, this degree of accuracy is required only in a very small percentage of the cases. It should be noted that double side printed circuitry and through-plating of holes are no more difficult when using this process than they are in the conventional one.

The authors wish to thank Mr. William M. Martin for suggesting the use of electrolytic etching.

1 At present almost all known printed circuitry techniques employing the photo resist process use a carbon arc as a light source.

2. For further information on the photo resist process see Eastman Kodak Company's Bulletin, *Industrial Uses of Kodak Photo Resist.*

CALLING ALL INVENTORS. Professional or amateur inventors often have germs of ideas useful in solving current National Defense problems. Commerce Dept.'s National Inventors Council says civilians have contributed 200 life-saving and money-saving ideas since 1940. Write to NIC, Dept. of Commerce, Washington 25, for current copy of "Tech. Problems Affecting National Defense."

Personals

Alan R. Pearlman has been appointed Chief Engineer by Universal Atomics Corp., Westbury, L. I., N. Y.

John B. Suomala, Jr., of Concord, Mass., has joined the engineering staff of D. S. Kennedy & Co., Cohasset, Mass.

Charles E. Arnold appointed manager of Sylvania's Avionics Laboratory at Waltham, Mass.

W. Dale Fuller has been appointed Director of Research as part of the Varo Mfg. Company's technical expansion program. He was Chief Electronics Engineer for Engineering Laboratories, Inc.

W. D. Fuller

E. Weiss

Eric Weiss, formerly senior staff physicist for Hughes Aircraft Co., has joined the engineering staff of Daystrom Systems Div. of Daystrom, Inc. He will concentrate on the application and usage of computers in automatic systems.

Alfred H. Grebe is now Chief Research and Development Engineer for Filtors, Inc., Port Washington, L. I., N. Y.

Paul D. Rockwell has been appointed Assistant Engineering Director for Design Engineering for Page Communications Engineers, Inc., Washington 5, D. C.

Donald E. Brown will now serve as Chief Engineer for the Glendale Div. of Consolidated Electrodynamics Corp., Pasadena, Calif.

The appointments of **Dr. Rolf W. Peter** as Director of the Physical and Chemical Research Laboratory and **Allen A. Barco** as Director of the Systems Research Laboratory of RCA Laboratories were announced.

Lawrence L. Hardin, Jr., has accepted a position as Advance Design Engineer with Stavid Engineering, Inc., Plainfield, N. J.

Walter T. Runiewicz is now Chief Components Engineer, and **William D. Dunwody** is Chief Systems Engineer for Clifton Precision Products Co., Inc., Clifton Heights, Pa.

RCA DATA FOR

HOW TO BUILD EXTRA DEPENDABILITY INTO YOUR DESIGNS

To meet the ever-growing demand for high-quality tubes that will measure up to critical military specifications and exacting commercial applications—RCA "Premium" Tubes are controlled *in process*. Process control, rigidly monitored by 100% microscopic inspection of 24 categories of workmanship, constantly improves RCA "Premium" Tubes ... maintains RCA leadership in quality and reliability. In addition, RCA "Premium" Tubes are controlled for—shock—stabilization—glass strain—heater-cycling life—fatigue—and low-frequency vibration. For reliable circuitry—under *tough* conditions of vibration, impact, humidity, and wide temperature variations—back your designs with RCA "Premium" Tubes. Check the chart for the types you need.

HANDY FACT BOOK ON RCA TUBES FOR DESIGNERS

Fast reference guide (RIT-104) includes technical data, socket diagrams, and descriptians an all RCA "Premium" and Special Red Tubes ... plus camputer, pencil, glaw discharge, small thyratrans, low micraphanic, and ather tube types especially suited far industrial and military applicatians. Far yaur capy, mail the caupan an next page.

RCA "PREMIUM" AND "SPECIAL RED" TUBES

—to meet Military Specifications and Critical Commercial Applications

RCA "Premium" Tube Type No.	Prototype No.▲	GOVERNMENT INSPECTED PRODUCT			
		Military Type No.	Applicable Military Specification	Qualification Approval Certificate No.	Point of Mfr.**
0A2-WA	0A2	JAN 0A2-WA	Mil-E-1/290A	20255A	W
0B2-WA	0B2	JAN 0B2-WA	Mil-E-1/291	20256A	W
2D21-W	2021	JAN 2021-W	Mil-E-1/756	N-4220	W
6AC7-W	6AC7	JAN 6AC7-W	Mil-E-1/354	N-3299	H
6J4-WA	6J4	USN 6J4-WA	Mil-E-1/619C (Navy)	BuShips Ltr 4/26/55	W
12AT7-WA	12AT7	JAN 12AT7-WA	Mil-E-1/3A	21058	H
5636	6AS6	JAN 5636	Mil-E-1/168C	20936	H
5636-A	6AS6	USN 5636-A	Mil-E-1/715A (Navy)	BuShips Ltr 8/24/56	H
5654	6AK5	—	—	—	—
5654/6AK5-W	6AK5	JAN 5654/6AK5-W	Mil-E-1/4 Mil-E-1/4A	A-1941	H
5654/6AK5-W/6096	6AK5	JAN 5654/6AK5-W/6096	Mil-E-1/236	20767	H
5690†	—	USN 5690	Mil-E-1/489 (Navy)	BuShips Ltr 4/28/55	H
5691†	6SL7-GT	JAN 5691	Mil-E-1/133A	N-3623	H
5692†	6SN7-GT	JAN 5692	Mil-E-1/134A	N-3621	H
5693	6SJ7	JAN 5693	Mil-E-1/81A	N-3624	H
5718	—	JAN 5718	Mil-E-1/172B	20775	H
5718-A	—	USN 5718-A	Mil-E-1/681 (Navy)	BuShips Ltr 8/4/55	H
5719	—	JAN 5719	Mil-E-1/173C	20793	H
5719-A	—	USN 5719-A	Mil-E-1/682 (Navy)	BuShips Ltr 8/4/55	H
5725	6AS6	—	—	—	—
5726	6AL5	—	—	—	—
5726/6AL5-W	6AL5	JAN 5726/6AL5-W	Mil-E-1/7A	A-1929	H
5726/6AL5-W/6097	6AL5	JAN 5726/6AL5-W/6097	Mil-E-1/235A	20055	H
5727/2021-W	2021	JAN 5727/2D21-W	Mil-E-1/83	20293	W
5749	6BA6	—	—	—	—
5751	12AX7	JAN 5751	Mil-E-1/10	A-1989	H
5751-WA	12AX7	JAN 5751-WA	Mil-E-1/237	20452	H
5814-A	12AU7	JAN 5814-A	Mil-E-1/12A	A-4131	H
5814-WA	12AU7	JAN 5814-WA	Mil-E-1/238A	20472	H
5840	—	JAN 5840	Mil-E-1/140B	20011A	H
5840-A	—	USN 5840-A	Mil-E-1/72C (Navy)	BuShips Ltr 8/20/54	H
6073	0A2	—	—	—	—
6074	0B2	—	—	—	—
6080-WA	6AS7-G	USN 6080-WA	Mil-E-1/510B (Navy)	BuShips Ltr 8/26/55	H
6099*	6J6	USAF 6099	USAF Exhibit WCL-582	—	H
6101	6J6	—	—	—	—
6101/6J6-WA	6J6	JAN 6101/6J6-WA	Mil-E-1/243A	A-4198	H
6186/6AG5-WA	6AG5	JAN 6186/6AG5-WA	Mil-E-1/244A	20200	H
6189/12AU7-WA	12AU7	JAN 6189/12AU7-WA	Mil-E-1/246A	20297	H
6201	12AT7	—	—	—	—
6205	5840	JAN 6205	Mil-E-1/140B	20954	H

NOTES: †"Special-Red" Tubes. **H=Harrison, N. J. W=Woodbridge, N. J.
*This type is intended for special Air Force application only. For other military uses, the 6101/6J6-WA is recommended.
▲Premium versions may differ from their prototypes in electrical characteristics, physical structure, or types of tests to which they are subjected. Tube data should, therefore, be checked before replacing a type in the prototype column with the listed "Premium" type.

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DESIGNERS

LONG-TERM POWER DELIVERY —with RCA Power Tubes

The remarkable endurance of RCA Power Tubes in commercial and military applications is related to tube designs that have withstood the tests of practical equipment operation for many years. RCA Power Tubes are available in a complete range of plate-input powers and frequency ratings. Some typical power types are pictured here.

BEAM POWER TUBES
RCA-2E26 RCA-6893

30 watts CW input to 125 Mc and 20 watts at 175 Mc (CCS) — identical CCS and ICAS ratings (except heater) for both types. For 6.3-v. heater circuits, specify RCA-2E26. For 12.6-v. specify RCA-6893.

POWER TUBE ANSWER BOOK

RCA Transmitting Tube Manual TT-4
(Types up to 4 Kw Plate Input)

256 fact-filled pages covering 108 power tube types and 13 rectifiers. Includes theory, data, installation, application, and circuits.

See coupon below.

BEAM POWER TUBES
RCA-6146
RCA-6159
RCA-6883

67.5 watts CW input to 60 Mc and 45 watts at 175 Mc (CCS) — identical CCS and ICAS ratings (except heater) for all three types. For 6.3-v. heater circuits, specify RCA-6146. For 12.6-v. specify RCA-6883. For 26.5-v. specify RCA-6159.

1 MEGAWATT INPUT TO 75 MC!

New RCA-6949 Super Power Triode

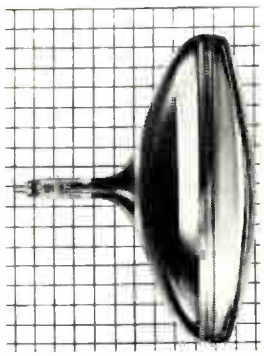
RCA-6949 is a water-cooled, shielded-grid beam triode capable of generating useful continuous rf power in the order of 500,000 watts — with high efficiency and exceptionally low driving power. It can be used as a class C rf power amplifier (modulated or unmodulated), and as a linear rf power amplifier in single-sideband service. It can provide the rf power needed for nuclear particle accelerators.

RCA-6161
POWER TRIODE

400 watts CW input to 900 Mc
250 watts CW input to 2000 Mc

NEW AF TRANSISTOR PROVIDES HIGH POWER GAIN AT LOW DISTORTION AND WITH HIGH EFFICIENCY

RCA-2N270...an hermetically sealed, alloy-junction transistor of the germanium p-n-p type... is designed especially for use in large-signal audio-frequency circuit applications in home-entertainment radio sets, phonographs, and battery-operated communications equipment. In class A service, one RCA-2N270 can deliver a maximum-signal power output of approximately 60 milliwatts with a power gain of 35 db. In push-pull class B service, two 2N270's can deliver a maximum-signal power output of approximately 500 milliwatts with a power gain of 32 db. Low collector saturation current permits design of af amplifiers which can operate under varying ambient temperature conditions and, at the same time, provides both high efficiency and a high degree of operating stability. Current transfer ratio of 2N270 is nearly constant over the full range of the output-signal swing, even when the peak output-signal current reaches the peak collector current rating. This feature minimizes distortion at high power outputs when low supply voltages are used.



1 square = 1 inch

DESIGN SLIMMER TV SETS WITH NEW RCA-17BZP4 110° TUBE

- Only 12-9/16" long
- No Ion-Trap Magnet Needed
- Super-Aluminized
- Weighs Only 10 lbs.

Designed specifically for large-screen TV sets in slimmer, lighter-weight cabinets, this 17"-type rectangular glass picture tube is actually 3" shorter than types having the same size faceplate and 90° deflection. "Straight-type" gun has improved focus and eliminates the need for an ion-trap magnet.

Do you want an RCA TT-4 Manual...or more technical data on items listed below? Just check the item in the coupon and mail to:

RCA, Commercial Engineering
Sec. D50R, Harrison, N. J.

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**Bulletin in preparation*

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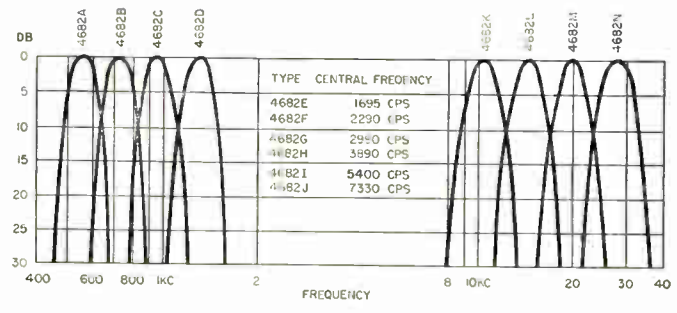
RADIO CORPORATION of AMERICA
Tube Division, Harrison, N. J. Semiconductor Division, Somerville, N. J.

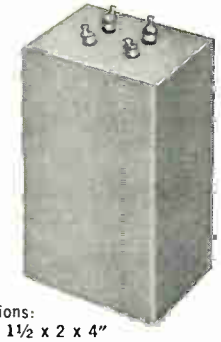
OUR MILLIONTH FILTER SHIPPED THIS YEAR...

FILTERS
FOR EVERY APPLICATION

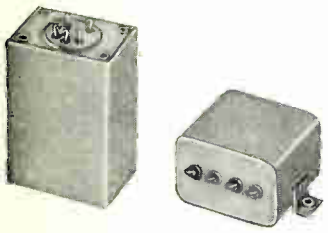
TELEMETERING FILTERS

UTC manufactures a wide variety of band pass filters for multi-channel telemetering. Illustrated are a group of filters supplied for 400 cycle to 40 KC service. Miniaturized units have been made for many applications. For example a group of 4 cubic inch units which provide 50 channels between 4 KC and 100 KC.

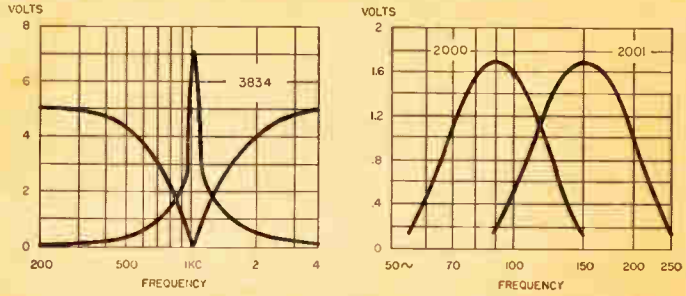




Dimensions:
(4682A) 1½ x 2 x 4"



Dimensions:
(3834) 1¼ x 1¾ x 2-3/16".
(2000, 1) 1¼ x 1¾ x 1⅝".



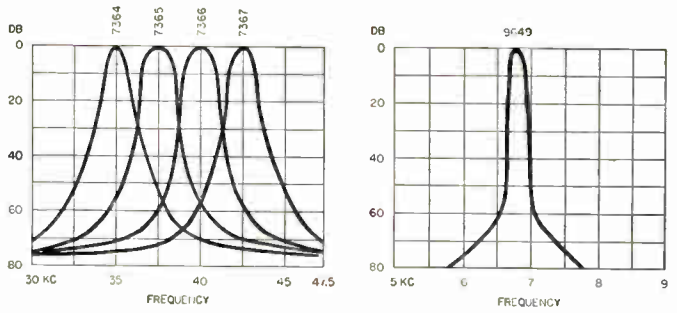
AIRCRAFT FILTERS

UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

CARRIER FILTERS

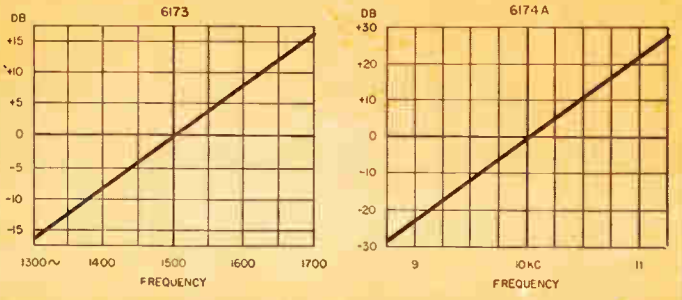
A wide variety of carrier filters are available for specific applications. This type of tone channel filter can be supplied in a varied range of band widths and attenuations. The curves shown are typical units.



Dimensions:
(7364 series) 1⅝ x 1⅝ x 2¼".
(9649) 1½ x 2 x 4".

DISCRIMINATORS

These high Q discriminators provide exceptional amplification and linearity. Typical characteristics available are illustrated by the low and higher frequency curves shown.



Dimensions:
(6173) 1-1/16 x 1⅜ x 3".
(6174A) 1 x 1¼ x 2¼".

For full data on stock UTC transformers, reactors, filters, and high Q coils, write for Catalog A.

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"

Helping Hand

Not long ago, a plane en route from Hawaii radioed a distress call that a fire aboard had disrupted its navigational aid system. FCC monitoring stations obtained bearings which enabled the Coast Guard to guide the plane to safety. Monitoring fixes also helped to bring in a military transport plane which developed engine trouble while nearing this country from the Azores. Through the same means, a lost Navy plane was directed to a landing in Bermuda with less than an hour's supply of fuel left.

Marine Filtering

(*Continued from page* 57)

the receiver, consists pricipally of establishing the background noise level by disconnecting the antenna and adjusting the r-f gain control to obtain a value of −10 db on the output meter, reconnecting the antenna and recording the ambient interference, energizing the equipment to be tested and recording the meter reading at the interference level. In tests of this type, the Navy Department considers interference objectionable when the measured interference is 3 db greater than the ambient interference. The Army considers any interference exceeding the permissible levels cited in MIL-S-13237 as objectionable.

Prior to the initiation of tests, all of the 25 potential interference producing devices installed aboard the craft were placed in operation and examined to determine adequate functioning. It was found that the 24 v. dc battery charging system of the 5 kw engine-generator, the 2 kw motor generator set, and the heater were not operating in a satisfactory manner. For this reason, these devices were not included in the test program; however, because of the large number of equipments which were tested, the effect of the omission of these items were considered negligible.

(*Continued on page* 122)

(*Continued from page* 121)

Test Results

The initial test results revealed that no objectionable interference was present over the frequency range of 14 KC to 0.15 MC and 220-400 MC as measured by the Navy equipments. The tests also revealed that the 120 v dc ship's generator and the tachometer of the two main engines emanated objectionable interference. This interference was present over the frequency range of 0.15 to 32.0 MC when measured with both Army and Navy equipments. The interference from the generator was traced to a broken capacitor lead at a generator brush and the omission of capacitors at the generator output terminals which, when corrected, attenuated the interference to an unobjectionable level on both Navy and Army equipments. The tachometer interference was found to be emanating from the 2 input and 4 output leads. The application of 0.1 μf by-pass capacitors at the input leads and 0.22 μf by-pass capacitors at the output leads satisfactorily attenuated this interference on all equipments.

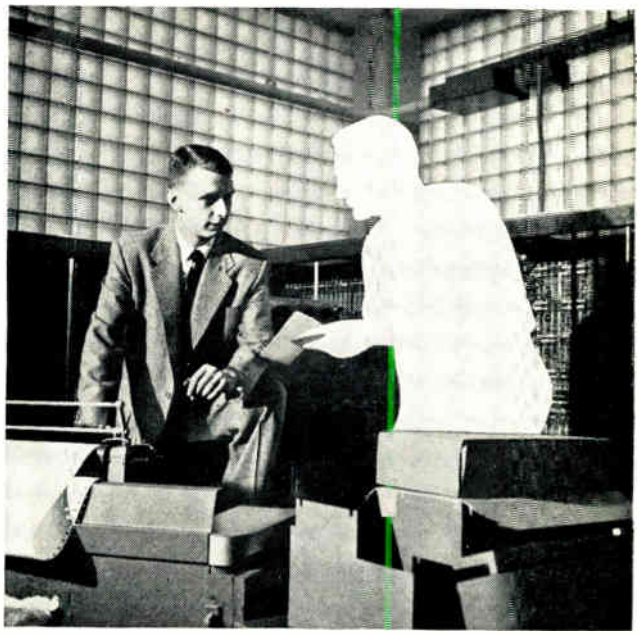
The next series of tests consisted of removing the suppression capacitors from 6 motors. The purpose of these tests was to determine if the motors were actually emanating interference, the degree of interference emanated, and the relative effectiveness of capacitors. Test results on both Army and Navy equipments revealed highly objectionable interference in the range of 0.15 to 32.0 MC. Of greater importance, interference of only a negligible level was present in the frequency range of 14-150 KC.

The last series of tests were performed with the positions of the low and medium frequency range Navy receivers interchanged and with 40 ft. horizontal wire antenna replacing the 9 ft. vertical whip. The receivers were interchanged to determine if interference in the VLF range could be detected in any other location. The horizontal antenna was used to simulate actual operating conditions aboard larger craft. The results of these tests indicated no substantial differences in the interference level compared

(*Continued on page* 124)

IBM GROWTH promoted these men

Research Engineer: Before his recent promotion, this man was a member of a small research team comprising three E.E.'s and a technician. His specific project entailed the creation of a transistorized electronic converter combining both digital and analog circuitry. "Research is really on the move at IBM," he says. "Personnel has increased ten-fold since 1950 and we expect to maintain this pace for some time."



Manufacturing Engineer: Also promoted recently, this man worked in one of IBM's many manufacturing plants. He was responsible for the analysis, design and procurement of equipment and facilities to produce the giant IBM electronic computers. "In a field as new as electronic computers," he'll tell you, "*unique* manufacturing equipment is often imperative. Creating this new equipment is a real challenge to an engineer's ingenuity."

Could you handle their responsibilities?

Jobs like these continually open up at IBM—due to rapid expansion. If you are an engineer or scientist—or have equivalent experience—you may be qualified for such a position. Innumerable opportunities exist in:

- Computer systems planning
- Computer systems testing
- Electronic circuit design and packaging
- Electrostatic phenomena
- Manufacturing process control
- Numerical analysis and programming
- Photo and magnetic device memory
- Real time systems engineering
- Semi-conductor research, development, and manufacturing
- Test equipment design

The electronic computer field offers one of the best ground-floor career opportunities today. Economic experts rank it with automation and nucleonics in growth potential. Sales at IBM, the recognized leader in this fast-growing field, have doubled, on the average, every five years since 1930. Engineering laboratory personnel has quintupled in the past five years. IBM's excellent salary and employee benefit program is instrumental in achieving an employee turnover rate far below the national average.

IBM DATA PROCESSING

DATA PROCESSING
ELECTRIC TYPEWRITERS
TIME EQUIPMENT
MILITARY PRODUCTS

Where would you like to work for IBM?

IBM plants and laboratories are located in:

Endicott, Kingston, New York City, Owego, Poughkeepsie, N. Y.; Burlington, Vt.; San Jose, Calif.; Washington, D. C.; Greencastle, Ind.; Lexington, Ky.; Rochester, Minn.; Sherman, Texas. Branch offices in 189 cities throughout the U.S.A.

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State_____

Experience and/or educational background_____

Circle 82 on Inquiry Card, page 97

(*Continued from page* 122)

to data obtained from tests conducted prior to the change of location.

Summarizing the test results, it was indicated that when the interference producing devices of a typical Army boat was equipped with by-pass type capacitors and power cable shielding, the grounding of which was ignored, adequate attenuation was furnished over the frequency range of 14 KC to 1000.0 MC.

Conclusions

The fact that no objectionable interference was recorded over the frequency range of 14 KC to 1000 MC by typical Navy communication receivers covering the frequency range of 14 KC to 32 MC and 220 to 400 MC and by Army test equipment covering the frequency range of 0.15 to 1000.0 MC when by-pass capacitors are properly used, even though the grounding of the power cable shielding was ignored, is of value to the procurement agencies and their contractors in possible evaluation of their interference reduction requirements. Of great interest to the interference reduction engineer, is the reason for and application of these results. A recent investigation conducted by the Navy Department is significant in this connection. This investigation consisted of a series of comparative interference tests on two identical wooden hull ships; one equipped with grounded metal sheathed electrical wiring and the other with unarmored cabling. The results of these tests proved that approximately 35 db shielding effect was furnished by the armored cable at frequencies below 2 MC and that this effect decreased to about 10 db at frequencies above 15 MC. The tests also indicated that direct radiation from the electrical machinery itself was not the most important factor but that the coupling of the interference emanating from the machinery to the wiring and thence to the receiving antennas contributed more than expected to the interference problem.

Although the armor of the cables was not grounded in the patrol

(*Continued on page* 126)

POLARAD

TV EQUIPMENT FOR STUDIO and LABORATORY

WIDE BAND VIDEO AMPLIFIER

10 cps to 20 mc

An oscilloscope deflection amplifier for measuring and analyzing pulses! Extremely wide band with extended low frequency response down to 10 cps. Will accurately analyze television signals. Excellent to increase the amplitude range of your vacuum tube voltmeters and signal generators.

MODEL VT

The Polarad Wide Band Video Amplifier offers an extremely wide band coverage flat within ±1½ db from 10 cycles to 20 megacycles per second. It has a time delay of 0.02 microseconds and assures extreme stability because of its associated electronically regulated unit. A low capacity input probe is provided.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

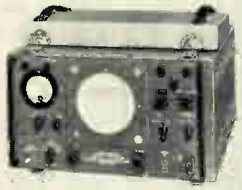
TV STUDIO MONITOR

MODEL M-105

MODEL M-105

The Polarad Model M-105 is portable — comes in sturdy aluminum case, can be rack mounted as well! And it is one of the finest instruments available to check the picture quality of video signals. Equipped with 12½" aluminized kinescope, capable of presenting highest definition transmitted pictures with exceptionally good "sync" stability over a wide range of operating conditions.

PORTABLE TV WAVE FORM MONITOR



MODEL TO-1

EXCELLENT FOR SUBCARRIER MEASUREMENTS

LOOK AT THESE FEATURES:

1. Can be rack mounted.
2. Can be used for both color and black and white TV.
3. Vertical Amplifier Bandwidth Switch for 2MC, 4MC, 6MC.
4. Special TV Sync. Circuits.
5. Horizontal Sweep Magnification 20 Tube Diameters.
6. Compact and Rugged.

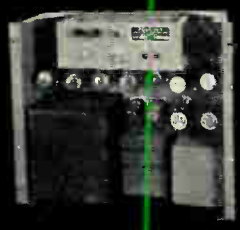
VERTICAL MOUNT REGULATED POWER UNITS

Here are electronically regulated power units completely accessible from the front and back because of their vertical mount design. They have extremely fine regulation, low ripple content and appreciable quantities of D. C. power.

MODEL PT-110

SPECIFICATIONS

	Model PT-110	Model PT-111
Output Voltage DC	400-450 Volts	250-300 Volts
Output Current	156-235 ma	100-400 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 12 mv rms	Less than 8 mv rms
Negative Supply	—150 V DC; 20 ma	—150V DC; 10 ma
Filament Supply	a. 6.3V @ 12 a b. 6.3V @ 12 a	a. 6.3V @ 12 a AC b. 6.3V @ 12 a
Power Input	105-125V 50/400 cps	105-125V 50/400 cps



MODEL PT-112

SPECIFICATIONS

	Model PT-111D Dual power unit, each side provides:	Model PT-112
Output Voltage	250-300 V DC	250-300 V DC
Output Current	100-400 ma	150-800 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 8 mv rms	Less than 8 mv rms
Line Voltage	105-125V, 50/400 cps	105-125V 50/400 cps
Series Operation Output Power	500-600 Volts 100-400 ma	
Parallel Operation Output Power	250-300 Volts 200-800 ma	

These features assure dependable, highest quality performance:

- Precise electronic voltage regulation
- Low ripple content
- Does not utilize electrolytic condensers
- Sturdy construction
- Provisions for rack mounting.

Polarad manufactures a complete line of color TV equipment including a Color Slide Scanner, Sync Generator, Bar Generator and Color Monitors.

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION** 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

REPRESENTATIVES: Albany, Albuquerque, Atlanta, Baltimore, Boston, Chicago, Cleveland, Dayton, Denver, Englewood, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, Rochester, St. Louis, San Francisco, Schenectady, Stamford, Syracuse, Washington, D. C., Winston-Salem, Canada: Arnprior, Ontario.
Resident Representatives in Principal Foreign Cities

(*Continued from page* 124)

boat jointly investigated, the very fact that the armor existed undoubtedly is the reason for the results that were obtained below 0.150 MC. In addition, the increased shielding effect obtained at the very low frequencies from grounding the cables is believed inconsequential in comparison to that obtained from the armor itself. The use of armor on power cable was originally intended for mechanical protection and since the advent of improved power cable insulation, it is now possible that unarmored cable will be considered in the near future. However, before such action is initiated, the effectiveness of the armor for suppression purposes must be considered and the economics of its removal carefully weighed against the cost of the resultant suppression measures required to obtain the same degree of attenuation.

Acknowledgement

The kind cooperation of the Bureau of Ships, U. S. Navy Department, is acknowledged in facilitating the tests performed in the joint investigation.

References

"Effect of Power Cable Armor on Radio Interference from Electrical Machinery," Navy Dept., BuShips, Code 960.

"Radio Interference Suppression Techniques," Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

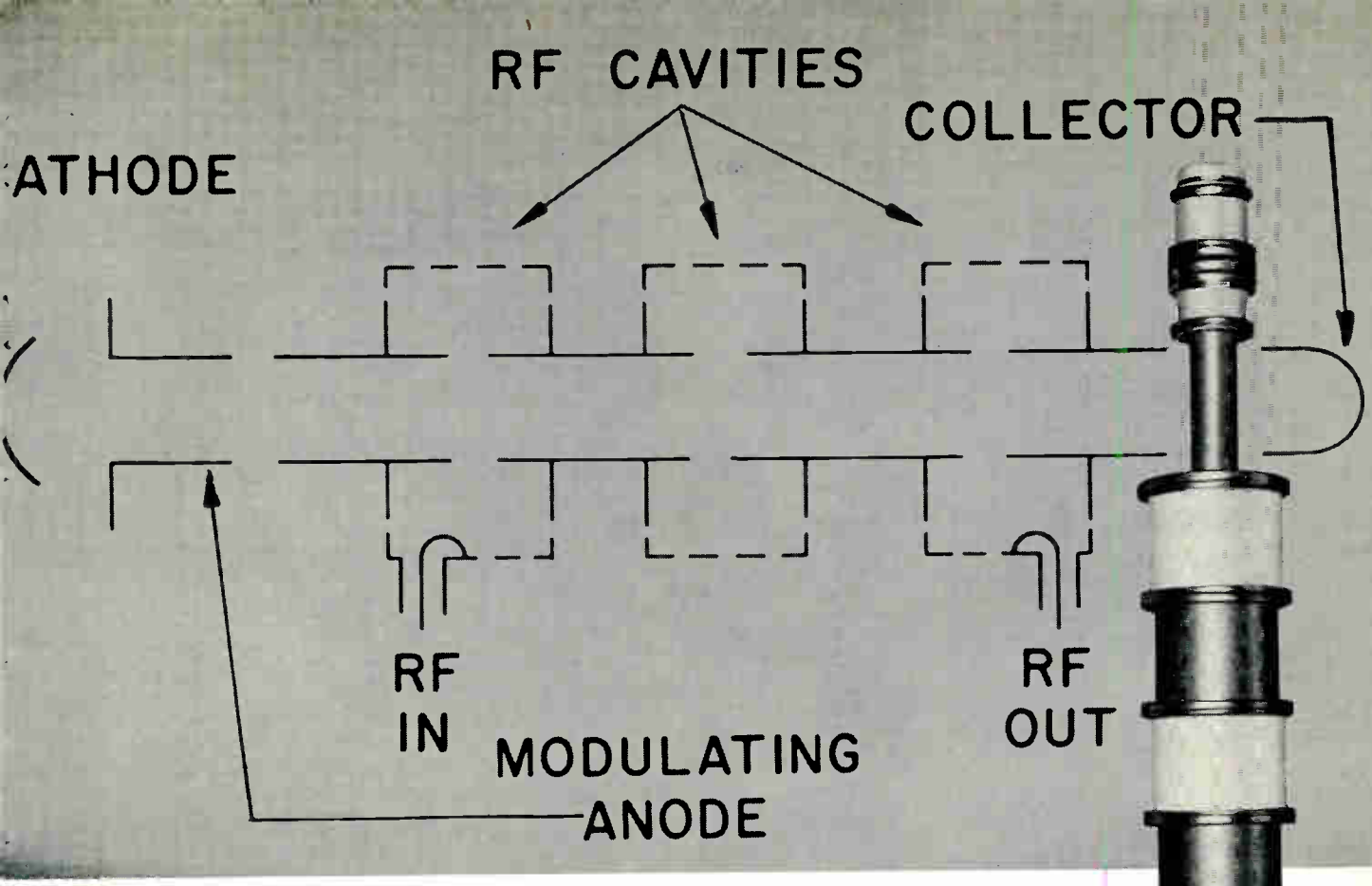
High Efficiency Feature of New Memory

Consisting basically of thin, printed plates of special magnetic material perforated with small holes, this new memory device can store over a million bits in a space the size of a shoe box.

Moreover, the new device lends itself to extremely simple molding production techniques, in contrast to the relatively complex threading of thousands of tiny cores onto a wire matrix to produce the presently used magnetic core devices.

Providing a compact and economical memory for small computing equipment, this development should permit the design and construction of larger and more versatile systems.

Dr. Jan A. Rajchman, RCA scientist who also developed the RCA high-speed magnetic core system, directed the research group responsible for this latest development.



AVAILABLE NOW!
Eimac high power klystron for 225-400 mc range

Eimac has spanned another frequency range . . . 225-400 mc with its new 3KM50, 000PA ceramic klystron. This tube, designed for the VHF/UHF border junction, will deliver 20KW CW power output with as low as one watt drive and an efficiency of 45%. This high efficiency and power gain of 20,000 times is typical of the incomparable performance of Eimac Klystrons.

Eimac has also incorporated the modulating anode which gives the 3KM50, 000PA 100 percent modulation ability to peak power outputs of 40 KW. It can easily be pulse modulated with low pulsing power.

Wide range tuning and an easy economical approach to high power UHF transmitters is made possible by the Eimac feature of completing RF circuitry outside the vacuum system. These permanent components, available at Eimac, make for ease of tube change plus economy since costly RF circuitry is not repurchased with each tube replacement.

For further information on the 3KM50, 000PA, as well as other Eimac firsts, please consult our Application Engineering Department.

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA
Eimac First in high power amplifier klystrons

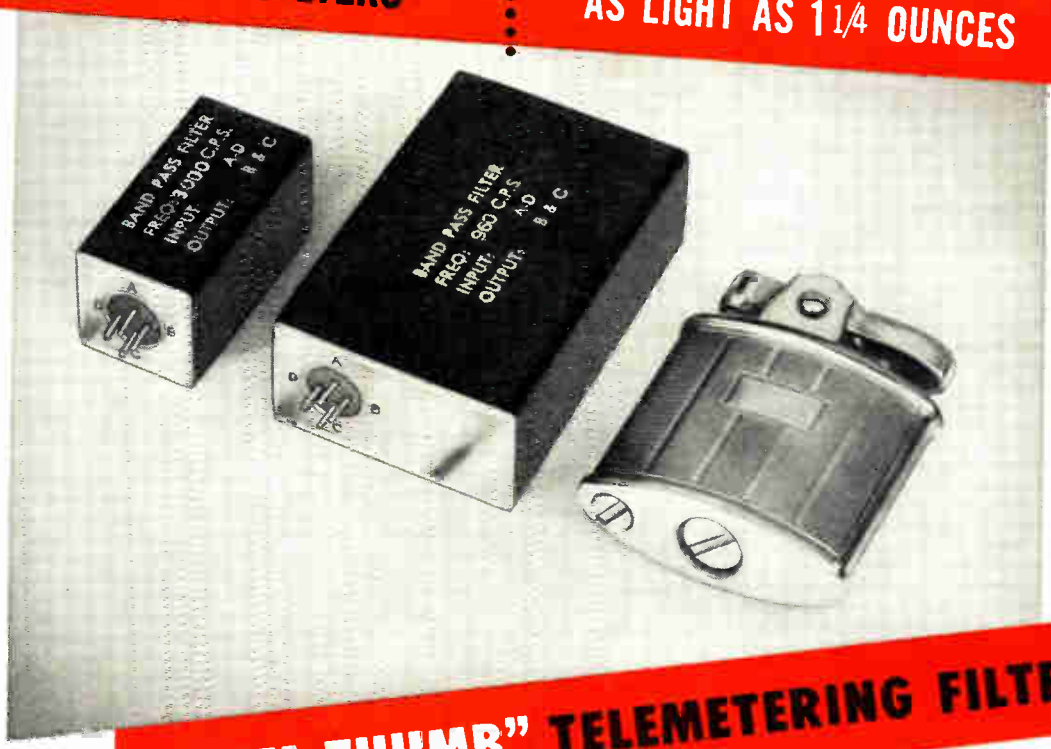
Eimac

Typical Operation of the 3KM50, 000PA

D-C Beam Voltage	20kv	Driving power	1w
D-C Beam Current	2.2 amps	Efficiency	45%
Power input	44kw	Power Gain	43db
[illegible]	20kw		

Burnell SUBMINIATURE FILTERS

AS SMALL AS 3/4" x 3/4" x 1 3/8"
AS LIGHT AS 1 1/4 OUNCES



"TOM THUMB" TELEMETERING FILTERS

CHAN. #	FREQ.	IMP. 100K P/N	B. W.	SIZE	WT.
1	400 cps.	S-60001	±7½%	¾ x 1½ x 2¼ H	4 oz.
2	560 cps.	S-60002	±7½%	¾ x 1½ x 2¼ H	4 oz.
3	730 cps.	S-60003	±7½%	¾ x 1½ x 2¼ H	4 oz.
4	960 cps.	S-60004	±7½%	¾ x 1½ x 2¼ H	4 oz.
5	1300 cps.	S-60005	±7½%	¾ x 1½ x 2¼ H	4 oz.
6	1700 cps.	S-60006	±7½%	¾ x 1½ x 2¼ H	4 oz.
7	2300 cps.	S-60007	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
8	3 KC	S-60008	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
9	3.9 KC	S-60009	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
10	5.4 KC	S-60010	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
11	7.35 KC	S-60011	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
12	10.5 KC	S-60012	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
13	14.5 KC	S-60013	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
14	22 KC	S-60014	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
15	30 KC	S-60015	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
16	40 KC	S-60016	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
17	52.5 KC	S-60017	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
18	70 KC	S-60018	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
A	22 KC	S-60019	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
B	30 KC	S-60020	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
C	40 KC	S-60021	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
D	52.5 KC	S-60022	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
E	70 KC	S-60023	±15%	¾ x ¾ x 1⅜ H	1¼ oz.

Designed and tested to specification =MIL-T 26985

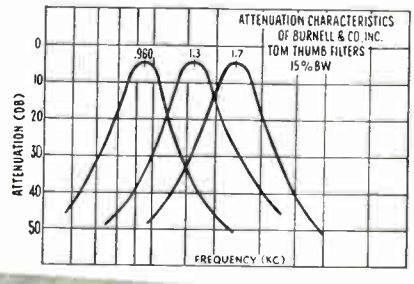
Supplied in two principal case sizes:

1. For RDB channels 1 through 6, case size is ¾ x 1½ x 2¼ inches high; weight: 4 ounces.
2. For channels 7 and up, case size is ¾ inches square and 1⅜ inches high; weight: 1¼ ounces.

These cases are generally equipped with a 4-pin plug to match the small Winchester socket.

ATTENUATION CHARACTERISTICS

Impedance: 100 K ohms in and out.
Insertion loss: less than 6 db.
At ± 7.5% band width is less than 3 db.
At ± 25% band width is greater than 15 db.
At 1.75 f attenuation is 40 db or more.
At .57 f attenuation is 40 db or more.



Burnell & Co. Inc.

45 WARBURTON AVENUE • YONKERS 2, N. Y. • YONKERS 5-6800

PACIFIC DIVISION • 720 MISSION STREET • SOUTH PASADENA, CALIFORNIA • RYAN 1-2841

LR Audiotape is available in the following reel sizes and lengths:

5" reel	900 ft.
7" "	1800 ft.
10½" "	3600 ft.
14" "	7200 ft.

Sound advice for every recordist who wants...

TIME-AND-A-HALF for OVERTIME*

***When recording time runs over the capacity of your machine, you can increase it by 50% with these two types of**

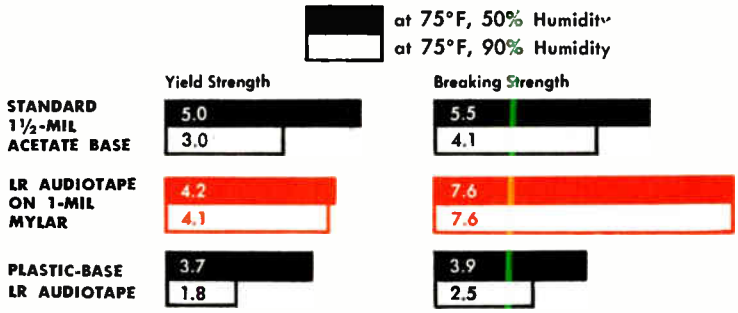
Longer LR recording audiotape TRADE MARK

- *One for maximum strength*
- *One for maximum economy*

If you've ever been faced with the problem of changing reels before a program is over, you know that this kind of "overtime" can be very frustrating. You either have to *interrupt* the performance, or *loose* part of it.

Fortunately, however, LR Audiotape offers a simple solution to the problem. It gives you *50% more recording and playback time on a single reel* — equal in footage to a reel-and-a-half of standard plastic-base tape. LR Audiotape also assures you of the same performance and quality that make Audiotape the first choice of professional recordists the world over.

The same coating formula is used on both types of LR. The only difference is in the base material. LR Audiotape on 1-mil Mylar* gives you high strength, immunity to heat and moisture, and freedom from embrittling with age. As shown by the chart below — it is actually stronger at high humidity than standard 1½-mil plastic base tape. Plastic-base LR Audiotape gives you the same longer recording time on a low-cost 1-mil cellulose acetate base, providing maximum economy for uses where high strength is not required.



Whatever the requirements of your "overtime" recording jobs, ask for LR Audiotape. For information on the complete Audiotape line — five different types for every recording need — write for Bulletin No. 250.

**DuPont Trade Mark*

audiotape *it speaks for itself*

manufactured by **AUDIO DEVICES, INC., 444 Madison Ave., New York 22, N.Y.**

In Hollywood: 1006 N. Fairfax Ave.
In Chicago: 5428 Milwaukee Ave.
Export Dept.: 13 East 40th St., N.Y. 16, N.Y.
Cables "ARLAB"

Coming Events

(*Continued from page* 12)

May 15-17: **Annual Conv.** sponsored by RETMA; at the Sheraton Hotel, Chicago.

May 15-17: **I. C. A. Convention,** sponsored by Industrial Communications Association; in Atlantic City, N. J.

May 19: **Annual Meeting,** sponsored by the NEDA; at the Conrad Hilton, Chicago.

May 20-22: **Armed Forces Communication & Electronics Asoc. Conv. & Exhibits,** sponsored by IRE; at the Sheraton Park Hotel, Washington 8, D. C.

May 20-23: **Electronics Parts Distributors Show;** at the Conrad Hilton Hotel, Chicago.

May 20-24: **Design Engineering Show;** at the Coliseum, N. Y.

May 23-25: **Spring Meeting,** sponsored by the Acoustical Society of America; in New York City.

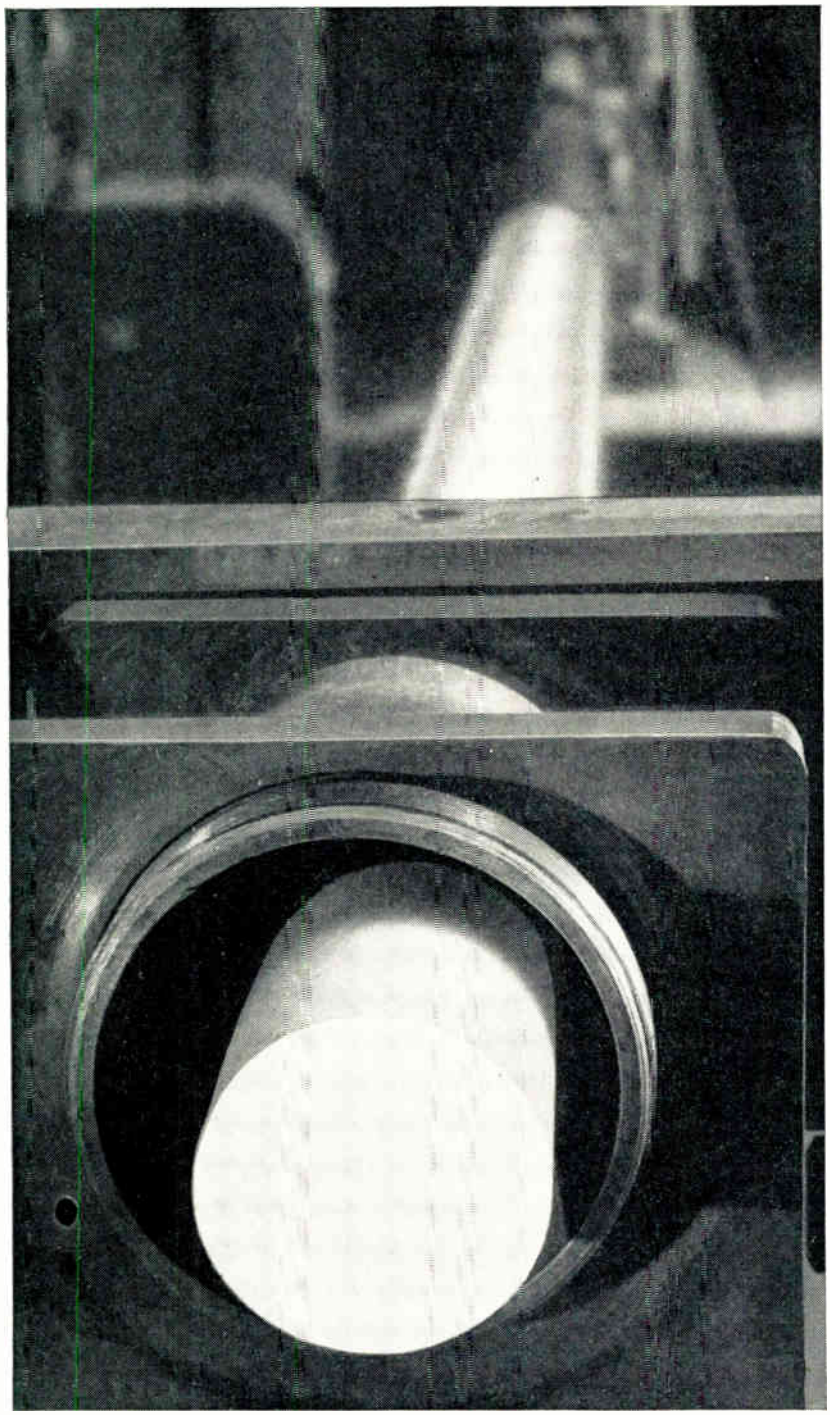
May 22-24: **11th National Convention,** sponsored by the American Society for Quality Control; in Detroit, Mich.

May 26-29: **49th Annual Convention,** sponsored by the National Association of Electrical Distributors; at the Sheraton Park Shoreham Hotels, Washington, D. C.

May 27-29: **National Telemetering Conf.,** sponsored by AIEE, ISA, IAS; at the Hotel Cortez, El Paso, Texas.

Flame-Powered Radio

Philips Research Laboratories, Netherlands, have designed this transistorized broadcast receiver and thermopile power supply. The thermopile is made of 192 chromel-alumel thermocouples. The hot junctions project into a chimney placed over a kerosene lamp. The cold junctions are outside, exposed to ambient temperatures. Internal pile resistance is 5 ohms, and the 180 degree Centigrade difference obtained in use can produce over 200 milliwatts— more than sufficient to operate the seven-transistor radio and give speaker output.

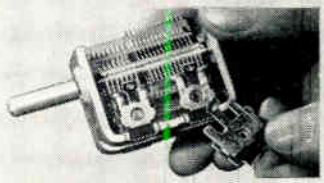


FAMOUS NYLON JOINS NATIONAL'S MATERIALS FAMILY. Proved in thousands of tough applications, versatile Nylon now becomes more useful to the designer than ever. National makes it so in extruded rods and 100% usable finished fabricated parts. Standard rod sizes range from ¼" through 2" in 3 and 6-foot lengths. Inquiries on other sizes and shapes are invited. National's expert engineering counsel assures the commercial soundness and economy of your product. And men, machines and capacity place National in a unique position to serve your immediate needs.

NATIONAL CAN HELP YOU reduce unit product cost or improve product performance at no added cost. Here's why: You can select the "one best material" from over 100 grades of PHENOLITE®, Vulcanized Fibre and NATIONAL Nylon—*without compromise in* properties or cost. You can simplify production and purchasing with the *timed delivery* of 100% usable parts—*from a single reliable source.* You gain competitively with National's new materials and grades *—the direct results of programmed materials-research.*

You benefit by calling National first. Check Sweet's PD File 2b/Na, the Telephone Directory Yellow Pages, or write Wilmington 99, Delaware, Dept. E.

INTRODUCING 5 NEW superior PHENOLITE® Laminated Plastic Grades:

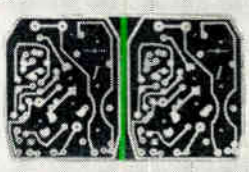


E-2040—A new low cold flow, hot punching paper base grade with good dielectric strength.

Y-2500—A good arc resistant paper base grade with excellent flame resistance plus superior punching and shaving characteristics.

G-8-881—A melamine bonded glass mat grade with excellent flame and arc resistant characteristics and good flexural and impact strength. Has high dimensional stability under humid conditions.

G-7-3604—A new thick-walled silicone fiber glass tubing material with exceptional heat resistance and electrical properties.



G-10-865—A new epoxy resin-bonded glass cloth sheet laminate with very low water absorption and excellent electrical properties.

THESE FIVE NEW PHENOLITE GRADES bring to over 80 the number of standard and special grades of this versatile laminated plastic.

NATIONAL
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KENNEDY INTRODUCES

the 28 foot "TUF-SCAT" *antenna*

This new scatter antenna is specifically designed for the world's toughest weather conditions. Recently static load tested with over 32 tons (105 lbs./sq. ft.) on its surface, this big dish and tower have been carefully engineered and constructed to withstand winds in excess of 150 M.P.H. Even a 6″ layer of ice won't disturb its performance. It is, in fact, the most rugged aluminum antenna ever built. Yet, its light weight, sectionalized aluminum construction keeps shipping costs down, makes assembly easy.

YOU CAN'T MISS US AT THE I.R.E. SHOW-BOOTH #2344

ANTENNA EQUIPMENT

D. S. KENNEDY & CO.

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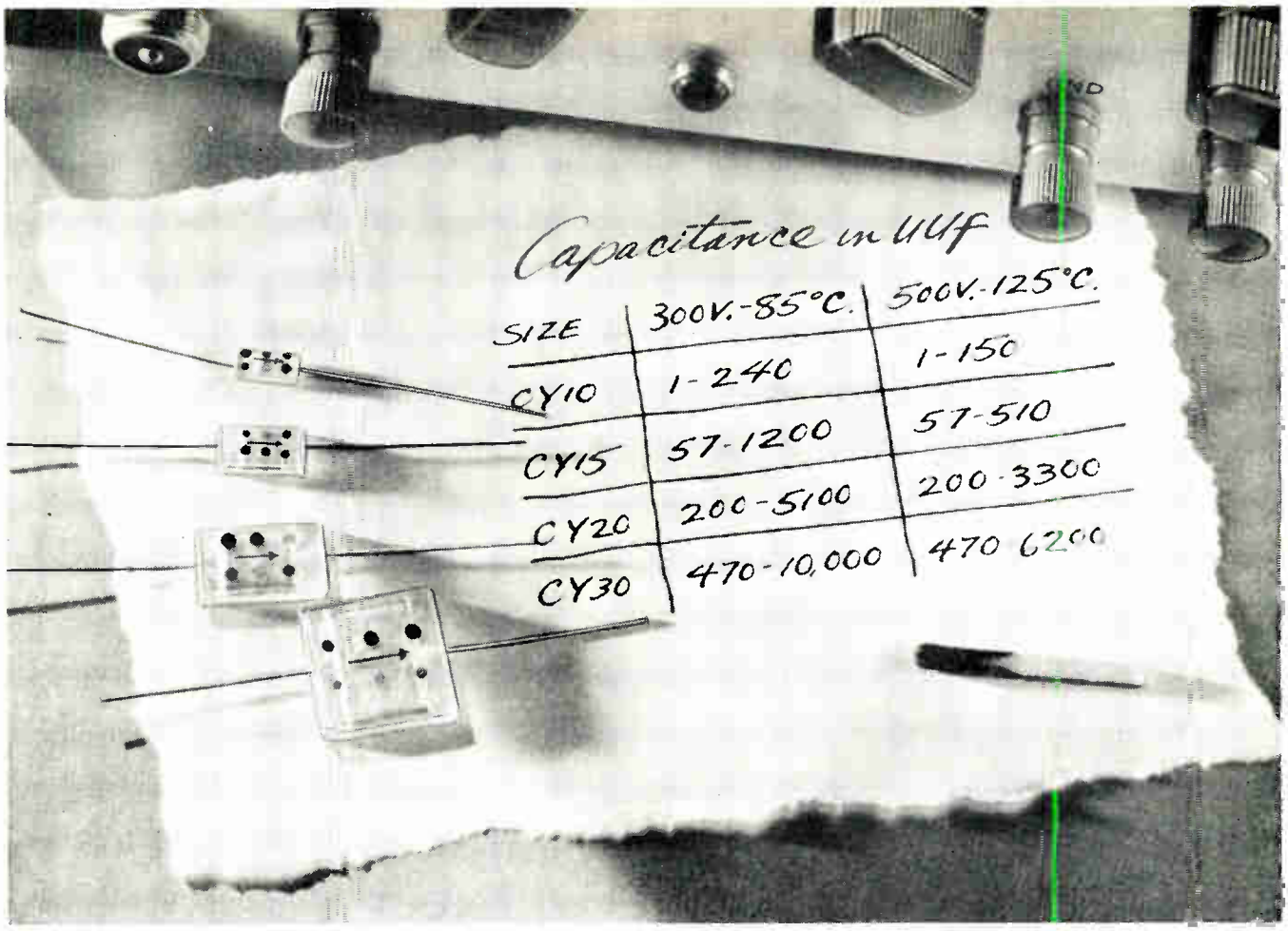
Tracking Antennas – Radio Telescopes – Radar Antennas –
"Trans-Horizon" Antennas: Ionospheric Scatter – Tropospheric Scatter



uuf for *uuf*, the smallest, most stable, fixed capacitors you can buy—Here's why...

These are *glass* capacitors—probably as much as one-third smaller than those you're used to: certainly much lighter.

Though made with glass, they are *not* fragile. In fact, the layers of glass dielectric, the metal foil plates and the leads are fused into a surprisingly rugged, inseparable unit.

This unusual construction, developed at Corning offers you these advantages:

Small size, light weight. If you're at work on guided missiles, fire controls, computors, and similar devices, you can cut valuable ounces and inches from your assemblies with these capacitors. See table above for some indications.

Exceptional stability. After a load life test at 50% more than rated voltage at 85° C., the average change in capacitance of these units is less than 0.4% after 1,000 hours, less than 0.6% after 10,000 hours.

Very low drift. This drift is so slight that it's generally within the normal error of measurement. Taking MIL-C-11272A as a standard, capacitance drift is less than 0.1% or 0.1 *uuf* (whichever is greater).

Predictable, retraceable TC. The difference in TC between any units at any given temperature is less than 15 ppm/° C. It is well within the limits of 140 ± 25 ppm/° C. from −55° C. to +85° C. and referred to 25° C.

Low loss. Even at elevated temperatures, the dielectric loss is relatively low. Dissipation factor at 1 kc. and 25° C. is about 0.055% and independent of capacitance.

Capacitance in uuf

Size	300 V. —85° C.	500 V. —125° C.
CY10	1-240	1-150
CY15	57-1200	57-510
CY20	200-5100	200-3300
CY30	470-10,000	470-6200

Bulletin shows performance charts. Bulletin CD-1.00 contains charts and other data on these capacitors. Circle this magazine's service card for a copy or write us direct at Corning.

Ask for information on these other Corning Capacitors:

Medium Power Transmitting—CY60 and CY70. Ideal for mobile RF transmitters.

Canned High Capacitance—Provide the advantages of rugged glass design to your specifications.

Subminiature Tab-Lead—Up to 90% less volume compared to pigtail types. To your specifications.

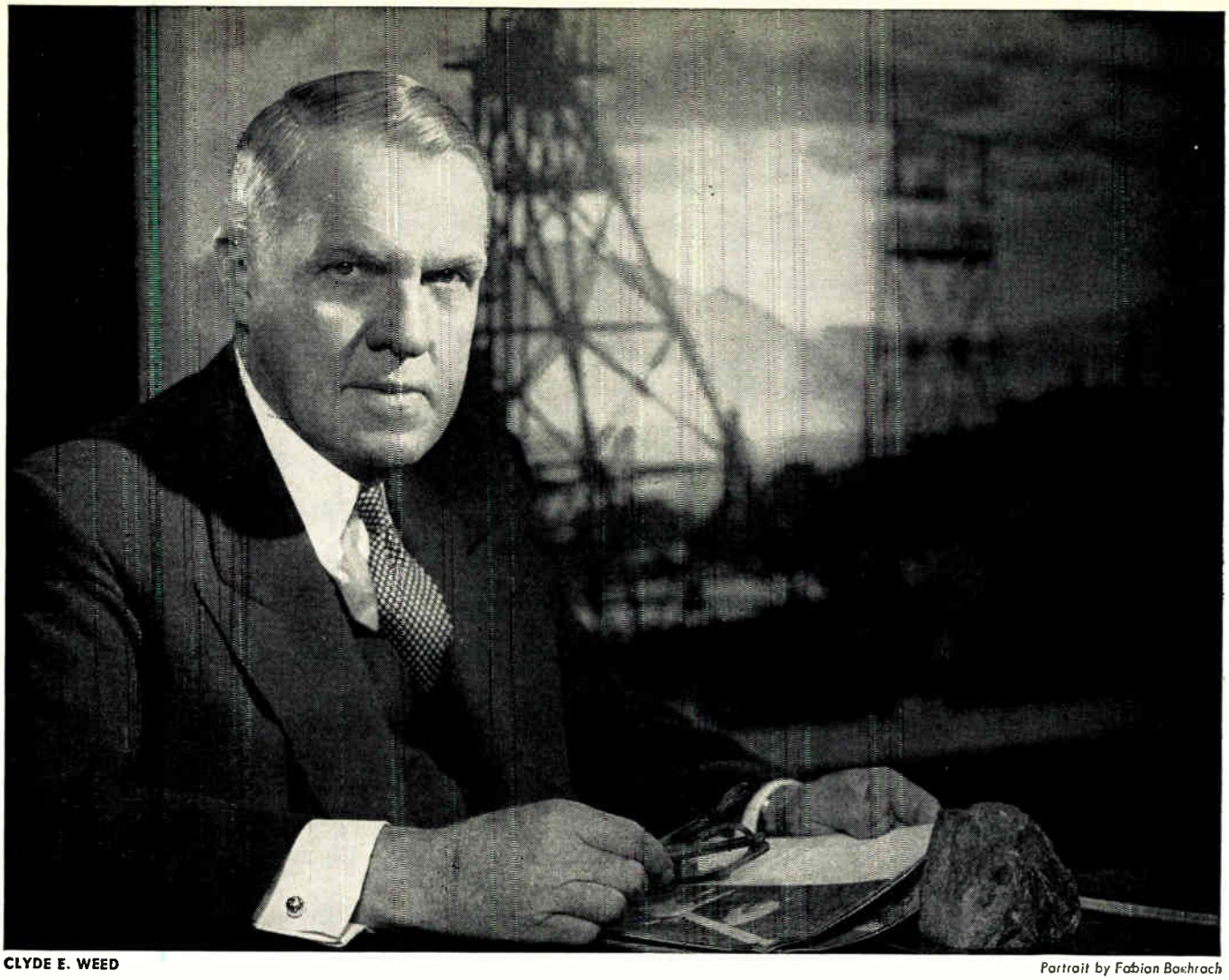
Special Combinations—The performance and benefits of glass in infinite shapes, sizes and leads. To custom order.

Other electronic products by Corning Components Department: Glass Film Type Resistors*, LP, LPI, H, R, N, S, HP and Water Cooled Styles. Direct Traverse and Midget Rotary Trimmer Capacitors*. Metallized Glass Inductances, Delayline Coil Forms, Bushings, Enclosure Tubes, Rectifier Tubes and Attenuator Plates. **Distributed by Erie Resistor Corporation*

Corning means research in Glass

CORNING GLASS WORKS, 95-3 Crystal Street, Corning, N.Y.

Electronic Components Department



CLYDE E. WEED

Portrait by Fabian Bachrach

"22,514 Anaconda Employees Are Buying U. S. Savings Bonds

"In October, 1955, only 34% (11,140) of the nearly 33,000 Anaconda organization employees in this country were buying U. S. Savings Bonds through the Payroll Savings Plan.

"Late in 1955, we conducted a simple person-to-person canvass which put a Payroll Savings Application Blank in the hands of every employee. There was no pressure, no special promotion – just the Application Blank. Our employees did the rest.

"Recently, our records showed that 22,514 of our men and women—69%—are now Payroll Savers. Every new employee is given a Payroll Savings Application Blank and an opportunity to join with his fellow workers in building personal security through systematic thrift.

"We believe The Payroll Savings Plan—with an enrollment of 8,000,000 employees of more than 40,000 companies—is a significant contribution to the Government's effort to check inflation and maintain a sound dollar."

CLYDE E. WEED, *President*
The Anaconda Company

Why not take a *personal* interest in *your* Payroll Savings Plan? Your State Director will be glad to show you how to install the Payroll Savings Plan or revitalize an existing plan. Phone, wire or write, today, to Savings Bond Division, U. S. Treasury Department, Washington, D. C.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

ELECTRONIC INDUSTRIES

PUBLIC SERVICE ADVERTISING COUNCIL

Will today's defense dollars buy safer air travel tomorrow?

Fabulous Radar—the ever-watchful eye that sees aircraft night and day through rain, fog and snow—continues to unfold new miracles to build an ever-stronger defense for America. A recent Avco-Crosley contribution to the military is the new height-finder radar, developed in close co-operation with the Rome Air Development Center, Rome, New York.

But there are peacetime benefits, too. Avco-Crosley, for example, has now combined radar research and development knowledge with electronic computers to produce Volscan, a semi-automatic air traffic control system. Already tested by the U. S. Air Force, Volscan has proved its ability to almost triple airport landing capacities... to help solve today's mounting air traffic problems.

Such progress leads the way to a completely automatic nationwide air traffic control system. Soon, passenger aircraft may wing coast-to-coast in complete and automatic safety—watched and controlled from the ground.

Thus, as defense dollars preserve the peace, they also help create a world of greater safety. And as Avco-Crosley serves defense, it builds for America's future.

For additional information about Volscan and other Crosley electronics developments, write on your letterhead to: Manager of Electronics Systems Engineering, Avco-Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.

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Air Weapons Systems • Ground Radar Systems and Components • Air Traffic Control Systems and Components • Communication Equipment Ordnance Systems and Components • Missile Systems and Components • Aircraft Structures

Flow Line Analysis

(*Continued from page* 54)

$$V_2 = \frac{kT}{q} \ln \alpha_N \frac{I_1}{I_{co}} = \text{floating potential} \quad (17)$$

for $I_2 = 0$, $= 0.10$ volts for RST and $I_1 = 0.25$ ma.

A small superposed addition to V_2 would be found to add a small current, I_2, such that—

$$I_2 = I_{co}\, \epsilon^{qV_2/kT} - \alpha_N I_1, \text{ from which} \quad (18)$$

$$r = \left(\frac{\partial V_2}{\partial I_2}\right)_{I_2=0} = \frac{kT}{q\, \alpha_N\, I_1}, \quad (19)$$

$= 110$ ohms for RST and $I_1 = 0.25$ ma.

Therefore the equivalent circuit at the output terminals when open is a floating potential, V_2, in series with a small resistance, r.

For the grounded-base "off" switch (Fig. 6), the equations are—

$$\alpha_N I_{ES} = -I_{CS}(\epsilon^{qV_C/kT} - 1) \quad (20)$$

= negative collector emission,

$$V_2 = -V_C, \text{ from which} \quad (21)$$

$$V_2 = \frac{kT}{q} \ln \frac{1}{1 - \alpha_I} \quad (22)$$

= floating potential

= 0.078 v. for RST.

If again a small current is superposed at the output,

$$I_2 = \frac{I_{co}}{1 - \alpha_I \alpha_N} \left[(1 - \alpha_I) - \epsilon^{-qV_2/kT}\right]. \quad (23)$$

Hence,

$$r = \left(\frac{\partial V_2}{\partial I_2}\right)_{I_2=0} = \frac{kT}{q\, I_{co}} \cdot \frac{1 - \alpha_I \alpha_N}{1 - \alpha_I}$$

$\cong$ 10,000 ohms for RST. (24)

The equivalent circuit at the open output terminals is therefore a voltage in series with a resistance.

The flow diagrams for the grounded-emitter switches are the same as for the grounded-base switches. Only the external input and output arrangements are changed as shown schematically in Fig. 7.

For the G.E. "on" switch—

$V_2 = V_E - V_C$, and it can be shown that for $V_E >> \frac{kT}{q}$, (25)

$$V_2 = \frac{kT}{q} \ln \frac{1}{\alpha_I} \cong 0.0013 \text{ v.}$$

for RST, and (26)

$$r = \left(\frac{\partial V_2}{\partial I_2}\right)_{I_2=0} = \frac{kT}{q\, I_1} \cdot \frac{1 - \alpha_I \alpha_N}{\alpha_N}$$

$\cong$ 11 ohms for RST. (27)

(*Continued on page* 138)

New Tech Data for Engineers

Atmospheric Structure

"Atmospheric Models" presents in tabular and topological forms, much information about the upper atmosphere. It is helpful to readers interested in the structure of the upper atmosphere, and is made more useful by tables which convert its metrical units of measurement to the English systems. General Electric Co., 3198 Chestnut St., Philadelphia.

Circle 127 on Inquiry Card, page 97

Polymers

Synthetic polymers are described in a 16-page booklet from Oronite Chemical Co., 200 Bush St., San Francisco, Calif. Booklet contains complete specifications, suggested uses, graphs and tables.

Circle 128 on Inquiry Card, page 97

Impulse Counters

A new 8-page, 2-color bulletin describing Sodeco Ti series predetermined electric impulse counters and impulse transmitters is available from Landis & Gyr, Inc., 45 W. 45th St., New York 36.

Circle 129 on Inquiry Card, page 97

Thermistors

Thermistor manual TH-13A is for the engineer concerned with thermistors. The 54-page booklet contains tables, charts, static and dynamic characteristic graphs, and applications. General Electric Co., Metallurgical Products Dept., Detroit 32, Mich.

Circle 130 on Inquiry Card, page 97

Switches

Rotary, slide and lever switches are described in a 36-page, 2-color catalogue from Central Lab, Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis. Catalogue is complete with photographs, drawings and specifications.

Circle 131 on Inquiry Card, page 97

Fiberglass

H. Koch & Sons, Corte Madera, Calif. have released a 20-page, 2-color booklet complete with photographs on the manufacture and fabrication of fiberglass.

Circle 132 on Inquiry Card, page 97

Coils

A 100-page book complete with specifications, prices, design data, tables and graphs for coils has been issued by Carlstedt Research, Inc., 2501 E. 68th St., Long Beach 5, Calif.

Circle 133 on Inquiry Card, page 97

Metal Cabinets

A newly completed catalogue showing isometric dimensional drawings of typical metal cabinets available, along with other specifications is issued by the Metal Products Div., Mid-West Conveyor Co., 7th and Sunshine Rd., Kansas City, Kansas.

Circle 134 on Inquiry Card, page 97

Luminous Resins

An 8-page booklet and color card for luminous resins is available from Luminous Resins, Inc., 166 W. Washington Street, Chicago 2, Ill. The booklet describes various products that may be made with this unique product.

Circle 135 on Inquiry Card, page 97

RETMA Standards

Six new RETMA standards have been issued. They are: RS-171 High Voltage Ceramic Dielectric Capacitors, Class 2; RS-172 Fixed Composition Resistors; RS-173 Emergency Stand-by Power Generators and Accessories for Microwave Systems; RS-174 Audio Transformers for Electronic Equipment; RS-175 Audio Inductors; RS-176 Pulse Transformers for Radar Equipment. Standards are available from the Engineering Office of RETMA, 11 W. 42nd St., N. Y. 36.

Circle 136 on Inquiry Card, page 97

Klystrons

Two new brochures on power amplifier klystrons, "The Care and Feeding of Eimac Power Klystrons," and "Power Amplifier Klystrons for UHF and Microwave Transmission" are issued by Eitel-McCullough Inc., San Bruno, Calif.

Circle 137 on Inquiry Card, page 97

Special Transducers

A 4-page bulletin on continuous phase shifting transducers used at specific frequencies to produce time delays or phase variations directly proportional to shaft rotation is available from the Nilsen Manufacturing Co., Addison, Ill.

Circle 138 on Inquiry Card, page 97

Magnesium & Titanium

Magnesium and Titanium Data is a new 44-page booklet on these two metals. Data covers physical and mechanical properties, metal weights, forming characteristics, specification tables, corrosion behavior, surface treatments, welding and joining, machining, heat treatment and stress relief, and other similar design data. Books & Perkins, Inc., 1950 West Fort St., Detroit 16.

Circle 139 on Inquiry Card, page 97

Servo Motors

A 10-page, 2-color bulletin #385 gives characteristics, drawings, and application data on servo motors. The bulletin offers engineers complete information on standard and custom servo motors. Norden-Ketay Corp., Commerce Rd., Stamford, Conn.

Circle 140 on Inquiry Card, page 97

Coils & Heaters

A 12-page, 2-color booklet describes in text, photographs, charts, and graphs, coils and heaters manufactured for the principal electronic and lighting applications and includes illustrations of production facilities and processes. Sylvania Electric Products, Inc., Towanda, Pa.

Circle 141 on Inquiry Card, page 97

Aircraft Equipment

Aircraft Radio Corporation, Boonton, N. J. has issued a 2-color catalogue on its aircraft and communication and navigation equipment with some special emphasis on business flying.

Circle 142 on Inquiry Card, page 97

Punch Presses

Bulletin #500 DM includes specifications and detailed information on features and operating principals of 40 to 150 ton capacity machines. Equipped with direct measuring gauges and table, these presses provide a flexible method of locating and piercing holes of many sizes in large metal sheets and plates in one handling. Wiedemann Machine Co., 4272 Wissahickon Ave., Phila. 32.

Circle 143 on Inquiry Card, page 97

Test & Measurement

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. has issued a catalogue covering their line of precision measuring instruments, scientific apparatus, industrial test and control equipment. This 8-page, 3-color booklet is complete with photographs, specifications and prices.

Circle 144 on Inquiry Card, page 97

Test Instruments

A short form catalogue describes briefly the more popular of 125 different instruments manufactured by Marconi. Also included are the precision instruments of Cintel, Eddystone and Wayne Kerr for whom Marconi Instruments is U. S. distributor. They are located at 44 New St., New York 4.

Circle 145 on Inquiry Card, page 97

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(*Continued from page* 136)

For the G.E. "off" switch—

$$V_2 = V_1 + V_C, \text{ and it can be shown that for } V_1 >> \frac{kT}{q}, \quad (28)$$

$$V_2 = V_1 - \frac{kT}{q} \ln \frac{1}{1 - \alpha_I} = 0.172 \text{ v.}$$

for RST and $V_1 = 0.25$ v., (29)

and

$$r = \left(\frac{\partial V_2}{\partial I_2}\right)_{I_2=0} = \frac{kT}{q\, I_{CO}} \cdot \frac{(1 - \alpha_I \alpha_N)}{(1 - \alpha_I)}$$

$\cong$ 10,000 ohms for RST. (24)

These G.E. cases should be found consistent with the work on N. W. Bell.[3]

Special Cases

An interesting case to examine is the grounded-emitter saturation current (Fig. 8). The key point in the flow diagram is that since the base terminal is open, the two currents lost in the base region must be equal and opposite. This equating of the two base currents makes possible the sufficient number of equations to solve the system. Physically it simply means that the emission at the collector junction is negative though assumed positive. Thus it will be found that a false assumption will not invalidate the results providing rules consistent with the assumption are employed. A solution reveals—

$$I = \frac{I_{CO}\,(1 - \epsilon^{-qV/kT})}{(1 - \alpha_N) + (1 - \alpha_I)\frac{\alpha_N}{\alpha_I}\epsilon^{-qV/kT}}, \quad (30)$$

which reduces for large applied voltages to the well known expresssion

$$I \cong \frac{I_{CO}}{1 - \alpha_N} = 100\ \mu a \text{ for RST.} \quad (31)$$

Furthermore it is found that for large applied voltages

$$V_E \cong \frac{kT}{q} \ln \left[1 + \frac{\alpha_N (1 - \alpha_I)}{\alpha_I (1 - \alpha_N)}\right], \quad (32)$$

which reduces to

$$V_E \cong \frac{kT}{q} \ln 2 = 0.018 \text{ volts @ } 300°K \quad (33)$$

for symmetrical transistors, showing an independence from α_s.

Another informative example is obtained by tying the emitter and collector together (Fig. 9). A solution yields—

$$I = \frac{I_{CO}}{1 - \alpha_I \alpha_N}\,(\epsilon^{qV/kT} - 1)$$

$$\left[(1 - \alpha_I) + \frac{\alpha_I}{\alpha_N}(1 - \alpha_N)\right], \quad (34)$$

(*Continued on page* 140)

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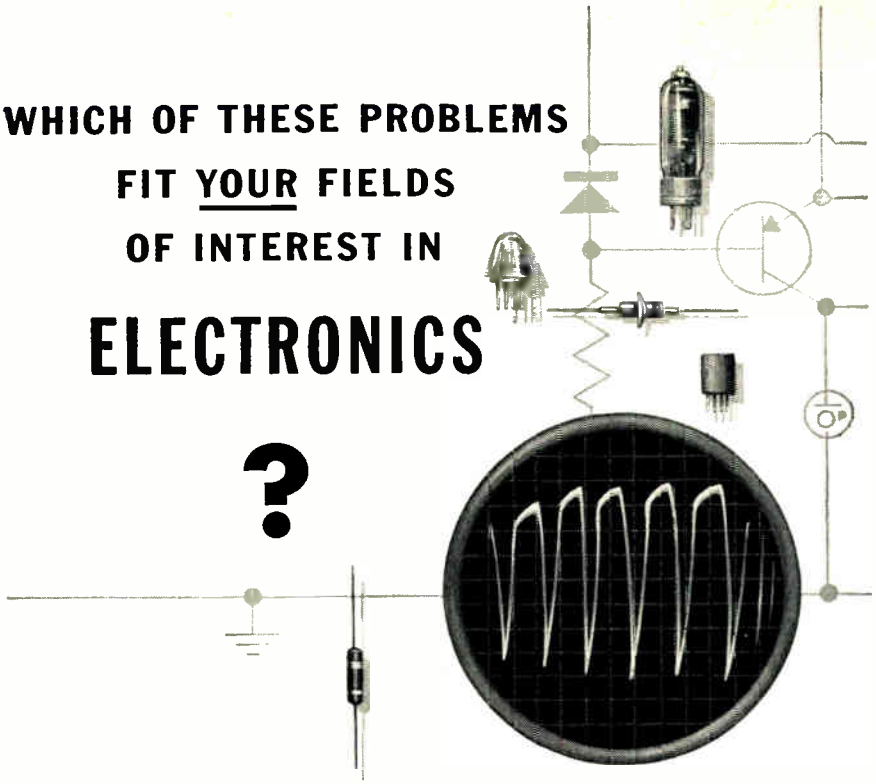

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- Weapons Systems Engineers
- Wave Guide Development Engineers
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(*Continued from page* 138)

which reduces for symmetrical transistors to

$$I = \frac{2}{1+\alpha_S} I_{CO}\,(e^{qV/kT} - 1), \qquad \alpha_I = \alpha_N = \alpha_S. \quad (35)$$

Thus the saturation current for this expression is appreciably less than twice that of either side alone, and it is considerably less than twice the internal body saturation currents, a condition which might not have been intuitively obvious. For RST—

$$\frac{2\,I_{CO}}{1+\alpha_S} \cong 5\ \mu a,$$

$$2\,I_{CO} = 10\ \mu a, \quad \text{and}$$

$$2\,I_{CS} = 100\ \mu a.$$

Therefore, another possible case of confusion is clarified quite readily by "looking" inside the transistor through a flow line analysis.

The expert criticisms, suggestions, and assistance rendered by R. H. Mayne (Research Engineer, Convair, Pomona) in the preparation of this article are greatly acknowledged.

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7. S. L. Miller and J. J. Ebers, "Alloyed Junction Avalanche Transistors," *BSTJ*, Sept., 1955, pp. 883-902.

New Computer Center

A new $250,000 computer is being installed at the Los Angeles Computation Center of Berkley Division of Beckman Instruments, Inc. Housed in a modern brick and reinforced concrete building, the new facility will be devoted, on a rental basis, to solving complex design problems for business, industry, and educational institutions.

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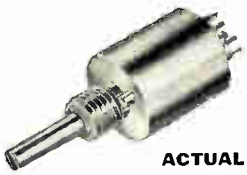

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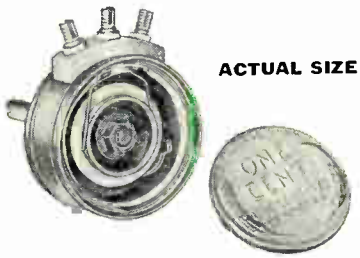

ACTUAL SIZE

- Unit height ⅜"; weight ½ oz.
- Independent linearity: ± 1% is standard.
- Linear or non-linear windings on flat card; res. tol. — ± 5% std., ± 1% on order.

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- Independent linearity: ± 0.5% of total resistance is standard.
- Linear or non-linear windings std., ± 1% on order. on flat card; res. tol — ± 5%
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- Linearity: ± 0.5% independent linearity is standard; ± 0.3% on special order for C-200; ± 0.2% on special order for BC-200.
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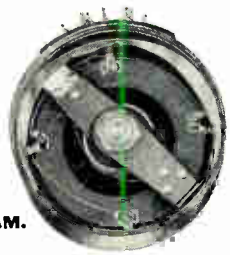

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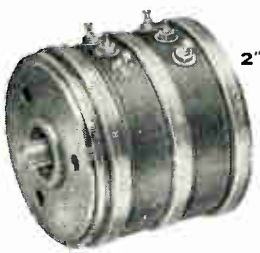

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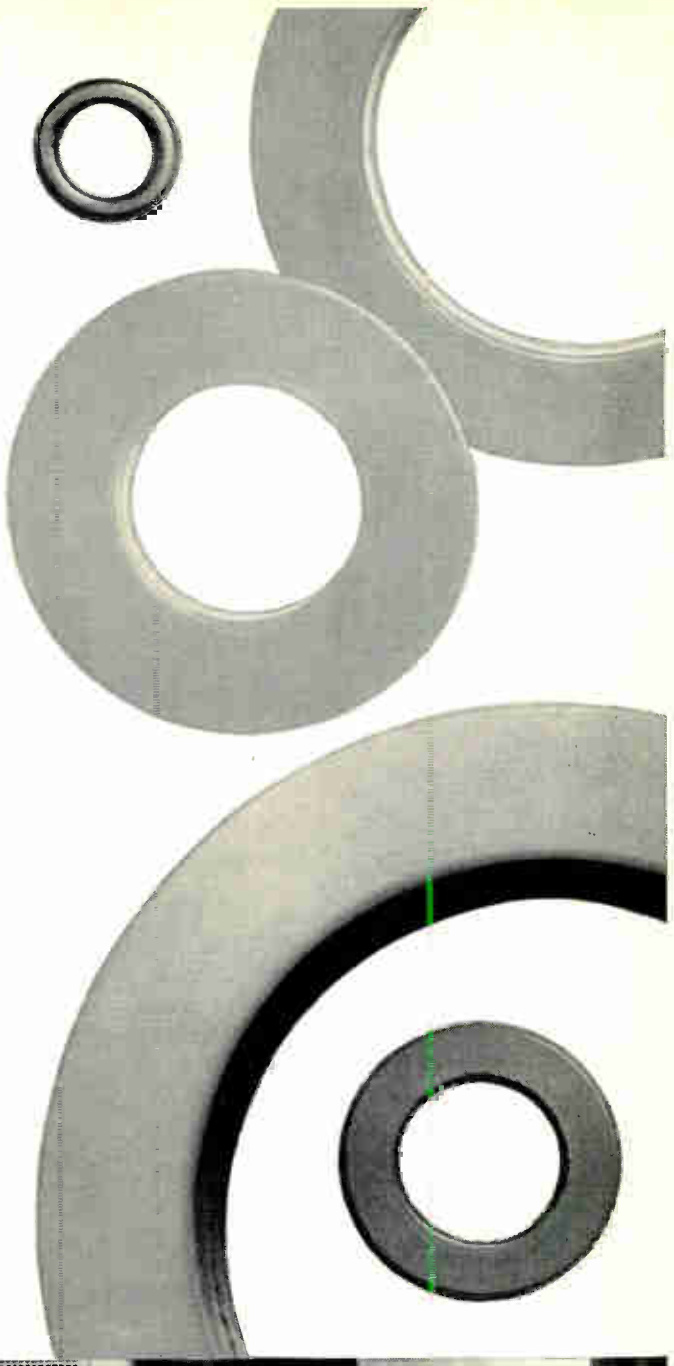

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Tube Names

(*Continued from page* 70)

We may have reached 1N650 and 2N300 at this time.

Suffix letters are assigned to solid-state devices as indicated for the other devices. That is, to indicate later and modified versions which may be unilaterally interchanged with the prototype.

When the new type number has been assigned, the applicant or sponsoring company is notified of the designation. Until such time as the sponsor is ready to release the tube (i.e. inform industry of its existence) information (reservation data) is kept confidential by the Engineering Office.

Registration

The type assignment procedure, as described above, is referred to as "reservation." To complete the picture, we have our "registration" procedure. When the sponsor is ready to release the device, he supplies sufficient copies of the final data for distribution to the tube - manufacturing industry. This process of releasing the data to industry is what was referred to as registration, after which the sponsor relinquishes all prior rights to the tube and any manufacturer may add it to his production line, provided patents, licensing arrangements, etc., are not a factor. The only stipulation being that all devices bearing the new type designation shall conform to the registered specifications.

After registration, any changes in the physical or electrical characteristics are handled through the process of reregistration. In this way, changing technology can be incorporated and perhaps better tubes made. These reregistrations may be suggested by any manufacturer. However, the tube industry is allowed a 30-day study period to weigh the relative merits of the proposed changes. If anyone offers valid reason for not making the change, the proposed reregistration is cancelled. If no objections are raised, the tube is characterized by the new data, superseding all previously registered information. Production lines are altered to incorporate

(*Continued on page* 146)

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If you cannot attend the show, write, wire or phone for information. A Panoramic Applications Engineer is always available to discuss specific problems.

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Circle 209 on Inquiry Card, page 97

(*Continued from page* 144)

the modifications which have now been made final.

Conclusions

So we see that the reservation, registration, and reregistration processes are open to any manufacturer. Reservation enables the sponsoring company to secure a type designation which will be universally recognizable. Registration allows for increased competition if the product is a good one, as, with the announcement of the device to industry, other manufacturers can decide whether they want to add the new type to their production or not. Lower costs and multiple sources of supply are the result. Reregistration affords a dynamic means of incorporating design changes to market a better product.

Approximately 98% of all electron devices manufactured in the United States, and a substantial number of new foreign types, are registered by JETEC through the RETMA Engineering Office. It is indeed fortunate that the electronics industry has a centralized group such as JETEC to develop standards in the field of electron tubes and allied devices. Since the manufacture of electronic products, by definition, is based upon the use of electron tubes, we can visualize the chaotic conditions that would exist if each manufacturer of tubes went his merry way on type numbering and the users had no common method for recognizing the characteristics of tubes. There would be no easy method for determining interchangeability and replacement. It is safe to say that the United States would have been greatly retarded in the field of electronics, and, hence, the entire economy, but for this standardization activity carried on through the Joint Electron Tube Engineering Council.

[1] As covered by the four Standard Designations Systems.

Pneumatic Dolly

Three new models of the PN6 line of pneumatic-balance camera dollys are illustrated in a new bulletin of Studio Television Products Sales Corp., 342 West 40th St, N.Y. 18, N.Y.

Ferro Inductors

(*Continued from page* 79)

measurements. The error being 50 to 200%.

Comparison

To find out what happens when a good air coil is combined with the iron core of high Q, a great number of toroids was made and measured. All were of the same dimension OD = 2.25 in., ID = 1.5 in. and 0.375 in. thick. Wound with the best available Litz wire, 100 strands No. 44, the best possible coil was started at around 1 MC with the wire thin enough to eliminate "skin effect." Of this great number, a few of particular interest are shown below. Toroids were used for easy determination of μ.

Of particular significance is the comparison of items 2 and 3 with item 4 in Table 2. When both toroids have the same number of turns, item 4, because of lower loss in iron, produces higher Q than item 2. However, the inductance of item 2 is higher because of higher μ.

Now let us equalize the inductances for comparison. The same core of item 2 is rewound to a smaller number of turns so that L becomes equal in both items 3 and 4. We see very surprising results. In spite of higher iron loss of "E," powder toroid 3 becomes superior to one of "TH" which can only be attributed to increased spacing between the turns.

Again, if the "TH" core has an increased spacing between the turns, its Q becomes still higher as item 6 shows. Thus, we have the first conclusion: The coil itself predominantly influences Q. We shall now demonstrate the influence of iron in a solenoid.

Here we have a coil wound with Litz wire into which 2 slugs of iron can be inserted, forming a core completely surrounded by the winding. By moving the slugs lengthwise, one can adjust the gap in the center thus varying μ_e. At the frequency of measurements, 800 KC, the Q of the coil is 175 and since its inductance is 112 μH, R_{rf} is calculated to be 3.2 Ω. A core of 2 slugs of carbonyl E (no gap) inserted into the coil yields $\mu_e = 4.1$ while Q is 170 or slightly lower than in the coil itself. Calculated R_{rf} becomes 13.0, or the increase in resistance due to the iron is about 10 Ω, while the calculated R_i is only 0.52 Ω. Now we insert 2 similar cores of carbonyl "SF" which yields $\mu_e = 3.0$ but the measured Q becomes 285 from which new $R_{rf} = 5.73$ or increase of only 3.4 Ω but the calculated R_i is only 0.27 Ω. We now revert back to the first core of "E" but arrange it with a gap in the center, of such magnitude so as to produce μ_e of the second case, i.e., 3.0. We see a surprising result. Q of the combination becomes 280 or just different enough to compensate for difference in calculated R_i.

Thus we arrive at a second equally important conclusion: The total loss due to insertion of the iron is predominantly a function of effective permeability.

Simultaneously, we observe that for maximum Q in each coil at a given frequency, there is an optimum effective permeability.

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Ferro-Inductors

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This case can be verified with a great variety of solenoidal coils ranging in diameter from ⅜ in. to 2 in. in diameter.

Prominent Factors

Now we can see that 2 factors prominently effect a coil with an iron core: (1) proximity of turns of the coil, and (2) the effective permeability of the core. The iron loss resistance, R_i, by the use of fine iron powders of carbonyl type, may be reduced to a negligible amount. A relatively large amount of loss resistance is added to the coil's resistance, which additional loss, previously unaccounted, may be termed as an "insertion loss." It is due to insertion of the coil of a permeability μ_e. If the total r-f resistance of the coil after insertion is R, and the coil proper resistance is R_{rf},

$R = R_{rf} + R_i + R_x$, where R_x is the added insertion loss resistance.

It appears from the above that an analysis of the coil is required in order to separate these losses.

Butterworth[2] in analyzing high frequency coils (in air) arrived at a general formula

$R_{rf} = R_o (1 + F + U_{nd}^2/c^2 G)$

in which R_o is dc resistance of the wire, F is a term depending on the frequency and representing an increase in wire resistance due to "skin effect," U_n a numerical coefficient depending on the number of strands of the wire (max. value being 3.29), d and c being diameter and spacing of the wires, respectively, and G a complicated function of the frequency. The last term of the equation is generally attributed to "coiling resistance," being an eddy current loss in the copper generated by the flux from turn to turn. The formula was later complicated to reconcile the actual findings with calculations and thoroughly analyzed by Jackson[3] who, in his work, employed very thick wire (No. 16 S.W.G.) of 1.6 mm. diam. and arrived at a substantial agreement (within 2-12%) between measured and calculated value. The general principle of separating loss components into "skin effect" and "coiling resistance" remained valid.

Contrary to the above, in this investigation, wire No. 44 (d = 0.025 mm.) was used which, at the frequencies employed, remained completely "penetrated." In accordance with well known formulas of depth of penetration, $\delta = \frac{1}{2}d$ and $\delta = 6.6f\text{-}\frac{1}{2}$, the complete penetration occurring up to a frequency of 40 MC. We, therefore, may disregard term F and simplify the equation to $R_{rf} = R_o (1 + \Gamma)$, where Γ is the term due to coiling resistance. Then $\Gamma = (R_{rf} - R_o)/R_o$. Measuring R_o and computing R_{rf} from Q, we get the term Γ for any coil with, or without, the iron. In the latter case, however, when R is computed from Q the value of R_i must be first calculated and subtracted from R to get new R'_{rf} of the coil with iron, which by previous designation is equal to $R_{rf} + R_x$.

Relationships

In view of our findings, it seemed logical that the term Γ_i is related to the coil's Γ, and de-

pends on the permeability μ_e, since the coiling resistance term is increased by virtue of increased flux due to iron. We, therefore, assume that $\Gamma_i = \Gamma\ \mu^x_e$ and proceed to evaluate x. Calculations show that the term Γ of the toroidal air coil (item 1), Table 2 varies from 0.3 at 800 KC to 1.4 at 2 MC, which values are approx. proportional to f^2. Similar calculations for a toroid wound on carbonyl E core produce considerably greater values of Γ ranging from 1.25 at 800 KC to 10.0 at 2 MC, being also substantially proportional to the same power of frequency. From our assumption, $\mu^x_e = \Gamma_i/\Gamma$, which ratio, when averaged within the frequency range, produces x = 1.0. Substantially, the same results when exponent x is calculated for items 3, 4 and 6. For item 5 (reduced μ), x comes out as 1.1. The fact that the ratio of the "coiling resistance" term with iron and the same for an air-cored toroid remains substantially constant, within the range of frequencies of this investigation, proves our assumption that the coiling resistance term of an air coil is increased by the presence of iron as a function of permeability. For toroids, this increase numerically equals μ. Therefore, expressing R_x in terms of R_{dc} and R_{rf}, we may present the total resistance R of a ferro-inductor as

$$R = R_{rf} + R_i\ (R_{rf} - R_o)\ (\mu - 1)$$

the last member being "insertion loss" due to the core. Calculations of losses for the toroidal inductor of item 2 at 1 MC gives the following figures: $R_{rf} = 0.55\ \Omega$: $R_i = 0.18\ \Omega$: $R_{dc} = 0.42\ \Omega$, hence R_x calculated at $\mu = 7$ is 0.78 Ω. Total r-f resistance of the inductor (from its Q) = 1.45 Ω. Subtracting R_{rf} and R_i from the total, we get the actual $R_x = 0.72\ \Omega$.

Thus, the total resistance is composed of:

R_{rf} of the coil 38%

R_i of the core 12%

R_x or insertion loss due to core 50%

This example clearly shows the predominance of insertion loss over the iron loss proper.

Approximately the same dependence of insertion loss on permeability is observable in long solenoidal coils. Again we note that a maximum Q is attained at a certain effective permeability.

Results

Many different shapes and windings were investigated. In some small coils, wound with progressive universal winding, a low "coiling resistance" term was observed with the resultant excellent Q in combination with the core. In such cases, the exponent x may be as low as ½, i.e., insertion loss very low. For larger size air coils with high inherent Q, the insertion loss was measured and found proportional to μ^2. This, incidentally, is the case of the solenoidal inductor of the first example cited in this article. While the investigation of other than toroidal cores is in its initial stage, certain conclusions can now be reached:

1. Coil winding should be composed of the thinnest possible strands, plurality of which governs R_{dc}, to reduce the "coiling resistance" term.

2. Coil turns should be adequately spaced, or laid down, in

(*Continued on page* 150)

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to-turn induction.

3. The ratio $(R_{rf} - R_{dc})/R_{dc}$ should be kept as small as possible so that ultimate insertion loss will be reduced.

4. Close proximity of the core to the turns should be avoided.

5. Extending the core outside the domains of the coil generally increases Q by increase of μ without increase in loss.

6. Same applies to "closed" magnetic circuits such as E & I cores, Pill-box type, providing that the return path is far enough from the winding.

7. In all investigated cases, the iron loss proper for carbonyl iron cores, properly chosen for frequency, is very small compared with other losses of the combination.

8. For maximum Q, the effective permeability should be chosen at an "optimum" value, as the permeability *per se* introduces more loss than the iron.

9. General expression for all losses in a ferro-inductor wound with Litz wire $R = R_{rf} + R_l + (R_{rf} - R_o)\ (6^x - 1)$ where x may vary from ½ to 2 depending on shape of coil, winding & proximity of core.

10. All of these conclusions may result in compact design of cores with coils having Q in excess of 300.

References

1. Magnetic Measurements at Low Flux Densities, V. Legg: *Bell Syst. Tech. J.* 15, 39 (1936).

2. Butterworth, S. High Frequency Resistance of Coils, *Wireless Engineer*, 1926, pp. 203 et seq.

3. Willis Jackson, Measurements of High-Frequency Resistance of Single Layer Solenoids, *Jour. I.E.E.*, pp. 440-445, 1937.

AM/TV Call Letters

The International Radio Convention of 1912 gave the U. S. the use of N, K and W as first initial letters of radio and, later, TV stations. Originally, all commercial stations east of the Mississippi were given the letter W; the west, K. N was reserved for the Navy. Some exceptions: WKY, Oklahoma City; KYW, Cleveland (formerly in Chicago, then Philadelphia); and KDKA, Pittsburgh.

Ionovac

(*Continued from page 77*)

unavoidable nature of moving parts. The finest diaphragms have their own resonance or vibration characteristics. They cannot accurately reproduce the wave combinations produced by such wave creators as the vocal cords or musical instruments. In addition, because of their inertia, diaphragms cannot respond fast enough to catch the subtle sounds, nuances and overtones, for which the Hi Fi fan so earnestly strives.

The need for non-mechanical reproduction of sound waves has been recognized by most great electrical and electronic scientists, dating back as far as Thomas Edison, who unsuccessfully tried to solve the problem with his Thermophone. This instrument and other similar devices failed because they attempted to produce air expansion and contraction with heated wires. The temperature "lag" made it impossible to generate any but low frequencies and intensities.

Sigfried Klein, a French physicist who conducted many ionic cloud sound reproduction experi-

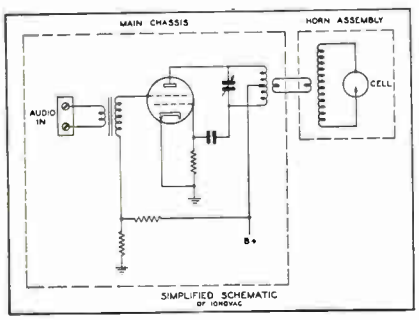

Fig. 2: Simplified Ionovac schematic

ments, six years ago invented the Ionophone, the first commercial use of the principle. In December, 1955, DuKane Corp. of St. Charles, Illinois, acquired the exclusive North American manufacturing license using the basic ideas and also employed Klein to assist in the further development of the device as a member of an engineering team.

Improved Design

The result of these activities was the Ionovac, similar in principle to the Ionophone, but so radically improved in design as to

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(*Continued from page* 151)

be almost unrecognizable in comparison to ionophonic products made by licenses abroad, such as the giant electronic firms of Telefunken in Germany; Plessy, Ltd., in France, and A. E. G. in Sweden. The Ionovac, according to DuKane engineers, is at least six times more efficient in performance and is the first to be considered practical by American standards.

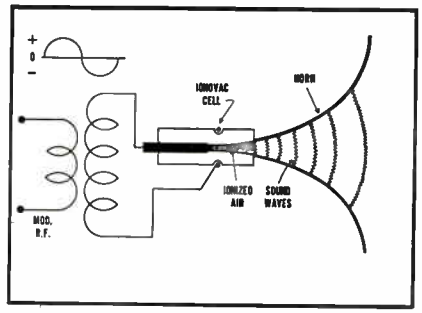


Fig. 3: Essential Ionovac elements

Silent Sound

Primarily, the Ionovac was developed as a variable generator of both audible and ultra-sonic waves—from 1 KC to 1 MC. In the past year or two the higher frequencies have been put to use by a wide variety of industries. The idea is mushrooming. Silent sound is now available for removing particles from industrial parts, including radio active materials; cleaning surgical instruments; aging wine; bonding hard-to-weld metals and similar applications. Some ultra-sonic units are being marketed to treat certain types of bursitis and arthritis as well as for use in deep-heat therapy. The principle is used by the Royal Dutch Airlines for completely blind touch-down landings, filling in where radar becomes inaccurate—below 250 feet.

Big advantage of the Ionovac in such applications is that it can accurately produce any desired silent sound frequency from a single electronic circuit. Present ultra-sonic wave producers have only a single frequency, requiring a new instrument for every slightly different task. Ionovac's extreme adaptability in sweeping the entire ultra-sonic range is expected to greatly accelerate industrial use and to speed up research in a number of sciences.

IGY To Meet in Toronto

The most spectacular example of international scientific cooperation is entering final stages of preparation. IGY, the International Geophysical Year, will be an 18-month concerted effort by more than 50 nations and 5,000 scientists — is expected to cost well over $300 million.

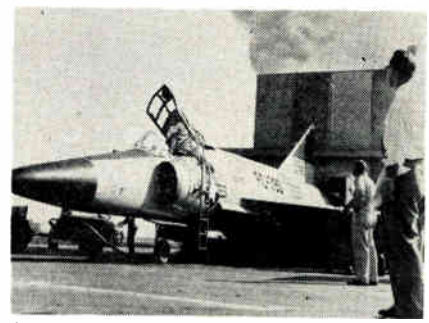
From July 1957 to January 1959, experts in 14 fields of research will investigate the earth from pole to pole, from ocean floor to outer space. All over the world simultaneous measurements will be taken on such phenomena as the aurora, cosmic rays, meteors, the upper atmosphere, glaciers, oceans, gravity, magnetism, earth tremors, solar flares, and sunspots.

At a meeting scheduled for Sept. 3 in Toronto, more than 1,500 experts will review IGY opening and lay final plans for this vast joint enterprise. Typical subjects will be: age of the earth, polar wandering, climatic cycle, origin of cosmic rays, solar flares, magnetic storms and radio communications.

Control Panels

Control panels for motors and generators are illustrated in form PAN 1156 available from Kato Engineering Co., 1415 First Ave., Mankato, Minnesota. A variety of sizes and mounting arrangements are shown.

WATER TAMES JET NOISE



A unique new jet silencer now in operation at Hughes Aircraft Company's Culver City, Calif., flight strip pulls run-up noise of a F-102A down from a 160 db blast to a mere 95 db—the sound level in a new station wagon traveling 70 mph with windows closed. The 3,500°F exhaust gases are reduced by water spray to 200 degrees, giving rise to the clouds of steam shown in the photograph. The $100,000 silencer, first successful installation of its kind, can be adapted to more than one type of jet. The Hughes chamber, and two others being tested at Norton AFB in San Bernardino, were developed and built by General Sound Control Inc., Los Angeles.

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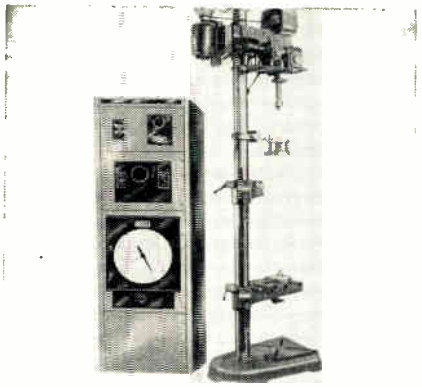
New Products

CRYSTAL PULLER

Designed for maximum single crystal silicon or germanium production, the unit also has the flexibility and design refinements required for laboratory work. Total quantities of



single crystals that can be produced will vary with techniques and requirements of the operator. Production rates of 300 grams of single crystal silicon and excesses of 1000 grams of single crystal germanium per 8-hr. day have been reported. Pulling speed of the device is continuously adjustable, during pull. Precision Tool & Engineering Co., 92-26 180th Street, Jamaica 32, N. Y.

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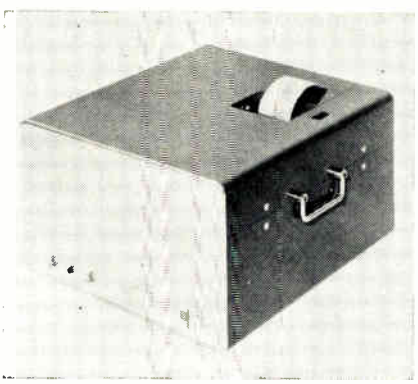
DIGITAL PRINTER

The Model 400A is a reliable, accurate and compact instrument specifically designed to fill an industry need for a high-speed digital printer at low cost. Featuring rapid print-out, parallel entry, and up to 12 digit printing, this new unit uses no stepping switches. It has been designed to operate from 4-line 1-2-2-4 binary code, thus it may be used with most



all existing counting equipment without modification. Accuracy & counting period: Identical to characteristics of counting instrument. Computer-Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif.

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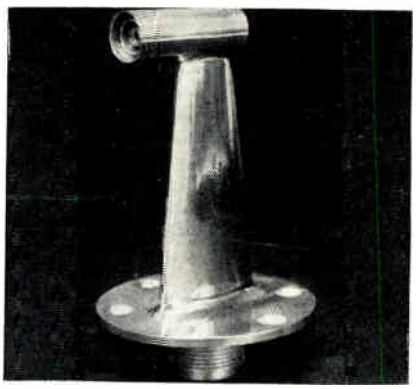
TEMPERATURE PROBE

The Model 101 probe series is particularly designed for use on operational airplanes, for a total temperature range from −80°C to +300°C and the Model 106 probe extends this



range to +650°C or more. The probe uses a platinum resistance thermometer sensing element (a platinum resistance thermometer is the international standard of temperature in this range). The resistance of the sensing element is 50 ohms at 0°C. The major characteristic is that the sensing element is hermetically sealed. Rosemount Engineering Co., Rosemount, Minnesota.

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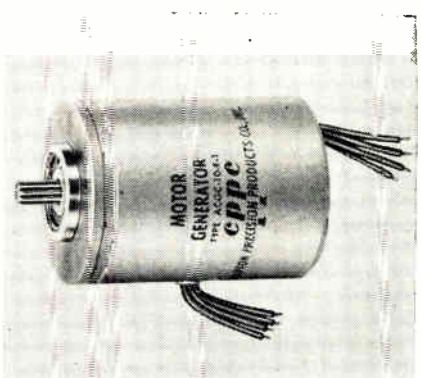
MOTOR GENERATOR

A size 10 ac motor generator, offering minimum length and weight, features cast rotor construction. Applications include error rate damping in servo systems for high stability. Motor Characteristics: Main phase voltage—26 v. 400 cps; Control phase voltage—0 to 26 v.; Max. current/phase—185 ma.; DC resistance/phase—58 ohms; Generator Characteris-



tics: Main phase voltage—10 v. 400 cps; Output— 0.16 v./1000 RPM; Input power—0.2 w.; DC resistance/phase—200 ohms. Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Pa.

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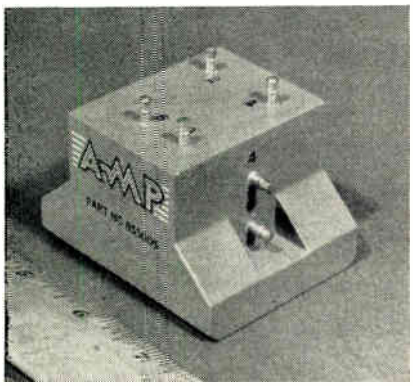
New Products

PULSE SYSTEM

New encapsulation techniques have resulted in successful encapsulation of complete pulse systems in epoxy resin. A typical unit is No. 855005 containing a resonant charging choke, pulse



forming network, and pulse transformer in a package 2 x 2 x 2 in. designed to drive a special magnetron. This unit withstands great extremes of mechanical shock and vibration as well as thermal shock. Use of Amplifilm pulse capacitors provides stability, reliability, and long life. Fully suitable for high altitude use in a radar transmitter. AMP Inc., Harrisburg, Pa.

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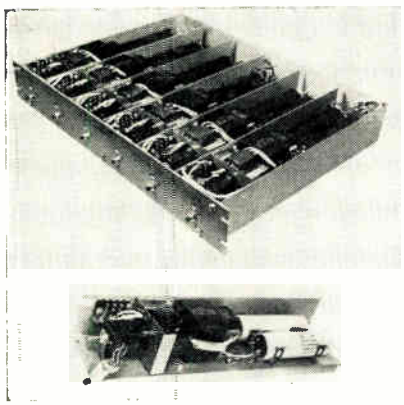
STRAIN GAGE SUPPLY

Model 7P01 single or multiple channel strain gage power supplies are now being produced. Specifications: 115 v., 60 cps input; 10 vdc. output, adjustable from 9-11 vdc. with a 10-turn potentiometer; output voltage changes less than ±.05% due to temperature change from 0 to 45°C, less than 0.1% due to 2% change in load current; output ripple, less than 300



mv. RMS, isolated from ground as follows: insulation resistance to ground —10,000 Meg, ac pickup to ground—5 mv. peak. Western Gear Corp., Electro Products Div., 132 West Colorado St., Pasadena 1, Calif.

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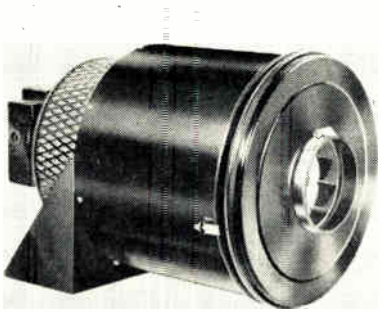
New Products

MULTISTAGE BLOWER

A line of new and unusually designed multistage centrifugal blowers allows delivery of 25 to 350 cfm at static pressure of 10 to 55 in. water column (2PSI) on suction or pressure. These blowers incorporate 3 to 9 cascaded pressure stages. They have no wearing parts and are direct-coupled (no belts) to a ¼ to 2 hp induction motor which is an integral part of the unit. The shaft speed of the blower being only 3400 RPM, noise levels are relatively very low. Entire assembly runs on only 2 ball bearings. Rotron Mfg. Co., Schoonmaker Lane, Woodstock, N. Y.



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ANCHOR NUT

A new self-sealing floating anchor nut has been developed. It is designed for use in pressurized cabins, covkpits, and other areas where positive sealing against gases and liquids is required. Known as part No. F1968, it contains an integrally molded rubber seal to provide "tolerance-free" sealing, thus eliminating the inconvenience and uncertainty of using sealing compounds to accomplish the same purpose. Featuring rigid construction, it provides increased resistance against deflection under push-out conditions. Kaylock Div., Kaynor Co., Los Angeles.

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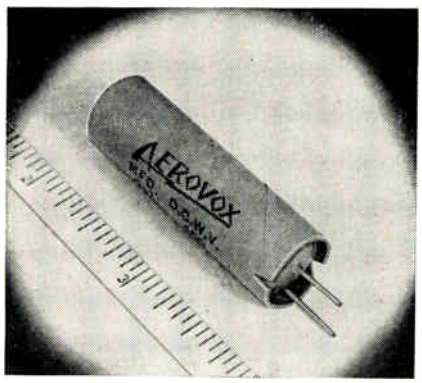
PAPER CAPACITOR

Availability of a new, economical upright mounting capacitor, especially for printed-wiring assemblies is Type P-156. It consists of the time-and-service proven standard paper tubular capacitor adapted for upright mounting by means of an outer insulating sleeve. Provision is made at the base of the capacitor to permit free circulation of air. The outer lead always indicates outside foil. Standard packaging includes a new styrofoam pad to keep all leads clean and straight and to facilitate handling on assembly lines. Aerovox Corp., New Bedford, Mass.



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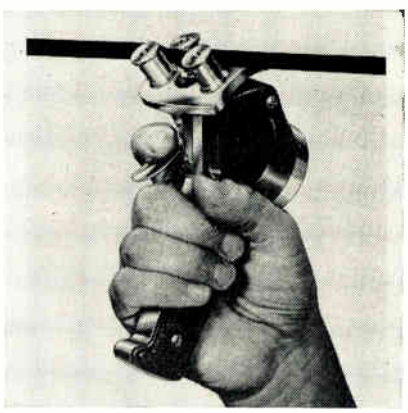
TAPE TENSION METER

A hand-held meter which accurately measures tape tensions for use with magnetic tape recorders has been released. The same instrument can also be used by manufacturers of typewriters, adding machines, and users or makers of narrow fabrics, ribbons, carton tape, and film. The Tension Meter as a range of 0-1000 grams with great resolution in the range of 0-200 grams. It is used extensively in measuring tape transient tensions, such as encountered in sudden braking and starting, during coating, and other processing operations. Tensitron, Inc., Harvard, Mass.



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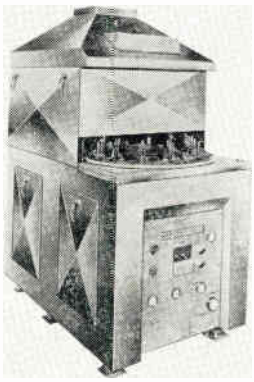
AUTOMATIC SOLDERING

An automatic soldering machine featuring a new concept in feeding solder automatically through magazines to pre-heated parts for solder fabrication has been developed. The



timing mechanism operates and regulates the flame and the exact amount of solder with an index table. It localizes the heat at the point of fabrication in the same manner as it would be done manually, thereby, accomplishing high quality soldering at a greatly increased production rate. The equipment is designed for one operator. It has been named Braze-O-Matic. Castle Machines, Inc., Erie, Pa.

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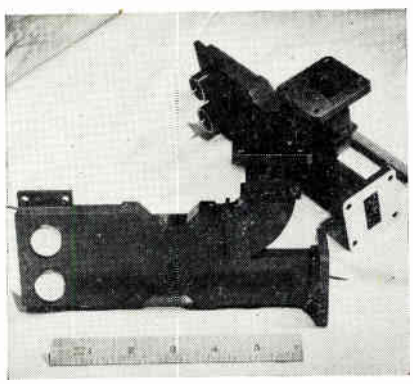
MICROWAVE MIXER

This mixer has been designed and developed to operate over a frequency band from 7800-8200 MC. in RG-51/U size waveguide. It is supplied with standard flanges, UG-51/U; and employs the new 1N23E type crystal diodes. The i-f outputs are solder lugs for this unit; however, this can readily be modified to any standard or special fitting. Performance has been



optimized so that an input VSWR of 1.25:1 can be assured. The unit can be provided in either brass or aluminum crystals can be supplied in place. Sage Laboratories, Inc., 30 Guinan St., Waltham, Mass.

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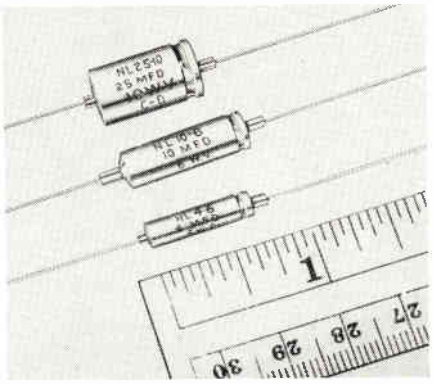
CAPACITORS

Designed expressly for transistorized and printed circuits, and other compact or miniaturized low-voltage dc equipment, the new Type NL electrolytics meet the demand for ultra-



compactness in bypass, filter and coupling applications. Available in dc working voltages of 1, 3, 6, 10, 15, 25, and 50 v.; in capacitances from 1.0 to 200 μf, and in sizes from 3/16 x ½ in. to ⅜ x 1 in., these units can be operated within the temperature range of −20° to +85°C. Extremely low dc leakage current. Cornell-Dubilier Electric Corp., South Plainfield, N. J.

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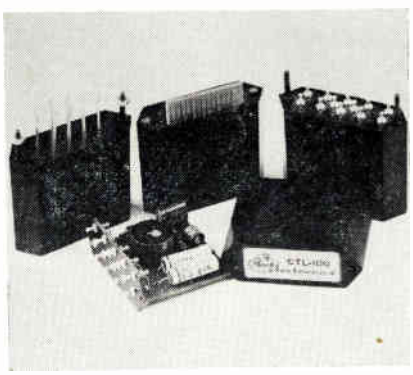
LOGICAL ELEMENT

These building blocks use one transistor and one rectangular hysteresis loop magnetic core per element. All logical functions can be economically implemented with these units, by their inherent ability to perform logical OR, logical inhibit, and data storage. Units feature low power, compactness, versatility, wide operating ranges, and long life. The power supply requirement is 12 v. ±20%. Available

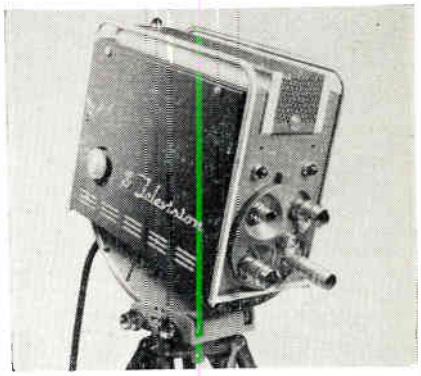


at two rated operating ranges of 0 to 50,000 and 100,000 bits/sec. A line of drivers supplement these blocks. Mack Electronics, Div. of Mack Trucks, Inc., 40 Leon St., Boston 15, Mass.

Circle 159 on Inquiry Card, page 97

STUDIO CAMERA

A highly simplified black-and-white TV studio camera, engineered with a vidicon pickup tube and advanced electronic circuitry for maximum economy in studio on-air or closed-circuit

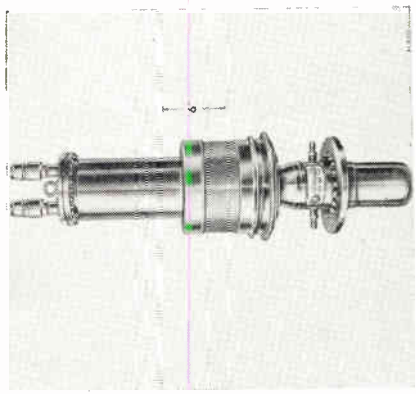


telecasting is now available. Features of the camera include: a 7-in. kinescope viewfinder, built-in video operating controls, one-man operation, a new type non-linear optical focus, a four-lens turret, and self-contained variable gamma circuit which provides highest quality gray scale rendition. Broadcast & TV Equipment Dept., Radio Corp. of America, Camden, N. J.

Circle 160 on Inquiry Card, page 97

500-KW BEAM TRIODE

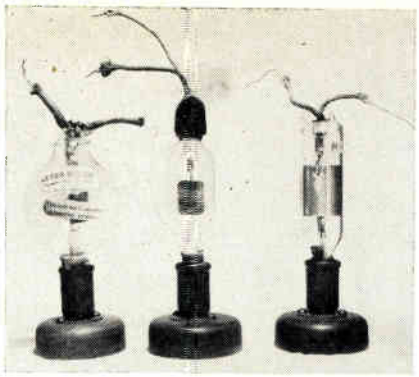
A new super-power, water-cooled shielded-grid beam triode of unique design (RCA-6949), capable of generating useful continuous r-f power in the order of 500,000 w. at high efficiency with exceptionally low driving power has been developed. Its shielded-grid construction permits separation of the r-f input and output circuits and makes feasible grid-driven



operation at very-high frequencies. It is useful as a Class C r-f power amplifier either modulated or unmodulated, and as a linear r-f power amplifier in SSB service. RCA Tube Div., Harrison, N. J.

Circle 161 on Inquiry Card, page 97

SEE THIS AT IRE



Pictured above are some of the early audion tubes and detectors developed by Dr. Lee DeForest—which are included in the historic exhibit. "Cavalcade of Electronics" by International Rectifier Corp., of El Segundo, California. The exhibit, being presented at the IRE Show includes approximately 18 of these prototypes and covers the period 1880-1957.

Flight Simulator Uses TV Projection

To add more and more realism to their flight simulators, Link Aviation, Inc., Binghamton, N. Y., will utilize TV cameras and projectors in the simulators they are now designing for use with the DC-8, Boeing 707, and the Lockheed Electra.

These aircraft are multi-jet, commercial transports. Not only has Douglas Aircraft Co., designer of the DC-8, ordered a jet transport flight simulator but also the airline. United Air Lines is the first airline to ever purchase a jet flight simulator.

The TV camera is mounted on a dolly and is so mounted as to give three-dimensional motion. Progress of the dolly along rails parallel to a panorama of a runway, with associated scenery, is controlled by the controls that would govern the speed of the aircraft in flight.

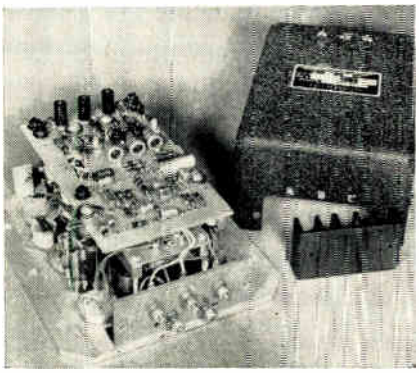
The horizontal position of the plane is obtained by vertical motion of the camera on the dolly. The reason for this is simple. The panorama is mounted on a wall—this accounts for the interchanging of the vertical and horizontal axes. The vertical position of the plane is accomplished by motion of the camera, and associated angled mirror in a horizontal plane.

The projector is mounted above the cockpit of the transport and casts the image on a regular TV screen placed in front of the nose of the plane.

New Products

TRANSISTORIZED INVERTER

This inverter is a transistorized device, with power handling capability in the order of 300 va. Advantages of the unit: The CW-1029 weighs 5.5 lbs. and its volume is 96 cu. in. It requires



no servicing, and its life is estimated in excess of 10,000 hrs. of operation. The inverter will withstand vibrations of 10 Gs, between 10 and 2000 cps. Voltage modulation will not exceed .25%. It controls 400 cps to ±.2 cycles. No radio interference filters because there are no brushes to arc. Electrosolids Corp., 7436 Varna St., No. Hollywood, Calif.

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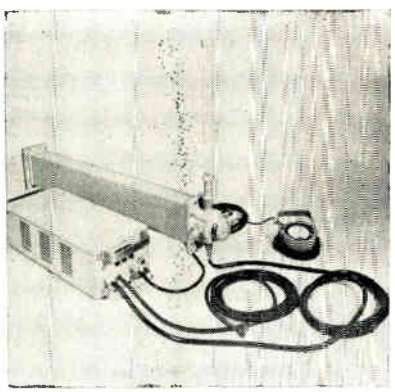
DUMMY LOAD

A new high-power, L-band, dummy load with direct indicating calorimetric wattmeter is now available. The light-weight load element of the dummy load is composed of two tapered fluid elements of molded fiberglass construction which is centered inside of a four foot long section of aluminum waveguide. A remote heat-exchanger unit pumps a constant volume of glossy liquid through the ta-



pered fiberglass elements. The liquid absorbs the microwave energy; the heat is dissipated by the exchanger. Operates in the 1150 to 1750 MC range. WacLine, Inc., 35 So. St. Clair St., Dayton 2.

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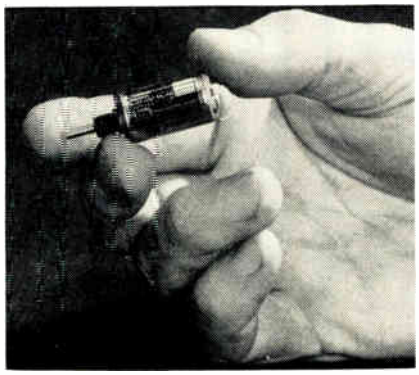
PRECISION POT

Weighing only 10 grams and no larger in diameter than a fountain pen, a new Series 341 ten-turn precision potentiometer is being manufactured. It is built in a metallic shell



1⅛ in. long and 17/32 in. in dia. The phase shift (20,000 ohm) is less than 0.1 degree at 400 cps. Its backlash is essentially zero. It has a best practical linearity tolerance of 0.1%. Power rating is 1 w. at 25°C ambient. Vibration range is 10 G's to 500 cps (3 attitudes). Daystrom Potentiometer Div., Daystrom Pacific, 11150 La Grange Ave., Los Angeles 25, Calif.

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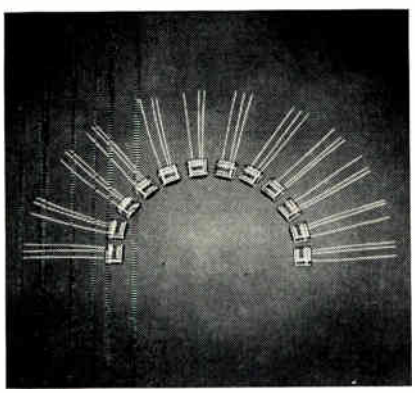
HIGH TEMP. TRANSISTOR

High quality npn grown junction high temperature type silicon transistors are now available. They offer these advantages: Improved power gains, from 34 to 40 db depending on the type. Increased emitter diode ratings make possible employment in large signal applications as found in computers, servos and magnetic amplifiers. Decreased leakage current ratings, and lower series resistance on



the collector side make switching applications more feasible. They also have the virtue of operating at very high temperatures. Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson 3, N. J.

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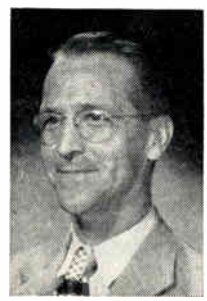
A change of address requires four weeks notice. Please notify the Circulation Department, ELECTRONIC INDUSTRIES & Tele-Tech, Chestnut & 56th Sts., Philadelphia 39, Pa., as early as possible. Include, if you can, the imprinted strip on the magazine wrapper showing exactly how it is now addressed. This will enable us to put the change into effect with a minimum of delay. Also, please notify your local postmaster.

IRE "Fellows . . .

(*Continued from page 65*)

activity even more than home television changed the entertainment habits of the American public. It is safe to assume that we will see within the next five years at least five national closed circuit television networks serving our industrial market and coupled with this thousands of applications of closed circuit television in our factories, mines, construction and allied industries."

A. H. Waynick, Penna. State Univ.— "It appears evident that the field of engineering education, particularly in electrical engineering, is in a phase of great and rapid transition. This results from the great complexity and variety of devices and equipments which now lie within the province of the electrical engineer and, in particular, the electronics man. The days of the "handbook" electrical engineer are now in the past and the electrical engineer of the present and the future must be essentially an applied scientist."



A. H. Waynick

S. Frankel

Sidney Frankel, Litton Industries— "Inherent in the endless duel for supremacy between radar equipments and the countermeasures developed to neutralize them is a highly productive pace of technological advancements But as the frontiers are pushed forward a very real challenge remains to improve the reliability and simplicity of maintenance of the equipment developed. The immediate future must witness great progress along these lines. . . ."

G. Hok

F. L. Ankenbrandt

Gunnar Hok, Univ. of Michigan—"Recent advances in the microwave art, solid-state electronics, and information theory promise to provide vastly more efficient communication and entertainment in the future. Broad-band low-noise electron tubes, maser amplifiers and other solid-state devices as well as new methods of coding information will give the design engineer the tools for reducing bulk and power requirements and improving the performance of electronic systems."

(Maj. Gen.) F. L. Ankenbrandt, RCA—"As a Lieutenant in the early thirties, I remember the low powered MF and HF radio sets, field wire, field telephones and pigeons Now, some twenty years later, the widespread military use of microwave, radar, carriers, computers, and complex electronics systems of all types was routine Obviously the usage curve is still rising rapidly and the next two decades will see greatly advanced usage of complex electronics systems in every phase of military warfare."

O. Hugo Schuck—"Man's insatiable desire to extend his will makes inevitable further applications of automatic control. In aeronautical control the challenge is particularly great and human limitations hampering. Here flight control and propulsion control are already being combined with navigation and computation into integrated mission control systems. In this as in other control fields the techniques of non-linear operation, quantization, redundancy and self-adaptation will be increasingly applied."

Howard K. Morgan, Bendix Aviation Corp.—"Air navigation will be augmented with automatic dead reckoners, corrected by doppler and fixed periodically by radio aids for more precise navigation. Much needed data links for control signaling will alleviate present frequency change problems and speed communication. Ground equipment probably will interrogate aircraft sequentially."

Dr. O. G. Villard, Jr., Stanford Univ.—"In recent years long distance radio channel capacity has been greatly increased by utilizing the ionosphere's scattering as well as its reflecting power. But the surface has only been scratched. For instance, it has now been demonstrated that signals from an existing low-frequency radio station can be regularly received at the geomagnetic conjugate point in the opposite hemisphere by the so-called "whistler" mode of propagation, by which radio waves penetrate the ionosphere and travel thousands of miles into space, guided by the earth's magnetic field lines. These new breakthroughs make research on the ionosphere an especially exciting field today."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G. S. Field


G. C. Gross


O. Hugo Schuck


C. D. Tuska

Eliminate Transistor Burnout

(*Continued from page 71*)

New Approach

In view of these facts, a different approach becomes interesting, namely an electrical reversal of a transistor's polarity with the aid of additional circuit elements. The simplest arrangement of this type is the back-to-back connection of two transistors diagrammed in Fig. 1a. More satisfactory is the device illustrated in Fig. 1b whose collector junctions are protected from being biased in the forward direction by two diodes. Perfect symmetry in both directions requires matched transistors.

Another approach is the paralleling of two transistors with opposite types of conductivity. Fig. 1c shows the circuitry including two protective diodes. A close inspection reveals output and input signals in phase so that opposite collector currents require input signals of opposite polarity. This is in contradiction to truly symmetrical units.

Diode Protection

Much better is the conversion of a single transistor into a symmetrical device with the aid of diodes. Fig. 1d illustrates the fundamental arrangement in the form of a standard transistor forming the diagonal branch of a ring modulator or rectifier bridge. In such a case, the polarity of the diodes determines the polarity of the supply voltage across the transistor so that the transistor "sees" the supply battery always with the correct polarity. Consequently, this "Terminal Symmetrical Transistor" exhibits standard characteristics and parameters regardless of battery polarity. In this way, special switching transistors with excellent transient response and large power handling capacity can be utilized without involving matching problems and response times of the diodes.

Terminal Symmetry

The "Terminal Symmetrical Transistor" may be utilized in the common-emitter configuration diagrammed in Fig. 2a with the base biased via the leak resistor R_b. A laboratory model containing a silicon transistor surrounded by four silicon diodes was mounted and soldered to a plug that fits a 7-pin miniature socket. In a transistor tester, the parameters can be measured with either polarity of the supply voltage, i.e., with the polarity switch in the npn—or pnp—position. For extra large current gain, a tandem transistor[1] may be inserted into the ring modulator and thus converted into a "Terminal Symmetric Tandem Unit."

The similarity between the Terminal Symmetrical Transistor and an inherently symmetrical specimen suggests equivalent applications, for example, in clamp circuits, phase—or FM—detectors, etc.[2] In addition the Terminal Symmetrical Transistor can be used in different stages of any transistor apparatus such as hearing aids, radio receivers, and the like. In such a case, the battery polarity does not matter, provided the capacitors are of the bipolar type.

Fool-Proof Sets

A further simplification is a bipolar transistor set in which the battery is connected to a complete transistor set through a ring modulator. Fig. 5 illustrates the circuitry in which the transistor set always "sees" the battery through the diodes with correct polarity. Future transistor apparatus may not require polarity marks for their batteries and replacement of the battery will be fool-proof.

References

1) H. E. Hollmann: "Applications for Tandem Transistors," Tele-Tech and Electronic Industries, Feb. 1956, p. 58 ff.
2) G. C. Sziklai: "Symmetrical Properties of Transistors and Their Applications," Proc. IRE, vol. 41, 1953, pp. 717-724.

SOLDERING GUN SIGNAL GENERATOR — Low frequency field established by tip of an energized soldering gun can be substituted as a signal source, thus avoiding need to move TV set to a signal generator. Loss of sound would indicate trouble in audio amplifier section; if gun tip is held near grid circuit of audio amplifier, the low frequency hum of guns becomes audible and can indicate any defect.

ELECTRONIC INDUSTRIES & Tele-Tech Advertisers — Apr. 1957

*In Operations Section Only

NEW COMPUTER

European aircraft, industrial, engineering, and research firms will use this ALWAC Computer, manufactured by Alwac Corp., to be installed in the Autronic Computing Center, Stockholm.

Chromation to be Developed

The Emeryville, California experimental and development facilities of Chromatic Television Laboratories, Inc., has been acquired by Litton Industries from Paramount Pictures Corporation.

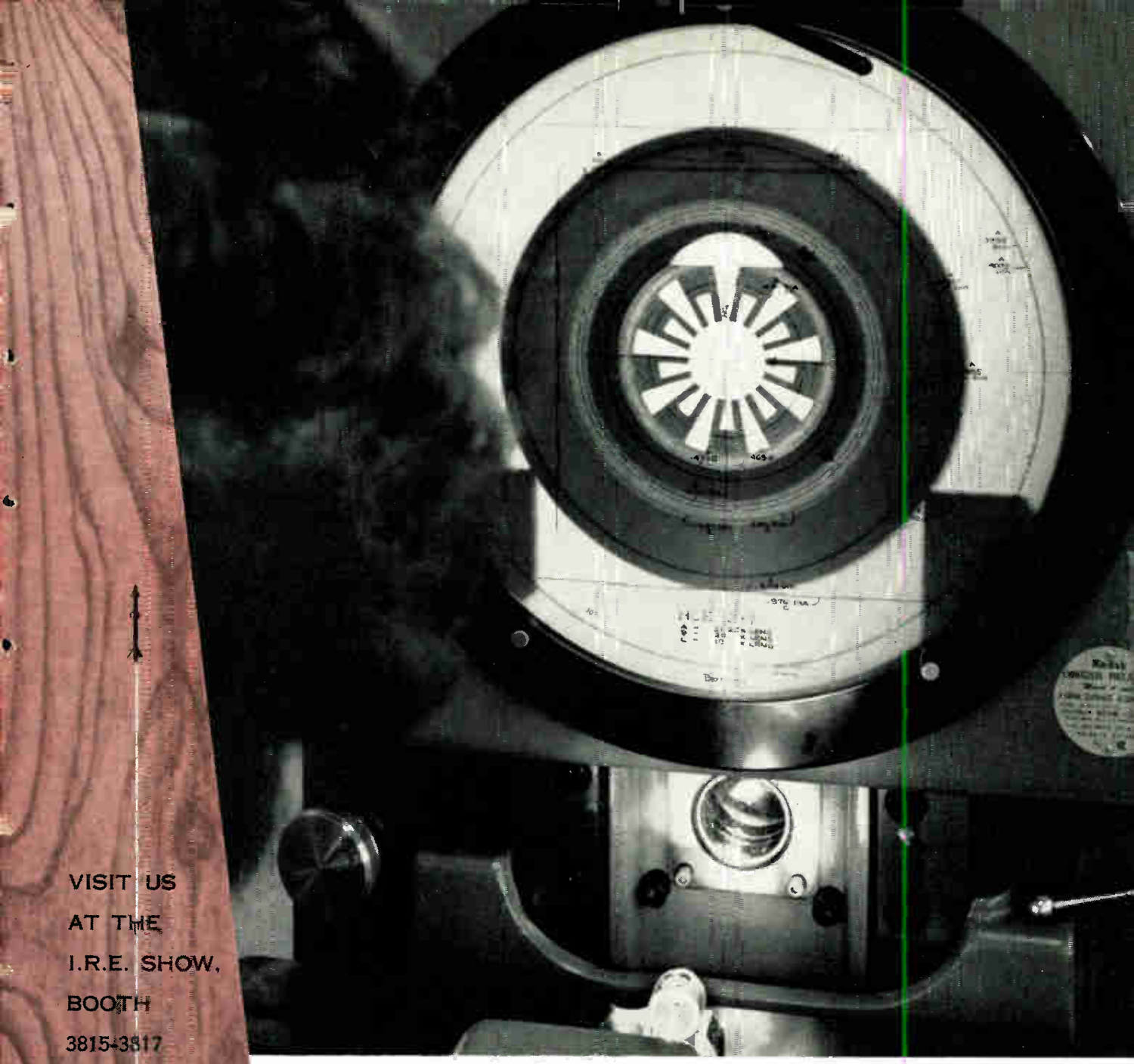
Chromatic is the developer of the unique Lawrence color television tube invented by Nobel Prize-winner Dr. Ernest O. Lawrence.

The Lawrence tube makes possible selective color displays in radar presentations, and opens the way to new progress in many important areas of military and industrial application.

In air traffic control, for example, automatic presentation of the landing airplanes in one color, planes taking off in a second color, and planes within a given distance in a third color, on the display panel is now possible.

Developments already underway foretell the advent of equipment which, through the use of color, will vastly improve the speed and accuracy with which a human operator will be able to understand complex situations being displayed, greatly aiding control of moving objects in spite of the extra-ordinary speed at which modern planes and missiles, as well as physical and chemical reactions, move.

The unique feature of the Lawrence tube is that color selection takes place at the screen surface of the cathode ray tube, rather than at the gun.



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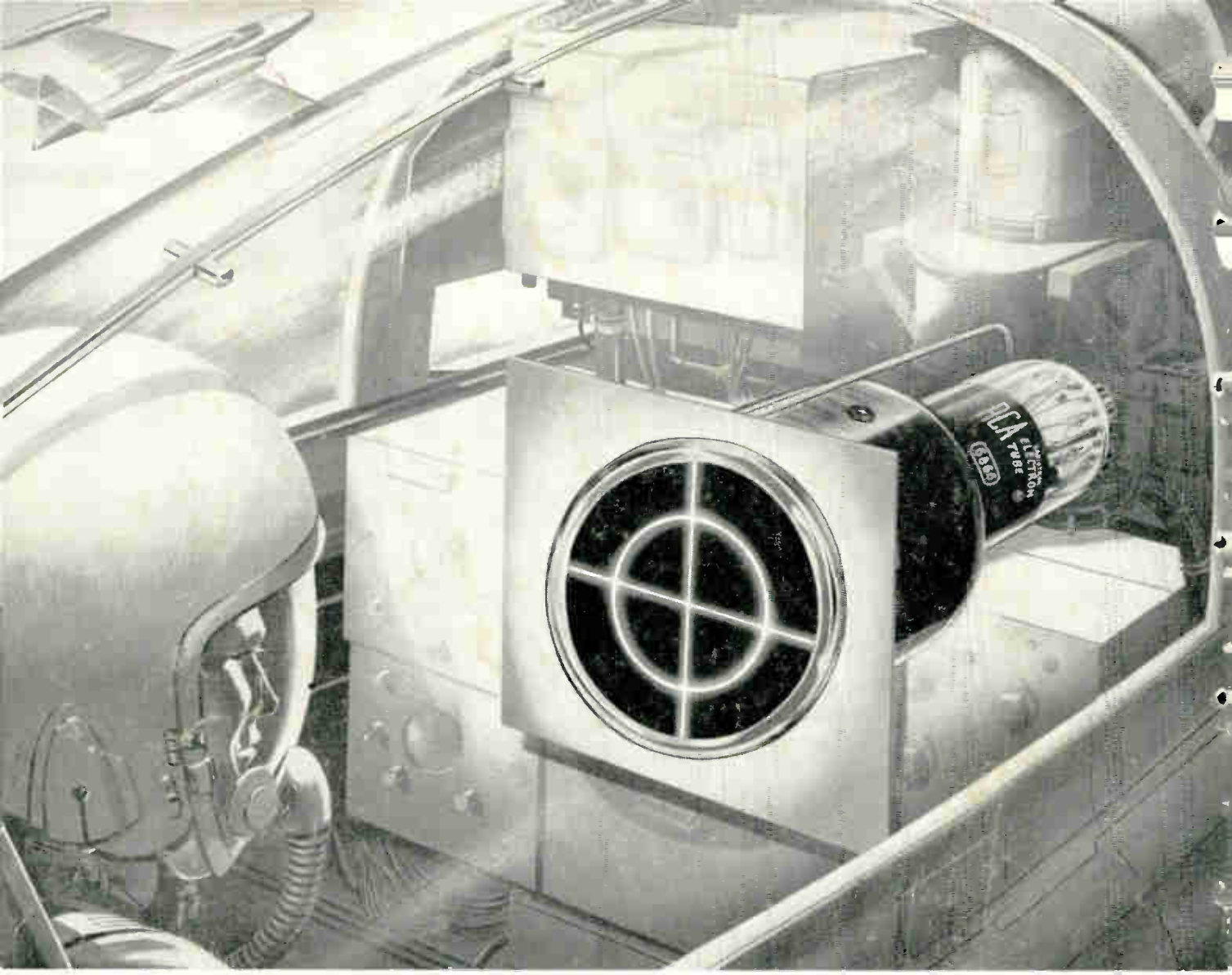

He "reads" his radar data...

IN BRIGHT DAYLIGHT

No hood needed for this presentation, because the RCA-6866 Display Storage Tube pictured here produces an average display brightness of 1750 foot-lamberts—brilliant enough to view directly in bright daylight!

In addition to its application in military electronics, RCA-6866 offers many exclusive features of special interest to equipment designers in the field of electronic data processing. For example, RCA-6866 can present non-flickering display of electronic information—for as long as 60 seconds after writing stops. It can "write" at speeds as high as 300,000 inches per second—fast enough to "freeze" microsecond transients for visual or photographic examination.

Are you working with airplane-cockpit radar—fire-control radar—airport surveillance—transient studies—data transmission, including half-tones—visual communications via narrow-bandwidth transmission? If you are, then don't overlook the unique advantages of the RCA-6866.

For technical bulletin on the 6866, write RCA, Commercial Engineering, Section D 50 O, Harrison, N. J. For sales information on this and on other RCA display storage tubes now in development...contact the RCA Field Office nearest you.

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Tube Division Harrison, N. J.