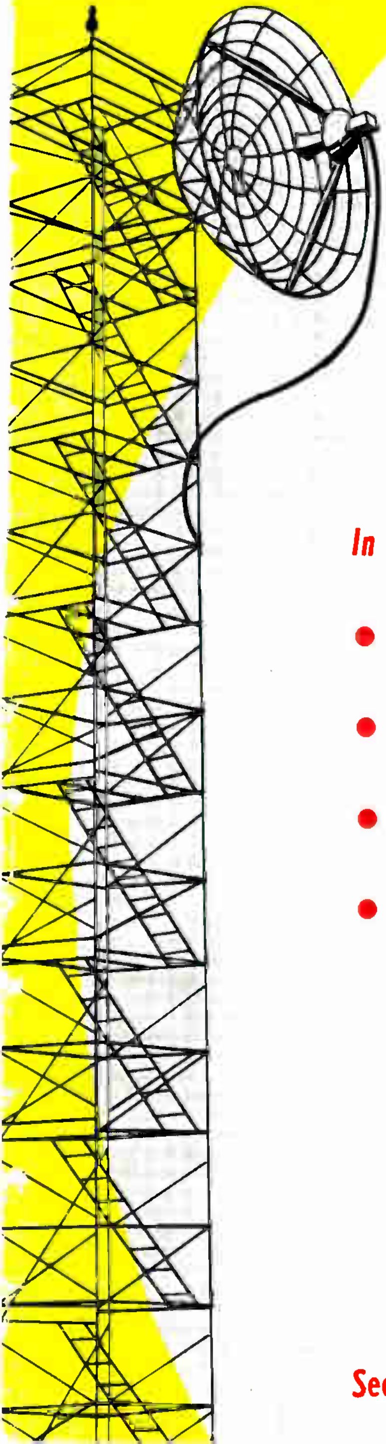
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

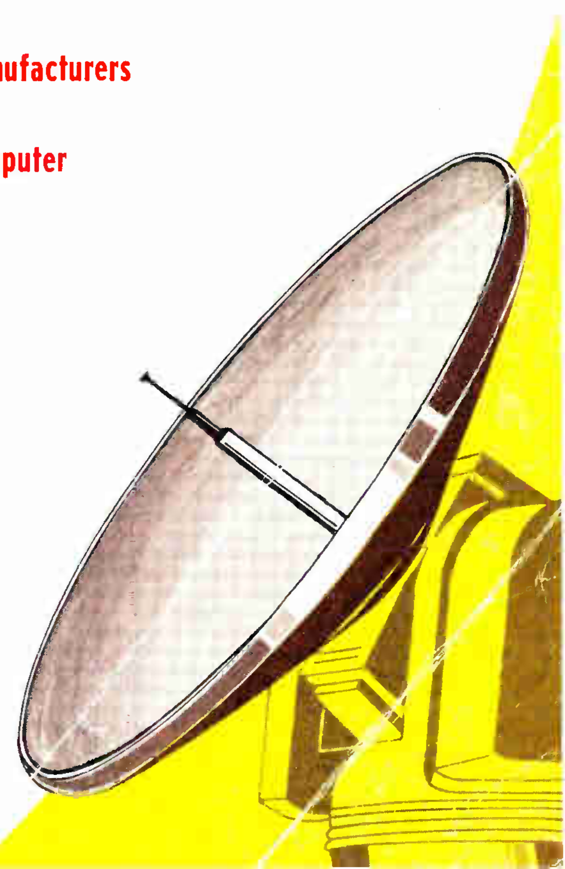
November
1960



8th Annual Microwave Issue

In this issue:

- 1961 Directory of Microwave Equipment Manufacturers
- Finding Radar Pattern Equations with a Computer
- Technical Specs for Microwave Power Tubes
- Future Trends in Microwave Beam Tubes



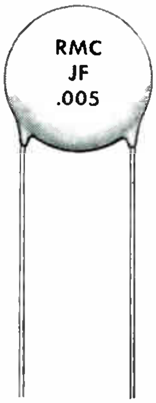
See pages 2 and 3 for complete contents

FLUCTUATING FREQUENCIES

can't upset

RMC "JF" DISCAPS

Type JF DISCAPS exhibit a characteristic frequency stability that is superior to similar capacitors. These DISCAPS show a capacity change of only $\pm 7.5\%$ over the range between $+10^{\circ}$ and $+85^{\circ}$C. Manufactured in capacities between 150 MMF and 10,000 MMF, Type JF DISCAPS are rated at 1000 V.D.C. Write on your letterhead for information on these and other quality RMC DISCAPS.



DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY

A DIVISION OF P. R. MALLORY & CO., INC.

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

Best Wishes to ESMA

In earlier editorials we pointed to the fact that the gross national product of the electronic industries was more than 50% military, and that there was considerable erosion of consumer product dollar volume due to foreign imports. If the electronic industries are to remain strong, grow, and stabilize it seems logical that they must also expand into hitherto unexplored realms. New electronic markets must be located and developed!

We are happy to report that something positive along these lines is now under way. At the WESCON show in August a new association called ESMA, of the Electronic Sales Managers Association, was formed. A first, very successful, meeting was held during the National Electronics Conference last month in Chicago. At this meeting a printed statement of the Association's purpose was distributed. This states:

The purpose for which this association is formed and the projects to be carried on and promoted by it are as follows:

a. To sponsor the improvement of marketing techniques, communications and policies in the electronics industry.

b. To provide for the mutual exchange of electronic marketing and sales management information.

c. To promote, by creative sales management the growth of electronics through the maximum utilization of our expanding electronic technology.

d. To advance the science and stature of the electronics sales management profession.

e. To promote, encourage and sponsor projects and programs which will attract and develop high calibre technical sales management personnel.

f. To promote fellowship and cooperation among sales managers and other groups and associations within the electronics industry.

Membership in the organization is on an individual basis with dues being $50.00 per year for the first member of each firm and $25.00 for each additional member. To date there are 42 full memberships and approximately 50 applications, with more coming in each day. The next all-member meeting will be held in New York City during the time of the National IRE Show, and the next executive committee meeting will be held during the forthcoming NEREM Conference in Boston this month. Present officers of the new association are: C. G. (Spec) Barker, Filtors Inc., President; Ward Brody, Consolidated Electrodynamics, Vice President; Jack Bisby, Airborne Instrument Laboratories, Secretary-Treasurer. Members of the Executive Committee include: Robert A. Bailey, International Resistance Corp.; Arthur B. Williams, Engineered Electronics Corp.; and Morton Scheraga, Analab International Corp.

The first objective will be to canvass every member and interested party to obtain a list of primary problems confronting each person's organization. These will be reviewed and consolidated to establish those of utmost overall importance on which the Association will concentrate. There are still three vacancies for committee chairmen who are later also to become members of the Executive Committee. Sub-Committees now being formed include By-Laws, Financial, Show Policy, Programs and Membership.

We extend our very best wishes for the success of ESMA. We believe that the discussions and activities of such a group can go a long way toward establishing new markets for electronic products in other industries. We are also favorably inclined to the individual membership plan. Many of today's electronic companies were formed by electronic engineers. Individual memberships will enable many of today's similarly ambitious engineers to obtain a prior exposure to modern marketing techniques, problems, and competition. This is in turn will tend to assure a greater percentage of "successes" in the new enterprises which our industry needs . . . regardless of whether new companies are formed or if established companies re-orient their productive efforts.

ROBERT E. McKENNA, Publisher
BERNARD F. OSBAHR, Editor

CREIGHTON M. MARCOTT
Managing Editor
RICHARD G. STRANIX
JOHN E. HICKEY, Jr.
Associate Editors
CHRISTOPHER CELENT
Assistant Editor
DR. ALBERT F. MURRAY
Contributing Editor
ROLAND C. DAVIES
Washington News
MARIE T. McBRIDE
Directory Editor
ELMER KETTERER
Art Editor
IDA M. GOOD
Editorial Secretary
MAE E. MOYER
Readers' Service

EDITORIAL CORRESPONDENTS

Washington—1093 National Press Bldg.
GEORGE BAKER
NEIL R. REGEIMBAL
DAVID R. HEINLY

BUSINESS DEPARTMENT

ELMER DALTON
Circulation Manager
DONALD J. MORAN
Marketing Manager
GORDON HERNDON
Production Manager

REGIONAL SALES MANAGERS

Philadelphia (39)—56th & Chestnut Sts.
SHerwood 8-2000
JOSEPH DRUCKER

New York (17)—100 East 42nd St.
OXford 7-3400
GERALD B. PELISSIER
Metropolitan N. Y.
MENARD DOSWELL III
New England

Chicago (1)—360 N. Michigan Ave.
RAndolph 6-2166
GEORGE H. FELT

Cleveland (15)—930 Keith Bldg.
SUperior 1-2860
SHELBY A. McMILLION

Los Angeles (57)—198 S. Alvarado St.
DUnkirk 7-4337
B. WESLEY OLSON

San Francisco (3)—1355 Market St.
UNderhill 1-9737
DON MAY

Atlanta (3)—911 William-Oliver Bldg.
JAckson 3-6791
JOHN W. SANGSTON

Dallas (6)—Meadows Bldg., Expressway at Milton
EMerson 8-47
HAROLD E. MOTT

London, S. W. (1)—67/68 Jermyn St. St. James'
MAX F. HOLSINGER

JOHN H. KOFRON
Chilton Research Director

G. C. BUZBY, President
Vice Presidents: P. M. Fahrendorf, Leonard V. Rowlands, George T. Hook, Robert E. McKenna; Treasurer, William H. Vallar; Directors: Maurice E. Cox, Frank P. Tighe, Everit B. Terhune, Jr., Russell W. Case, Jr., Charles A. S. Heinle, John H. Kofron, George E. Cameron. Washington member of the Editorial Board, Paul Wooton.

Comptroller, Stanley Appleby.

Cable Address—"CHILTON PHILADELPHIA"

ELECTRONIC INDUSTRIES, November, 1960. Vol. 19, No. 11. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Accepted as controlled circulation publication at Phila., Pa. $1 a copy; Directory Issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 19, No. 11 November, 1960

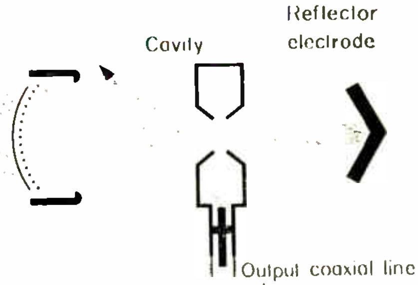
MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

BPA NBP

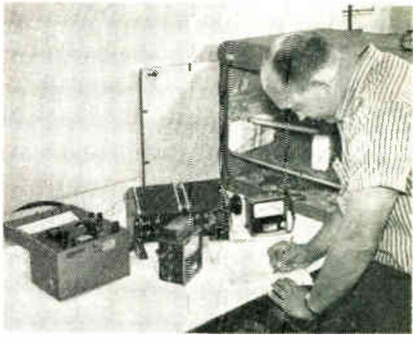
Highlights of this issue



Microwave Beam Tubes

Future Trends in Microwave Beam Tubes — page 70

The relevant technology of microwave beam tubes has been refined to the point where manufacture is highly competitive. However hazardous predictions may be, there is a need for information on which to base future plans.

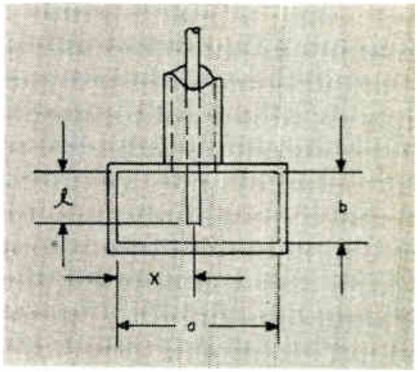

Coaxial Lines

Determining Temperature Rise of Coaxial Lines — page 78

Manufacturers frequently give data for only one center conductor temperature and one ambient temperature. It is often difficult to extrapolate temperature data for other power levels and other ambient temperatures. Here is a method which simulates electrical loss without applying microwave energy. It produces a maximum amount of data with a minimum expense in time and also a minimum expense in money.

At Microwave Frequencies . . . Determining Dielectric Constants — page 86

New dielectric materials for microwave and antenna use create a need for fast, accurate determining of dielectric constants and dissipation factors. Most commercial dielectrometers are too expensive for occasional laboratory use. This method uses existing equipment.



Rotary Waveguide Joints

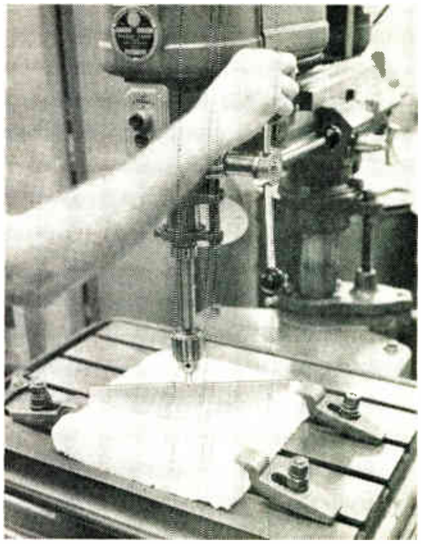
Finding Radar Pattern Equations With a Computer — page 89

The expression for the far field antenna pattern on a horizontal plane does not lend itself to convenient analytical manipulation. Also, it is inexact if applied to the pattern of an antenna enclosed within a radome. Approximations are sought which facilitate computation and design. These have acceptable accuracy and analytical convenience.

Make Your Own Waveguide Bends — page 241

Costs can be sharply reduced on custom waveguide installations by bending and twisting your own waveguide. With the simple bender described here, relatively unskilled persons can make these bends and twists.

Antenna Test Parabolas



1961 Microwave Power Tube Chart — page 135

The most comprehensive listing of microwave tubes in the industry, this chart provides technical specifications on magnetrons, klytrons, traveling wave tubes, backward wave tubes, and planar triodes available commercially.

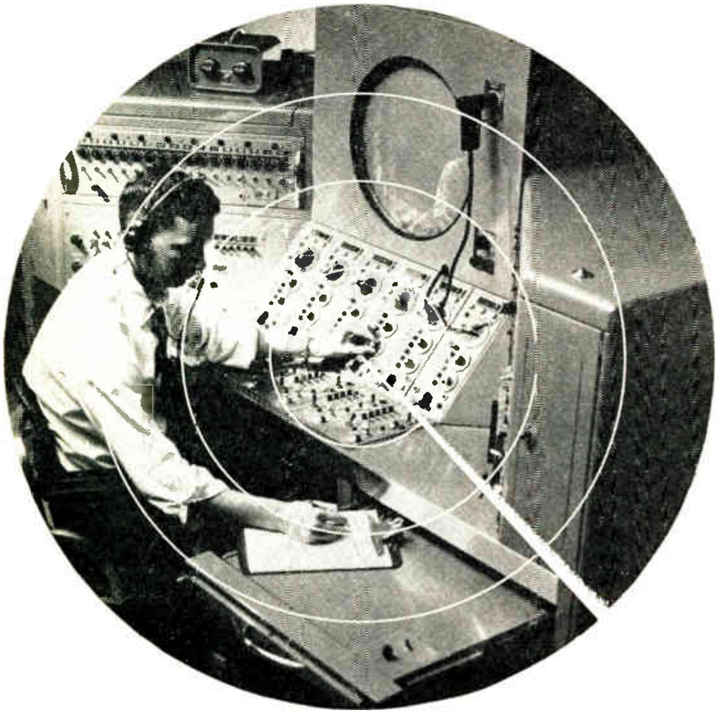
Designing Rotary Waveguide Joints — page 94

The theory of probe type transitions for radar antennas between rectangular waveguide and coaxial line is summarized. The design of rotary joints using these transitions is discussed. A rotary joint design with low VSWR for the 8.8 to 10.4 KMC range is presented.

Build Antenna Test Parabolas—Fast — page 98

Building antenna test parabolas often takes weeks of engineering time. Here is a new tool—the Para-Shaper—which can do the job quickly, economically and with the same accuracy as conventional methods.

RADARSCOPE



NEW AIR TRAFFIC CONTROL SYSTEM

"Volscan" system of air traffic control, being developed at Avco's Electronics & Ordnance Div., makes it possible for 120 aircraft to takeoff and land each hour. Here operator at one of the "Volscan" consoles is setting in initial data for an aircraft's approach.

SCIENTISTS AND SCIENCE TEACHERS have been invited by the National Science Foundation to submit proposals for the development of prototypes of new laboratory equipment for use in the Nation's schools and colleges. NSF is at 1951 Constitution Ave. N.W., Washington 25, D. C.

SHIPMENTS OF RADIO receivers and radio phonographs in 1959 reached a new high for the decade, totaling more than 16 million units and a value of almost $424 million.

GRADUATE ENROLLMENTS have been rising steadily in recent years. It will be interesting to see whether the increasing demands for engineers will affect this trend.

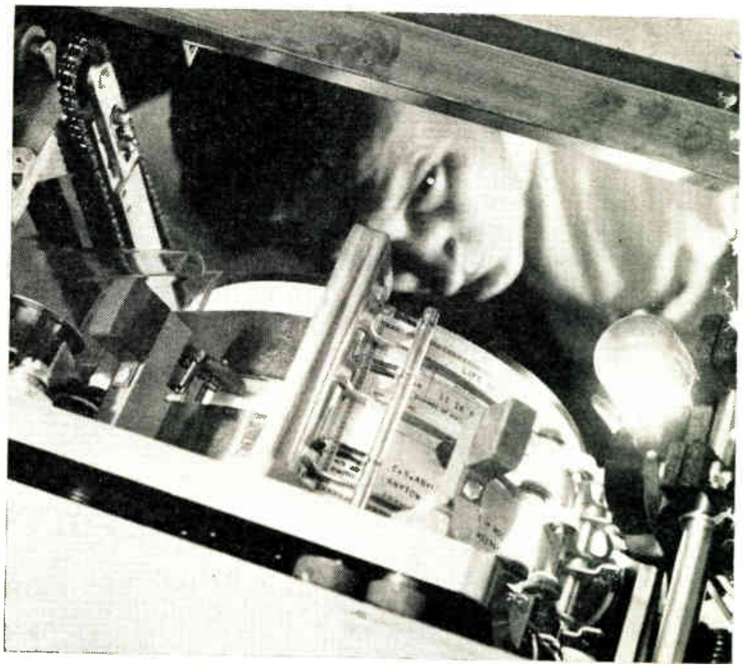
INTER-LANGUAGE CONVERSATIONS from continent to continent will be possible within the next 20 years, predicts Dr. Edwin G. Schneider of Sylvania Electronic Products, Inc. "Automatic translation of transoceanic conversations," he says, "will be performed through advanced communications and data processing devices." Among the other possibilities for the future he sees 2-way wireless telephone calls by pedestrians using 2-way pocket radios the size of a package of cigarettes; and transmission of still photographs through the telephone system at moderate cost.

JAPANESE EXPORTS of electronic products to the United States in the first six months of 1960 totalled $38.7 million, compared with $22.1 million during the same period last year, reports the Electronics Div., Business and Defense Services Administration, U. S. Dept. of Commerce. The April-June quarter this year, the export total—22.8 million—was 1 million in excess of shipments to the U. S. for the entire year of 1958. The 1959 exports were $75.6 million. Radio receivers are accounting for 77% of all Japanese exports in electronic products to the U. S.

DON'T LEAN ON THE GOVERNMENT for help in supporting research and development," warns Lt. Gen. Arthur G. Trudeau, U. S. Army's Chief of Research and Development. "The expenditures from military R&D will remain at the current annual figure of $5 billion," he said. But more companies "must face the facts of a cold-war world and perceive that some reasonable percentage of gross sales or profits must be flatly earmarked for the exclusive use of basic and supporting research. There is too much effort devoted in some industries to merely selling today's hardware." "The current lead-time," said Gen. Trudeau, "from conception of a new weapon until its delivery is 7 to 8 years here in the U. S. Russia does a comparable job in 5 years."

READING PRINTED DATA

IBM engineer inspects a reading station in the company's new 1418 optical character reader. By exclusive scanning method the 1418 reads typewritten or printed numbers recorded in ordinary ink. The information is fed directly into the storage of an IBM computer for processing at electronic speeds.



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

ONE OF INDUSTRY'S keenest competitors for personnel is the Wright Air Development Div. of ARDC, Wright-Patterson Air Force Base, Ohio. The Development Div. has established more than 450 new professional positions for physicists, metallurgists, aeronautical, ceramic, electrical, electronic, instrumentation, and mechanical engineers at all degree levels, and with or without experience.

"INERTIAL GUIDANCE for merchant vessels should soon become a practical reality," says Frederick Stevens, Vice-President and Manager of Electronic Systems & Equipment Dept. of Nortronics, Div. of Northrup Corp. Stevens points out that there is no significant difference between navigational problems of airborne vehicles and seaborne vessels. There is a great need for increased precision in maritime navigation and inertial guidance seems to fit all requirements. "Star tracking" telescopes of the Astro-inertial system contract pre-selected stars and compare observed star lines with precomputed star lines on the ship's path. When differences exist, the system can give steering commands to correct for these disparities.

RADAR AUGMENTER developed by Lockheed Electronics may mark the end of the drone plane as Air Force targets. The device, which is placed inside a small rocket, magnifies the rocket's "electronic size" many times, making it appear as large as a plane on the radarscope. The target rockets in which the radar augmenters are mounted flies at supersonic speeds, equal to the current speeds of jet fighters and bombers. The augmenters consist of 2 antennas, one antenna receiving the signals sent out by the fighter plane and the second antenna to bounce it back to the fighter plane radarscope. In between is the amplifier which increases the signal. Without the augmenter, the radar cannot pick up the target.

U. S. ELECTRONIC FIRMS dealing abroad are finding increasing difficulty competing with local manufacturers. One of the pet subterfuges now employed is the specification "written around" foreign equipment. The way the specifications are written automatically excludes most American equipment. In Scandinavia, for instance, safety standards for equipment operating from electric power lines automatically exclude U. S. receivers, phonographs, and other electronic equipment. It is becoming so important that the U. S. be a party to international agreements, that the U. S. industry officials are urging that the U. S. Government underwrites the expenses of delegates attending these functions. What brought this to a head is the forthcoming meeting of the International Electro-Technical Commission in New Delhi, India. The traveling expenses for the delegates are so high that no small group of firms in the industries can foot the bill.

MANNED AIRCRAFT will account for about half of next year's $13 billion budget for aerospace projects, predicts Dr. Herbert F. York, Director of the Office of Defense Research and Engineering.

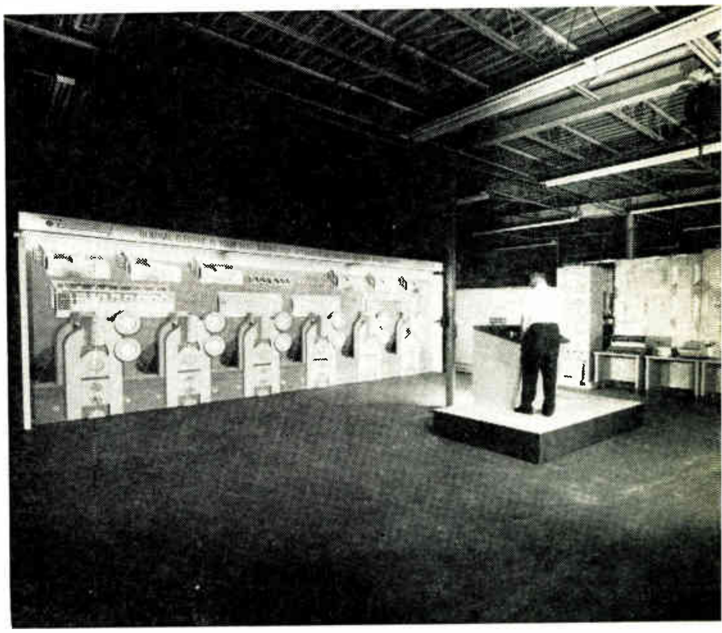
NEW PERMANENT MAGNET material, an isothermally-treated alnico of higher cobalt content, developed by Thomas & Skinner, Inc., Indianapolis, is said to represent a 30% improvement over present high coercive alnicos. The new product has coercive strength in excess of 1300 oersteds and energy levels above 4 million gauss-oersteds. The new material will allow smaller magnetron tubes and BWO tubes and opens the way for smaller diameter electric motors.

AN EXTRA BILLION DOLLARS annually will have to be spent over and above the presently allotted billion and a half, according to Courtney Johnson, Ass't Army Secretary for Logistics, in order to obtain U. S. arms and equipment. He points out a little more than 2% of the $2 billion spent last year went for equipment produced in the arsenals.

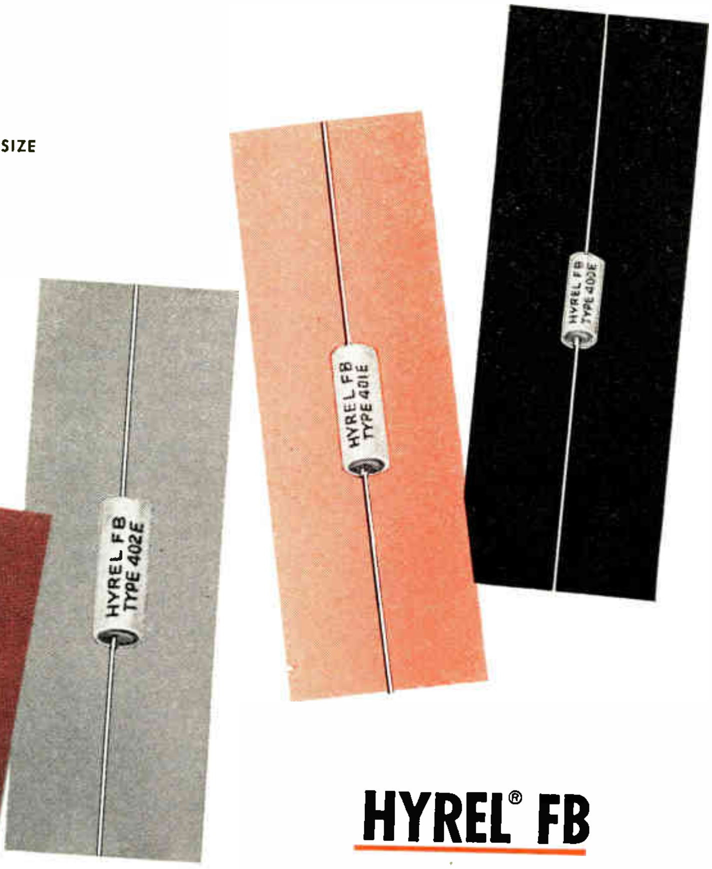
EXPERIMENTAL FUEL CELL that converts unpurified air and ordinary hydrogen gas directly into electric power has been developed by Ionics, Inc. Keys to the process are: 1. Combination of fuel electrode and Ionics, and membrane similar to those used in water desalting plants. 2. Platinum-coated electrode. 3. Bromine-bromide acid solution in cell to facilitate utilization to produce power.

AUTOMATED STEEL MILL

Working simulation of a GE-312 computer-controlled hot strip mill was demonstrated in the General Electric exhibit at the 1960 Iron & Steel Exposition in Cleveland. Operator actually rolls his own steel strip in this "island of automation."



ALL UNITS ACTUAL SIZE



HYREL® FB DEPOSITED CARBON RESISTORS ARE UNMATCHED FOR PERFORMANCE

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

HYREL® FB DEPOSITED CARBON RESISTORS
are hermetically sealed in ceramic jackets against moisture and vapor. . . safely protected against mechanical abuse.
The Hyrel FB series is intended for applications in military, commercial and telephone equipment where long life under high humidity, small size, and stability of electrical characteristics are important.

WRITE FOR ENGINEERING BULLETIN 7010B
SPRAGUE ELECTRIC COMPANY
233 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE®
THE MARK OF RELIABILITY

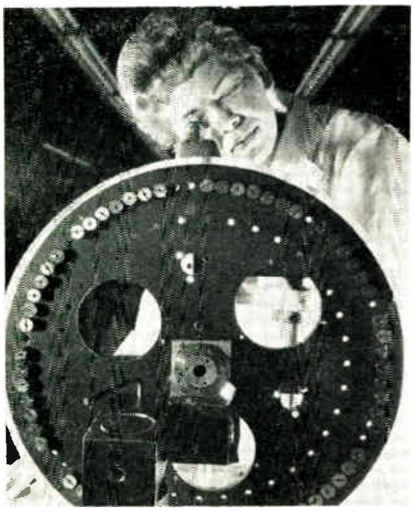
Made to far exceed MIL-R-10509C Specifications

SPRAGUE COMPONENTS:
CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

Circle 2 on Inquiry Card

As We Go To Press . . .

"LOOKING INTO THE MATTER"



Joan Shave "eyes" some of the 60 ultra-thin wires on "spinning wheel" used in making grids for RCA new nuvistor-RCA-6CW4.

AT&T Plans To Launch Its Own Space Satellite

AT&T plans to put the first station of a satellite relay system into space within a year to enable experimental transmission of telephone calls, television, data transmission and other types of communication between the U. S., the U. K. and continental Europe.

The company is now prepared to contract for the launching of the necessary satellites and to proceed with the construction of transmission and receiving stations on the ground, AT&T's Long Lines Depart. stated in an application to the FCC.

The project would be financed and the facilities operated by AT&T, in coordination with telephone administrations abroad—a similar practice for many years in handling overseas communications by cable and radio.

In the development of this project, the company expects to work closely with NASA.

AT&T also asked the FCC for rule changes which would allow the company to proceed, following satisfactory tests, with the initial stages of commercial service.

"We are planning a system that would make use of solar-powered satellites orbiting at an altitude of about 2200 miles," Henry T. Killingsworth, AT&T vice president in charge of Long Lines, said.

"Electronic amplifiers aboard the space stations would catch signals from earth, immediately boost and relay them on to ground stations in the United States, The United Kingdom and western Europe."

The proposed spheres would be four feet in diameter and weigh about 175 pounds. About 60 per cent of the surface would be covered by glass-coated solar cells.

Optical Maser Transmits Light Pulses Over 25 mi.

An optical maser (or "laser") has been used in preliminary experiments in long distance communications by scientists at Bell Telephone Labs. The device transmitted pulses of light between Murray Hill, N. J., and Holmdel, N. J., a distance of about twenty-five miles.

The device generates a beam of "coherent" light—light in which there is a definite phase relationship from point to point in all parts of the beam. The property of coherence in radio waves makes it possible to control, direct and modulate them, so it may be possible to use coherent light in the same way.

(*Continued on page* 234)

Army Courier Satellite Relays 1st Space Photo

The U. S. Army COURIER communication satellite has produced another scientific and practical first for the U. S.—the active radio relay of "space-photos" from a ground station through the satellite and back.

The photograph was sent from the Army Signal Corps ground station at Ft. Monmouth, N. J., to the Army satellite and retransmitted back to earth virtually unchanged in quality.

The electronic relay of photographs, from the time they are inserted into a facsimile machine (which scans photographs and transmits them as electrical pictures) at the ground station, to the time a Polaroid type print is taken from the companion machine on the return, takes five minutes.

Army Signal engineers at the U. S. Army Signal R&D Laboratory, Ft. Monmouth, developers of both the COURIER and the facsimile system, said the process does not involve a passive relay, that is, "bouncing" the photograph off the surface of the bird. The space-photo is actively relayed through the electronic equipment in the satellite in a manner similar to radio-photos on the ground, except that it travels hundreds of miles through space to the satellite and back.

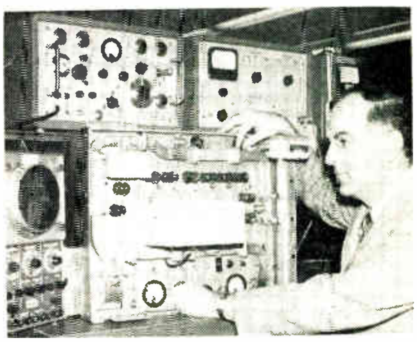
The photographs are sent out from the Army ground station, received by COURIER, and then retransmitted back to the ground station, all during one pass while the satellite is in working range.

The successful result establishes the definite groundwork for satellite storage and relay of all types of facsimile messages — photographs, letters, maps, charts—between properly equipped ground stations throughout the world.

FLIGHT SIMULATOR

Viewing new 3-axis Flight Simulator at Lockheed's Missile and Space Div. in Sunnydale are: (L) Leo K. Yoskowitz, Simulation Laboratory Staff Head; and (R) Roy J. Niewald, Manager, Dynamics Analysis and Simulation Dept.

PARAMETRIC UPCONVERTER



Production model of GE's new parametric up-converter is checked out by Dr. Harry Peppiatt. An incoming signal of 400 MC is converted up to 10,000 MC, and then down to an intermediate frequency, with low noise gain.

More News on Page 8

Electronic SHORTS

▶ Lockheed Aircraft Corp. engineers have developed a new TV system to spy out trouble aboard rockets on their 18,000-mile-an-hour flights. This system will allow engineers on the ground to see design errors and be better prepared to make corrections.

▶ An unmanned plane (drone) and a matching spy system (AN/USD-5) designed for field army level permit surveys of enemy territory, relaying photographic, radar, and infrared data to a field commander, day or night, under all weather conditions. The drone is pre-programmed for its flight and mission. After flight it parachutes into a selected open area.

▶ ONR has received a survey report on the status of digital computers, here and abroad. Isaac L. Auerbach, head of the International Federation of Information Processing Societies, under contract to the Navy, has revealed that China's rapid development of computer technology and automatic control has astounded the Russians. In Western Europe, 31 countries and institutes have developed 64 computer models.

▶ NASA will negotiate with Grumman Aircraft Engineering Corp. on a $23-million contract (not including the experiments) to develop a 1½-ton, eight-sided Orbiting Astronomical Observatory (OAO). Astronomers will use telescopes in the OAO space platform to study cosmic phenomena . . . X-rays, ultraviolet and infrared rays . . . obscured to ground observatories by the earth's atmosphere.

▶ Infrared Traffitrol Detector, designed for in-minutes installation and easy mobility copes with changing traffic patterns. Introduced by the Heiland Div. of Minneapolis-Honeywell Regulator Co., it offers wide flexibility to traffic engineers and law enforcement officials in studying and controlling traffic.

▶ New concept in detection of unannounced satellites utilizes high altitude (20 miles) balloon-borne optical systems for all-sky surveillance. Under development by Electro-Optical Systems, Inc., for the Air Force Geophysics Research Directorate (AFRCL) the device is essentially a balloon-borne telescope with a telemetering link to the ground. It is immune to electronic countermeasures and provides 360-degree hemispherical coverage.

▶ ARDC has awarded GE a $392,000 contract to cover applied research on information processing, evaluation and decision-making in complex operational situations. Interest will focus on Threat Evaluations and Action (TEAS), Combat Operations Control (COC) Systems and work performed by GE's Military Planning Operations (TEMPO) at Santa Barbara, Calif.

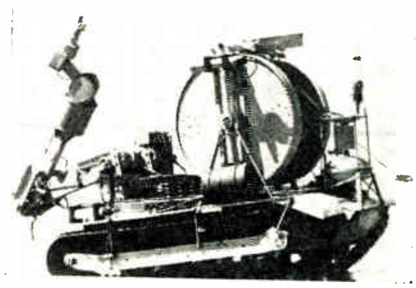
▶ FAA's Bureau of R&D, upon recommendation of FAA's National Aviation Facilities Experimental Center, Atlantic City, N. J., has adopted the British Royal Aircraft Establishment (RAE) Visual Glide Indicator Landing Lights as a national standard for use at U. S. airports.

▶ AEC has awarded General Instrument Corp. a contract for initial research leading to a first-of-its-kind Thermoelectric Generator, as part of its SNAP (Systems For Nuclear Auxiliary Power) Program. Generator will be designed to produce electricity directly from heat of fission products produced in nuclear reactors.

▶ A new photoemissive material translates light into electrical signals permitting "electronic eyes" to operate for long periods at high temperatures (140 hours at 120°C). Material was developed by Westinghouse's Electronic Tube Div. for BuShips as part of DOD's long-range supporting research program.

▶ A new Thermoelectric Generator, without moving parts, developed by the Minnesota Mining & Mfg. Co., is used in a gas-fired wall heater, converting heat energy into the electrical energy required to operate a fan circulating warm air throughout a room. The generator draws its heat energy directly from the heater's combustion chamber.

"ONTOS" MOBILE TANK



Equipped with four "eyes" (TV cameras) and almost "human" (electro-mechanical arm) ONTOS was developed for the Navy for use in studying ocean depths as great as 20,000 feet. It is "shore-controlled" through a silver-plated cable, five miles long. It was designed and produced at the Worcester, Mass. Electrical Cable Works of U. S. Steel and Wire Div. for a Scripps Institute of Oceanography Project.

Lack Of Inventor's Recognition Decried

At the formal opening of the U. S. Patent Offices Electrical Exhibit, Dr. D. L. Jaffe, President of Polarad Electronics Corp., referred to statistics showing that the rate of U. S. inventions per capita were quite mediocre, when compared to other leading industrial nations of the free world. A relatively low number of books is being produced per capita, he said, as opposed to a higher concentration of television sets and stations.

Dr. Jaffe stated that most great inventions were made by single individuals, rather than by large industrial research teams. Increased recognition for the individual and possibly even "eccentric" inventor were recommended as a step in the right direction.

Exports To Cuba Under Stringent Control

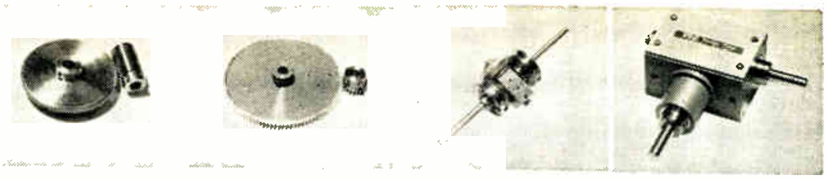
The Depart. of Commerce has taken action to ban shipments of most commodities to Cuba.

With the exception of unsubsidized foodstuffs, medicinals, and certain medical supplies, all other exports to Cuba, including unpublished technical data, will not be approved.

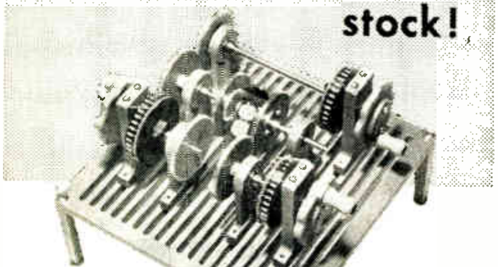
Consequently, most general licenses covering shipments to Cuba are revoked, except for those covering such shipments as plane or ship stores, baggage and personal effects, intransit shipments of foreign- origin goods, and certain types of gifts.

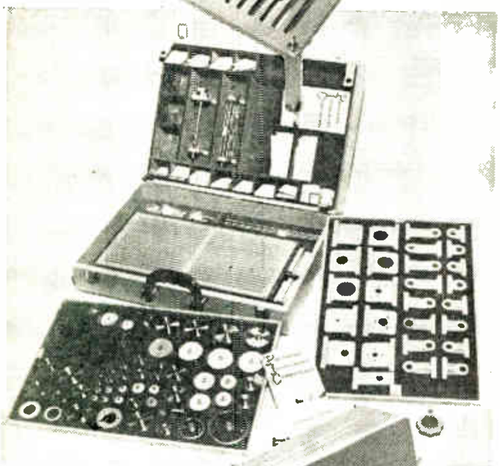
More News on Page 14

Circle 3 on Inquiry Card



PIC from stock!





PRECISION INSTRUMENT PARTS AND ASSOCIATED COMPONENTS

Gears—Shafts—Collars—Couplings—Differentials—Speed Reducers, etc. Over 12,000 Items—For Immediate Delivery!

A completely integrated system of STOCK precision parts and components—engineered for maximum flexibility of use—in all design, research and military development applications.

PRECISION BREADBOARD DEVELOPMENT KITS

40 Different Types Available—from stock!
1/8"—3/16"—1/4" Shaft Sizes

Complete, low cost, general purpose kits of laboratory precision instrument parts and components, designed by practical engineers for all mechanical, electro-mechanical breadboards, prototype, test fixture and servo control system applications.

Specialized Kits of Spur Gears, Speed Reducers, Differentials and Couplings also available.

Detailed information and parts list available, upon request.

FREE PIC 416-PAGE MASTER CATALOG #21

Lists over 12,000 STOCK instrument, tool and electronic parts and components, with complete specifications, drawings and prices...PLUS, new PIC Technical Data Sheets.

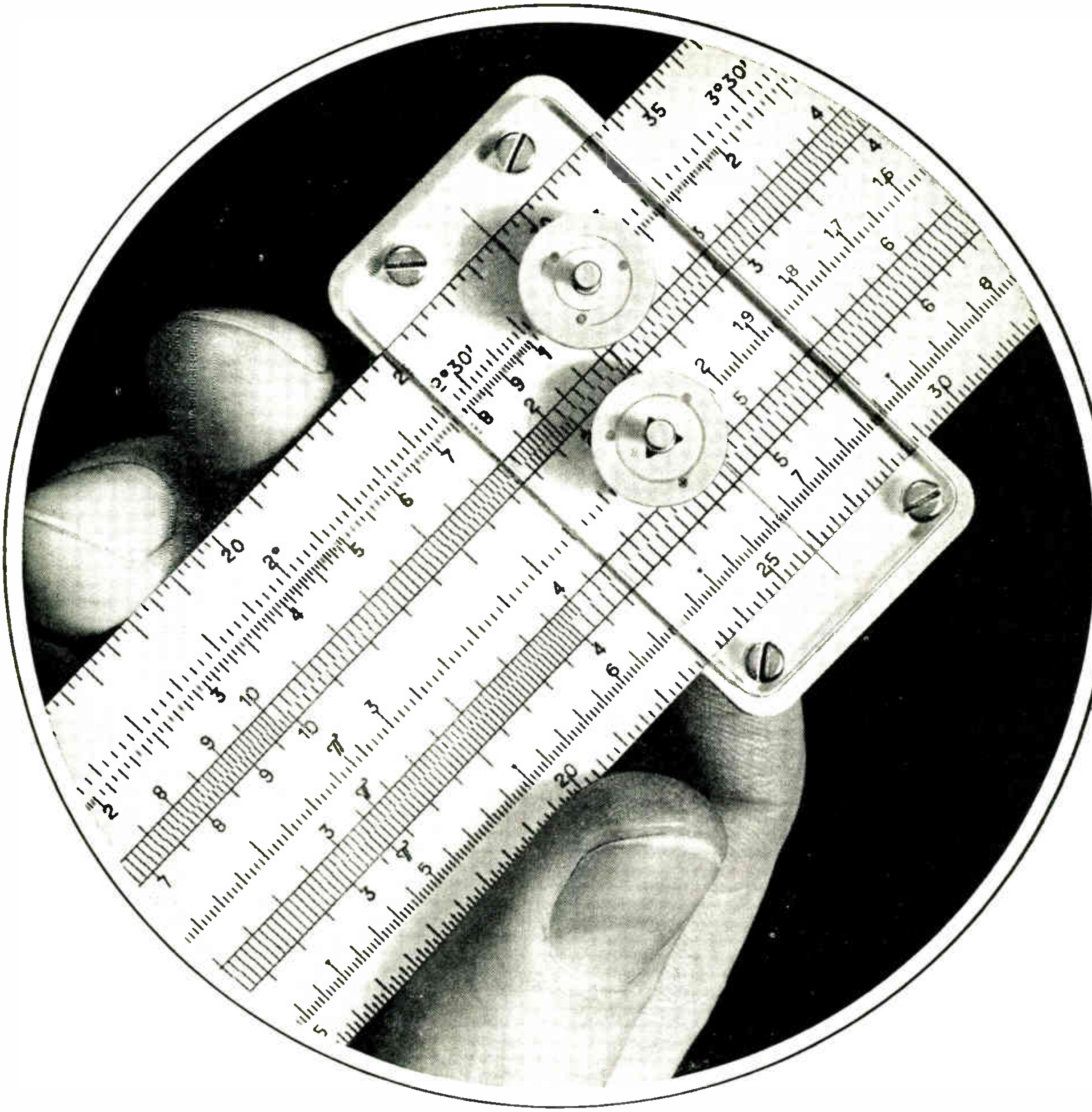
Includes full information on all PIC Development Kits.

PIC DESIGN CORP.

Subsidiary of BENRUS WATCH COMPANY, Inc.

477 Atlantic Avenue
East Rockaway, L. I., N. Y.

Telephone:
LYnbrook 3-6470



NOW MINIATURE DISC CATHODES HAVE FAST WARMUP TOO

The vital difference between the miniature (.090 in. OD shank) disc cathode you see above and the one you have been using is the triangular hole in the ceramic. The cathode shank touches the ceramic at only three points. Actually there is 60% less contact area than with round hole ceramics. So heat doesn't escape as fast. The cathode warms up faster. The TV picture comes on quicker.

Superior introduced the triangular hole .490-in.-dia. ceramics for miniature disc cathodes just a year ago. Now this feature is being offered in miniature disc cathodes with .365-in.-dia. ceramics, too.

The triangular hole grips the cathode shank firmly and locks it in place. Embosses above and below the ceramic prevent both rotation and longitudinal movement. A shadow groove in the ceramic is standard to protect against sublimation leakage.

Write for dimensional drawings and samples. Superior Tube Company, 2502 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

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

Circle 7 on Inquiry Card

As We Go To Press . . .

(Continued)

Scientists Say Too Many Intn'l Organizations

Prof. H. S. W. Massey of Britain refused to join a proposed International Academy of Astronautics at the 11th Congress of the International Astronautical Federation (IAF), in Stockholm, Sweden, where more than 600 Western and Communist bloc scientists had convened, recently. He contended research was suffering because scientists were trotting from one international conference to another. The Russians, too, refused to join indicating there were already enough international bodies for cooperation in solving the problems of exploring outer space. They also refused to join a second international organization—an Institute of Space Law—feeling that this problem should be a function of the U.N. As for the new Academy, Prof. L. I. Swlov, President of the IAF, indicated that cooperation could be carried on through the Committee on Space Research set up by the International Council of Scientific Unions with its headquarters in Paris.

COMMUNICATIONS CENTRAL

New 12-state Automatic Communications System at the Miami, Fla. hdqts. of the Mackle Company-General Development Corp. Private line teletypewriter net puts headquarters and nine development sites in direct contact with offices in the Eastern section of the nation.

New 'Length' Standard

A wavelength of light replaces the standard meter bar as the new standard of length. The action was taken by the 11th General Conference on Weights and Measures meeting in Paris. Dr. Allen V. Astin, National Bureau of Standards, headed the American delegation to the conference.

The new definition of the meter is 1,650,763.73 wavelengths of the orange-red line of krypton 86.

10 Million Refund To DOD on Missile Master

The Martin Company of Baltimore, awarded a $95 million contract in 1955, to design, develop, manufacture and put into operation Missile Master Systems, will refund $10 million to the Army. Savings in manufacture and the difference between actual and estimated costs account for this refund. The Missile Master, now being installed throughout the U. S., is a computing machine designed to coordinate the launching of air defense missiles and aircraft in event of an enemy attack.

Component Shipments Continue 1959 Increase

Shipments of electronic components by U. S. manufacturers reached another all-time high during the first quarter 1960, the Electronics Div., BDSA, U. S. Depart. of Commerce, has reported.

Output of electron tubes, semiconductor devices, and other major electronic components during the first 3 months of 1960 increased 8% over the preceding six-month rate and more than 20% above the first half 1959 rate. The increase was not general. Shipments of quartz crystals, transformers, and transistors were up sharply, whereas output of TV picture tubes, which is generally subject to seasonal declines during the first quarter, and power and special purpose tubes declined slightly during the first quarter 1960.

Electronic Banking

Depositor's bank statements are now being prepared electronically by the First National Bank of San Jose (Calif.). Center of the system is a Burroughs "220" Data Processing System. Check and deposit information is recorded on punched paper tapes which, along with stop payment and other information on punched cards, are transformed into magnetic tape. The information is stored in memory cores. New tapes are made daily including a statement tape which records each individual transaction in a depositors account during a month's time. The tape is used by the computer in conjunction with 5000 different instructions to print the depositor's statement.

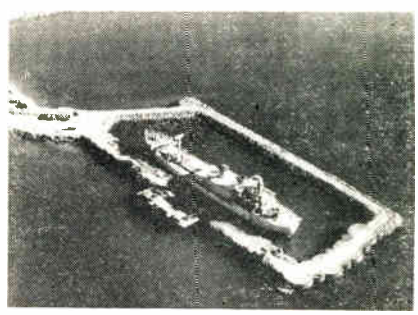
EXECS STUDY SHOW PLANS

Examining Futuronics Exposition Floor Plans are: (l to r), E. C. Towl, President of Grumman Aircraft Engineering Corp., E. H. Swanson, President of Instrument For Industry, Inc., and J. J. Dempsey, President of the Long Island Electronics Mfg's Council, which sponsors the Exposition. Mr. Dempsey is also General Manager of the Mechatrol Div. of Servomechanisms, Inc. and Vice President of the Parent Company.

L. I. Futuronics Show Slated Nov. 30-Dec. 2

The Third Futuronics Exposition, sponsored by the Long Island Electronics Manufacturers Council (composed of 65 member companies representing most of the area's three-quarter-billion dollar electronic industry), will be held from Nov. 30 to Dec. 2 at the Roosevelt Raceway Exhibit Hall in Westbury, N. Y. Theme for the technical meetings will be "Forecasts in Electronics" with different sessions covering, "Systems Concepts," "Component Developments," and "U. S. Government Needs." Chairman of the show committee is Franklin Meyer, President of Tempo Instrument, Inc. Joseph Margolin of Dorne & Margolin, Inc., is chairman of the technical paper committee. Over 100 companies will exhibit during the three-day show.

FLOATING POWER STATION



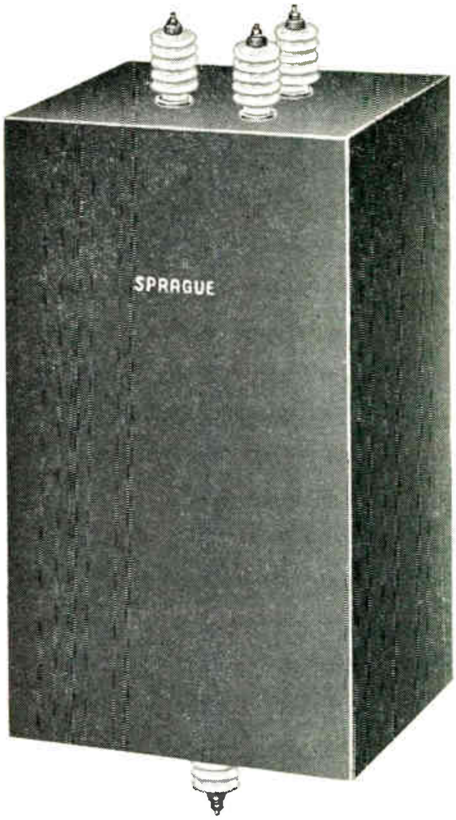
YFP-10, a converted dry cargo ship, now supplies power to the first BMEWS Installation. A lagoon, formed by earth-filled caissons, completely surrounds the YFP-10 to protect it from violent seas and 7-ft. tides. Burns and Roe, Inc., N. Y. has been awarded an RCA contract to operate and maintain the station.

More News on Page 24

PULSE-FORMING NETWORKS

FROM WATTS

to **MEGAWATTS**



...and everything in between!

When it comes to pulse capacitors and pulse-forming networks, many complexities in parameters and design factors must be considered. These specialized units must be designed and manufactured by a specialized organization. And because Sprague maintains a highly-technical special engineering section devoted exclusively to pulse capacitors and networks, it has been, from the very beginning, a major supplier of these complex units for radar equipment (ground, marine, aircraft, missile), tube testing, and similar pulse circuit applications.

This special engineering section performs four important functions: One group *designs* custom units in accordance with required parameters. Another group *builds* pulse capacitors and networks to these precise specifications. In another area, a group of specially-trained field engineers *provides application assistance* wherever needed. And yet another independent group *works toward the future* developing new materials, new design concepts, and new techniques for manufacture.

This concentration on pulse capacitors and pulse-forming networks has enabled Sprague to introduce product improvements such as heliarc sealing of cases, rugged alumina bushing assemblies, Fabmika® dielectric, and improved hermetic sealing of closures.

Save time and money by working with Sprague from the start. Application engineering services are available to you without obligation.

Write for Engineering Bulletin No. 10,001 to Technical Literature Section, Sprague Electric Co., 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:
CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE-FORMING NETWORKS • PIEZOELECTRIC CERAMICS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES • FUNCTIONAL DIGITAL CIRCUITS

Circle 8 on Inquiry Card

IN ELECTRONICS... AVIONICS... ASTRIONICS

STEMCO THERMOSTATS

RANK FIRST IN PRECISION TEMPERATURE CONTROL

In today's military and commercial projects, you can't afford to overlook any one of these important areas: Reliability, Size, Availability, Economy.

And because Stevens is in production now on the largest number of different types and styles of bimetal thermostats, all these advantages are yours automatically when you specify Stemco thermostats.

1st in Reliability. Proven designs, latest production techniques, most stringent inspection procedures.

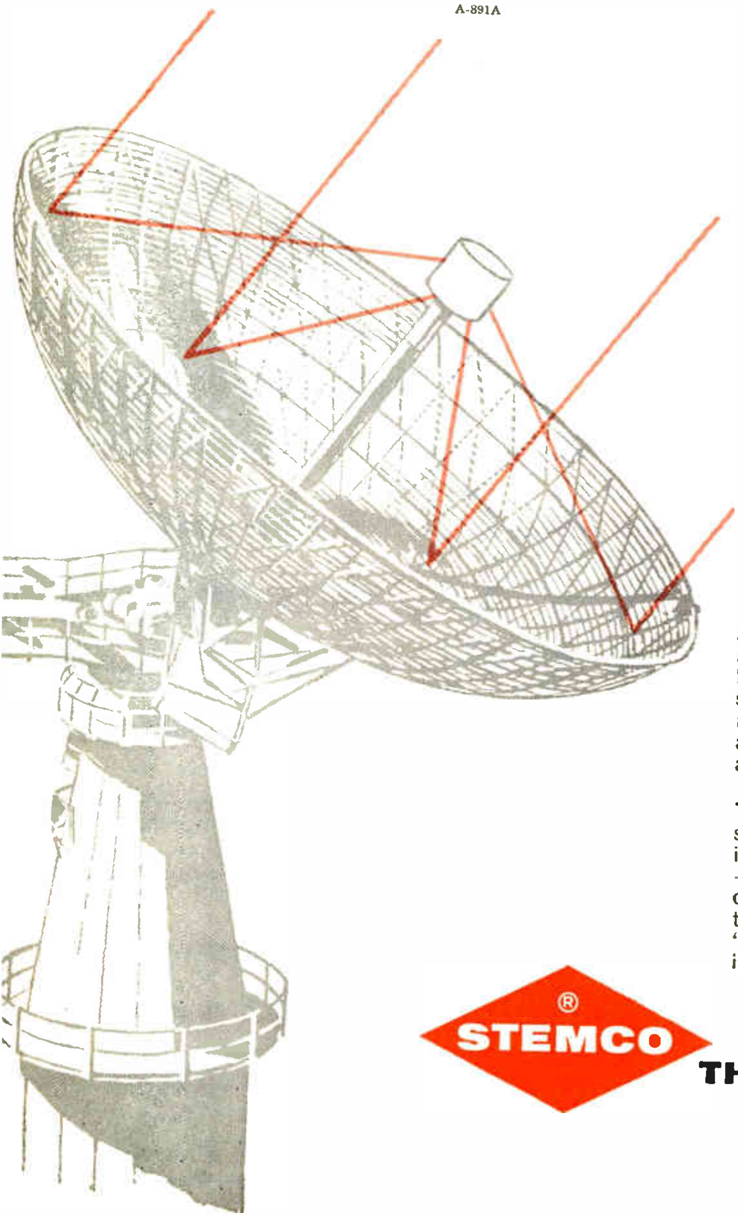
1st in Size. Stemco thermostats score in compactness and lightness without sacrificing performance.

1st in Availability. Tooling for most types is in existence. Flexibility of design cuts lead time on other types.

1st in Economy. Mass production of many standard Stemco types with hundreds of terminal arrangements and mounting brackets cuts your costs.

*Refer to Guide 400EO for U.L. and C.S.A. approved ratings.

A-891A



TYPE A* semi-enclosed. Bimetal disc type snap action thermostats; give fast response to temperature changes. Can be made to open on rise or close on rise. Single-throw with double make and break contacts. Operation from -20 to 300°F. Lower or higher temperatures on special order. Average non-inductive rating 13.3 amps, 120 VAC; 4 amps, 230 VAC and 28 VDC. Various mountings and terminals available. Bulletin 3000.

TYPE A hermetically sealed. Electrically similar to semi-enclosed Type A. Various mountings, including brackets, available. Bulletin 3000.

TYPE MX hermetically sealed. Snap acting bimetal disc type units to open on temperature rise. 2 to 6°F differentials as standard. 1 to 4°F differentials available on special order. Depending on duty cycle, normal rating 3 amps, 115 VAC and 28 VDC for 250,000 cycles. Various terminals, mountings and brackets available. Bulletin 6100.

TYPE MX semi-enclosed. Construction and rating similar to MX hermetically sealed type. Bulletin 6100.

TYPE M hermetically sealed. Bimetal disc type, snap acting thermostats. Also available in semi-enclosed. Operation from -20 to 300°F. Lower and higher temperatures available on special order. Depending on application, rated non-inductive 10 amps, 120 VAC; 3 amps, 28 VDC. Various terminals, wire leads and brackets available. Bulletin 6000.

TYPE C hermetically sealed. Also semi-enclosed styles. Small, positive acting with electrically independent bimetal strip for operation from -10 to 300°F. Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.

STEMCO® THERMOSTATS

STEVENS *manufacturing company, inc.*
P.O. Box 1007, Mansfield, Ohio

Circle 10 on Inquiry Card

Coming Events in the electronic industry

Oct. 31-Nov. 1-2: 13th Annual Conf. on Electrical Techniques in Medicine and Biology, IRE, AIEE, ISA, PGBME and Joint Exec. Committee in Medicine & Biology; Sheraton-Park Hotel, Washington, D. C.

Oct. 31-Nov. 1-2: Radio Fall Meeting, IRE, EIA; Syracuse Hotel, Syracuse, N. Y.

Nov. 1-2: 4th Annual Conf. on Aeronautical Material Reliability, Bureau of Weapons Industry Advisory Board on Reliability & Operation Design Requirements; Shoreham Hotel, Washington, D. C.

Nov. 1-3: Central States Show, The Material Handling Institute, Inc.; Kentucky Fair & Exposition Center, Louisville, Ky.

Nov. 1-4: Business Equip. Expos., OEMI; Memorial Sports Arena, Los Angeles, Calif.

Nov. 3-4: 9th Annual Instrumentation Conf., School of Eng'g, Louisiana Polytechnic Inst.; Campus, Ruston, La.

Nov. 4-5: Communications Symp., IRE; Queen Elizabeth Hotel, Montreal, Canada

Nov. 7-11: Education & Nuclear Energy—Region Symp.; Argentina

Nov. 8-9: Symp. on Space Instrumentation, IRE, Wash., D. C.

Nov. 9-11: 2nd Industry Computer Application Conf., AIEE; Chase Hotel, St. Louis, Mo.

Nov. 11-12: Aircraft & Missile Div. Conf., American Soc. for Quality Control; Lord Baltimore Hotel, Baltimore, Md.

Nov. 13-18: 2nd Eng'g Materials & Design Exhib.; Earls Court, London, England

Nov. 14-15: Fall Conf., Nat'l Assoc. of Broadcasters; Statler-Hilton Hotel, Washington, D. C.

Nov. 14-16: Meeting, Nat'l Paperboard Assoc.; Waldorf-Astoria Hotel, New York, N. Y.

Nov. 14-17: 6th Annual Conf. on Magnetism & Magnetic Materials; AIEE, AIP, ONR, IRE, PGMTT, AIME; New Yorker Hotel, New York, N. Y.

Nov. 14-18: Symp. on Nuclear Ship Propulsion (Safety), Int'l Atomic Energy Agency; Taormina, Sicily, Italy

Nov. 14-18: Western Tool Show and Semi-annual Conv., ASTE; Memorial Sports Arena, Los Angeles, Calif.

Nov. 14-18: Annual Meeting, Nat'l Electrical Mfrs. Assoc.; Traymore Hotel, Atlantic City, N. J.

"CALL FOR PAPERS"

1961 Nat'l Symp. of Prof. Group on Microwave Theory and Techniques, IRE, May 15-17, 1961, Sheraton Park Hotel, Wash., D. C. Original papers in all fields of Microwave Research, Development and Application. 500-word summaries by Dec. 12, 1960, to: Gustave Shapiro, Chairman, Tech. Prog. Comm., Eng'g Electronics Sec., Nat'l Bureau of Standards, Wash. 25, D. C.

The Electrochemical Society, Inc., Apr. 30, May 1-4, 1961, Claypool Hotel, Indianapolis, Ind.; Abstracts, not to exceed 75 words in length. Submit in triplicate to Society Hdqs. not later than Jan. 2, 1961. Indicate Symp. and author's name. Send complete manuscripts to Mgt. Editor of Journal, same address.

1961 Winter Conv. on Military Electronics, IRE, Feb. 1-3, 1961; Los Angeles, Calif. 100-word abstracts, 500-word summaries. Submit to: Dr. J. Myers, Hoffman Electronics Corp., Military Products Div., 3717 S. Grand Ave., Los Angeles 7, Calif. by 15 Nov., 1960 for perusal of Tech. Prog. Comm.

American Society for Testing Materials Annual Meeting, ASTM, June 25-30, 1961, Chalfonte-Haddon Hall, Atlantic City, N. J. Deadline for papers is January, 1961. Contact Society Hqs., 1916 Race St., Phila. 3, Pa.

39th Annual Conv. of Nat'l Assoc. of Broadcasters & Broadcast Engineering Conf., May 7-11, 1961, Shoreham & Sheraton Park Hotels, Wash., D. C. Deadline for submission of topics for engineering papers is 15 Dec. 1960. Contact A. Prose Walker, Mgr. of Engineering, NAB, 1771 N St. N. W. Wash., D. C. for more info.

American Mathematical Soc., Jan. 24-27, 1961, Wash., D. C. Deadline date for scientific papers and exhibits: Dec. 9, 1960; Feb. 22, 1961, Yeshiva Univ., N .Y. Deadline date: Jan. 10, 1961; Aug., 1961, Stillwater, Okla. Deadline date: Jan. 10, 1961; Nov. 17-18, Milwaukee, Wisc. Deadline date: Jan. 10, 1961. Contact: Mrs. Robert Drew-Bear, Head, Special Project Dept., AMS, 190 Hope St., Providence, 6, R. I.

Annual Soc. of Vacuum Coaters Tech. Symp., Mar 1-2, 1961, Conrad Hilton Hotel, Chicago, Ill. Papers deadline: Jan. 1, 1961. Contact: Thomas J. LaBounty, Midwest Tech. Services, 5512 South Lyman, Downers Grove, Ill.

(Continued on page 20)

Nov. 15: Electronic Parts & Equip. Mfrs. Meeting, EP, EM; Chicago, Ill.

Nov. 15-16: Symp. on Eng'g Applications of Probability & Random Function Theory, IRE, PGIT; Purdue Univ., Lafayette, Ind.

Nov. 15-16: 12th Annual MAECON Conv. (Exhibits), IRE; Hotel Muehlebach, Kansas City, Mo.

Nov. 15-16: 4th Annual Conf., PG on Product Eng'g & Production, IRE, PGPT NEREM, PGPEP; Sheraton Plaza & Commonwealth Armory, Boston, Mass.

Nov. 15-17: Northeast Electronics Research & Eng'g Meeting (NEREM), IRE (Region 1;) Commonwealth Armory & Sheraton-Plaza Hotel, Boston, Mass.

Nov. 18: Reg. Tech. Conf., Soc. of Plastics Engineers, Inc.; Essex House, Newark, N. J.

Nov. 20-21: Conf. on Electro-Optical & Radiation Devices, PGED, AIEE; Stanford Research Institute, Menlo Park, Calif.

Nov. 20-22: Fall Meeting, Fluid Controls Inst., Inc.; Drake Hotel, Chicago, Ill.

Nov. 21: Monthly Meeting, Purchasing Agents of the Radio, TV and Electronics Industry; Gov. Clinton Hotel, New York, N. Y.

Nov. 21-22: Fall Conv., Nat'l Assoc. of Broadcasters; Edgewater Beach Hotel, Chicago, Ill.

Nov. 21-23: Annual Meeting, Div. of Fluid Dynamics, American Physical Soc.; Baltimore, Md.

Nov. 21-25: 2nd Industrial Photographic & Television Exhib.; Royal Albert Hall, London, England

Nov. 24-25: Meeting of the American Physical Soc., APS; Chicago, Ill.

Nov. 27-Dec. 2: Annual Meeting, ASME; Statler-Hilton Hotel, New York, N. Y.

Nov. 28-29: Fall Conf., Nat'l Assoc. of Broadcasters; Biltmore Hotel, New York, N. Y.

Nov. 28-Dec. 2: 24th Nat'l Expos. of Power & Mechanical Eng'g, ASME; New York Coliseum, New York, N. Y.

Nov. 30-Dec. 2: 18th Electric Furnace Conf., AIME; Morrison Hotel, Chicago, Ill.

Nov. 30-Dec. 2: Symp. on Steels in Reactor Pressure Circuits, Iron & Steel Inst.; London, England

Nov. 30-Dec. 2: 3rd Annual Futuronics Expos., L. I. Electronics Mfrs. Council; Roosevelt Raceway Exhibit Hall, Westbury, L. I., N. Y.

Coming Events

(*Continued from page 19*)

"CALL FOR PAPERS"

Second Symp. of Eng'g Aspects of **Magnetohydrodynamics, Mar. 9-10, Univ. of Pa., Phila. 4, Pa.** Abstracts to be submitted to appropriate session chairman by Nov. 15, 1960. Reproducible copy of each author's paper by Feb. 1, 1961. Communications & Diagnostics: C. B. Wharton, Lawrence Radiation Labs, Livermore, Calif.; Flight Applications: Dr. G. J. Janes, Avco Research Labs, Everett, Mass.; Fusion: Dr. C. W. Little, Atomic Energy Div., Allis-Chalmers Mfg. Co., Milwaukee 1, Wisc.; Power Conversion: Dr. C. W. Sutton, G. E. Co., Missile & Space Vehicle Dept., Phila. 24, Pa.

Symp. on Materials and Electron Device Processing, Apr. 10-12, 1961, Franklin Institute, Phila., Pa. Submit title and 200-word abstract to Dr. D. E. Koontz, Bell Tel. Labs., Murray Hill, N. J. no later than Jan. 2, 1961. Manuscripts by Feb. 15, 1961.

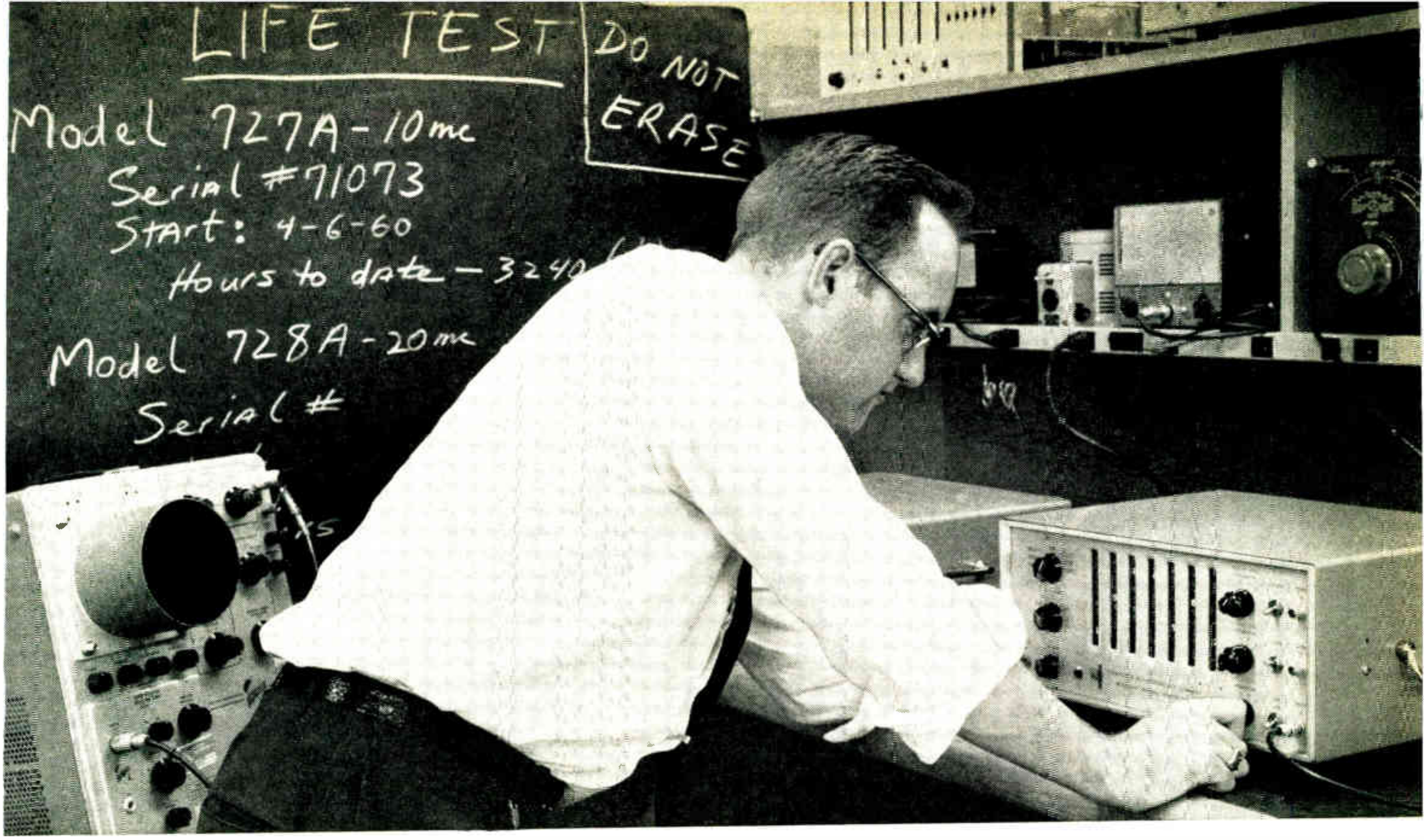
Plastics for Tooling, Reg. Tech. Conf., April 25, 1961, Indianapolis, Ind. Deadline date for proposal to present papers—Jan. 1, 1961. For info. write to: Milton Brummer, Sect. Pres., 4241 Marrison Place, Indianapolis, Ind. **Plastics in Automotive Industry, Reg. Tech. Conf., May 9, 1961, Detroit, Mich.** Deadline date for proposal to present papers—Jan. 15, 1961. For info. write to: John D. Young, Sect. Pres., 13000 W. Mile Rd., Detroit 35, Mich.

1961 Western Joint Computer Conf., May 9-11, The Ambassador Hotel, Los Angeles, Calif. Detailed summaries of papers by Dec. 15 to C. T. Leondes, Assoc. Prof. of Eng'g, Dept. of Eng'g, Univ. of Calif., Los Angeles, Calif.

Fifth Nat'l Symp. on Global Communications (GLOBECOM V), May 22-24, Sherman Hotel, Chicago, Ill. Abstracts: Approx. 250 words with brief prof. record of author (both in duplicate) by Nov. 30, 1960 to: D. C. Campbell, Tech. Prog. Com., ITT-Kellogg, 5959 S. Harlem Ave., Chicago 38, Ill.

National Telemetering Conf., May 22-24, 1961, Sheraton-Towers Hotel, Chicago, Ill. Deadline dates: Abstracts: Dec. 15, 1960, Papers: Mar. 1, 1961. Contact: Jack W. Becker, Dept. 32-29, A-C Spark Plug Div., GMC, Milwaukee 1, Wisc.

International Symp. on the Transmission and Processing of Info., Sept. 6-8, 1961, M.I.T., Cambridge, Mass. Receipt of 500-1000 word Abstracts . . . Jan. 1, 1961. Receipt of full length papers . . . Apr. 1, 1961. Submit to: Peter Elias, Research Lab of Electronics, M.I.T., Cambridge 39, Mass.



How long will you keep buying obsolete counters when CMC counters with solid state reliability cost so little more?

Announcing the CMC 728A

A SOLID STATE 20 MC UNIVERSAL COUNTER-TIMER

Introduction of the CMC 728A marks another frequency step-up from the company that brought you the first transistorized universal counter-timers. CMC, the leader in truly advanced counting, timing, and frequency measuring equipment offers 100 kc, 250 kc, 1 mc, 10 mc and now 20 mc all solid state instrumentation.

	Most Popular 10 mc Vacuum Tube Counter	CMC Solid State 10 mc Counter
Base Price	$2,300	$2,750
Printer Output	75	n/c
Time Interval Section	175	n/c
Total	$2,550	$2,750
Weight	118 lbs.	27 lbs.
Size	21⅛"H x 20"W x 23½"D	7"H x 17"W x 13"D
Power Requirements	600 watts	46 watts
Accuracy	± 1 count ± crystal stability	± 1 count ± crystal stability
Remote Programming	not available	Standard option
Warranty	1 year	2 years
Time Interval Measurements	1 μsec to 10^7 sec in 1 μsec increments	0.1 μsec to 10^7 sec in 0.1 μsec increments
Period Measurement	0 cps to 10 kc	0 cps to 3 mc
Gate Times	0.001, 0.01, 0.1, 1.0 & 10 sec	0.000001 to 10 sec in decade steps
Time Base	10 to 1 multivibrator type	decade dividers — no adjustment

Can You Afford To Settle For Less? If you are considering any counter, will your engineering judgement and sense of *real* economy dictate purchase of old fashioned equipment? Stop and look at the merits of solid state counters. Did you know that the reliability of all CMC solid state counters is backed with a 2 year warranty—double the guarantee of tube counters? Did you know CMC's solid state 10 mc universal counter timer only costs $200 more than comparable vacuum tube counters? That's the beginning. Compare the rest of these specifications.

Compare the 20 mc Solid State Universal Counter-Timer—We'd like to, but frankly, there aren't any comparable vacuum tube counters. This might lead the discerning engineer to think that at 10 mc, vacuum tubes are driven "hard", right to their capacity. *And he'd be right.*

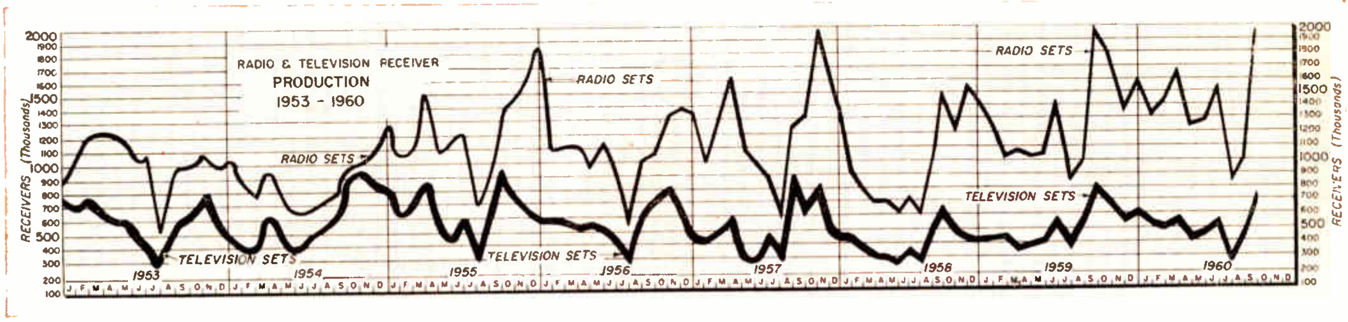
More Information—For complete technical information on high reliability solid state counting instrumentation, call your nearby CMC engineering representative, offices in 33 cities throughout the U.S. and Canada, or write directly to Dept. 44.

35

Computer Measurements Co.
A Division of Pacific Industries
12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

Facts and Figures Round-Up
November 1960

ELECTRONIC INDUSTRIES TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in September, 1960.

Amplifiers	94,176
Amplifiers, intercom	74,317
Analyzers, circuit	60,582
Anodes, cathodic protection	63,401
Antennas	688,601
Battery assemblies	2,382,626
Batteries, dry	230,772
Batteries, storage	325,080
Bridges, dc	39,550
Cable	47,167
Cable assemblies	122,295
Cable, telephone	421,992
Cameras, recording	51,840
Channel selectors	41,870
Communications equipment	1,875,527
Computers	83,195
Computers, digital	117,096
Control system, flight	332,999
Converters	234,005
Correlators, video radar	69,105
Couplers, antenna	136,253
Diodes, semiconductor	245,000
Electronic equipment, general	236,955
Gyroscopes	667,912
Infrared equipment	284,488
Meters, volt	111,859
Microscope, electron	29,840
Mounts, crystal	30,019
Organs, electronic	52,776
Power supplies	80,000
Printers, page	1,158,117
Radars	6,675,717
Radiosondes	146,160
Radomes	26,674
Readers, film	40,197
Receivers	100,000
Recorders	179,240
Sets, telephone	33,247
Simulators, radar signal	541,498
Standards, frequency	1,146,476
Systems, data handling	78,000
Systems, surveillance, drones	8,486,025
Systems, telemetry	61,061
Systems, wave analysis	63,100
Tape, electronic	31,102
Test equipment	50,909
Test sets, radar	160,000
Transducers	99,225
Transmitters	49,400
Transponders	31,486
Tubes, electron	149,054
Tubes, klystron	31,350
Tubes, thyratron	53,677
Tubes, traveling wave	30,000
Tuning units, r-f	40,543
Waveguide components	44,888
Wire	50,400

UNDERGRADUATE ENGINEERING ENROLLMENT

Fall	Enrollment	Percentage change from previous year
1959	242,992	—5.4
1958	256,779	—4.5
1957	268,761	+7.0
1956	251,121	+13.4
1955	221,448	+14.3
1954	193,692	+12.8
1953	171,725	+10.0
1952	156,080	+6.9
1951	145,997	—9.7
1950	161,592	—20.0
1949	201,927	———

—*"Engineering Enrollments & Degrees 1959," U. S. Dept. of Health, Education, and Welfare.*

ESTIMATES OF U. S. RAW MAGNETIC TAPE SALES

The following tabulation shows the median average of 22 "completed" questionnaires. Many more "partially completed" questionnaires were received but discarded. Several other questionnaires were eliminated because they rephrased previously published trade articles and as such did not necessarily reflect the individual company's estimate.

Estimates of 1959 sales volume at manufacturers' selling prices fluctuated from a low of $18 million to a high of $50 million. Manufacturers' estimates were far more optimistic than users' estimates but both groups indicate at least a doubling of sales by 1965.

Video tape sales estimates were supplied by several firms not active in video tape manufacture, distribution or use. For this reason, the video tape estimates may be suspected.

Tape	Estimated 1959		Percent Growth			
Type	Sales	Percent	1959	1960	1965	1970
Audio	$20,350,000	55%	100%	120%	190%	240%
Video	1,850,000	5%	100%	130%	300%	500%
Computer	7,770,000	21%	100%	133%	200%	290%
Instrument	7,030,000	19%	100%	128%	200%	300%

Prepared by: Market Research Department Capitol Records Distribut'ng Corp.

ESTIMATED ELECTRONIC COMPONENT SHIPMENTS—FIRST QUARTER OF 1960

Category	Quantity (in thousands of units) Total	Military	Nonmilitary	Value (in millions of dollars) Total	Military	Nonmilitary
Capacitors	328,585	35,601	292,984	65.5	20.3	45.2
Complex Components[a]	10,093	138	9,955	5.2	2.7	2.5
Connectors	27,612	17,012	10,600	43.1	28.4	14.7
Quartz Crystals	1,646	629	1,017	4.8	1.4	3.4
Relays (electronic applications)	10,377	3,212	7,165	48.8	22.5	26.3
Resistors	532,771	59,892	472,879	61.2	27.6	33.6
Power and Special Purpose Tubes	3,211.3	745.2	2,466.1	62.5	40.2	22.3
Receiving Tubes	106,962	6,570	100,392	95.2	14.6	80.6
TV Picture Tubes	3,070	—	3,070	61.9	—	61.9
Semiconductor Devices	63,507	19,648	43,859	129.0	63.4	65.6
Transformers & Reactors	10,294	1,684	8,610	46.4	19.9	26.5

[a] Includes packaged component assemblies (PEC's, PAC's, couplates, etc.) modules assembled from purchased components, and modules manufactured from components which were fabricated during the manufacturing process.

—*BDSA, U. S. Dept. of Commerce*

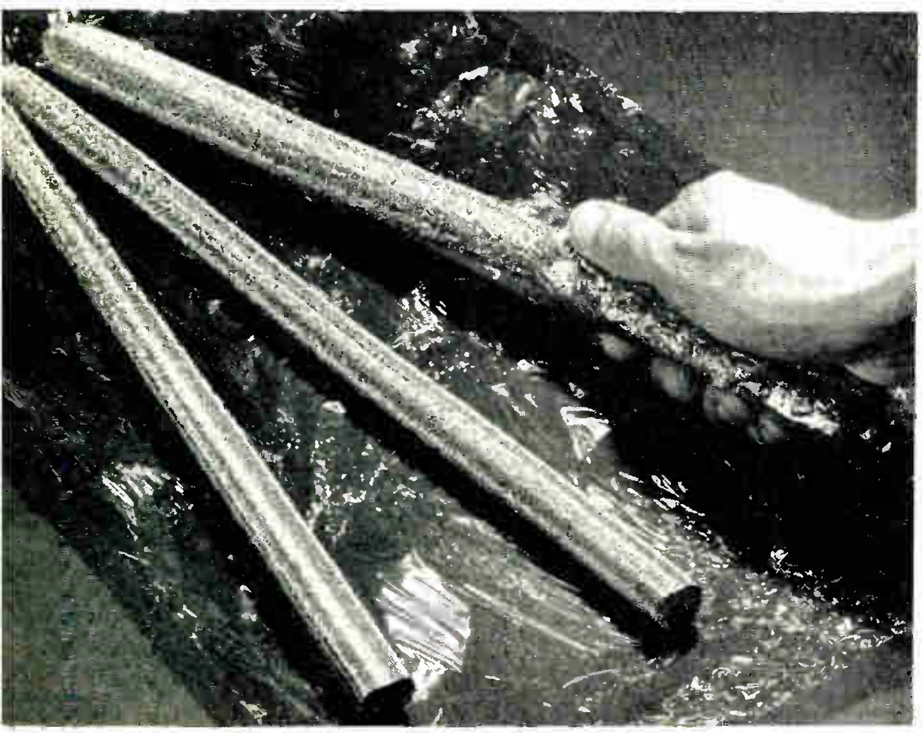
Snapshots

SEMICONDUCTOR SILICON

Hyper-pure silicon from Dow Corning Corp., Midland, Mich., is used for diodes, transistors, solar cells, etc. These are ⅝ and 1 in. dia. rods. Navan Products, Inc., El Segundo, Cal. makes the wheel.

SEMICONDUCTOR DICER

Diamond cutting "wheel" for dicing semiconductor materials concentrates on the cutting ring not the core. It uses special solid arbor.



RADIATION DETECTOR

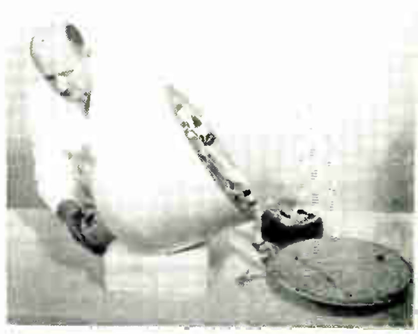
Hughes Aircraft Co.'s radiation detectors will measure radiation penetrating simulated space cabins in future spaceshots.

ARMY BOTTLENECK SMASHED

RCA's Data Processing System is credited with "smashing" critical bottleneck in the flow of Ordnance Vehicular spare parts. Col. D. W. Hiester, program Coordinator for the Army Ordnance Tank and Automotive Command, points out shipping destination to operator Theresa Uriarte at computer console.

PROBE VAN ALLEN BELT

NERV (nuclear emulsion recovery vehicle) used by NASA to research Van Allen Radiation Belt is checked out by GE's MSVD, Phila.



NEW SOLAR CELL

New solar cell developed by U.S. Army's Signal R & D Labs, Ft. Monmouth, will work even under intense atomic radiation.

BLUE SCOUT JUNIOR

Heat shields fall clear of final stage in Air Force's 609A 4-stage rocket. Ford Motor's Aeronutronic Div. is system engineer.

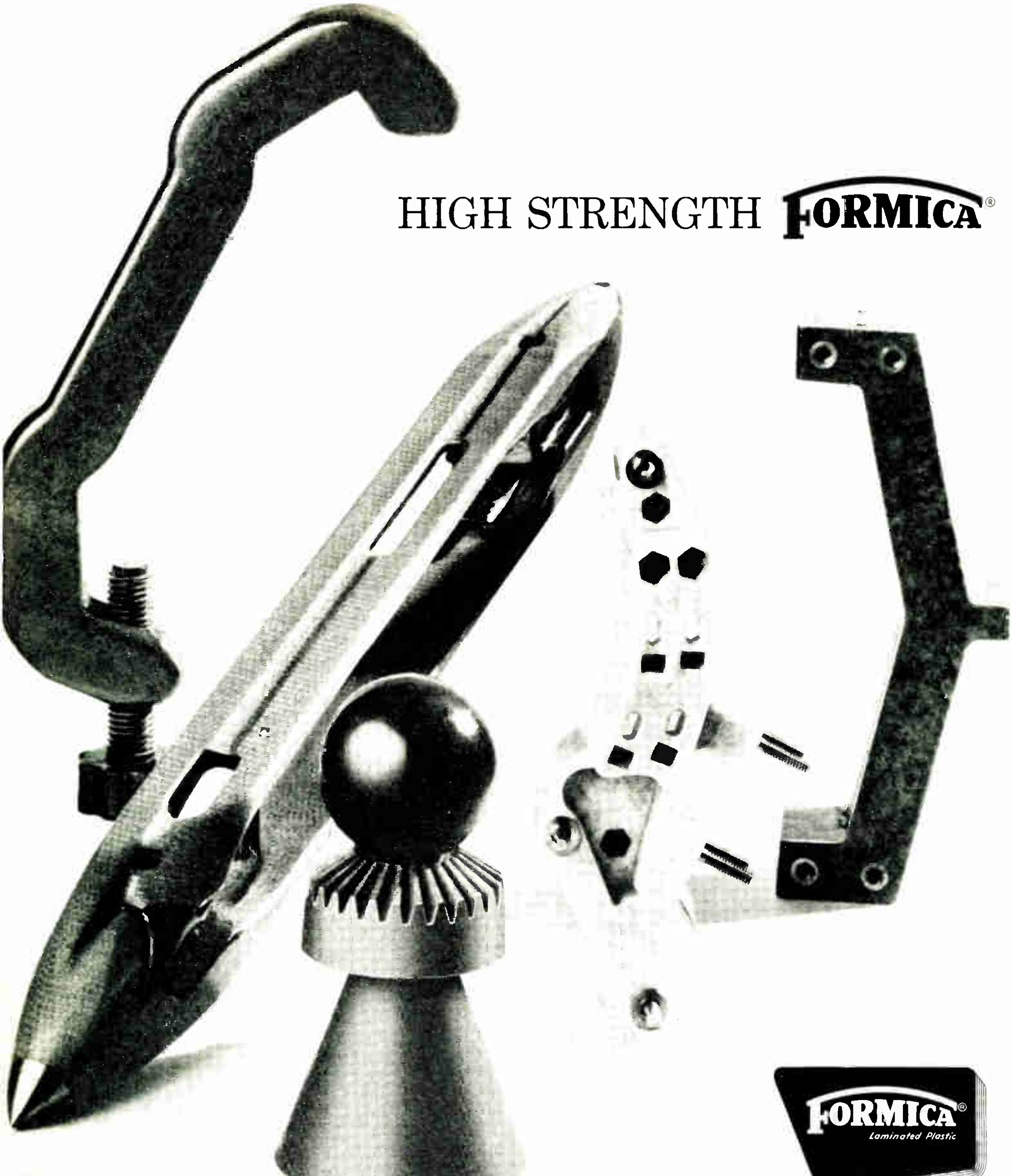
MAYAN ART?

Cherri Vallance of Electro Etch Circuits, Inc., Los Angeles, displays large printed circuit board manufactured by the company.

. . . of the Electronic Industries

THREE DISHES

Secretaries, Janet Pulichine and Judy Rooney, are sitting in a 40-ft. parabolic "dish" antenna at International Telephone and Telegraph Labs, Nutley, N. J. The antenna will be used for "listening in" on radio signals reflected in space by the moon or man-made satellites.



save more with parts that do more

THERMOSETTING MOLDED PLASTIC PARTS

Save on Sub-assembly. Here's how: by combining several properties and functions, one Formica molded part frequently replaces two or three made of ordinary materials. And by molding laminated and macerated plastic materials together, with one or more metal inserts, the Formica part becomes a *component* that's far more useful than conventional parts.

Save on Material. Formica's unique strength/weight ratio helps you improve product performance and save on direct material costs, too. It's strong as steel, has excellent impact and flexural strength, plus good electrical insulating and corrosion resisting properties. It's lighter in weight and costs about the same per pound, so you can buy several Formica molded parts for less than one comparable metal part.

Save on Replacement, too, because lighter weight means reduced wear, longer part life. And remember, molding uniformity eliminates costly machining.

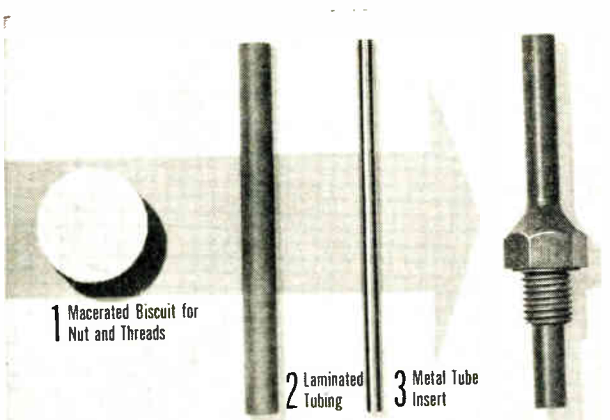
Get complete information on how Formica molded parts are tailor-made to give you exactly the right formulation of properties, functions, size, shape and finish. Use coupon below to request your free copy of bulletin 909.

FORMICA HIGH IMPACT THERMOSETTING PLASTIC PARTS COMPRESSION AND TRANSFER MOLDED

PROPERTIES	RANGE
Izod impact, ft. lbs. per in of notch	0.65 to 12.0
Dielectric strength, 1/8" perpendicular, short time, vpm	210 to 750
Flexural strength, flatwise, psi	8,000 to 25,000
Compressive strength, psi	18,000 to 35,000
Moisture absorption, 2" diameter disc (ASTM D570—57), percent	0.15 to 2.2
Chemical resistance	Resistant to mild solutions of acids and alkalies
Finishes	Sanded to mirror-smooth

BASIC FORMS—Laminated, macerated or laminated-macerated parts, compression or transfer molded, of paper, glass, canvas and asbestos cloth fillers, impregnated with phenolic, melamine, silicone, D.A.P. and epoxy resins.

APPLICATIONS—For electrical, mechanical and chemical applications in a wide range of industries including textiles, aviation, missiles, electrical/electronic, appliances, automotive, chemical, machinery, materials handling and many others.



BUILD-UP FOR SAVINGS—Formica molds laminated and macerated forms with metal tube insert to produce another do-more, save-more part. This light bulb frosting nozzle features chemical and moisture resistant properties for superior acid-carrying performance. Combining nut, thread and metal tube insert into one unit saves costly assembly and machining time.

FORMICA CORPORATION
4536 M Spring Grove Avenue
Cincinnati 32, Ohio

☐ Send free copy of Molded Products Bulletin 909.

NAME____________________

COMPANY______________ TITLE________

ADDRESS____________________

CITY__________ ZONE_____ STATE_____

FI-2599

Circle 15 on Inquiry Card

EI's International News

EUROPE

$2,500,000 Loan For Syrian Microwave

Damascus—The Syrian region of the United Arab Republic is getting a loan from the Development Loan Fund for long-distance telephone and telegraph system with capacity for future expansion. Loan was made to the Posts, Telegraphs, and Telephones Administration of the Syrian Region, Hidjaz St., Damascus. All procurement under the loan will be from the U. S.

A microwave system will link 8 stations with terminals at Damascus, Aleppo, and Latakia. Radio equipment will have an ultimate capacity for 600 telephone channels, but the initial installation will be about 120 channels at the Damascus and Aleppo terminals.

Equipment will include: microwave multiplex and supervisory equipment; towers, antennas; waveguide; and power plant; installation material; text equipment; and spares; and engineering and installation services. Supplier will be responsible for supervision of equipment installation—The PTT staff is doing the engineering with assistance from equipment suppliers.

New French Subsidiary

Servance (Haute-Saône)—Two French firms and Robertshaw-Fulton Controls Co., Richmond Va., have formed a new subsidiary to manufacture automatic controls for home appliances in France. The new company will be known as Rebertshaw-Madec, S. A. Two French firms are Madec and Mater. Headquarters will be at Servance.

Dutch Subsidiary Formed

Stanford, Conn. — Branson Instruments, Inc. manufacturers of ultrasonic cleaning and test equipment have formed a wholly-owned subsidiary in the Netherlands—Branson Europa N. V. Initially components and complete units will be imported from the U. S., but as dependable European sources are located, they will be used.

General Manager of the new subsidiary is R. P. Ruffles. The company will occupy space at Industrieweg 14, Loosdrecht (about a half-hour's drive from Amsterdam).

Pool Resources

Waltham, Mass.—Raytheon Co., prime contractor in the U. S. for the Hawk surface to air missile, has approved formation of the Societe Europeanne de Teleguidage (SETEL). The company was formed to coordinate industrial resources in Europe for producing Hawk.

The five companies are: Thomson-Houston, France; Finmeccanica, Italy; Telefunken, West Germany; Ateliers de Construction Electrique de Charleroi, Belgium; and Philips, Netherlands. SETEL will acquire certain patent and "know-how" rights from Raytheon. Hawk is now operational in the U. S.

Call For Bids

Washington—A $159,000 project in Denmark is open to bids by U. S. Firms. Project calls for supply of radio and carrier equipment. Bid deadline is Dec. 29. Contact: For suarest Telegrafforualtning, Borgmester Jensens Alleia, Copenhagen—or: Bureau of Foreign Commerce, U. S. Dept. of Comm., Washington 25, D. C.

Test European Market

Berkeley Heights, N. J.—Nytronics, Inc. is testing the marketability in several European locations of commercial components for television, communications and other electronic

(*Continued on page 32*)

PACKAGE-SORTING SYSTEM

Mail order execs from West Germany and Holland tour computer-linked package-sorting conveyor system installed by Speaker Sortation System, Inc. R. L. Speaker, President of the firm (hand on tray) demonstrates system.

SOUTH AMERICA

Set up Export Division

Syosset, L. I.—U. S. Transistor Corp. has set up a foreign sales dept. under P. Williams. Electronic Manufacturers Export Co., Plainview, L. I. has been appointed Latin American sales representative for the Co.'s TO-101 transistor kit.

Form Mexican Corporation

Norwalk, Conn. — Burndy Corp. and Ingeneria Electrica Industrial, S. A. have formed a jointly owned Mexican Corp., Burndy I. E. I. de Mexico, S. A. The agreement provides for licensed manufacture and sale of Burndy electrical connectors throughout Mexico and Latin America. Enrique M. Gonzales, Dir. Gen. of I. E. I. will be Dir. Gen. of Burndy I. E. I. Burndy appointed directors are: Eric E. DeMarsh; George M. Szabad; and Stanley M. Loomis.

RECEIVES AWARD

William P. Lear, Lear, Inc., (cntr) receives "Great Silver Medal" of Paris from Gen. Martial Valin of the Superior Council of National and Air Defense (L). Jullen Tardlieu Ores. of French Municipal Council presented award for Mr. Lear's contribution to aircraft safety (an autopilot used on the Caravelle airliner).

FAR EAST

Australian Plant Starts Production

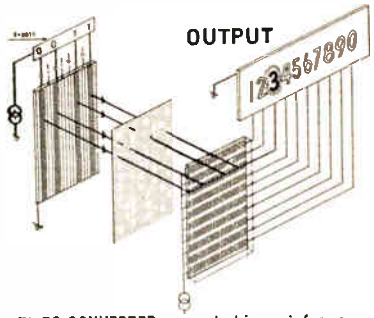
Finsbury, Australia—Production has begun at Texas Instruments' Incorporated Australian subsidiary, Australmac Limited. The plant, at Finsbury, is producing metal strip for Australia's electronics and telephone cable industry. Later, production will be diversified to include other solid and clad metal mill products.

New Jap Licensee

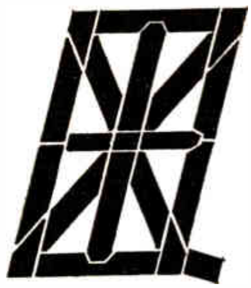
Tokyo—Tokyo Electro Acoustic Co. (TEAC) has been licensed by American Concertone, Inc. to manufacture most models of their commercial tape recorder line for sale and use in Japan. Licensing agreement is for three years.

ELECTROLUMINESCENT-PHOTOCONDUCTIVE DEVICES

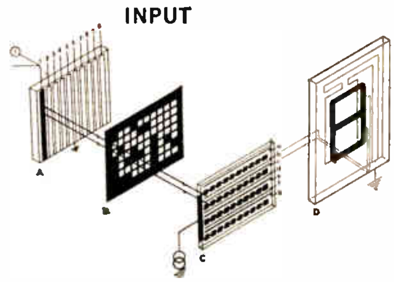
A phenomenon made practical . . . by SYLVANIA



EL-PC CONVERTER converts binary information to decimal form. The output of the CONVERTER can be used as the input to the TRANSLATOR shown below. EL-PC matrices for decimal-to-binary conversion are also available from Sylvania.



EL "READOUT" DEVICE is composed of strips of electroluminescent lamps, insulated from each other and separately terminated. By selective excitation of the "strips," alpha-numeric symbols are produced for readout purposes.



EL-PC "TRANSLATOR" makes practicable use of the luminous properties of EL phosphors on panel "A" and of photoconductive elements on panel "C." Mask "B" enables selective excitation of the electroluminescent phosphors on readout panel "D."

Physical dimensions of EL-PC panels are shown here in exaggerated scale for purposes of clarity.

FEATURING • Compact, flat construction • Minimal catastrophic failure • Exceptional reliability and long life • Simplified circuitry • Negligible power requirements

SYLVANIA combines photoconductive elements with the luminous properties of electroluminescent phosphors to provide design engineers with a group of alpha-numeric readout devices and components capable of performing simple and complex logic functions, the conversion of digital information, and the storage and memory of data. These offer new and significant possibilities for end-product miniaturization together with dramatically enhanced reliability.

For example, new "crossed-grid" panels have been developed that utilize conductive strips placed at right angles to each other on opposite sides of an electroluminescent phosphor layer. These "strips" when separately excited glow at the points of intersection. This provides a point of light that can be moved in X-Y directions to create a display that is exceptionally small in front-to-back dimensions and is highly useful in position-plotting applications.

Sylvania Sales Engineers can give you details on specific EL-PC devices. Too, write for ten-page brochure, "Sylvania Electroluminescent-Photoconductive Devices," to Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 1911, 1100 Main Street, Buffalo, N. Y.

SYLVANIA

Subsidiary of ***GENERAL TELEPHONE & ELECTRONICS***

Circle 16 on Inquiry Card

International News

(*Continued from page* 30)

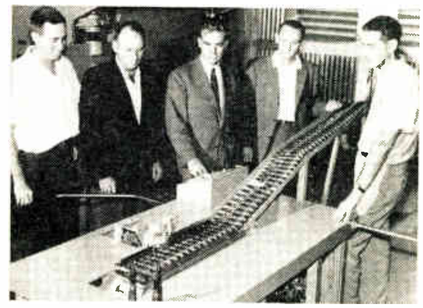
industries. They believe they will find an "appreciable and sympathetic market."

The Company has signed its first international sales representative agreement with Originator Engineering Co., Stockholm, Sweden.

Telex Link With Rumania

New York — RCA Communication, Inc. has opened teleprinter exchange (telex) service between New York and Bucharest, Rumania. This brings to 54 the number of overseas points served. Rates are $3.00 per min—a $9.00 minimum is charged.

INSPECT SCORING DEVICE



Nato reps wind-up 60 day trip through U. S. Shown inspecting device at Franklin Systems, Inc., West Palm Beach, Fla. are (L to R): M. J. Cohen, VP Engineering—Franklin Sysems; Capt. W. F. Kirlin, USAF; Major Jean Bastien-Thiery and Pierre Boutroux, Nato and French Air Ministry; and H. C. Gibson, Pres., Franklin Systems.

AFRICA

Design New VOA Station

Monrovia, Liberia—Engineering and architectural design for the Voice of America's powerful mid-African radio relay station outside Monrovia will be done by Page Communications Engineers, Inc., Washington, D. C. The station will have six 250,000 watt and two 50,000 watt transmitters. It will provide radio coverage of Africa and supplemental coverage of parts of Central Europe and the Middle East. It will also permit relay around the world of broadcasts originating in Washington. Contracts for the 8 transmitters will soon be let.

The new station, although high power, will operate under international rules when it goes on the air and will not interfere with other broadcasts in the African area.

The Voice's East Coast facility, planned for completion by the end of 1962, is on schedule. The 500,000 watt, 250,000 watt, and 50,000 watt transmitters will cover Europe, Africa, the Middle East, and South America. It will also transmit VOA broadcasts for relay by the new Liberian station.

Reliability in volume...
CLEVITE
TRANSISTOR
WALTHAM, MASSACHUSETTS

Tele-Tips

METERS that measure out the alcohol and water for guided missiles must be highly accurate—for which a lot of happy catfish around Kansas City can be very grateful. To check the calibration of a Neptune Red Seal Meter the Columbian Steel Tank Co. last month filled a tank with 1,300 gallons of 190-proof alcohol and water. The amount was carefully measured as it was put into the tank, and measured again as it was poured into the Missouri River. The accuracy had to tally within one-tenth of one per cent. . . . And the Missouri catfish enjoyed one gigantic binge.

JET CONTRAILS can be minimized, the Air Force has found, by mixing tiny hygroscopic (dust-like) particles in the engine exhaust. The resultant vapor trail is made up of droplets too small to be seen from the ground.

THE (VERY) CORRECT TIME IS . . . National Bureau of Standards has developed a system for synchronizing and setting widely separated clocks to a relative accuracy closer than a millionth of a second. It is being adopted by the Dept. of Defense for application at military installations. Synchronized with the highly accurate uniform time source at the Naval Observatory, Washington, D. C., the system may soon provide the timing necessary for the DOD's coast-to-coast missile ranges.

"COCKTAIL PARTY EFFECT" allows a person to concentrate on the specific voice in which he is interested amid high surrounding noise levels. Two Bell Labs scientists have duplicated the effect using separate inputs to two microphones (as human ears do) and a "gating wave" which is generated by the combined output of the two microphones. The effect of this gating was that the intensity of the combined signal was raised only when the desired voice arrived simultaneously at both microphones.

(*Continued on page* 38)

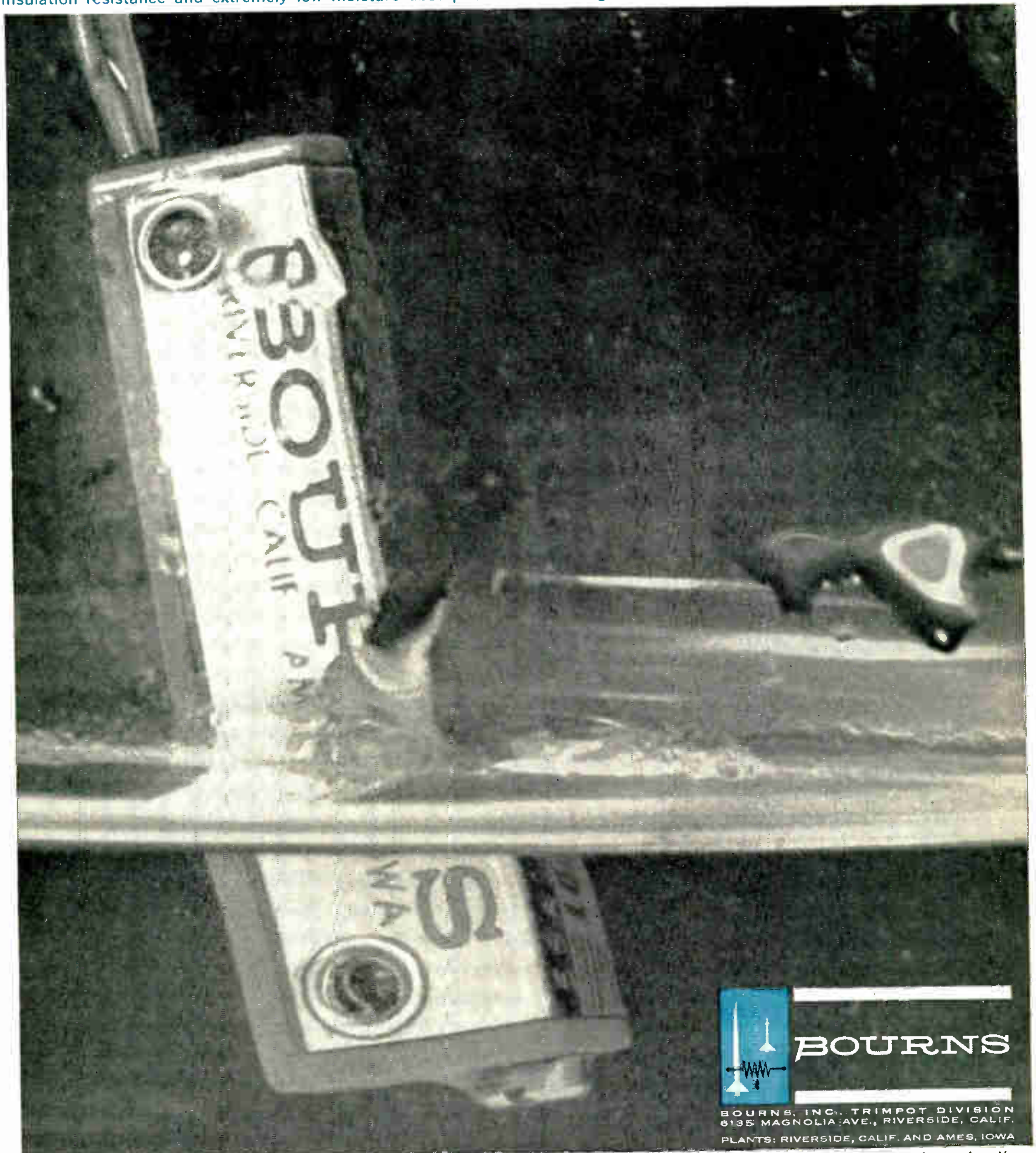
Bourns Trimpot®
Puts the Proof in Humidity-Proof

Plunging a potentiometer into near-boiling water is just one of the ways Bourns puts the proof in humidity-proof. Every Trimpot unit made takes this 60-second bath with the water simmering at 90°C. Air expanded by the heat creates four pounds of pressure inside the potentiometer—enough to cause bubbles—if it leaks. Only if the unit is completely leak-free does it pass the test.

Bourns humidity proofing starts at the beginning—with original design and selection of materials. The plastic chosen for Trimpot cases, for example, displays the unusual properties of high insulation resistance and extremely low moisture absorption.

Further protection against humidity results from manufacturing procedures, such as internal potting of the resistance element and sub-components. Finally, Bourns samples all production for compliance to MIL-STD-202A, Method 106 as a routine part of a Reliability Assurance Program. As a result, Trimpot does more than "resist" moisture; it keeps moisture out.

For more information about the industry's largest selection of humidity-proof adjustment potentiometers—wirewound and carbon in a variety of sizes, power ratings, operating temperatures, etc.—write for new Trimpot summary brochure and list of stocking distributors.



BOURNS, INC., TRIMPOT DIVISION
6135 MAGNOLIA AVE., RIVERSIDE, CALIF.
PLANTS: RIVERSIDE, CALIF. AND AMES, IOWA

Exclusive manufacturers of Trimpot®, Trimit®, and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

Circle 21 on Inquiry Card

Tele-Tips

(*Continued from page 36*)

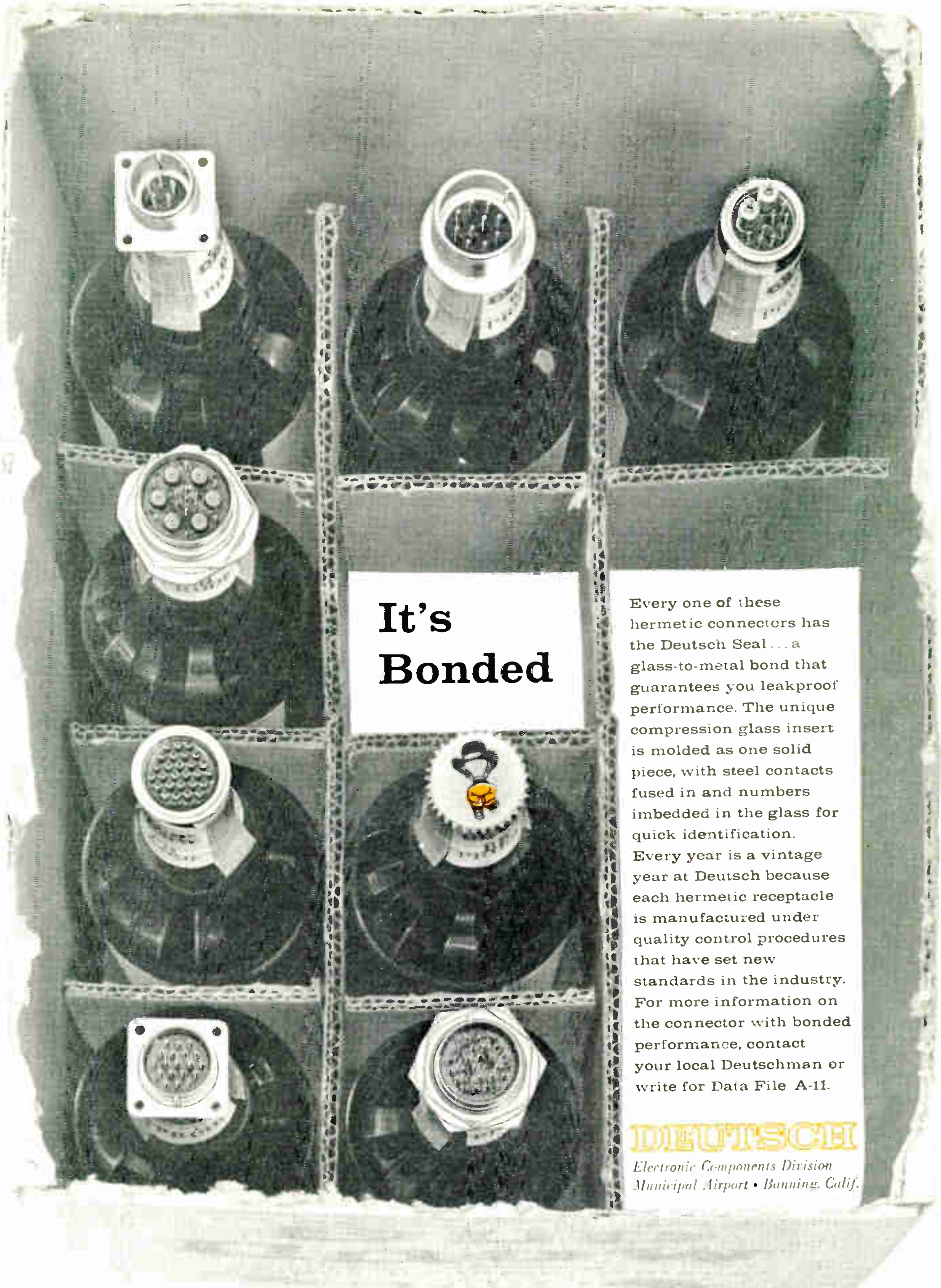
WHEN REBUILT CRT'S are sold to TV owners in New York State there must now be written notification on the bill that the tube is "rebuilt" — not "new." The law went into effect Oct. 1. Survey had shown that 8 out of 10 families buying pix tubes thought they were buying new tubes. But industry sales figures showed that only 20% of the approximately 6,000,000 replacement tubes sold each year are all new.

35-LB. RADAR SETS will be developed by Airborne Instrument Lab for the Signal Corps. The set "will detect a moving man at ranges from 150 ft. to over 2 miles and a moving ¼ ton vehicle at ranges from 150 ft. to 3 miles."

PRODUCTION CONTROL gets a big assist from a new addition to IBM's 357 data collection system that allows it to read employees' identification badges. Information punched into the identification badge is automatically correlated with the job for payroll and personnel purposes.

INDUSTRY VETERAN SARKES TARZIAN was one of the 11 outstanding U. S. industrialists singled out by the Free Enterprise Awards Association, Inc., this year as "examples of the success possible under American free enterprise democracy."

ELECTRONIC "NEEDLE" that warns drowsy drivers that they are heading off the road is being tested at General Motors proving grounds. The device uses a wire in the center of the pavement, radiating a 2 kc signal. On the fenders of the car are mounted two ferrite coils, picking up the signals from the wire. The closer the coils are to the wire, the stronger the signal, so that when the car veers to one side the pickup from that side increases. The signal is amplified and fed to warning lights. If the warning lights are not heeded, a speaker is switched in to add an audible alarm.



ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

Circle 23 on Inquiry Card

Letters to the Editor

"Is the USSR This Good—?"

Editor, ELECTRONIC INDUSTRIES:

I am highly impressed by the contents of your September issue and would like to have reprints of the following articles:

How to Duplicate Technical Papers, p. 242

Storing with Thin Films, p. 89.

Reliability and Printed Circuit Connectors, p. 82, including the Part II.

Conversion of Binary to Analog Codes, p. 70.

I was also impressed by your transcript of the speech by Mr. D. Packard, at WESCON. What I would like to know is: 1) How come Soviet technical achievements are this good? 2) Why are their scientific articles so full of substance?

I agree with him that our achievements are superb—but the truth is not solely on our side. Nor the lies, on theirs. I guffawed over his description of his query at a Soviet school about the Ohm's Law, which no one knew. You see, it is not known as OHM's LAW there. No more than advertising is known as PAVLOV'S REFLEX here. And your small note about the declining engineering school enrollment was much more to the point. It is easier to be a manager than an engineer, the kids found out—and much more profitable. Doesn't take any brains either. Not if you can blame the Federal Govt. for everything.

I will appreciate your reprints, and I like your mag.

Orest A. Meykar
Development Engineer
Burroughs Corporation
Great Valley Laboratory
Research Center
Paoli, Pa.

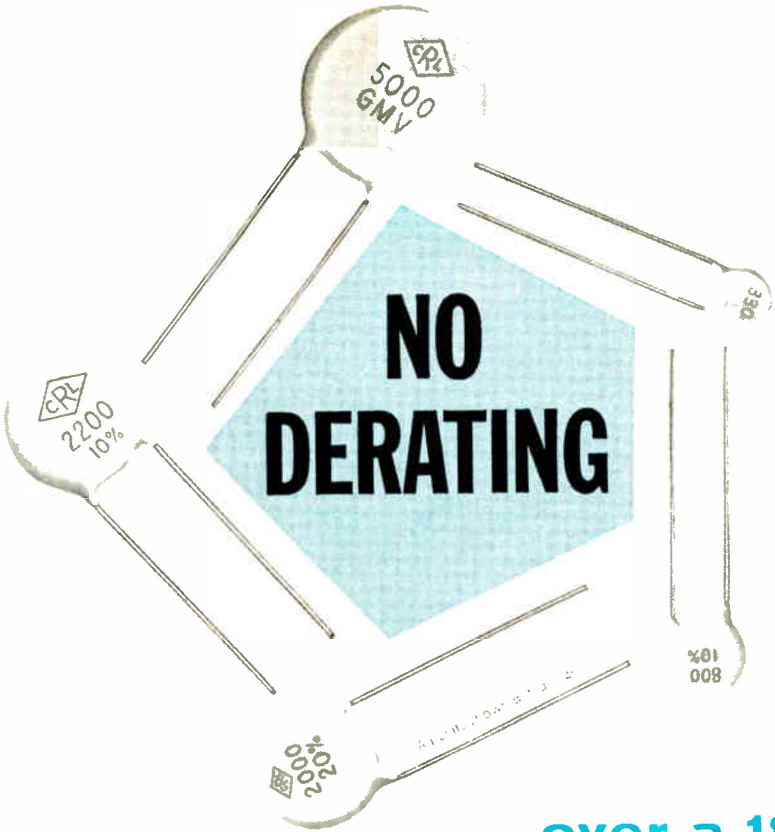
"A Navy Consultant—"

Editor, ELECTRONIC INDUSTRIES:

As Educational Consultant in the Advanced Electronics Training School with the Navy at Memphis, I am responsible for keeping the Instructor staff abreast of the latest developments in Electronics.

In the August, 1960, edition of ELECTRONIC INDUSTRIES, there were several reprints of articles that were available to subscribers. They were as follows:

1. The Binistor—A New Semiconductor Device, by Nicholas DeWolf.
2. Electronics and the Future of Agriculture, by Richard G. Stranix.
3. New Use for Fluxgate Principle, by George S. Kan.
4. Determining Transistor Power Dissipation, by John G. Naborowski.

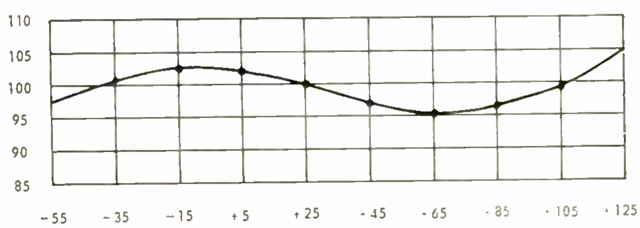


over a 180° C range with Centralab's temperature stable Ceramic Capacitors

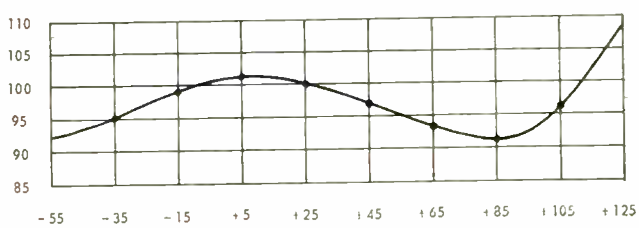
These low-cost Type CE ceramic disc Hi-Kaps® have been extensively tested over an 18 month period by prime contractors in the missile and radar fields. Their findings: *the excellence of the* CENTRALAB *design parameters for standard commercial units permits the identical capacitors to be used in military applications.*

In radio-TV as well as military usage, these units operate from —55° C to +125° C without derating. They last longer than paper or mica capacitors, and their small size makes them economical to work with. Semi-stable Type CF CENTRALAB Hi-Kaps® offer similar advantages.

TYPE CE—% of 25°C Capacity vs. Temperature in °C



TYPE CF—% of 25°C Capacity vs. Temperature in °C



SPECIFICATIONS

CAPACITIES: 150-6200 mmf
SIZE: .290"—.920" diameter, .156" thick
WORKING VOLTAGE: 500 VDC
LEAKAGE RESISTANCE: Initial, 10,000 Megohms minimum; after humidity test, over 1000 Megohms
POWER FACTOR: 2% Max. at 1KC
TOLERANCES: GMV, ±20%, ±10%, +80—20%

Detailed information on these and many other CENTRALAB ceramic capacitors can be found in Catalog 42-857. Write for your free copy.

Centralab CRL ®

D-6036

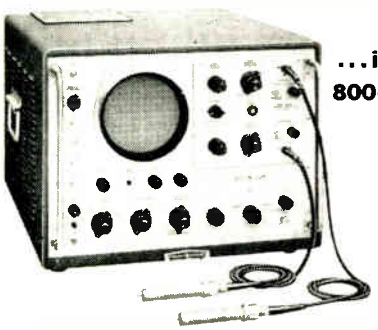
The Electronics Division of Globe-Union, Inc.
938L E. Keefe Ave., Milwaukee 1, Wisconsin
Centralab Canada Limited • Ajax, Ontario

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

Circle 25 on Inquiry Card

In RELIABILITY, test the equipment tested. G-E Five-Star Tubes application needs best

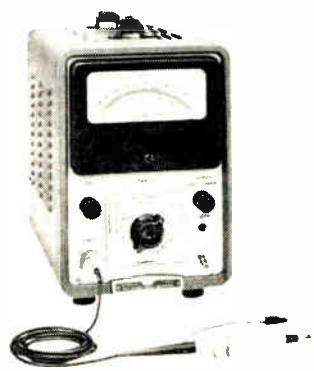
TUBE LIFE REQUIREMENTS: LOW GRID CURRENT, HIGH G_m



...in hp Model 185A 800-mc Oscilloscope

Advanced pulse-sampling circuitry of the 185A calls for an amplifier tube with (1) grid current so low that current is not withdrawn from a grid-to-ground storage capacitor, and (2) high G_m for maximum amplification. These characteristics must be maintained. General Electric's 5-Star 5654 was chosen by Hewlett-Packard after extensive tests; helps in producing a dependable high-speed instrument to measure transistor response time and diode switching speeds, and test fast computer circuits and surveillance radars.

TUBE NOISE MUST REMAIN AT MINIMUM LEVEL



...in hp Model 425A Micro Volt-Ammeter

So sensitive it will measure down to 10 microvolts and 10 micro-microamperes—stable, with extremely low drift – Hewlett-Packard's 425A calls for sustained tube performance at minimum noise level. In the key amplifier socket for modulator output, General Electric 5-Star 5751-WA's have cut line rejects from noise sharply, and help preserve usefulness of the equipment after it is placed in service. Before, another tube in the same socket caused a 30% reject rate!

instruments must surpass

Hewlett-Packard (hp) uses

because they satisfy

....here is your proof!

Circle 26 on Inquiry Card

TUBES MUST STAY FREE OF INTERFACE EFFECTS

...in (hp) Model 460B
Wide Band Amplifier

In order that high pulse power or voltage may be applied to a load, Hewlett-Packard's 460B uses 13 5-Star 5654 tubes in a distributed-amplifier circuit. Tube requirements are severe. The high-voltage, low-duty cycle pulses entail operation at max ratings for brief intervals, between long periods of tube cut-off. Interface effects would handicap reliability. General Electric's 5654's score both in minimum interface and high over-all performance...help Model 460B meet consistently, often exceed, its operating specifications.

TELEPHONE TODAY! New York, WI 7-4065...Boston, DE 2-7122...Washington, EX 3-3600
Chicago, SP 7-1600...Dallas, RI 7-4296...Los Angeles, GR 9-7765, BR 2-8566...San Francisco, DI 2-7201

Progress Is Our Most Important Product

GENERAL (GE) ELECTRIC

431-101

Letters to the Editor

(*Continued from page* 40)

5. Recordings from DC to 1 MC, by G. Nels Johnson and Lal Mirchandani.

Thank you for your excellent service to us. The EI magazine is an excellent source of information that would be almost impossible for us to obtain elsewhere.

Ronald E. Drew
Educational Consultant
AT(B) School, Building S-241
Naval Air Technical Training Center
Memphis 85, Tenn.

Congratulations!

Editor, ELECTRIC INDUSTRIES:

Please forward reprint of article: "An Introduction to Boolean Algebra," and also current September article "Electronic Industries Look at Unconventional Power Converters."

I would like to congratulate your staff for the terrific comprehensive editorial coverage.

Eugene Ross
Sales Manager
Photomation, Inc.
96 S. Washington Ave.
Bergenfield, N. J.

Unconventional Power Converters

Editor, ELECTRONIC INDUSTRIES:

Please send me a copy of the article on "Unconventional Power Supplies" that appeared in the September 1960 issue of *Electronic Industries*.

Incidentally, the article describing the production of thermionic converters by the General Electric Company has a small error. The descriptive headings under the pictures of the vapor and vacuum thermionic are reversed. The vapor converter may be distinguished from the vacuum converter by the cesium reservoir tube attached to the anode of the vapor converter.

Charles D. Buell
EEIT
General Electric Company
Defense Electronics Division
Mountain View Road
Lynchburg, Va.

Editor, ELECTRONIC INDUSTRIES:

The September article by Christopher M. Celent added one more gem to the display showcase that has been accumulated over the years. This article presents, in easily understandable language, the principal exotic power converters, and describes their operation in simple terms.

It would be appreciated if you could furnish 10 copies of this article

Measure dc currents 0.3 ma to 1 ampere

with

No Breaking of Leads
No DC Connection
No Circuit Loading

428A CLIP-ON MILLIAMMETER.

Probe clamps AROUND wire; measures by sensing magnetic field!

Think of the measuring convenience, time saved and accuracy gained when you don't have to break into a circuit, solder on a connection, or worry about probe loading.

With the hp 428A Milliammeter and its new probe, you literally *"clamp around"* and read! You get maximum accuracy because there is no effective circuit loading from the 428A's dc probe. The instrument easily measures dc currents in the presence of ac. And insulation is more than adequate to insure safe measurements at all normal voltage levels

For extremely low current level measurement, sensitivity can be increased by looping the conductor through the "jaws" of the 428A probe two or more times.

Brief specifications are given here, for complete details and demonstration *on your bench*, call your hp representative or write direct.

Specifications

Current Range: Less than 0.3 ma to 1 amp, 6 ranges. Full scale readings from 3 ma to 1 amp: 3 ma, 10 ma, 30 ma, 100 ma, 300 ma, 1 amp.

Accuracy: ± 3% ± 0.1 ma.

Probe Inductance: Less than 0.5 μh maximum.

Probe Induced Voltage: Less than 15 mv peak.

Effects of ac in circuit: Ac with peak value less than full scale affects accuracy less than 2% at frequencies different from the carrier (40 KC) and its harmonics.

Power: 115/230 v ± 10%, 50-60 cps, 70 watts.

Size: Cabinet mount, 7½" wide, 11½" high, 14¼" deep. Weight 19 pounds. Rack mount, 19" wide, 7" high, 12½" deep. Weight 24 pounds.

Probe Tip Size: Approximately ⅝" x 7/16". Wire aperture diameter 3/16".

Price: (Cabinet) $475.00; (Rack) $480.00.

Data subject to change without notice.
Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY
1005B PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
HEWLETT-PACKARD S.A., RUE VIEUX BILLARD NO 1, GENEVA, SWITZERLAND
CABLE: "HEWPACKSA" • TEL. NO. (022) 26. 43, 36
CABLE "HEWPACK" • DAVENPORT 6-7000
Field representatives in all principal areas

6058

Test the new hp 405A DC Digital Voltmeter

Letters to the Editor

(*Continued from page 44*)

for the personal files of myself and my co-workers.

J. K. Hayden
CAMPS Engrg. Sub-Section
General Electric Company
Low Voltage Switchgear Department
6901 Elmwood Avenue, Phila. 42, Pa.

Editor, ELECTRONIC INDUSTRIES:

Please send me a reprint of the splendid article on "Unconventional Power Converters" that appears in the September, 1960, issue of your magazine.

C. Thomas Maney
Professor of Electrical Engineering
University of Kentucky
Lexington, Ky.

Editor, ELECTRONIC INDUSTRIES:

We shall appreciate it very much if you will send us two copies of the reprint of the article entitled, "Electronic Industries Looks at Unconventional Power Converters" which appears in your periodical for September, 1960. Our Research Department and engineers are extremely interested in this subject.

Marie B. Spillane
Librarian
Philadelphia Electric Company
1000 Chestnut Street, Phila. 5, Pa.

Editor, ELECTRONIC INDUSTRIES:

In conjunction with the keeping abreast of progress in direct conversion of heat to electricity, we shall appreciate a reprint of the article entitled "Unconventional Power Converters" by Assistant Editor C. M. Celent and as occurring in the September, 1960, issue of ELECTRONIC INDUSTRIES.

This is a well-rounded article, and Mr. Celent is to be complimented on the fine job done.

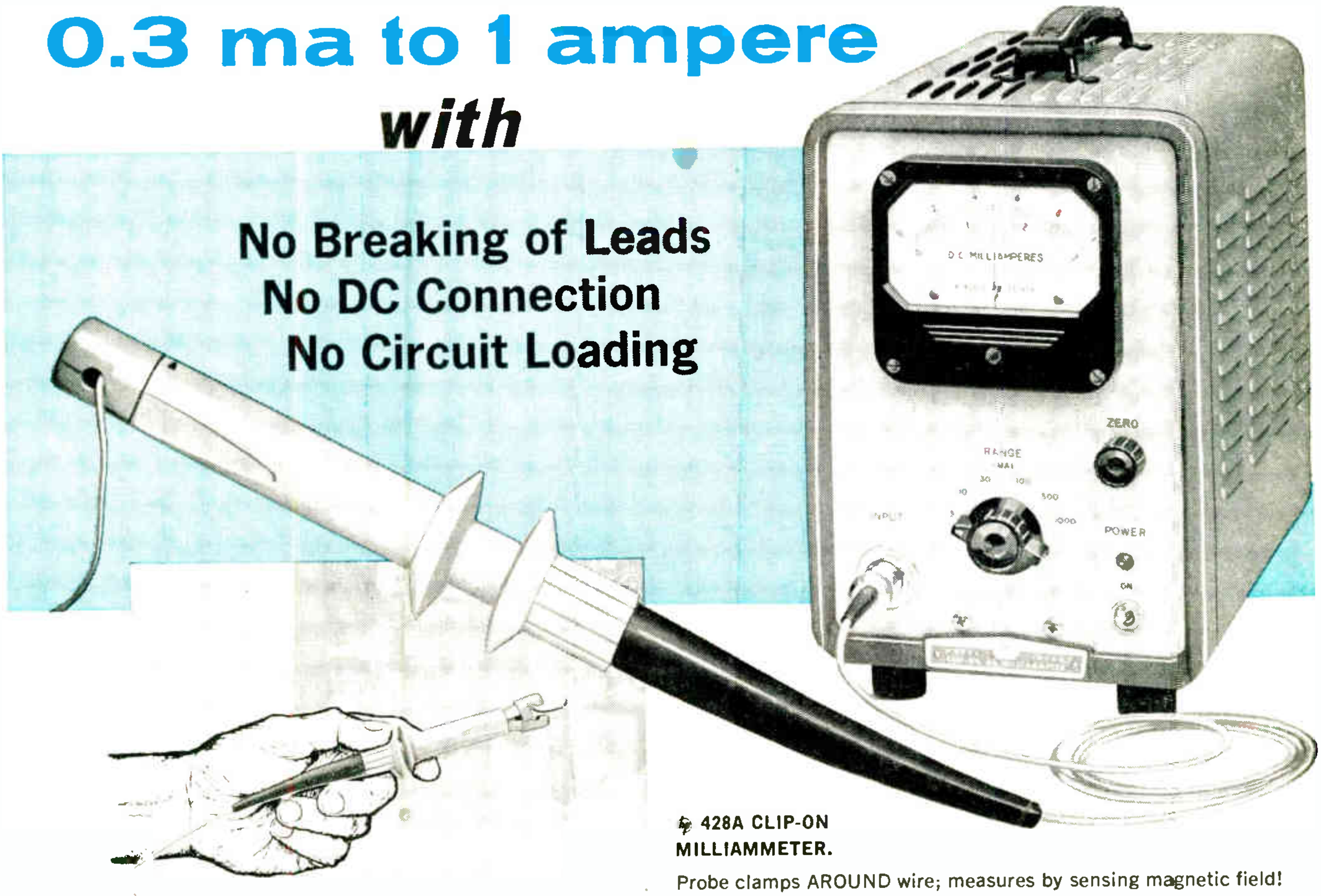
L. A. M. Barnette
Production Department
Petroleum Engineering
Humble Oil & Refining Company
Humble Division
Houston 1, Texas

Editor, ELECTRONIC INDUSTRIES:

Much interest has been displayed among our engineers and physicis with reference to the article "En-tronic Industries Looks at Unpear-tional Power Converters," issue of ing in the September, 196 like to ob-your magazine. We wor nts of this tain 6 additional re article.

B. Gerstein
Section Chief
Nuclear Radiation Laboratory
Admiral Corporation
3800 Cortland Street, Chicago 47

Measure dc currents
0.3 ma to 1 ampere
with



No Breaking of Leads
No DC Connection
No Circuit Loading

428A CLIP-ON MILLIAMMETER.
Probe clamps AROUND wire; measures by sensing magnetic field!

Think of the measuring convenience, time saved and accuracy gained when you don't have to break into a circuit, solder on a connection, or worry about probe loading.

With the hp 428A Milliammeter and its new probe, you literally "*clamp around*" and read! You get maximum accuracy because there is no effective circuit loading from the 428A's dc probe. The instrument easily measures dc currents in the presence of ac. And insulation is more than adequate to insure safe measurements at all normal voltage levels

For extremely low current level measurement, sensitivity can be increased by looping the conductor through the "jaws" of the 428A probe two or more times.

Brief specifications are given here, for complete details and demonstration *on your bench*, call your hp representative or write direct.

Specifications

Current Range: Less than 0.3 ma to 1 amp, 6 ranges. Full scale readings from 3 ma to 1 amp: 3 ma, 10 ma, 30 ma, 100 ma, 300 ma, 1 amp.

Accuracy: ± 3% ± 0.1 ma.

Probe Inductance: Less than 0.5 μh maximum.

Probe Induced Voltage: Less than 15 mv peak.

Effects of ac in circuit: Ac with peak value less than full scale affects accuracy less than 2% at frequencies different from the carrier (40 KC) and its harmonics.

Power: 115/230 v ± 10%, 50-60 cps, 70 watts.

Size: Cabinet mount, 7½" wide, 11½" high, 14¼" deep. Weight 19 pounds. Rack mount, 19" wide, 7" high, 12½" deep. Weight 24 pounds.

Probe Tip Size: Approximately ⅝" x 7/16". Wire aperture diameter 3/16".

Price: (Cabinet) $475.00; (Rack) $480.00.

Data subject to change without notice.
Prices f.o.b. factory.

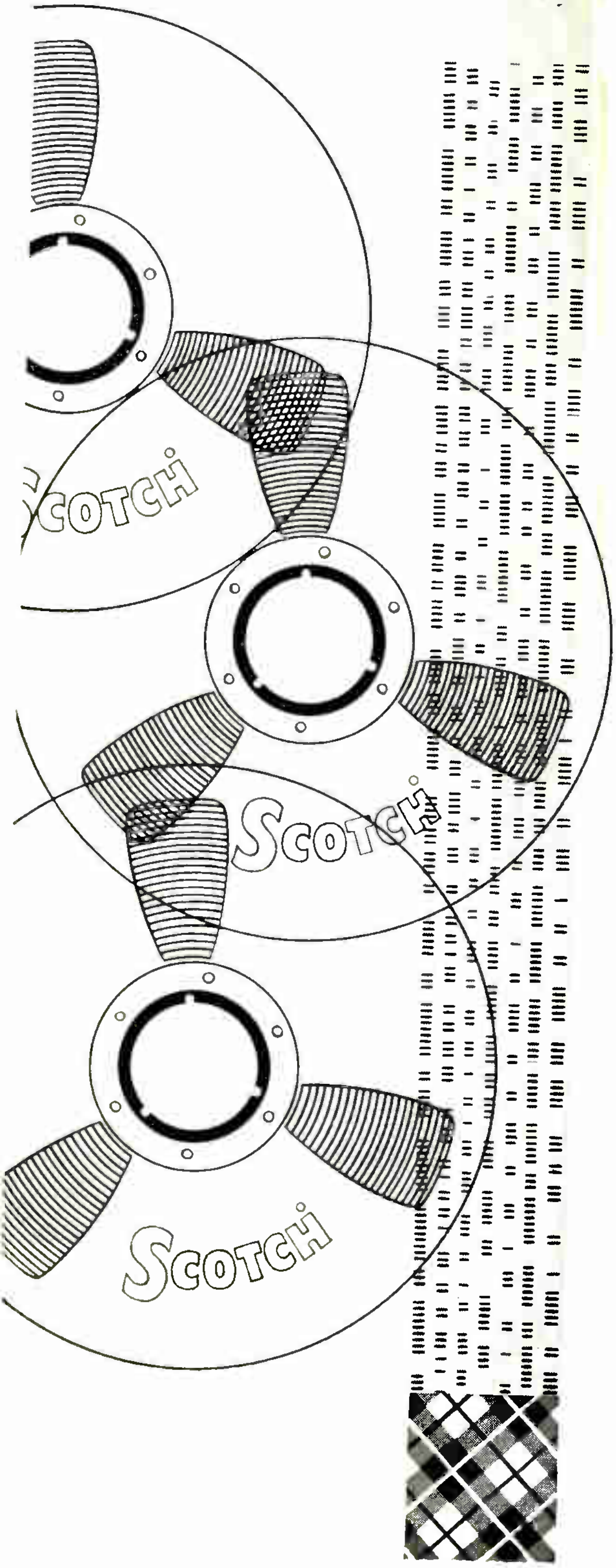
HEWLETT-PACKARD COMPANY
1005B PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
HEWLETT-PACKARD S.A., RUE VIEUX BILLARD NO 1, GENEVA, SWITZERLAND
CABLE: "HEWPACKSA" • TEL. NO. (022) 26. 43, 36
CABLE "HEWPACK" • DAVENPORT 6-7000
Field representatives in all principal areas

6058

Test the new hp 405A DC Digital Voltmeter

NO DISTORTION OF THE FACTS

"SCOTCH" BRAND Precision Reels stack up well, thread smoothly



IN INSTRUMENTATION, it nearly goes without saying that your choice of reels is as important as your choice of magnetic tapes. You can't afford any distortion of the facts you deal with—so why not give your "SCOTCH" BRAND Tape the best running mate—a "SCOTCH" BRAND Precision Reel.

While most drop outs come from dust or other contaminants on the tape surface, the next most significant factor is related to improper handling. Dents or creases in the tape backing, damage to tape edges caused by uneven winding, too much tension on the tape at the end of a pass—all of these affect performance. Any stresses which exceed the yield point of the tape can cause a permanent set—a physical distortion which in turn leads to the attenuation or loss of important signals.

Precision is no empty word when applied to the "SCOTCH" BRAND reel. Every detail—design, materials and production techniques—grows out of years of careful research and testing by the same 3M research teams who have continually led in the development of magnetic tapes.

The "SCOTCH" BRAND Precision Reel is machined of aluminum. Its unique design offers maximum protection against tape damage from handling, while greatly lowering the moment of inertia—exerting less stress in stops and starts. Because the flanges are precision machined, they can be held to a fine tolerance—thicker at the hub, thinner toward the rim. These closely spaced, tapered flanges guide the tape into a smooth, even stack. Tape edges are kept perfectly aligned.

Threading up is easy on you and the tape. The "SCOTCH" BRAND reel employs a precision ground neoprene ring instead of a threading slot which can cause distortion of the inner turns of tape. To thread up, you simply start a turn of tape on the take-up reel. The neoprene ring, moreover, acts as a cushion for the innermost tape layers and guards against distortion from winding pressure and expansion-contraction stresses.

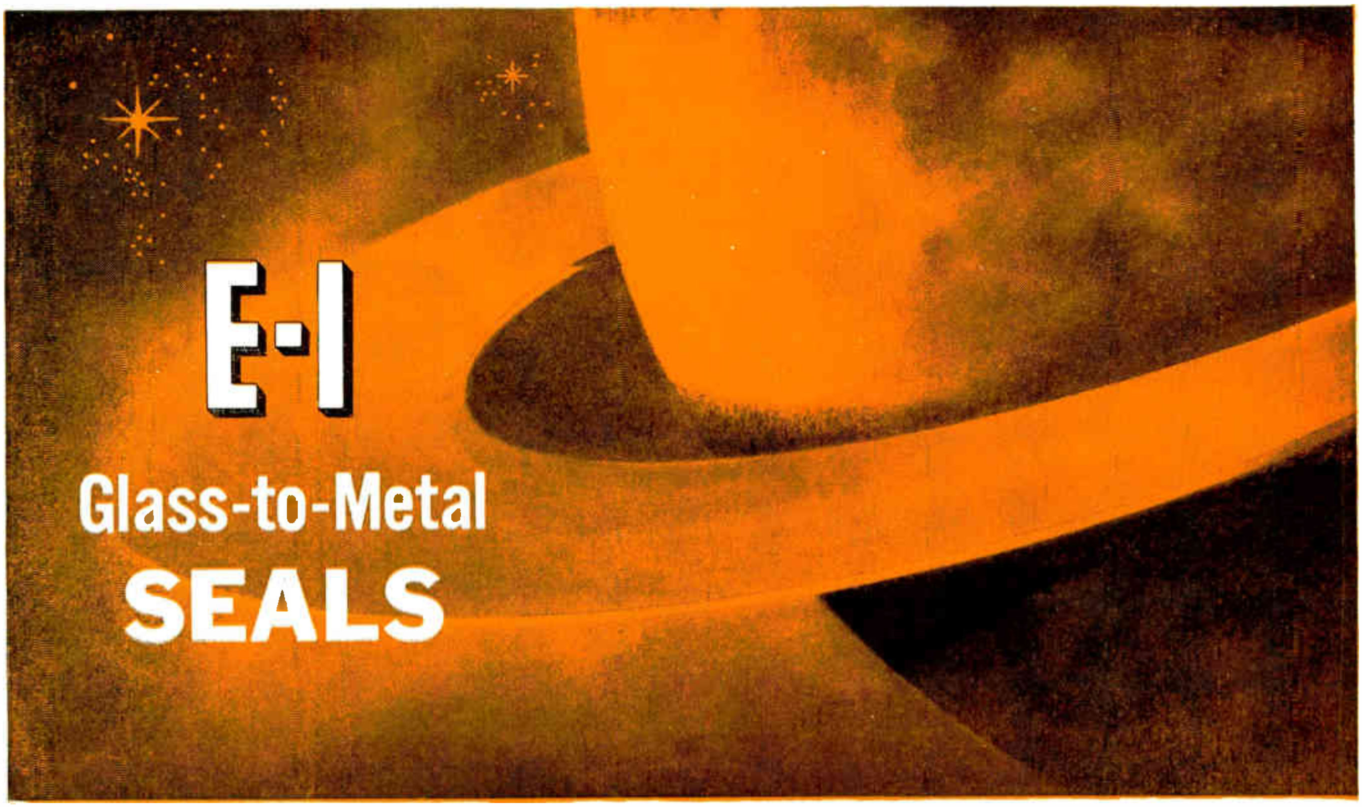
Flange apertures are reduced to the minimum compatible with the need for observation and threading—giving further protection to tape and greater rigidity to the reel. Compare—as the moment of reel decision approaches, a look at all the facts should lead you to come out in favor of "SCOTCH" BRAND Precision Reels.

Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details on reels and tape constructions, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

Universal in Application...



Universal in Reliability...

SEMI-CONDUCTOR SEALS

INDIVIDUAL TERMINALS

MULTIPLE-LEAD HEADERS

CONDENSER END SEALS

COLOR CODED TERMINALS

THREADED END SEALS

CUSTOM SEALING SERVICE

Standardized Production

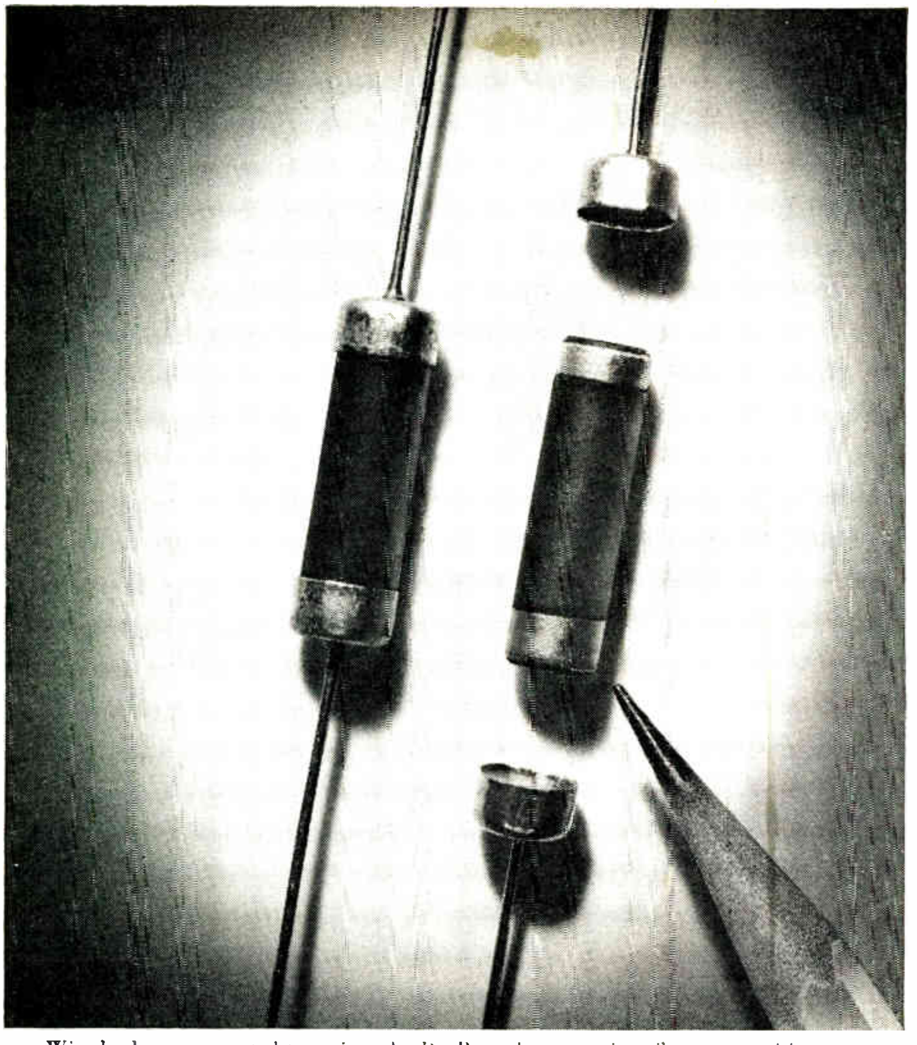
E-I offers designers and engineers the complete flexibility and economy of standardized production on all types of seals from individual terminals to sub-miniature closures. For proven reliability, specify the seals employed by leading manufacturers in both commercial equipment and space age projects.

Nation-wide Field Service

Write today for complete information on standard E-I seals or custom sealing of terminal assemblies of your own manufacture. E-I field engineers will gladly make recommendations on your specific requirements on receipt of your application data.

ELECTRICAL INDUSTRIES
MURRAY HILL, NEW JERSEY
A Division of Philips Electronics & Pharmaceutical Industries Corp.

Patented in Canada, No. 523,390; in United Kingdom, No. 734,583; licensed in U.S. under No 2561520



Wire leads are cemented to resistor by Du Pont thermosetting silver composition.

Du Pont CONDUCTIVE CEMENTS

are easy to apply . . . eliminate soldering

Du Pont offers high-quality thermosetting gold and silver cements, especially formulated for application on silicon, germanium, carbon and other bases. These Du Pont conductive cements are easily applied by dip, brush or squeegee . . . eliminate soldering:

- Thermosetting gold compositions #5780 and #7728 are suitable for dip, brush or squeegee application.
- Thermosetting silver composition #5504-A is suitable for application by squeegee—composition #5815 for application by dip or brush.

After proper curing and drying, these compositions exhibit good adherence, electrical conductivity and abrasion resistance.

Du Pont conductive cements find wide application for lead attachments in diodes, transistors, resistors and similar components. Gold cements are particularly suitable for applications where resistance to strong etching acids is required.

Silver Preparations: Du Pont also offers a full line of silver preparations—conductive coatings used in the electronic industry. Du Pont silver preparations are solderable . . . easy to handle . . . have excellent electrical properties.

For more detailed information, write for bulletins on high-quality Du Pont Conductive Cements or silver preparations. Mention the application you have in mind so that appropriate literature can be supplied. Du Pont, Electrochemicals Department, Ceramic Products Division, Wilmington 98, Del.

DU PONT

REG. U.S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

Letters to the Editor

(*Continued from page 44*)

for the personal files of myself and my co-workers.

J. K. Hayden
CAMPS Engrg. Sub-Section
General Electric Company
Low Voltage Switchgear Department
6901 Elmwood Avenue, Phila. 42, Pa.

Editor, ELECTRONIC INDUSTRIES:

Please send me a reprint of the splendid article on "Unconventional Power Converters" that appears in the September, 1960, issue of your magazine.

C. Thomas Maney
Professor of Electrical Engineering
University of Kentucky
Lexington, Ky.

Editor, ELECTRONIC INDUSTRIES:

We shall appreciate it very much if you will send us two copies of the reprint of the article entitled, "Electronic Industries Looks at Unconventional Power Converters" which appears in your periodical for September, 1960. Our Research Department and engineers are extremely interested in this subject.

Marie B. Spillane
Librarian
Philadelphia Electric Company
1000 Chestnut Street, Phila. 5, Pa.

Editor, ELECTRONIC INDUSTRIES:

In conjunction with the keeping abreast of progress in direct conversion of heat to electricity, we shall appreciate a reprint of the article entitled "Unconventional Power Converters" by Assistant Editor C. M. Celent and as occurring in the September, 1960, issue of ELECTRONIC INDUSTRIES.

This is a well-rounded article, and Mr. Celent is to be complimented on the fine job done.

L. A. M. Barnette
Production Department
Petroleum Engineering
Humble Oil & Refining Company
Humble Division
Houston 1, Texas

Editor, ELECTRONIC INDUSTRIES:

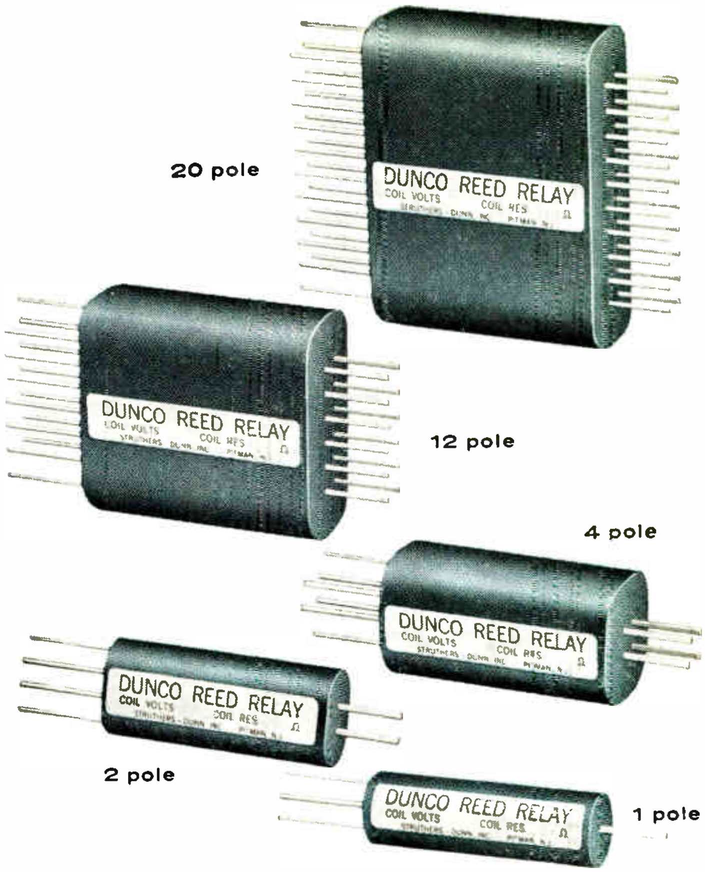
Much interest has been displayed among our engineers and physicists with reference to the article "Electronic Industries Looks at Unconventional Power Converters," appearing in the September, 1960, issue of your magazine. We would like to obtain 6 additional reprints of this article.

B. Gerstein
Section Chief
Nuclear Radiation Laboratory
Admiral Corporation
3800 Cortland Street, Chicago 47

New!

Standard line of

DRY REED RELAYS



Encapsulated units provide practically any combination of normally-open (Form A) and normally-closed (Form B) contact arrangements.

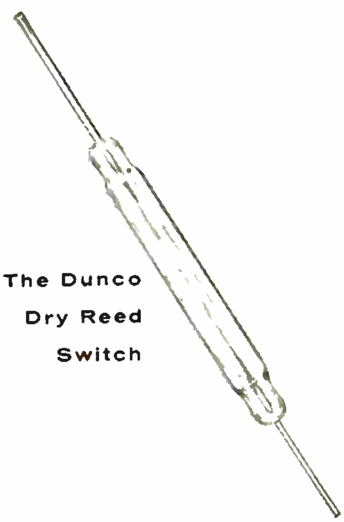
Mount in any position.

Contacts completely unaffected by atmospheric contamination.

BREAK-MAKE ACTION can be furnished to insure non-overlapping of contact closures.

Multi-coil arrangements for logic elements available.

Write for Dunco Reed Relay Bulletin.



The Dunco Dry Reed Switch

DUNCO DRY REED RELAYS provide economical and exceptionally fast low level and light load switching for computer and data handling applications. Life is on the order of hundreds of million operations. From one to 20 switches with surrounding magnetizing coil are encapsulated to form a relay unit. The Dry Reed Switch is rated 15 watts for resistance loads at maximums of 250 volts or 1 ampere; 50 milliohms maximum contact resistance; 500 V. a-c minimum breakdown voltage; and 500,000 megohms minimum insulation resistance.

STRUTHERS-DUNN

PITMAN, N. J.

WORLD'S LARGEST ASSORTMENT OF RELAY TYPES

Member National Association of Relay Manufacturers

Sales Engineering offices in: Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Dayton • Denver Detroit • High Point • Kansas City • Los Angeles • Montreal • New York • Orlando • Pittsburgh • St. Louis • San Carlos • Seattle • Toronto
Export: Langguth-Olson Co., New York

Circle 32 on Inquiry Card

Books

Statistical Theory of Communication

By Y. W. Lee. Published 1960 by John Wiley Sons, Inc., 440 Park Ave., So., New York 16. 509 pages. Price $16.75.

This is an introductory book. The object of the book is to present clearly and rigorlessly a physically motivated and systematic account of the statistical theory of communication—an account that includes essentially all of the basic elements. In preparing this book, the author has been guided by the idea that a teacher should not attempt to cover the subject of study but should attempt to uncover it for the student.

The book is primarily written for the first year graduate student in electrical engineering as a one-semester course. As such it does not include material non-linear systems.

Electronic Business Machines

Edited by J. H. Leveson. Published 1960 by Philosophical Library, Inc., 15 E. 40th St., New York. 272 pages. Price $15.00.

This work is based on two courses of lectures given at the Dundee Technical College. The objects of the courses are to provide an introductory study of the applications of electronic computers to industrial and commercial situations and to provide an opportunity for those already possessing this knowledge to study recent developments in the field of business data processing.

The lectures have been rewritten in a style suitable for publication in book form and provide a study of computers —their scope, characteristics, operation and application—and a review of business problems from this viewpoint.

The book is divided into three main sections: programming for business purposes; business management and electronic data processing; computer equipment and applications.

Video Tape Recording

By Julian Bernstein. Published 1960 by John F. Rider Publisher, Inc., 116 W. 14th St., New York, N. Y. 272 pages. Price $8.95.

This definitive book presents a basic yet thorough treatment of the techniques, mechanics and circuitry used in the rapidly expanding field of video tape recording. For those having a limited technical background, the author has provided sufficient basic theory to enable them to comprehend the functioning of video tape equipment.

The text begins with an introductory history and develops the types of waveforms and signals used and required for tape recording. Since this text deals predominantly with recording of television signals, considerable space is devoted to electronic photography. Techniques and mechanics of recording are first reviewed and then the specifics of video recording are presented. The various types of tape transports, video track patterns, and basic block diagrams of a television tape recorder are discussed.

Silicon Carbide, a High Temperature Semiconductor

Edited by J. R. O'Connor and J. Smiltens. Published 1960 by Pergamon Press, Inc., 122 E. 55th St., New York 22. 521 pages. Price $12.50.

This volume contains the authoritative proceedings of the 1959 Boston Conference on Silicon Carbide, and as such is the first work to be devoted exclusively to silicon carbide technology.

The book contains the complete proceedings—papers, all discussions and written comments—of the conference. Further it reviews the present state of knowledge on this potentially, tremendously useful material, and evaluates its uses as a rectifier, transistor, electroluminescence source, thermoelectric generator, etc. The volume also contains the silicon carbide phase diagram and details of crystal growth, physical properties, semiconductor properties and applications.

Alternating Current Circuits, 4th Ed.

By Russell M. Kerchner and George F. Corcoran. Published 1960 by John Wiley & Sons, Inc., 440 Park Ave., So., New York 16. 602 pages.

In this edition, numerous additions and modifications have been made thorughout where experience has shown the need for improvement. An introductory chapter on network concepts has been added to give the student a deeper insight into the general methods of network analysis. Network variables, topology, and duality are considered.

In order not to interfere with the vector terminology of electro-magnetic theory, the term *phasor* has been adopted for a time-varying quantity which is handled by vector methods. The change from vector to *phasor* diagram is made although as used in this book the distinction is unnecessary. To many electrical engineers a vector diagram will always be a vector diagram.

Introduction of Laplace Transforms for Radio and Electronic Engineers

By W. D. Day. Published 1960 by Interscience Publishers, Inc., 250 Fifth Ave., New York 1. 183 pages.

A difficulty which has been experienced by students and practicing engineers who have not been taught the subject was the finding of an introductory text that would cater to their particular needs. This is because the subject of Laplace Transforms was for so long the preserve of mathematicians with little practical understanding of radio and electronics.

In general the engineer is not interested in rigid mathematical proofs; he wants to use mathematics as a tool to solve his particular technical problem. That is the approach in the pres-

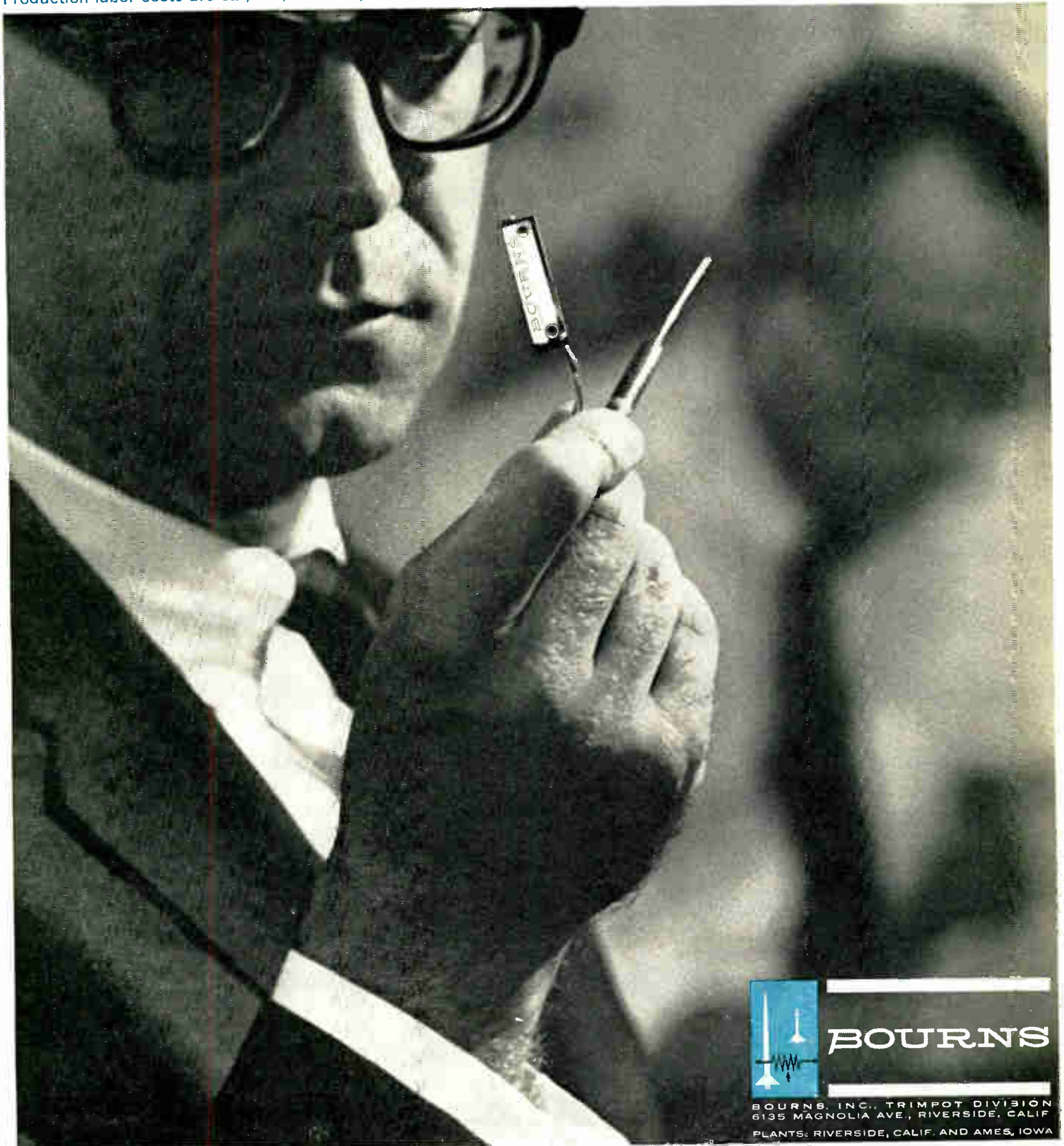
(*Continued on page 54*)

Bourns Trimpot® Instead of a Fixed Resistor?

Yes, these units meet the same Mil-Specs that fixed resistors meet and give you the added advantage of adjustability! Because of their design and construction, Trimpot potentiometers are virtually unaffected by the most severe shock and environmental conditions—a fact proven repeatedly in major missile and space programs.

Trimpot units offer several kinds of savings. They minimize the need to maintain stocks of close-tolerance resistors—you can adjust to compensate for the variances of fixed components. Production labor costs are cut, too, for Trimpot units eliminate trial-and-error matching of fixed units to the system. Savings also carry over to maintenance because the technician can adjust equipment quickly in the field—no time and dollars spent to replace components.

Before you specify fixed units, investigate all the advantages offered by Trimpot potentiometers. Over 20 basic models (wirewound and carbon)—in four terminal types and three mounting styles—are available on short notice from stocking distributors or factory. Get the facts . . . write for the new Trimpot brochure and list of distributors.



Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

Books

(*Continued from page 51*)

ent volume. It deals with electrical circuits from the very first paragraph, and very rapidly fills up to the stage when the student is using transforms to investigate transient conditions.

The Surface Chemistry of Metals and Semicondutors

Edited by Harry C. Gatos, J. W. Faust, Jr., and W. J. Lafleur. Published 1960 by John F. Wiley & Sons, Inc., 440 Park Ave., So., New York 16. 526 pages. Price $12.50.

This volume contains the papers presented at the Joint Symposium of the Corrosion and Electronics Divisions of the Electrochemical Society on the surface chemistry of metals and semiconductors held in Columbus, Ohio, October 19-21, 1959. The symposium was conceived as a medium when effective exchange of theory and technology between the fields of metal surfaces and semiconductor surfaces.

Dictionary of Automatic Control

By Robert J. Bibbero. Published 1960 by Reinhold Publishing Corp., 430 Park Ave., New York 22. Price $6.00.

Here is an encyclopedic dictionary of automatic control terms. More than a mere collection of definitions, it provides a condensed discussion of each topic, including applications and related subjects. The book covers control theory and basic concepts, computers and data processing, industrial machine and process control, aircraft and missile control and telemetering, and control components and design factors.

Principles of Semiconductor Device Operation

By A. K. Jonscher. Published 1960 by John Wiley & Sons, Inc., 440 Park Ave. So., New York 16. 168 pages. Price $5.00.

There are, on the one hand, many text books dealing at all levels with the basic framework of semiconductor physics. On the other hand, there is ample literature on the physics and applications of junction transistors and, to a much lesser extent, of other devices. It appears, however, that one topic of basic importance for the operation of semiconductor devices has been neglected by the former and taken for granted by the latter. This is the broad subject of injection, transports, and decay of excess carriers and semiconductors. The behavior of excess carriers follows its own specific laws which are neither self evident from basic semiconductor theory, nor can they be neglected if adequate understanding of device operation is to be achieved.

Books Received

Installing Hi-Fi Systems

By Jeff Markell and Jay Stanton. Published by Gernsback Library, Inc., 154 W. 14th St., New York 11. 224 pages, paper bound. Price $3.20.

(*Continued on page 58*)

SOME VERY IMPORTANT ODDS . . . AND ENDS

What odds will you accept that your circuitry connections perform with absolute reliability, every time you need them? Chances are you **demand** odds approaching 100 percent in your favor—you cannot afford a compromise with precision in the thousands of terminals in your equipment.

AMP INCORPORATED has a single task: to make wire terminations so reliable that the odds on failure at the end of your wires are **zero.**

AMP makes wire terminations—15,000 solderless, snowflake-different kinds of them—for any circuit connection anywhere in the world, backed by 1800 patents issued or pending in the U.S.A. and 18 other countries. It makes the tools to apply its terminals to any size, shape or kind of wire. It makes these products in the U.S., and in Great Britain, France, Holland, West Germany, Italy, Australia, and Japan, for distribution anywhere, to any industry.

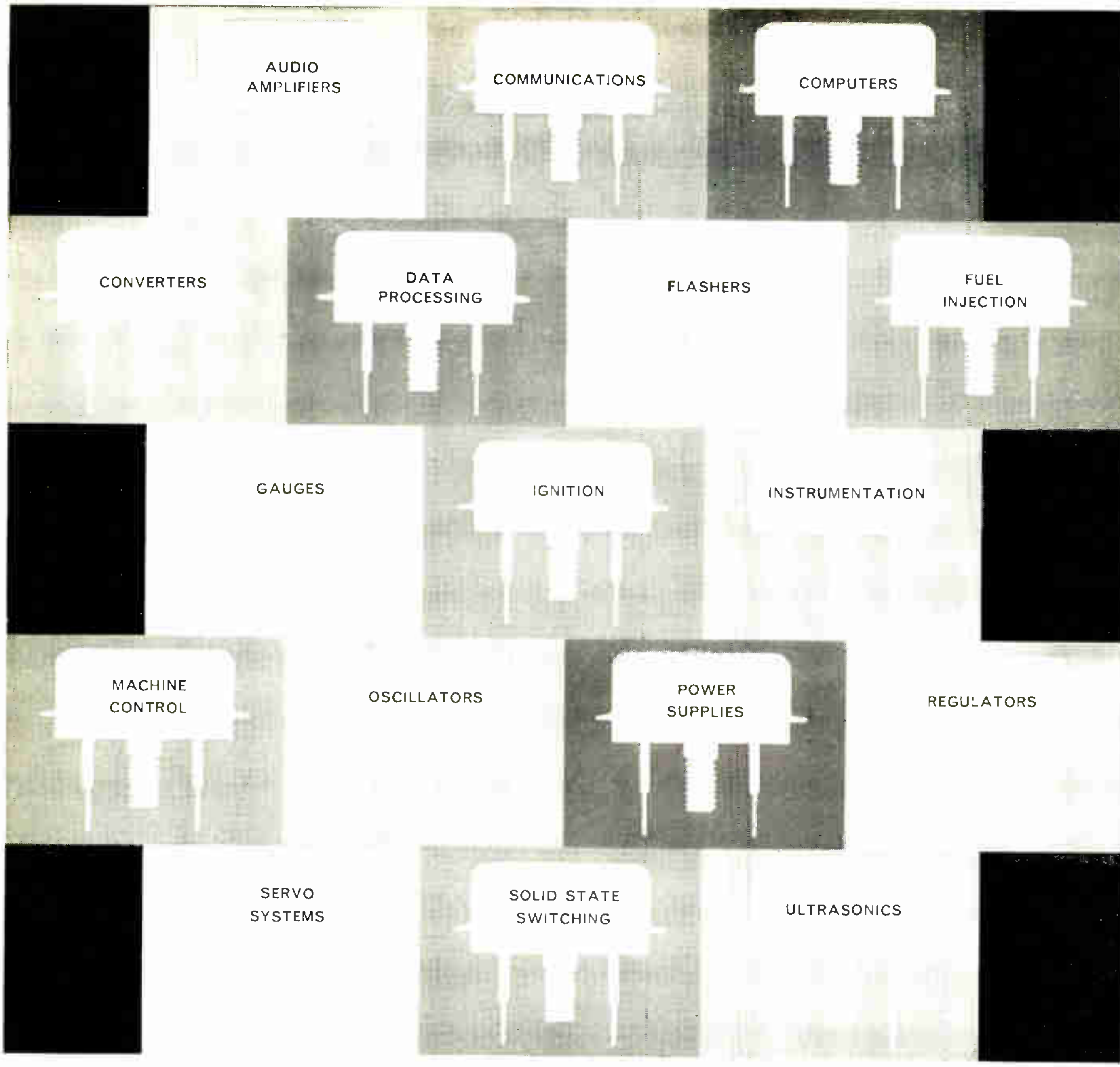
For the unabridged AMP story, write for our Selectalog and Autolog catalogs.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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

Circle 38 on Inquiry Card



DELCO RADIO—THE LEADER IN POWER TRANSISTORS

For top performance in a wide, wide range of applications, specify Delco Radio's 2N174. ■ This multi-purpose PNP germanium transistor is designed for general use with 28-volt power supplies, and for use with 12-volt power supplies where high reliability is desired despite the presence of voltage transients. ■ It has a high maximum emitter current of 15 amperes, a maximum collector diode rating of 80 volts and a thermal resistance below .8°C per watt. The maximum power dissipation at 71°C mounting base temperature is 30 watts. Low saturation resistance gives high efficiency in switching operations. ■ The 2N174 is versatile, rugged, reliable, stable and low priced. For more details or applications assistance on the 2N174 or other highly reliable Delco transistors, contact your nearest Delco Radio sales office.

DELCO RADIO

Newark, New Jersey
1180 Raymond Blvd.
MItchell 2-6165

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807

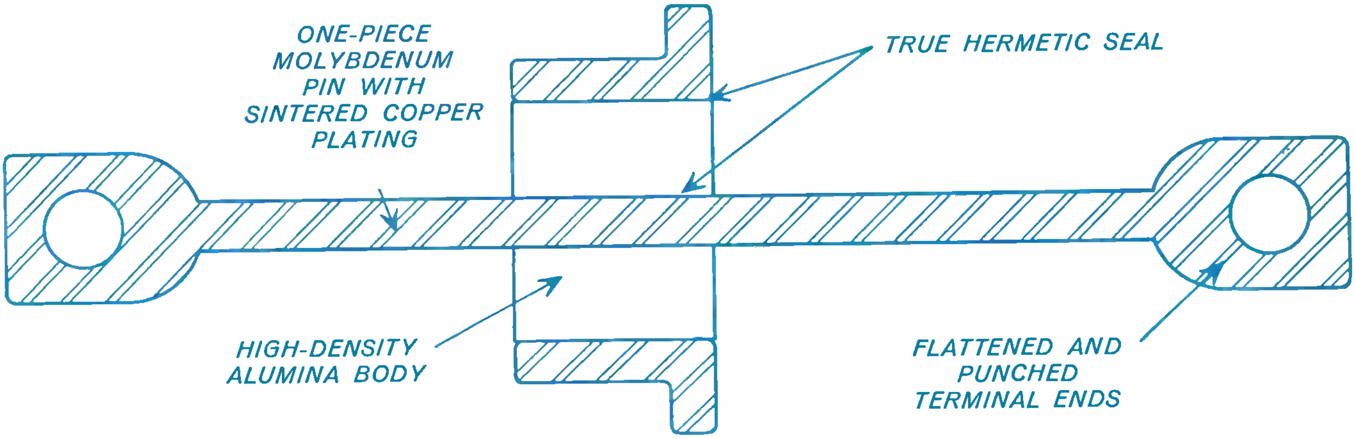
Chicago, Illinois
5750 West 51st Street
POrtsmouth 7-3500

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

Division of General Motors · Kokomo, Indiana

NEW BENDIX CERAMETERM is offered as a
(CERAMIC-METAL TERMINAL)

superior solution to glass terminal problems confronting manufacturers of military electronics gear, transformers, condenser banks, relays, transistors and similar equipment.



Now in production—this new and better terminal with 8 big advantages: **1** Developed especially for super-reliability on high-performance applications involving shock and high temperatures. **2** Vacuum-tight seal. **3** Will withstand brazing temperatures at 1500°F. **4** Tested to 11,000 psi shear stress without failure. **5** Ideal for encapsulated devices. **6** For both replacement and original equipment use. **7** Extreme resistance to cracking under mechanical or thermal stresses. **8** Variety of configurations. Send for full details.

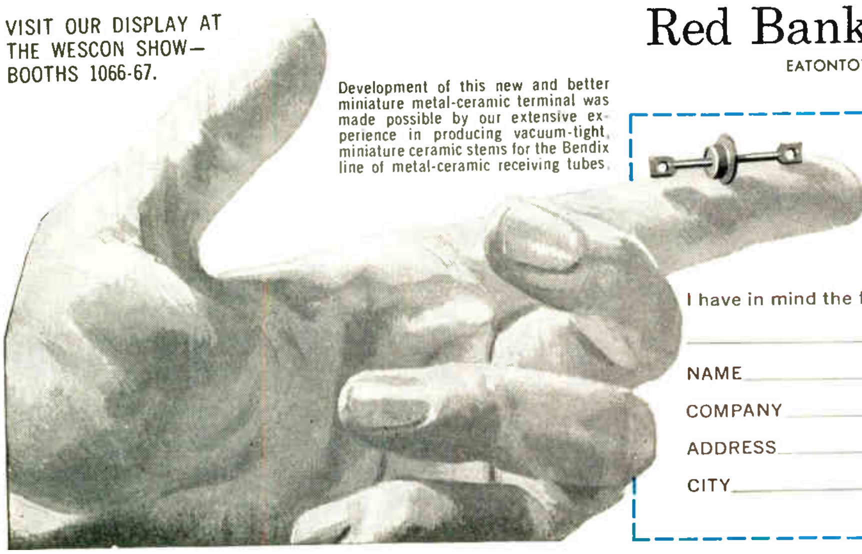
VISIT OUR DISPLAY AT THE WESCON SHOW—BOOTHS 1066-67.

ELECTRON TUBE PRODUCTS

Red Bank Division

EATONTOWN, N. J.

THE Bendix CORPORATION



Development of this new and better miniature metal-ceramic terminal was made possible by our extensive experience in producing vacuum-tight, miniature ceramic stems for the Bendix line of metal-ceramic receiving tubes.

Electron Tubes Dept. E8
The Bendix Corporation
Eatontown, New Jersey

Gentlemen: Please send me complete details on your new Bendix CERAMETERM.

I have in mind the following applications ______

NAME ______ TITLE ______

COMPANY ______

ADDRESS ______

CITY ______ ZONE ____ STATE ______

Books

(Continued from page 54)

Books Received

Magnetic Amplifiers, Principles and Applications

By Paul Mali. Published 1960 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 112 pages, paper bound. Price $2.45.

Getting the Most Out of Vacuum Tubes

By Robert B. Tomer. Published 1960 by Howard W. Sams & Co., Inc., 2201 46th St., Indianapolis 6, Ind. 160 pages. Price $3.50.

Practical TV Trouble-Shooting

Published 1960 by Gernsback Library, Inc., 154 W. 14th St., New York 11. 128 pages, paper bound. Price $2.35.

Motorola Power Transistor Handbook

Published 1960 by Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, Ariz. 205 pages. Price $2.00.

Handbook of Pilot Lights

Published 1960 by Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y. 256 pages. Interested individuals are invited to write to the above address for a "Handbook Application Form."

Topics in Noise

Published 1960 by Airborne Instruments Laboratory, Deer Park, L. I., N. Y. 51 pages, paper bound. Interested engineers should write on company letterhead to the above address.

Annual Review in Automatic Programming, Vol. I

Edited by Richard Goodman. Published 1960 by Pergamon Press Inc., 122 E. 55th St., New York 22. 160 pages. Price $10.00.

Symposium on Spectroscopy

Published 1960 by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 246 pages. Price $7.00.

GOVERNMENTAL PUBLICATIONS

Orders for these reports 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, Dept. of Commerce." Prepayment is required. Use complete title and PB number for each report ordered.

A Direct-Reading Six-Decade Precision Frequency Generator

By J. E. McGeogh and G. K. Jensen. 14 pages. PB151158. Price 50¢.

Synthesis and Purification of Dielectric Materials

By T. W. Dakin, et al. 141 pages. PB161366. Price $2.75.

Optical and Electromagnetic Techniques for Predication of Radome Boresight Errors

By G. M. Hahn. 86 pages. PB161126. Price $2.25.

Research and Development Services Leading to the Control of Electrical Properties of Materials for High Temperature Radomes

By L. M. Atlas. 34 pages. PB161423. Price $1.00.

Measure 10cps to 110Mc with one compact meter

Comprehensive range for only $1895. Never before has so broad a range been offered for so low a price—a combination made possible by closely integrating a simple heterodyne converter with a top-notch 10Mc counter. Frequencies up to 10Mc are measured by direct counting. To measure frequencies above 10Mc, the operator simply rotates reference frequency selector until panel meter shows strong deflection, then reads counter indication. Measurements take less than a minute to make. Accuracy far exceeds FCC requirements over communications range. Possible error is .00004% or less from 1Mc to 110Mc.

Write for technical bulletin on Model 7175.

Frequency measuring range
10cps to 110Mc
Sensitivity
100mv rms into 1M ohms up to 10Mc
100mv rms into 100 ohms up to 110Mc
Accuracy
Oscillator accuracy ± 1cps
Oscillator stability
3 parts in 10^7 per week
Recording facility
Rear jack carries code signals to actuate Beckman printer
Dimensions:
8¾" x 19" panel, 17" deep
Weight
Ready for rack: approx. 47 lbs.
In cabinet: approx. 60 lbs.
Price $1895

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

Beckman® *Berkeley Division*
Richmond, California

T24

Circle 42 on Inquiry Card

Personals

Walter Hanstein, Jr. — appointed Associate Director of Engineering, Burroughs Corp., Detroit, Michigan.

Dr. Francis S. Johnson, Manager of Lockheed's Space Physics Research, was appointed a Consultant to Subcommittees of NASA's Space Sciences Steering Committee. He will serve on the Ionspheric Physics Panel.

Paul S. Mirabito—promoted to Vice President in charge of Burroughs' Defense Contracts Organization, Detroit, Michigan.

Joseph G. Koosman—promoted to Manager, Photosensitive Devices Lab, Electronic Tube Div., Allen B. Du-Mont Labs Div.'s, Fairchild Camera and Instrument Corp., Clifton, N. J.

William O. Swinyard, Vice President and Director of Hazeltine Research, Inc., was presented a diamond pin upon recent completion of 30-years' service.


W. O. Swinyard


Dr. A. Stevenson

Dr. Alden Stevenson—named Director of Research, Pacific Semiconductors, Inc., Culver City, Calif.

Roger E. Dumas — appointed Director of R&D, Inductive Products Div., Statham Instruments, Los Angeles, Calif.

Andrew E. O'Keefe—appointed Research Associate by Keuffel & Esser Co., Hoboken, N. J., specializing in electro-photographic research and techniques.

Robert W. Pike—named Chief Engineer in charge of R&D at Industro Transistor Corp.'s new Semiconductor R&D Center, Natick, Mass.

Richard V. Carroll—promoted to Senior Applications Engineer in charge of R-F Instrumentation at Borg-Warner Controls, Santa Ana, California.

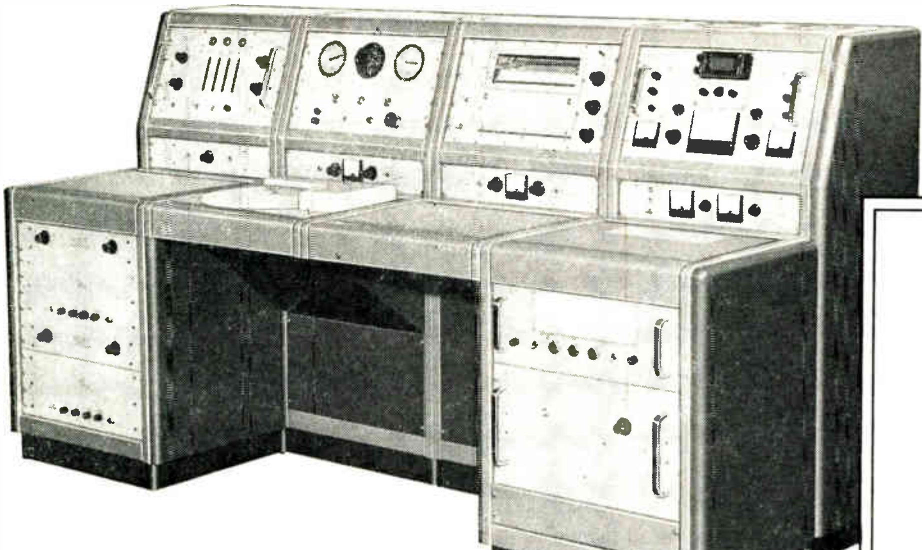
Dr. Wendell Moyer, Jr.—joins Marbon Chemical Div., Borg-Warner Corp., Washington, West Virginia, as a Group Leader in Exploratory Research.

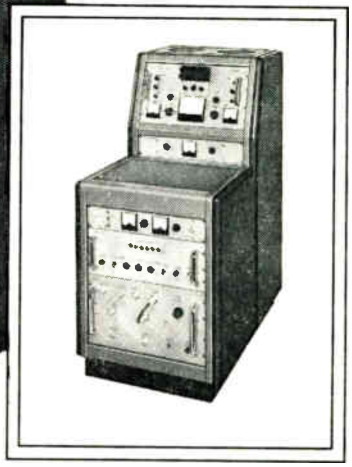
(*Continued on page 66*)


SURGICALLY
CLEAN
IS NOT
CLEAN
ENOUGH...

MAJORS and MINORS

...A Message to the Antenna Designer





● Series 402 Wide Range Receiving Systems are available in consoles, consolettes, and racks. Shown are a complete antenna pattern recording and receiving system and the new consolette receiver.

A crowded spectrum plus high power radar and communication systems critically compound the problems of the antenna design engineer.

More than ever, the complete pattern including all the major and minor lobes of every radiating element must be graphed for sound engineering evaluation.

S-A Receiver Gets the Whole Signal

Scientific-Atlanta Series 402 Wide Range Receiving Systems are specifically designed for antenna pattern measurements. Unique in design, these receivers combine maximum sensitivity and linearity from 30 mc to above 100 kmc. They are also useful as multipurpose laboratory instruments for microwave testing, monitoring, and measuring applications.

Only from S-A, 1 db Linearity over Full 60 db Dynamic Range

A recent development, S-A's P-4 modification adds 20 db to the normal 40 db dynamic range. The modification takes advantage of the gain vs AGC voltage characteristics of the Series 402. Existing receivers can be modified at the factory.

New Modification Z Broadens Use

Modification Z adds a precision IF attenuator and VTVM to the Series 402. Now RF and microwave signal level, gain, and isolation measurements can be made with fewer components and instruments. *For instance*, an X band 80 db attenuator can be calibrated to within ±0.5 db with a 1 mw signal source, a flap attenuator, a mixer, and an S-A Series 402Z Receiver. Antenna gain can be measured by direct comparison with a standard gain antenna. Signal levels can be compared against a reference standard.

Other Features

One coaxial cable from antenna to receiver eliminates costly lossy waveguides and rotary joints. Antenna can be located up to 75 feet away with negligible loss in sensitivity ☆ One receiving system covers 30 mc to above 100 kmc without plug-ins ☆ Reception of cw signals from simple sources eliminates need for precise modulation ☆ High sensitivity means low source power and long ranges ☆ High selectivity reduces interference and cross talk between adjacent test ranges ☆ Positive AFC action over full dynamic range provides pattern recording in deep nulls.

PRICES

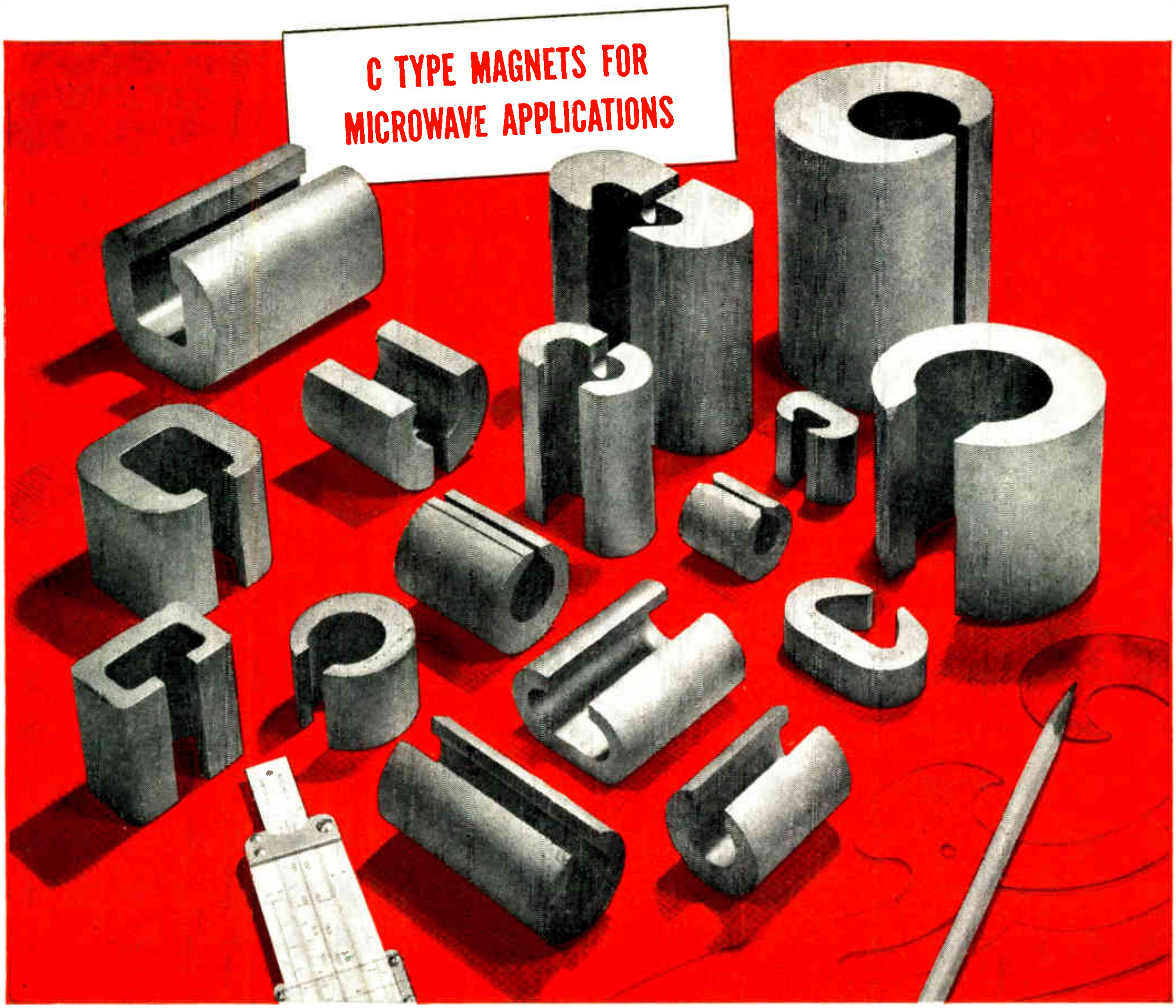
Series 402, 2 to above 100 kmc	$7500
Series 402A, 2 to above 100 kmc with AGC	8000
Series 402B, 30 mc to above 100 kmc	8500
Series 402C, 30 mc to above 100 kmc with AGC	9000
Modification P-4	500
Modification Z	1000

NEW DATA FOLDER READY

For complete information ask for our new data folder from your nearby S-A engineering representative or write directly to Dept. 44.

SCIENTIFIC-ATLANTA, INC.
2162 PIEDMONT ROAD, N. E.
ATLANTA 9, GEORGIA
PHONE: TRinity 5-7291

Circle 45 on Inquiry Card



C TYPE MAGNETS in a wide range of sizes to meet your design needs in ★ Transverse Field Isolators ★ Differential Phase Shifters ★ Duplexers

Arnold C-type Alnico Magnets are available in a wide selection of gap densities ranging from 1,000 to over 7,500 gausses. There are six different basic configurations with a wide range of stock sizes in each group.

The over-all size and gap density requirements of many prototype designs can be met with stock sizes of Arnold C Magnets, or readily supplied in production quantities.

When used in transverse field isolators, Arnold C Magnets supply the magnetizing field to bias the ferrite into the region of resonance, thus preventing interaction between microwave networks and isolating the receiver from the transmitter. These magnets are also used in differential phase shifters and duplexers, and Arnold is prepared to design and supply tubular magnets to provide axial fields in circular wave guides.

A feature of all Arnold C Magnets is the excellent field uniformity along the length of the magnet. Versatility in design may be realized by using multiple lengths of the same size magnet stacked to accomplish the needs of your magnetic structure.

Let us work with you on any requirement for permanent magnets, tape cores or powder cores. ● For information on Arnold C Magnets, write for Bulletin PM-115. Address *The Arnold Engineering Company, Marengo, Illinois.*

ADDRESS DEPT. EI-11 7428 B

ARNOLD

SPECIALISTS in MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES

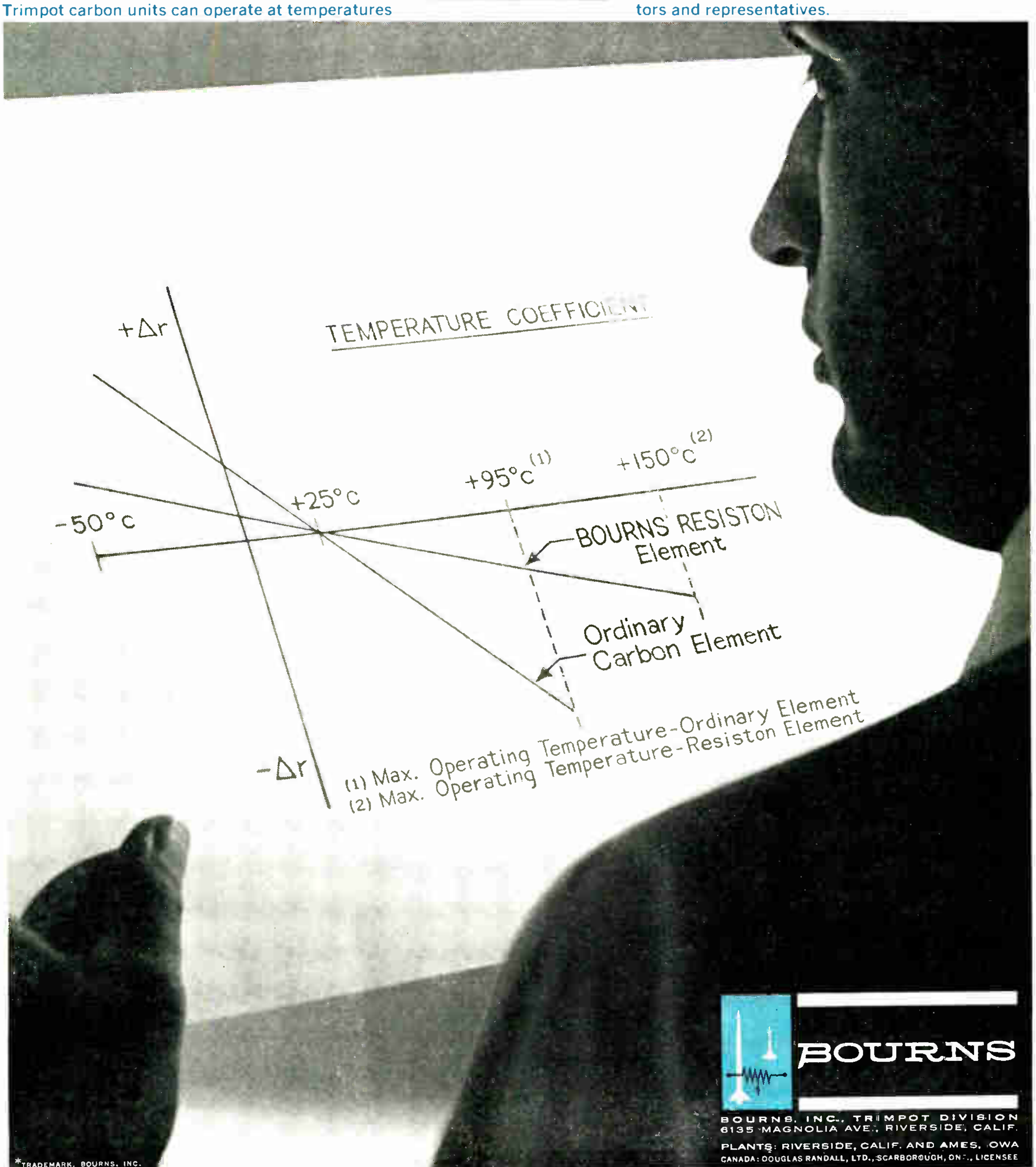
Find them FAST in the YELLOW PAGES

At Last—High Reliability in Carbon-Film Potentiometers!

Bourns Trimpot® carbon-film potentiometers now offer you twice the stability of any carbon unit heretofore available . . . at temperatures as high as 150°C. Now, for the first time, you can incorporate high-resistance, infinite-resolution potentiometers in your circuit without sacrificing reliability. The reason: Resiston*, a remarkable new carbon element that virtually eliminates the problems normally caused by extremes of temperature and humidity.

Thanks to this exclusive Bourns development, Trimpot carbon units can operate at temperatures up to 150°C—with resistance shift only half that of ordinary carbon elements. In addition, they far exceed the requirements of Mil-Specs for humidity and MIL-R-94B.

Trimpot Resiston units are available from factory and distributor stocks with three terminal types . . . three mounting styles . . . and standard resistances ranging from 20K to 1 Meg. Resiston elements are available in most Bourns configurations. Write for the new Trimpot summary brochure and list of stocking distributors and representatives.



*TRADEMARK, BOURNS, INC.

BOURNS

BOURNS, INC., TRIMPOT DIVISION
6135 MAGNOLIA AVE., RIVERSIDE, CALIF.
PLANTS: RIVERSIDE, CALIF. AND AMES, IOWA
CANADA: DOUGLAS RANDALL, LTD., SCARBOROUGH, ONT., LICENSEE

Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

Circle 48 on Inquiry Card

Personals

Henry M. Ruppel—elected to Vice President in charge of Engineering, responsible for Production Engineering and Quality Control at all Allied Control Co. plants in California, Connecticut and New York City.

Dr. John W. Coltman and **Dr. John K. Hulm**—named Associate Directors of the Westinghouse Research Labs.

Dr. E. John Whitmore—joins Sylvania Electric Products, Inc. as Manager of Development Engineering at the Williamsport facilities of the company's Special Tube Operations.

H. K. Smead—returns to Univac Military Div. Hdqs in St. Paul, Minn. as Assistant Manager, Advanced Navy Computer Dept. E. R. Quady succeeds Smead as East coast office manager.

Walter W. Kunde, Jr. named Chief Engineer, Hermetic Seal Transformer Co.'s Components Div., Garland, Texas.

W. W. Kunde, Jr.

O. O. Schaus

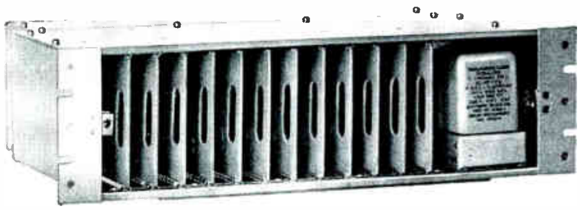
Orland O. Schaus—joins Audio Devices, Inc. N. Y., as Manager of Research and Engineering.

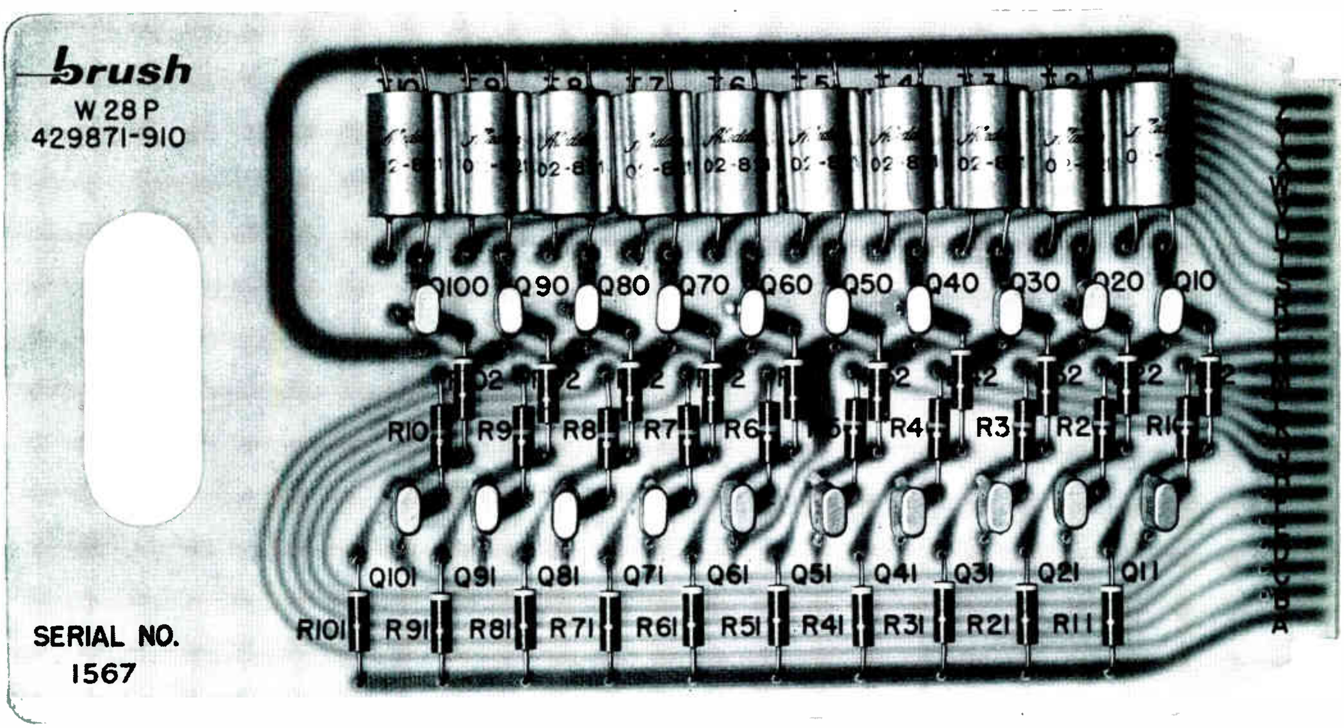
Lewis W. Imm—resigns as President of the Librascope Div., General Precision, Inc., to "enter a new dynamic frontier of Technology." He continues in a special consultant capacity. **William E. Bratton** assumes the Librascope presidency.

W. Walter Watts elected Director of RCA succeeding Charles B. Jolliffe, Vice President and Technical Director of RCA who reached retirement age December 1, 1959. He also became Chairman of the Board and President of RCA Sales Corp. on August 18, in addition to his post as RCA Group Executive Vice President.

Frederick A. Schaner — promoted to Vice President in charge of Engineering, The Daven Co., Livingston, N. J., a subsidiary of General Mills, Inc.

compact transistor switching for millisecond monitoring

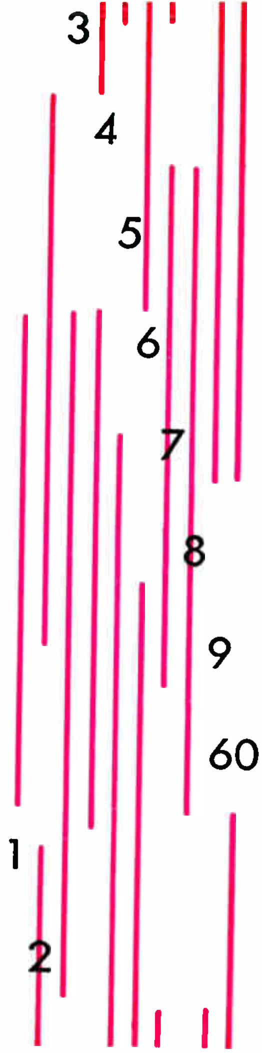




The new Brush Trans-Switcher eliminates relays—greatly simplifies your problems of operations monitoring. Designed to take full advantage of the fast response and high resolution of Brush Operations Monitors, this compact, solid-state switching unit accepts up to 100 different "on-off" signals in a broad range of pulse shapes and amplitudes. Interchangeable, plug-in decade boards are designed to accept different voltage ranges and modes of operation. Avoid the "black box" approach—specify the *standard* Brush Trans-Switcher for the ultimate in precise, reliable monitoring. Write for complete details.

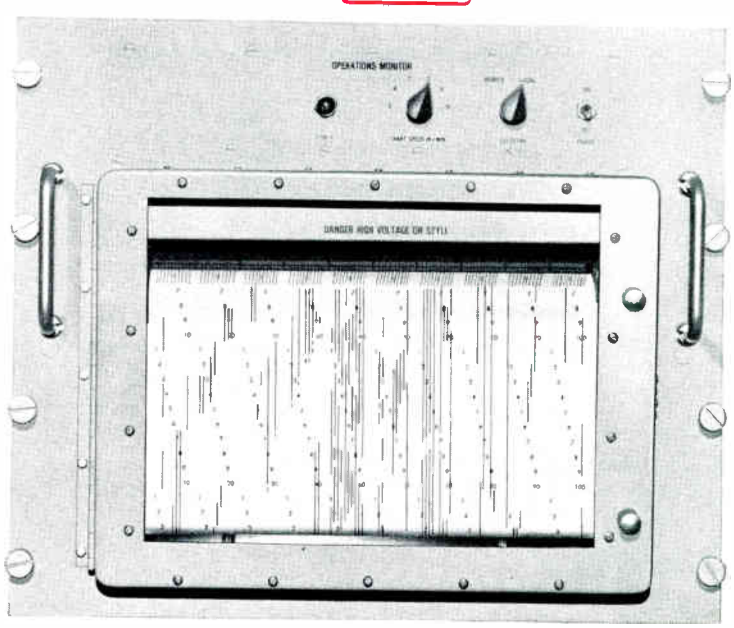
brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

verify events permanently in milliseconds



Brush Operations Monitors' response to signals is virtually instantaneous—less than 4 milliseconds. Multiple high-speed events are clearly defined from start to stop, on a common time base—and at rates up to 500 per second. Portable 30 channel or rack-mounting 100 channel models record sharp reproducible traces with fixed-stylus electric writing that provides the utmost in reliability. "Built-in" transistor switching to eliminate relays is optional. No direct writing recording system can match the capabilities of Brush Operations Monitors for industrial and military analysis and control. Write for complete specifications and application data.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS **CLEVITE** CORPORATION CLEVELAND 14, OHIO



Next month

- **THE MINUTEMAN PROGRAM . . . BRUTE FORCE FOR TRUE RELIABILITY**

  Another in EI's series of engineering staff studies. This feature describes the bold new industry-wide program to achieve near absolute reliability in a missile system. Sponsored by the United States Air Force, and involving some 13 electronic component suppliers, the program will in time be responsible for evaluating the quality and reliability of components and equipments to an unprecedented new high plateau. . . . 100 times higher than present levels. Get the details on white room testing, checking, recording, storage, etc. procedures employed. They are the keys to future manufacturing techniques.

- **COMPACT TRAVELING WAVE TUBE DESIGN**

  These small S-band tubes use a permanent magnet focus structure that it miniaturized along with other tube structures. The result is ruggedized, light weight, wideband 10 milliwatt and one watt tubes that are well suited for confined spaces such as found in airborne vehicles.

- **USING TRANSIENT-TESTING TECHNIQUES**

  Transient testing of linear networks has certain desirable features over steady state techniques. Before considering transient methods, however, a rough idea of the network to be tested should be had to determine which technique to use. This article gives simple tools to make a good choice.

- **PROPAGATION CONSIDERATIONS IN RFI**

  Another feature in Electronic Industries' continuing RFI series. The electromagnetic field generated by a radiating antenna is quite complex. This complex field is the result of the simultaneous propagation of the energy by several modes. These modes are used for desired transmissions and, unfortunately, are also available for undesired signals. The characteristics of these modes are described.

- **SHIELDING CRT'S FROM MAGNETIC FIELDS**

  The field of magnetic shielding is notable for its lack of numerical values. While the subject of how to achieve good quality shielding is not emphasized, a significant contribution is made in that the artcle indicates how to establish the essential shielding objectives.

Plus all our other regular departments

Our regular editorial departments are designed to provide readers with an up-to-the-minute summary of world wide important electronic events. Don't miss Radarscope. As We Go To Press, Electronic Shorts, Coming Events, EI Totals, Snapshots of the Electronic Industries, EI International, News, Briefs, Tele-Tips, Books, Representatives News, International Electronic Sources, Personals, etc.

COMING SOON

- **1961 CALENDAR OF COMING ELECTRONIC EVENTS**

  Year-round reference guide to all electronic symposia, conventions and shows.

Watch for these coming issues:

***JANUARY**
Industry Review

***MARCH**
Annual IRE Issue

***JUNE**
Annual All-Reference & Directory Issue

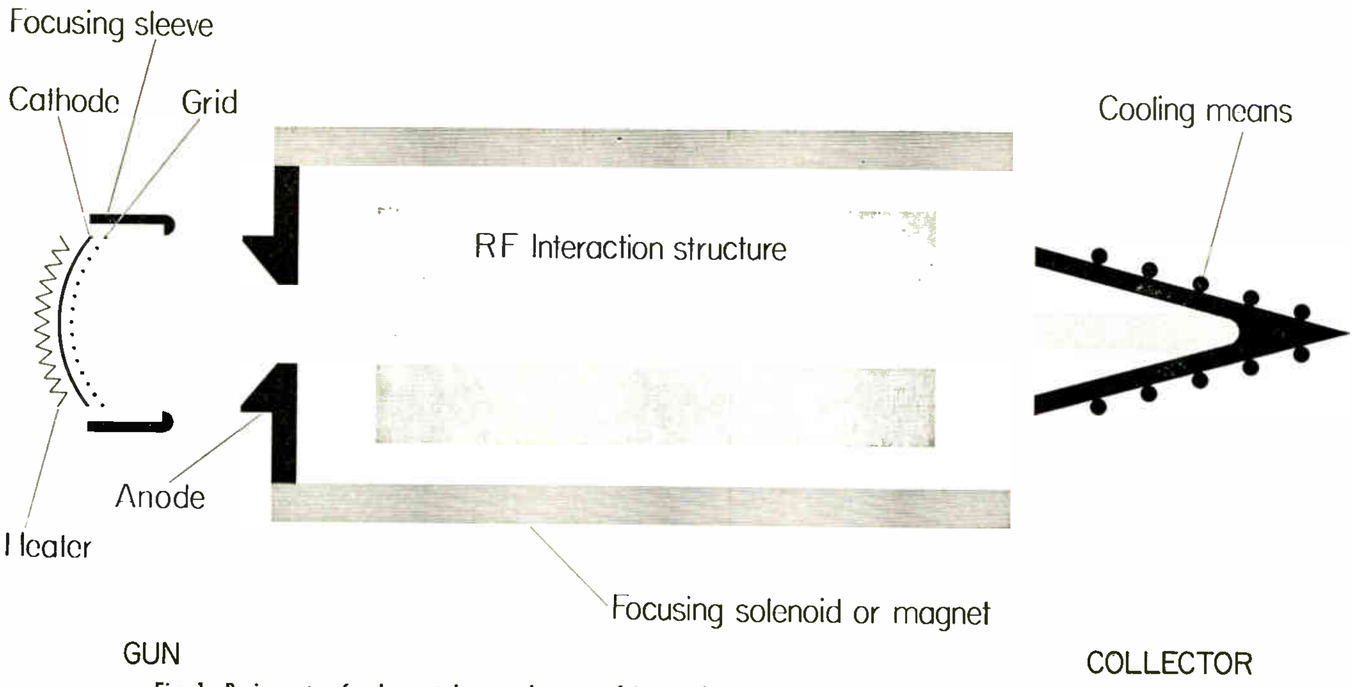


Fig. 1: Basic parts of a beam tube are the gun, rf interaction structure, focusing arrangement, and collector.

Future Trends

BEFORE entering into a detailed discussion of trends in microwave beam tubes, it is well to pause to define our terms. The principal parts of a beam tube, Fig. 1, are the gun, the rf interaction structure, collector, and focusing arrangement. The gun is further subdivided into the cathode and associated electrodes, and must be suitably related to the focusing mechanism, which is ordinarily a solenoid or magnet.

Interaction Principles

A given gun and collector with some suitable focusing arrangement produces an electron beam usable in a great variety of tubes. It must, therefore, be regarded as a basic building block. This idea is clarified and extended in Figs. 2, 3 and 4 which show several different useful tube types which may be built around a given electron beam.

The electrical characteristics of the simple helix, Fig. 2(a), are extremely attractive, especially for tubes operating at low levels of power and voltage. The wave velocity is relatively constant at a convenient value, which is approximately equal to the speed of light reduced by the radio of the pitch to the perimeter. The impedance is higher than that of any other known structure suitable for low-voltage operation. Therefore, the gain and other performance characteristics of helix-type traveling-wave tubes (TWT) are fairly constant over bandwidths of approximately an octave. For these various reasons it appears un-

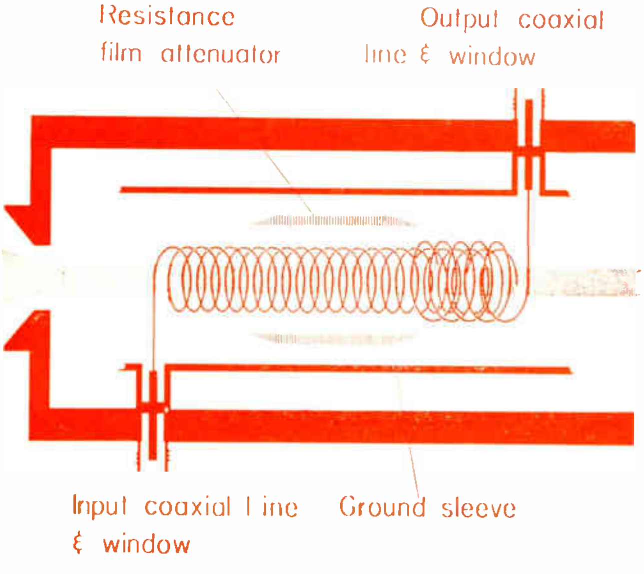
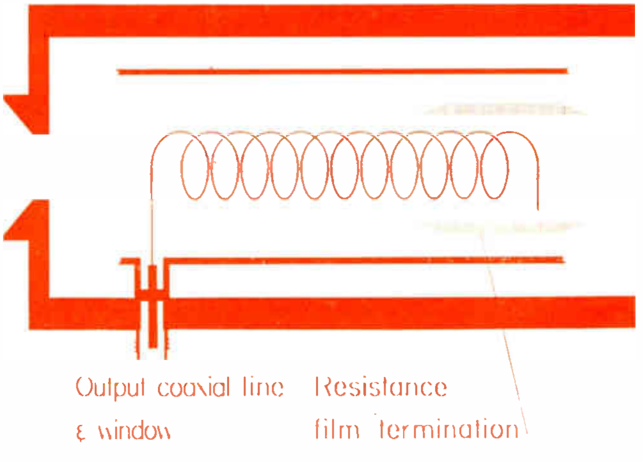


Fig. 2a (left): When the gun and collector are regarded as basic building blocks, this is the modification for a helix TWT amplifier.

Fig. 2b (below): Structure for a helix backward-wave oscillator.



In a brief twenty years the relevant technology of microwave beam tubes has been refined to the point where manufacture of such tubes is highly competitive. However hazardous predictions may be, a definite need exists for information on which to base future plans. This article fills that need.

By **WILLIAM A. EDSON**
General Electric Microwave Laboratory
Power Tube Dept.
Palo Alto, Calif.

In Microwave Beam Tubes

likely that the helix will ever be replaced as the circuit used in broad-band, high gain amplifiers for low to medium power applications.

Fig. 2(a) shows a helix with a direct input connection and a coupled-helix output arrangement. The usefulness of the latter is based upon the fact that two concentric helices are strongly and directionally coupled if the phase velocities are made equal and the two have opposite pitches. In a relatively short distance the entire power on the inner helix transfers to the outer helix for delivery to the useful load. Either form of coupler, or other arrangements such as waveguide or cavity and coaxial combinations may be used at either input or output of the tube.

The attenuator, which is necessary to avoid regeneration and possible oscillation due to reflections from input and output mismatches, consists of a resistive film. This film absorbs energy from the electric fields which extend outward from the helix. A variety of other arrangements including coupled helices with resistive terminations are also useful as attenuators.

The oscillator, Fig. 2(b), also uses a simple helix

Fig. 3a: Conventional four-cavity klystron amplifier with tuners.

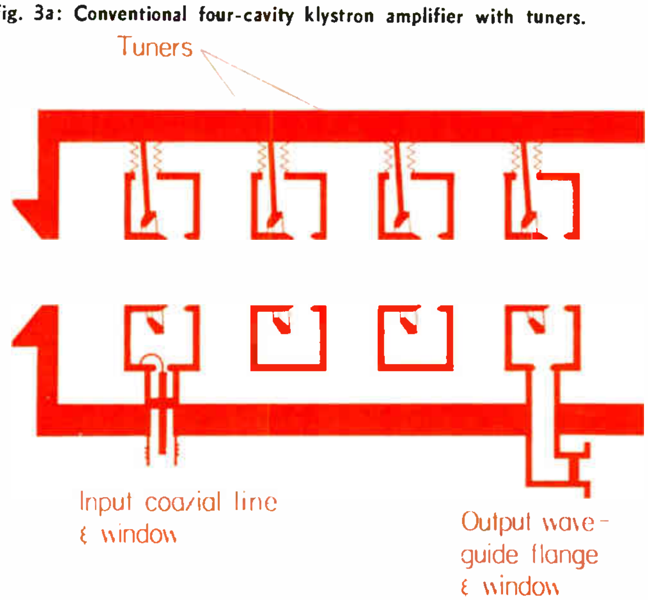
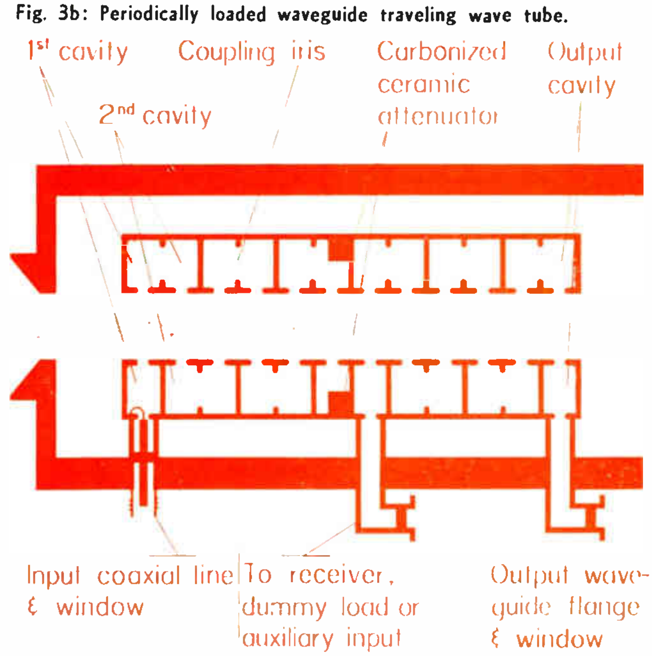


Fig. 3b: Periodically loaded waveguide traveling wave tube.



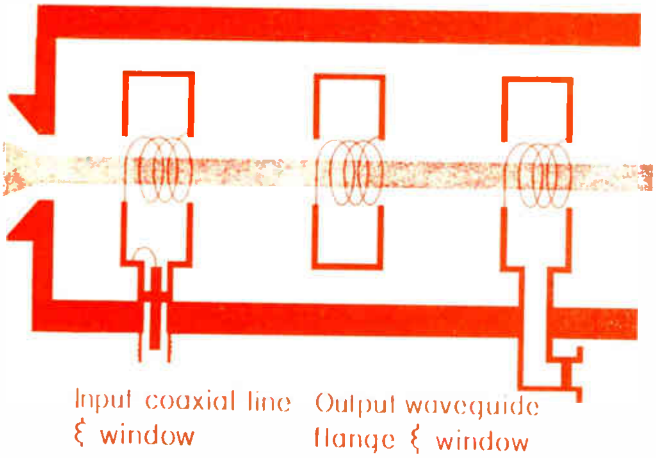


Fig. 4a: Resonant helices achieve interaction in this klystron.

Fig. 4b: In a reflex klystron, beam passes twice through cavity.

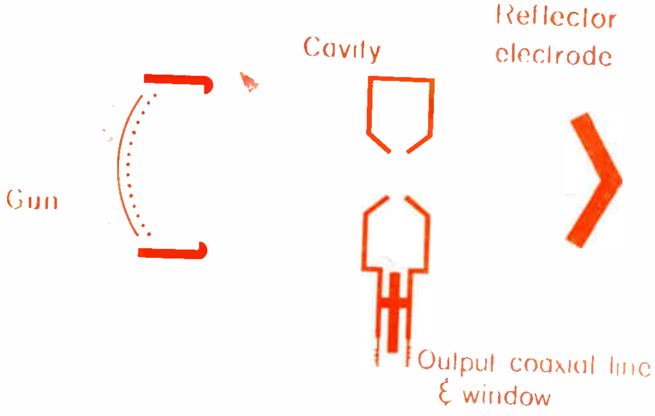
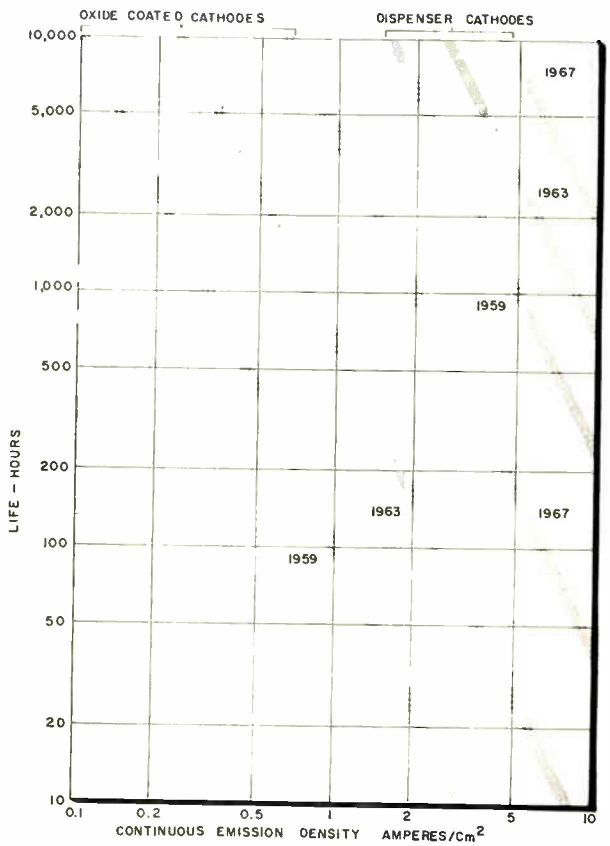


Fig. 5: The present and project cathode performances in beam tubes.



Future Trends *(Continued)*

but employs a different type of propagation referred to as a backward-wave because the direction in which phase is increasing is opposite to the direction of energy flow. Thus, to get interaction with a beam moving from cathode to collector, rf energy must be fed in at the collector end, propagating towards the cathode end of the tube. Unlike the ordinary forward-wave, this wave has a velocity which varies sharply with frequency. Therefore, the frequency of interaction can be varied through a range as much as two octaves by changing the velocity of the electrons by adjustment of the accelerating voltage. This principle of interaction can be exploited in two ways:

(a) A voltage-tunable regenerative amplifier which is highly selective results if a backward-wave tube is driven by a small signal connected to the collector end of the helix.

(b) Oscillations which are voltage tunable ensue if the beam current is increased somewhat above the value appropriate for amplification.

Klystron Amplifier

Fig. 3(a) shows a conventional four-cavity klystron amplifier featuring the rocking-ring tuner developed at our laboratory. A small signal delivered to the first cavity produces in the electron beam a small degree of velocity modulation which in the first drift tube leads to a small amount of density or current modulation at the second cavity. This current develops in the second cavity a voltage which results in additional velocity modulation of the beam and compounds the effect of the first cavity. In typical circumstances, the peak voltage developed in the third cavity is a substantial fraction of the dc accelerating voltage, and the beam reaching the output cavity is strongly bunched. The output resonator is heavily loaded by the output waveguide so as to abstract as much energy as possible from this bunched beam.

Unlike the TWT, the klystron produces coupling between the input and output circuits only by the action of the electron beam. Because the beam is unilateral and the intrinsic shielding of the cavities is essentially complete, it is possible to realize stable amplification with gain values as high as 100 db in a single tube.

The periodically loaded waveguide of Fig. 3(b) may be thought of as a hybrid between a multicavity klystron and a helix TWT. Cavities somewhat resembling those of a klystron are stacked up and strongly coupled by means of large apertures or loops. The nature of the coupling determines whether the device operates on a fundamental forward-wave, such as the "cloverleaf" type TWT, or whether it operates on a higher order component forward-wave referred to as spatial harmonic TWT. The wave initiated near the cathode grows and produces a substantial degree of bunching in the electron beam as it travels toward the collector. As in helix-type TWT's, there will be an undesirable tendency toward oscillation unless some sort of internal attenuation is provided. This attenuation is sometimes provided by spraying Kanthal or other high resistance material on the surface of some of the cavities near the center of the tube.

The same purpose is accomplished by severing the tube, Fig. 3(b). The amplified electromagnetic wave is absorbed in a ring or slab of carbonized ceramic, and the pre-bunched electron beam passes through a short drift tube to excite a new growing wave in the output portion of the tube. This wave is coupled out near the collector to drive the useful output load. Any reflection from the load passes with little loss through the several cavities back to the auxiliary coupler near the middle of the tube, which may be connected to a receiver, dummy load, or auxiliary input as the system needs dictate.

The structure just described includes features identifiable with both klystrons and TWT's. That is, traveling-wave interaction is used to obtain substantial bandwidth, while a drift tube is used to decouple the output from the input. These two ideas can be combined in many other ways. One example of such a combination is the extended interaction klystron, Fig. 4(a). In this case the interaction is achieved by means of resonant helices. However, the same general remarks apply to a great variety of structures using either traveling or standing-waves.

Extended interaction devices of this general kind combine the best features of conventional klystrons and TWT's. That is, considerable bandwidth, stability, high gain and good efficiency. Therefore, it is probable that they will ultimately replace both basic tube types.

Reflex Klystron

An important form of oscillator, commonly referred to as the reflex klystron, results if the electron stream is caused to reverse its direction and pass twice through a single cavity, Fig. 4(b). Reflex klystrons, like backward-wave oscillators, are relatively inefficient because it is impossible to establish simultaneously, conditions for optimum bunching and catching of the electrons in the beam. They are, however, of great economic importance because they are relatively cheap, require but one cavity, and are capable of a fair range of voltage tuning through the reflector electrode.

Of many other possible interaction principles, one which is novel and promising employs an electron beam in a smooth-walled waveguide such as a circular metal tube operating in a TE mode. Propagation in this system is characterized by a fast-wave which has a velocity substantially in excess of the speed of light. However, this wave will interact with an electron beam having a much lower velocity, provided the latter is periodically perturbed in velocity (speed and/or direction) by means of a (stationary) magnetic field or in some other suitable way. There is little doubt that a number of very useful devices will be developed from this novel interaction method, especially for extremely high peak and average powers. Because fast-wave interaction takes place in a simple unloaded waveguide of large size, it is very attractive for use in producing extremes in power (tens of megawatts) and frequency (say 300 KMC). These devices also will

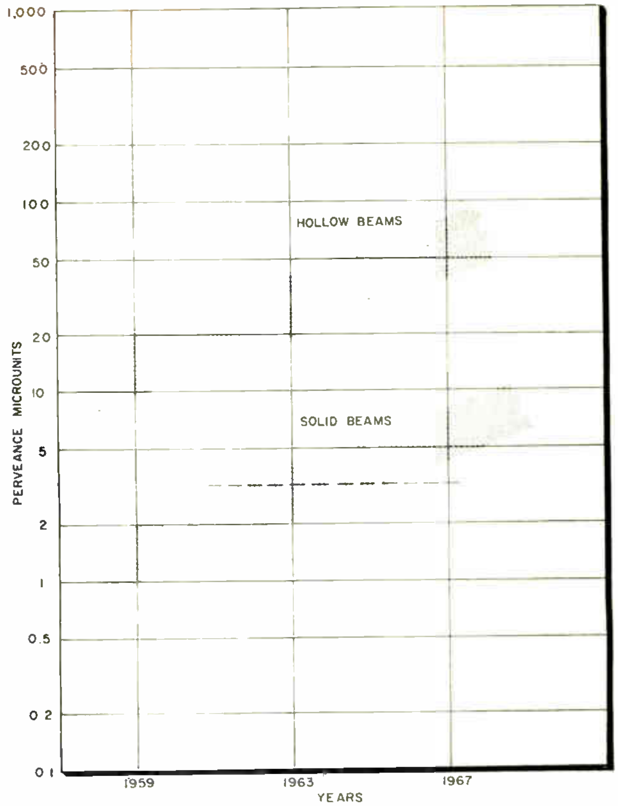
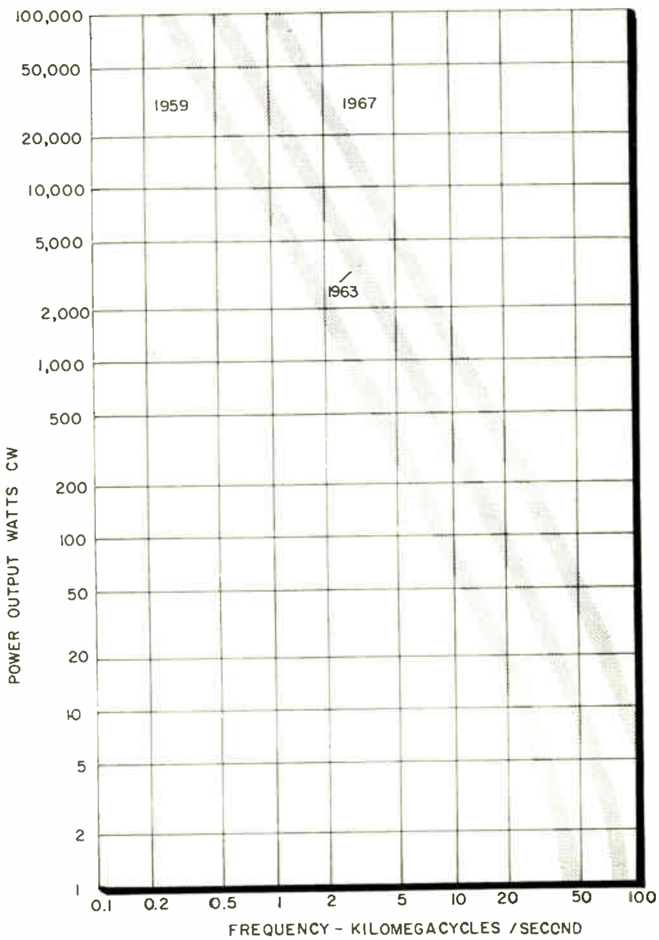


Fig. 6: Present and project trends in perveance, solid & hollow beams.

Fig. 7: Predicted available power output vs. midband frequency for octave-wide CW TW amplifiers. Parameter is year of initial production.



Future Trends *(Continued)*

become increasingly important at present powers and frequencies as soon as their efficiency can be shown to be competitive.

Other novel structures that are attractive for production of extremes in power or frequency are those using electron streams in parallel, such as the traveling-wave klystron (with some long-needed improvements for higher gain and efficiency), the multi-stream, multi-helix TWT and hollow stream TWT's and klystrons.

Cathodes and Beam Perveance

The oxide coated cathode is now about fifty years old. During that interval it has received extensive and intensive study. Although many important questions remain unanswered, there now exists a great wealth of experience with this cathode. Present processes yield cathodes which are fully satisfactory in situations where moderate values of life and emission density are sufficient or where the applied voltages are low. However, the trends toward higher powers and frequencies require increasing levels of voltage and emission density. Present cathodes do not yield satisfactory values of life in these situations and the rate at which over-all tube performance may be improved is likely to be limited by the rate at which cathodes can be improved.

Research work at our laboratory has indicated that oxide cathodes may be operated at extremely high emission levels for long periods of time in special diodes or triodes which have been fabricated from materials of utmost purity and which have been processed under conditions of extreme cleanliness. Unpublished results of Professor Coomes (Notre Dame University) corroborate these findings. While it is reasonable to hope that similar results can be achieved in beam type tubes there is no certainty this will prove to be true.

The dispenser cathode avoids some of the drawbacks of the conventional oxide coated cathode by supplying a reserve of barium or other active metal in a porous matrix of tungsten. Such cathodes run at rather high temperatures and evaporate relatively large amounts of barium. They are, therefore, of limited usefulness in many applications. However, they are capable of good life at substantially higher emission densities than are now allowable in oxide cathodes. They are also less vulnerable to contamination by their environment.

Curves showing present and projected values of life *versus* emission density for such cathodes are shown in Fig. 5. These curves can be used unchanged for the average density in pulsed operation provided the pulse length does not exceed about 10 μsec and the duty cycle is not less than about 0.1. In more typical situations of low duty cycle, the peak density during the pulse may exceed the values indicated by a factor

Fig. 8: Predicted locus of available power output vs. midband frequency for octave-wide pulsed traveling-wave tubes. Duty order: 0.01.

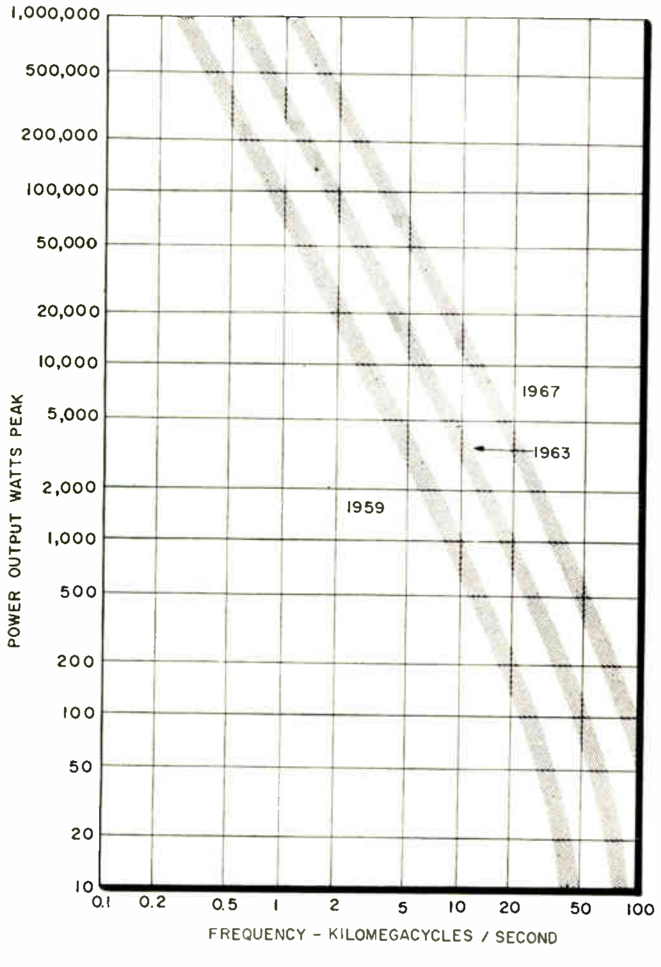
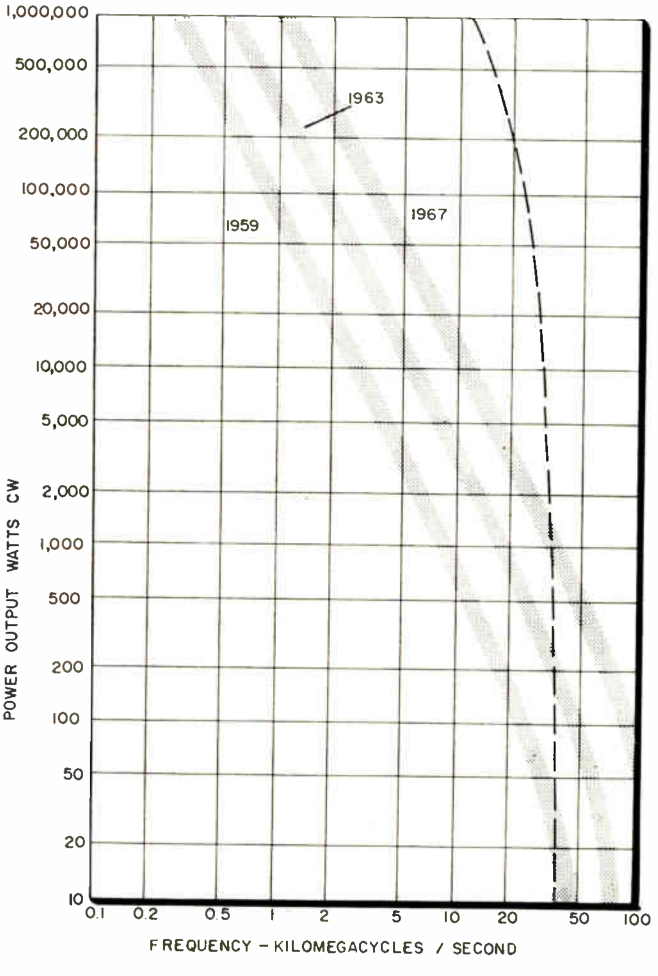


Fig. 9: Predicted locus of available power output vs. midband frequency for CW Single-beam klystrons and narrow-band traveling-wave tubes, including fast-wave interactions. Production year is parameter.

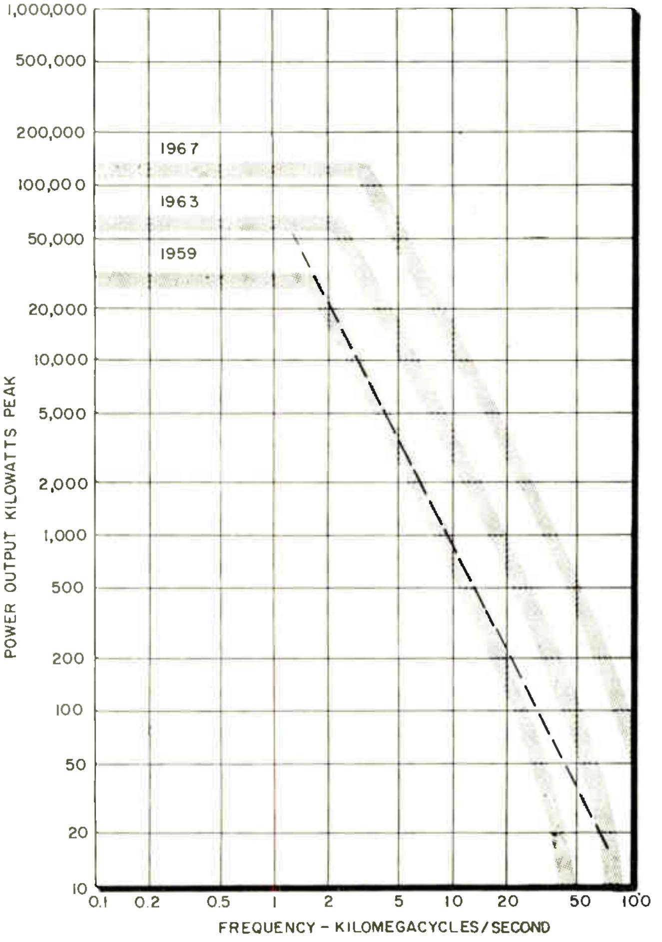


of about 10 provided the pulse length does not exceed about 10 μsec. In long-pulse applications it is necessary to use values applicable to continuous emission regardless of how low the duty cycle.

Electron beams are characterized by a geometrical constant called the "perveance" which is the ratio of beam current to beam voltage raised to the three halves power. Because high perveance beans tend to reduce the operating voltages and to increase the bandwidth capabilities of beam tubes, there is great interest in producing such beams. Though in principle solid beams of perveance about 30 x 10^{-6} can be made, the useful perveance of such beams appears to be limited to values less than or equal to about 3 x 10^{-6}. This limitation is caused by space charge forces which oppose the formation of "bunches" of electron charge due to rf modulation. It appears impossible to avoid these "space charge debunching" forces which oppose build-up of rf modulation on the beam. Therefore, one must avoid increasing the charge density in the beam for a given current and voltage. To obtain increased beam current and power output for a given voltage, one may parallel many beams, each of moderate perveance, or use a hollow beam which may be thought of as an array of many separate beams in parallel. A thin cylindrical hollow electron beam of perveance 20 x 10^{-6} is used in the Z-5092, and much larger values of perveance are at least theoretically possible for hollow beams.

Curves showing present and projected values of

Fig. 10: Predicted locus of same characteristics as in 3 preceding illustrations but for pulsed klystrons and TWT's. Duty order: 0.01. Frequency coverage order: 15%. Parameter is year of initial production.



REFERENCE PAGES
The pages in this section are perforated for easy removal and retention as valuable reference material.
SOMETHING NEW HAS BEEN ADDED
An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

perveance for solid and hollow single beams are shown in Fig. 6.

Power Output

The maximum power which may be developed at a given frequency is an important measure of the usefulness of a given electronic device or interaction principle. In general, the maximum power which may be generated in a given way decreases sharply with increase of frequency. Many varied influences are involved and the over-all situation is complicated. However, one relatively simple principle is present in nearly every case. This is the principle of similitude or geometric scaling which states that the electromagnetic performance of a given geometry is preserved if the wavelength is scaled together with all linear dimensions. Thus, the surface area of a given design varies as the square of the wavelength. Because heat which may be dissipated tends to vary directly with surface area, the average power handling capability of a given design tends to vary with the square of wavelength unless limitations due to other influences such as output windows are encountered. This approximation is used in a number of curves discussed in the following paragraphs.

The variation of power output with frequency (or wavelength) is well illustrated by CW helix-type TWT's, to which electromagnetic scaling laws apply rather exactly and in which helix heating is the dominant limitation of power output. Curves of present and projected performance are shown in Fig. 7. It is seen that present techniques would yield a continuous power output of 100 kw at frequencies up to about 300 MC, though the tube would be inconveniently large. The curvature at frequencies near 100 KMC results from thermal spreading of the beam and other difficulties associated with producing small high-intensity beams.

The projected performance of pulsed helix-type TWT's is shown in Fig. 8. It differs from Fig. 7 mainly in that the peak power is increased by a factor of ten while the average power is substantially reduced.

The conventional multi-cavity klystron is extremely rugged and is subject to excellent cooling. As a CW amplifier it is able to handle approximately ten times as much power as a helix-type traveling-wave tube for the same frequency. This advantage, which is shared by all-metal loaded-waveguide traveling-wave tubes, is indicated in Fig. 9. The dotted line superimposed on these curves was derived several years ago. It represents a practical limit of power output for solid beam tubes based on various physical limitations as to beam density, focusing, and heat dissipation. Extension of the 1967 curve to the right of this dotted

Future Trends *(Concluded)*

line is justified on the basis of parallel circuit devices, hollow stream devices and the early promise shown by a fast-wave interaction principle, all of which use relatively large beams and structures for a given frequency.

For a number of system applications it is desirable to generate a given amount of mean microwave power by means of pulsed operation. In this mode of operation many megawatts of peak power at several hundred kilovolts have been obtained from klystrons. TWT's have not yet operated at such extreme levels, but are rapidly catching up with klystrons. Relatively high voltages are required, so that moderate values of current and current density result in tremendous power levels. The situation is represented by Fig. 10 which shows that the state of the art has already reached the power level at which a normal air-filled waveguide breaks down. The horizontal portions of the curve represent an arbitrary limitation of 300 kilovolts, dictated from external system considerations. Future power increase is associated with the perveance increases indicated in Fig. 6.

Efficiency

The efficiency with which power is converted from dc to ac is of central importance at all frequencies and all power levels. Unfortunately, present beam-type tubes are only moderately efficient. Nor is it likely that the efficiency will quickly or easily be improved. Present and projected efficiency values for a variety of tube types are given in Fig. 11. Two principal approaches to increase efficiency are available: improved interaction and improved collection of the spent beam. Of these the former is preferable because it is straightforward and increases the power output available from a given beam voltage and current. However, improved interaction is very difficult to realize requiring improved beam formation and control and, for TWT's, circuits of higher impedance. Therefore, it may prove more expedient to modify the collector in such a way that unused energy originally invested in the beam is returned after passage through the interaction structure.

Noise Figure and Gain

In most systems the same performance advantage results from a one db improvement of receiver noise figure as from a db increase of transmitter power. Therefore, reduction of receiver noise is of tremendous economic importance. Recent development of parametric devices, both solid state and beam type. suggest that the equivalent temperature of the receiving amplifier can be reduced far below room temperature. Microwave systems which employ highly directive upward-pointed antennas may take advantage of such devices because the equivalent temperature of space is much lower than that of the earth. Therefore, it is possible to achieve noise reductions to substantially lower values than the 4 to 8 db which may be taken as a typical contemporary noise figure relative to room temperature.

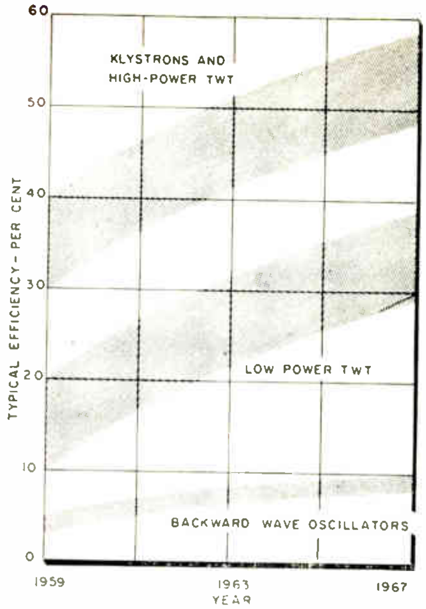


Fig. 11: Predicted efficiency vs. the year of initial production.

A projection of future noise reduction is shown in Fig. 12 which also shows a substantial increase in the typical gain of future beam-type amplifiers. Increased gain is desirable because it reduces the number of cathodes required by representative systems, provides for the possibility of negative feedback, and permits padding and other loss-adding techniques which are often desirable or essential.

Bandwidth

Helix-type TDT's readily provide a useful bandwidth of an octave or more. Because this bandwidth exceeds that which may be handled in a conventional waveguide or most other passive components, and because few systems can make use of so much bandwidth, there is little incentive to increase this parameter. Exactly the opposite situation exists with respect to klystrons and non-helix TWT's. Here the present state of the art produces bandwidths of only a few per cent while system needs suggest future use of 20 to 40%. Therefor, a great incentive to improvement exists. Present and future bandwidths are indicated in Fig. 13, where the curve for high power TWT is also applicable to hollow stream klystrons and hybrid tubes using extended interaction.

Weight Reduction

In the past it has proved so difficult to achieve creditable electrical performance in microwave beam

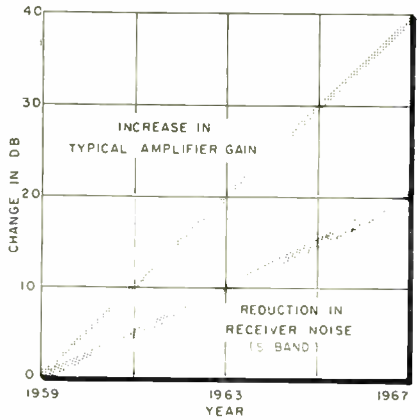


Fig. 12: Predicted performance parameters vs. initial production year.

tubes that little effort has remained for cost or weight reduction. However, this interim phase is now at or near an end, and weight and cost must be reduced to produce devices which are fully salable. The rate at which these parameters may be reduced is estimated in the upper line of Fig. 13. It is immediately obvious that no single line can represent all tube types and that the results achieved will vary enormously with the design and application of the particular tube. However, the trend indicated appears about right as an over-all average.

Current Control

A grid is a desirable adjunct to any microwave beam tube because it facilitates modulation of the output. Both improved results and reduction of modulator costs may be expected to result from the provision of a suitable grid. Therefore, designers are under considerable pressure to provide tubes with grids, and an increasing number of tube types have grids. This trend is also indicated in Fig. 13.

Linearity

Advanced systems for both radar and communication place increasingly severe requirements on the gain constancy, linearity, and phase stability of microwave tubes. Many relatively complicated factors are involved including delay distortion, non-linear distortion, and change of phase with voltage and current. If does not appear practical to illustrate these trends in a graphical way. However, there can be no doubt that substantial improvements in performance will be demanded and produced, and that failure to comply with this demand will be disastrous.

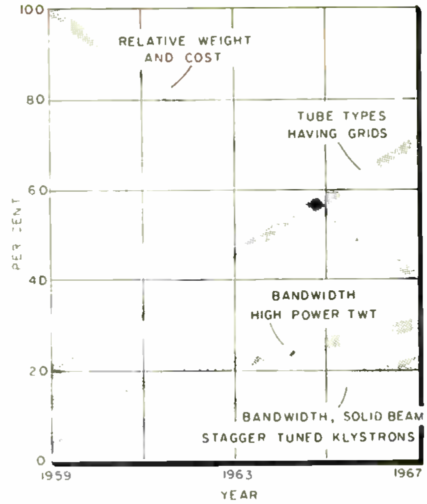


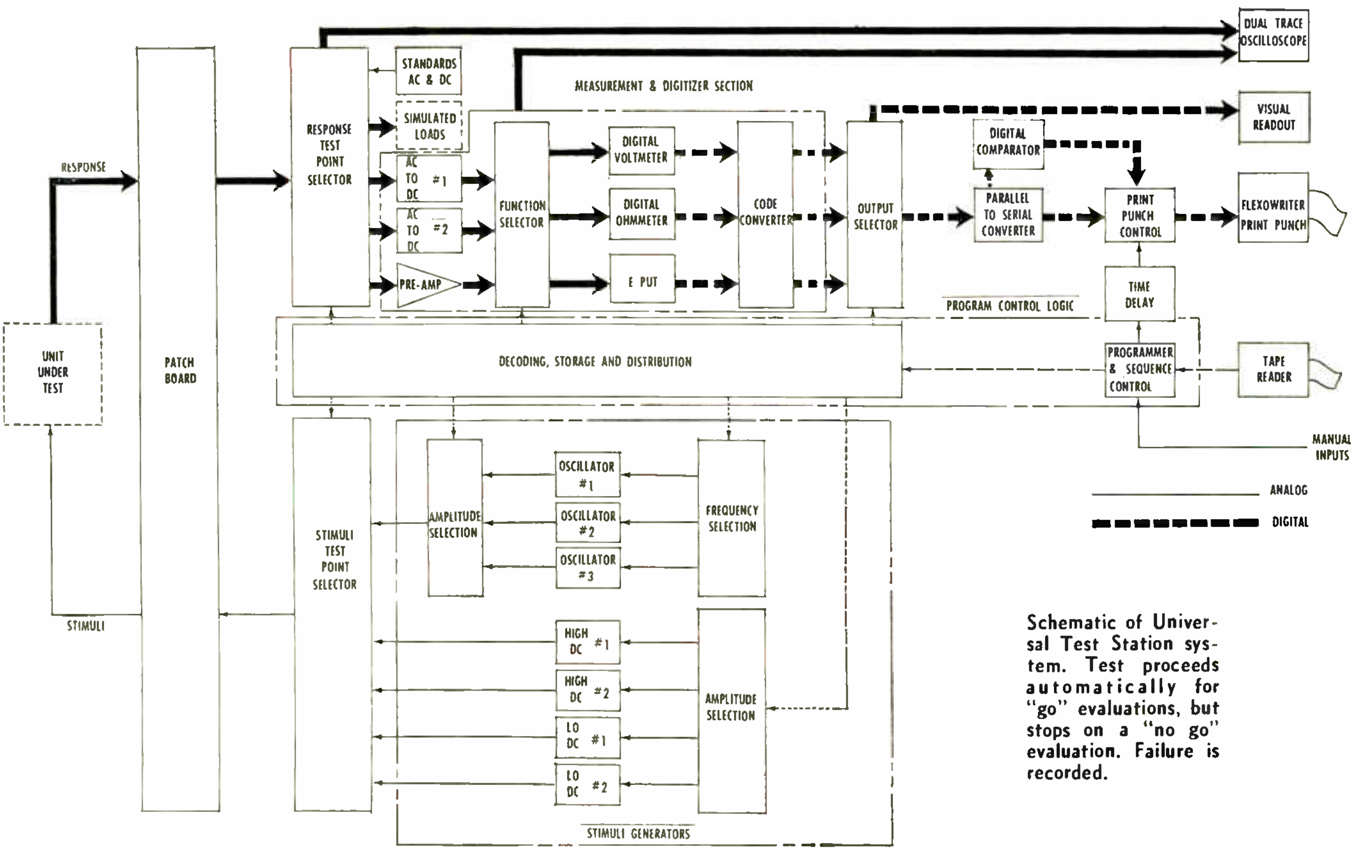
Fig. 13 More of the predicted performance parameters as they are compared with year of the initial production.

Universal Test Station

DEVISING, building and preparing specialized test setups used for a limited number of times often adds considerably to design and manufacturing costs. This new automatic Universal Test Station, built by Consolidated Avionics Corp., 800 Shames Dr., Westbury, N. Y., can perform a variety of tests on electronic products such as transistors, tubes, diodes, transformers, signal generators, passive networks, transducers, power supplies, batteries, dc and ac amplifiers, filters, recorders, rate gyros, programmers, servos, etc.

Test procedures are pre-programmed and the results are pre-

(*Continued on page* 253)



Schematic of Universal Test Station system. Test proceeds automatically for "go" evaluations, but stops on a "no go" evaluation. Failure is recorded.

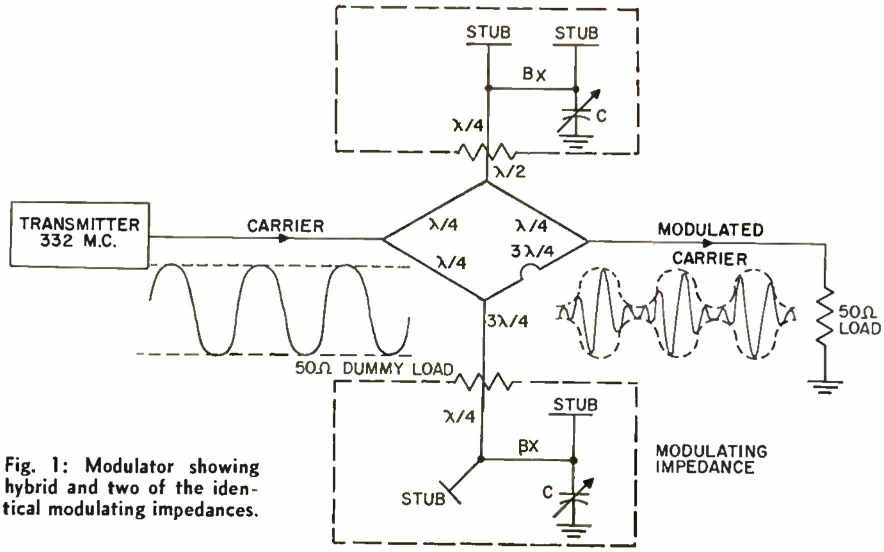


Fig. 1: Modulator showing hybrid and two of the identical modulating impedances.

By JOSEPH HABRA

Member, Technical Staff
U. S. Science Corp.
5221 West 102nd St.
Los Angeles 45, Calif.

Designing

THE mechanical modulator is used in the FAA's Glide Slope Projector. This projector is a radio facility which provides vertical guidance for instrument landings. The system provides a glide path by transmitting a combination of radiation patterns which result in two modulated signal areas.

Two mechanical modulators are used in each unit. The first furnishes a 150 CPS modulated signal below the glide path; the second, a 90 CPS modulated signal above the path.

The modulator consists of a $3\lambda/2$ hybrid with a characteristic impedance of $50\sqrt{2}$ ohms; two identical variable impedances, each consisting of a 50 ohms dummy load; two inductive stubs; and, a variable impedance paddle wheel, Figs. 1 and 4.

The two variable impedances set up the condition for modulation.

The analysis is done in steps: first, the hybrid, then the variable impedance system. Only the important equations of the analysis are shown here.

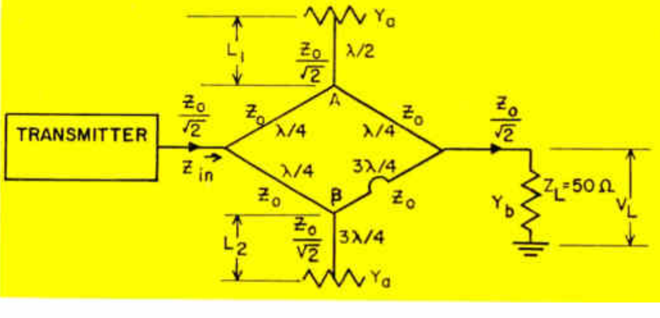
Hybrid

The $3\lambda/2$ hybrid characteristic impedance Z_o is $50\sqrt{2}$ ohms. All the transmission lines connected to the hybrid have a characteristic impedance of 50 ohms. The two modulating impedances Y_a, Fig. 2, are identical and are connected to the hybrid so that the following relation holds:

$$L_2 - L_1 = \frac{\lambda}{4} \qquad (1)$$

in the laboratory prototype $L_2 = \frac{3\lambda}{4}$ and $L_1 = \frac{\lambda}{2}$.

Fig. 2: Input and load impedances of hybrid are constant and equal.



Assuming negligible losses, the internal impedance Z_{in} of the hybrid is found to be equal to:

$$Z_{in} = Z_o \frac{(y_b + \sqrt{2})^2}{\sqrt{2}\,(y_b + \sqrt{2})^2} = \frac{Z_o}{\sqrt{2}} = \text{constant} \qquad (2)$$

Where y_b is the normalized admittance at point B, Z_o (equal to $50\sqrt{2}$ ohms) is the characteristic impedance of the hybrid. This is an important result since the transmitter supplying the unmodulated carrier has constant impedance. If the input impedance of the hybrid is not constant, reflection will result and the hybrid efficiency will go down rapidly.

Since the hybrid impedance is $50\sqrt{2}$ ohms while the load impedance $Z_L = 50\ \Omega$,

$$Z_{in} = \frac{\sqrt{2}\,Z_L}{\sqrt{2}} = Z_L = \text{constant} \qquad (3)$$

This shows that the input impedance of the hybrid is constant and equal to the load impedance. If the load impedance is 50 ohms, then the transmitter internal impedance should be 50 ohms for good matching. This is an important result and if Eq. (2) is not valid, the hybrid is of little use.

Let the transmitter voltage be V_S and its impedance Z_S, then, if Z_L the hybrid load termination is 50 ohms, the hybrid load voltage V_L is:

$$V_L = V_S \cdot \frac{y_a - y_b}{y_L y_a y_b + y_a + y_b + Z_S Y_o\, y_L\,(y_a + y_b) + 4}. \qquad (4)$$

Then,

$$Z_S = \frac{Z_o}{\sqrt{2}} \qquad (5)$$

Also from the condition of Eq. (1), the following is true:

$$y_b = \frac{2}{y_a} \qquad (6)$$

Substituting Eq. (5) and (6) in Eq. (4) we get:

$$\frac{V_L}{V_S} = \frac{1}{2}\,\frac{y_a - \sqrt{2}}{y_a + \sqrt{2}} \qquad (7)$$

Since a sinusoidally modulated carrier is wanted, then, tubes that little effort has remained for cost or weight reduction. However, this interim phase is now at or near an end, and weight and cost must be reduced to produce devices which are fully salable. The rate at which these parameters may be reduced is estimated in the upper line of Fig. 13. It is immediately obvious that no single line can represent all tube types and that the results achieved will vary enormously with the design and application of the particular tube. However, the trend indicated appears about right as an over-all average.

Current Control

A grid is a desirable adjunct to any microwave beam tube because it facilitates modulation of the output. Both improved results and reduction of modulator costs may be expected to result from the provision of a suitable grid. Therefore, designers are under considerable pressure to provide tubes with grids, and an increasing number of tube types have grids. This trend is also indicated in Fig. 13.

Linearity

Advanced systems for both radar and communication place increasingly severe requirements on the gain constancy, linearity, and phase stability of microwave tubes. Many relatively complicated factors are involved including delay distortion, non-linear distortion, and change of phase with voltage and current. If does not appear practical to illustrate these trends in a graphical way. However, there can be no doubt that substantial improvements in performance will be demanded and produced, and that failure to comply with this demand will be disastrous.

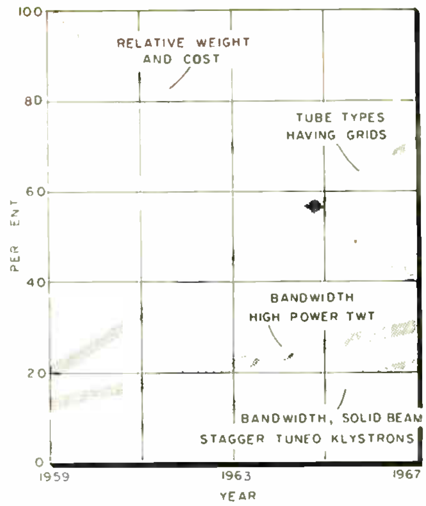


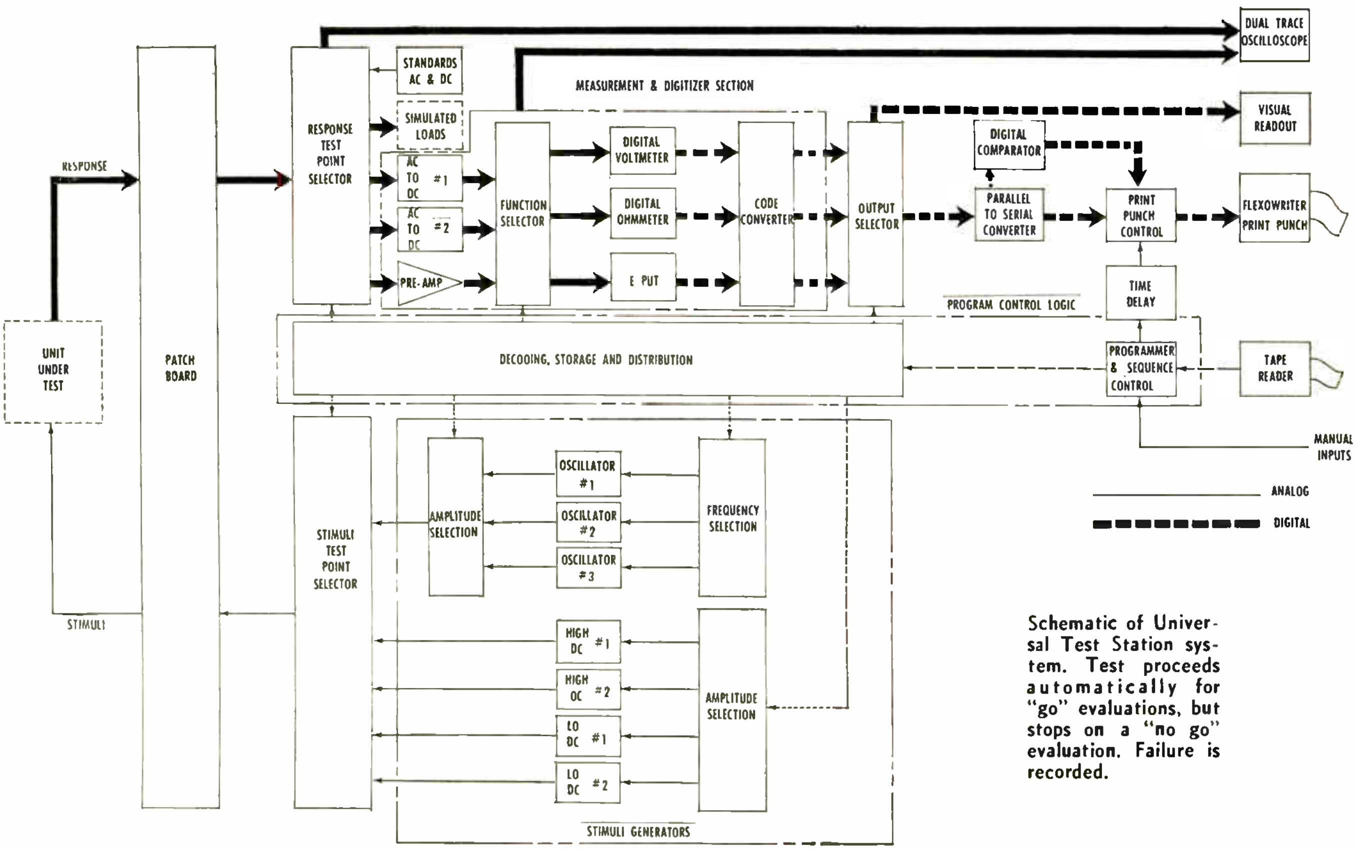
Fig. 13 More of the predicted performance parameters as they are compared with year of the initial production.

Universal Test Station

DEVISING, building and preparing specialized test setups used for a limited number of times often adds considerably to design and manufacturing costs. This new automatic Universal Test Station, built by Consolidated Avionics Corp., 800 Shames Dr., Westbury, N. Y., can perform a variety of tests on electronic products such as transistors, tubes, diodes, transformers, signal generators, passive networks, transducers, power supplies, batteries, dc and ac amplifiers, filters, recorders, rate gyros, programmers, servos, etc.

Test procedures are pre-programmed and the results are pre-

(*Continued on page* 253)



Schematic of Universal Test Station system. Test proceeds automatically for "go" evaluations, but stops on a "no go" evaluation. Failure is recorded.

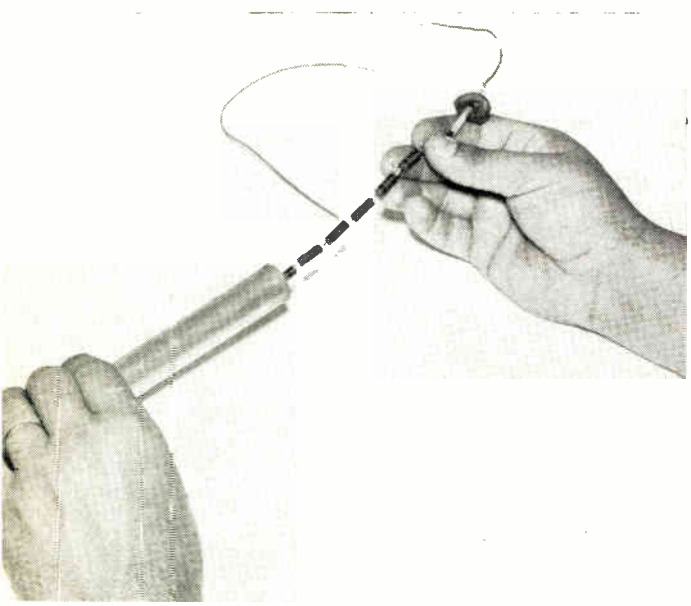
A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

Manufacturers frequently give data for only one center conductor temperature and one ambient temperature. It is often difficult to extrapolate temperature data for other power levels and other ambient temperatures. Here is a method which simulates electrical loss without applying microwave energy. It produces a maximum amount of data with a minimum expense in time and money.

Determining Temperature Rise

THE increasing level of microwave power transmitted through coaxial transmission lines makes it necessary to consider heat transfer in the design and specification of these lines. Relatively small electrical losses in a coaxial line can result in surprisingly high center conductor temperatures. These increased temperatures not only increase electrical loss but may also result in failure of dielectric beads used to support the inner conductor. In designing high power rotating coaxial joints, conductor temperature is a major consideration in specifying mechanical clearances. Conductor temperature data is needed for the proper design of almost any high power coaxial line.

Inserting heat-dispersing resistors. Simulation of heat transfer conditions produce max. amount of data with a minimum expense.



Will a particular coaxial configuration in a proposed design require forced cooling? The question is difficult to answer even for standard coaxial lines because manufacturers frequently give data for only one center conductor temperature and one ambient temperature. It is often difficult (or even impossible) to extrapolate temperature data for other power levels or other ambient temperatures.

To help solve this problem, temperature data was obtained for three typical sizes of air dielectric coaxial lines operating in various ambient temperatures over a wide range of power levels. A technique was used which simulated electrical loss in the lines without applying microwave energy. The method produced a maximum amount of data with a minimum expense in time and money. With this data it is possible to determine whether a similar proposed coaxial transmission line will require forced cooling when it operates at its designed power level.

Allowable conductor temperature will, of course, vary from application to application. Where forced cooling should be employed is a matter of engineering judgment. This data should serve as a valuable basis for judgment.

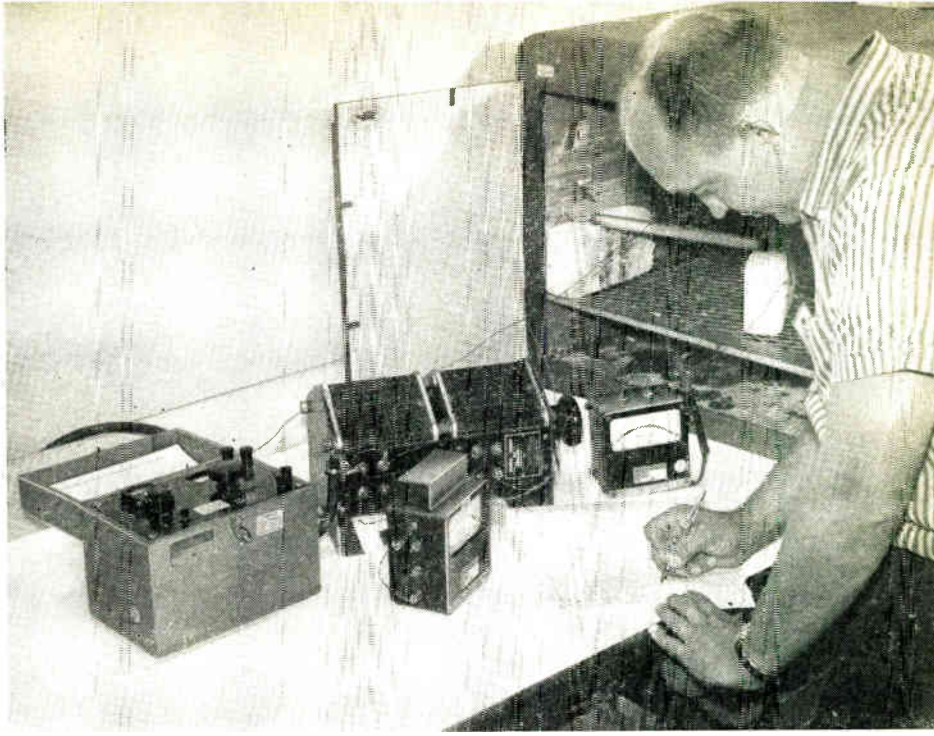
Heat Developed in a Coaxial Line

The resistance, R_1 per unit length of outer conductor of a coaxial line at frequency f, may be expressed as:

$$R_1 = \frac{1}{r_1}\sqrt{\frac{f\,u'_1}{4\,\pi\,\sigma_1}}$$

The resistance, R_2 per unit length of inner conductor of a coaxial line at frequency f may be similarly expressed as:

$$R_2 = \frac{1}{r_2}\sqrt{\frac{f\,u'_2}{4\,\pi\,\sigma_2}}$$



Laboratory set-up. Voltmeter - ammeter readings determine wattage dissipated.

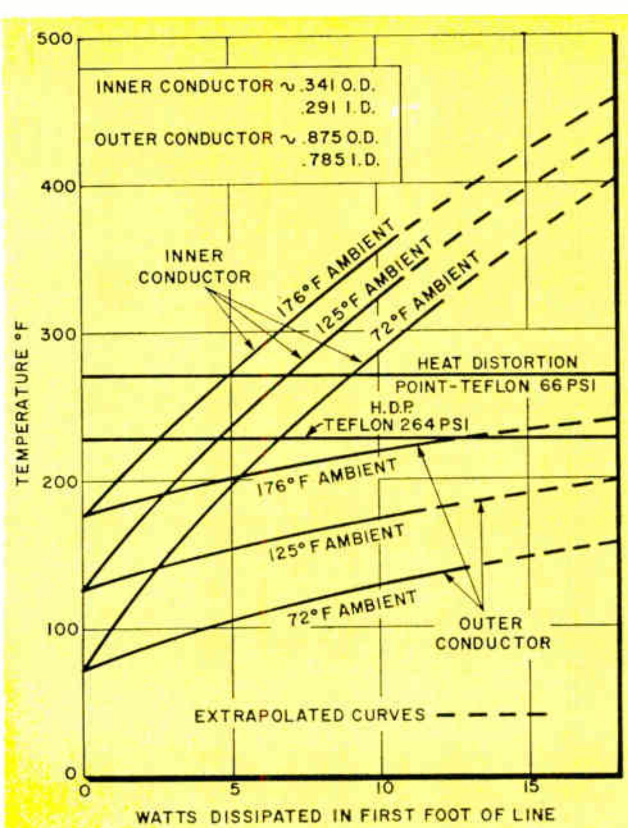
By **DENIS J. LOGAN**

Surface Armament Div.
Sperry Gyroscope Co.
Div. of Sperry Rand Corp.
Great Neck, L. I., N. Y.

# of Coaxial Lines

where: μ'_1 = permeability of outer conductor
μ'_2 = permeability of inner conductor
σ_1 = conductivity of outer conductor
σ_2 = conductivity of the inner conductor
r_1 = radius to inside diameter of outer conductor

Fig. 1: Watts dissipated in 1st ft. of line vs temp. (7/8 in. brass coaxial—unpainted.)



r_2 = radius to outside diameter of inner conductor
f = frequency

For most coaxial lines constructed with both inner and outer conductors of the same material, the equations above show that a greater resistance per unit length, and hence greater copper loss, will occur in the center conductor. For representative lines with characteristic impedance equal to 50 ohms, we have closely:

$$r_1 = 2.3\, r_2$$

from which it follows that the resistance per unit length of outer conductor is about 0.4 times that of the inner conductor. The total attenuation of a copper coaxial line with air dielectric having the dimensions r_1 and r_2 (in centimeters) may be expressed.[2]

$$\alpha = \frac{\sqrt{f}\left(\frac{1}{r_1} + \frac{1}{r_2}\right)}{0.288 \log_\epsilon \frac{r_1}{r_2}} \times 10^{-8} \text{ neper/meter}$$

Since 1 neper = 8.68 db and 1 ft = 0.3048 meters:

$$= \frac{9.18\sqrt{f}\left(\frac{1}{r_1} + \frac{1}{r_2}\right) \times 10^{-8}}{\log_\epsilon \frac{r_1}{r_2}} \text{ db/ft}$$

It can be seen that attenuation is expressed in db/ft rather than in w/ft. Hence, the heat loss is not uniform but is greater toward the input power end. If 1000 w of power enters one end of a 100 ft line and only 500 w leaves the other end, a total loss of about 3 db has taken place. The average power lost would be 5 w/ft. However, the loss in every foot of line would be 0.03 db, (3db/100), which for 1000 w of input power would be equivalent to about 7 w in the 1st foot. Apparently the end of the line closest to the input end will be the hottest.

Temperature With Known Power Loss

It is usually possible to determine the attenuation of a coaxial line from calculations, experimentation.

Temperature Rise *(Continued)*

or manufacturer's data. With the attenuation known it is possible to calculate the wattage lost in the first foot of line. Determination of the temperatures in the line by heat transfer calculations is rather involved and requires quite a few assumptions and approximations. It was decided that, by simulating the heat transfer conditions that exist in a coaxial line under high power, the maximum amount of temperature data could be obtained with a minimum expense in time and money.

Three representative coaxial lines were studied. Each had hollow inner conductors. Strings of power resistors were inserted in series within the center conductors. It was possible to simulate varying degrees of electrical loss by adjusting the voltage across these resistors. The fact that all the heat was generated within the center conductor only approximated the condition of the line under high microwave power. Since 100% of the microwave power is not lost in the center conductor, this method results in inner conductor temperatures that are somewhat higher than those achieved under actual microwave power.

The procedure used in the experiments was relatively simple. One foot lengths of 7/8", 1 5/8" and 3 1/8" outer conductor coax with 50 ohm characteristic impedance were used in the tests. Thermocouples were attached to the outside diameter of the inner and outer conductors at the midpoint of each one foot test specimen. Both ends of each coax line were then sealed with Duxseal. Each test piece was placed on small wooden blocks in an oven set to carefully maintain the selected ambient temperatures. In each case the voltage across the power resistors was varied with a Variac. Readings of a voltmeter and ammeter determined the wattage being dissipated. Temperature readings were obtained with a thermocouple bridge.

From the data obtained, plots of temp. vs. dissipated power were made and are shown in Fig. 1, Fig. 2 and Fig. 3.

Table 1 shows the point at which teflon beads will soften in the three representative coax lines.

TABLE I

AMBIENT TEMPERATURE (°F)	NOMINAL OUTER-CONDUCTOR SIZE OF COAX LINE ($Z_0 = 50\Omega$)	TEMPERATURE OF OUTER CONDUCTOR (°F)	*PERMISSIBLE POWER LOSS PER FOOT (WATTS)
72	7/8	122	9.1
125	7/8	160	6.9
176	7/8	200	4.9
72	1-5/8	120	13.1
125	1-5/8	155	9.7
176	1-5/8	197	6.0
72	3-1/8	126	24
125	3-1/8	166	17.4

* POINT AT WHICH CENTER CONDUCTOR REACHES HEAT DISTORTION POINT OF TEFLON AT 66 psi (270° F)

Fig. 2: Watts dissipated in 1st ft. of line vs temp. (1 5/8 in. brass coaxial line—unpainted).

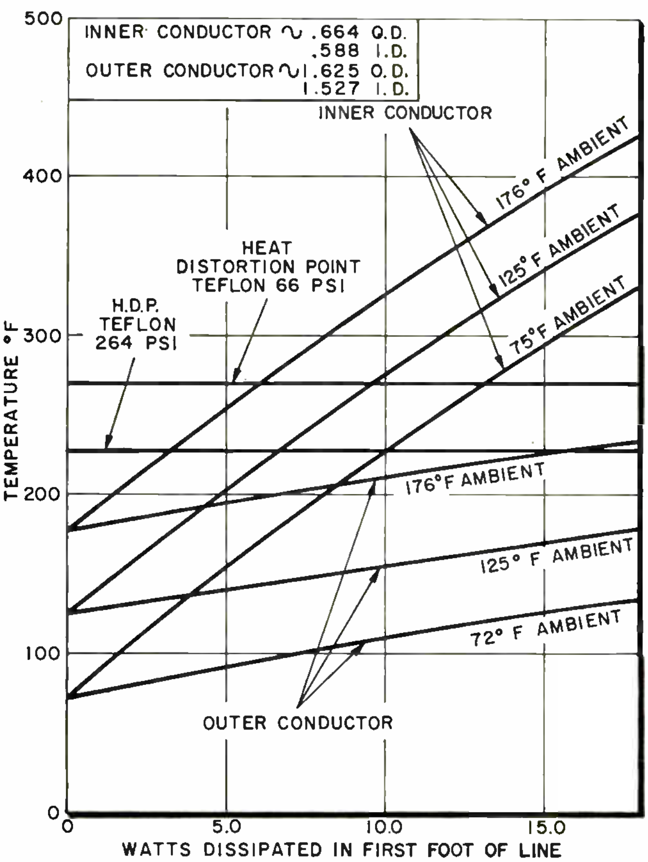
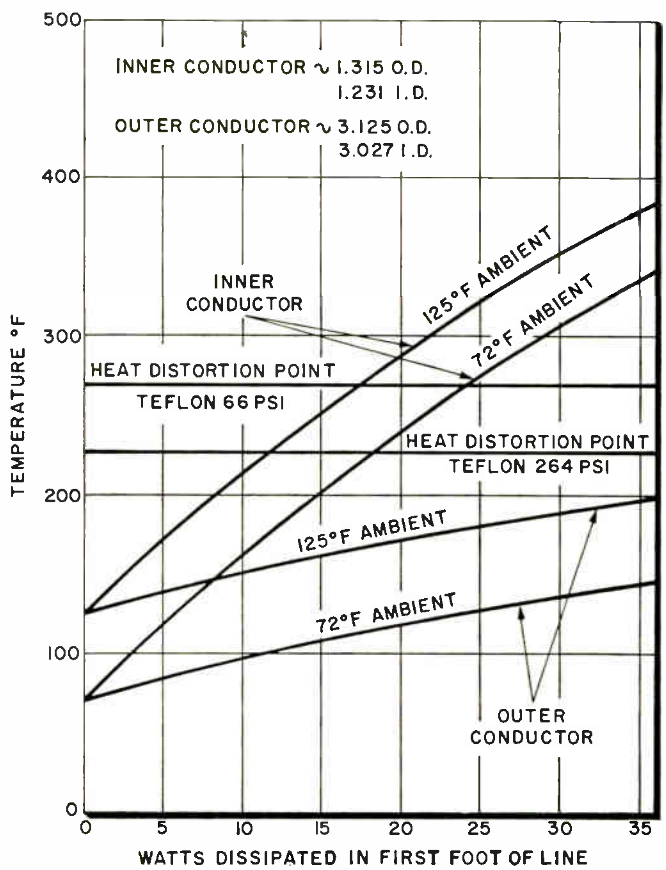


Fig. 3: Watts dissipated in 1st ft. of line vs temp. (3 1/8 in. brass coaxial line—unpainted).



Graphic Plots

Note that all the plots in Fig. 1, Fig. 2, and Fig. 3 were made for brass coaxial lines. Actually, because of the type of heat transfer occurring in these cases, the type of material is insignificant (material will, however, play an important part in the electrical attenuation). The chief barrier to heat flow in a coaxial line is the air between the inner and outer conductor. The metallic tubes which are relatively thin in cross section offer very little resistance to heat transfer. Hence, the temperatures obtained from these curves will apply fairly closely to lines constructed of aluminum, magnesium, steel, etc. Surface condition will play some part in the heat transfer phenomenon and the use of dark finishes, preferably black, on both inner and outer conductors will undoubtedly result in lower temperatures than are indicated on the curves.

To determine the temperature of the inner and outer conductor, calculate the power dissipated in the first foot of line, enter the curve plotted for the appropriate ambient temperature and read the conductor temperatures directly. For a very short line the curve may be entered with the average power dissipated per foot since heat conduction in the line will tend to even the temperatures out. Dissipated power per foot is used on the graphs rather than input power because, for a given input power the loss will vary with frequency.

Seldom will a coaxial configuration be as simple as that from which the curves were plotted. However, where the center conductor is kept isolated from metal to metal contact with the outer conductor, the conductor temperatures should be of the same order as those on the graphs.

Where heat sinks exist on the inner or outer conductor, the graph values for the temperatures will be too high. Heat will be drawn from the conductors by conduction—the temperatures will be lower. An approximation of the temperature drop due to a heat sink may be obtained by applying basic heat transfer theory.

Although the curves have been plotted for heat transfer conditions which may be more severe than are encountered in a particular application, they can still serve as a valuable guide to conservative design.

Conclusions

The data in the curves has been found useful in designing several coaxial components. It was possible to forsee cooling problems in several proposed designs before actual breadboards were constructed. In at least two cases the need for liquid cooling center conductors was recognized at the proposal stage.

By using the curves and low power attenuation data it was possible to determine the approximate center conductor temperature that could be expected in a line at a specific level of high power and to decide if the materials used in the design were satisfactory.

The data can be used in determining the power handling capacity of existing lines or components (where attenuation is known) without expensive high power testing. This is of particular significance when a source of sufficient output power is not available.

Although data was presented for only three coaxial lines, the method of simulating high power losses can readily be adapted to innumerable particular cases to obtain fairly reliable heat transfer data with a minimum of expense.

REFERENCE PAGES
The pages in this section are perforated for easy removal and retention as valuable reference material.
SOMETHING NEW HAS BEEN ADDED
An extra-wide margin is now provided so as to permit them to be punched with standard three-hole-punch without obliterating any of the text. They can then be filed in standard three-hole notebooks or folders.

Photoemissive Material for High-Temperature

A NEW photoemissive material reported by the Westinghouse electronic tube div. maintains high level of sensitivity over many hours of operations at 250°F. Developed under a contract with the Bureau of Ships, it is expected to be used in such devices as imaging and photomultipler tubes. It will permit operation at temps well above 140°F, the temp at which the operating life of conventional materials has generally been inadequate. Also: the "dark current"—a residual current produced in total darkness—is less than 1% of that for conventional materials.

The surfaces are of the bi-alkali type and are made by combining sodium and potassium with antimony. In a number of experimental tubes, the material has been applied as a semi-transparent surface over a glass substrate. Photoresponse values up to 80 ua/lumen have been recorded with response uniform within 10% over the useful cathode area.

When continuously illuminated and subjected to thermal aging at temp to 250°F and over periods up to 140 hrs, decline in photoemission displays an exponential rate of decay after an initial 10-hr aging period. Generally, decay of photosensitivity at a fixed temp follows an exponential function of the form: $I = I_0 e^{-kt}$, where I = photocurrent at time t, I_0 = initial photocurrent, t = time at elevated temp, k = constant indicative of the rate of decay of photosensitivity.

Average bi-alkali surfaces tested at 250°F display an exponential rate of decay, k, of 1.0×10^{-3} corresponding to an absolute decrease in photosensitivity of 20% over a 100-hr period. The best surfaces achieved, however, show a decay rate of 0.34×10^{-3} for an absolute decrease of 7% after 100 hrs. Measurements of spectral response before and after operation at elevated temperatures show that the decay in photoelectric yield is not constant at all wavelengths and is least in the region of 420 millimicrons.

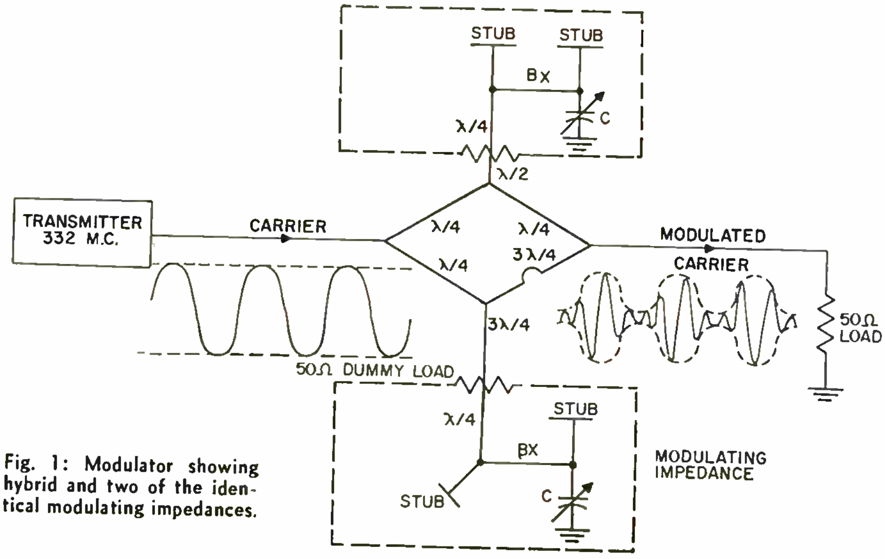


Fig. 1: Modulator showing hybrid and two of the identical modulating impedances.

By JOSEPH HABRA

Member, Technical Staff
U. S. Science Corp.
5221 West 102nd St.
Los Angeles 45, Calif.

Designing

THE mechanical modulator is used in the FAA's Glide Slope Projector. This projector is a radio facility which provides vertical guidance for instrument landings. The system provides a glide path by transmitting a combination of radiation patterns which result in two modulated signal areas.

Two mechanical modulators are used in each unit. The first furnishes a 150 CPS modulated signal below the glide path; the second, a 90 CPS modulated signal above the path.

The modulator consists of a $3\lambda/2$ hybrid with a characteristic impedance of $50\sqrt{2}$ ohms; two identical variable impedances, each consisting of a 50 ohms dummy load; two inductive stubs; and, a variable impedance paddle wheel, Figs. 1 and 4.

The two variable impedances set up the condition for modulation.

The analysis is done in steps: first, the hybrid, then the variable impedance system. Only the important equations of the analysis are shown here.

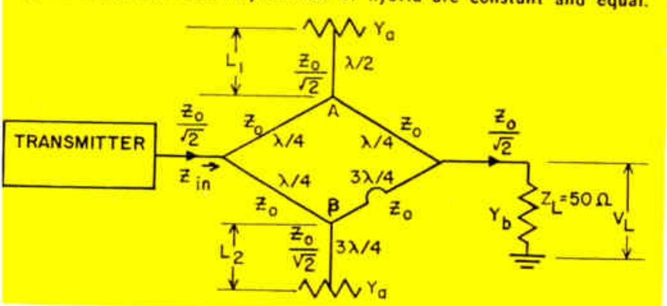
Hybrid

The $3\lambda/2$ hybrid characteristic impedance Z_o is $50\sqrt{2}$ ohms. All the transmission lines connected to the hybrid have a characteristic impedance of 50 ohms. The two modulating impedances Y_a, Fig. 2, are identical and are connected to the hybrid so that the following relation holds:

$$L_2 - L_1 = \frac{\lambda}{4} \qquad (1)$$

in the laboratory prototype $L_2 = \frac{3\lambda}{4}$ and $L_1 = \frac{\lambda}{2}$.

Fig. 2: Input and load impedances of hybrid are constant and equal.



Assuming negligible losses, the internal impedance Z_{in} of the hybrid is found to be equal to:

$$Z_{in} = Z_o \frac{(y_b + \sqrt{2})^2}{\sqrt{2}\,(y_b + \sqrt{2})^2} = \frac{Z_o}{\sqrt{2}} = \text{constant} \qquad (2)$$

Where y_b is the normalized admittance at point B, Z_o (equal to $50\sqrt{2}$ ohms) is the characteristic impedance of the hybrid. This is an important result since the transmitter supplying the unmodulated carrier has constant impedance. If the input impedance of the hybrid is not constant, reflection will result and the hybrid efficiency will go down rapidly.

Since the hybrid impedance is $50\sqrt{2}$ ohms while the load impedance $Z_L = 50\ \Omega$,

$$Z_{in} = \frac{\sqrt{2}\,Z_L}{\sqrt{2}} = Z_L = \text{constant} \qquad (3)$$

This shows that the input impedance of the hybrid is constant and equal to the load impedance. If the load impedance is 50 ohms, then the transmitter internal impedance should be 50 ohms for good matching. This is an important result and if Eq. (2) is not valid, the hybrid is of little use.

Let the transmitter voltage be V_S and its impedance Z_S, then, if Z_L the hybrid load termination is 50 ohms, the hybrid load voltage V_L is:

$$V_L = V_S \cdot \frac{y_a - y_b}{y_L y_a y_b + y_a + y_b + Z_S Y_o y_L (y_a + y_b) + 4}. \qquad (4)$$

Then,

$$Z_S = \frac{Z_o}{\sqrt{2}} \qquad (5)$$

Also from the condition of Eq. (1), the following is true:

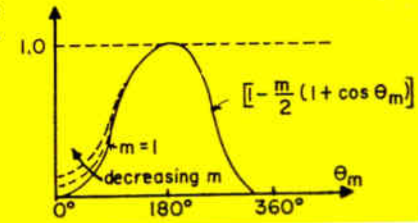
$$y_b = \frac{2}{y_a} \qquad (6)$$

Substituting Eq. (5) and (6) in Eq. (4) we get:

$$\frac{V_L}{V_S} = \frac{1}{2}\,\frac{y_a - \sqrt{2}}{y_a + \sqrt{2}} \qquad (7)$$

Since a sinusoidally modulated carrier is wanted, then,

Fig. 3: Details of the modulation envelope.



Featuring phase and frequency stability, the mechanical modulator has won a berth in FAA equipment being used at air terminals to reduce hazards. A thorough treatment on its design is presented here.

a Mechanical Modulator

$$\left|\frac{V_L}{V_S}\right| = 1 - \frac{m}{2}(1 + \cos\theta_m) = \frac{1}{2}\left|\frac{y_a - \sqrt{2}}{y_a + \sqrt{2}}\right|. \tag{8}$$

If y_a, normalized Y_a, is found for a desired impedance, using m as the modulation index, then a capacitance function can be found for a sinusoidally modulated output V_L.

Variable Impedance System

The variable impedance system used to modulate the carrier sinusoidally is shown in Fig. 4.

The variable capacitor C is actually a paddle wheel, of predetermined shape, rotating between a blade, of predetermined shape, and ground.

The capacitance change is created by varying the dielectric constant of the medium, air, between the blade and ground. The capacitance function C at any time is made up of two parts: that due to the common area between the wheel and the blade; and, the stray capacitance which has its greatest effect at C_{min} when the wheel and blade are out of mesh.

Two boundary conditions exist. The first when a high impedance exists at point P; this corresponds to C_{max} of the variable capacitance. The second condition is when a zero impedance or short exists at point P. This corresponds to C_{min} of the paddle wheel. The first stub is set so that its inductive reactance is equal to the reactance of C_{max}. The second stub is set so that its reactance equals the reactance of the transmission line Z_2 at point N when C is equal to C_{min}.

The first stub, across the variable capacitor paddle wheel, has an inductive reactance ωL_1 equal to:

$$\omega L_1 = j\frac{1}{\omega C_{max} - \dfrac{1}{Z_1 \tan\beta x}}. \tag{9}$$

Where Z_1 is the characteristic impedance of the line, $\beta x < \lambda/4$, and C_{max} is the maximum value of C. The value of C_{max} determines a condition corresponding to maximum modulation (zero voltage for $m = 1$).

The second inductive stub, a distance βx away from the paddle wheel capacitor, has an inductive reactance ωL_2 equal to:

$$\omega L_2 = j\frac{Z_1^2\,\omega\,(C_{max} - C_{min})\tan\beta x}{\tan\beta x + \dfrac{1}{\tan\beta x} - Z_1\,\omega\,(C_{max} - C_{min})} \tag{10}$$

This value of reactance corresponds to $m = 1$, or 100% modulated carrier in the derivation of Eq. (10). For Eqs. (9) and (10) to be true, the following condition was found:

$$\frac{1}{\omega\,C_{max}\tan\beta x} < Z_1 < \frac{\tan\beta x + \dfrac{1}{\tan\beta x}}{\omega\,(C_{max} - C_{min})} \tag{11}$$

The normalized admittance y_a of the system as shown in Fig. 4 is equal to:

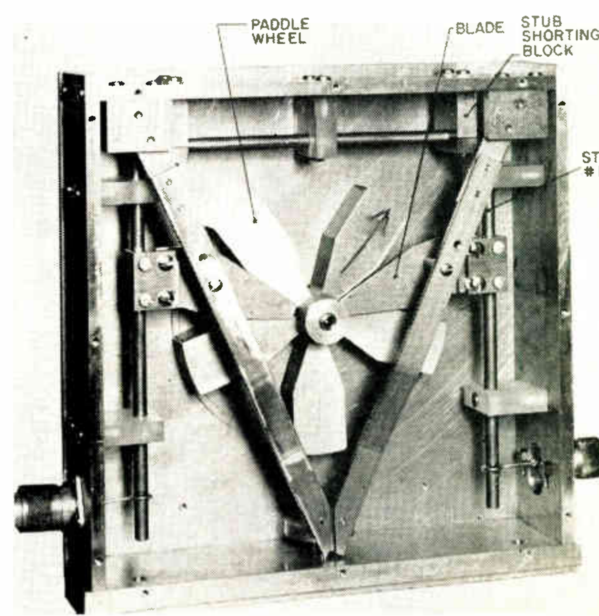
$$y_a = \frac{50\sqrt{2}}{Z_D} + j\frac{50\sqrt{2}\,Z_1^2\,\omega\tan\beta x}{Z_2^2\left(\tan\beta x + \dfrac{1}{\tan\beta x}\right)} \cdot \left[\frac{1}{\dfrac{1}{C_{max} - C_{min}} - \dfrac{1}{C_{max} - C}}\right]. \tag{12}$$

Where Z_0, Z_1, Z_2, βx, C_{max}, and C_{min} are all fixed parameters, the capacitance function C of the paddle wheel is the only variable.

Laboratory Prototype

Substituting Eq. (12) in Eq. (8) and solving for C, the paddle wheel capacitance function *versus* the modulation envelope angle θ_m, we get *Eq.* (13) which appears at the foot of page 84.

Illustration of the casing, paddle wheel, blade and first stub.



Mechanical Modulator

(Continued)

The values used in the laboratory prototype are:

$C_{max} = 6\ \mu\mu f$, $C_{min} = 3\ \mu\mu f$, $Z_1 = 150\Omega$, $Z_2 = 50\Omega$, $\beta x = 45°$ $f = 332$ MC.

Using the above values, the capacitance function equation becomes:

$$C = 6 - \frac{1}{0.334 + 0.665\sqrt{\dfrac{0.125}{\left[1 - \dfrac{m}{2}(1 + \cos\theta_m)\right]^2} - .125}}\ \mu\mu f \qquad (14)$$

Eq. (14) is plotted in Fig. 5 for different modulation indices.

The capacitance function of Fig. 5 is the capacitance that the paddle wheel and blade should duplicate to get a distortionless sinusoidal modulated output. The figure also shows the effect of modulation on the maximum value of capacitance C_{max}.

A means of lowering C_{max} without changing C_{min}, Fig. 5, is also a method of controlling modulation of the carrier wave.

The other variables besides the paddle wheel capacitance are the two inductive stubs.

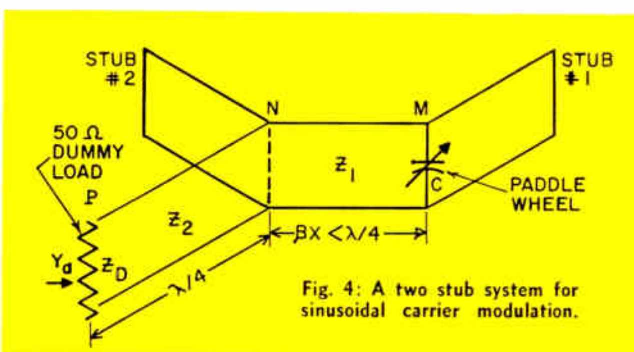


Fig. 4: A two stub system for sinusoidal carrier modulation.

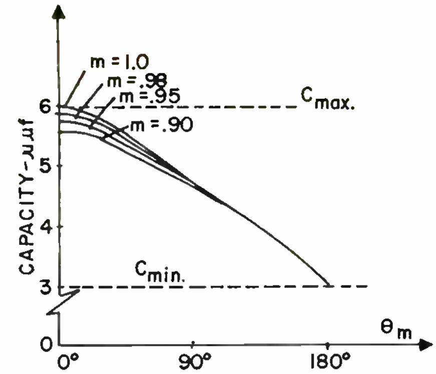
Stub No. 1 Variation

Analyzing the capacitance function as given in Eq. (14), and taking into consideration a small variation of stub No. 1 inductance, we get Eq. 15 at the foot of this page.

Where δ stands for a small change of stub length; $\delta = 0$ corresponds to $m = 1$ (100% modulation).

Eq. (15) is plotted in Fig. 6. This figure shows that increasing the inductance or length of the stub will shift the capacitance function downward at C_{max} without changing C_{min}. This shift downward corresponds to decreasing the modulation at the expense of slight distortion increase. The introduction of a little distortion is obvious since the curves of Fig. 6 are not identical to the curves of Fig. 5.

Fig. 5: Plot of Eq. 14 for different indices.



Stub No. 1 then can be used as a means of varying the modulation of the carrier. In the laboratory prototype, shorting the end of the stub is accomplished by a sliding brass block which shorts the center conductor of the stub to ground, Fig. 9.

Stub No. 2 Variation

The analysis of the capacitance function C for a small change of stub No. 2 reactance is similar to the analysis of stub No. 1. The result is Eq. 16 at the foot of page 85.

Where δ corresponds to a small change of the stub length, Fig. 7 shows that a change in stub No. 2 will vary the minimum value of the capacitance function without altering the maximum value. This will only change the carrier amplitude or power and will not affect the modulation which is a function of C_{max}. This power change is also at the expense of some increase in distortion. This stub could be a means of varying the carrier power output while the first stub is a means of changing the modulation.

The paddle wheel and blades shape gives a capacitance function which corresponds to a modulation index and a distortionless output. As the stubs are varied to control the carrier modulation and power output, a slight distortion is introduced and in the prototype this added distortion is within specificaton.

Tolerances

Tolerances on the paddle wheel and blades are of great importance. Solving for the modulated output carrier wave $f(_m)$, we get Eq. 17, also at the foot of page 85. This holds true

if $Z_1 = 150\Omega$, $Z_2 = 50\Omega$, $\beta x = 45°$, $C_{max} = 6\ \mu\mu f$, $C_{min} = 3\ \mu\mu f$ and $f = 332$ MC.

$$C = C_{max} - \frac{1}{\dfrac{1}{C_{max} - C_{min}} + \dfrac{50\sqrt{2}\,Z_1^2\,\omega\tan^2\beta x}{Z_2^2(\tan^2\beta x + 1)}\sqrt{\dfrac{0.125}{1 - \dfrac{m}{2}(1 + \cos\theta_m)^2} - .125}}\ \mu\mu f \qquad (13)$$

$$C = (6 \pm \delta) - \frac{1}{\dfrac{1}{(3 \pm \delta)} + 0.665\sqrt{\dfrac{0.125}{\left[1 - \dfrac{1}{2}(1 + \cos\theta_m)\right]^2} - .125}}\ \mu\mu f \qquad (15)$$

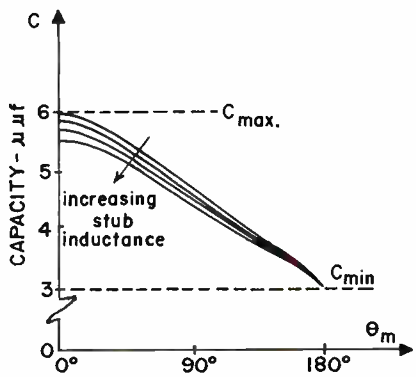


Fig. 6: Notice the introduction of a little distortion in this plot of Equation 15.

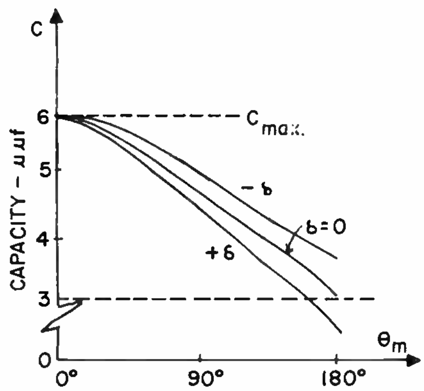


Fig. 7: This plot of Eq. 16 shows that the effect of a small change in length of Stub 2.

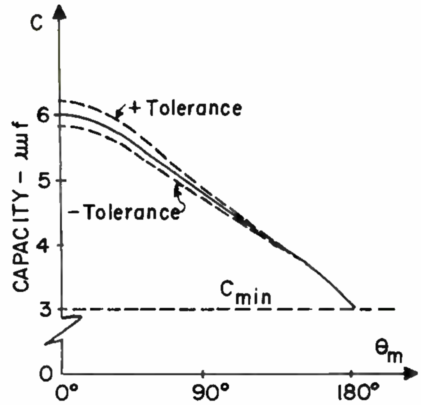


Fig. 8: The capacitance functions for the plus and minus tolerances are shown here.

Then

$$(\theta) = 1 - 2 \cdot \sqrt{1 - \frac{1}{1 + 0.0553\left[\dfrac{1}{0.334 - \dfrac{1}{6 - C}}\right]^2}} \qquad (18)$$

if values for distortionless modulation are substituted for C in Eq. (18), then $f(\theta) \approx \cos \theta$, which corresponds to the carrier envelope for distortionless modulation.

Assuming certain mechanical tolerances for the paddle wheel, the blade, etc., two capacitance functions can be found for plus and minus mechanical tolerances, Fig. 8. These two capacity functions will determine by Eq. (18) two modulation envelopes $f_1(\theta)$ and $f_2(\theta)$ corresponding to $\pm$ tolerances. Now by using Fourier analysis, the harmonics can be found and distortion in db computed.

TABLE I

NORMALIZED HARMONICS FOR ± TOLERANCES

	Max. Negative Tolerance	Max. Positive Tolerance
Fundamental	1.00000	1.00000
2nd harmonic	.01285	.04304
3rd harmonic	.00394	.01286
4th harmonic	.00255	.00741
5th harmonic	.00138	.00919

The harmonics of plus tolerance are −26.465 db. Below the fundamental for minus tolerance, the harmonics are −37.233 db below the fundamental. These two figures were computed for a given mechanical tolerance of ±.010.

The modulating frequency depends on the speed of the motor driving the paddle wheel and on the number of paddles in the paddle wheel. For an 1800 RPM motor and a five paddle, paddle wheel, the modulating frequency is 150 CPS.

On p. 83 is a photographic reproduction of the casing that includes the paddle wheel, the blade, and the first stub. The case is grounded, thus eliminating any power radiation. The second stub is out of the casing and is simulated by an open length of line with a fine tuning capacitor at the end.

Advantages

The advantages of this mechanical modulator over conventional modulators are:

a. Phase stability; the phase is locked solid and does not drift at all.
b. Frequency stability; the modulating frequency is very stable because it depends only on the modulator motor RPM and the number of paddles on the paddle wheel.
c. Over-all reliability.
d. Constant modulation depth regardless of modulating frequency or output power.

Frequency Limitations

The frequency range over which this modulator will operate satisfactorily is as described below:

The carrier frequency range is 100MC-1000MC. The lower limit depends on the physical size of hybrid, coaxial lines, etc.

The modulating frequency equals RPM/60 × No. of paddles.

The range is from dc to a maximum possible of about 1000 CPS.

The results achieved are good compared to conventional modulators. The harmonics distortion obtained is −30db with a power efficiency of 30%. A depth of modulation of 99% was easily obtained.

$$C = 6 - \frac{1}{(0.334 \pm \delta) + .665\sqrt{\dfrac{0.125}{\left[1 - \dfrac{1}{2}(1 + \cos\theta_m)\right]^2} - 0.125}}\ \mu\mu f \qquad (16)$$

$$f(\theta) = 1 - 2 \cdot \sqrt{1 - \frac{1}{1 + \dfrac{1}{8} \cdot \left[\dfrac{50\sqrt{2}Z_1^2\,\omega \tan\beta x}{Z_2^2\left(\tan\beta x + \dfrac{1}{\tan\beta x}\right)}\right]^2 \cdot \left[\dfrac{1}{\dfrac{1}{C_{max} - C_{min}} - \dfrac{1}{C_{max} - C_{min}}}\right]^2}} \qquad (17)$$

Dielectric Constants *(Concluded)*

less than 0.01, an oil bath will suffice. Although care must be taken in monitoring frequency, modulation can be accomplished at the repeller plate of the klystron. Greater stability may be obtained by making use of a ferrite modulator. The input to the ferrite modulator should be a very stable sine wave function generator or, better still, a frequency standard capable of modulating a microwave carrier to 100%.

Because of the very high VSWR, adequate isolation is essential. Again, ferrites designed for the specific frequency being used are recommended since they have very low forward loss compared to the isolation afforded. Isolation of the slotted section is extremely important, since it may act as a slide screw tuner.

The wave meter should be a high Q resonant cavity with provisions for monitoring the frequency to at least four significant figures. The detected wave meter output should be connected to a standing wave amplifier which is operated on its expanded scales. The expanded scales are recommended since the slightest frequency drift will result in a wide deflection on the VSWR indicator, making a frequency change more noticeable to the operator.

The attenuator should be a variable precision attenuator to compensate for any power level changes at the signal source. Since power level is important, as little attenuation as possible should be used.

The probe should be fixed to a carriage that is permanently fixed to a slotted section, thus insuring that the probe will travel the precise path intended through the slot. The probe should also contain a very sensitive crystal detector such as a type 1N23.

The correct depth of the probe is, of course, essential. In no case should the probe depth exceed 1/32 in. Any greater depth will upset the standing wave pattern to such an extent as to make the formulas for computation no longer applicable.

The standing wave amplifier should offer a high impedance to the crystal input from the probe; 200K ohms should be adequate. The reason for the high impedance is due to the very sharp nulls of low energy that are being detected.

Since the power in the null, with simple equipment, is almost undetectable, it is necessary to use the so-called two-position method where a probe position reading is taken on either side of the null. These two readings are added and their sum divided by two to give the correct null position. It is necessary to take two probe position readings 3 db up from the null in order that X_o, X_1, and ΔX may be determined and $\tan \delta$ can be computed. These same two probe positions may also be used to find the null. If the null is detectable, it should not be used to calculate ψ. There may be FM in the null due to undetectable voltage fluctuations and, of course, there will be a certain degree of noise.

The short should be the very best possible and, if a rectangular guide operating in the TE_{01} mode is used, it should be replaced in the very same position at the end of the guide every time it is removed and replaced. The mounting holes in the short should have a minimum amount of play in them. Any change, however slight, in the short position will cause a change in the standing wave pattern that will affect the parameters measured.

Sample Preparation

Preparation of the sample is extremely important. If a rectangular hollow guide is used and operated in the TE_{01} mode, the b dimension of the dielectric material should be held to within ± 0.0005 of the b dimension of the hollow guide. This close tolerance is necessary because the e field is at a maximum across this dimension. The a dimension should fit flush with the sides to a tolerance of ± 0.001. Here the tolerance is more lax since the e field is at a minimum. The thickness of the dielectric material is also important. It should be held to ± 0.0005 because of its effect on the value of ψ (the phase shift plus thickness). If it is desired, the dimension on the thickness may be held to ± 0.001 and the dielectric material rotated through four possible positions to obtain four values of the parameters, then the average values may be used for computation.

For dielectric materials that have a high or even moderate absorption factor, care should be taken to insure that all moisture has been removed.

Plexiglass, of the non-heat resistant variety, is recommended as a control because of its easy machineability and moisture resistance. Needless to say, it is important that exact data at the specific test frequency be available. Reference 1 contains the dielectric constants and dissipation factors of two types of polymethyl methacrylate (plexiglass).

Accuracy

The accuracy of the input impedance method is limited chiefly by the physical tolerances on both the equipment and the dielectric sample. A correction factor for the dielectric sample tolerance is given in Reference 3, Page 576, but it is strongly recommended that the sample tolerances given earlier in this paper be held.

When the loss tangent approaches values close to 0.1, the errors (using the lossless technique) become more pronounced but will not exceed 1% for perfect equipment provided nK'' is less than 0.2. The number of wave lengths in the sample is represented by n. Obviously, it is impossible to use perfect equipment, but using a dielectric sample that is three-quarters of a wavelength thick will greatly reduce measurement error.[1] The three-quarter wavelength refers to a three-quarter wavelength in the dielectric sample, within the guide.

References:

1. Von Hippel, A., et al, *Dielectric Materials and Applications*, MIT Press and John Wiley & Sons, Inc., New York.
2. Von Hippel, A., *Dielectrics and Waves*, John Wiley & Sons, Inc., New York. Chapman & Hall, Limited, London.
3. Montgomery, *Technique of Microwave Measurements*, MIT Radiation Laboratory Series, Vol. II.
4. Dakin, T. W., and Works, C. N., "Microwave Dielectric Measurements," *Journal of Applied Physics*, Vol. 18, No. 9, Sept. 1947.
5. Surber, W. H., Jr., and Crouch, G. E., Jr., "Dielectric Measurement Methods for Solids at Microwave Frequencies," *Journal of Applied Physics*, Vol. 19, Dec. 1948.
6. Westphal, W. B., "Techniques and Calculations Used in Dielectric Measurements on Shorted Lines," Report No. IX, Laboratory for Insulation Research, MIT, Aug. 1945.
7. Gray, B. C., "An Application of Digital Computers to Computation of Dielectric Constants and Loss Tangents,"—*Automatic Control*.

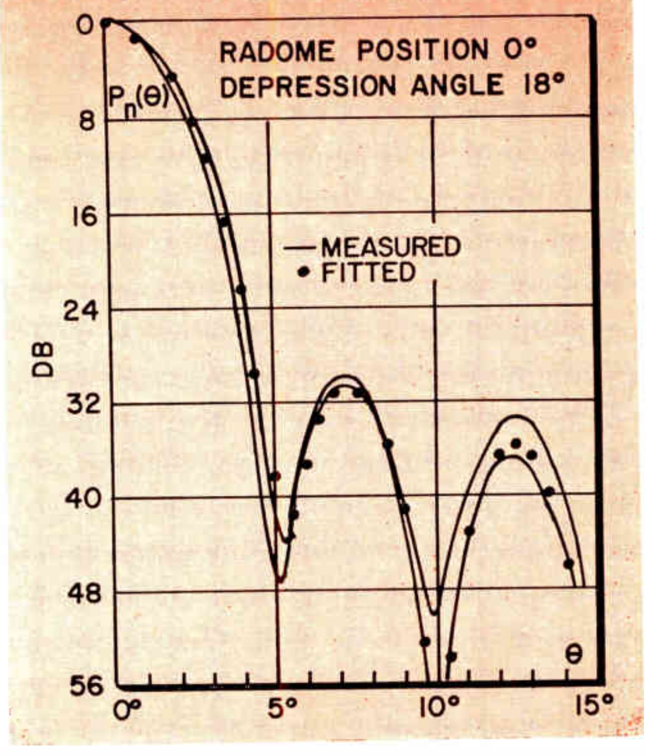
The expression for the far field antenna pattern on a horizontal plane does not lend itself to convenient analytical manipulation. Furthermore it is inexact if applied to the pattern of an antenna enclosed within a radome. Approximations are sought which facilitate computation and design. These have acceptable accuracy and analytical convenience.

Finding Radar Pattern Equations with a Computer

By N. D. DIAMANTIDES
Dept. 475/G
Engineering Scientist
Goodyear Aircraft Corp.
1210 Massillon Rd.
Akron 15, Ohio

MILITARY technology is placing an unprecedented emphasis on radar for both offense and defense. Long range navigation, mapping, weather monitoring, search, bombing, reconnaissance and surveillance operations, advanced warning and interception, all depend primarily on radar of various types.

Fig. 1: Two-way secondary antenna pattern.



As need for radar information becomes more pressing, so does the need for increasing the sensor's resolution capabilities in both range and azimuth. Range resolution may be advanced, to a certain extent, by reducing the pulse length, but azimuth resolution is a much more difficult problem.

Since azimuth resolution is proportional to antenna size and inversely proportional to wave length, the effort is directed toward increasing the former and decreasing the latter. But there are limitations in both directions.

Decreasing the radiated wave length is limited since the beamed energy is attenuated more at high frequencies, which decreases the useful range.

Increasing antenna size, on the other hand, increases problems of increased space, weight, and structural adequacy—especially in airborne applications. Computational methods, therefore, are being relied upon to sharpen the display, for instance, in doppler and monopulse radars.

The Secondary Pattern

One radar feature that invariably enters the picture is the far field antenna pattern on a horizontal plane, i.e., the secondary pattern of radar terminology.

Theoretically, this feature may be described by an expression of the form $(\sin x/x)^2$. Physically it measures the power radiated in a direction a certain number of degrees away from the optical axis on a plane perpendicular to the vertical.

This particular expression, however, does not lend itself to convenient analytical manipulations. Furthermore, the expression is inexact if applied to the pattern of an antenna enclosed within a radome. The

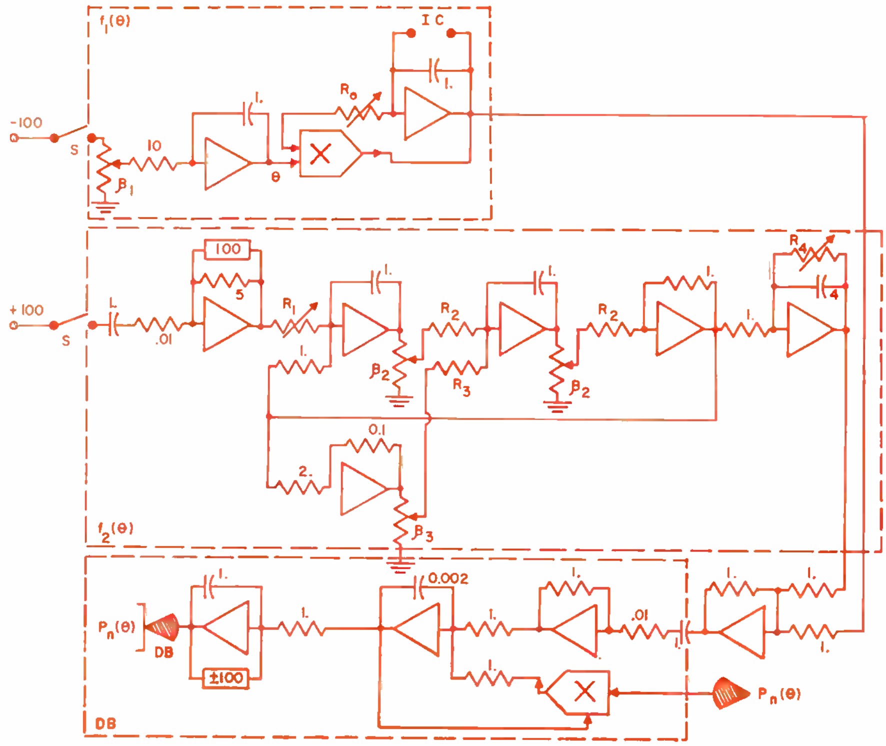


Fig. 2: Computer diagram for antenna pattern curve fitting.

Radar Patterns

(Continued)

resulting error increases as the radome cross section by the radar beam plane of symmetry deviates increasingly from the circular shape. This is particularly true in the case of airborne radar where the radomes are forced into streamlined configurations. Reflection at the radome interfaces and diffraction aberrations redistribute the radiated power within the beam. Radome effects, for instance, include uneven attenuation and elimination of some of the zeroes which according to the above theoretical expression exist at the points.

$$x = \pm k\,\pi,\ k = 1, 2, 3, \ldots$$

Similar effects may be present in the pattern generated through Lunemberg lenses.

Approximations

Because of difficulties in describing secondary antenna patterns with formulae derived through strict theory, approximations are generally sought. These will facilitate computational and design work. Within the desired azimuth range, these approximations describe the pattern mathematically in an inclusive way and with an acceptable accuracy and analytical convenience.

Eq. 1 is satisfactory for cases of small rocket-carried mapping radars and lends itself to a quick fitting of the experimental data from secondary pattern measurements:

$$P(\theta) = P_o\left[\exp\left(-\,a\,\frac{\theta^2}{w^2}\right) + m.\exp\left(-\,b\,\frac{\theta}{w}\right)\sin^2\left(\frac{c}{2}\,\frac{\theta}{w}\right)\right], \qquad (1)$$

where P_o, a, b, c and m are constants for a given antenna-radome combination and relative orientation angle with respect to the radome meridian. On the other hand, θ is the azimuth angle, and w one-half the beam width as defined by:

$$P(w) = \frac{1}{2}P_o. \qquad (2)$$

The validity of Eq. 1 is shown in Fig. 1. This is the result of actual measurements for a 2-way transmission on a small antenna to be mounted within the tail of a rocket for high altitude radar picture studies. The data were taken with the antenna inside the radome. The assymmetry and attenuation effects are evident in the difference between the plots of the two halves of the pattern.

The parameter value for this particular case, after P was normalized to the peak value, were determined as:

$$a = 0.8421;\ b = 0.0454;$$
$$m = 0.0604;\ c = 158.4; \qquad (3)$$
$$w = 2.2^\circ;\ \text{with } \theta \text{ expressed in degrees.}$$

Using the Analog Computer

Curve-fitting for such parameter estimates is greatly simplified if advantage is taken of the analog computer. Eq. 1 in its normalized form:

$$P_n(\theta) = \frac{P(\theta)}{P_o}, \qquad (4)$$

may be written as the sum of three elementary functions for positive values of the independent variable θ:

$$P_n(\theta) = f_1(\theta) + f_2(\theta) - f_3(\theta), \qquad (5)$$

where:

$$f_1(\theta) = \exp\left(-\,\frac{a}{w^2}\,\theta^2\right) \qquad (6)$$

and:

$$\sin^2\left(\frac{c}{2w}\theta\right) = \frac{1}{2} - \frac{1}{2}\cos\left(\frac{c}{w}\theta\right),$$

$$f_2(\theta) = \frac{m}{2}\exp\left(-\frac{b}{w}\theta\right), \tag{7}$$

$$f_3(\theta) = \frac{m}{2}\exp\left(-\frac{b}{w}\theta\right)\cos\left(\frac{c}{w}\theta\right). \tag{8}$$

The first function, $f_1(\theta)$, may be considered as the solution of the differential equation

$$\dot{f}_1(\theta) + 2\frac{a}{w^2}\theta f(\theta) = 0 \tag{9}$$

For the two others, $f_2(\theta)$ and $f_3(\theta)$, which are linear, using the definition of the Laplace transform for zero initial conditions results in:

$$f_2(s) = \frac{m}{2}\,\frac{1}{s + \frac{b}{w}}, \tag{10}$$

$$f_3(s) = \frac{m}{2}\,\frac{s + \frac{b}{w}}{\left(s + \frac{b}{w}\right)^2 + \frac{c^2}{w^2}}. \tag{11}$$

Hence:

$$f_2(s) - f_3(s) = \frac{mc^2}{2w^2}\,\frac{1}{\left(s + \frac{b}{w}\right)\left[\left(s + \frac{b}{w}\right)^2 + \frac{c^2}{w^2}\right]}$$

$$= \frac{mw}{2b}\,\frac{1}{\left(\frac{s^2}{\omega^2} + \frac{2\zeta}{\omega}s + 1\right)(\tau s + 1)}, \tag{12}$$

where

$$\omega = \frac{b^2 + c^2}{w} \doteq \frac{c}{w},$$

$$\zeta = \frac{b}{b^2 + c^2} \doteq \frac{b}{c}, \tag{13}$$

$$\tau = \frac{w}{b},$$

because in practice $b^2 << c^2$.

Hence, the damped trigonometric term of Eq. 1 may be simulated by the system described in Eq. 12 subjected to an impulse input. Implementation of equations 9 and 12 on the analog computer as shown in Fig. 2 will give the pattern $P_n(\theta)$ at the throw of the multiple switch S.

The last cell in the circuit diagram is a means of automatic conversion of the values $P_n(\theta)$ into decibels as antenna patterns are ordinarily plotted. The conversion is based on the computer implementation of the fundamental integral:

$$-20\int_0^\theta \frac{1}{P_n(\theta)}\dot{P}_n(\theta)\,d\theta = -20\int_1^{P_n(\theta)} \frac{dP_n(\theta)}{P_n(\theta)} =$$

$$-20\,ln\,P_n(\theta) = -P_n(\theta)\Big]_{db} \tag{14}$$

REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

However, this plot in decibels cannot extend beyond the main lobe of the pattern, because the valleys between lobes represent vast db values which the limited voltage range of the computer cannot accommodate.

Computer Circuitry

In setting up the computer circuitry one is helped by the analytical format of Eq. 1 toward establishing good first order estimates of the parameters involved.

Thus, the first of the elementary functions, $f_1(\theta)$, usually overpowers the two others within the span of the antenna beam width, w. Consequently, from the experimental data the azimuth $\theta = w$ corresponding to the half power level may be read, a fact that subsequently establishes the value of a through equation 6 as:

$$f_1(w) = \frac{1}{2} = e^{-a}.$$

Hence:

$$a_* = 0.693 \tag{15}$$

where $_*$, implies a first guess value. On the other hand, by noting that the distance θ_I between the valleys separating the first and second lobes corresponds approximately to π radians in the trigonometric term of Eq. 1 we establish that:

$$c_* \doteq 2\pi\frac{w}{\theta_I}. \tag{16}$$

Furthermore, the peaks of the second and third lobe occuring at the points θ_1 and θ_2 for which the sine-squared term is roughly equal to unity, result in:

$$\begin{aligned} P_{n1} - \exp\left(-a_*\frac{\theta_1^2}{w^2}\right) &= m_*\exp\left(-b_*\frac{\theta_1}{w}\right), \\ P_{n2} - \exp\left(-a_*\frac{\theta_2^2}{w^2}\right) &= m_*\exp\left(-b_*\frac{\theta_2}{w}\right), \end{aligned} \tag{17}$$

from which:

$$b_* \doteq \frac{w}{\theta_1 - \theta_2}\left\{ln\left[P_{n2} - \exp\left(-a_*\frac{\theta_2^2}{w^2}\right)\right] - ln\left[P_{n1} - \exp\left(-a_*\frac{\theta_1^2}{w^2}\right)\right]\right\}. \tag{18}$$

With b known, Eq. 17 yield:

$$m_* \doteq \left[P_{n1} - \exp\left(-a_*\frac{\theta_1^2}{w^2}\right)\right]\exp\left(+b_*\frac{\theta_1}{w}\right). \tag{19}$$

Once the computer circuit is set up and adjusted to the values a_*, b_*, c_*, and m_*, a systematic step wise variation of one parameter at the time, while the three others are held constant, provides a curve

$$P_n(\theta)]\,\text{db}$$

increasingly closer to the experimental plot. Through iteration between all four parameters a satisfactory approximation is quickly reached.

The resistor and capacitor values in the circuit diagram are in ohms and microfarads. Also, the following circuit-parameter settings should hold:

$$IC = -100\,v; \quad \beta_1 = 0.10;$$

$$\beta_2 = R_2\,\omega = R_2\frac{C}{w}; \quad \beta_3 = 20\,R_3\,\zeta = 20\,R_3\frac{b}{c};$$

$$R_o = \frac{w^2}{2_a}; \quad R_1 = \frac{1}{200m}; \quad R_4 = \frac{\tau}{4} = \frac{w}{4b}.$$

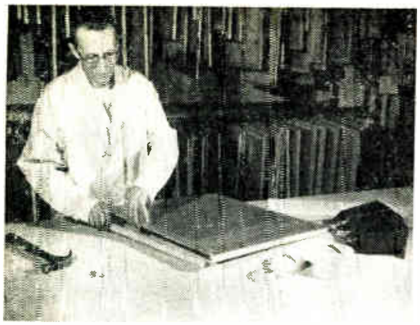


Fig. 1: Wooden straps are placed around edges.

Fig. 2: Blueprint affixed to board with masking tape.

Fig. 3: Light behind work gives precise view of perforations.

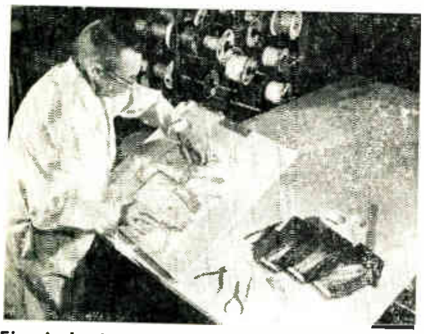
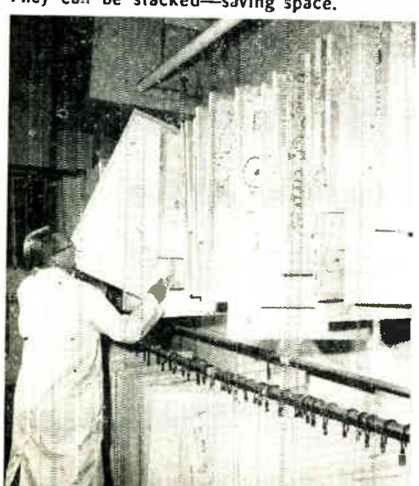


Fig. 4: Laying in wire on the board.

Fig. 5: Metal boards do not need to be hung. They can be stacked—saving space.



What's New

Metal Harness Boards

RAYTHEON Co.'s Cable Dept. (N. Dighton, Mass.) is successfully using perforated aluminum sheeting to replace plywood in the manufacture of electronic harnesses. The metal sheeting—available as a stock item in the correct thickness, perforation dia. and alloy—outlasts plywood for this purpose and reduces the storage problem.

The material is first cut to the proper size. Next, four pieces of 1 x 1 in. wood strapping are placed around the edges to form a border, like a picture frame (this allows sufficient clearance for the stud portion of the specially pins to be installed through the holes of the aluminum "boards"). The blueprint is fixed to the aluminum with masking tape. A light source placed behind the sheet permits precise viewing of the perforations so that pins can be pushed through the blueprint and into the aluminum sheet. Holes in the aluminum are staggered so that any combination of pins to a tolerance of ±1/8 in. is accommodated.

Some advantages: By pre-determining the size of cables being produced, the shop can have on hand just 4 or 5 standard size perforated boards; time for assembly and disassembly of cable board jigs is reduced to 40% of normal time; the pins can be removed for storage thus saving storage space; also: the metal boards will last from 3 to 5 years—and be used constantly.

New Wire Shielding Method

MANY methods have been conceived and used to shield insulated wire or cable. Methods such as braiding and placing wire inside of tubing have been used. Now a new process has been developed. It is said to be cheaper to manufacture, can be produced in unlimited lengths, and can be applied to all wire sizes.

The new process starts with the insulated wire to be shielded and lengths — up to 8000 feet — of metallic tape of any desired thickness. The tape is formed in a continuous process into a tube around the insulated wire. The joint in the tube is then arc welded without injury to the wire insulation. The welded joint and tube are then "cold-worked" until a perfect gas and water tight cylindrical tubing, which closely fits around the insulated wire, is produced.

Long continuous lengths of insulated wire have been shielded using this process. The shielding is pure aluminum with a wall thickness of 0.010 in. The process is faster in production than other methods of shielding, and speeds of double or triple its present capacity are easily possible.

The tubing flexibility has proven satisfactory to industrial and governmental users, while the savings in weight and costs are noticeable. Wires as small as 0.075 in. in diameter, over the insulation, have been shielded with this process, and thought is now given toward the application and the process to cables in excess of 3 in. diameter. Due to the nature of the process, it is actually easier to make this shielding with thin walls of less than 0.025 in., and the developers say that wall thicknesses of 0.007 in. and 0.005 in. are not only possible, but probable.

This process was developed by Electrarc, Inc., 20 Pemberton Square, Boston 8, Mass.

* * *

Microfilm At Redstone

Small space is needed at ARGMA for full, active file of 850,000 engineering documents. Cabinets have documents for guided missile program.

THE U. S. Army Rocket and Guided Missile Agency (ARGMA) at Redstone Arsenal, Huntsville, Ala., is one of the largest Defense Department users of microfilm mounted in aperture cards. Their engineering documents section contains an active file of over 850,000 drawings and related documents, and they possess a historic file in excess of 1,500,000 drawings and documents.

Prime contractors are permitted to supply complete engineering records in microfilm already mounted in aperture cards where provision is made for this procedure in the contract. In such a case they are not permitted nor required to submit drawings in hard copy.

ARGMA can instantly retrieve any of its 1,500,000 drawings and can also print out in virtually any form desired — paper-to-paper, card-to-paper, card-to-card and paper-to-card. Concerned personnel can view enlarged microfilm drawings and, within seconds, obtain paper copy.

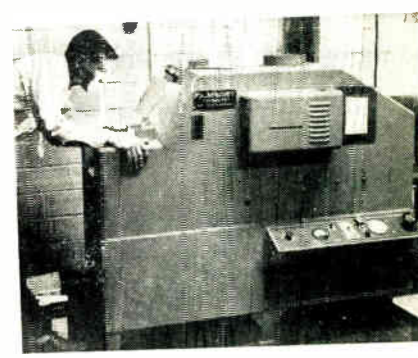
Future plans call for further expansion of the mechanized filing system. Feasibility studies are being conducted on additional modifications which will permit more rapid search of filed microfilm documents, and studies are being made on using closed circuit TV.

Prime contractors and suppliers submit engineering data directly on microfilm already mounted into aperture cards to ARGMA and other agencies of the Army Ordnance Missile Command and to specified depots. ARGMA continues to receive and process hard copy engineering documents from contractors whose work load does not justify the installation of filming, card punching and mounting equipment and whose contracts do not permit this kind of operation. ARGMA then microfilms, maintains, and provides EAM cards for all such hard copy engineering documentation, as well as those engineering documents and related data originating at the Agency.

The single great advantage

(*Continued on page* 236)

Camera microfilms all engineering documents. More than 30,000 drawings a month are filmed.



Immediate reproduction comes from card-to-card printer. Rates are up to 600 cards/hour.

Printer-reader for fast scanning of microfilmed documents. Machine can also produce paper copy within 10 seconds.

Electronic accounting machines, coupled with aperture cards, are backbone of system. One card can easily be selected from file.

C. A. Bolt, Jr.

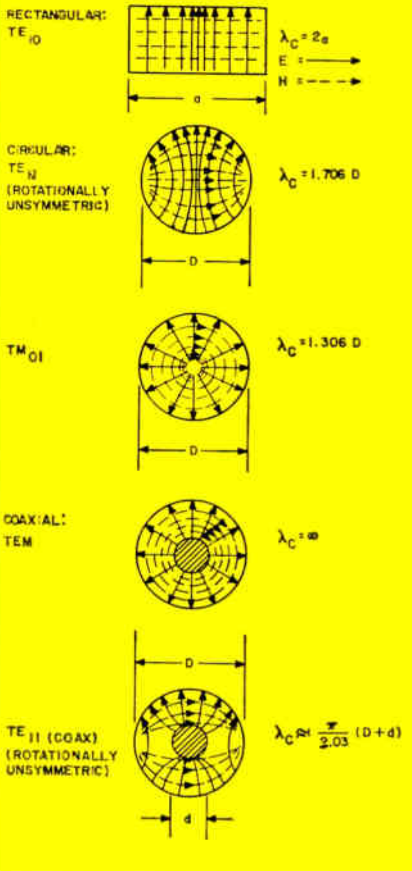
The theory of probe type transitions for radar antennas between rectangular waveguide and coaxial line is summarized. The design procedure of rotary joints using these transitions is discussed. A typical rotary joint design with very low VSWR for the 8.8 to 10.4 kmc range is also presented.

Designing Rotary Waveguide Joints

By CONWAY A. BOLT, Jr.

Westinghouse Electric Corp.
Air Arm Div.
P. O. Box 746
Baltimore 3, Md.

Fig. 1: Cross sectional field configurations encountered in rotary joint design



In the design of typical radar scanners, rotary joints are used in the waveguide transmission line between the movable antenna and the stationary portions of the scanner. These rotary joints usually consist of a transition from the dominant mode in rectangular waveguide to a short section of waveguide operating in a rotationally symmetric mode followed by a second transition to rectangular waveguide. Examples of rotationally symmetric modes which would be suitable for rotary joint designs are the TEM mode in coaxial transmission line and the TM_{01} mode in circular waveguide. Field configurations of these modes are shown in Fig. 1.

Circular waveguide of sufficient diameter to propagate the TM_{01} mode will also propagate the TE_{11} mode, which is not rotationally symmetric (Fig. 1). If the TE_{11} mode is not properly suppressed in a rectangular to circular waveguide transition, appreciable variation in reflection with rotation of the complete rotary joint results. The necessity of suppressing the TE_{11} mode in rotary joints employing circular waveguide generally limits the application of circular waveguide in wideband rotary joint designs.

The TEM mode is the dominant mode in coaxial line. Despite disadvantages of lower impedance (which complicates the matching problem somewhat) and lower power capability than in circular waveguide, coaxial transmission line is more satisfactory in wideband designs because of the absence of lower order mode suppression problems. The selection of dimensions small enough to eliminate the next higher order coaxial mode (TE_{11})* gives an outer diameter smaller than that of circular waveguide operated in the TM_{01} mode over the same frequency range.

Since a rotary joint essentially consists of two identical transitions, one to and one from a rotationally symmetric mode, the following discussion will be simplified by considering the design of single transitions between the dominant rectangular (TE_{10}) mode and the coaxial (TEM) mode and their application in the design of a complete rotary joint.

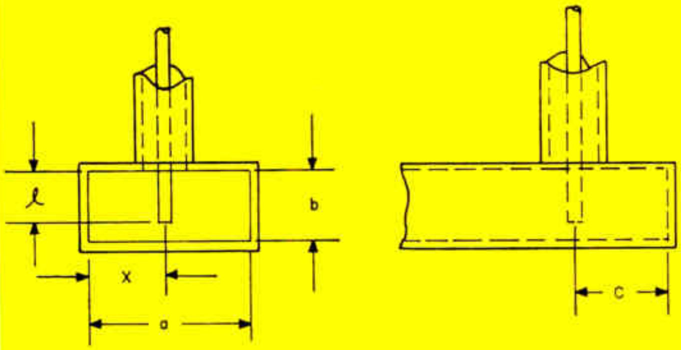
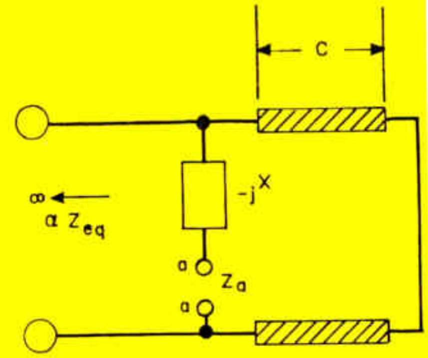


Fig. 2: Probe type rectangular to coaxial waveguide transition

Fig. 3: Transmission line equivalent circuit of ideal rectangular to coax waveguide transition



Equivalent Circuit

The TE_{10} mode in a rectangular waveguide oriented perpendicular to the longitudinal axis of a coaxial line (TEM mode) may be excited by a probe-antenna parallel to the E field in the rectangular waveguide. As shown in Fig. 2, the probe is an extension of the center conductor of the coaxial line.

The transmission line equivalent circuit of an ideal transition of this type is shown in Fig. 3. In this figure, α is a coupling coefficient which serves as a measurement of the effectiveness of the probe-antenna in inducing a field in the rectangular waveguide; Z_{eq} is the equivalent impedance of the rectangular waveguide operating in the TE_{10} mode; X is the reactance of the antenna as affected by the walls of the guide (the antenna resistance is assumed to be negligible); Z_a is the impedance at the terminals of the coaxial line; c is the distance along the waveguide from the short circuit to the center of the probe; and β is $2\pi/\lambda g$.

Looking into the rectangular waveguide from the terminals of the coaxial line, the solution of the transmission line equivalent circuit (Fig. 3) is:

$$Z_a = \alpha Z_{eq} (\sin^2 \beta c + j \sin \beta c \cos \beta c) - jX \qquad (1)$$

If Z_a is assumed to be resistive and equal to the impedance of the coaxial line, Z coax, Eq. 1 indicates that a matched transition at a particular frequency is obtained when:

$$Z_{coax} = \alpha Z_{eq} \sin^2 \beta c, \text{ and} \qquad (2)$$

$$-jX = -j\alpha Z_{eq} \sin \beta c \cos \beta c. \qquad (3)$$

The purpose of this brief study of the transmission line equivalent circuit of the rectangular-coaxial transition is not to obtain actual design dimensions immediately, but instead to become more acquainted with the physical significance of the various terms involved in its solution and thus to obtain more of a working knowledge of the transition and its component parts before proceeding with an actual design.

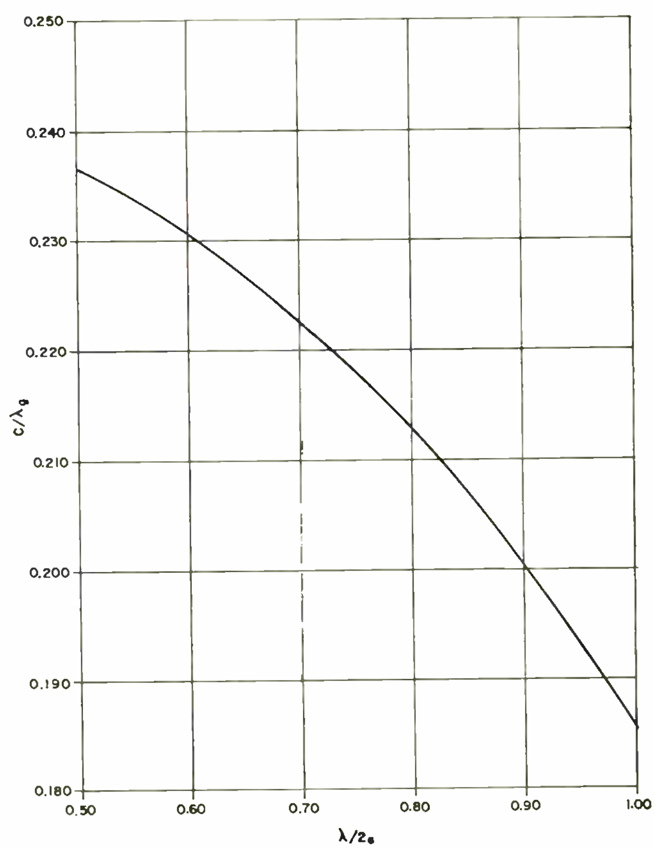
Radiation Resistance

The radiation resistance of an antenna in a rectangular waveguide closed at one end has been obtained by a number of investigators (Ref. 1, 8, 13, 15, 17 and 18). In general, either a uniform or sinusoidal current distribution is assumed along the length of the probe-antenna which is oriented parallel to the E field in the rectangular waveguide. The radiation resistance is then derived from the field at large distances from the antenna and the assumed current. Pearcey[8] derives an expression for the current distribution instead. However, the expression for radiation resistance obtained is, to a first approximation, the same as that obtained by assuming a sinusoidal current distribution.

For a uniform current distribution, the radiation resistance of a small diameter cylindrical antenna of length l in a rectangular waveguide (as shown in Fig. 2) is given by:

(*Continued on following page*)

Fig. 4: Solution of equation 11 may be obtained from graph



* This mode is analogous to the TE_{11} mode in circular waveguide; see Marcuvitz.[4] Grantham[3] refers to the lowest order coaxial mode with non-vanishing cutoff as the TE_{10} mode.

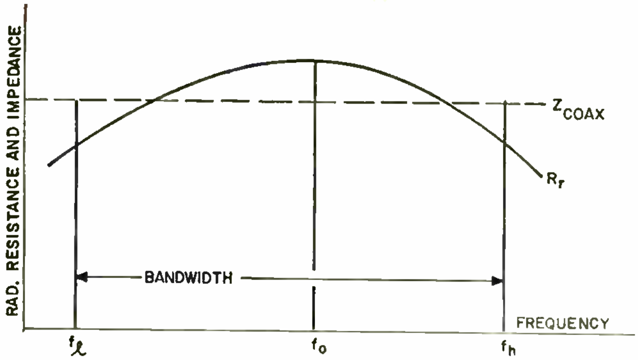


Fig. 5: Broadband matching of R_r to a constant coax impedance

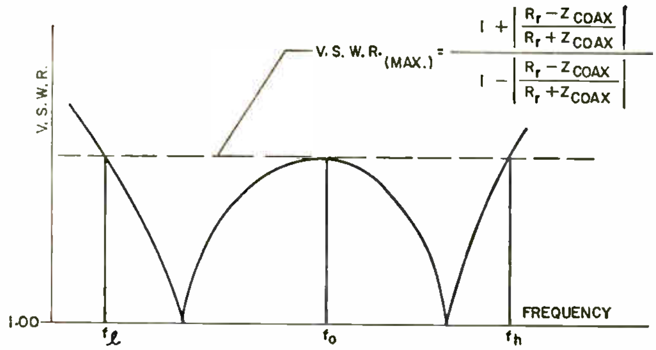


Fig. 6: VSWR as a function of frequency for the transition match shown in figure 5 graph.

Rotary Joint *(Continued)*

$$R_r = \frac{\pi}{2} \frac{l^2}{ab} \left(\frac{\mu_o}{\epsilon_o}\right)^{1/2} \frac{\lambda_g}{\lambda} \sin^2 \frac{\pi x}{a} \sin^2 \beta c \text{ (ohms).} \quad (4)$$

For a sinusoidal current distribution, the radiation resistance is given by:

$$R_r = \frac{\lambda_g \lambda}{8ab} \left(\frac{\mu_o}{\epsilon_o}\right)^{1/2} \tan^2 \frac{\pi l}{\lambda} \sin^2 \frac{\pi x}{a} \sin^2 \beta c \text{ (ohms).} \quad (5)$$

It should be noted that the radiation resistance of a small diameter $\left(\text{diam.} \ll \frac{\lambda}{4}\right)$ antenna is independent of its diameter.

If the equivalent impedance of a rectangular waveguide is defined as the ratio of the maximum voltage to the total longitudinal current in the top or bottom wall (Refs. 2, 9 & 12) it is given by:

$$Z_{eq} = \frac{\pi}{2} \frac{\lambda_g}{\lambda} \frac{b}{a} \left(\frac{\mu_o}{\epsilon_o}\right)^{1/2} \text{ (ohms).} \quad (6)$$

Eqs. 4 and 5 may be expressed in terms of the equivalent impedance resulting in equations of the form:

$$R_r = \alpha Z_{eq} \sin^2 \beta c \text{ (ohms),} \quad (7)$$

in which, for a uniform current distribution:

$$\alpha_u = \frac{l^2}{b^2} \sin^2 \frac{\pi X}{a} \quad (8)$$

and, for a sinusoidal current distribution:

$$\alpha_s = \frac{\lambda^2 \tan^2 \pi l/\lambda}{4 \pi b^2} \sin^2 \frac{\pi x}{a}. \quad (9)$$

Referring to Eq. 1, it can be seen that the resistive component of the solution of the transmission line equivalent circuit is equal to the radiation resistance of the antenna as given by Eq. 7. One criterion for obtaining a matched transition is, therefore, that the resistive component of the impedance at the terminals of the coaxial line be equal to the radiation resistance of the probe-antenna. For a uniform current distribution, this may be expressed as follows:

$$\text{Real } (Z_a) = \frac{\pi}{2} \frac{l^2}{ab} \left(\frac{\mu_o}{\epsilon_o}\right)^{1/2} \frac{\lambda_g}{\lambda} \sin^2 \frac{\pi x}{a} \sin^2 \beta c. \quad (10)$$

Reactance

The radiation resistance of an antenna inside a rectangular waveguide was obtained from the limiting value of the field at relatively large distances from the antenna and an assumed current distribution. The reactance, however, is determined from the non-propagating field components close to the antenna. Consequently, it can be expected to depend a great deal upon antenna geometry. The reactance of a small diameter cylindrical antenna surrounded by air dielectric in rectangular waveguide has been investigated (Refs. 1 & 8). However, the results obtained are, in general, too unwieldy for application to practical design problems. In addition, mechanical and high power capability considerations often dictate various antenna shapes or supporting structures (such as dielectric sleeves) which add further to the complexity of an analytical solution for the reactance. It is usually much more convenient to determine the antenna reactance experimentally.

The solution of the equivalent circuit for the rectangular-coax transition (Eq. 1) contains two reactive terms, one of which is a function of c: $jx\, Z_{eq} \sin\beta c \cos \beta c$. This term gives the correction to the reactance of the probe-antenna resulting from its image in the end wall of the waveguide. The second term $(-jX)$ is the reactance of the probe-antenna.

Broadband Transition Design

In Eq. 2 and 3, Z_{coax} is constant, depending only upon conductor diameters and the dielectric constant of the material between them. However, the radiation resistance and reactance of the probe and the end wall correction term are functions of frequency. For frequencies on either side of the design center frequency the transition is mismatched. Methods of obtaining a reasonably well matched transition over a relatively wide frequency range, in other words a broadband transition, will now be considered.

The first method which will be considered has been based on work by Mumford.[6] Since the radiation resistance of the probe-antenna is a function of the length, c, of a short circuited section of transmission line, it would appear that for some value of c the

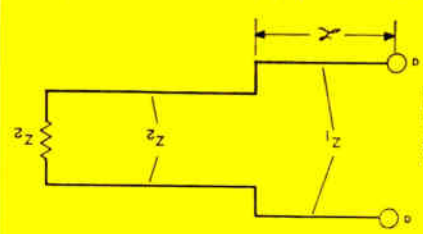


Fig. 7: Transmission line equivalent circuit of impedance transformer

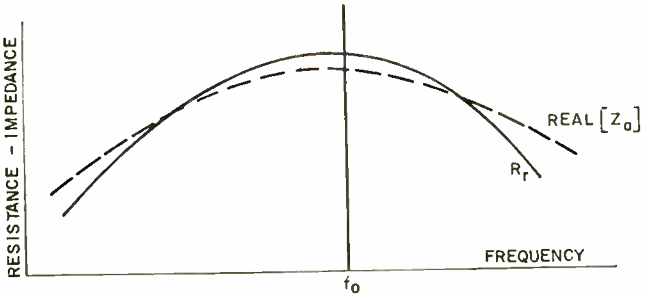


Fig. 8: Broadband matching of radiation resistance to coax impedance using coaxial transformer section

variation of the radiation resistance with frequency could be minimized. Then Z_{coax} could be approximately matched to the radiation resistance over the greatest bandwidth; and reactive mismatch could be compensated for by varying x and l simultaneously (to maintain a constant value of radiation resistance at the design center frequency) or by selecting a suitable reactive matching element such as an iris.

The value of c resulting in zero slope of the radiation resistance as a function of frequency may be obtained by setting the first derivative of R_r with respect to λ equal to zero. For an assumed uniform antenna current distribution (using Eq. 4 for radiation resistance), the following relationship is the result:

$$\frac{\tan \beta c}{\beta c} = \frac{2}{(\lambda/2a)^2}\,. \tag{11}$$

Values of c satisfying this relationship correspond to short circuit positions giving minimum variation of R_r with frequency.

The assumption of a uniform antenna current distribution appears to give analytical results in better agreement with experimental measurements.

Eq. 11 may be solved using Fig. 4. In Fig. 4, c/λ_g is plotted as a function of $\lambda/2a$.

Once the "optimum bandwidth" value of c has been determined from Eq. 11 or Fig. 4, the radiation resistance is matched to the coax characteristic impedance as shown in Fig. 5.

The bandwidth of a transition is generally specified as the frequency range over which the VSWR is less than or equal to a particular value.

For maximum bandwidth, the ratio R_r/Z_{coax} is made equal to the maximum allowable VSWR at approximately the center frequency (Fig. 5). This results in a VSWR frequency characteristic similar to Fig. 6. Reactive matching has not been included in this discussion; therefore, the calculated performance characteristics of a transition matched in this manner are undoubtedly somewhat optimistic.

A second method of broadbanding the transition employs a coaxial transformer section. The transmission line equivalent circuit of such an impedance transformer is shown in Fig. 7. If section 2 is terminated by its characteristic impedance, Z_2, and if the discontinuity capacitance at the junction of sections 1 and 2 is neglected, the impedance at terminals "a" is given by:

$$Z_a = R_a + jX_a = \frac{Z_1^2 Z_2 + jZ_1 (Z_1^2 - Z_2^2) \sin \frac{2\pi L}{\lambda_1} \cos \frac{2\pi L}{\lambda_1}}{Z_2^2 + (Z_1^2 - Z_2^2) \cos^2 \frac{2\pi L}{\lambda_1}} \tag{12}$$

in which λ_1 is the wavelength in the transformer section (Section 1 of the transmission line).

The value of L resulting in zero slope of the resistive portion (R_a) of Eq. 12 is found by letting $\frac{dR_a}{d\lambda} = 0$. For L to be a maximum (so that R_a will vary directly with the radiation resistance, R_r) the result is $L = \frac{n\lambda_1}{4}$ in which n is an odd integer.

If a coaxial transformer section is included in a rectangular-coaxial transition (by connecting the equivalent circuits of Figs. 3 and 7 at terminals "a"), Eqs. 1 and 12 are combined to give, for a matched transition:

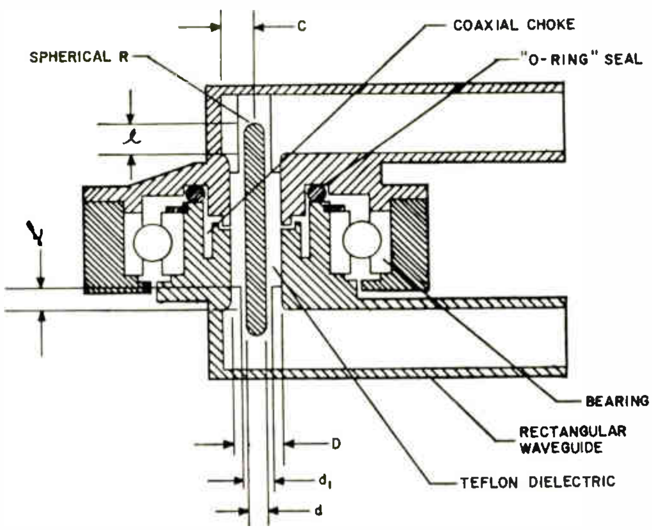
$$R_r = \frac{Z_1^2 Z_2}{Z_2^2 + (Z_1^2 - Z_2^2) \cos^2 \frac{2\pi L}{\lambda_1}}\,, \text{ and} \tag{13}$$

$$X - \alpha Z_{eq} \sin \beta c \cos \beta c = \frac{Z_1 (Z_1^2 - Z_2^2) \sin \frac{2\pi L}{\lambda_1} \cos \frac{2\pi L}{\lambda_1}}{Z_2^2 + (Z_1^2 - Z_2^2) \cos^2 \frac{2\pi L}{\lambda_1}}\,. \tag{14}$$

Considering only the radiation resistance match relationship (Eq. 13), through suitable choice of values of Z_1, Z_2,c, L etc., it is now possible to make the resistive portion of Z_a approximately equal to the radiation resistance over a wide band as is shown in Fig. 8. The "optimum bandwidth" value of c at the center frequency is found using Eq. 11 or Fig. 4. The "optimum bandwidth" value of L is $\lambda_1/4$ at the center frequency. Once these optimum values of c are determined, values of l, Z_1, etc., are obtained using Eq. 4 and 13.

Since various factors (such as the effects of probe geometry, probe supports, and the reactance of the relatively large hole in the top wall of the rectangular waveguide at the junction with the coaxial line) have

Fig. 9: Cross-sectional view of TEM mode rotary joint



been purposely neglected from the equivalent circuit to avoid complicating it, the results obtained from its solution give only approximate design dimensions. Final design dimensions are obtained experimentally by a "cut and try process" based on the approximate dimensions obtained analytically or by appropriate scaling from a similar design.

Assembling Transitions

A cross sectional view of a typical TEM mode rotary waveguide joint is shown in Fig. 9. Broadband matching of the rectangular-coaxial transitions was accomplished by using a coaxial transformer section. The rotary joint consists of two broadband transitions connected by a short section of coaxial line with a coaxial choke in its outer conductor.

The Coaxial Line

Coaxial line dimensions are chosen to be sufficiently small to be below cut-off for the next higher order coaxial mode (TE_{11}) over the desired frequency range (to minimize VSWR variation with rotation), and sufficiently large to provide a generous safety margin for the power to be transmitted. The cut-off wavelength for the TE_{11} coaxial mode (Fig. 1) is given by:

$$\lambda_c \cong \frac{\pi\sqrt{\epsilon}}{2.03}(D + d) \qquad (15)$$

in which D and d are the conductor diameters, and ϵ is the relative dielectric constant of the material between them. This relationship is accurate to $\pm 1\%$ for values of D/d from 1.8 to 2.7.

For minimum voltage between the conductors consistent with the condition that the coaxial line is below cut-off for the TE_{11} mode (see Ref. 3), the design parameters are:

$$D/d = 2.09 \qquad (16)$$

$$D + d < \frac{2.03\,\lambda_c}{\pi\sqrt{\epsilon}} \qquad (17)$$

λ_c is the shortest free-space wavelength which must be transmitted. The characteristic impedance of a coaxial line, Z_{coax}, is given by the familiar relationship:

$$Z_{coax} = \frac{60}{\sqrt{\epsilon}}\log_e\frac{D}{d}\ \text{(ohms)}. \qquad (18)$$

Coaxial Impedance Transformer

In the rotary joint design shown in Fig. 9, the coaxial transformer section is a section of coaxial line partially filled with a solid dielectric. The solid dielectric sleeve surrounds the inner conductor and extends into the rectangular waveguide, also serving as a mechanical support for the probe-antenna.

The wavelength λ_1 in a coaxial line with two concentric dielectrics as shown in Fig. 11 may be obtained from the following approximate relationship (see Ref. 5).

(*Continued on page* 250)

Build Antenna

By SHELDON ISAACSON
The Marton Company
Orlando, Florida

THE precise construction of test parabolas for antenna development calls for weeks of engineering time in parabola construction, in calculations, and in final measurements of predicted data. A fresh approach to this problem produced a new tool for parabola construction—the Para-Shaper.

The Para-Shaper is a parabolic shaped tool that spins its contour into a foam dielectric base. The dielectric is then coated, sanded and silver painted. The finished product serves as an accurate, low-cost parabolic reflector for antenna development tests.

The Para-Shaper can be constructed and final test measurements made in two days. It supplies the need for a rapid, low-cost method of fabricating test parabolas with the same accuracy as obtained from conventional methods.

Constructed of one-quarter inch aluminum, the Para-Shaper is shaped to the desired reflector curve. Its cutting edge is fluted with a 15 degree rake angle (Fig. 1). A mandrel is welded to the base to permit fabrication of test parabolas in a drill press. The material to be formed can be an expendable plastic,

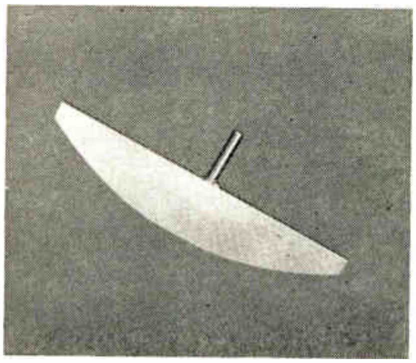


Fig. 1: Para-Shaper tool. Cutting edge is fluted with a 15° rake angle.

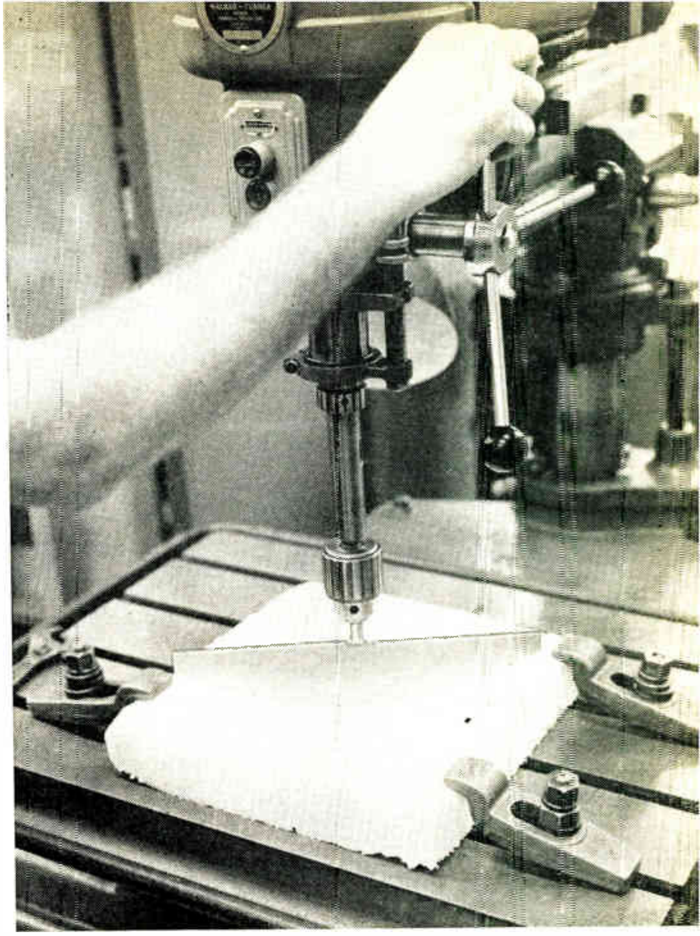


Fig. 2: Grinding out Styrofoam parabola. Material can be an expendable plastic or any fine-grain unicellular material.

Building antenna test parabolas often takes weeks of engineering time. Here is a new tool—the Para-Shaper—which can do the job quickly, economically and with the same accuracy as conventional methods.

Test Parabolas —Fast

Styrofoam, or any fine-grain, unicellular material, Fig. 2.

The Para-Shaper first grinds out the poly-foam plastic block into the shape desired, see Fig. 3. The air pockets are then filled with a suitable filler by coating the surface. A final grind is then done by the Para-Shaper. A light sanding follows which provides a smooth base for the final coating.

Silver coating of the surface is the final process in the construction of a test parabola. Two coats of Handy and Harmon silver paint No. 340 produced excellent results. If a cut parabola is to be built, the cutting operation can be performed before painting. Fig. 4 shows the sections of a parabola cut on the bandsaw. After parabola construction, the Para-Shaper is used as the checking template.

Electrical Properties

To determine the accuracy of the Para-Shaper technique, a standard parabolic reflector was designed, using the parabolic equation:

$$Y^2 = 4\,PX \qquad (1)$$

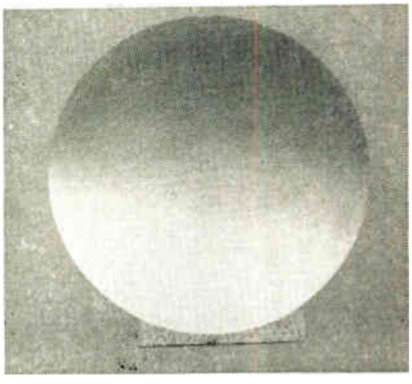


Fig. 3: Finished test parabola.

The reflector diameter was 2Y = 18 inches and the focal point (P) 5 inches. Solving X in terms of Y and P generated the shape of the parabolic

$$X = Y^2/4\,P \qquad (2)$$

The base values determined for the Para-Shaper construction are shown in Table I. The frequency used was 36,000 MC, where the wavelength was 0.328 inch. The measured smoothness of the reflector constructed by the Para-Shaper technique was well within 0.1 wavelength.

A feed horn was designed to illuminate the 18 inch reflector with a 16 db taper across the aperture. The measured SWR was 1.08:1 at the design frequency. The antennas were then pattern tested at 36 kmc. The results are tabulated in Table 2.

Table 1

Base values determined for the Para-Shaper construction (4P = 20 In.)

Y	X
9.0	4.050
8.5	3.621
8.0	3.200
7.5	2.812
7.0	2.450
6.5	2.112
6.0	1.800
5.5	1.501
5.0	1.250
4.5	1.012
4.0	0.800
3.5	0.612
3.0	0.450
2.5	0.312
2.0	0.200
1.5	0.112
1.0	0.050
0.5	0.012
0	0.000

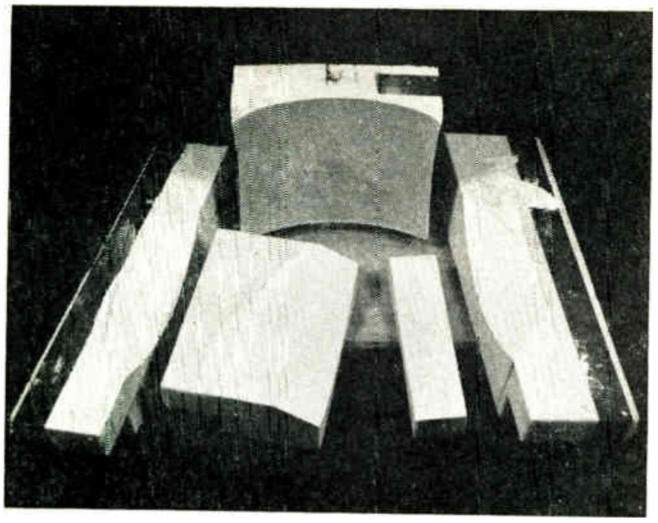


Fig. 4: Sections of a parabola cut on a bandsaw.

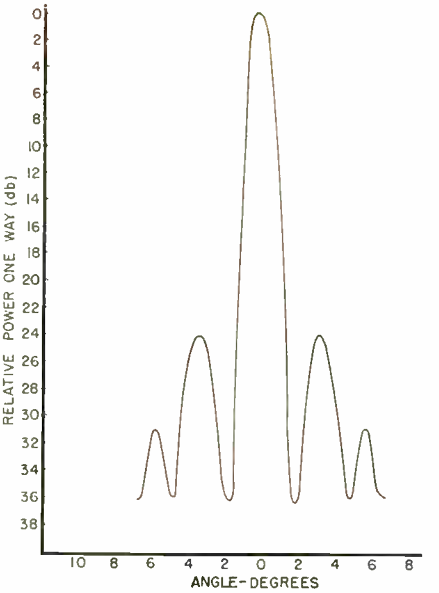


Fig. 5: Single element pattern.

Test Parabolas *(Concluded)*

Since the H-plane pattern shown in Fig. 5 was promising, a dual polarized feed system was designed for the cut parabola. Fig. 6 shows the horn and cut reflector.

The feed horns were tilted 23 degrees from the horizontal dish axis. The parabola was cut asymmetrically as shown in Fig. 4. Tests were made of both single-element and dual polarized patterns (Fig. 7 and 8). The results are listed in Table 3.

Table 2

	Calculated	Measured
Half Power Beamwidth		
H Plane	1.168 deg	1.2 deg
E Plane	1.305 deg	1.34 deg
Side Lobe Amplitude	25 db	24 db
Gain	40.28 db	39.6 db

Table 3

	Calculated	Measured
Half Beamwidth		
H Plane	1.42 deg	1.51 deg
E Plane	1.63 deg	1.72 deg
Side Lobes		
H Plane	24 db	25 db
E Plane	22 db	21 db
Cross Polarized Energy		
H Plane	25 db	23 db
E Plane	23 db	20 db

Test Results

In general, the test parabola results checked with the predicted data. The half power beamwidth for the cut parabola ran approximately 7% higher than predicted. This increase was caused by the change in edge taper on the off-axis feed. The most significant results achieved by the technique were low cost, accuracy, and short construction time. The entire test including all calculations, construction, and measurements took only two days.

Other Uses

The Para-Shaper technique is not limited to the construction of parabolic reflectors. Other items such as dielectric lenses can be constructed. The shape of the cutting tool need not be limited to the parabolic shape. Zoned lenses can be constructed by properly shaping the cutting tool. The technique may also be adaptable to the testing of complex lens structures, such as those used in optics.

Fig. 6: Feed horn and cut parabola.

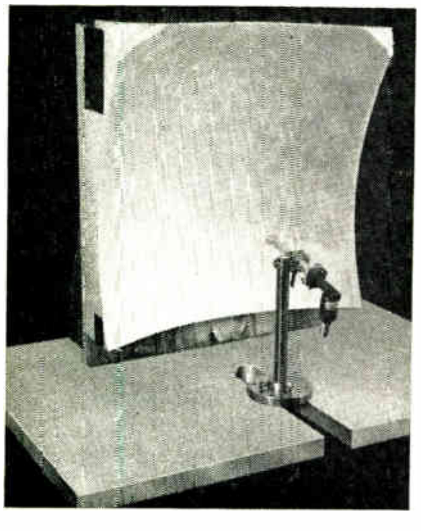
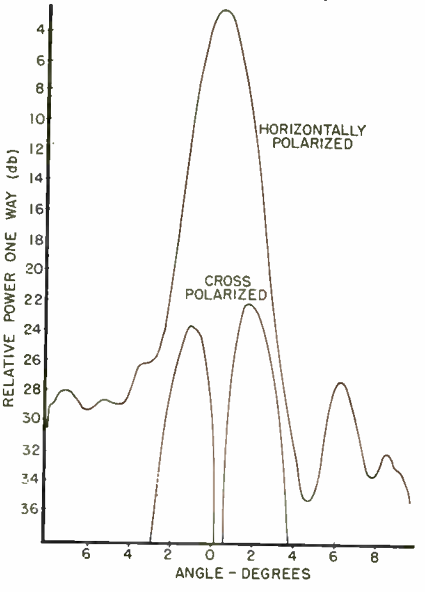


Fig. 7: H-plane dual-polarized pattern.



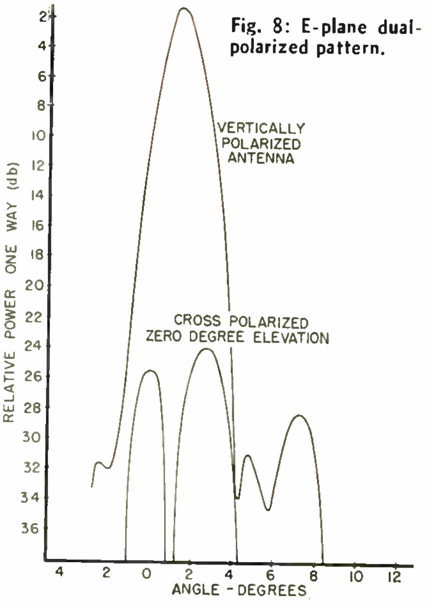
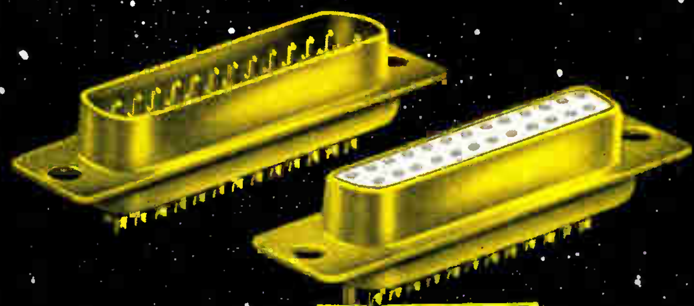


Fig. 8: E-plane dual-polarized pattern.

For protection against

PROBE DAMAGE



the NEW CINCH GOLDEN "D"*

designed for high performance, reliability . . . in aircraft, missiles and electronic equipment.

FEATURES:

- **Closed Entry Contacts For Protection Against Probe Damage.**
- Monobloc Insulators
- Low Engagement/Separation Forces
- Golden Iridite Finish to Meet MIL Q-Q-P-416A, Type II Class 2.
- Insulators to Meet MIL-M 19833 Type GDI-30 Or MIL-M-14E Type MDG.
- Fully Interchangeable With Standard "D"

CINCH "D" SUB-MINIATURE CONNECTORS*

For Commercial Requirements

The CINCH STANDARD "D"*

designed to withstand rigid environmental conditions imposed by Military Specs—

*Manufactured by agreement with Cannon Electric Company

AVAILABLE NOW!

Complete engineering data on both the Golden D Connector and the Standard D Connector is yours for the asking. Specification sheets and Catalog 100, cover Cinch Connectors, D Sub-Miniature, DPX and DPA types. Phone NE 2-2000 today or write/wire:

Cinch ELECTRONIC COMPONENTS ®

CINCH MANUFACTURING CORPORATION

1026 South Homan Avenue • Chicago 24, Illinois

Division of United Carr Fastener Corporation, Boston, Massachusetts

Circle 51 on Inquiry Card

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.

New Tech Data for Engineers

Microwave Equipment

Thirty-two-page catalog from Lel, Inc., 380 Oak St., Copiague, L. I., N. Y., presents the Company's products in the microwave, r-f, and i-f fields. Included are: Mixer-preamplifiers; Receivers, VHF Beacons; etc. Information includes technical specs, mechanical details, and electrical data. Also available: preliminary specs on a Solid-state Microwave Local Oscillator and on Parametric Telemetry Preamplifier Model RA-1. Some specs for RA-1 are: passband, 225-260 MC; Gain, 30db nom.; 25 db min.; Noise figure, 1 to 2 db (depending on Varactor); Source impedance, 50 ohms; Load impedance, 50 ohms; and Power input, 115 v 60 CPS. Supplement to catalog No. 60 gives specs on several new products.

Circle 160 on Inquiry Card

ECM Equipment

Special test and support equipment for ECM systems are featured in bulletin 05260750-134 from General Electric Co.'s, Light Military Electronics Dept., French Road, Utica, New York. Featured is a broad product interest—radar, sonar, communications, navigation, missile guidance and infrared, and supporting facilities. Support equipment includes ECM preflight test sets, antenna coupler test sets, waveguide and coaxial test assemblies, tuner test sets, maintenance sets, servo-noise amplifier test sets, etc.

Circle 161 on Inquiry Card

RF Calorimeters

Information on microwave calorimeters and loads to measure and absorb microwave energy between 1000 and 75,000 MC in all ranges of power up to 50,000 wave. and 20 megawatts peak. Units are used for primary standards, functional test, quality control, maintenance, and training. Included is a sheet of formulaes used for calorimetric devices. Chemalloy Electronics Corp., Gillespie Airport, Santee, Calif.

Circle 162 on Inquiry Card

Electron Tubes

Short form catalog from Litton Industries, Electron Tube Div., San Carlos, Calif., lists (in tabular form) their Miniature Noise Sources; Klystrons; Magnetrons; Duplexers and TR Tubes; TW Tubes; Backward Wave Oscillators; Carcinotrons; Crossed-Field Forward Wave Amplifier Tubes; Display Tubes; and Barratron[R] Transmitting Tubes. Includes specs.

Circle 163 on Inquiry Card

Application Notes

Five application notes on Microwave subjects available from Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. They are: 1: Note 21 "Microwave Standards Prospectus"—standards, frequency, attenuation, impedance, and power. 2: Note 2 (revised) "Measuring Frequency from VHF up to and Above 18 KMC With Transfer Oscillator / Counter Techniques." 3: Note 43, "Continuous Monitoring of Radar Noise Figures"—a discussion of theory of noise figure measurements, and methods for measuring noise figure in operating radar systems. 4: Note 44A, "Synchronizing the 185A Oscilloscope"—methods of synchronization to permit direct presentation of waveshapes up to 1 KMC. 5: Note 46, "Introduction to Microwave Measurements."

Circle 164 on Inquiry Card

Rotary Joints

New 4-page technical bulletin describes line of stock-design waveguide rotary joints. The 2-color, illustrated brochure has electrical and mechanical specs and ordering information for 24 models of rotary joints. (Catalog RJ-60.) Microwave Development Laboratories, 92 Broad St., Babson Park 57, Wellesley, Mass.

Circle 165 on Inquiry Card

Power Converter

Information on a new power converter designed to supply 12 vdc from a 6 v battery from Hoover Electronics Co., 110 West Timonium Rd., Timonium, Md. With input voltage nominally at 6.3 v, the unit can supply output currents from 2 to 25 a at 12.6 to 14.0 v. Two outputs are supplied—one filtered and one unfiltered. A ferrite choke is used in the filtered output to achieve low output noise levels for supplying transistorized receivers. Amb. temp. range is −30 to +65°C.

Circle 166 on Inquiry Card

Antennas

Data sheets from D. S. Kennedy & Co., Cohasset, Mass., describe a mobile tracking antenna which is completely self-contained. The dish of the antenna is permanently connected to the tower which is a part of the trailer. The dish folds in a stow position when not in use—it uses an imported reflective plastic cloth. Also: information on a process for manufacturing antennas called "Spincasting." The process gives an unusually high precision surface for antennas by spinning resinous materials in standard dishes to form a perfect paraboloid.

Circle 167 on Inquiry Card

Microwave Paths

"Microwave Path Engineering Considerations" ($3.00) from Lenkurt Electric Co., San Carlos, Calif., talks about: "Route and Site Selection"—Microwave paths, Sources of path data; Site Data; Path Profiles; "Radio Engineering" — Propagation; Free Space Attenuation; Terrain Effects; Atmospheric Effects; System Design Criteria; "Equipment including radio, antenna systems, waveguide, and r-f combiners," and "Calculations for a Hypothetical Microwave System."

Circle 168 on Inquiry Card

Passive Repeaters

"Passive Repeater Bearing Calculations and Settings," a 16-page technical discussion of the calculations necessary to properly orientate a large microwave passive repeater, is available from Microflect Company, Inc., 3450 25th St. S. E., Salem, Oregon. The booklet also contains a graph for the selection of the proper passive repeater size to do a particular job.

Circle 169 on Inquiry Card

Microwave Equipment

The standard and special products of Empire Devices Products Corp., Amsterdam, New York, are presented in catalog No. 604. Tech data is provided for such items as Noise and Field Intensity Meters; Receivers; Impulse Generators; Broadband Power Density Meters; Balanced Crystal Mixers; Coaxial Attenuators; Power Dividers; Stub Tuners etc. (48-pages.)

Circle 170 on Inquiry Card

Choppers

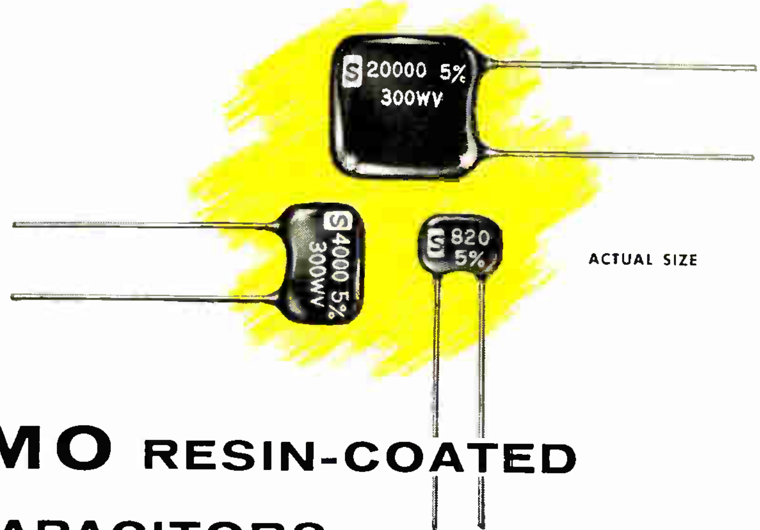
Newly revised 4-page data sheet on VECO "Chopperette" which is non-hydroscopic, shock, vibration, and acceleration proof and meets MIL-E-5272C. Sheet gives details of operation, electrical and matching characteristics, transformer coupling, and zener diode choice, circuitry and typical applications. Data Sheet V383 B, Victory Engineering Corp., 521 Springfield Rd., Union, N. J.

Circle 171 on Inquiry Card

Thin Film Resistors

Bulletin No. 10A from Film Resistors, Inc., P. O. Box 49, 242 Ridgedale Ave., Morristown, N. J., describes their ultra-pure pyrolytic carbon and vacuum deposited metallic thin film microwave resistors. Sheets include curves, outline drawings, and tech data.

Circle 172 on Inquiry Card



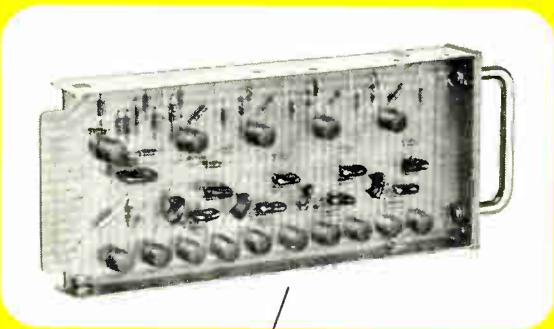
ACTUAL SIZE

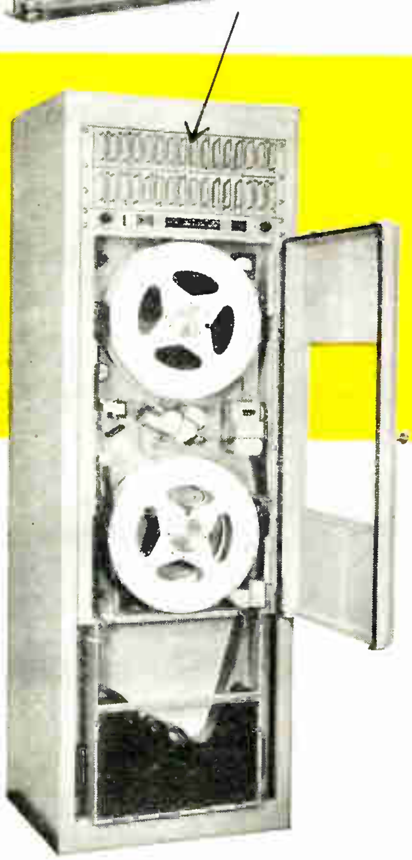
NEW SANGAMO type D RESIN-COATED SILVERED-MICA CAPACITORS...

are significantly smaller . . . operate to +150° C . . . exceed proposed dipped-mica capacitor military specifications

Sangamo experience with mica capacitors and years of engineering know-how and quality development underline two new Type D Resin-Coated Silvered-Mica Capacitors. Designed for operation at temperatures of +125° C and +150° C, both offer the advantages of radial leads, small size, full rated working voltage without derating, and a clean, moisture-sealed protective resin coating. Physical and electrical features of the Type D capacitor are ideal for etched circuits, high component-density equipments, missiles, computers, and instrumentation devices. Type D capacitors are available with characteristics C, D, E, or F, in nearly all capacitance values.

Test these new Sangamo Type D Resin-Coated Silvered-Mica Capacitors — they more than meet proposed military specifications. Try them in your own circuits — they will fulfill all expectations of today's most critical applications. Those who know capacitors choose Sangamo for outstanding performance and long life.





. . . Type D Resin-Coated Silvered-Mica Capacitors are an important part of the transistorized circuitry of this Sangamo Type 460 Tape Transport System. Their small size, high-temperature performance, and reliability contribute materially to the transport's recording uniformity and play-back accuracy —

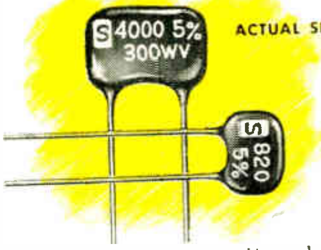
SC60-7

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

— designing toward the promise of tomorrow after routing, clip and save

a continuing series on technical topics of specific interest to engineers

Folio 13 REFERENCE DATA FILE SANGAMO



ACTUAL SIZE

What constitutes a superior dipped-mica capacitor?

Silvered-mica capacitors have achieved a reputation over many years of use for high stability and high reliability. Mica's inherent low power factor, high dielectric strength, low dielectric absorption and high insulation resistance have made mica capacitors most desirable in electronic circuits where good stability with respect to temperature, frequency, and aging are required.

But refinements of mechanical features were required for today's high component-density equipment utilizing etched-circuit construction. Some of the requirements that led to development of the dipped mica capacitor were:

1. A protective covering, that is thermally and mechanically rugged, impervious to moisture, and non inflammable.
2. Radial leads for rapid assembly, rigid mounting, and cool operation.
3. Small size and dimensional uniformity for more compact and standardized assemblies.
4. A glossy surface to which dirt does not adhere and which also enhances appearance.
5. Lower cost through improved automated manufacturing techniques.

Considering these requirements, Sangamo has designed two new Type D resin-coated, silvered-mica capacitors. They have a better coating resulting from finer materials used in the dipping process, and also possess the excellent performance characteristics previously established by other types of Sangamo silvered-mica capacitors.

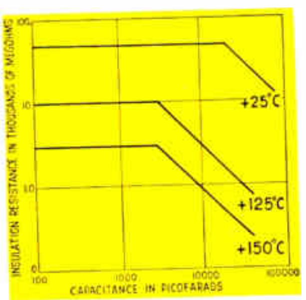
MECHANICAL DESCRIPTION: The mica is carefully selected for electrical excellence and dimensional uniformity. The silver is screened on the mica and fired to effect a positive bond. A positive low-resistance connection is assured by clips and leads of tinned brass pressure clamped to the section.

Good thermal shock characteristics, moisture resistance, and a glossy surface are provided by five separate resin coatings that do not appreciably alter the electrical characteristics of the silvered-mica section.

OPERATIONAL PERFORMANCE:

Type D capacitors are available in two maximum temperature ratings, +125° C or +150° C. Both can be operated at rated voltage without derating.

The insulation resistance for capacitance values is shown in Figure I for +25° C, + 125° C, and +150° C.



These capacitors are available in C, D, E, or F characteristics over the temperature range of −55° C to +125° C or +150° C as shown in the following table:

TABLE I

Characteristics Available in Type D Resin-Coated, Silvered-Mica Capacitors

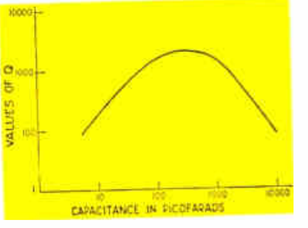
Characteristic	Temperature Coefficient ppm/° C	Capacitance Drift Per Cent	Availability of Characteristic
C	±200	±0.5	All Values
D	±100	±0.3	All Values
E	−20 to +100	±(0.1 + 0.1 pf.)	Above 20 pf.
F	0 to +70	±(0. 05 + 0.1 pf.)	Above 50 pf.)

The moisture resistance is given as an insulation resistance greater than 10,000 megohms after a ten day cycle outlined in Method 106A, Figure 106-1 of Mil-Std-202B.

Thermal and immersion cycling is given as an insulation resistance greater than 10,000 megohms when subjected to temperatures between −55° C and +125° C or +150° C as outlined in Method 102A, test condition D and Method 104A, test condition B of Mil-Std-202B.

These capacitors will withstand a constant acceleration of 20 G's in accordance with Mil-Std-202B, Method 204A, test condition D.

Values of Q at various frequencies are shown in Figure II.



Type D capacitors can be stored at −55° C without injury. Case insulation strength is 200 per cent of rated voltage.

They will have an insulation resistance of 10,000 megohms at +25° C after an accelerated life test of 2,000 hours duration at 150 per cent of rated voltage, at high ambient test temperatures of +125° C or +150° C.

Acceptable Quality Levels (AQL) of completed units are fully met using the sampling plan set forth in Mil-Std-105A. This limits visual and mechanical AQL to 1.5%; Electrical AQL to 0.65%; and environmental AQL to 2.5%.

Sangamo also supplies the Type D as a non-standard capacitor in accordance with special requirements. Where maximum dimensions are critical and military humidity specifications do not apply, Type D capacitors are available with fewer resin coats. If circuit design requires a lower temperature coefficient, it can be provided when specified. Where improved reliability is an important factor, Type D capacitors can be 100 per cent short-term, accelerated life tested. In addition to straight lead design, Type D is also available with crimped leads which provide a positive stop when capacitors are mounted on etched-circuit boards.

SC60-8

New Tech Data for Engineers

Pulse Transformers

"Slabbed" circle cases for pulse transformers designed for ease of manufacture in the new Type 32Z Pulse Transformer series are listed in Engineering Data Sheet No. 40240, from Sprague Electric Co., 233 Marshall St., North Adams, Mass. They offer means of anchoring leads and quickly inserting transformer windings, soldering the external leads to the ends of the windings, and pouring the encapsulating material.

Circle 173 on Inquiry Card

Converter

Data sheets from Vidar Corp., 2107 El Camino Real, Palo Alto, Calif., describe the Vidar 250A and 250B ac-dc Voltage-to-Frequency Converters. These will develop output pulses at a rate precisely proportional to input dc or ac voltages. The two models are distinguished by output frequency range, the VIDAR 250A being a 0-100 KC unit—the VIDAR 250B 0-10KC. For high accuracy instrumentation, response is instantaneous—a step change in the input causes a step change in frequency, delayed no more than the period of one cycle. A 5-position attenuator provides full-scale sensitivities ranging from 0.1 v. to 1000 vac or vdc. Voltage range and ac or dc mode can be selected manually at the front panel or by remote switch closure.

Circle 174 on Inquiry Card

Filters-High Q Coils

New 1960-61, 16-page supplement, 2-color, catalog offers complete information on Electric Wave Filters and High Q coils. An easy reference Reactance-Frequency chart is also included. Also, information on Company's transformers, reactors, magnetic amplifiers and pulse transformers. United Transformer Corp., 150 Varick St., New York 13, N. Y.

Circle 175 on Inquiry Card

Cleaning Ultrasonically

Comprehensive information on the advantages of ultrasonic cleaning is contained in Bulletin 60-1, "How to Clean Ultrasonically with Self Tuning," offered by Powertron Ultrasonics Corp., Patterson Pl., Roosevelt Field, Garden City, N. Y. It provides a basic explanation of how ultrasonics works, what it can do to cut time and labor costs, and a guide to the selection of tank and generator sizes for various jobs. A discussion of the Company's new development, the Autosonic line of self tuning cleaners, is also included. A thorough chart-guide to the correct cleaning solutions and temperatures for ultrasonic removal of more than 20 different common contaminants completes the bulletin.

Circle 176 on Inquiry Card

Regulated Power Supplies

Power supplies connected in parallel to provide low-cost, regulated dc power supply systems of greater power output and higher current ratings are described in Application Note DC400 from Sorensen & Co., (a subsidiary of Raytheon Co.) Richards Ave., So. Norwalk, Conn. It illustrates the method of paralleling 2 MD supplies across a 115 vac line to double the current rating of the units.

Circle 177 on Inquiry Card

Storage Oscilloscope

Information and specs on a new wide-band, high frequency storage oscilloscope which features a 10-MC bandwidth and a writing speed of 1,000,000 in. a sec. is available from the Industrial Systems Div., Hughes Aircraft Co., P. O. Box 90904, Airport Sta., Los Angeles 45, Calif. The Memo-Scope oscilloscope is designed with plug-in amplifiers, 1-shot trigger circuits, delay lines and swing-out circuit boards for maintenance access. The company used epoxy glass circuit boards for high circuit stability.

Circle 178 on Inquiry Card

Pressure Windows

New 12-page brochure describes waveguide pressure windows, their applications and installation suggestions. Pressure windows are available as standard units to operate in from 2.4 to 40 KMC are designed to serve increasing power handling requirements over exceptionally wide temp. ranges. Window types covered are: flange-mounted glass-kovar; flange-mounted mica; pressure window-waveguide assemblies; and solderable windows (including the new flexframe construction) for sealing reference cavities, filters, etc. Microwave Associates, Inc., Burlington, Mass.

Circle 179 on Inquiry Card

Components Catalog

Twenty-page catalog includes illustrations, technical information, performance charts on Anderson Solenoids, coils, transformers and electrical components. Of special interest, in addition to their "Series D Solenoids" are the new "ME Series Miniature Solenoids." Anderson Controls, Inc., 9959 Pacific Ave., Franklin Park, Ill.

Circle 180 on Inquiry Card

Gold Alloy Preforms

Tech. data sheets on gold alloys and other semiconductor device alloys available from Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J. Gold 99.99+ pure alloyed with antimony, silicon, germanium, gallium or tin is fabricated into spheres, foil, washers, discs, rectangles and squares for semiconductor devices.

Circle 181 on Inquiry Card

Trimmer Capacitors

Advance specs for a new line of miniature trimmer capacitors which include 4 models, each available for panel or printed circuit mounting. Capacitance ranges are 1 to 4.5, 1 to 8.5, 1 to 12, and 1 to 18 μμf. Behind-panel lengths (overall lengths for printed circuit types) are 27/64, ⅝, 13/16, and 1 3/32 in. Q factor for all models is 500 at 50 MC; Temp. coefficients are ±50, ±75 and ±1.00. Corning Glass Works, Corning, N. Y.

Circle 182 on Inquiry Card

High-Frequency Bus Duct

Application data, 30-663—for high-frequency bus duct, is contained in a new 12-page booklet available from Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. Descriptions, drawings, dimensions, specs, and engineering and test data give specific information needed to lay out, specify and install this type of bus duct. Applications of high-frequency bus duct include induction heating systems, missile-launching sites, and air-frame and electronics manufacturing facilities.

Circle 183 on Inquiry Card

Dielectric Ceramics

Technical data on "The Use of Rare Earths and Their Allied Elements in Dielectric Ceramic Materials," available from Vitro Chemical Co., 342 Madison Ave., New York 17, N. Y.

Circle 184 on Inquiry Card

Military Components

New edition of Military Components Catalog, No. 50A. This 36-page catalog can be considered a manual on U. S. Military specs covering those components which Ohmite manufactures. The catalog covers the latest versions of the following specs: MIL-R26, MIL-R-22, MIL-R-19365, MIL-R-93, MIL-R-9444, MIL-R-10509, MIL-R-19074; MIL-R-6749, MIL-R-6274, MIL-R-3965, MIL-R-5757, and MIL-R-6106. The catalog reduces the formidable maze of military specs to a fundamental basis that makes simple, the writing of "type designations" and the ordering of military components. Ohmite Mfg. Co., 3679 Howard St., Skokie, Ill.

Circle 185 on Inquiry Card

VHF Power Generator

Circuit details of a high-power, solid state VHF power generator are discussed in a new publication from Pacific Semiconductors, Inc., 12955 Chadron Ave., Hawthorne, Calif. Contents of the brochure are limited to discussion and circuitry of a 250 MC 2½ w VHW power generator for which components are immediately available. A supplementary brochure discussing a 1 KMC UHF generator will be published later this year when required components become available.

Circle 186 on Inquiry Card

New from Sarkes Tarzian

HIGH VOLTAGE

Silicon Cartridge Rectifiers

Latest in the growing line of Sarkes Tarzian semiconductor devices are High Voltage Silicon Cartridge Rectifiers in two series. Each series includes 18 different types with operating temperatures ranging from —55°C to 150°C ambient. The units feature low voltage drop and low reverse current.

Ferrule Mounted Series (S-5490 thru S-5507)

This high voltage series is equipped with a ferrule type mounting of silver plated brass and is available in both hermetically sealed glass or phenolic tubing. The units range in sizes from 1 13/16" to 6 1/16", have maximum rectified DC output currents varying from 45 to 100 milliamperes, and peak inverse voltage ranging from 1500 to 16,000 volts.

Axial Lead Series (S-5518 thru S-5535)

This high voltage series is equipped with axial leads, with units ranging in size from ½" to 2½" and lead lengths varying from 1" to 2½". Peak inverse voltage starts at 1000 volts up to 10,000 volts, with maximum RMS input voltage ranging from 420 to 7000 volts. Maximum average rectifying currents at 25 degrees C vary from 70 to 250 MA, and at 100 degrees C, from 25 to 100 MA.

Both series are immediately available in production quantities! For additional information on the new Sarkes Tarzian High Voltage Silicon Cartridge Rectifiers, write Section 5652C.

Sarkes Tarzian is a leading producer of semi-conductor devices in production quantities, including silicon power rectifiers, silicon tube replacement rectifiers, selenium rectifiers, modular silicon rectifiers and zener voltage regulators. Application engineering service is available without cost or obligation.

(FERRULE MOUNTED SERIES)			
Operating Temperature Range—55°C to 150°C Ambient		Max. Ratings Half Wave Res. Load at 75°C Ambient	
JEDEC TYPE	S. T. TYPE	PEAK INVERSE VOLTS	MAX. RECTIFIED DC OUTPUT MA
1N1133	S-5490	1500	75
1N1134	S-5491	1500	100
1N1135	S-5492	1800	65
1N1136	S-5493	1800	85
1N1137	S-5494	2400	50
1N1138	S-5495	2400	60
1N1139	S-5496	3600	65
1N1140	S-5497	3600	65
1N1141	S-5498	4800	60
1N1142	S-5499	4800	50
1N1143	S-5500	6000	50
1N1143A	S-5501	6000	65
1N1144	S-5502	7200	50
1N1145	S-5503	7200	60
1N1146	S-5504	8000	45
1N1147	S-5505	12000	45
1N1148	S-5506	14000	50
1N1149	S-5507	16000	45

When ordering phenolic tubing as a substitute for glass tubing, add the letter "P" to S. T. Type No.

MAXIMUM RATINGS				
Operating Temperature Range —55°C to 150°C Ambient				
JEDEC TYPE	S. T. TYPE	PEAK INVERSE VOLTS	MAX. RMS INPUT VOLTS•	MAX. RECT. DC OUTPUT (MA) @100°C
1N1730	S-5518	1000	700	100
1N1731	S-5519	1500	1050	100
1N1732	S-5520	2000	1400	100
1N1733	S-5521	3000	2100	75
1N1734	S-5522	5000	3500	50
1N2373	S-5523	600	420	100
1N2374	S-5524	1000	700	100
1N2375	S-5525	1500	1050	100
1N2376	S-5526	2000	1400	100
1N2377	S-5527	2400	1680	75
1N2378	S-5528	3000	2100	75
1N2379	S-5529	4000	2800	50
1N2380	S-5530	6000	4200	50
1N2381	S-5531	10000	7000	25
1N2382	S-5532	4000	2800	75
1N2383	S-5533	6000	4200	50
1N2384	S-5534	8000	5600	35
1N2385	S-5535	10000	7000	35

• Derate 50% for capacitive load in half wave circuits.
For capacitive, motor, or battery loads, derate DC current by 20%.

SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

In Canada: 700 Weston Rd., Toronto 9 • Export: Ad Auriema, Inc., New York

New Tech Data for Engineers

Waveguide Data Chart

New Standard Waveguide Data Chart is a complete listing of waveguide information. It features military as well as EIA designation numbers, and shows virtually all required electrical as well as mechanical parameters for all waveguides in use today. Some parameters covered are: cut-off frequency, theoretical attenuation for both brass and aluminum waveguides, theoretical CW power rating, and the waveguide wavelength from the lowest to the highest frequency in any given band. Mechanical dimensions are also given for all waveguides, along with their tolerances. Also given is the Narda designation number for each waveguide along with the EIA and military numbers. Narda Microwave Corp., 118-60 Herricks Rd., Mineola, L. I., N. Y.

Circle 187 on Inquiry Card

Carrier System

The General Electric TCS-600, a fully transistorized multiplex-carrier system designed to transmit from 1 to 600 full duplex-toll quality-voice channels over a single microwave beam, is described in a bulletin from GE's Communication Products Dept., Lynchburg, Va. Also available: bulletins describing their Alarm/Control equipment for monitoring and fault location; their Dual-Beam Microwave; and their microwave terminal equipment.

Circle 188 on Inquiry Card

Microwave Instruments

Series of technical data sheets from Wave Particle Corp., Div. of Ramage & Miller, Inc., 3221 Florida Ave., Richmond, Calif., describes their line of microwave instruments. Included are: Traveling Wave Tube Amplifiers; High power Microwave Signal Sources; B.W.O. Microwave Signal Sources; and X-band Weather Radar Systems. Specs are included.

Circle 189 on Inquiry Card

UHF-VHF Measurements

A line of high-frequency measuring equipment and accessories for signal and pulse generation, impedance measurement, detection, modulation, attenuation, and transmission through shielded coaxial lines is presented in a brochure from General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass. The 12-page, 2-color bulletin (catalog type) contains specs —electrical, mechanical, etc.—on all the equipment.

Circle 190 on Inquiry Card

System Engineering

"Microwave System Engineering," a 24-page booklet, from Sarkes Tarzian, Inc., East Hillside Drive, Bloomington, Indiana, is available to those requesting it on Company Letterhead. It provides basic information on the fundamentals of microwave propagation and on the limitations imposed by the high frequency of the microwave spectrum. Information includes: Propagation Fundamentals; Fresnel Zone; Fading; System Planning; and Equipment & Site Selection.

Circle 191 on Inquiry Card

Microwave Equipment

Waveline, Inc., Caldwell, N. J., offers several items of interest to microwave engineers: A 4-page brochure, "WR-51 Test Equipment"—a compilation of 60 waveguide instruments for use in the WR-51 waveguide size; a 4-page brochure, "Coaxial Microwave Filters"—5 representative types of coax microwave filters with tech data; a data sheet describing their Model 609 Variable Fixed Attenuator (X, and K_u band); Description of a two section coaxial filter, 90116 (3.5 to 4.0 KMC); and information on a new product, "Coaxial Wavemeter" including tech data.

Circle 192 on Inquiry Card

Waveguide Assemblies

Catalog # TL 601 from Technicraft Div. of Electronic Specialty Co., Thomaston, Conn., describes the company's products including: rectangular and circular waveguides, Broadband Ridge Waveguides; Flexible and Rigid Waveguide assemblies; Mixers, Duplexers; Matched Tees; Directional and Bi-directional Couplers; Short Slot Hybrids; Coaxial Adapters; Crystal Holders; Attenuators; Disconnects and Quick Clamps; Tuners; Loads, Phase Shifters; Antenna Feeds and Ferrite Devices.

Circle 193 on Inquiry Card

Microwave Ferrites

Microwave Ferrites produced by Indiana General Corp., General Ceramics Div., Keasbey, New Jersey, are featured in bulletin No. 259. It contains a microwave ferrite application chart and a table of magnetic properties. The inside spread features curves of magnetic and dielectric properties vs frequency. Also available: Bulletin 18 (Indox permanent Magnets); Catalog 20 (Alnico V load Isolator Magnets); and Engineering Bulletin 353 (Indox VI magnets for TWT's).

Circle 194 on Inquiry Card

Microwave Diode Handbook

Microwave diode handbook (50¢) from Sylvania Electric Products, Inc., 100 Sylvan Road, Woburn, Mass., includes: "Theory of Microwave Crystals"—physical design, general characteristics, mixer crystals, detector crystals, harmonic generation, and balanced sideband modulator; "Physical Testing"; "Application Testing" —generator impedance, power level of mixer, reverse polarity, coaxial vs. waveguide design, matched pairs, crystal burnout, temperature effects, etc. (42-pages.) Also available: the 1960 edition of "Sylvania Microwave Diodes—Characteristics and Replacement Guide," and 2 booklets listing microwave tubes and other products by frequency bands.

Circle 195 on Inquiry Card

Microwave Oscillators

Bulletin 814-A from Laboratory For Electronics, Inc., 1079 Commonwealth Ave., Boston 15, Mass., describes Series 814, high-power, ultrastable, tunable, microwave oscillators. It includes features, description, and applications. Bulletin is illustrated with graphs, tables and specs. Also available: Bulletin 820 XLK on the Series 820 XLK Ultra Stable Microwave Oscillators; a bulletin on the Epsi-Line Microwave components, and bulletins on Microwave Spectroscopy and the MTI Radar Test Set.

Circle 196 on Inquiry Card

Antenna Pattern Analyzer

Brochure form the Bendix Corp., Radio Div., Baltimore 4, Md., features Antenna Pattern Analyzer AN/ASM-13. The system features direct recording of radar antenna patterns quickly and precisely. It is an airborne system that can be used with any ground radar to provide permanent graphs of the antenna pattern. Items for which data can be provided are: beamwidth, side lobe levels, dead spots, general beam shape, beam pointing accuracy, the effect of frequency changes or adjustments to the radar structure, and interference.

Circle 197 on Inquiry Card

Microwave Links

Four-page leaflet from Pye Telecommunications Ltd., Newmarket Rd., Cambridge (England), features their TV microwave link equipment Type PTC M1000. The unit is a long-range microwave equipment suitable for the transmission of monochrome video-signals simultaneously with high fidelity audio signals. Output power is 1 watt.

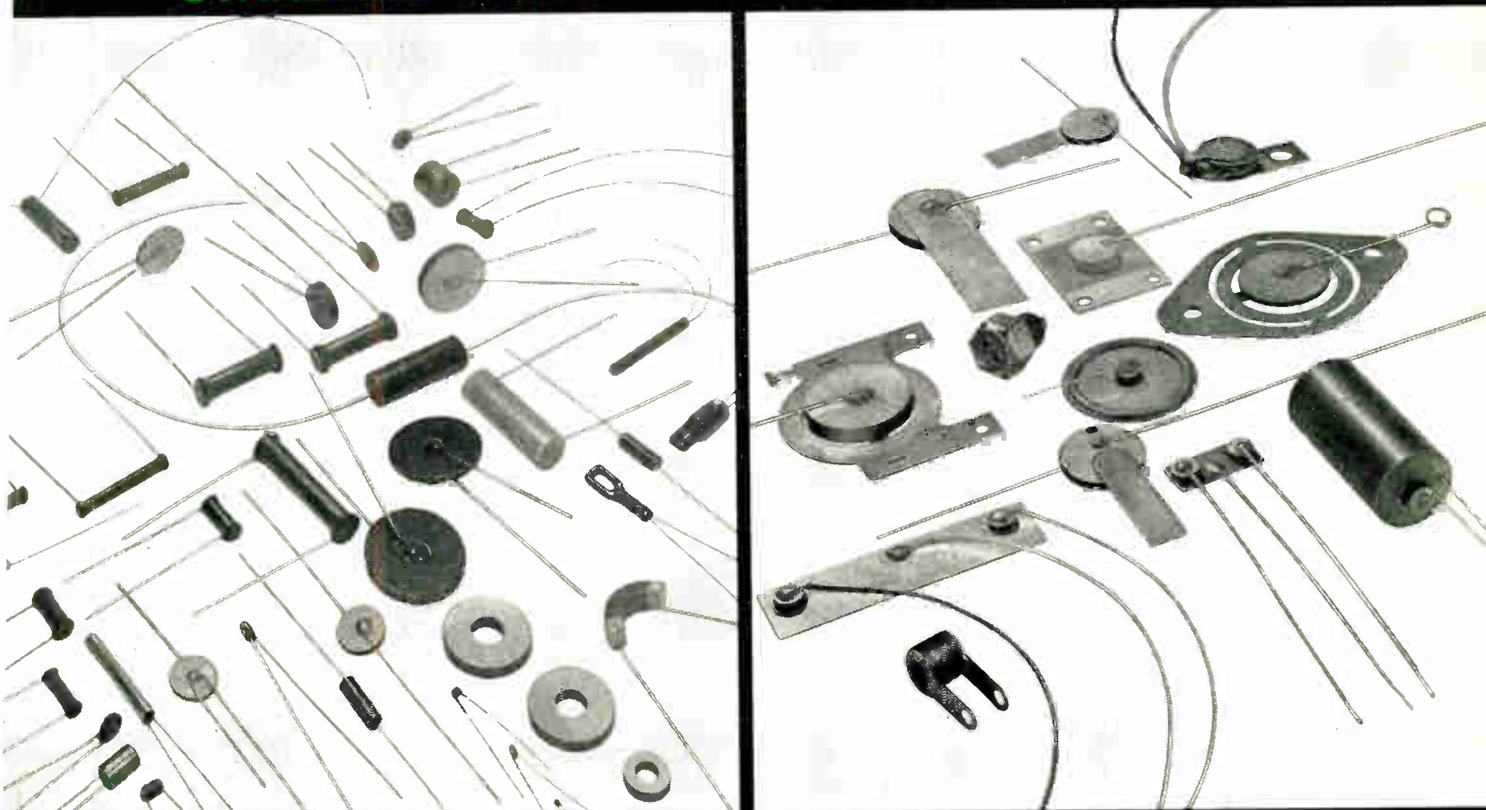
Circle 198 on Inquiry Card

IN THERMISTORS

—the key name is **Keystone**

...whether you need **10** or **10,000,000** pieces—

STANDARD PARTS ... or SPECIAL ASSEMBLIES



Versatility Plus ...

A partial list of small discs and rods, all with identical characteristics

Temperature Coefficient (25° C) −3.8% / °C
Beta Value (37.8° C / 104.4°C) 3500° K
Ratio (37.8° C / 104.4°C) 7.3

Resistance 25° C	Keystone Type Number	Diameter (Inches)	Thickness (Inches)
500	L0503-312-73	0.050	0.030
160	L0903-100-73	0.100	0.030
500	L0903-312-73	0.100	0.030
1000	L0909-623-73	0.100	0.100
100	L2003-62-73	0.200	0.030
180	L2006-112-73	0.200	0.060
200	L2006-125-73	0.200	0.060
230	L2006-143-73	0.200	0.060
270	L2008-168-73	0.200	0.080
300	L2008-187-73	0.200	0.080
100	L3006-62-73	0.300	0.060
200	L3008-125-73	0.300	0.080
250	L3008-156-73	0.300	0.080
300	L3018-187-73	0.300	0.180
270	L060637-168-73	Rod, 0.060" square, ⅜" Length.	
5000	L060637-3120-73		
10000	L060437-6234-73		

Special Mounting Requirements

Thermistor applications often dictate special mounting requirements. As a result, Keystone units are supplied with many types of special lead assemblies, mounting tabs, heat dissipating fins. Units are mounted in probes and transistor type cans, attached to plates and metal parts of wide variety.

Keystone has the experience (over almost a quarter of a century), the knowledge and production capability to handle your thermistor requirements in any quantity—of any type and size.

Because of unsurpassed quality control, your tolerance specifications are acceptable to ± 2% on resistance value and Beta value (in fact, we maintain a ± 2% production tolerance on the material constant of *all* Keystone thermistors regardless of resistance tolerance). All parts can be supplied in pairs or sets matched closely in resistance-temperature or voltage drop characteristics.

We can supply discs, washers, rods, beads and special shapes including washer segments, square rods, rectangular wafers, square wafers, etc. Our experienced sales staff and engineering and research and development organizations are available for consultation. Write us or call today.

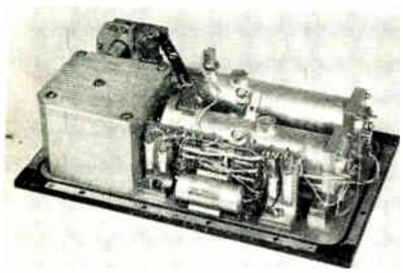
Circle 56 on Inquiry Card

Keystone
CARBON COMPANY
RESISTOR DIVISION • St. Marys, Pa.
Telephone: Terminal 4-1591

New Products . . . for the Electronic Industries

TRANSMITTER

L Band CW Transmitter Assembly feaures: Number of transmitters, 2; Frequency, transmitter No. 1, 990 mc ± 10 mc — transmitter No. 2, 1800 mc ± 10 mc; stability, ± 3 mc, Δ T = 70°C; power output, 5 w Peak, 50% duty cycle; modulation, square

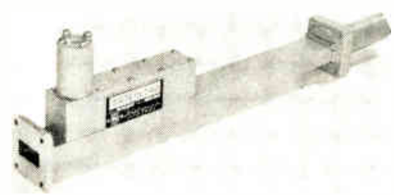


wave, transmitter No. 1, 700 cps nominal — transmitter No. 2, 900 cps nominal; cooling, forced air provided within assembly; packaging, pressurized for 300,000 ft.; input voltage, 24 — 30 vdc @ 3 a, 6 vdc @ 3.5 a; weight (max.), 19½ lbs. Environmental specs: Temperature, −20°C to +80°C; vibration, 0.25 in. 20 — 48 cps, 17 g, 48 — 2000 cps; shock, 50 g 3 axes; and acceleration, 50 g 3 axes. ACF Electronics Div., ACF Industries, Inc., 11 Park Place, Paramus, N. J.

Circle 199 on Inquiry Card

WAVEGUIDE TERMINATIONS

New C-Band and XB-Band Water Loads, liquid-cooled, waveguide terminations, cover 5.8 to 8.2 kmc (Model 187B-C) and 7.0 to 10.0 kmc (Model 1 1878-XB). These are precision devices suited for Calorimetric r-f power measurement as well as straight for-

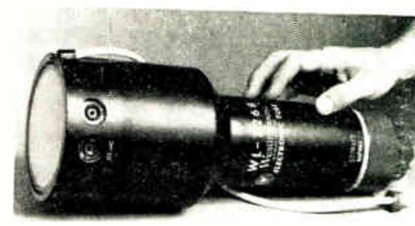


ward dummy loads. It combines low r-f radiation and vswr (max. vswr of 1:10 and typical values of 1:05) with max. reliability and power capability. Unpressurized, Model 187B-C can be operated at ave. 5 kw or peak 500 kw, Model 187-XB is rated at 3 kw ave. or 300 kw peak. Both can be pressurized to 45 psig for operation at higher levels. SL, S and X-Band Water Loads are also available for 1.7 to 2.6 kmc, 2.6 to 4.0 kmc and 8.2 to 12.4 kmc applications. Sierra Electronic Corp., Menlo Park, Calif.

Circle 201 on Inquiry Card

STORAGE TUBE

New direct-view storage tube, type WL-7268, incorporates 2 writing guns and a viewing gun system producing a bright, non-flickering, uniform display over a 4 in. dia. area. Two electrostatically focussed and deflected writing guns permit independent, si-

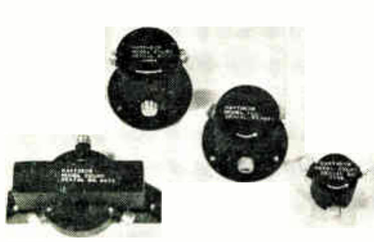


multaneous writing of 2 signals. Performance characteristics of the tube include brightness up to 2500 ft.-lamberts with 10,000 v. applied to the phosphor, good resolution of half-tone displays, and excellent display uniformity. The writing speed of 36,000 in./sec. is sufficient to freeze high frequency transients, and storage time is long enough for examining and recording the display. Max. dia. is 5¼ in.—length is 15¾ in. Westinghouse Electronic Tube Div., P. O. Box 284, Elmira, N. Y.

Circle 203 on Inquiry Card

THREE-PORT CIRCULATORS

Miniaturized 3-port circulators for UHF, L and S-bands, come in 4 basic designs covering 800 to 4000 mc with operation over 10% bandwidths in each range. Each provides less than 4 db insertion loss and min. isolation of 20 db. VSWR on all units is 1.25 max. A feature of the L and S-band units makes it possible to mount them within external magnetic fields or close to ferrous metals without affecting operating characteristics. All have Type N female connectors and can handle peak power of 5 kw and ave. power of 5 w. Use of Type HN connectors in the 800 to 1700 mc range

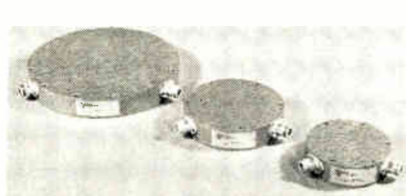


makes possible handling capabilities of up to 100 kw. They have broad operating temp. ranges. Special Microwave Device Operations, Raytheon Co., 130 Second Ave., Waltham 54, Mass.

Circle 200 on Inquiry Card

ISOLATOR ELEMENTS

Models 200, 210, 220, 230, 240, 250, Y-circulator or isolator elements, available at a specific frequency in the VHF-UHF region with these characteristics: Band (mc), 200-800; Max. isolation (db), 40; Max. loss (db), 0.5; VSWR max., 1.1; Approx. Peak power (kw), 20; and Amb. temp., 20 to 23°C. They will provide 20 db of isolation, with insertion loss not exceeding 1.0 db, over a frequency band of f_{max} = 1.3 to 1.5 times f_{min} if a variable magnetic field is applied. The VSWR over this band is not greater than 1.3. For a fixed magnetic field, the 20 db—isolation bandwidth de-

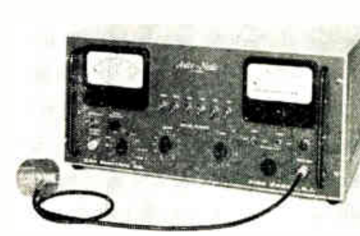


creases to the order of 9 to 12% of the center frequency. Electro or permanent magnets can be supplied. Electronic Communications, Inc., Research Div., 1830 York Rd., Timonium, Md.

Circle 202 on Inquiry Card

NOISE FIGURE BRIDGE

The Auto-Node, a flexible automatic noise figure bridge for simplified, automatic noise figure meter displays, features a small (probe size) temp. modulated resistor as a noise generator. Characteristics: Sine wave temp.-modulation at a 10 cps rate with temp. excursions between 300° and 400°K; small VSWR variations during modulation (less than 2 parts in 1000); useful freq. range of noise generator from 2 to 2000 mc. High-gain, low-noise post amplifier has noise-figure stability better than 3.5 db (matched). Gain raises input noise to 10 v. after final detection.



Bandwidth is 2 mc (supplied with 1 of 3 center freqs.: 30, 60 and 70). Measurements are to within 0.2 db accuracy (gain or less measurements). Kay Electric Co., Maple Ave., Pine Brook, N. J.

Circle 204 on Inquiry Card

in the interests of more stable telemetry power...

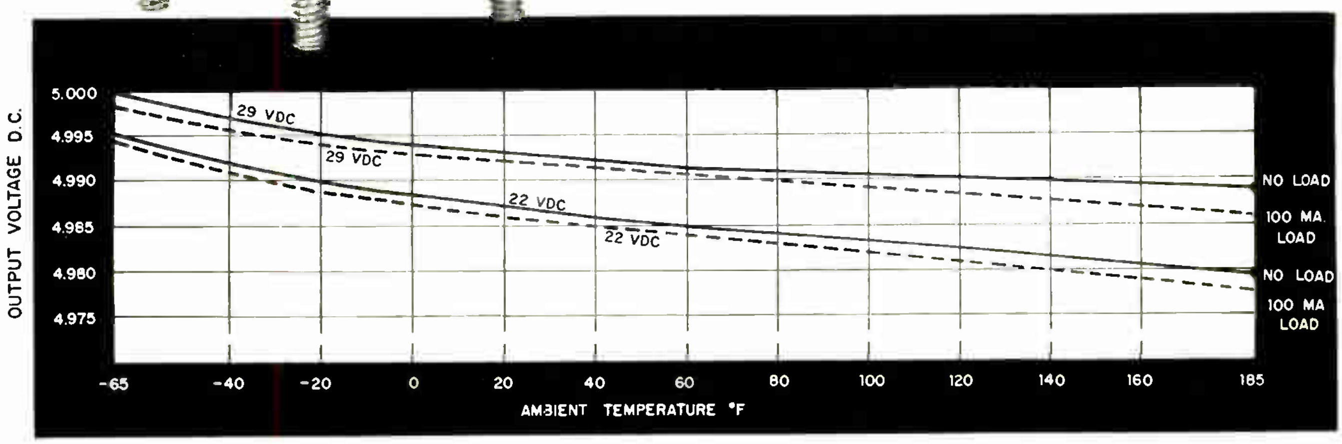
VĀP-AIR 5-VOLT D.C. POWER SUPPLYS

Compact, low-voltage, low-current reference power supply for airborne telemetering transducer circuits.

Assures highly stable voltage regardless of input and load variances over a wide operating temperature range.

Regulator incorporates minimum number of components to achieve optimum performance, highest reliability.

ACTUAL SIZE



VĀP-AIR . . . SPECIALISTS IN AIRCRAFT THERMAL CONTROLS FOR NEARLY 20 YEARS

Entire systems and a complete line of sensors, cooling effect detectors, electronic controls and precise voltage regulators, electro-pneumatic and electro-mechanical valves, advanced hot-air in-line valves and pressure regulators, electric power controllers and heat exchange equipment —for aircraft, missiles and ground support.

BRIEF SPECIFICATIONS

Input Voltage	22 to 29 Volts D.C.
Maximum Input Transient	80 Volts above zero level, 10 to 20 milliseconds duration
Output	4.975 to 5.000 Volts D.C. under all conditions of line load, and temperature variations
Load	0 to 100 milliamps
Output Ripple	30 millivolts peak-to-peak under input transient conditions
Ambient Temperature Range	−65°F. to +185°F. (can be furnished to 212°F.)
Altitude	100,000 feet
Dimensions	1½" by 1½" by 1½"
Weight	5 ounces

for complete technical information and applications write:

VĀP-AIR THE AERONAUTICAL DIVISION OF
VAPOR HEATING CORPORATION. Dept. 61-K
80 East Jackson Blvd., Chicago 4, Illinois

New York • St. Paul • Denver • Washington
Philadelphia • Seattle • San Francisco • Houston
Richmond • Los Angeles • St. Louis

Please send me more information on the Vāp-Air 5-Volt D.C. Power Supplys.

NAME ____________________

FIRM ____________________

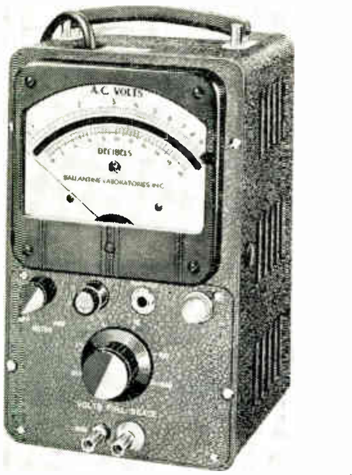
ADDRESS ____________________

CITY, ZONE, STATE ____________________

New Products . . . for the Electronic Industries

VOLTMETER

New Model 300-G Precision Electronic Voltmeter features 1% accuracy over the entire meter scale from 1 mv to 250 v. from 20 CPS to 20 KC. Accuracy is better than 2% to 1000 v. and for the wider band of 10 CPS to 250 KC. Voltage coverage is from



1 mv to 1000 v. in 6 decade ranges. Shaped pole pieces are used to achieve a logarithmic characteristic over a 10 to 1 voltage range. The 5-in. mirror-backed scale with a 10 to 1 range has a 10% extension at both ends to reduce the amount of switching necessary when working at or near the end points of the scale. Basic meter error is less than ±0.5% at all points. Input impedance is 2 megohms shunted by 15 pf, except 25 pf on the lowest voltage scale. Ballantine Laboratories, Boonton, N. J.

Circle 205 on Inquiry Card

MICROWAVE MODULATOR

New high power microwave modulator, Model 10002, accommodates any of 76 magnetrons, covering 5,400 MC to 35,000 MC, with peak outputs from 20 kw to 500 kw. It is complete, compact, and self-contained, including high voltage power supply,

pulse generator, meters, viewing connectors for all principal parameters, controls and protective circuits. High voltage power supply is continuously variable from 0 to 8 kv at 200 ma; pulse power output is 37 kv at 40 a max.; magnetron filament supply is continuously variable from 0 to 20 v. at 16 a. The pulse generator is free running and continuously variable from 180 to 3,000 pulses/sec. Standard pulse width is one µsec. The Narda Microwave Corp., 118-160 Herricks Rd., Mineola, L. I., N. Y.

Circle 207 on Inquiry Card

PHASELOCK RECEIVER

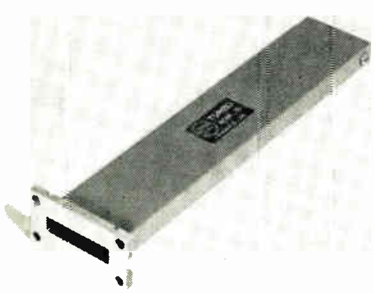
Model 90708 Phaselock Receiver provides sensitivity and flexibility for tracking of low level signals. Elec. specs: Input freq., 860-962 MC, Input impedance, 50 ohms; Input noise fig., 8 db max.; I-f bandwidth, 1000 CPS; Sensitivity (Loop S/N = 1.4)—Noise

bandwidth at −150 dbm = 20 CPS acceleration capability = 57 ft/sec^2; Doppler tracking range, 72 KC; Manual acquisition tuning range, 72 KC; Zero input signal tracking filter drift, 3°/sec; Doplar output—Balanced output, 500 ohms impedance level 2.8 v RMS—100 ohms impedance level 3.3 v. RMS. Mech. specs: Drawers, standard 19 in. wide rack mountings, drawers on slides; Ht., standard 6 ft. rack; weight, 360 db (approx). Resdel Engineering Corp., 330 So. Fair Oaks Ave., Pasadena, Calif.

Circle 209 on Inquiry Card

BROADBAND TERMINATION

Addition to the Half-X Component line, a broadband termination for 0.900 by 0.200 in. ID waveguide. This absorbing load exhibits a VSWR of less than 1.03:1 from 8.2 to 12.4 KMC. Max. power dissipation is 1 w ave. making the termination suitable for most low power design measurements

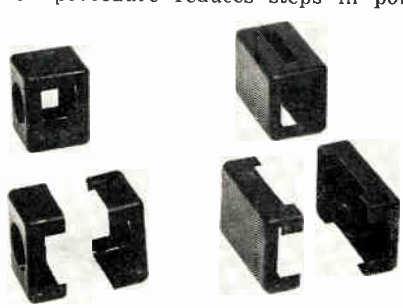


and production testing. Measuring 6 in. in length, cast aluminum construction results in a rugged yet light device. Flanging consists of a centered UG-67/U configuration. Turbo Machine Co., Lansdale, Pa.

Circle 206 on Inquiry Card

TRANSFORMER CASES

Glass epoxy laminated cases are used to eliminate metal cans or potting molds in the encapsulation of high temperature transformers. The two halves are bonded together with the winding enclosed and the case is filled with potting compound. Simplified procedure reduces steps in pot-

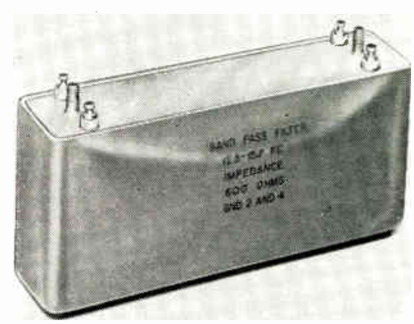


ting, reduces weight of the unit, eliminates rejects due to thin spots. Thin wall, glass reinforced, laminated cases are available in all temperature classes. Stevens Products Inc., 86-88 Main St., East Orange, N. J.

Circle 208 on Inquiry Card

SPECIAL PURPOSE FILTERS

A line of special purpose for telemetering, band pass, high and low pass, amplifier, discriminator and aircraft glide slope indicator applications. All units in line are hermetically sealed, and are designed in accordance with MIL-F-18327A. They



are built on special order. Detailed specifications available including bandwidth data and attenuation curves. Chicago Standard Transformer Corporation, 3501 W. Addison Street, Chicago 18, Ill.

Circle 210 on Inquiry Card

ONE INTEGRATED SOURCE for Ceramic-to-Metal Seals

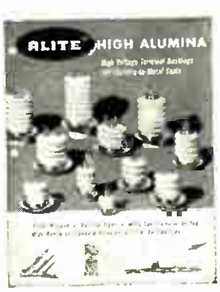
Standard types of Alite high voltage bushings are available in various sizes and configurations.

In *all* phases of planning for ceramic-to-metal seals—from design to finished assembly—you can rely on ALITE for the know-how and "*do*-how" required to produce highest quality ceramic-metal components for critical applications.

High alumina Alite is the ideal material for making rugged, high performance hermetic seals and bushings. It has superior mechanical strength, high temperature and thermal shock resistance, plus reliable electrical characteristics. Our complete high temperature metalizing and bonding facilities assure delivery of the finest seals available—mass-spectrometer tested for vacuum-tightness.

Please contact us for valuable performance data and information regarding ceramic-to-metal applications . ... no obligation.

INSIDE LOOK AT ALITE—



Fact-packed, illustrated Bulletin A-40 gives vital technical data and product information. Write today.

ALITE DIVISION

U. S. STONEWARE
Orrville, Ohio

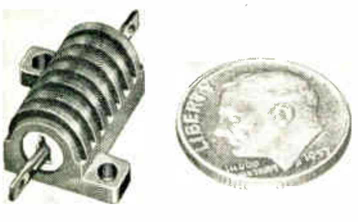
New York Office
60 East 42nd St.

12F-1

New Products . . . for the Electronic Industries

POWER RESISTOR

Type RH-5 wire wound, precision power resistor for problems where power and heat dissipation are complicated by miniaturization requirements. RH-5 is a 5 w resistor sealed in silicone and inserted in a radiator finned aluminum housing. It meets



MIL-R-18546B. It is impervious to moisture and salt spray. Type RH-5 measures 0.600 x 0.334 in.; has a resistance range from 0.5 ohm to 20K ohms. Tolerance range is 0.05%, 0.1%, 0.25%, 0.5%, 1% and 3%. Temp. coefficient is 0.00002/°C. It has welded construction from terminal to terminal. Max. operating temp. is 275°C. When mounted on a heat sink, it is rated at full power up to 100°C., derating to 0 at 275°C. Free air rating is full power up to 25°C., derating to 0 at 275°C. Dale Products, Inc., Box 136, Columbus, Nebr.

Circle 211 on Inquiry Card

CRYSTAL MOUNTS

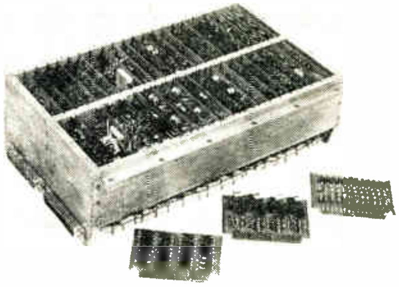
New line of coaxial crystal mounts accommodate almost all types of coaxial semiconductors and provide a wide range of connector types, frequency ranges, and other characteristics. Four basic types of mounts hold the ceramic cartridge, small and

large coaxial, and tri-polar types of crystals. They are equipped with a choice of N, BNC, TNC, C or HN male or female input connectors and BNC, TNC, or Microdot output connectors. Internal dc returns cover from 30 to 13000 MC. Padded mounts, with attenuators built into the input can be supplied to provide a low input can be supplied to provide a low VSWR. Where max. sensitivity is required, mounts tuned to a particular octave are also available. Microlab, 570 W. Mt. Pleasant Ave., Livingston, N. J.

Circle 213 on Inquiry Card

DIGITAL DATA SYSTEM

Airborne Digital Data System, Model ADS-1 is for missile application to convert system parametric voltage measurements to a digital equivalent for use with FM-Telemetry systems, magnetic or paper tape recorders. It features a digital "yes-no"

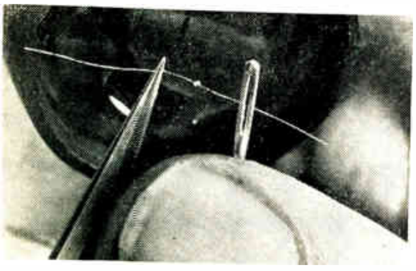


type of information. Includes input multiplexing, analog to digital converter, output switching, channel identification and parity checking. It has 12 channels. Sampling rate is 120 samples/sec., conversion accuracy ± 0.2% over operational temp. range, a 10 mv resolution and repeatibility and weighs 9.5 lbs. Full scale inputs of −5 to +5 v. at input impedances of greater than 10 megohms dc and 1 megohm, 60 CPS ac standard. Inter-Mountain Instruments Br., Curtiss-Wright Corp., Electronics Div., P. O. Box 8324, Albuquerque, N. M.

Circle 215 on Inquiry Card

THERMISTORS

Midget bead thermistor for measuring temperature on the inside and outside surfaces of the Polaris and Atlas missiles is 0.010 inches in diameter and is mounted on a wire 0.001 inches in diameter. Made of manganese nickel oxide, the thermistors can be used in medical applications inside a hypodermic needle to measure blood temperature. They are also used in radio frequency power measurements in the micro-



wave field and in the measurement of low gas pressures. They can measure temperatures ranging from −76°F to 572°F. Gulton Industries, Inc., 212 Durham Avenue, Metuchen, N. J.

Circle 212 on Inquiry Card

TELEMETRY TRANSMITTER

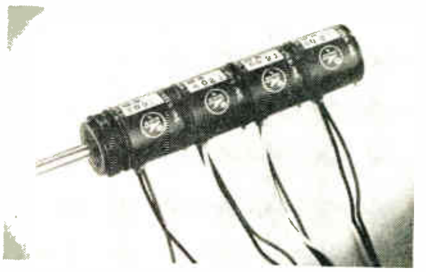
TR-10 is a transistorized FM telemetry transmitter for FM/FM and PCM systems. Specifications include: 2.5 w output with true FM modulation over complete 215-265 MC telemetry band; 99.9% reliability for 500 hrs.; modulation freq. response ±2 db from 3 CPS to 300 KC; vibration-induced noice less than 1.5 KC deviation at 20 G's from 20 CPS to 2000 CPS; modulation linearity less than 1% from straight line at 125 KC de-

viation. It qualifies to radio noise spec MIL-STD-442, is hermetically sealed and exceeds military environmental specs including MIL-E-5272. United Electro-Dynamics, Inc., 200 Allendale Rd., Pasadena, Calif.

Circle 214 on Inquiry Card

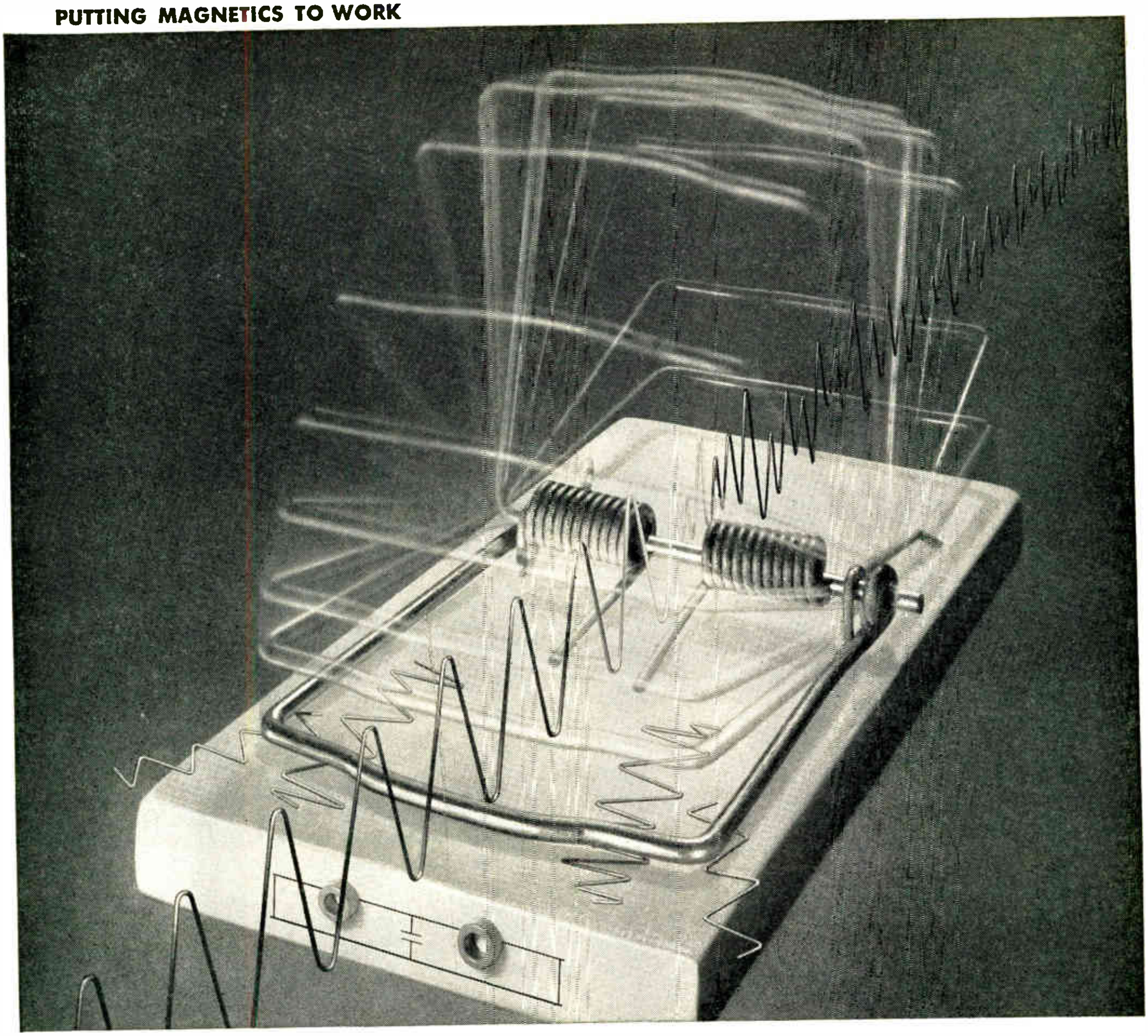
POTENTIOMETERS

New multigang configurations of ½ in. dia., precision wire-wound potentiometers and trimmers, for missile and airborne use. Standard configurations include up to 6 gangs, servo or bushing mounted, with choice of ball or jewel bearings. The "ACEPOT" potentiometers feature standard linearity of 0.3%, while the "ACETRIM" trimmers provide 3% linearity. The "ACEPOTS" are available in standard resistance from 100



ohms to 250K; the "ACETRIMS" from 2 ohms to 250K. Power Ratings are up to 2.5 w at 65°C; maximum operating temperature is 150°C. Ace Electronics Assoc. Inc., 99 Dover St., Somerville 44, Mass.

Circle 216 on Inquiry Card



How to build a better (audio signal) trap!

Magnetics Inc. permalloy powder cores give filter designers new attenuation and stability standards—and miniaturization to boot!

The art of trapping unwanted frequencies has been advanced during the past year with a succession of improvements in molybdenum permalloy powder cores by Magnetics Inc. Most audio filter designers now work with smaller cores, more stable cores and cores whose attenuation characteristics are ultra-sharp. Do you?

Do you, for example, specify our 160-mu cores when space is a problem? With this higher inductance, you need at least 10 percent fewer turns for a given inductance than with the 125-mu core. What's more, you can use heavier wire, and thus cut down d-c resistance.

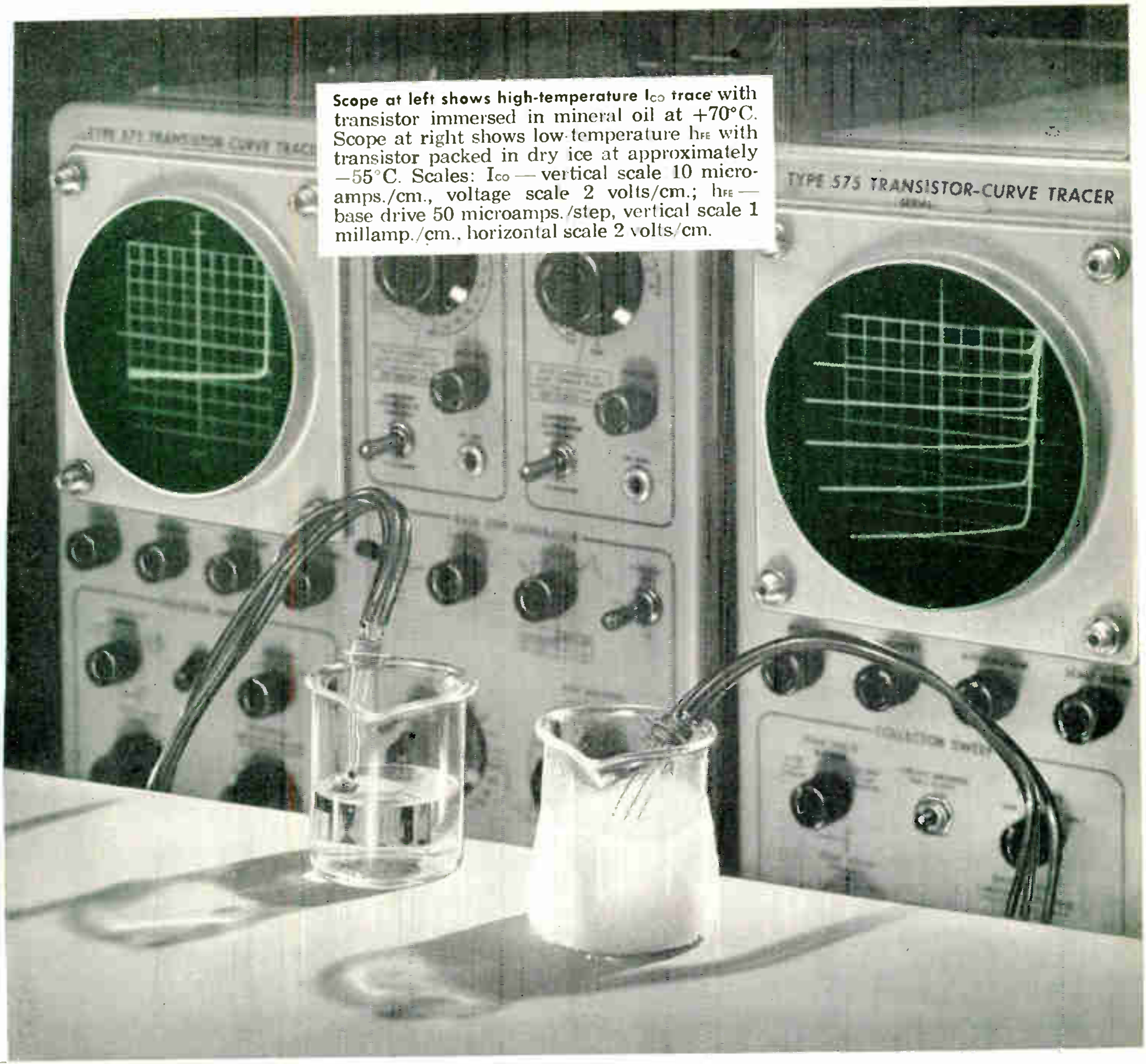
What about temperature stability? Our linear cores are used with polystyrene capacitors, cutting costs in half compared to temperature stabilized moly-permalloy cores with silvered mica capacitors. Yet frequency stability over a wide swing in ambient temperatures is increased!

And what do you specify when you must rigidly define channel cut-offs, with sharp, permanent attenuation at channel crossovers? Our moly-permalloy cores have virtually no resistive component, so there is almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in high and low band pass ranges.

Why not write for complete information? Like all of our components, molybdenum permalloy powder cores are *performance-guaranteed* to standards unsurpassed in the industry. *Magnetics Inc., Dept. EL-82, Butler, Pa.*

MAGNETICS inc. ®

Circle 59 on Inquiry Card



Scope at left shows high-temperature I_{CO} trace with transistor immersed in mineral oil at +70°C. Scope at right shows low-temperature h_{FE} with transistor packed in dry ice at approximately −55°C. Scales: I_{CO} — vertical scale 10 microamps./cm., voltage scale 2 volts/cm.; h_{FE} — base drive 50 microamps./step, vertical scale 1 millamp./cm., horizontal scale 2 volts/cm.

TYPE	MAXIMUM RATINGS (25°C)				ELECTRICAL CHARACTERISTICS				
	V_{CBO}	V_{CER}	V_{EBO}	P_T	25°C Max. I_{CO}	70°C Max. I_{CO}	25°C h_{FE} min.	25°C h_{FE} max.	h_{FE} min.
2N526	−45***	−30	−15	225 mw	−10μa @ −30V	−220μa @ −30V	53	90	27 (−25°C)
2N396A	−30	−20*	−20	200 mw**	− 6μa @ −20V	−120μa @ −20V	30	150	20 (−55°C)

*V_{CEO}
**Mil Version 150 mw ***Mil Version −30V

For fast delivery at factory low prices, call your authorized General Electric Distributor.

GENERAL ELECTRIC

Circle 60 on Inquiry Card

New Products

CRYOGENIC COOLER

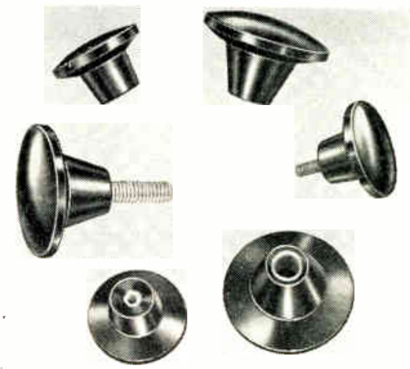
Model FW-22 Cryogenic Cooler, for cooling dewar-type infrared detector cells with liquid nitrogen, liquid oxygen, or liquid air, will operate for 22 hrs from filling, 16 hrs after 24 hrs standby, or proportionate times up to 82 hrs total. It uses the natural pres-

sure build-up from thermal leakage or the residual pressure of filling operation to provide driving power to force liquid from the storage container to the cooling head. Self-limiting flow provides operation over a wide range of differential pressures using only an on-off control. Unit may be operated at reduced exhaust pressures to obtain colder temp. (down to 63°K with liquid nitrogen). Various cool-down times and operating times are possible. ITT Laboratories, 3700 E. Pontiac St., Ft. Wayne, Ind.

Circle 217 on Inquiry Card

KNOB FAMILY

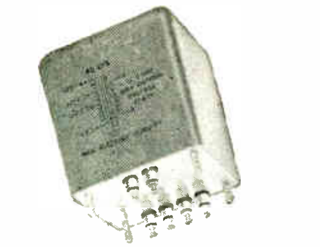
New family of molded push-pull and lid knobs. This 2-member family —#236 and #237—combines a smart angular contour and crowned top surface with functional design for a variety of pushing and lifting applications. Difference is that the #237 is molded in ¾ scale, so the two may be matched whenever 2 sizes are required. The #236 measures slightly less than 2 in. across the top and is



available with ¼ in. to ⅜ in. D. tapped brass inserts and same size protruding studs. The #237 has a 1⅜ in. D. top and offers a choice of #10 to 5/16 in. D. tapped brass inserts or protruding studs. Dimco-Gray Co., 207 E. 6th St., Dayton 2, O.

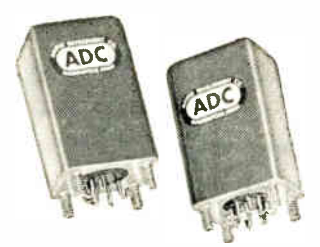
Circle 218 on Inquiry Card

TRANSFORMERS · FILTERS · REACTORS
JACKS & PLUGS · JACK PANELS

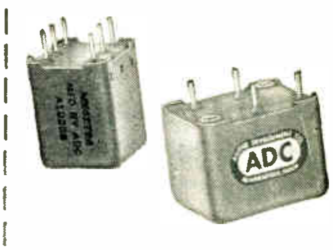


Military Standard POWER Transformers—Types MS-90016 through MS-90036.

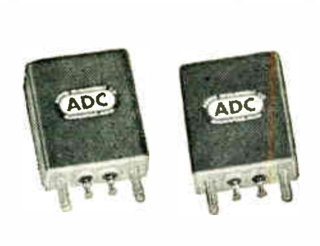
Military Standard AUDIO Transformers—Types MS-90000 through MS-90008.



Sub-Miniature, hermetically sealed, low frequency inductors and transformers.



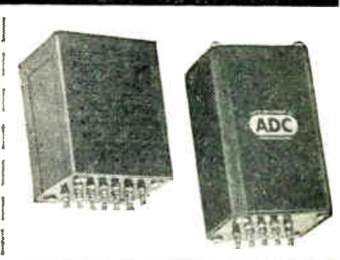
Transformers and filters for TRANSISTOR and PRINTED CIRCUIT applications to meet MIL-T-27A Grade 5, Class R or S.



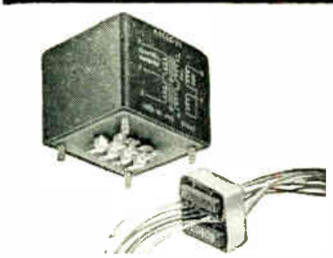
Toroids—Hermetically sealed or open units for all frequency ranges.

Filters—Sub-Audio to 1.5 mcs.

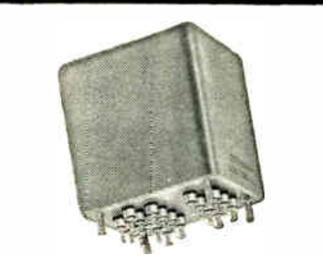
Telephone Coils—Mechanically and electrically interchangeable with Western Electric.



Broadcast Quality Transformers—Standard of the Industry.

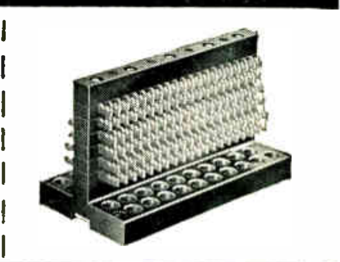


Magnetic Amplifiers and Saturable Transformers—For servo motor control; DC-DC Power Supplies, and switching silicon controlled rectifiers.

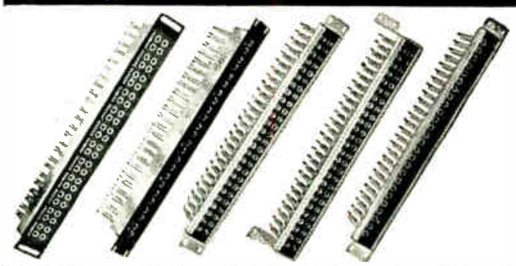


Balanced Modulators—Designs over a wide range up to 500 kcs.

Encapsulated Transformers—Using custom epoxy compounds for military and commercial applications.



Terminal Blocks—Molded to your specifications. Six popular sizes in stock.



Jack Panels—Several size panels in stock.

Plugs, Patch Cords and Jacks—Standard in the communication industry. Long frame telephone type jacks; wide variety; two and three conductor.

PACIFIC BRANCH
7247 Atoll Avenue
North Hollywood, Calif.
Phone: TRiangle 7-7169

Government Approved Qualification Testing Laboratory.

Choose from over 500 stock items or let ADC design to your requirements

25th Anniversary Year

ADC INCORPORATED

2839-13TH AVENUE SOUTH • MINNEAPOLIS 7, MINNESOTA
PACIFIC BRANCH *North Hollywood, California*

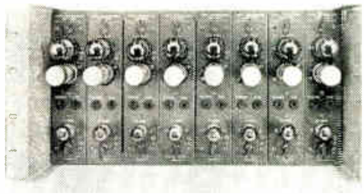
TRANSFORMERS • REACTORS • FILTERS • JACKS AND PLUGS • JACK PANELS

Circle 62 on Inquiry Card

New Products

AMPLIFIERS

Modular amplifiers for color and black-and-white video. Type VA-P-101 Video Distribution Amplifier is for systems requiring a simple 1 input, 1 output unity-gain unit. Eight amplifiers plug into a shelf 8¾ in. high. Type VA-P-102 Sync Adding Ampli-



fier plugs into 1 of the positions, allowing the addition of sync to 1 or any number of the remaining 7 VA-P-101's. Type VA-P-103 Video Distribution Amplifier complements standard equalizer, since the equalizer has a loss of 3 db which must be made up to bring the system gain back to unity. It is a 1 input, 1 output unit —nom. gain is ± 3 db—permits 8 amplifiers to be plugged into 8¾ in. The VA-P-201 is a multiple output type of amplifier for simultaneously feeding 3 identical signals to several different points. The Daven Co., Livingston, N. J.

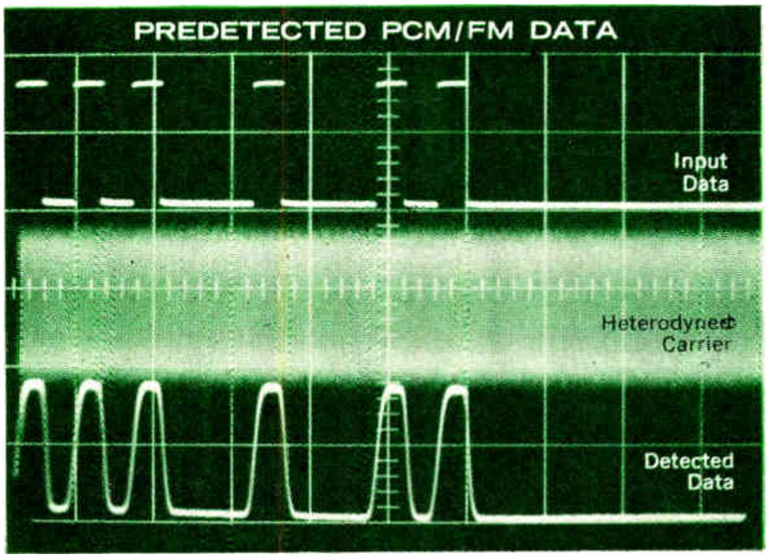
Circle 219 on Inquiry Card

WEATHER RADAR SYSTEM

The WP-103 Airborne Weather Radar System, weighs 49.9 lbs. Pulse-modulated system operates in the X-band range. It requires 320 wac and covers the general sky area with a stabilized antenna up to 150 nautical mi. ahead of aircraft. Antenna makes a 120° sweep with 60 scans/min. and can be tilted 15° upward or downward. Basic units include the 374A-3

receiver/transmitter, 776C-3 synchronizer, 561G-3 control kit, 493A-4 indicator and 537F-7 12 in. dish antenna. A 30 in. dish antenna which sweeps 360° is also available. Collins Radio Co., P.O. Box 1891, Dallas 21, Tex.

Circle 220 on Inquiry Card



5.0-mc IF carrier heterodyned down to 750 kc. Random-spaced pulses. 20 μs on-20 μs off-type information. Sweep rate: 50 μs/cm.

ONLY THE MINCOM CM-100 IS NOW PERFORMING OPERATIONAL PREDETECTION RECORDING

...and actually doing it at defense facilities as you read this advertisement

Months of exhaustive field testing prove that the Model CM-100, Mincom's latest instrumentation recorder/reproducer, is capable of performing predetection recording on an everyday operational schedule. Because of the CM-100's 1-megacycle response and constant phase equalization at all speeds, an original IF signal of 5.0 mc can be heterodyned so that the carrier and its sidebands fall within the system's frequency range.

Standard Production Model

In this standard production model, Mincom has reduced the series elements before data storage to receiver and mixer only, one step from the antenna. CM-100 thus records and reproduces the sidebands and carrier swing of a receiver intermediate frequency—and it does this with FM, FM/FM modulation, PCM and PCM/FM.

Compatible Recording, Phase Equalization

With Mincom's predetection reception and playback, recording ground stations can be universal in the sense that all types of data systems can be handled by the same equipment. Uniform phase equalization at all speeds means that recorded predetected signals can be reduced in speed and studied with consistently good pulse response, using tunable discriminators.

Versatile System

The Mincom Model CM-100 does the work of two magnetic tape systems by storing both analog and pulse data with equal facility. It is also capable of recording and reproducing greater bandwidths at slower speeds, making possible longer recording times—from 3 hours and 12 minutes at 62.5 kc—7½ ips, to 12 minutes recording 1 mc—120 ips.

Interested? Write today for brochure.

3M COMPANY ...WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

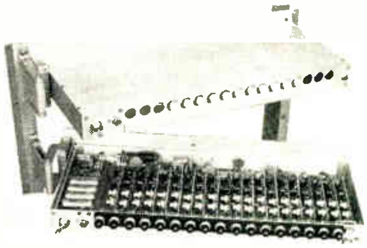
2049 SOUTH BARRINGTON AVENUE, LOS ANGELES 25, CALIFORNIA • 425 13th STREET N.W., WASHINGTON 4, D.C.

Circle 64 on Inquiry Card

New Products

FAULT ALARM

Transistorized fault alarm for microwave system can report 11 or 17 different fault conditions. Transmitter at each station continuously scans for faults and reports to its receiver at a supervisory station every 4 sec. with a single AM tone. Tones can



be set within 1 of 5 ranges between 1 and 30 kc. More than 30 separate remote stations can report over a single baseband without interfering with other communications. Transmitter output may be bridged directly on the baseband, while receiver inputs may be bridged on an isolation amplifier or service channel output. Transmitter and receiver may also be used for binary data communication or remote control. For very large systems, they may be arranged for automatically interrogated operation. Collins Radio Co., 1930 Hi-Line Dr., Dallas 7, Tex.

Circle 221 on Inquiry Card

CURRENT INDICATOR

Combining high sensitivity and low drift, Model I-309A Current Indicator is a wide-range current measuring instrument for measurement of electron or positive-ion beam current and general laboratory use. Full-scale sensitivity can be varied from 1 ma to 3mμa in 12 switch settings. Drift is less than 0.01% per hour and overall accuracy is 1% of full scale. An

auxiliary output is provided to drive a 1 ma recorder. The instrument has a response time of 10 msec and can be used as a low-drift dc amplifier as well as a current indicator. Elcor, Inc., 1225 W. Broad St., Falls Church, Va.

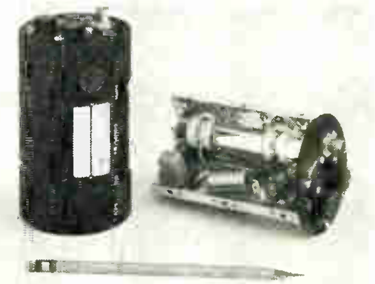
Circle 222 on Inquiry Card

Circle 66 on Inquiry Card

New Products

L-BAND TRANSMITTERS

A new L-Band Transmitter, Model 2701 is packaged for either airborne or ground use—a typical application would be for a beacon on target missiles. Specs include a frequency range of 1650 to 1680 MC, FM modu-

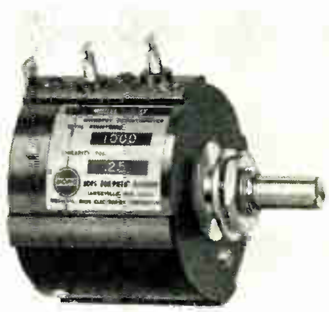


lated with a minimum power output of 800 milliwatts. The transmitter contains an integral power supply and operates from an input power of 0.7 amps at 29 volts over a temperature range of −55 to 72°C. Size, 5½ inches long by 3 5/16 diameter. R S Electronics Corp., 435 Portage Ave., Palo Alto, Calif.

Circle 223 on Inquiry Card

POTENTIOMETER

New Borg 205-3T (3-turn) Micropot has been added to line of Micropopot potentiometers. Terminals are soldered to resistance wire ends, prevision positioned and molded integrally with the housing. A stainless steel lead screw guides the moving contact to assure accurate settings, low torque and long life. Standard resistance values and other major specs (non-standard resistances are available to 100K ohms): Total resistance range, 10 to 50,000 ohms; Mechanical rotation, 1080° +15° −0°; Electrical Rotation, 1080°



+14.4° −0°; Linearity, independent or zero-based; Linearity accuracy, ±0.5% to ±0.1%; Length (housing), 1 31/64 in.; and weight, 3.2 oz. Borg Equipment Div., Amphenol-Borg Electronics, 120 So. Main St., Janesville, Wis.

Circle 224 on Inquiry Card

New Products

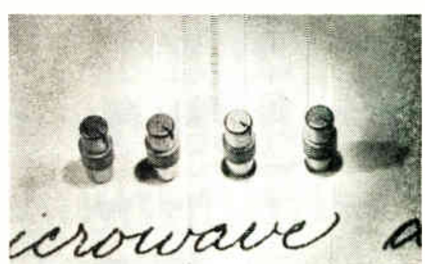
ULTRASONIC GRINDER

Faster-operating ultrasonic impact grinder can machine an area up to 1⅜ in. in dia. Model 2-333 is for precision machining operations in the manufacture of semiconductor and other electronic devices. It can also be used for general purpose work including cleaning and soldering. It features an air-cooled, 300-w magnetostrictive transducer and eliminates bothersome plumbing arrangements. The magnetostrictive transducer provides continuous operation, eliminating down-time for cooling often necessary with ceramic transducers. Transducer is an insert-type. Either coil or transducer can be removed without disturbing the other. Commercial Apparatus & Systems Div., Raytheon Co., 1415 Providence Tpke., Norwood, Mass.

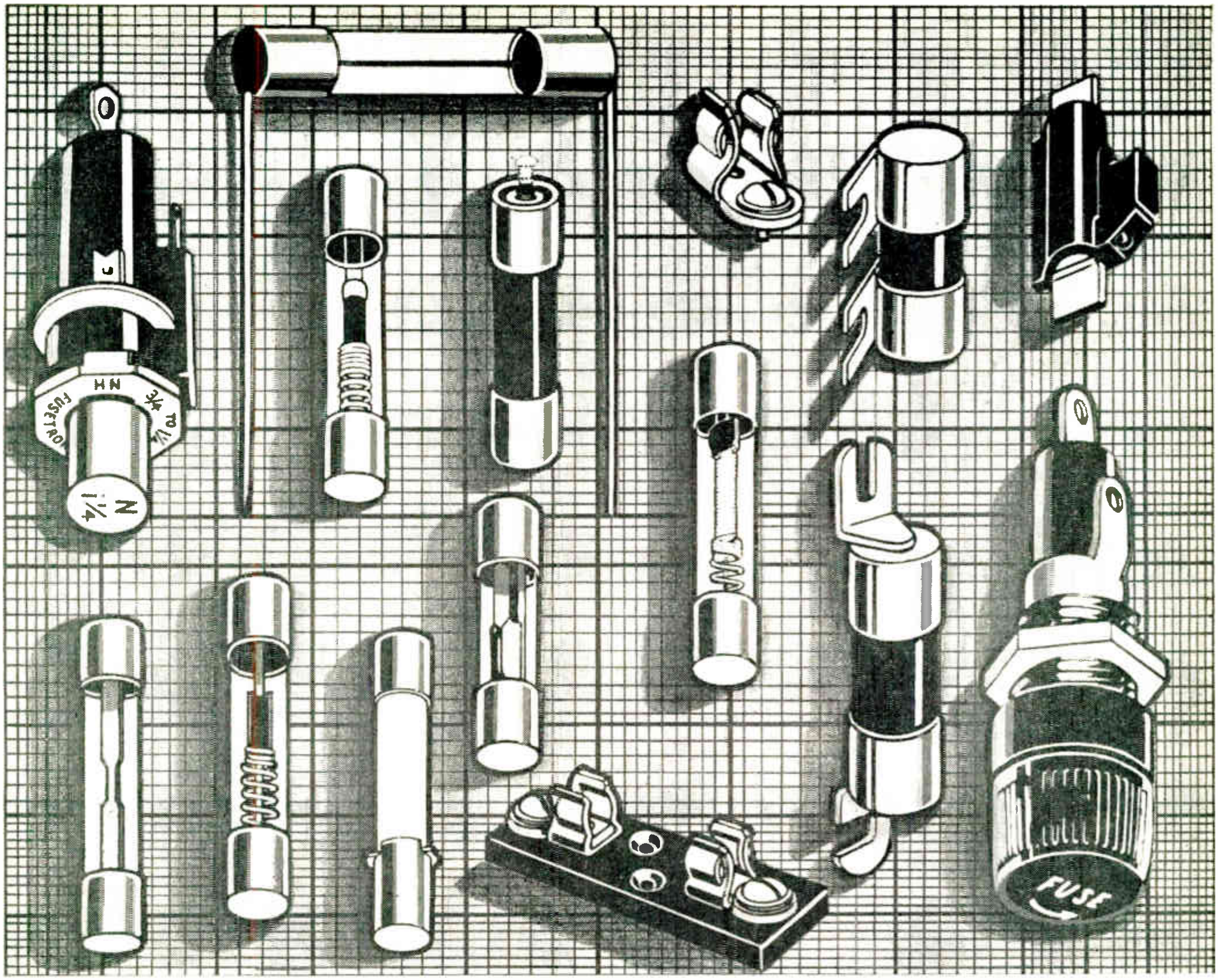
Circle 225 on Inquiry Card

VARACTOR DIODES

Three new device types (the XD-501, 502, and 503) added to line of diffused gallium arsenide mesa microwave varactor diodes. The new XD-503 is rated for a minimum cutoff frequency at breakdown of 310 KMC. At $V_R = -2$ v, the min. cutoff frequencies of the XD-500, 501, 502, and 503 are rated at 60, 81, 108, and 144 KMC. They are packaged in the double-ended beryllium oxide cartridge for optimum microwave performance. They also feature a low total capacitance range (0.5 μμf min. to 1.4 μμf max.) and low series inductance (0.7 mμh at 9.4 KMC). Texas Instruments Incorporated, P. O. Box 312, Dallas 21, Tex.



Circle 226 on Inquiry Card



BUSS fuses can help protect

your product and it's reputation for quality

You get double protection when you specify BUSS fuses.

First, BUSS fuses are designed and manufactured to give maximum electrical protection.

But it doesn't stop there.

Every BUSS fuse is carefully tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

This is your assurance that BUSS fuses will operate as intended.

Second, BUSS fuses help protect your reputation as a quality manufacturer. A fuse that opens prematurely causes a needless shutdown. Likewise, one that doesn't function properly may cause other components to burn out or be damaged. In either case, it's an annoying headache for the customer who buys your equipment. More often than not, he will blame your product for his trouble.

With dependable BUSS fuses, you need have no worries that faulty fuses will give your product a bad name. That's why it makes good sense to specify BUSS fuses.

For more information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.

BUSSMANN MFG. DIVISION
McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

1160

BUSS FUSES ARE MADE TO PROTECT - NOT TO BLOW NEEDLESSLY

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS — McGRAW EDISON

BUSS MAKES A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, ELECTRICAL, AUTOMOTIVE AND INDUSTRIAL USE.

New Products

POWER SUPPLY

The TA-3, a small, lightweight, portable power supply, can be used for operating all cold-start miniature noise sources and noise generators and for many of the standard noise sources at currents up to 125 madc. Starting spike is approx. 1000 v. By

single control, it provides a current range from 60 to 125 madc for any tube with an operating voltage from 30 to 100 v. and lower currents for tubes with higher operating voltages. Max. ripple voltage under load is 4 vac. Characteristics: Input, 115 vac at 115 vac at ¼ aac; Output, Unloaded Supply Voltage, 350 vdc, nom; Loaded Supply Voltage, 230-275 vdc; Current 125 madc, max.; Size 4½ x 6¾ x 5¾ in. The Bendix Corp., Red Bank Div., Eatontown, N. J.

Circle 227 on Inquiry Card

DIGITAL CLOCK

Direct reading full vision in line digital clock features: digits can be reset individually by independent front panel reset controls; large ⅝ in. digits on the 12 hr clock and 5/16 in. digits on the 24 hr. clock; calibrated rotating visual 1 rpm seconds wheel. Clock movement shock resistant to withstand shock of 2000 lbs. per in.; clock movement fully en-

closed in anodized dustproof aluminum case, size: height is 4½ in. width 6 in. depth 3¼ in.; weight, 3½ lbs. Available in 50 or 60 cycle, in all voltages. Pennwood Numechron Co., 7249 Frankstown Ave., Pittsburgh 8, Pa.

Circle 228 on Inquiry Card

SWITCHING PROBLEMS?

get fast off-the-shelf answers from complete stocks of basic precision switches and actuators

always available for immediate delivery

BASIC SWITCH SERIES	DESCRIPTION	MODEL NUMBER

SUB-SUBMINIATURE T type

Exceptionally high current capacity in tiny case. Only ½" x ¼" x ⅜" yet UL listed at 7.5 amps. 125/250 VAC. Also rated at 7.5 amps, 30 VDC resistive, 3 amps. 30 VDC inductive. Mounts side-by-side, four switches to the inch.

ACTUATORS ROLLER LEAF LEAF

DESCRIPTION	MODEL NUMBER
SPDT solder terminals	T3
SPDT solder terminals, U.L.	T12
leaf actuator	A5-71**
roller leaf actuator	A5-73**

SUBMINIATURE E4 type

Ideal for compact electrical and electronic equipment. Low movement differential and operating force gives precision control in critical applications. Can be stacked and gang mounted. Meets MIL Specs. MS-25085 and is UL listed at 5 amps, 125/250 VAC. Also handles 4 amps, 30 VDC resistive, 2.5 amps, 30 VDC inductive. Size: 25/32" x ¼" x 23/64"

ACTUATORS TOGGLE PUSHBUTTON LEAF ROLLER LEAF

DESCRIPTION	MODEL NUMBER
SPDT, solder terminals	E4-103
SPDT, turret terminals	E4-110
DPDT maintained toggle switch, 15/32" bushing	A3-32-103*
TPDT maintained toggle switch, 15/32" bushing	A3-33-103*
DPDT maintained toggle switch, ¼" bushing	A3-41-103*
SPDT maintained toggle switch, ¼" bushing	A3-42-103*
DPDT momentary push-button switch, 15/32" bushing	A4-86-103*
DPDT push-on, push-off, push-button switch, 15/32" bushing	A4-87-103*
leaf actuator	A5-9*
roller leaf actuator	A5-10*

MINIATURE F type

Low cost precision switch that meets military specs and is UL listed. Rugged design—positive over-travel stop protects mechanism from damaging over-actuation. Easy to mount. Size: 1 3/32" x 13/32" x ⅝". Rating: 10 amps 125/250 VAC / 28 VDC resistive, 6 amps, 30 VDC inductive.

ACTUATORS LEAF ROLLER LEAF

DESCRIPTION	MODEL NUMBER
SPDT basic switch, screw terminals, U.L.	F2-13
roller leaf actuator	A5-47**
leaf actuator	A5-49**

Toggle Switches

Space-Saving Cylindrical Types

Exceptionally rugged, cam-roller Hetherington Toggle Switches positively cannot be teased off contact. Cylindrical anodized aluminum cases reduce size by 25% over conventional rectangular switches. Firmly anchored terminals separated by heavy insulation barrier. All are 2-position, snap-action.

	CIRCUIT	RATINGS (Resistive Loads) 28v. dc.	115v. ac.	MTG. HOLE DIA.	SPECIAL FEATURES
MODEL T2104	2-circuit	10 amps.	5 amps.	¼"	Designed to JAN-S-23, Amend. 3.
MODEL T2150	DPDT	1 amp.	1 amp.	¼"	Miniaturized
MODEL T3103	SPDT	5 amps.	2½ amps.	¼"	Anodized aluminum case

For information on full switch line, write for new CONDENSED CATALOG ≠ 100

ELECTROSNAP HETHERINGTON

CONTROL SWITCH DIVISION

CONTROLS COMPANY OF AMERICA
1420 Delmar Drive • Folcroft, Pennsylvania
TELEPHONE LUdlow 3-2100 • TWX SHRN-H-502

*Designates actuator assembled with switch. **Order these actuators separately. Assemble on switch when mounting.
NOTE: ALL SWITCHES MOMENTARY CONTACT UNLESS OTHERWISE NOTED

New Products

COAXIAL CIRCULATORS

Line of miniaturized coaxial line circulators with no external permanent magnets. Units can be designed for operation at C, S, and L-band and designated as models D52C1, D52S1, and D52L1, operate over 10% bandwidths and provide more than 20

db isolation and less than 0.5 db insertion loss with a max. input VSWR of 1.3 in any arm. Bandwidths covered are 5.4 to 5.9, 2.7 to 2.9, and 1.25 to 1.35 KMC. Compact and lightweight, the C-band unit is 1.4 in. dia. x 1.4 in. height, exclusive of connectors. Weight is 6 oz. Scaled values apply for lower freq. units. Design uses a type of strip transmission line structure to form a 3-port junction. Sperry Microwave Electronics Co., Clearwater, Fla.

Circle 229 on Inquiry Card

HIGH-Q TUNABLE FILTER

Model 828 is a shortened coaxial cavity tunable over the 375-475 Megacycle range. It features a practically constant loaded Q (300 minimum) and insertion loss of 3 db maximum.

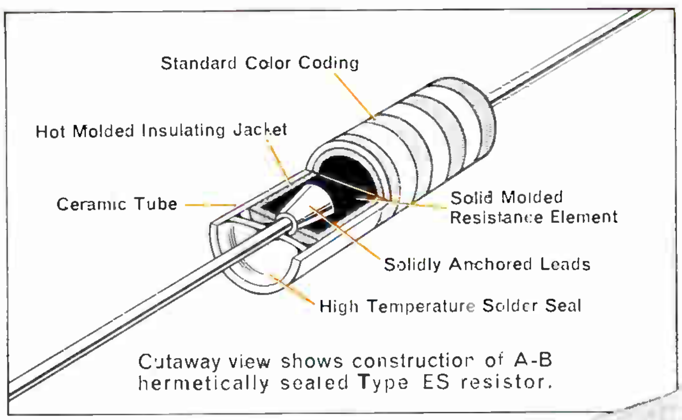
The micrometer is readable to 0.0001 in. and a calibration chart is furnished. Radar Design Corporation, Microwave Components, Pickard Drive, Syracuse 11, New York.

Circle 230 on Inquiry Card

......A-B hermetically sealed composition resistors defy the severest atmospheric conditions

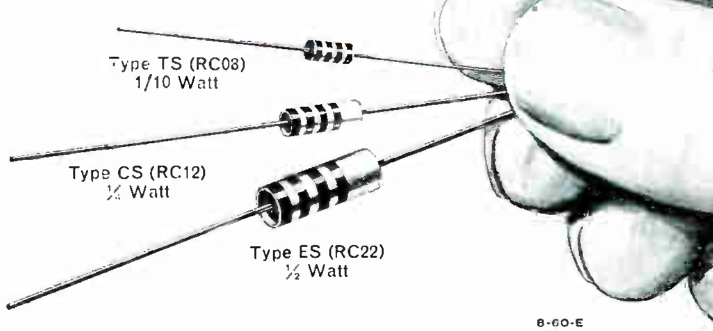
Allen-Bradley hermetically sealed composition resistors provide stability, reliability, and uniformity under extremes of humidity, such as illustrated above. This resistor consists of a specially processed, hot molded, carbon composition unit with an integral insulating jacket surrounding the carbon element. The entire unit is then hermetically sealed by means of a metallic seal and a ceramic jacket. This assures complete immunity to all effects of moisture and humidity. And under extremes of vibration and shock, A-B resistors remain undamaged, stable, and extremely low in noise factor.

A-B ceramic encased resistors are available in 2% and 5% tolerances in standard EIA values to 22 megohms, and in higher values on special order. Since catastrophic failure does not occur in A-B hot molded resistors, these units combine narrow tolerances with absolute reliability. Designed for continuous operation at full rated wattage at 70°C, Type ES resistors have a zero derating of 165°C; Type CS and Type TS at 150°C and 110°C respectively. For full details, write for Technical Bulletin 5003.



Cutaway view shows construction of A-B hermetically sealed Type ES resistor.

ACTUAL SIZE



6-60-E

ALLEN-BRADLEY

Quality
Electronic Components

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

now 100 times greater average power

Now you can obtain traveling-wave tubes capable of 10 to 100 times the average power of conventional helix tubes. These X-band tubes are representative of a wide variety of the first commercially available all metal filter-type structures yielding both high gain and wide bandwidth. Their attractively small size and weight are made possible through application of the latest periodic focusing techniques.

Typical of these recent advances is the pictured 308H. For the first time a power traveling-wave tube is offered with a high-μ grid-controlled gun. This advantage, coupled with 53 db of saturation gain, provides exciting possibilities for the systems designer.

Consult with Hughes Microwave Tube Division if you have exacting design requirements of pulse rise time, phase shift sensitivity, bandwidth or power output. These qualities are yours in a light, compact, yet rugged package of all metal-ceramic construction. These advanced products can make your program a success. Orders are being accepted now for delivery in three or four months.

307H LEFT: 100 kw peak power output (500 watt average), 8.5—9.5 kmc frequency range, 54 db saturation gain, 1% maximum duty cycle, beam voltage = 38 kv, 21 lbs. total weight of tube and magnet.

308H

Control grid μ = 55. 15 kw peak power output (150 watt average), 8.6—9.9 kmc frequency range, 53 db saturation gain, 1% maximum duty cycle, beam voltage = 24 kv, 14 lbs. total weight of tube and magnet.

319H

20 kw peak power output (200 watt average), 8.4—9.6 kmc frequency range, 54 db saturation gain, 1% maximum duty cycle, beam voltage = 24 kv, 17 lbs. total weight of tube and magnet.

For full details on these and other equally outstanding tubes write or wire Hughes Microwave Tube Division, 11105 Anza Avenue, Los Angeles 45, California.

Creating a new world with ELECTRONICS

HUGHES

MICROWAVE TUBE DIVISION
HUGHES AIRCRAFT COMPANY

MAGNETRONS—(Continued)

CANADIAN MARCONI CO.—(Continued)

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
7141	osc, .0025	9.05–9.55	6.3,0.51	7.8k,8	15	2.5	18kw
7142	osc, .0025	9.05–9.55	6.3,0.51	7.8k,8	15	2.5	18kw
7143	osc, .0025	9.05–9.55	6.3,0.51	7.8k,8	15	2.5	18kw
7182	osc, .0015	2.75–2.86	12,14	33k,185	5	6	2.5megw
2J42	osc, .0025	9.345–9.405	6.3,0.51	6k,5.5	15	2.5	7kw
2J42A	osc, .0025	9.345–9.405	6.3	8k,7.5	15	2.5	18kw
4J50	osc, .002	9.345–9.405		23k,3.75	15	2.7	225kw
4J50A	osc, .002	9.345–9.405		23k,3.75	15	2.7	225kw
5J26	osc, .0025	1.22–1.35	23.5,2.2	34k,55	5	6	400kw
5586	tun	2.7–2.9	16,3.1	30k	15	2.5	800kw
5657	tun	2.9–3.1	16,3.1	30k	15	2.5	800kw
6027	osc, .0025	9.345–9.405	6.3	8k,8	15	2.5	18kw
6249A	osc, .0013	8.5–9.6	10	29k	15	2.8	200kw

COMPAGNIE GENERALE DE T.S.F. 79, Boulevard Haussmann, Paris 8, France

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
MC567	osc, .0015	1.27–1.37	20–13	42k			2.5megw
MCV101	osc, 0.2	2.9–3.7	6.3–1.2	2k			100w
MC83/103	osc, .0005	2.925–3.525	5.3–2.6	32k			400kw
MC1055	osc, .0011	2.9–3.2	14V–5.6	33k			1.1megw
MCV1055	osc, .0011	2.9–3.2	14V–5.6	33k			1.1megw
2J52T	osc, .0015	8.5–9.6	12.6–2.2	17k			65kw
4J52A	osc, .0012	9.35–9.4	12.6–2.2	16k			70kw
4J50TO	osc, .0015	8.5–9.6	13.75–3.3	24k			200kw
4J50A	osc, .0012	9.35–9.4	13.75–3.3	23k			230kw

EITEL–McCULLOUGH, INC., San Carlos, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
X747	v. tun	0.4–1					100mw

ELLIOTT BROTHERS, LTD., Elstree Way, London

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
8MA8	fix osc, .0004	34.4–35.4	12,4	22k,25	45	0.4	100kw
4MA1	fix osc, .0005	75					5kw

EMI ELECTRONICS, LTD., Hayes, Middlesex, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
R6138	fix, .0004	34.8	6.3	16k,4.5	40	0.5	18kw
R9551	plsd	80	9,3	12k,8		0.3	2.5kw
R9515	plsd	34.5–35.3	6.3,4	16k,25	80	0.5	35kw
R9509	plsd	16.2–17.2	6.3,7	18k,30	10	1	50kw
MAG3		9.345–9.405	6.3,0.55	6k,7		0.1	12kw

ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
2J30–34	mult res., .002	2.7–2.9	6.3,1.5	22k,30	15	1	300kw
2J42	mult res., .002	9.345–9.405	6.3,0.5	6k,5.5	15	2	8kw
2J55	mult res., .001	9.345–9.405	6.3,1	16k,13	15	2	45kw
2J56	mult res., .001	9.215–9.275	6.3,1	12k,12	15	1	45kw
4J31–35	mult res., .001	2.7–2.9	16,3.1	30k,70	15	1	1megw
4J43–44	mult res., .001	2.965–3.019	16,3.1	28k,70	15	1	900kw
4J50A	mult res., .001	9.345–9.405	13.7,3.2	22k,25	15	1	225kw
4J52A	mult res., .001	9.35–9.4	12.6,2.2	15.5k,15	13	1	80kw
4J53	mult res., .001	2.793–2.813	16,3.1	28k,70	15	1	1megw
4J78	mult res., .002	9.003–9,168	13.7,3.5	21.5k,27.5	15	1	250kw
714AY	mult res., .001	3.28–3.32	6.3,1.5	20k,20	15	1	180kw
5586	mult res., .001	2.7–2.9	16,3.1	30k,70	15	1	1megw
5657	mult res., .001	2.9–3.1	16,3.1	30k,70	15	1	1megw
6027	mult res., .002	9.345–9.405	6.3,0.5	6.9k,7	15	1	20kw
7182	mult res., .001	2.75–2.86	12,15	38k,185	7	5	2.5megw
M501,A,B	mult res., .001	2.94–3.06	5,2.6	27k,35	35	2	500kw
M502A	mult res., .0005	9.323–9.425	12.6,2.2	21k,22.5	15	1	180kw
M503,A	mult res., .002	9.345–9.405	6.3,0.5	5.5k,4.5	15	0.1	8kw
M504	mult res., .0006	9.325–9.425	5,40	35k,50	15	0.6	750kw
M505	mult res., .001	9.36–9.46	3,3.5	11.1k,12	15	2	45kw
M506A	mult res., .001	9.36–9.46	3,3.5	11.2k,12	15	1	450kw
M507	mult res., .001	3.23–3.38	5,2.6	27k,40		0.5	425kw
M508	mult res., .001	9.21–9.27	6.3,0.5	5.5k,4.5	15	2	8kw
M509	mult res., .001	8.77–8.83	6.3,0.5	5.5k,4.5	15	2	8kw
M513A	mult res., .0005	9.345–9.405	6.3,0.5	7.5k,7.5	15	1	18kw
M519	mult res., .0002	3.45–3.614	5,2.6	27k,40		0.5	425kw
M521	mult res., .001	9.6–9.7	3,3.5	11.1k,12	15	1	45kw
M523	mult res., .001	9.58–9.705	13.7,3.2	22k,25	15	1	225kw
M525	mult res., .001	2.75–2.855	8.5,9	36k,70	7	1	1.15megw
M528	mult res., .001	3–3.12	6,1.25	22.5k,22.5	7	0.5	200kw
M529	mult res., .001	8.83–8.995	13.7,3.2	22k,25	15	1	225kw
M535	mult res., .0001	9.5–9.6	6.3,0.5	5.5k,4.5	15	1	7.2kw
M537	mult res., .002	8.77–8.83	6.3,0.5	5.5k,4.5	15	1	8kw
M538A	mult res., .001	9.21–9.27	13.7,3.2	22k,25	15	1	225kw
M539	mult res., .001	8.665–8.83	13.7,3.2	22k,25	15	1	225kw
M546	mult res., .001	9.7–9.85	13.7,3.2	22k,25	15	1	225kw
M547	mult res., .001	9.85–10	13.7,3.2	22k,25	15	1	225kw
M548	mult res., .001	9.003–9.168	3,3.5	13.5k,12	12	1	50kw
M549	mult res., .001	8.5–8.665	13.7,3.2	22k,25	15	1	225kw
M554	mult res., .001	1.295–1.365	20,13.5	39k150	4	5	2.6megw
M555	mult res., .001	14–16.5	12.6,2.2	16k,15	25	1	65kw
M565	mult res., .002	1.215–1,365	48,14	48k,240		10	5megw
M566	mult res., .001	2.75–2.86	12,15	38.5k,145	7	5	2.5megw
M569	mult res., .001	2.85–2.96	12,15	40k,140	7	5	2.5megw
M570	mult res., .001	2.95–3.06	12,15	40k,140	7	5	2.5megw
M573	mult res., .001	2.85–2.96	12,15	38k,144	7	5	2.5megw
M574	mult res., .001	2.95–3.06	12,15	41k,132	7	5	2.5megw

GENERAL ELECTRIC, Power Tube Dept., Schenectady 5, N.Y.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
GL6787		0.89–0.94	12,56	3.7k,1.1	2	cw	2.5kw
GL7398	v. tun	2.2–3.85	2.5,3	1.25k, .02		cw	2w
Z5266	v. tun	2.35–3.6	2.6,3	2k, .03		cw	0.5mw
Z5312	v. tun	2.2–2.3	2.5,3	1.85k, .02		cw	10w
Z5321	v. tun	2.9–3.1	2.6,3	1.25k, .02		cw	10w
Z5360	v. tun	2.8–3.5	2.6,3	1.25k, .02		cw	100mw
Z5405	v. tun	1–2.3	2.5,3	1.35k, .015		cw	1w
Z5424	v. tun	2.9–3.2	2.5,3	2.2k, .05		cw	50w

GENERAL ELECTRIC—(Continued)

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
Z5425	v. tun	1.48–1.6	2.8,3	1k, .01		cw	1w
Z5428	v. tun	2.2–2.3	2.37,3	1880, .02		cw	10w
Z5436	v. tun	2.4–3.3	2.6,3	900, .02		cw	5mw
ZM6006	v. tun	2.8–3.2	2,2.5	960, .02		cw	2w
Z5429	v. tun	8.5–11	2.5,3	1250, .02		cw	1mw
ZM6000	v. tun	2.09–2.41	2.3,3	1875, .02		cw	10w
ZM6001	v. tun	1.625–1.7	2,2.5	500, .02		cw	2w
ZM6003	v. tun	4.2–4.4	2,2.5	1k, .02		cw	2w

LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
L3204	0.25	8.8±.025					40w
L3105	.027	9.3±.04					100w
L3028	.027	9.28–9.32					120w
L3379	.003	8.8–9.5*					1kw
L3058	.003	9.33–9.35*					1kw
L3358	.001	16–16.5*					1kw
L3380	.002	8.8–9.5*					2kw
L3359	.001	16–16.5*					2kw
L3381	.001	8.8–9.5*					3kw
L3382	.001	8.8–9.5*					4kw
LT6233	.003	9.28–9.345					7kw
L3103	.002	8.5–9.6*					30kw
L3168	.002	9.375±.03					30kw
L3306	.002	16–17*					30kw
L3083A	.001	16–17*					60kw
LT6543A	.001	8.5–9.6*					65kw
L3305	.001	8.6–9.5*					65kw
LT6510	.001	9.375±.03					65kw
LT4J52A	.001	9.375±.03					70kw
L3312	.001	8.5–9.6*					200kw
L3313	.001	8.6–9.5*					200kw
LT4J50A	.001	9.375±.03					225kw
L3456	cw	0.35–0.59					500w
L3459	cw	0.59–0.97					500w
L3465	cw	0.975–1.5					400w
L3464	cw	1.5–2.35					400w
L3460	cw	2.35–3.575					500w
L3461	cw	3.575–4.975					400w
L3467	cw	4.975–6.175					400w
L3468	cw	6.175–7.275					300w
L3462	cw	7.275–8.775					300w
L3463	cw	8.775–10.475					250w

** Fix freq. types generally available thru range*

METCOM, INC., 76 Lafayette Street, Salem, Mass.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
MCM10	fix, .0003	5.5–5.6		7.5k,4		0.2	10kw
MCM11	tun, .002	5.4–5.9		1.3k,0.8		1	100w
MCM12	tun, .002	5.4–5.9		2k,1.1		1	400w
MCM13	tun, .002	5.4–5.9		2.8k,1.9		1	1kw
MCM14	tun, .002	5.4–5.9		2.2k,1.2		1	400w
MXM10	fix, .0004	9.375+.03		2.8k,1.5		0.25	800w
MXM11	tun, .002	9–9.5		0.8		1	100w
MXM12	fix, .0004	9.375±.03		3.7k,4.3		0.25	3.5kw
MXM13	tun, .002	8.5–8.9		1.32k,0.9		1	100w
MXM14	tun, .002	8.9–9.6		1.22k,0.9		1	100w

MICROWAVE ASSOCIATES, INC., Burlington, Mass.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
MA221	fix	7.5–8.8	5,0.4	420, .015		cw	1w*
MA212	fix	8.8–10	5,0.4	420, .015		cw	1w*
MA217	tun	7.5–8.5	5,0.4	430, .015		cw	1w*
MA219	tun	8.5–9.6	5,0.4	430, .015		cw	1w*
MA214	tun	9–10	5,0.4	430, .015		cw	0.5w*
MA221	fix, 0.1	7.5–8.8	5,0.4	500,0.15		0.25	10w*
MA212	fix, 0.1	8.8–10	5,0.4	500, 0.15		0.25	10w*
MA217	tun, 0.1	7.5–8.5	5,0.4	500, 0.15		0.25	10w*
MA219	tun, 0.1	8.5–9.6	5,0.4	500, 0.15		0.25	10w*
MA214	tun, 0.1	9–10	5,0.4	500, 0.15		0.25	5w*
MA208	tun, .02	7.125–8.5	6.3,0.6	800, 0.2		0.3	20w*
MA205	fix, 0.25	8.775–8.825	6.3,0.5	800, 0.2		5	40w*
MA215	fix, .05	8.8–9.6	6.3,0.5	900, 0.5		1	100w*
6229	tun, .0005	8.9–9.4	5,0.4	4k,0.5		0.25	400w*
6230	tun, .003	8.9–9.4	5,0.4	4.3k,0.8		1	900w*
MA222	fix, .002	9.345–9.405	6.3,0.5	5.5k,4.5		1	7kw*
MA209	tun, .001	9.3–10	6.3,0.5	5.8k,4.5		0.5	7kw*
MA218	tun, .002	9.3–10	6.3,0.5	5.8k,4.5		1	7kw*
MA226	fix, .0005	33–33.4	12.6,3	12k,10		0.25	16kw*
MA225	tun, .0004	32.95–33.45	12.6,3	12k,20		0.25	32kw*
MA224	fix, .00025	33–33.4	12.6,3	12k,20		0.25	32kw*
MA227	fix, .0008	33–33.4	12.6,3	12k,10		0.25	20kw*
MA206	fix, .0005	34.7–35	12.6,3	12k,10		0.25	16kw*
MA210A	tun, .0004	34.2–34.7	12.6,3	12k,20		0.25	32kw*
MA210B	tun, .0004	34.6–35.1	12.6,3	12k,20		0.25	32kw*
MA210C	tun, .0004	35–35.5	12.6,3	12k,20		0.25	32kw*
MA200	fix, .0002	34.7–35	12.6,3	12k,20		0.25	32kw*
5789	fix, .0002	34.5–35.2	6.3,2.4	12k,20		0.25	32kw*
MA207A	fix, .0004	34.7–35	12.6,3	12k,20		0.25	50kw*
MA220	tun, .0003	5.4–5.9		10k,12		10	40kw*

** Minimum*

RADIO CORP. OF AMERICA, Tube Division, Harrison, N.J.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
6521	fix	5.4±.02	10,3.2	15k,13.5			85kw
7008	tun, .001	8.5–9.6		23k,27.5			200kw
7111	tun, .001	8.5–9.6		23k,27.5			200kw
A1127	tun, .001	8.5–9.6		28k,27.5			250kw
6865A	tun, .001	8.75–9.6		23k,27.5			190kw
4011A	tun, .001	8.5–9.6	13.75,3.15	23k,27.5			215kw
A1135	tun, .002	8.5–9.6		23k,27.5			190kw
A1163	tun, .001	8.75–9.6		23k,27.5			215kw
A1150	fix, .027	9.28–9.32		900,0.55			140w

ABBREVIATIONS AND NOTES

a—ampere
ampl—amplifier
cav—cavity
cw—continuous wave
elect—electrostatic
fix—fixed frequency
gg—grounded grid
int—intermediate amplifier
k—thousand
megw—megawatt
min—miniature
mw—milliwatt
mod—modulator
mult—frequency multiplier; multi-resonator
osc—oscillator
p—peak
pkgd—packaged
plsd—pulsed
ppm—periodic permanent magnet
pm—permanent magnet
pwr—power
refl—reflex
res—resonator
rug—ruggedized
sol—solenoid
tetr—tetrode
tri—triode
tun—tunable
v. tun—voltage tuned
w—watt

Note 1: Velocity modulated oscillators are listed under Magnetrons.

Note 2: Pencil tubes and other coaxial tube types are listed under Planar Triodes and Tetrodes.

MAGNETRONS – *(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
RAYTHEON MFG. CO., Microwave & Power Tube Operations, Waltham, Mass.							
QK172	osc, .001	9.33–9.42		30k			440kw
QK264	osc, .001	1.25–1.35		75k,100			2megw
QK313	osc, .001	5.4–5.8		27k,30			250kw
QK324	osc, .0028	15.8–16.1		30k,14			70kw
QK362A	osc, .002	9.3–9.5		2k,1.25			60w
QK366	osc, .001	9.2–9.28		16k,14.5			75w
QK367	osc, .001	9.01–9.07		16k,16			40kw
QK389	osc, .0007	23.8–24.2		16k,19			50kw
QK390	osc	2.42–2.47		6.2k,.375			800kw
QK456	osc, .001	5.3–5.4		16k,20			75kw
QK457	osc, .002	5.5–5.8		2k,1			200w
QK470	osc, .0012	1.2–1.3		75k,100			2mw
QK520	ampl	1.22–1.35		40k,35			800kw
QK366A	ampl, .001	9.245±.04		15k,13.5		0.5	100kw
QK665	fix, .0018	1.25–1.285	15,150	72k,150		5	9.9kw
QK666	fix, .0018	1.32–1.35	15,150	72k,150		5	9.9kw
QK735	tun, .003	5.4–5.9	5,1	2.3k,1.5		1	400w
RK4J30	fix, .002	1.22–1.232	23.5,2.2	39k,60		4	600kw
RK5J26	tun, .002	1.22–1.35	23.5,2.2	31k,60		4	400kw
RK6517	tun, .0013	1.25–1.35	2.5,85	70k,60		3	1000kw
RK5609A	fix	2.425–2.475	6.3,1.5	1.6k,0.15			80w
RK4J61	tun	2.45–2.72	6.3,1.5	1.5k,0.15			50w
RK2J69	tun, .001	2.695–2.755	6.3,1.5	20k,25		1	150kw
RK4J62	tun	2.695–3.015	6.3,3.5	1.5k,0.15			50kw
RK2J34	fix, .002	2.7–2.74	6.3,1.5	22k,30		1	240kw
RK4J35	fix, .001	2.7–2.74	16,3.1	30k,70		1	800kw
RK5586	tun, .001	2.7–2.9	16,3.1	32k,70		1	700kw
RK6518	fix, .007	2.7–3.01	13,40	45k,92		2	1500kw
RK2J33	fix, .002	2.74–2.78	6.3,1.5	22k,30		1	240kw
RK4J34	fix, .001	2.74–2.78	16,3.1	30k,70		1	800kw
RK2J68	tun, .001	2.745–2.805	6.3,1.5	20k,25		1	150kw
RK6410	fix, .001	2.75–2.86	8.3,85	76k,135		2	4500kw
RK2J32	fix, .002	2.78–2.82	6.3,1.5	22k,30		1	240kw
RK4J33	fix, .001	2.78–2.82	16,3.1	30k,70		1	800kw
RK2J67	tun, .001	2.795–2.855	6.3,1.5	20k,25		1	150kw
RK2J31	fix, .002	2.82–2.86	6.3,1.5	22k,30		1	240kw
RK2J32	fix, .001	2.82–2.86	16,3.1	30k,70		1	800kw
RK2J66	tun, .001	2.82–2.905	6.3,1.5	20k,25		1	150kw
RK6406	fix, .0006	2.25–2.91	8.3,85	56k,95		2	1750kw
RK2J30	fix, .002	2.86–2.9	6.3,1.5	22k,30		1	240kw
RK4J31	fix, .001	2.86–2.9	16,3.1	30k,70		1	800kw
RK5657	tun, .001	2.9–3.1	16,3.1	32.5k,70		1	700kw
RK2J29	fix, .002	2.914–2.939	6.3,1.5	22k,30		1	240kw
RK2J28	fix, .002	2.939–2.965	6.3,1.5	22k,30		1	240kw
RK2J27	fix, .002	2.965–2.992	6.3,1.5	22k,30			240kw
RK4J44	fix, .001	2.965–2.992	16,3.1	30k,70			900kw
RK4J63	tun	2.985–3.335	6.3,3.5	1.5k,0.15			50w
RK4J43	fix, .001	2.992–3.019	16,3.1	30k,70			900kw
RK2J26	fix, .001	2.992–3.019	6.3,1.5	22k,30			240kw
RK2J25	fix, .002	3.019–3.047	6.3,1.5	22k,30			240kw
RK2J70	fix, .002	3.03–3.11	6.3,1.25	7.5k,15			20kw
RK2J24	fix, .002	3.047–3.071	6.3,1.5	22k,30			240kw
RK2J23	fix, .002	3.071–3.1	6.3,1.5	22k,30			240kw
RK2571	fix, .002	3.19–3.301	6.3,1.25	5.5k,8			6kw
RK4J64	tun	3.305–3.675	6.3,3:5	1.5k,0.15			50w
RK4J41	fix, .001	3.4–3.45	16,3.1	30k,70			700kw
RK6042	tun, .0016	3.43–3.57	8.3,43	57k,55			700kw
RK6403	tun, .0014	3.43–3.57	8.3,43	65k,90			2000kw
RK6695	tun, .001	3.43–3.57	16,3.1	33k,65			600kw
RK4J40	fix, .001	3.45–3.5	16,3.1	30k,70			700kw
RK4J39	fix, .001	3.5–3.55	16,3.1	30k,70			700kw
RK4J38	fix, .001	3.55–3.6	16,3.1	30k,70			700kw
RK4J37	fix, .001	3.6–3.65	16,3.1	30k,70			700kw
RK4J36	fix, .001	3.65–3.7	16,3.1	30k,70			700kw
RK6177	osc	4.268–4.35	6.3,0.6	350,.035			11w
RK6344	tun, .001	5.45–5.825	11,11	24k,30			175kw
RK6843	tun, .0012	5.45–5.825	9.5,11	26k,30			250kw
RK4J59	fix, .001	6.276–6.375	12.6,3.75	25k,35			180kw
RK4J58	fix, .001	6.375–6.475	12.6,3.75	25k,35			180kw
RK4J57	fix, .001	6.475–6.575	12.6,3.75	25k,35			180kw
RK2J51	tun, .0012	8.5–9.6	6.3,1	16k,16			45kw
RK2J51A	tun, .0011	8.5–9.6	6.3,1	16k,15.5			40kw
RK6249	tun, .0013	8.5–9.6	9,14.4	32k,32			200kw
RK2J50	fix, .0012	8.75–8.9	6.3,1	16k,16			40kw
RK2J49	fix, .0012	9–9.16	6.3,1	16k,16			40kw
RK6229	tun, .003	8.9–9.4	5,0.45	5k,1			400w
RK6230	tun, .003	8.9–9.4	5,0.45	5k,1			910w
RK2J36	fix, .002	9.003–9.168	6.3,1.3	13.5k,12			14kw
RK2J56,A	fix, .001	9.215–9.275	6.3,1	16k,16			40kw
RK6002	fix, .002	9.230–9.404	4,40	30k,40			225kw
RK5982	fix, .001	9.345–9.405	6.3,2.9	16.5k,14.5			75kw
RK2J55	fix, .001	9.345–9.405	6.3,1	16k,16			40kw
RK2J42	fix, .0025	9.345–9.405	6.3,0.5	6k,5.5			7kw
RK730A	fix, .001	9.345–9.405	6.3,1	16k,16			40kw
RK725A	fix, .001	9.345–9.405					
RK6841	fix, .001	16.41–16.625					
RK7461	tun, .002	9.3–9.5					
2J23	osc, .002	3.1–2.7		22k,30			240kw
2J24	osc, .002	3.1–2.7		22k,30			240kw
2J25	osc, .002	3.1–2.7		22k,30			240kw
2J26	osc, .002	3.1–2.7		22k,30			240kw
2J27	osc, .002	3.1–2.7		22k,30			240kw
2J28	osc, .002	3.1–2.7		22k,30			240kw
2J29	osc, .002	3.1-2.7		22k,30			240kw
RAYTHEON MFG. CO., –*(Continued)*							
2J30	osc, .002	3.1–2.7		22k,30			240kw
2J31	osc, .002	3.1–2.7		22k,30			240kw
2J32	osc, .002	3.1–2.7		22k,30			240kw
2J33	osc, .002	3.1–2.7		22k,30			240kw
2J34	osc, .002	3.1–2.7		22k,30			240kw
2J36	osc, .002	9–9.1		14k,12			14kw
2J42	osc, .002	9.3–9.4		5.7k,4.5			8kw
2J50	osc, .0012	8.7–8.9		16k,16			40kw
2J49	osc	9–9.1					
2J51	osc, .0012	8.5–9.6		16k,16			45kw
2J55	osc, .001	9.3–9.4		16k,16			40kw
2J56	osc, .001	9.21–9.27		16k,16			40kw
2J66	osc, .001	2.8–2.9		20k,25			150kw
2J67,68	osc	2.7–2.8					
4J35	osc, .001	2.7–2.9		30k,70			800kw
4J34	osc, .001	2.7–2.9		30k,70			800kw
4J33	osc, .001	2.7–2.9		30k,70			800kw
4J32	osc, .001	2.7–2.9		30k,70			800kw
4J31	osc, .001	2.7–2.9		30k,70			800kw
4J41	osc, .001	3.4–3.7		30k, 70			700kw
4J40	osc, .001	3.4–3.7		30k,70			700kw
4J39	osc, .001	3.4–3.7		30k,70			700kw
4J38	osc, .001	3.4–3.7		30k,70			700kw
4J37	osc, .001	3.4–3.7		30k,70			700kw
4J36	osc, .001	3.4–3.7		30k,70			700kw
4J63	osc	2.98–3.33		1.5k,.15			50w
4J64	osc	3.3–3.6		1.5k,.15			50w
2J70	osc, .002	3–3.1		7.5k,15			20kw
2J71	osc, .002	3.1–3.2		5.5k,8			6kw
4J30	osc, .002	1.22–1.23		30k,60			600kw
2J69	osc, .001	2.6–2.7		20k,25			150kw
4J43	osc, .001	2.9–3		30k,70			900kw
4J44	osc, .001	2.96–2.99		30k,70			900kw
4J57	osc	6.57–6.47		35k			180kw
4J59	osc	6.2–6.3		25k			210kw
4J58	osc	6.3–6.4					
4J61	osc	2.4–2.7		1.5k			50w
4J62	osc	2.6–3					
5J26	osc, .002	1.2–1.3		31k,60			400kw
725A	osc, .001	9.3–9.4		16k,16			40kw
730A	osc, .001	9.3–9.4		16k,16			40kw
5982	osc, .001	9.3–9.4		17k,14.5			75kw
6002	osc, .002	9.2–9.4		30k,40			225kw
6177	osc	4.2–4.3		350,.025			1w
6229	osc, .003	8.9–9.4		5k,1			400w
6230	osc, .003	8.9–9.4		5k,1			910w
6249	osc, .0013	8.5–9.6		29k,32			200kw
6344	osc, .001	5.45–5.825		24k,30			175kw
6402	osc, .0016	3.4–3.5		57k,55			700kw
6406	osc, .0006	2.8–2.9		56k,95			1.75megw
6410	osc, .001	2.7–2.8		76k,135			1.5megw
6517	osc, .0013	1.2–1.3		70k,60			1megw
6518	osc, .007	2.7–3		45k,92			1.5megw
6841	osc, .001	1.64–16.6		19k,16			50kw
6843	osc, .0012	5.4–5.8		26k,30			250kw
5586	osc, .001	2.7–2.9		30k,70			800kw
5657	osc, .001	2.9–3.1		33k,70			700kw
5609A	osc, .001	2.42–2.47		1.6k,0.15			80w
6695	osc, .001	3.43–3.57		33k,65			650kw
6403	osc, .001	3.43–3.57		65k,90			2megw
SYLVANIA, Special Tube Operations, 1891 E. Third St., Williamsport, Pa.							
2J42	fix, .001	9.345–9.405		5.5k,4.5		2	7kw
2J42H	fix, .00036	9.345–9.405		5.5k,4.5	20	0.4	7kw
6027	fix, .002	9.345–9.405		6.5k,3.5		1	18kw
6027H	ixi, .001	9.345–9.405		7.4k,4.5	15	1	18kw
6874	tun, .001	8.8–9.4		21k,25		1	180kw
7006	tun, .001	9–9.6		21k,25		0.45	190kw
M4163	tun, .001	8.5–9.6		21k,25		2.35	180kw
M4164	tun, .001	8.5–9.6		21k,25		2.35	200kw
M4193	tun, .001	8.5–9.6		23k,27		2.5	200kw
M4193B	tun, .pp1	9.0–9.6		23k,27		2.5	200kw
7098	tun, .002	9.3–9.5		1.45k,1	15	1	60w
7503	tun, .002	9.3–9.5		1.45k,1	15	1	100w
7449A	fix, .00037	23.8–24.2		15k,18		.09	55kw
5789	fix, .0004	34.5–35.2		13k,20	55	1	32kw
6799	fix, .0005	34.5–35.2		18.5k,20	40	0.8	40kw
M4064	fix, .00025	34.5–35.2		18k,24	40	0.25	70kw
M4155A	fix, .00025	34.5–35.2		12k,20	40	0.25	40kw
6551	fix, .0006	23.8–24.2		14k,15		0.15	40kw
WESTINGHOUSE, Electronic Tube Div., P.O. Box 284, Elmira, N. Y.							
WL6177	osc, cw	4.268–4.35	6.3,0.6	315,.030	4		1w
WL6285	osc, .0018	1.31		70k,350		10	6.5megw
WL7008	osc, .001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7796	osc, cw	4.2–4.4	6.3,0.6	350,.030			2w
WL7794	osc, cw	4.2–4.4	6.3,0.6	425,.030			10wp
WL7795	osc, cw	4.2–4.4	6.3,0.6	425,030			10wp
WL7110	osc, .001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7111	osc, .001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7112	osc, .001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7541	osc, .001	8.5–9.6	9.0,14	28k,25	12	1.1	250kw
WL6249B	osc, .001	8.5–9.6	9.0,14	28k,25	12	3.3	240kw

PLANAR TRIODES AND TETRODES

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Anode V;MA	Ampl Fac	Max Diss.	Power Output
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y.							
7377	twin tetr	0.96	6.3*,0.6	250,2x40			5w
TBL2/500	tri ampl	1	3.4,19	2k,400		500w	
6907	twin tetr	0.6	6.3*,1.3	400,2x50		25w	15w
6252	twin tetr	0.6	6.3*,1.3	400,2x50		25w	15w
EC157	tri ampl	4	6.3,0.73	200,60			
EC88	tri ampl	0.9	6.3,0.19	160,12.5		2.2w (μ ~ 65, gm = 14k)	
*Also 12.6V.							
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N. Y.							
A2521	tri	1	6.3,0.37	250,20	60	2.5w	
A2244	tri	3	6.3,0.4	350,150	30	10w	1w
A2327	tri	3	6.3,0.4	350,150	30	10w	1w
CV2204	tri	3	6.3,0.4	350,150	30	10w	1w
DET22	tri	3	6.3,0.4	350,150	30	10w	4w
DET29	tri	6	6.3,0.4	450,120	55	10w	1.7w
DET24	tri	2	6.3,1	400,600	33	20w	10w
ACT22	tri	1	6.3,4	600,1.5a	22	75w	90w
ACT25	tri	1	13.5,2.8	1k,5a	75	400w	300w
ACT27	tri	0.6	15,6.7	1.5k,10a	45	1.5kw	1kw
ALLEN B. DUMONT LABS, INC., Clifton, N.J.							
6280A	lw noise tri	5					10wp
6280/416B	wide-band tri	5					5w
7739	plsd tri	4–5					3w
EITEL – McCULLOUGH, INC., San Carlos, Calif.							
2C39	tri ampl	2.5	6.3,1.1	800,80		100w	27w
2C39WA	tri ampl	2.5	6,1.05	800,80		100w	27w
3CPN10A5	tri ampl, .002	3	6,1.05	3.5k,3a		10w	1.6kw
3CX100A5	tri ampl	2.5	6,1.05	800,80		100w	27w
3X100A5	tri ampl	2.5	6.3,1.1	800,80		100w	27w
4X150G	tri ampl	1.5	2.5,7.3	7kp,6a		150w	17kwp
X685C	tri ampl	2.5	6,1.05	900,90		100w	15w
X779	tri ampl	2.5	26.5,0.225	900,90		100w	15w
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England							
6181	tv tetr.	0.9	120,1.6	2k,1.7a		2kw	1.1kw
L. M. ERICCSON, Stockholm 20, Sweden (State Labs Inc., 215 Park Ave., South New York 3, N.Y.)							
416B	tri ampl	0.2-4.2	6.1,1.15	270,33	300		0.5w
GENERAL ELECTRIC, Power Tube Dept., Schenectady 5, N. Y.							
GL2C40	tri ampl	3.37	6.3,0.75	250,25	36	6.5w	75mw
GL2C40A	tri ampl	3.37	6.3,0.75	250,25	35		75mw
GL2C43	tri, .001	3.37	6.3,0.9	3kp,2.5	48	6w	1.75kwp
GL6299	tri ampl	3	6.3,0.3	200,12	115		
GL6442	tri, .001	5	6.3,0.9	3kp,2.5ap	50	7.5w	500wp
GL6771	tri ampl	4	6.3,0.57	250,25	90		450mw
GL6897	tri ampl	2.5	6.3,1.05	1k,125	100	100w	17w
GL7391	tri osc	6	6.3,0.38	150,15	62		65mw
GL7644	tri, .001	3	6.3,0.3	200,12	110	2w	
Z5099A	tri ampl	2.5	6.3,1	1k,117	100		
Z5387	tri ampl	2.5	6.3,1.05	1k,125	100	10w	
Z5435	min tri	3	6.3,0.3	200,12	115		
GENERAL ELECTRIC—*(Continued)*							
GL6283	tetr ampl	0.9	6.3,3.6	16k,300	10	300w	185w
GL6942	tetr ampl	0.9	5.7,24	4k,700	20	1.5kw	1kw
GL7399	tetr, .001	1.5	6.3,5.6	10kp,10a	10.5	300w	52kw
Z5102	tetr ampl	0.8	6.7,14.5	7k,1a	20	3.5kw	3.2kw
Z5049	tetr ampl	0.8	6.7,14.5	7k,1a	20	2kw	3.2kw
Z5033	tri osc						
MACHLETT, LABORATORIES, INC., Springdale, Conn.							
ML2C39A	tri	2.5	6.3,1	1k,0.125	100	100	
ML2C41	tri plsd	3	6.3,1	3.5kp,6.5a	100	35	
ML3CX100A5	tri	3	6,1	1k,0.125	100	100	
ML3CPN10A5	tri	3	6,1	3.5kp,4.5a	100	10	
ML6442	tri	5	6.3,0.9	3kp,3.75a	50	8	
ML6771	tri	4	6.3,0.57	0.3k, .033	90	6.25	
ML7209	tri plsd	3	6,1	3.5kp,4.5a	100	35	
ML7210	tri	3	6.3,0.85	1k, .095	75	100	
ML7211	tri	3	6.3,1.3	1k,0.19	80	100	
ML7289	tri	3	6,1	1k,0.125	100	100	
ML7698	tri	3	6.3,1.3	3.5kp,7.5a	80	10	
ML7815	tri	3	6,1	3.5kp,4.8a	100	10	
NIPPON ELECTRIC CO., LTD., Tokyo, Japan							
2C39A,B*	tri ampl	2.5	6.3,1	900, .09	100	100w	15w
2C40	tri ampl	3.37	6.3,0.75	250, .02	35	6.5w	85mw
2C43	tri ampl, .001	3.37	6.3,0.9	3kp,2	48	12w	1kwp
5861	tri ampl	3.7	6.3,0.4	300, .03	30	10w	0.5w
2C46	tri osc	1.3	6.3,0.75	250, .015	65	12w	
LD-497	tri ampl	2.5	6.3,1.3	900, .14	90	140w	26w
LD-509*	tri ampl	2.5	6.3,1.3	1250, .15	90	230w	50w
LD-531*	tri ampl	2.1	6.3,2.3	1.7k, .35	130	550w	100w
*Ceramic Sealed							
RADIO CORP. OF AMERICA, Tube Div., Harrison, N. J.							
5675*	tri gg	3	6.3,0.135	135,24	20		50mw
5876*	tri gg	1.7	6.3,0.135	250, .018			
5893*	tri, .001, gg	3.3	6.3,0.33	1.75k,3ap			1.2kwp
6263*	tri	1.7	6.3,0.28	275, .033	27	13w	
6264A*	tri	1.7	6.3,0.28	400, .055	40	13w	
6562*	fix tri osc	1.68	6.6,0.16	120, .034		3.6w	
7533*	tun tri osc	1.66–1.7	6.6,0.16			3.6w	
7552*	tri ampl	1	6.3,0.225	125, .025		2.5w	
7553*	tri ampl rug	1	6.3,0.225	125	80	2.5w	
7554*	tri	3	6.3,0.225	250, .025		2.5w	
*Pencil-type Construction							
SYLVANIA, Special Tube Operations, 1891 E. Third St., Williamsport, Pa.							
2C36	plsd osc	3	6.3, .4	1.2k,0.9	25	5w	200w
2C37	cw osc	3.3	6.3, .4	200, .025	25	5w	450mw
5764	cw osc	3.3	6.3, .425	200, .025	25	5w	450mw
5765	cw osc	2.9	6.3, .4	180, .025	25	5w	250mw
5768	gg ampl	3	6.3, .4	150, .007	90	2w	(10 db gain)
6481	cw osc	3.3	6.3, .4	180, .016	25	5w	500mw
6503	cw osc	3.3	6.3, .4	200, .025	23	5w	450mw
5767	cw osc	3.3	6.3, .4	200, .025	25	5w	450mw

KLYSTRONS

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y.							
55334	refl	3.336–3.414	6.3,0.75	3k, .024	850		10w
2K25	tun refl	8.5–9.66	6.3,0.44	300, .025	200	35mc	25mw
DX122	2 cav f.f.	8.5–10.5	11,1.2	2.75k, .035			5w
DX123	2 cav f.f.	8.5–10.5	11,1.2	4.35k, .071			33w
DX124	2 cav f.f.	8.5–10.5	11,1.2	8.8k,0.18			210w
723A/B	tun refl	8.702–9.548	6.3,0.44	300, .025	185	40mc	30mw
DX184	tun refl	31–36	6.3,0.8	2.25k, .015	500	60mc	100mw
DX151	tun refl	68–75	3.5,1.8	2.4k, .017	300	100mc	100mw
BENDIX AVIATION CORP., Red Bank, Eatontown, N. J.							
6541	osc	23.2–24.7		330			8.5mw
6584	osc	5.1–5.9		330			70mw
6845	osc	8.5–9.6		350			20mw
TK37	osc	34–35.6		425			8.5mw
TK60	osc	23.5–24.5		330			8.5mw
TK61	osc	10.52		350			20mw
6116	refl	8.5–9.66					
6940	refl	5.2–10.9					
6845	refl	8.5–9.6					
2K50	refl	23.5–24.4					
TK38	refl	5.1–5.9					
TK53	refl	34–35.6					
TK80	refl	5.3–5.9					
BOMAC LABORATORIES, INC., Salem Rd., Beverly, Mass.							
BL801	tun	8.5–9.6		300			30mw
BL800A	tun	8.5–10		200			20mw
BL803	tun	8.5–10		200			20mw
BL800	tun	8.5–10		200			25mw
BL811	fix	8.5–10		210			25mw
6310	tun	8.5–10		300			70mw
6312	tun	8.5–10		300			70mw
BL806	tun	8.5–10		500			0.3w
BL825	tun	8.5–10		500			0.5w
BL807	tun	8.5–10.5		350			120mw
BL818	tun	8.5–10.5		350			120mw
BL830	tun	8.69–8.79		250			15mw
BL815	fix	9.142–9.152		200			30mw
BL831	fix	9.26		300			80mw
BL832	fix	9.34		300			80mw
BL814	tun	10.4–12.3		400			0.2w
BL812	tun	8.5–9.6		300			60mw
BL829	fix	8–9.5		500			0.5w
BOMAC LABORITIES, INC.,—*(Continued)*							
BL802	tun	8.8–9.2		250			30mw
BL819	tun	9–9.2		300			60mw
BL820	tun	9.05–9.25		300			60mw
BL824	tun	9.2–9.5		300			60mw
BL841	fix	8–9.5		300			60mw
BL843	fix	8–9.5		200			20mw
BRITISH INDUSTRIES CORP,, 80 Shore Road, Port Washington, N. Y.							
KLX1	4 cav	4.1,4.8	4.1,4.8	11k,0.3		±30mc	1130w
KLS2	3 cav	5,9.5	5,9.5	10k,1		±50mc	1.7kw
COMPAGNIE GENERALE DE T.S.F., 79, Boulevard Haussmann, Paris 8, France							
AX435	ampl	3	340W	125k–120			6megw
AX436	ampl	3	650W	250k–250			25megw
6BL6	osc	1.6–6.5	6.3–0.68	35mA	700	10mc	40mw
5836	osc-pm	1.6–6.5	6.3–0.68	29mA	700	10mc	40mw
6BM6	osc	0.5–3.8	6.3–0.68	32mA	700	12mc	20mw
KR117	osc	2.7–3.6	6.3–1	40mA	450	25mc	150mw
KR142	osc	2.7–3.6	6.3–2.4	80mA	275	26mc	180mw
KR740	osc mod	2.9–3.5	6.3–1		1k	40mc	2.5w
KR741	osc mod	3.45–3.75	6.3–1		1k	40mc	2.5w
KR742	osc mod	3.75–4	6.3–1		1k	40mc	2.5w
KR743	osc mod	4–4.25	6.3–1		1k	40mc	2.5w
EITEL – McCULLOUGH, INC., San Carlos, Calif.							
1K20XS	refl osc	8.5–9.2	6.3,1	350, .055	150		75mw
1K20XK	refl osc	9.2–10	6.3,1	350, .050	150		75mw
1K20XD	refl osc	10–10.7	6.3,1	350, .055	150		75mw
1K20KA	refl osc	10.7–11.5	6.3,1	350, .055	150		40mw
1K015CA	refl osc	5.35–5.95	6.3,1	350, .049	240		130mw
1K015CG	refl osc	5.35–5.95	6.3,1	350, .049	240		130mw
1K75CH	refl osc	4.3 ± 50mc	6.3,1.5	750, .060	350		1w
1K75CK	refl osc	4.3 ±50mc	6.3, 1.5	750, .060	350		1w
1K125CA	refl osc	3.7–4.4	6.3,1.5	1k, .075	275		1.6w
1K125CB	refl osc	4.4–5	6.3,1.5	1k, .075	345		2.5w
1K125CC	refl osc	4.5–5	6.3,1.5	1k, .075	345		2.6w
3K2500LX	3 cav ampl	9.8–1.2	7.5,5.8	7k,0.455			1.32kw
3K2500SG	3 cav ampl	1.7–2.4	7.5,5.8	7k,0.57			1.3kw
3K3000LQ	3 cav ampl	0.61–0.985	5,32	9k,0.6			2.4kw
3K50000LA	3 cav ampl	0.4–0.6	8,40	15k,1.65			10.7kw
3K50000LF	3 cav ampl	0.57–0.72	8,40	15k,1.65			10.7kw
3K50000LQ	3 cav ampl	0.72–0.985	8,40	15k,1.65			10.7kw
3KM3000LA	3 cav ampl	0.385–0.585	5,32	9k,0.59			2.3kw

KLYSTRONS — (Continued)

EITEL-McCULLOUGH, INC. — (Continued)

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
3KM4000LT	3 cav ampl	0.96–1.215	7.5,5.5	26k,0.133			38.2kw
3KM50000PA	3 cav ampl	0.225–0.4	7.5,40	23k,2.6			23.1kw
4K50000LQ	4 cav ampl	0.6–0.985	8,40	16k,1.59			11.2kw
4KM3000LQ	ampl	0.71–0.985	5,33	9k,0.58			2.15kw
4KM3000LR	ampl	0.61–0.985	5,31	8.5k,0.55			2.1kw
4KM50000LA	ampl	0.4–0.63	7.5,40	17k,1.8			10kw
4KM50000LQ	4 cav ampl	0.61–0.985	7.5,40	17k,1.8			10kw
4KM50000SG	4 cav ampl	1.7–2.4	6.3,37.5	17k,1.9			12kw
4KM170000LA	4 cav ampl	0.3–0.5	11,47.5	33k,4.8			77kw
4KMP10000LF	4 cav ampl	0.57–0.63	12,25	61.5k,0.15			400kwp
6K50000LQ	4 cav ampl	0.72–0.98	8,40	19.5k,2.3			9kw
X626	3 cav ampl	0.4–0.45	7.5,95	105k,2.07			1.25megw
X602K	4 cav ampl	0.375–0.5	11,47.5	45k,1.69			155kw
X632	ampl, 0.167	2.845–2.865	11,25	235k,105			10megw
X700	4 cav ampl	2.4–2.9	7.5,5.5	21k,0.138			20kw
X563K,L,M	ampl	5.4–7.1	6.3,1	3k,0.13			60w
X768	3 cav ampl	0.755–0.985					75kw
Y222	refl osc	10.5–10.7					70mw

ELLIOTT BROTHERS, LTD., Elstree Way, London, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
4FK1	fix osc	75	6.3,2.3	4k, .045	1k*		100mw
4FK2	fix osc	75	6.3,2.3	4k, .045	1k*		500mw
6FK1	fix osc	50	6.3,2.3	4k, .040	1k*		5w
6TFK2	tun osc	50	6.3,2.3	4k, .040	1k*	1.5kmc	3w
8FK1	fix osc	33–37	6.3,2.3	4k, .045	1k*		15w
8TFK2	tun osc	33–37	6.3,2.3	4k, .045	1k*	1.6kmc	10w
8RK4	tun refl	34.5–35.5	6.3,1.4	2.1k, .011	290	1kmc	30mw
8RK8	tun refl	34.5–35.5	6.3,1.4	2.5k, .020	290	1kmc	250mw
12FK1	fix osc	21–25	6.3,2.3	4k, .060	1k*		10w
12TFK2	tun osc	21–25	6.3,2.3	4k, .060	1k*		8w
12RK3	tun refl	21–25	6.3,2.0	2.5k, .020	290		30mw
12RK4	tun refl	21–25	6.3,2.0	2.5k, .020	290		500mw
100RK2	plug-in refl	3.3–3.7	6.3,0.66	0.3k, .045	220		95mw

*Focus

EMI ELECTRONICS, LTD., Hayes, Middlesex, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
R9555	refl	37.5–43	6.3,0.8	2k, .012	300	60mc	30mw
R9521	refl	35–40	6.3,0.8	2k, .012	300	60mc	40mw
R5146	refl	34–36.5	6.3,0.8	2k, .012	300	60mc	60mw
R9518	refl	27.8–32.2	6.3,0.8	2k, .01	300	60mc	60mw
R9547	refl	24–27.8	6.3,0.8	2k, .012	300	60mc	60mw
R9520	refl	16.2–17.2	6.3,0.6	2k, .012	100	45mc	30mw
25182	refl	8.2–11.7	6.3,0.7	350, .035	350	20mc	130mw
25157	refl	7–10.3	6.3,0.7	350, .05	270	20mc	200mw
25181	refl	5.4–8.2	6.3,0.7	350, .04	300	20mc	150mw
R5222	refl	5–11.7	6.3,0.7	250, .04	500		200mw
R9546	refl	32–37.5	6.3,0.8	2k, .012	300	60mc	40mw
R9538	refl	9.1–9.3	6.3,1.2	350, .04	210	20mc	60mw
R9539	refl	9.3–9.5	6.3,1.2	350, .04	220	20mc	60mw
R9540	refl	9.5–9.7	6.3,1.2	350, .04	230	20mc	60mw
R9541	refl	9.7–9.9	6.3,1.2	350, .04	240	20mc	60mw
R9542	refl	9.9–10.1	6.3,1.2	350, .04	250	20mc	60mw
R9543	refl	10.1–10.6	6.3,1.2	350. .04	260	20mc	60mw
R9544	refl	10.6–11	6.3,1.2	350, .04	300	20mc	45mw
KRN3	refl	9.55–9.9	4,1.3	1.35k, .008	250	25mc	25mw
R9516	refl	7.05–7.3	12.6,1.1	1k,0.12	300	40mc	2.2w
R9537	refl						
R6010	refl	4.4–4.8	6.3,0.9	750,0.14	290	50mc	3.7w
R6015	refl	4.27–4.76	6.3,0.9	250, .04	175	20mc	150mw
R5081	refl	3.9–4.2	6.3,0.9	750,0.14	350	40mc	4w
RK6112	refl	1–4	6.3,0.7	250, .02	400		150mw
R9559	refl	1–5.4	6.3,1.2	300, .035	350	35mc	100mw
R9585	refl	0.5–3	6.3,0.7	300, .02	400		50mw
R9586	refl	0.5–3					
25205	refl	3.28–3.72	6.3,1.2	300, .035	200	30mc	120mw
KR6/1	refl	3.36–3.55	4,1.3	250, .032	140	30mc	150mw
KR6/2	refl	3.17–3.39	4,1.3	250, .032	140	30mc	150mw
KR6/3	refl	2.93–3.13	4,1.3	250, .032	140	30mc	150mw
R9570	3 cav, .002	2.7–3.05	11,8	45k,9		5mc	100kw
R9571	4 cav, .005	2.7–3.05	11,8	20k,6.5		30mc	15kw
R9602	refl	22–26	6.3,0.8	2k, .015	500	40mc	50mw
R9621	refl	20–24	6.3,0.8	2k, .01	300	40mc	50mw
25212	refl	3.95–5.5	6.3,1.2	350, .04	500	25mc	80mw
25221	refl	3.3–4.9	6.3,1.2	350, .04	300	25mc	80mw

ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
K300	refl osc	9.32–9.5	6.3,0.6	350, .035	140	30mc	30mw
K301	refl osc	2.5–3.5	6.3,0.6	350, .035	375	15mc	30mw
K302	refl osc	9.32–9.5	6.3,0.6	350, .035	155	30mc	30mw
K305	refl osc	9.25–9.5	6.3,0.6	350, .035	160	35mc	25mw
K308	refl osc	8.8–10	6.3,0.6	350, .035	210	40mc	40mw
K311	refl osc	8.5–9.5	6.3,0.6	350, .035	355	30mc	45mw
K312	refl osc	9.43–9.65	6.3,0.6	350, .035	170	30mc	30mw
K313	refl osc	9.645–9.775	6.3,0.6	350, .035	175	30mc	25mw
K315	refl osc	9.105–9.205	6.3,0.6	350, .035	260	30mc	20mw
K317	refl osc	8.2–8.3	6.3,0.6	350, .035	310	30mc	20mw
K321	refl osc	9.43–9.65	6.3,0.6	350, .035	170	30mc	25mw
K323	refl osc	9.645–9.775	6.3,0.6	350, .035	175	30mc	25mw
K324	refl osc	9–10	6.3,0.6	350, .035	390	30mc	45mw
K328	refl osc	9.555–9.685	6.3,0.6	350, .035	180	30mc	25mw
K335	refl osc	9.555–9.685	6.3,0.6	350, .035	170	30mc	25mw
K337	refl osc	9–10	6.3,0.6	350, .035	390	24mc	45mw
K340	refl osc	9.3–9.5	6.3,0.6	300, .025	165	40mc	35mw
K342	refl osc	8.5–9	6.3,0.6	350, .035	265	35mc	45mw
K343	refl osc	12–14.5	6.3,0.6	350, .030	220	59mc	40mw
K345	refl osc	5.925–7.725	6.3,0.8	750, .072	350	30mc	1w
K346	refl osc	14.5–17	6.3,0.6	350, .030	180	75mc	45mw
K347	ampl, .002	.58–.615	7,35	75k, 10			600kw
K350	2 cav osc	8.5–10	6.3,1.7	700, .070		12mc	1.2w
K351	refl osc	8.5–9.6	6.3,1.2	300, .040	150	35mc	65mw
K352	ampl, .001	2.998	4.3,83	190k,100			6megw
K353	refl osc	10.5–12.2	6.3,1.2	400, .060	250	60mc	250mw
K357	refl osc	10.66–10.72	6.3,0.6	250, .015	100	30mc	12mw
K358	refl osc	10.5–12.2	6.3,1.2	400, .060	250	60mc	250mw
K359	refl osc	8.1–8.75	6.3,1.2	350, .045	500	55mc	90mw
K361	refl osc	10.7–10.625	6.3,0.6	300, .025	200	20mc	27mw

LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
L3270	.0025	1.25–1.35					2megw
LT7504	.0025	1.24–1.36					2.2megw
L3257	.0003	1.28–1.33					4megw
L3227	.002	1.28–1.33					5megw
L3250	.0015	1.25–1.35					10megw
L3387	.0033	1.25–1.35					30megw
L3302	.0015	2.855					10megw
L3355	.0015	1.25–1.35					20megw

METCOM, INC., 76 Lafayette St., Salem, Mass.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
MXK14	refl	8.5–10	6.3	300	225	30mc	25mw
MXK15	refl	8.5–10	6.3	300	225	30mc	25mw
MXK16	refl	8.5–10	6.3	300	225	30mc	25mw
MXK17	refl	8.5–10	6.3	250	120		30mw
MXK18	refl	8.5–10	6.3	300	225	30mc	40mw
MXK11	refl	8.5–10	6.3	200	165	20mc	15mw
MXK19	refl	8.5–10	6.3	300	225	30mc	25mw
MXK20	refl	10.25–11.75	6.3	300	275	30mc	25mw
MXK21		8.5–9.6	6.3	300	150	30mc	20mw
MXK22		10–10.25	6.3	500	225	30mc	100mw
MXK23		9.1–9.5	6.3	300	150	400mc*	15mw
MXK24		8.5–10.5	6.3	300	225	30mc	50mw
MKK11		13.295–13.305	5.55	3k			15mw

*V. tun ferrite cav

NIPPON ELECTRIC CO., LTD., Tokyo, Japan

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
2K25	refl	8.5–9.66	6.3,0.44	300, .025	180	40mc	35mw
2K26	refl	6.25–7.06	6.3,0.44	300, .025	115	50mc	100mw
2K54A	refl	4.05–4.3	6.3,0.45	400, .025	350		500mw
2K54B	refl	3.85–4.1	6.3,0.45	400, .025	350		500mw
2K54C	refl	3.65–3.9	6.3,0.45	400, .025	350		500mw
2K54DA	refl	4.25–4.35	6.3,0.45	250, .012	160	35mc	50mw
5976	refl	6.2–7.425	6.3,0.44	300, .012	110	60mc	120mw
5721	refl	4–11	6.3,0.58	1k, .020	150		100mw
4V27	refl	3.5–4.5	6.3,0.675	325, .025	180		150mw
6V200	refl	6.225–6.325	6.3,0.76	750, .070	130	50mc	300mw
6V201	refl	5.925–6.225	6.3,0.76	750, .070	330	35mc	1.2w
6V202	refl	6.125–6.425	6.3,0.76	750, .070	330	35mc	1.2w
6V203	refl	6.425–6.575	6.3,0.76	750, .070	330	35mc	1.2w
7V204	refl	6.575–6.875	6.3,0.76	750, .070	330	35mc	1.2w
7V205	refl	6.875–7.125	6.3,0.76	750, .070	330	35mc	1.2w
7V206	refl	7.125–7.425	6.3,0.76	750, .070	330	35mc	1.2w
8V207	refl	7.425–7.750	6.3,0.76	750, .070	330	28mc	1w
8V208	refl	7.750–8.1	6.3,0.76	750, .070	330	23mc	1w
6V211	refl	5.985–6.285	6.3,0.44	300, .023	100	40mc	35mw
6V212	refl	6.285–6.585	6.3,0.44	300, .023	100	40mc	35mw
7V213	refl	6.585–6.705	6.3,0.44	300, .023	100	40mc	40mw
7V214	refl	6.705–7.005	6.3,0.44	300, .023	100	40mc	40mw
7V215	refl	6.955–7.255	6.3,0.44	300, .023	100	40mc	40mw
7V216	refl	7.255–7.555	6.3,0.44	300, .023	100	40mc	40mw
6V221	refl	5.925–6.225	6.3,0.76	750, .070	330	35mc	1.2w
6V222	refl	6.125–6.425	6.3,0.76	750, .070	330	35mc	1.2w
6V223	refl	6.425–6.575	6.3,0.76	750, .070	330	35mc	1.2w
7V224	refl	6.575–6.875	6.3,0.76	750, .070	330	35mc	1.2w
7V225	refl	6.875–7.125	6.3,0.76	750, .070	330	35mc	1.2w
7V226	refl	7.125–7.425	6.3,0.76	750, .070	330	35mc	1.2w
8V227	refl	7.425–7.750	6.3,0.76	750, .070	330	35mc	1w
8V228	refl	7.750–8.1	6.3,0.76	750, .070	330	35mc	1w
11V13	refl	10.5–11.7	6.3,1.0	400, .060	180	45mc	200mw
Z239/1G	refl	3.65–4.2	6.3,1.0	1.1k, .060	180	40mc	1.2w
V233A/1K	Frot. Drift	3.6–4.16	6.3,0.3	350, .040			500mw
V239C/1K	Frot. Drift	3.780–4.040	6.3,0.25	350, .040			500mw
V241C/1K	Frot. Drift	4–4.24	6.3,0.25	350, .040			500mw
6V26AM	refl	6–6.5	6.3,0.44	300, .025	110	60mc	120mw
8V69	refl	7.350–7.850	6.3,0.44	300, .025	110	50mc	80mw

RAYTHEON MFG. CO., Microwave & Power Tube Operations, Waltham, Mass.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
5837	osc	0.55–3.8		325	235	12	160mw
RK5777	osc	0.6–2.35		400	625	8	160mw
707B	osc	1.5–3.75		300	300	20	140mw
2K28A	osc	1.5–3.75		300	277	20	140mw
5981	osc	1.245–1.46		225	220	2.5	100mw
RK5778	osc	1.8–4.62		300	460	8	150mw
6BL6	osc	1.6–5.5		300			121mw
5836	osc	1.6–5.5		300		6	121mw
5721	osc	2–12		1250		12	150mw
6236	osc	3.8–7.6		1k	510	10	125mw
726C	osc	2.7–2.96		300	135	25	100mw
6043	osc	2.95–3.275		300	175	20	175mw
2K29	osc	3.4–3.96		300	180	28	106mw
2K56	osc	3.84–4.46		300	150	30	100mw
QK381	osc	4.1–4.45		250	87	30	4.5mw
2K22	osc	4.24–4.91		300	180	30	115mw
2K48	osc	4–11		1250	300		20mw
6115A	osc	5.1–5.9		300	175	30	100mw
QK412	osc	5.1–5.9		300	160		100mw
RK6037	osc	5.12–5.43		300	160	40	30mw
QK461	osc	5.925–6.45		300	175	30	120mw
QK404	osc	5.925–6.45		300	275	20	120mw
QK549	osc	5.925–6.45		300	275	20	120mw
5976	osc	6.2–7.425		300	158	32	100mw
2K26	osc	6.25–7.06		300	115	32	100mw
QK531	osc	6.575–6.875		300	285	32	110mw
QK532	osc	6.875–7.125		300	305	32	110mw
QK623	osc	7.125–7.65		300	380	32	110mw
QK422	osc	7.125–8.125		300	225	20	150mw
RK6390	osc	6.87–10.75		1250	420	6	80mw
RK6310	osc	8.5–10		300	170	48	70mw
RK6312	osc	8.5–10		300	170	48	70mw
RK6316	osc	8.5–10		300	170	48	70mw
2K25	osc	8.5–9.66		300	183	64	32mw
2K45	osc	8.5–9.66		300	145	70	32mw
6116	osc	8.5–9.66		300	145	70	32mw
6940	osc	8.5–9.66		300	145	70	32mw
QK414	osc	9.66–10.25		300	183	50	20mw
QK448	osc	12–13		300	275	60	85mw
QK510	osc	12–13		300	275	60	85mw

5836 refl 1.6–6.5 6.3, .75 325, .028 220 250mw

KLYSTRONS—(Continued)

EITEL-McCULLOUGH, INC.—(Continued)

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
3KM4000LT	3 cav ampl	0.96–1.215	7.5,5.5	26k,0.133			38.2kw
3KM50000PA	3 cav ampl	0.225–0.4	7.5,40	23k,2.6			23.1kw
4K50000LQ	4 cav ampl	0.6–0.985	8,40	16k,1.59			11.2kw
4KM3000LQ	ampl	0.71–0.985	5,33	9k,0.58			2.15kw
4KM3000LR	ampl	0.61–0.985	5,31	8.5k,0.55			2.1kw
4KM50000LA	ampl	0.4–0.63	7.5,40	17k,1.8			10kw
4KM50000LQ	4 cav ampl	0.61–0.985	7.5,40	17k,1.8			10kw
4KM50000SG	4 cav ampl	1.7–2.4	6.3,37.5	17k,1.9			12kw
4KM170000LA	4 cav ampl	0.3–0.5	11,47.5	33k,4.8			77kw
4KMP10000LF	4 cav ampl	0.57–0.63	12,25	61.5k,0.15			400kwp
6K50000LQ	4 cav ampl	0.72–0.98	8,40	19.5k,2.3			9kw
X626	3 cav ampl	0.4–0.45	7.5,95	105k,2.07			1.25megw
X602K	4 cav ampl	0.375–0.5	11,47.5	45k,1.69			155kw
X632	ampl, 0.167	2.845–2.865	11,25	235k,105			10megw
X700	4 cav ampl	2.4–2.9	7.5,5.5	21k,0.138			20kw
X563K,L,M	ampl	5.4–7.1	6.3,1	3k,0.13			60w
X768	3 cav ampl	0.755–0.985					75kw
Y222	refl osc	10.5–10.7					70mw

ELLIOTT BROTHERS, LTD., Elstree Way, London, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
4FK1	fix osc	75	6.3,2.3	4k, .045	1k*		100mw
4FK2	fix osc	75	6.3,2.3	4k, .045	1k*		500mw
6FK1	fix osc	50	6.3,2.3	4k, .040	1k*		5w
6TFK2	tun osc	50	6.3,2.3	4k, .040	1k*	1.5kmc	3w
8FK1	fix osc	33–37	6.3,2.3	4k, .045	1k*		15w
8TFK2	tun osc	33–37	6.3,2.3	4k, .045	1k*	1.6kmc	10w
8RK4	tun refl	34.5–35.5	6.3,1.4	2.1k, .011	290	1kmc	30mw
8RK8	tun refl	34.5–35.5	6.3,1.4	2.5k, .020	290	1kmc	250mw
12FK1	fix osc	21–25	6.3,2.3	4k, .060	1k*		10w
12TFK2	tun osc	21–25	6.3,2.3	4k, .060	1k*		8w
12RK3	tun refl	21–25	6.3,2.0	2.5k, .020	290		30mw
12RK4	tun refl	21–25	6.3,2.0	2.5k, .020	290		500mw
100RK2	plug-in refl	3.3–3.7	6.3,0.66	0.3k, .045	220		95mw

*Focus

EMI ELECTRONICS, LTD., Hayes, Middlesex, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
R9555	refl	37.5–43	6.3,0.8	2k, .012	300	60mc	30mw
R9521	refl	35–40	6.3,0.8	2k, .012	300	60mc	40mw
R5146	refl	34–36.5	6.3,0.8	2k, .012	300	60mc	60mw
R9518	refl	27.8–32.2	6.3,0.8	2k, .01	300	60mc	60mw
R9547	refl	24–27.8	6.3,0.8	2k, .012	300	60mc	60mw
R9520	refl	16.2–17.2	6.3,0.6	2k, .012	100	45mc	30mw
25182	refl	8.2–11.7	6.3,0.7	350, .035	350	20mc	130mw
25157	refl	7–10.3	6.3,0.7	350, .05	270	20mc	200mw
25181	refl	5.4–8.2	6.3,0.7	350, .04	300	20mc	150mw
R5222	refl	5–11.7	6.3,0.7	250, .04	500		200mw
R9546	refl	32–37.5	6.3,0.8	2k, .012	300	60mc	40mw
R9538	refl	9.1–9.3	6.3,1.2	350, .04	210	20mc	60mw
R9539	refl	9.3–9.5	6.3,1.2	350, .04	220	20mc	60mw
R9540	refl	9.5–9.7	6.3,1.2	350, .04	230	20mc	60mw
R9541	refl	9.7–9.9	6.3,1.2	350, .04	240	20mc	60mw
R9542	refl	9.9–10.1	6.3,1.2	350, .04	250	20mc	60mw
R9543	refl	10.1–10.6	6.3,1.2	350, .04	260	20mc	60mw
R9544	refl	10.6–11	6.3,1.2	350, .04	300	20mc	45mw
KRN3	refl	9.55–9.9	4,1.3	1.35k, .008	250	25mc	25mw
R9516	refl	7.05–7.3	12.6,1.1	1k,0.12	300	40mc	2.2w
R9537	refl						
R6010	refl	4.4–4.8	6.3,0.9	750,0.14	290	50mc	3.7w
R6015	refl	4.27–4.76	6.3,0.9	250, .04	175	20mc	150mw
R5081	refl	3.9–4.2	6.3,0.9	750,0.14	350	40mc	4w
RK6112	refl	1–4	6.3,0.7	250, .02	400		150mw
R9559	refl	1–5.4	6.3,1.2	300, .035	350	35mc	100mw
R9585	refl	0.5–3	6.3,0.7	300, .02	400		50mw
R9586	refl	0.5–3					
25205	refl	3.28–3.72	6.3,1.2	300, .035	200	30mc	120mw
KR6/1	refl	3.36–3.55	4,1.3	250, .032	140	30mc	150mw
KR6/2	refl	3.17–3.39	4,1.3	250, .032	140	30mc	150mw
KR6/3	refl	2.93–3.13	4,1.3	250, .032	140	30mc	150mw
R9570	3 cav, .002	2.7–3.05	11,8	45k,9		5mc	100kw
R9571	4 cav, .005	2.7–3.05	11,8	20k,6.5		30mc	15kw
R9602	refl	22–26	6.3,0.8	2k, .015	500	40mc	50mw
R9621	refl	20–24	6.3,0.8	2k, .01	300	40mc	50mw
25212	refl	3.95–5.5	6.3,1.2	350, .04	500	25mc	80mw
25221	refl	3.3–4.9	6.3,1.2	350, .04	300	25mc	80mw

ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
K300	refl osc	9.32–9.5	6.3,0.6	350, .035	140	30mc	30mw
K301	refl osc	2.5–3.5	6.3,0.6	350, .035	375	15mc	30mw
K302	refl osc	9.32–9.5	6.3,0.6	350, .035	155	30mc	30mw
K305	refl osc	9.25–9.5	6.3,0.6	350, .035	160	35mc	25mw
K308	refl osc	8.8–10	6.3,0.6	350, .035	210	40mc	40mw
K311	refl osc	8.5–9.5	6.3,0.6	350, .035	355	30mc	45mw
K312	refl osc	9.43–9.65	6.3,0.6	350, .035	170	30mc	30mw
K313	refl osc	9.645–9.775	6.3,0.6	350, .035	175	30mc	25mw
K315	refl osc	9.105–9.205	6.3,0.6	350, .035	260	30mc	20mw
K317	refl osc	8.2–8.3	6.3,0.6	350, .035	310	30mc	20mw
K321	refl osc	9.43–9.65	6.3,0.6	350, .035	170	30mc	25mw
K323	refl osc	9.645–9.775	6.3,0.6	350, .035	175	30mc	25mw
K324	refl osc	9–10	6.3,0.6	350, .035	390	30mc	45mw
K328	refl osc	9.555–9.685	6.3,0.6	350, .035	180	30mc	25mw
K335	refl osc	9.555–9.685	6.3,0.6	350, .035	170	30mc	25mw
K337	refl osc	9–10	6.3,0.6	350, .035	390	24mc	35mw
K340	refl osc	9.3–9.5	6.3,0.6	300, .025	165	40mc	35mw
K342	refl osc	8.5–9	6.3,0.6	350, .035	265	35mc	45mw
K343	refl osc	12–14.5	6.3,0.6	350, .030	220	59mc	40mw
K345	refl osc	5.925–7.725	6.3,0.8	750, .072	350	30mc	1w
K346	refl osc	14.5–17	6.3,0.6	350, .030	180	75mc	45mw
K347	ampl, .002	.58–.615	7,35	75k, 10			600kw
K350	2 cav osc	8.5–10	6.3,1.7	700, .070		12mc	1.2w
K351	refl osc	8.5–9.6	6.3,1.2	300, .040	150	35mc	65mw
K352	ampl, .001	2.998	4.3,83	190k,100			6megw
K353	refl osc	10.5–12.2	6.3,1.2	400, .060	250	60mc	250mw
K357	refl osc	10.66–10.72	6.3,0.6	250, .015	100	30mc	12mw
K358	refl osc	10.5–12.2	6.3,1.2	400, .060	250	60mc	250mw
K359	refl osc	8.1–8.75	6.3,1.2	350, .045	500	55mc	90mw
K361	refl osc	10.7–10.625	6.3,0.6	300, .025	200	20mc	27mw

LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
L3270	.0025	1.25–1.35					2megw
LT7504	.0025	1.24–1.36					2.2megw
L3257	.0003	1.28–1.33					4megw
L3227	.002	1.28–1.33					5megw
L3250	.0015	1.25–1.35					10megw
L3387	.0033	1.25–1.35					30megw
L3302	.0015	2.855					10megw
L3355	.0015	1.25–1.35					20megw

METCOM, INC., 76 Lafayette St., Salem, Mass.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
MXK14	refl	8.5–10	6.3	300	225	30mc	25mw
MXK15	refl	8.5–10	6.3	300	225	30mc	25mw
MXK16	refl	8.5–10	6.3	300	225	30mc	25mw
MXK17	refl	8.5–10	6.3	250	120		30mw
MXK18	refl	8.5–10	6.3	300	225	30mc	40mw
MXK11	refl	8.5–10	6.3	200	165	20mc	15mw
MXK19	refl	8.5–10	6.3	300	225	30mc	25mw
MXK20	refl	10.25–11.75	6.3	300	275	30mc	25mw
MXK21		8.5–9.6	6.3	300	150	30mc	20mw
MXK22		10–10.25	6.3	500	225	30mc	100mw
MXK23		9.1–9.5	6.3	300	150	400mc*	15mw
MXK24		8.5–10.5	6.3	300	225	30mc	50mw
MKK11		13.295–13.305	5.55	3k			15mw

*V. tun ferrite cav

NIPPON ELECTRIC CO., LTD., Tokyo, Japan

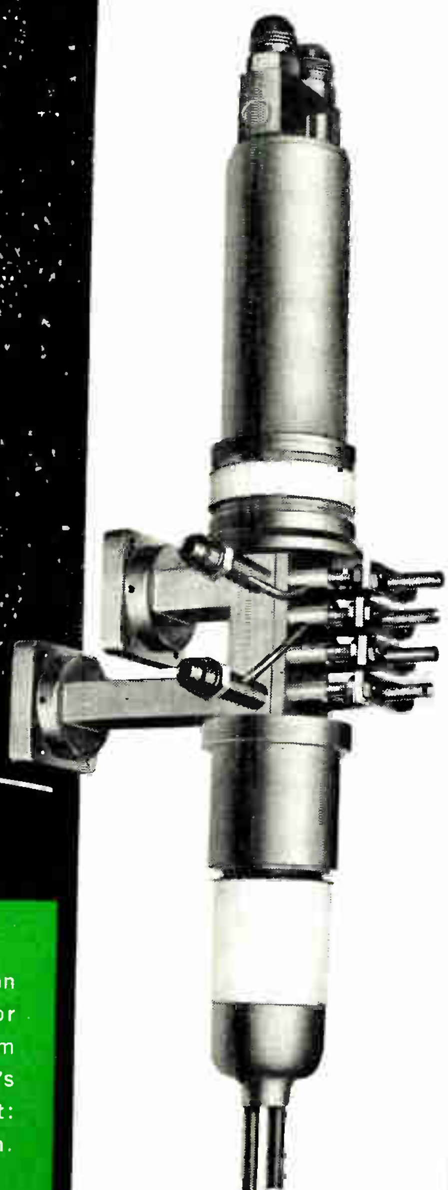
Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
2K25	refl	8.5–9.66	6.3,0.44	300, .025	180	40mc	35mw
2K26	refl	6.25–7.06	6.3,0.44	300, .025	115	50mc	100mw
2K54A	refl	4.05–4.3	6.3,0.45	400, .025	350		500mw
2K54B	refl	3.85–4.1	6.3,0.45	400, .025	350		500mw
2K54C	refl	3.65–3.9	6.3,0.45	400, .025	350		500mw
2K54DA	refl	4.25–4.35	6.3,0.45	250, .012	160	35mc	50mw
5976	refl	6.2–7.425	6.3,0.44	300, .012	110	60mc	120mw
5721	refl	4–11	6.3,0.58	1k, .020	150		100mw
4V27	refl	3.5–4.5	6.3,0.675	325, .025	180		150mw
6V200	refl	6.225–6.325	6.3,0.76	750, .070	130	50mc	300mw
6V201	refl	5.925–6.225	6.3,0.76	750, .070	330	35mc	1.2w
6V202	refl	6.125–6.425	6.3,0.76	750, .070	330	35mc	1.2w
6V203	refl	6.425–6.575	6.3,0.76	750, .070	330	35mc	1.2w
7V204	refl	6.575–6.875	6.3,0.76	750, .070	330	35mc	1.2w
7V205	refl	6.875–7.125	6.3,0.76	750, .070	330	35mc	1.2w
7V206	refl	7.125–7.425	6.3,0.76	750, .070	330	35mc	1.2w
8V207	refl	7.425–7.750	6.3,0.76	750, .070	330	28mc	1w
8V208	refl	7.750–8.1	6.3,0.76	750, .070	330	23mc	1w
6V211	refl	5.985–6.285	6.3,0.44	300, .023	100	40mc	35mw
6V212	refl	6.285–6.585	6.3,0.44	300, .023	100	40mc	35mw
7V213	refl	6.585–6.705	6.3,0.44	300, .023	100	40mc	40mw
7V214	refl	6.705–7.005	6.3,0.44	300, .023	100	40mc	40mw
7V215	refl	6.955–7.255	6.3,0.44	300, .023	100	40mc	40mw
7V216	refl	7.255–7.555	6.3,0.44	300, .023	100	40mc	40mw
6V221	refl	5.925–6.225	6.3,0.76	750, .070	330	35mc	1.2w
6V222	refl	6.125–6.425	6.3,0.76	750, .070	330	35mc	1.2w
6V223	refl	6.425–6.575	6.3,0.76	750, .070	330	35mc	1.2w
7V224	refl	6.575–6.875	6.3,0.76	750, .070	330	35mc	1.2w
7V225	refl	6.875–7.125	6.3,0.76	750, .070	330	35mc	1.2w
7V226	refl	7.125–7.425	6.3,0.76	750, .070	330	35mc	1.2w
8V227	refl	7.425–7.750	6.3,0.76	750, .070	330	35mc	1w
8V228	refl	7.750–8.1	6.3,0.76	750, .070	330	35mc	1w
11V13	refl	10.5–11.7	6.3,1.0	400, .060	180	45mc	200mw
Z239/1G	refl	3.65–4.2	6.3,1.0	1.1k, .060	180	40mc	1.2w
V233A/1K	Frot. Drift	3.6–4.16	6.3,0.3	350, .040			500mw
V239C/1K	Frot. Drift	3.780–4.040	6.3,0.25	350, .040			500mw
V241C/1K	Frot. Drift	4–4.24	6.3,0.25	350, .040			500mw
6V26AM	refl	6–6.5	6.3,0.44	300, .025	110	60mc	120mw
8V69	refl	7.350–7.850	6.3,0.44	300, .025	110	50mc	80mw

RAYTHEON MFG. CO., Microwave & Power Tube Operations, Waltham, Mass.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
5837	osc	0.55–3.8		325	235	12	160mw
RK5777	osc	0.6–2.35		400	625	8	160mw
707B	osc	1.5–3.75		300	300	20	140mw
2K28A	osc	1.5–3.75		300	277	20	140mw
5981	osc	1.245–1.46		225	220	2.5	100mw
RK5778	osc	1.8–4.62		300	460	8	150mw
6BL6	osc	1.6–5.5		300			121mw
5836	osc	1.6–5.5		300		6	121mw
5721	osc	2–12		1250		12	150mw
6236	osc	3.8–7.6		1k	510	10	125mw
726C	osc	2.7–2.96		300	135	25	100mw
6043	osc	2.95–3.275		300	175	20	175mw
2K29	osc	3.4–3.96		300	180	28	106mw
2K56	osc	3.84–4.46		300	150	30	100mw
QK381	osc	4.1–4.45		250	87	30	4.5mw
2K22	osc	4.24–4.91		300	180	30	115mw
2K48	osc	4–11		1250	300		20mw
6115A	osc	5.1–5.9		300	175	30	100mw
QK412	osc	5.1–5.9		300	160		100mw
RK6037	osc	5.12–5.43		300	160	40	30mw
QK461	osc	5.925–6.45		300	175	30	120mw
QK404	osc	5.925–6.45		300	275	20	120mw
QK549	osc	5.925–6.45		300	275	20	120mw
5976	osc	6.2–7.425		300	158	32	100mw
2K26	osc	6.25–7.06		300	115	32	100mw
QK531	osc	6.575–6.875		300	285	32	110mw
QK532	osc	6.875–7.125		300	305	32	110mw
QK623	osc	7.125–7.65		300	380	32	110mw
QK422	osc	7.125–8.125		300	225	20	150mw
RK6390	osc	6.87–10.75		1250	420	6	80mw
RK6310	osc	8.5–10		300	170	48	70mw
RK6312	osc	8.5–10		300	170	48	70mw
RK6316	osc	8.5–10		300	170	48	70mw
2K25	osc	8.5–9.66		300	183	64	32mw
2K45	osc	8.5–9.66		300	145	70	32mw
6116	osc	8.5–9.66		300	145	70	32mw
6940	osc	8.5–9.66		300	145	70	32mw
QK414	osc	9.66–10.25		300	183	50	20mw
QK448	osc	12–13		300	275	60	85mw
QK510	osc	12–13		300	275	60	85mw

for space systems

20kW CW at X-band



Varian's new VA-849 amplifier klystrons are rated to deliver higher CW power at X-band than any existing tube in the world . . . 20kW!

Varian's new VA-849 power klystron opens up a variety of new design approaches to space systems. Possible applications exist in communication concepts such as repeater satellites, moon-bounce signalling, or in reflections from clouds of tiny orbiting needles. Radio astronomers, too, will welcome the VA-849.

Immediate applications include CW radar and illuminator service. Low incidental noise. Water cooling. Electromagnet focusing. Another significant advance In microwave components from Varian's broad experience and research in super-power tubes.

FEATURES

- **7.125 to 8.5 kMc**
- **20 kW CW**
- **50 db Gain.**
- **30 Mc Minimum Bandwidth**
- **Tunable 60 Mc.**

It's likely that Varian can provide a solution for your particular system design problem. There's a good way to find out: write Tube Division.

VARIAN associates

PALO ALTO 19, CALIFORNIA

Representatives throughout the world

KLYSTRONS, WAVE TUBES, GAS SWITCHING TUBES, MAGNETRONS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NMR AND EPR SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

Circle 86 on Inquiry Card

KLYSTRONS—*(Continued)*

RAYTHEON MFG. CO.—*(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
RK6178	osc	15.75–16.25		300	200	60	25mw
QK246	osc	15–16.2		1.5k	173	25	51mw
RK6573	osc	15.5–17		300	210	75	25mw
QK306	osc	18–22		1.8k	220	40	40mw
6253	osc	18–22		1.8k	220	40	40mw
2K33	osc	22–25		1.8k	220	40	40mw
6254	osc	22–25		1.8k	220	40	40mw
QK463	osc	24.5–27.5		1.8k	250	40	40mw
QK289	osc			2.25k	200	45	20mw
QK290	osc			2.25k	200	45	20mw
QK291	osc			2.25k	200	45	18mw
QK288	osc	34.3–35.3		2.25k	210	50	20mw
QK292	osc			2.25k	200	45	10mw
QK293	osc	34.9–42.8		2.5k	200		5mw
QK294	osc	40–51.8		3k	200		5mw
QK295	osc	50–60		3.5k	200		
QK661	osc	7.125–8.5		1k,0.1	500	36	1.8w
QK754	osc	5.925–6.425		1k,0.1	500	50	1.8w

SPERRY ELECTRONIC TUBE DIV., Gainesville, Fla.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
SAL219	3 res	9.6–12.15	4.2,37.0	24k,6.2			37kw
SAL81	3 res .01	12.15–13.65	4.5,70.0	20k,5			21kw
SAL89	3 res	9.6–12.15	4.2,40.0	20k,4.5			30kw
SAL153	6 res	12.7–14.0	12.0,45.0	190k,250			14megw
SAS28	3 res	2.6–2.7	9,13.0	4k, .35			225w
SAS60,A	3 res	2.67–3.33	6.3,2.0	1k, .3			25w
SAS60,B	3 res	2.7–2.93	6.3,2.0	1.4k, .65			20w
SAS61	3 res	2.7–2.9	6.3,6.0	15k, 5.5			15kw
SAC9	3 res	4.97–5.09	6.3, .8	1k, .175			9w
SAC19	2 res	5.8–6.42	6.3,2.0	625, .16			6w
SAC33	3 res	4.8–5.3	7.0,6.5	5.4k, .45		± 15mc	500w
SAC41	3 res	3.7–4.2	6.3,2.0	750, .2			30w
SAC225	3 res	4.2–6.8	4.75,56.0	130k,98			3megw
SMS27	2 res	2.6–2.7	6.3,4.0	1250, .025		±20mc	0.5w
SMC11	2 res	4.5–5.7	6.3,1.1	1k, .05		50mc	1w
SMX32	3 res	9–10.5	6.3,1.6	1k, .15			3.5w
SMK40	3 res	23.5–26	6.3,2	1.5k, .17		±250mc	0.6w
SOC150	3 res	4.91–5.01	6.3, .8	1.1k, .175		fix	11w
SOU201	2 res	12.5–15	6.3,1.6	1.7k, .14		fix	15w
SRL7	refl	1.7–2.4	6.3,2	1k, .22			10w
SRL17	refl	0.75–0.99	6.3,1.5	1k, .09			3w
SAX240	3 res	X-Band	6.3,2.8	6.25k, .195			200w
SAX253	3 res	10–10.5	6.3,2.8	8.75k, .360		fix	600w
5981	refl	1.24–1.46	6.8, .485	250, .05			0.17w
2K41	refl	2.66–3.31	6.3,1	1250, .06	750		2.75w
SRC43	refl	5.92–7.72	6.3, .8	750, .072	355	300mc	1.5w
SRC64D1	refl	5.43–5.93	6.3, .8	900, .09	750	500mc	1.8w
2K42	refl	3.3–4.2	6.3,1	1250, .06	750	300mc	1.5w
2K43	refl	4.2–5.7	6.3,1	1250, .06	750	450mc	1.25w
2K44	refl	5.7–7.5	6.3,1	1250, .06	750	500mc	1w
SRX92	refl	8.5–10.5	6.3, .45	300, .30	300	2kmc	30mw
2K25	refl	8.5–9.66	6.3, .44	300, .037		90mc	30mw
2K39	refl	7.5–10.3	6.3,1	1250, .060	750		1w
SRU55C	refl	15.7–17	6.3, .55	300, .031	350	45mc	25mw
SRU95	refl	12.4–15.5	6.3, .55	300, .032	253		52mw
SRU210	refl	15.7–17	6.3, .55	300, .035	110	50mc	20mw
SRV38	refl	34–35.6	6.3, .6	425, .04	400	60mc	30mw
SRV215	osc	34.2–35.4	6.3, .6	400, .04	500	110mc	30mw
SRU216	osc	15–17	6.3, .55	300, .031	500		20mw
SOC217	osc	4–6	6.3, .3	380, .015		fix	300mw
SOC258	osc	C-Band	6.3, .75	3.1k, .75		± 25mc	1w
SAX151	ampl, 5 res	9.0–9.5	5,25	80k,45			1megw
SOX239	osc	8.2–12.4	6.3, .5	2.9k, .017		fix	1w
SOX241	osc	8.2–12.4	6.3, .3	900, .033		fix	1.5w
SOX254	osc	8.2–12.4	6.3, .8	515, .015		fix	450mw
SRX230	refl	8.5–10.5	6.3, .45	300, .026			30mw
SRX232	refl	7–8.6	6.3, .45	400, .055	300		100mw
SRX233	refl	7–8.6	6.3, .45	400, .055	300		100mw
SRX262	refl	8.2–12.4	6.3,1.3	400, .045	400		100mw
SOU245	osc	13–13.5	6.3,1.7	1750, .140		fix	5w
SRU226	refl	15–17	6.3, .55	300, .035	160		45mw
SRU266	refl	15–17	6.3, .55	300, .03	100		20mw
SRX265	osc	8.6	6.3,1.3	700, .058	430		1w

STANDARD TELEPHONES & CABLES, LTD., London, England
(Available through ITT Components Div., Clifton, N.J.)

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
V190/1M•	cw	0.8–1	6.3,1	220, .08	220	4mc	2w
V218A/1K•	cw	1.7–2	6.3,0.3	250, .05	270		500mw
V231C/1K•	cw	3.06–3.18	6.3,0.25	210, .045	230	16mc	40mw
V233A/1K•	cw	2.7–4.2	6.3,0.3	250, .065	270	2mc	300mw
V235A/1K•	cw	2.7–4.2	6.3,0.3	250, .065	270	2mc	500mw
V237C/1K•	cw	3.6–3.8	6.3,0.26	285, .05	300	8mc	350mw
V238A/1K•	cw	3.5–4.3	6.3,0.25	325, .065	355		900mw
V239C/1K•	cw	3.8–4	6.3,0.26	280, .065	300	8mc	350mw
V241C/1K•	cw	4–4.24	6.3,0.26	285, .065	300	8mc	350mw
V243A/2F•	cw	4.2–4.4	6.3,0.25	275, .065	295		750mw
V245C/1K•	cw	4.4–4.6	6.3,0.3	260, .065	300	17mc	200mw
V246A/2K•	cw	4.65–4.86	6.3,0.3	250, .065	270	6mc	250mw
V247C/1K•	cw	4.6–4.8	6.3,0.3	260, .065	300	17mc	200mw
V246C/4K•	cw	4.4–4.85	6.3,0.3	320, .05	340	6mc	300mw
V249C/1K•	cw	4.76–5	6.3,0.3	290, .065	310	16mc	200mw
V271C/3M•	cw	6.85–7.35	6.3,0.25	530, .06	550	16mc	800mw
V275C/3M•	cw	7.25–7.77	6.3,0.25	530, .06	550	16mc	800mw
V261C/1M•	cw	5.85–6.35	6.3,0.25	330, .06	350	16mc	800mw
V265A/1M•	cw	5.85–7.1	6.3,0.25	330, .06	350		200mw
V266C/1M•	cw	6.35–6.85	6.3,0.25	330, .06	350	16mc	800mw
Z211/1G	3 res, plsd	0.96–1.21	12.6,1.8	5k,2.5ap	15k		7kwp
Z220/1G	refl	1.7–2.3	6.3,0.75	350, .05	250	16mc	250mw
Z237/1K	refl	3.5–3.54	6.3,0.75	350, .055	250	42mc	125mw
Z239/1G	refl	3.6–4.2	6.3.1.1	1.1k, .07	700	45mc	1.2w

• *Velocity—modulated oscillators. Colloctor voltages shown in reflector voltage column.*

SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
6BM6,A	refl	0.5–3.8	6.3, .65	325, .018	325		175mw
5837	refl	0.55–3.8	6.3, .675	325, .028	235		150mw
6BL6	refl	1.6–6.5	6.3, .75	325, .028	220		250mw
5836	refl	1.6–6.5	6.3, .75	325, .028	220		250mw

SYLVANIA—*(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
6974	refl	4.6–5	6.3, .9	800,0.1	410		1w
6468	refl	6.125–6.425	6.3, .9	750, .08	400		1w
6469	refl	6.575–6.875	6.3, .9	750, .08	400		1w
6470	refl	7.125–7.425	6.3, .9	750, .08	400		1w
K839B	refl	7.125–7.425	6.3, .9	750, .08	400		1w
K840B	refl	6.575–6.875	6.3, .9	750, .08	400		1w
K841B	refl	6.125–6.425	6.3, .9	750, .08	400		1w
K4008	refl	5.3–6.3	6.3, .9	750, .07	380		900mw
K4009	refl	5.3–6.6	6.3, .9	750, .07	390		900mw
K4010	refl	5.8–7.125	6.3, .9	750, .07	390		950mw
K4011	refl	6.3–7.5	6.3, .9	750, .07	360		800mw
SK220Z	refl	7.75–8.1	6.3, .9	750, .08	400		1w
SK220A	refl	7.425–7.75	6.3, .9	750, .08	400		1w
SK220B	refl	7.125–7.425	6.3, .9	750, .08	400		1w
SK220C	refl	6.875–7.125	6.3, .9	750, .08	400		1w
SK220D	refl	6.575–6.875	6.3, .9	750, .08	400		1w
SK220G	refl	6.425–6.575	6.3, .9	750, .08	400		1w
SK220E	refl	6.125–6.425	6.3, .9	750, .08	400		1w
SK220F	refl	5.925–6.225	6.3, .9	750, .08	400		1w
K4203	refl	10.7–11.7	6.3, .75	400, .055	400		100mw

VARIAN ASSOCIATES, Tube Div., Palo Alto, California

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
X12	refl	12.4–17.5		600		40mc	100mw
X13	refl	8.2–12.4		500		45mc	200mw
X13B	refl	7.5–11		500		45mc	200mw
V23	2 res osc	9.1–11		1350			5w
V24B	ampl, .0075	9–9.6		36k		100mc	40kw
V24C	ampl, .0075	9.0–9.6		36k		100mc	50kw
X26B,D,E,F	refl	5.3–7.5		750		35mc	1w
V27	2 res	9.1–11		1350			6w
V27B	2 res	8.5–10		1350			6w
VA28	2 res osc	13.35–13.65		2950			14w
VA39B,C	refl	10–15.5		650		25mc	50mw
V40B,C	refl	15–21		700		20mc	50mw
V45	mult	9–10		1k			1.15w
V53B,C	refl	10.7–11.7		300		40mc	50mw
V54	refl	10.5–12.2		400		45mc	200mw
V55,B	refl	8.2–11.5		500		45mc	300mw
V58,C	refl	8.5–10		500		45mc	600mw
V63	2 res osc	8.0–9.5		1260			5w
V67B	2 res osc	13.35–13.65		1550			1w
V82	ampl, .025	9.31 ± .013		17k		fix	7kw
V87B,C	ampl, .002	2.7–2.9		105k		± 50mc	2mw
VA92	refl	14–17.5		600		40mc	100mw
VA64F,G	2 res osc	13.5,13.3		3k			18w
VA92B	refl	12.4–14.5		600		55mc	200mw
VA92C	refl	12.4–14.5		600		55mc	200mw
VA93	refl	13.3–12.7		250			20mw
VA94	refl	16–17		300		65mc	40mw
VA94B	refl	15.8–16.2		300		65mc	30mw
VA96	refl	22–25		750		120mc	30mw
VA96B	refl	22–25		750		100mc	80mw
VA97	refl	34–35.6		400		100mc	15mw
VA97B	refl	32.6–34		400		90mc	20mw
VA98	refl	23.6–24.4		375		75mc	20mw
VA113,114,115	refl	5.92–7.72		750		20mc	300mw
V151	refl	8.5–10		300		25mc	25mw
V153	refl	8.5–10		250		60mc	70mw
V154	refl	10.5–12.2		400		45mc	200mw
VA157	refl	8.5–10		385		60mc	70mw
VA201B	refl	8.5–9.6		300		40mc	60mw
VA203B	refl	8.5–9.6		300		50mc	30mw
VA210B	refl	9.6–10.8		300		40mc	30mw
VA217C	refl	8.5–9.6		250		50mc	30mw
VA220AG,Z	refl	5.92–8.1		750		40mc	1w
VA221BG	refl	5.92–7.45		300		40mc	40mw
VA221H	refl	5.25–5.56		250		35mc	40mw
VA222AG,Z	refl	5.92–8.1		750		40mc	1w
VA225A,B,C	refl	7.0–8.5		750		30mc	1w
VA232	refl	9.2–10		350		40mc	225mw
VA242 Ser.	refl	8.5–11		500		55mc	870mw
VA244A,B,C	refl	5.8–7.9		750		50mc	1w
VA246	refl	12–14		500			500mw
VA249 Ser.	refl	8.5–11		300		30mc	100mw
V260	refl	8.5–10		300		48mc	70mw
V262	refl	8.5–10		300		48mc	50mw
V270	refl	8.5–10		300		40mc	70mw
V290	refl	8.5–10.5		350		65mc	120mw
VA800	cw ampl	1.7–2.4		15k		700mc	10kw
VA800C	cw ampl	2.16–2.4		15k		240mc	10kw
VA802B	cw ampl	1.7–2.4		6k		700mc	1kw
VA804	cw ampl	4.4–5.875		9k		± 75mc	2kw
VA804L	cw ampl	4.4–5.0		9k		600mc	2kw
VA805	cw ampl	5.875–6.425		9k		± 25mc	2kw
VA806	cw ampl	7.125–8.5		8k		± 25mc	1kw
VA808	ampl, .016	5.3–5.9		22k		± 25mc	20kw
VA812C	ampl, .0037	.40–.45		160k		50mc	8mw
VA816J	ampl, .004	3.43–3.57		115k		fix	2.5mw
VA820B,C	ampl, .002	2.7–2.9		130k		fix	5mw
VA822	cw ampl	9.0–11		8k		200mc	1kw
VA823	cw ampl	7.5–10		15k		100mc	5kw
VA833C	cw ampl	.680–.985		11.5k		305mc	11kw
VA834B	cw ampl	4.4–5		7.5k		600mc	1kw
VA838	cw ampl	.470–.685		15k		315mc	20kw
VA839	ampl, .002	2.73–2.87		125k		fix	5mw
VA842	ampl, .06	.40–.45		107k		50mc	1.25mw
VA845	ampl, .10	9.3–9.6		14k		50mc	5kw
VA846	cw ampl	4.4–6		12.5k		150mc	5kw
VA848	cw ampl	9.0–10.8		10k		200mc	2kw
VA849	cw ampl	7.125–8.5		23k		60mc	20kw
VA851	cw ampl	10–10.55		10.5k		250mc	2.5kw
VA856	cw ampl	7.125–8.5		9.5k		300mc	2kw

WESTINGHOUSE, Electronic Tube Div., P.O. Box 284, Elmira, N.Y.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
WL6781	osc, cw	8.5–9.6	6.3,1.2	200, .016	105		20mw

BACKWARD WAVE TUBES

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Power Output
BENDIX AVIATION CORP., Red Bank Div., Eatontown, N.J.							
TE57	osc	49–59		3k			5mw
TW066	osc	61–71					
TW067	osc	49–59					
TW075	osc	40–50					
TW082	osc	50–60					
TW083	osc	65–75					
TW085	osc	70–85					
TW087	osc	85–100					
COMPAGNIE GENERALE DE T.S.F., 79 Boulevard Haussmann, Paris 8, France							
CO515	osc	0.98–2.1	6.3–3	1.5k	pm		0.8w
CO210A	osc	1.6–3.2	6.3–2.7	1.5k	pm		0.6w
CO119A	osc	2.4–4.7	6.3–2.4	1.5k	pm		0.6w
CO94A	osc	3.6–7.2	6.3–2.1	1.5k	pm		
CO63A	osc	4.8–9.6	6.3–2.1	1.5k	pm		15mw
CO43A	osc	7–11	6.3–2.1	1.45k	pm		0.25w
CO521	osc	8–16	6.3–2.1	1.85k	pm		0.1w
CO2012A	osc	15.5–24	6.3–1.6	2.45k	pm		0.2w
CO1308A	osc	23.5–37.5	6.3–1.6	3.3k	pm		0.2w
CO8060	osc	37–50	6.3–1.6	3k	pm		4mw
CO6045	osc	50–65	6.3–1.6	3k	pm		2mw
CO4637	osc	65–80	6.3–1.6	3.5k	pm		1mw
CO3833	osc	80–90	6.3–2.8	5k	pm		0.2mw
CO3330	osc	90–100	6.3–2.8	4k	pm		0.2mw
CO40	osc	68–72	6.3–2.2	6k	pm		2w
CO20	osc	145–155	6.3–2	5k	pm		10mw
CM32	osc	0.2–0.3	7–16	10k	pm		8kw
CM34	osc	0.3–0.4	7–16	8k	pm		8kw
CM153	osc, .002	2.7–3.2		24k	pm		75kw
CM154	osc, .002	3.1–3.7		24k	pm		75kw
CM252	osc	1.45–2	5–14	5k	pm		250w
CM253	osc	1.1–1.5	4–17	5k	pm		200w
CM5200	osc	1.2–1.5	3.9–19	5k	pm		500w
CM7060A	osc	3.2–4	6.3–3	5k	pm		200w
CM7080A	osc	2.6–3.4	6.3–3	5k	pm		200w
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England							
N1010,A*	cw, plsd osc	7–11.5	6.3,2.3	150	pm		150mw
N1010S	cw, plsd osc	7–11.5	6.3,2.3	150	sol		150mw
N1034,A*	cw, plsd osc	2.4–4.5	6.3,2.4	170	pm		800mw
N1034S	cw, plsd osc	2.4–4.5	6.3,2.4	170	sol		800mw
*Electrodes isolated from shell.							
HUGGINS LABORATORIES, INC., 999 E. Arques Ave., Sunnyvale, Calif.							
BA1	ampl	2.4–3.6	6.3,2.3	1.5k	820	10	
BA2	ampl	8.2–12.4	6.3,1.2	2.4k	1k	10	
BA4	ampl	12–18	6.3,1.2	2k	1k	30	
HO1	osc	2–4	6.3–1.2	3.4k	800		1mw
HO2	osc	8.2–12.4	6.3–1.2	2k	1k		10mw
HO3	osc	3.75–7	7,0.8	3.4k	800		1mw
HO4	osc	12–18	7,0.8	2k	1k		1mw
HO9	osc	1–2	6.3–2.5	2.8k	800		10mw
HO10	osc	3.7–5.9	6.3,2	2k	1k		10mw
HO11	osc	5.2–8.3	6.3,1.4	2k	1k		10mw
HO13	osc	4–8	6.3,1.4	2.4k	1k		1mw
HO14	osc	8.2–12.4	7,0.8	2k	1k		1mw
HO17	osc	7–11	6.3,1.2	2k	1k		1mw
HO19	osc	12–18	6.3,1.2	2.2k	1k		1mw
HO20	osc	3.75–7	6.3,1.4	2.6k	1k		10mw
HO21	osc	4–8	6.3–1.4	2.4k	1k		10mw
HO22	osc	8.2–12.4	6.3–1.2	2k	ppm		3mw
HUGHES AIRCRAFT CO., Microwave Tube Div., 11105 Anza Ave., Los Angeles 45, Calif.							
315H	osc, cw	15.8–17.2			pm		50mw
316H	osc, cw	12.4–18			pm		60mw
317H	osc, cw	13.5–15.5			pm		60mw
318H	osc, cw	17.5–19.5			pm		60mw
LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.							
L3148	cw	8.5–11			pm		150mw
RAYTHEON MFG. CO., Microwave & Power Tube Operations, Waltham, Mass.							
QK546	osc	1–2	6.3–3.1	14.5k			1.5w
QK544	osc	1.6–3.2	6.3–3.1	1.45k			1w
QK518	osc	2–4	6.3–1.5	1.5k			1w
QK533	osc	2.4–4.8	6.3–2.4	1.45k			1w
QK528	osc	3.6–7.2	6.3,1	1.45k			400mw
QK543	osc	4.8–9.6	6.3–2.1	1.45k			200mw
QK529	osc	7–11	6.3–2.1	1.5k			150mw
QK535	osc	7.5–15	6.3,2.1	1.7k			150mw
QK634	osc	8.5–11	10,1.7	5.2k			250w
QK625	osc	2.5–3	10,2	4.95k			300w
QK684	osc	8.5–9.6		325			50mw
QK610	tun	6.7–11.4	6.3–1.5	1.5k			300mw
QKB786	osc	1–2	6.3	1.5k			100mw
QKB816A	osc	2–4	6.3	1.5k			70mw
QKB760A	osc	4–8	6.3	1.5k			30mw
QKB776	osc	8–12	6.3	1.5k			50mw
STANDARD TELEPHONES & CABLES, LTD., London, England (Available through ITT Components Div., Clifton, N.J.)							
Y257/1E	osc	4–7.5	6.3,0.3	1.5k	sol		120mw
Y257/2E	osc	4–7.5	6.3,0.3	1.5k	pm		120mw
Y322/1E	osc	18–27	6.3,0.3	3k	sol		60mw
Y330/1E	osc	26.5–40	6.3,0.3	3.2k	sol		60mw
STEWART ENGINEERING COMPANY, 467 Bean Creek Road, Santa Cruz, Calif.							
OD1–2	osc	1–2	6.3, .73	1.06k	800		50mw
OD2–4	osc	2–4	6.3, .73	1.8k	800		10mw
OD3.75–5.9	osc	3.5–5.9	6.3, .73	2.15k	800		30mw
OD4–8	osc	4–8	6.3, .73	2.3k	800		10mw
OD5.2–8.3	osc	5.2–8.3	6.3, .73	2.2k	800		10mw
OD611	osc	7–11	6.3, .64	2.2k	800		10mw
OE6–11	osc	7–11	6.3, .64	2.2k	800		30mw
OD6–12	osc	6–12	6.3, .64	2.1k	800		10mw
OE6–12	osc	7.3–10.3	6.3, .64	1.15k	800		50mw
OD7–13B	osc	8.2–12.4	6.3, .64	2k	800		10mw
OD7–13	osc	8.2–12.4	6.3, .64	2k	800		10mw
OD10–.5.5	osc	10–15.5	6.3, .64	2.3k	800		10mw
OD12–18	osc	12.4–18	6.3, .64	2.2k	800		10mw
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.							
6699	osc, cw	1–2	6.3,3.9	660	sol		700mw
7069	osc, cw	2–4	6.3	1.4k	pm		100mw
6496	osc, cw	2–4	6.3,2.7	1.68k	sol		700mw
BW623	osc, cw	4–8	6.3,2.4	2.3k	sol		135mw
6902	osc, cw	18–26.5	11,1.2	2.25k	pm		50mw
BW1757	osc, cw	26.5–41	11,1.2	2.25k	pm		
BW1779	osc, cw	60–75	11,1.2	2.4k	pm		3mw
BW4198	osc, cw	2–4	6.3	1.4k	pm		100mw
VARIAN ASSOCIATES, Tube Division, Palo Alto, Calif.							
VA161	osc	8.2–12.4		650			80mw
VA161B	osc	7.5–11		550			40mw
VA162	osc	12.4–18		850			40mw
VA163	osc	18–27		1.1k			10mw
VA164	osc	27–40		1.1k			10mw
VA168	osc	8–10		800			80mw
VA169	osc	7.5–11		875			200mw
VA179	osc	3.1–5.5		1k			50mw

TRAVELING WAVE TUBES

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.								
55340	ampl	3.8–4.2	6.3,0.8	1.1k	600	37		5w
7537	ampl	4.4–5	6.3,0.8	1.1k	600	34		3.5w
BENDIX AVIATION CORP., Red Bank, Eatontown, N.J.								
RXB103401	ampl	4–8		1.1k		40	30	200mw
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N.Y.								
TWS1	ampl	1.5–3		2.2k	600*	40		35w
TWC4	ampl	6–7.5		2.6k	600*	40		2w
TWC5	ampl	5.9–8		1.8k		38	30	10w
TWS6	ampl	2.5–4.1		2.4k	500*	20	30	0.5w
TWS7	ampl	2.7–3.5		2.4k	500*	20	30	3w
TWX8	ampl	7–11.5		2.8k	pkgd	25	30	0.75w
*Oersted								
CANADIAN MARCONI CO., 2442 Trenton Ave., Montreal 16, Canada								
N1001	ampl	1.7–2.3	6.3,1.6	2.8k	400	25		16w
COMPAGNIE GENERALE DE T.S.F., 79 Boulevard Hausmann, Paris 8, France								
TP0101	ampl	2.7–3.3	6.3	400	pm	27	6	
TP0301	ampl	8.5–9.6	6.3	800	pm	25	8	
TP0153	ampl	1.7–2.3	6.3	1k	pm	25		10w
TP0410	ampl	5.9–7.4	6.3	1.85k	pm	25		5w
TP0103	ampl	2.9–3.1	6.3	1.7k	pm	27		10w
TP0921	ampl	3.8–4.2	6.3,1.4	1.1k	pm	20		2w
TP0430	ampl	3.8–4.2	6.3,2.3	1.8k	pm	25		6w
TP0570	ampl	3.8–4.2	6.3	2k	pm	37		15w
EITEL-McCULLOUGH, INC., San Carlos, Calif.								
X778	ampl	5–11	6.3,0.6	3k	ppm	60	34	1w
EMI ELECTRONICS, LTD., Hayes, Middlesex, England								
TWS1	ampl, cw	1.5–3	5,5.5	2.4k		40		30w
TWS3	ampl, cw	2.7–4.1	6.3,0.5	350		25	7	3mw
TWC4	ampl, cw	6–8	4,3.5	2.6k		39		2w
TWS2	ampl, cw	1.7–2.7	6.3,0.5	350		25	7	3mw
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England								
6861	lw noise	2.7–3.5	5,0.5	375	525	24.5	6.5	1mw
N1001	pwr	1.7–2.3	6.3,1.5	2630	450	26		15w
N1002	lw noise	1.7–2.3	6.3,0.36	565	459	21	9	2.5mw
N1004	pwr	3.8–4.2	6.3,0.68	2350	500	23		4w
N1005M	lw noise	3.6–4.2	6.3,0.36	380	350	20.5	9	1.5mw
N1013	pwr	1.7–2.3	6.3,0.36	650	400	30	20	250mw
N1016M	wide band	4.1–7	6.3,0.36	600	450	25	9	1mw
N1017M	lw noise	1.2–1.4Gc	6.3,0.36	260	450	25	6.5	2mw
N1018M	int	3.6–4.2	6.3,0.36	450	400	20	21	75mw
N1029	pwr	5.85–8.4	6.3,1.2	2.5k	600	35		5w
N1031	lw noise	3.8–4.2	6.3,0.36	500	550	25	8.5	2.3mw
N1032	int	3.8–4.2	6.3,0.36	1450	350	37	19	300mw
N1033	pwr	3.8–4.8	6.3,0.71	2260	550	37.25		7w
GEISLER LABS, P.O. Box 252, Menlo Park, Calif.								
G10	ampl	2–4						10mw
G12	ampl	2–4						10mw
G100	ampl	2–4						10mw
G100P	ampl	2–4						10mw

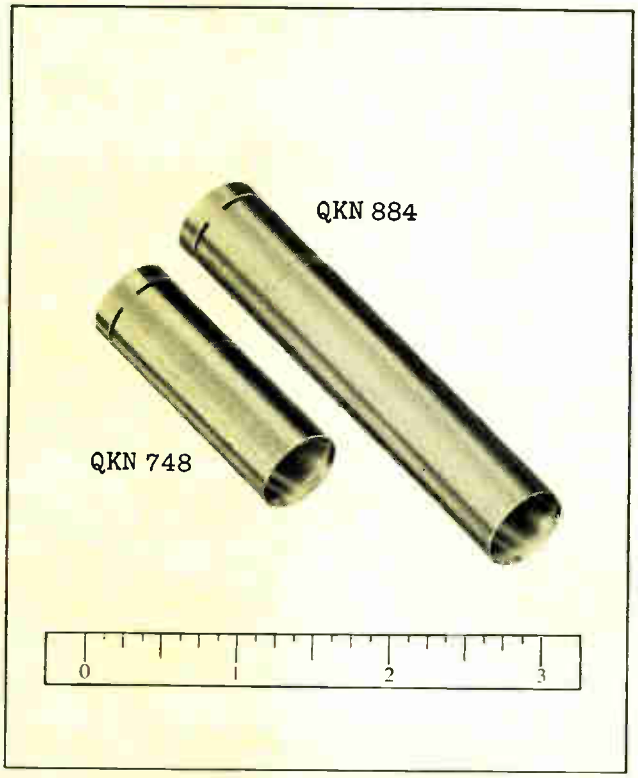
Creative Microwave Technology

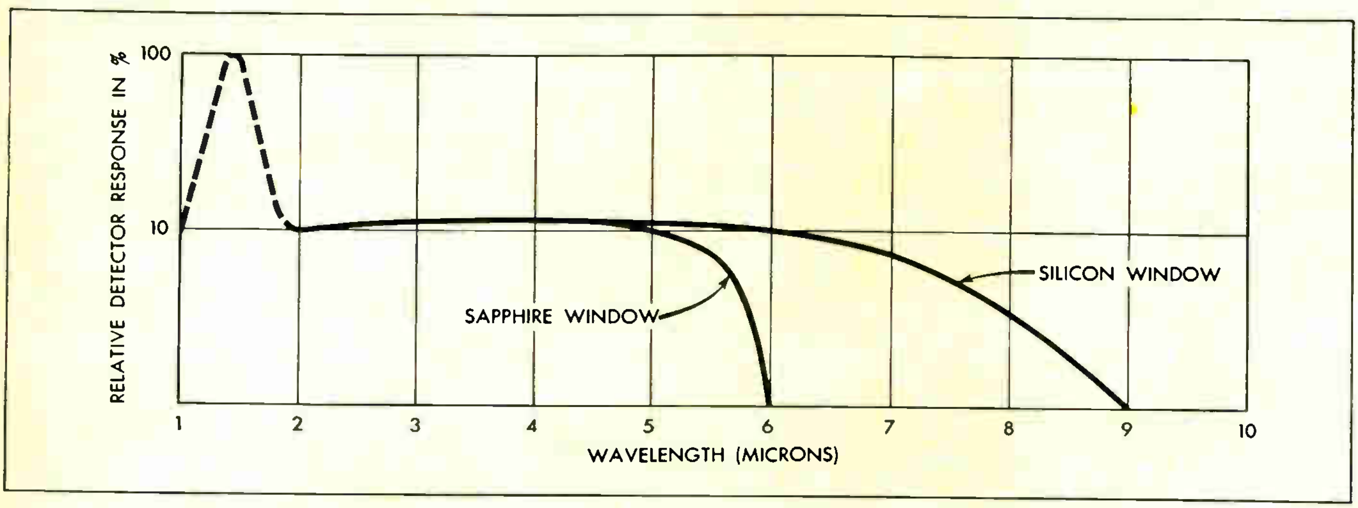
Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 5

NEW RAYTHEON MINIATURE, ALL-METAL INFRARED DETECTORS

Specially designed and constructed to resist shock and vibration in airborne applications

Raytheon's QKN748 and QKN884 are highly sensitive, compact, P-type infrared detectors. These gold-doped germanium devices feature all-metal construction and hermetically sealed windows of sapphire barium fluoride or anti-reflection coated silicon. They are ideally suited for airborne applications, including passive missile guidance and air traffic control systems, where resistance to shock, vibration and other extreme environmental conditions is required. Their detecting element has a spectral sensitivity ranging from 2 to 9 microns at an operating temperature of about -195°C. The standard effective detector area is 2.0 x 2.0 millimeters. Larger or smaller effective detector areas can be manufactured to meet specific requirements. The impedance range is 50,000 ohms to 1 megohm. The acceptance angle is dependent upon the effective detector area and can be as large as 150 degrees. The time constant is less than 1 microsecond.





Excellence in Electronics

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Co., Waltham 54, Mass. In Canada: E. Waterloo, Ontario. In Europe: Zurich, Switzerland

RAYTHEON

WORLD'S LEADING PRODUCER OF MICROWAVE TUBES

Circle 84 on Inquiry Card

TRAVELING WAVE TUBES – *(Continued)*

GEISLER LABS, INC. – *(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
G10	ampl	2–4						10mw
G11		2–4						1w
G110		2–4						1w
G20	ampl	4–8						10mw
G200	ampl	4–8						10mw
G21	ampl	4–8						1mw
G40	ampl	8.2–12.4						100mw
G41	ampl	8.2–12.4						1w

GENERAL ELECTRIC, Power Tube Dept., Schenectady, N.Y.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
Z3028	ampl	4–8	7,0.35	550	600	25	8	1mw
Z3031	ampl	12–17	6,0.2	1.4k	610	25	14	1mw
Z3036	ampl	7–11	6.3,0.3	700	500	35	15	5mw
Z3040	ampl	35–40	6,0.2	2.6k	pm	25	15	1mw
Z3088	ampl	7–11	6.3,0.3	780	ppm	35	15	5mw
Z3090	ampl, .005	8.5–9.7	4,3.8	16k	1.5k	35		10kw
Z5259	ampl	8–12	6.3,0.3	850	600	25	10	5mw

HUGGINS LABORATORIES, INC., 999 E. Arques Ave., Sunnyvale, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
HA1	ampl	2–4	6.3,1	525	300	30		10mw
HA2	ampl	2–4	7,1.2	1.1k	600	30		1w
HA4	ampl	8–12.4	6.3,1.2	1.3k	400	30		10mw
HA5	ampl	1–2	6.3,1.4	220	400	30		10mw
HA6	ampl	4–8	7,1.3	1.5k	1k	30		0.5w
HA7	ampl	0.5–1	6.3,1.5	120	300	30		10mw
HA9	ampl	8–11	6.3,1.2	2.4k	1k	30		0.5w
HA10	ampl	8.2–12.4	7,1.2	2.3k	1k	25		100mw
HA18	ampl	1–2	7,1.4	850	1k	30		1w
HA20	ampl	8–11	6.3,1.2	1.3k	ppm	30		10mw
HA21	ampl	8–11	6.3,1.2	2.4k	ppm	30		0.5w
HA22	ampl	1.6–2.6	6.3,1	500	300	30		10mw
HA24	ampl	12.4–15	6.3,1.2	1.3k	400	20		5mw
HA25	ampl	12–18	6.3,1.4	1.3k	1k	30		5mw
HA26	ampl	4–8	6.3,1	800	400	30		10mw
HA27	ampl	1–2	8.5,1	500	elec.	30		10mw
HA28	ampl	4–8	6.3,1	800	ppm	30		10mw
HA29	ampl	2–4	6.3,1	525	ppm	30		10mw
HA30	ampl	2–4	7,1.2	1.1k	ppm	30		0.5w
HA31	ampl	1–2	6.3,1.4	220	ppm	30		10mw
HA35	ampl	4–8	7,1.3	1.6k	ppm	30		0.5w
HA36	ampl	0.5–1	6.3,1.4	300	ppm	20		10mw
HA49	ampl	10.5–16	6.3,1.2	1.3k	ppm	30		3mw
HA51	ampl	0.24–0.5	6.3,1.5	220	ppm	20		10mw
HA52	ampl	0.5–1	6,1	200	elec.	20		3mw
HA58	ampl	0.5–1	6,3	850	elec.	30		1w
HA70	ampl	2.3–3.5	5,1.1	470	750	30	7	1mw
HA75	ampl	2.2–3.7	5,1.1	470	750	30	8	1mw
HA76	ampl	2.3–2.9	5,1.1	470	750	30	6	1mw
HA14	ampl	1–2	5,0.8	200	1k	25	10	1mw
HA15	ampl	8.2–12.4	5,1.1	1.25k	1k	25	15	5mw
HA17	ampl	1–2	5,0.8	200	1k	25	15	1mw
HA19	ampl	1.6–2.6	5,0.8	200	1k	25	15	1mw
HA23	ampl	8.2–11	5,1.1	1.25k	1k	25	10	1mw
HA32	ampl	4–8	5,1.1	700	1k	25	15	1mw
HA37	ampl	2–4	4.5,1	475	750	25	11	1mw
HA40	ampl	0.5–1	5,1	120	820	25	15	1mw
HA43	ampl	12–18	5,1.4	1.3k	1k	25	17	1mw
HA44	ampl	8.2–12.4	5,1.1	1.25k	1k	25	15	1mw
HA45	ampl	0.5–1	5,1	120	820	25	10	1mw
HA46	ampl	12–18	5,1.4	1.3k	1k	25	12	1mw
HA47	ampl	4–8	5,1.1	700	1k	25	10	1mw
HA48	ampl	12–16	5,1.4	1.3k	1k	25	13	1mw
PA1	ampl, .03	8–11	6.3,1.5	2.6k	1k	28		1w
PA3	ampl, 0.1	2–4	7,1	1.1k	1k	30		10w
PA5	ampl, 0.1	8.2–12.4	7,0.8	2.3k	1k	30		25mw
PA6	ampl, 0.1	2–4	7,1	950	600	33		1w
PA7	ampl, 0.1	4–8	7,1.2	1.6k	1.1k	33		1w
PA9	ampl, .03	8–11	6.3,1.4	2.6k	ppm	30		1w
DA1	v. tun	2–4	6.3,0.85	2.38k	250	28		
DA2	v. tun	1–2	6.3,1.2	1.02k	250	33		
DA3	v. tun	0.5–1	6.3,1.1	1065	250	30		
DA4	v. tun	4–8	6.3,1.1	2.5k	400	25		
HA16	mult	1.76/8.8	7,1.2	1.2k	600	–10		2mw
HA34	mult	0.4–1/2–4	6.3,1	250	550	–10		2mw

HUGHES AIRCRAFT CO., Microwave Tube Div., 11105 Anza Ave., Los Angeles 45, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
314H	ampl, cw	2 ± 10%			ppm	40		2.5w
313H	ampl, .005	2–4			ppm	33		1kw
312H	ampl, .005	2–4			ppm	33		1kw
311H	grid, .01	2–4			ppm	33		1kw
304H	ampl, .01	2–4			ppm	33		1kw
321H	ampl, .006	2.85–3.15			ppm	26		250kw
323H	ampl, cw	2–4			sol	20	5	1mw
306H	grid, .02	5.4–5.9			ppm	43		20kw
310H	grid, .02	8.5–10.5			ppm	40		1kw
307H	ampl, .01	8.5–9.5			ppm	54		100kw
308H	grid, .01	8.6–9.8			ppm	53		15kw
324H	ampl, cw	8.5–9.5			sol	20	5.5	0.1mw

INTERNATIONAL TELEPHONE & TELEGRAPH CORP., Components Div., P.O. Box 412, Clifton, N.J.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
D2013	ampl, cw	8–9.6	6.3,2.3	3.2k	1.3k	33		10w
D2014	*ampl, .005	8–9.6	6.3,5.2	9.6k	2.4k	33		1kw
D2020	ampl, cw	8–9.6	6.3,2.5	1.2k	1k	30		10w
D2023	*ampl, .01	4–8	6.3,5.2	9k	2k	27		1kw
D2024	*ampl, cw	8–9.6	6.3,2.3	3.2k	1.3k	30		10w
X244D	**ampl, .032	0.95–1.22	6.3,3	500	800	36		40kw
X258	ampl,cw	2–4	6.3,2	750	400	30		0.1w
X281	ampl, cw	4–8	6.3,1	1k	600	30		0.1w
X282	ampl, cw	4–8	6.3,1.5	2.6k	1.2k	33		10w
X287	ampl, cw	0.65–1.2	5,0.65	120	pkgd	25	10	.001w
X298	ampl, cw	4–8	6.3,2	850	pkgd	37		10w
X314	ampl, cw	1.1–1.8	6.3,1.9	1350	700	40		10w
X319	ampl, cw	5–6	6.3,2.2	2.8k	1.2k	27		10w
X320	ampl, .005	5–6	6.3,5	11k	2k	27		2kw
X322	ampl, cw	0.24–0.51	6.3,2.4	150	250	37		.032w

* Gridded. ** *Grid for amplitude modulation.*

INTERNATIONAL TELEPHONE & TELEGRAPH CORP. – *(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
X323	ampl, cw	0.50–1.0.	6.3,1.75	200	250	38		.032w
X325	*ampl, .02	0.65–1.20	6.3,5.4	4.6k	500	35		1kw
X314A	ampl, cw	0.50–1.01	6.3,1.7	400	400	35		1w
X343	ampl, cw	0.95–2.05	6.3,1.6	1350	600	24		10w
X362	ampl, cw	0.50–1.50	6.3,2.3	1250	700	24		10w
F6658	ampl, cw	1.7–4	6.3,2.5	1k	750	30		2w
F6825	ampl, .005	2–4	6.3,5	8k	1.2k	30		1kw
F6826	*ampl, .005	2–4	6.3,5	7.5k	1.2k	30		1kw
F6867	ampl, cw	8–9.6	6.3,0.85	1.4k	1.3k	30		100mw
F6868	ampl, cw	1.7–4	6.3,2.5	1.2k	1k	30		10w
F6996	ampl, cw	8–9.6	6.3,2.3	3.2k	1.3k	30		10w
F7066	ampl, cw	8–12	6.3,0.85	1.4k	900	30		50mw
F7067	*ampl, .01	8–12	6.3,2.3	3.6k	1.2k	30		1w
F7338	*ampl, .005	2–4	6.3,5	7.8k	1.2k	40		1kw
F7339	*ampl, .005	8.5–9.6	6.3,2.5	1.1k	2.4k	27		1kw
F7340	*ampl, .005	8–9.6	6.3,5.2	9.6k	2.4k	30		1kw
F7341	*ampl, .04	8–9.6	6.3,2.3	3.2k	1k	25		5w
F7347	*ampl, .005	2–4	6.3,5.2	7.5k	1.2k	30		1kw
F7524	ampl, cw	8–12	6.3,1.7	3.8k	1.2k	20		5w
F7525	ampl, cw	8–12	6.3,1.7	3.8k	pkgd	20		5w
F7526	ampl, cw	8–12	6.3,0.85	1.4k	pkgd	30		50mw
D94A	*ampl, .004	8–9.6	6.3,5.2	9.6k	2.4k	30		1kw
D95B	*ampl, .004	8–9.6	6.3,5.2	9.6k	2.4k	30		1kw
D2009	*ampl, .03	4–8.0	6.3,2.5	2350	pkgd	35		1kw

* *Gridded*

LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
L3266	cw	7–11			ppm			20mw
L3236	cw	7–11			ppm			2w
L3470	cw	4–8			ppm			20mw
L3471	cw	4–8			ppm			2w
L3472	cw	8.5–9.6			ppm			10w

MICROWAVE ELECTRONICS CORP., 4061 Transport St., Palo Alto, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
M2101A	ampl	8–11	6.3,0.25	1.2k	1k	25	10	5mw
M2101B	ampl	8–11	6.3,0.25	1.2k	ppm	25	13	5mw
M2106A	ampl	7–11	6.3,0.25	1.2k	ppm	30	20	10mw
M2106B	ampl	7–11	6.3,0.25	1.2k	ppm	30	20	10mw
M2106G	ampl	7–11	6.3,0.25	1.2k	ppm	33	20	10mw
M2201A	ampl	7–12.4	6.3,0.25	1.2k	400	30	30	10mw
M2201B	ampl	8–12.4	6.3,0.25	1.2k	400	30	30	10mw
M2201C	ampl	8–11	6.3,0.25	1.2k	ppm	30	30	10mw
M2203B	mod	4–8	6.3,0.25	800	400	25		10mw
M2202E	mod	5.4–5.9	6.3,0.25	900	ppm	35		50mw
M2204A	mod	7–12.4	6.3,0.25	1.2k	400	20		10mw
M2207A	ampl	4–8	6.3–0.25	800	400	30	25	10mw
M2403A	ampl	8–12.4	6.3,0.5	2.2k	1k	33		1mw
M2405A	ampl	12–18	6.3,0.5	3.1k	1.1k	30		1w

NIPPON ELECTRIC CO., LTD., Tokyo, Japan

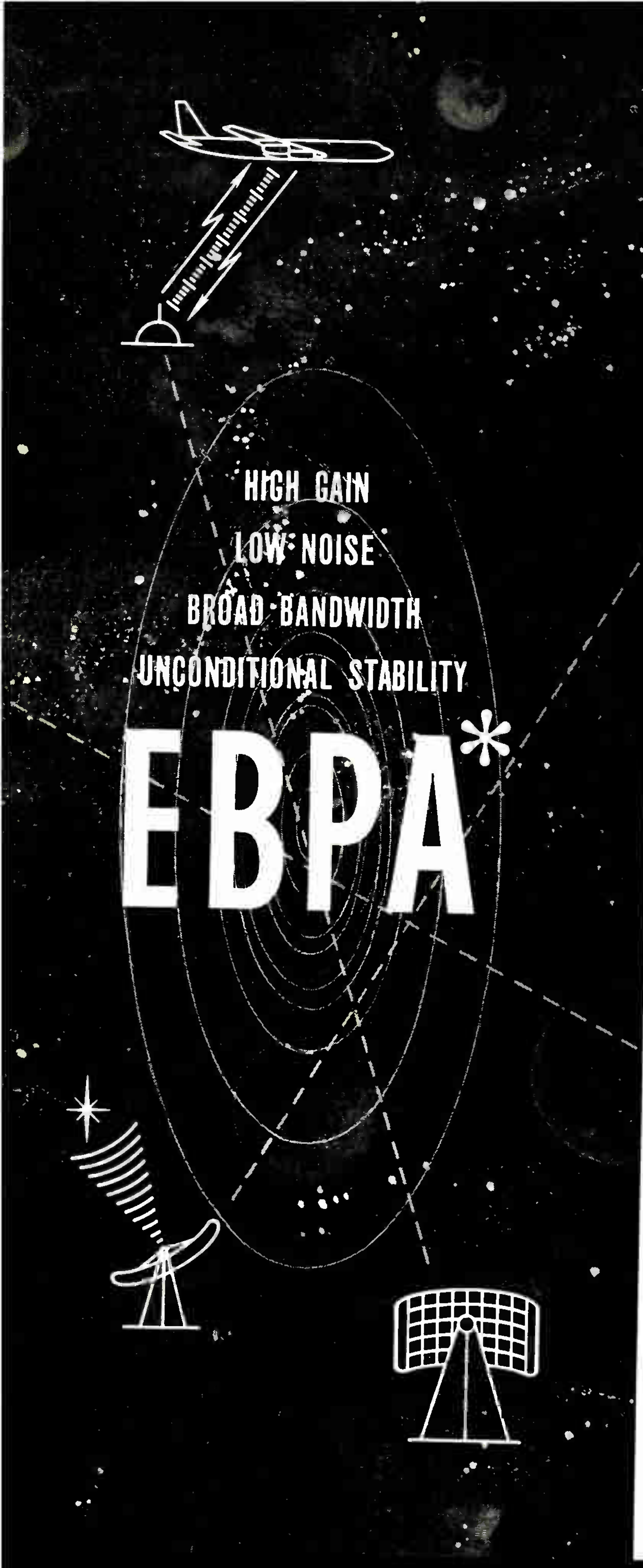
Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
4W75A	ampl, cw	3.6–4.2	6.3,1	3k	ppm	23		2w
4W76A	ampl, cw	3.6–4.2	6.3,1.2	3.19k	ppm	30	27	10w
4W85	ampl, cw	3.7–4.2	6.3,1.5	1.13k	400	24		200mw
4W86A	ampl, cw	3.7–4.2	6.3,1.5	2.03k	400	12		1.5w
8W75	ampl, cw	6–7.5	6.3,1	3.2k	ppm	23		2w
8W76	ampl, cw	6–7.5	6.3,1	3k	ppm	30	27	5w
6W50	ampl, cw	5.8–6.5	6.3,1.1	3.2k	ppm	30	27	10w
11W17	ampl, cw	9–1.2	6.3,1	2k	ppm	30		1w
LD418	lw noise	5.8–6.5	6.3,0.5	850	700	25	7	15mw

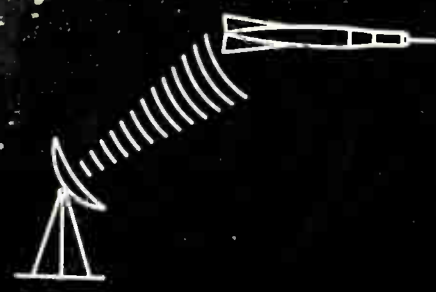
RADIO CORP. OF AMERICA, Tube Division, Harrison, N.J.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
A1139	ampl	1–2		1k	425	20	12	5mw
A1121	ampl	1–2		700	ppm	25		100mw
A1056	ampl	1.1–1.4		200	425	20	8	1/4mw
4009	ampl, grid	2–4		700	ppm	35	30	10mw
4010	ampl, grid	2–4		1.1k	ppm	35	30	1w
A1166A	ampl	2.7–3.5		2.5k	ppm	25		10w
A1160	ampl, 0.1	2–4		2.4k	ppm	25		7w
A1097	ampl	2–3.5		3.5k	elec.	20		2w
6861	ampl	2.7–3.5		400	425	20	7	1mw
A1136	ampl, .01	5–6		5k	ppm	30		50w
A1181	ampl, .05	7.5–11.2		6.8k	ppm	27		25w
A1140	ampl, grid	8–12		2k	ppm	33		10mw
A1101V2	ampl, 0.1	2–4		4.5k	ppm	23		
A1207	ampl	2.7–3.5		800		20	4.5	1/4mw
A1113V2	ampl, grid	2.7–3.5		700	ppm	25		
A1078V1	ampl	2.5–4		400	425	20	8	1/4mw
A1078V2	ampl	3.3–3.7		400	425	20	7	
A1078V3	ampl	3.5–4.1		400	425	20	8	1/4mw
4020	ampl	4–7		1k	ppm	28	18	10mw
A1189	ampl, grid	4–7		1.5k	ppm	30		100mw
A1205	ampl, grid	4–7			ppm	30		1w
A1188	ampl, grid	7–11		3k	ppm	30		1w
4015	ampl	8–12		3.5k	ppm	33		1w
A1215	ampl	12–15			ppm			10mw
A1225	ampl	12–15			ppm			1w
A1206	ampl	5.6–11		2.6k	ppm	60		1w
A1217	ampl	1.1–1.4				20	5	1mw
4019	ampl	1–2		400	ppm	28	17	10mw
4021	ampl, grid	1–2		1k	ppm	27		
A1125	ampl	1.35–1.85		200		20	8	1/4mw
A1094	ampl	1.7–2.3		600	ppm	30	28	200mw
A1093	ampl	1.7–2.3		2.3k	ppm	32		15w
A1078V5	ampl	2.19–2.31		400	425	22	7.5	1/4mw
A1078V10	ampl	2.09–2.41		400	425	20	8	1/4mw
A1078V7	ampl	2.39–2.71		400	425	20	7.5	1/4mw
A1134	ampl, .02	2.2–3.6		7.75k	ppm	30		1kw
A1119	ampl	2–4		450		20		5mw
4017	ampl	2–4		550	ppm	30		10mw

RAYTHEON MFG. CO., Microwave & Power Tube Operations, Waltham, Mass.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
QK542	ampl	5.9–7.4	6.3,1	1.8k	pm	35		5w
QK622	ampl	2.9–3.1				12		3megw
QK783	ampl	2.7–2.9				12		3megw
QK653	ampl	1.28–1.35		94k		10		5megw





* Electron Beam Parametric Amplifier—the exclusive Zenith concept that achieves a unique combination of unconditional stability, low noise, high gain and broad bandwidth.

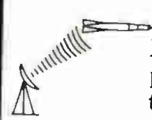
Zenith reports proved capability in these service tests:

RADAR

EBPA improves MDS of a typical installation by 4-7 db.

TACAN

EBPA increased a system's sensitivity from −95 dbm to −99.5 dbm—equivalent to a 68% increase in range.



TRACKING

EBPA affords less than 70°K noise temperature for phase-locked phase modulation systems.

RADIO ASTRONOMY

EBPA has these noise temperatures:
40°K at 400 mc (broad band)
70°K at 1420 mc (synchronous pumping)
150°K at 1420 mc
(non-synchronous pumping)

For information on how EBPA can help solve your problem, send your specifications and special requirements to Scott B. Morency, Contracts Division, ZENITH RADIO CORPORATION, 6001 W. Dickens Avenue, Chicago 39, Illinois. A detailed synopsis of EBPA characteristics and applications also is available upon request.

ZENITH

Creative research and development in space age electronics

Zenith Radio Corporation
Wincharger Corporation
Central Electronics Corporation
Zenith Radio Research Corporation

TRAVELING WAVE TUBES – (Continued)

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
SPERRY ELECTRONIC TUBE DIV., Gainesville, Fla.								
STL111	ampl, cw	1.1–1.6	6.3,1.8	800	300	24		4w
STL114	ampl, .004	1.1–1.6	4.3,2.1	14k	700	39		7kw
STS113	ampl, .01	2–3.6	6.3,1.8	8.5k	650	34		2kw
STX77	grid, cw	7–11	10.5,1.05	5k	1k	37		10w
STP49	ampl, cw	0.24–0.51	12.6,2.4	1.9k	380	25	–42/mc	200w
STL48	ampl, cw	0.5–1	12.6,4.3	3275	200	25	–42/mc	200w
STP130	ampl	0.24–0.51	6.3,1.3	800	200	33	28	3w
STX182	ampl	8–12	6.3,1.5	3.2k	ppm	35	35	30w
STS268	grid	2–4	6.3,1.1	950	ppm	50	35	1w
STC119	ampl, .010	5.4–5.9	6.3,2.2	13k	1.7k	20		1kw
STC124	ampl, .003	5.25–5.75	6.3,3	11.5k	1560			1.125kw
STC152	ampl, .002	5.4–5.9	6.6,3	15.2k	1850	27		2kw
STC174	grid, cw	5.4–5.9	6.3,1	1850	ppm	55		5w
STC250	ampl, cw	3.3–4.9	6.3,1.5	2.6k	ppm	35	28	10w
STC236	ampl, cw	5.9–8.2	6.3, .75	2.6k	ppm	35	28	10w
STL100	ampl, cw	1–2	12.6,5.2	5.5k	475	42	–60/mc	200w
STL222	grid, either	1.1–1.8	6.3,3.2	1k	ppm	48	38	2w
STL235	grid, cw	.5–1	6.3,2.5	750	ppm	37	35	2w
STL248	ampl, cw	.5–1	12.6,2.5	2k	500	28		200w
STL257	ampl, cw	.5–1	6.3,2.5	750	ppm	32	40	2w
STL260	grid	1–2	6.3,2.5	1.9k	ppm	60		30w
STP108	ampl	.3–.6	12.6,3	2k	750	25	–50/mc	200w
STP234	grid, cw	.25–.5	12.6,2.5	590	ppm	37	40	2w
STP256	grid, .5	.3–.6	12.6,2.5	850	ppm	30		1w
STS125	grid, .002	2–4	6.3–3.3	9.5k	875	33		1kw
STS270	ampl, cw	2–4	6.3,2.6	5.3k	800	43	–45/mc	200w
STX104	ampl, cw	7–8.5	6.3,3.4		1.1k	30		175w
STX105	ampl, cw	8.65–11	6.3,3.4		1.4k	30		175w
STX175	grid, cw	5–11	11,1	2.2k	ppm	60	32	1w
STX264	grid, cw	5.4–10	11,1	2.2k	ppm	30	32	1w
STANDARD TELEPHONES & CABLES, LTD., London, England (Available through ITT Components Div., Clifton, N.J.)								
W5/1G	ampl	5.8–7.15	6.3,0.85	3.4k	700*	38	27	15w
W7/1G	ampl	3.6–4.2	6.3,0.85	1.6k	250*	24		120mw
W7/2D	ampl	3.6–4.2	6.3,1	3k	350*	20		2.5w
W7/3G	ampl	3.6–4.2	6.3,0.85	3k	500*	26	27	10w
W7/4G	ampl	3.6–4.2	6.3,0.85	3.2k	500*	42	27	10w

*Oersteds

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
STANDARD TELEPHONES & CABLES, LTD. –(Continued)								
W9/1E	ampl	2.5–4.1	6.3,0.95	500	600*	28	21	50mw
W9/2E	ampl	2.5–4.1	5,0.55	400	550*	40	10	10mw
W9/3E	ampl	2.5–4.1	6.3,0.6	200	450*	50	16	0.3mw
W10/1D	ampl	2.26–3.55	6.3,0.85	1.5k	250*	24		130mw
W10/2D	ampl	2.6–3.55	6.3,0.85	3.2k	350*	22		5w
W10/3E	ampl	2.7–3.3	5,6	550	750*	23	6.2	3mw
*Oersteds								
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.								
TW4006	cw	1–2	6.3, .96	250	pm	35		15mw
TW4007	cw	1–2	6.3,1.5	600	pm	30		1w
6753	cw	1–2	6.3, .96	250	sol	35		15mw
6752	cw	1–2	6.3,1.5	600	sol	33		2w
TW620A	cw	1–2	6.3,1.5	600	sol	33		2w
TW538	plsd	1–2	6.3,3.5	8k	sol	35		1kw
TW4002	cw	2–4	6.3,1.5	450	pm	37		10mw
TW4002F	cw	2–4	6.3,1.5	450	pm	37		10mw
7072	cw	2–4	6.3,1.5	825	pm	30		1w
TW956H	cw	2–4	6.3,1.5	825	pm	37		2w
TW4260	cw	2–4	6.3,1.5	825	pm	30		1w
6493	cw	2–4	6.3, .96	450	sol	35		10mw
TW4261	cw	2–4	6.3,1.5	450	pm	35		10mw
6559	cw	2–4	6.3,1.5	825	sol	33		2w
TW534B	cw	2–4	6.3,1.5	800	sol	33		2w
6698	plsd	2–4	6.3,3.5	8k	sol	35		1kw
TW621	cw	4–8	6.3,1.5	2.1k	sol	33		2w
TW591	plsd	8–10.6	6.3,2	8.9k	sol	36		1kw
TW613	cw	8–11	6.3,1.5	1.15k	sol	35		5mw
TW622	cw	8–11	6.3,1.5	2.75k	sol	33		2w
VARIAN ASSOCIATES, Tube Div., Palo Alto, Calif.								
VA121B	ampl, .01	2–4		2.25k		30		40w
VA125A	ampl, .002	2.65–2.97		120k				2mw
VA125B	ampl, .002	2.92–3.25		120k				2mw
VA126	ampl, .002	5.4–5.9		130k				3.3mw
VA128	ampl, .003	2.7–3.5		14.5k				5kw
VA131	ampl, .004	1.15–1.55		25k				50kw
VA132	ampl, cw	0.5–1		2k				200w
VA133	ampl, .066	1.254–1.386		12k				5kw

PARAMETRIC AMPLIFIERS

Type	Description Application	Frequency (kmc)	Bandwidth	Gain (db)	Pump Freq (kmc)	Pump Power (mw)	Noise Fig. (db)	Power Output
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England								
N1037	lw noise	0.6	60mc	20	1.2	100	2	50µw
MICROWAVE ASSOCIATES, INC., Burlington, Mass.								
MA2–750	ampl, mix	0.7–1	2mc				2	
MA2–750A	ampl, mix	0.9–1	2mc				2	
MA2–1000	ampl, mix	0.95–1.25	2mc				2	
MA2–10002	ampl, mix	1.25–1.35	2mc				2	
MA1–150	ampl	0.1–0.23	1%			100	2	
MICROWAVE ASSOCIATES, INC. –(Continued)								
MA1–350	ampl	0.22–0.4	1%			100	2	
MA1–450	ampl	0.35–0.5	1%			100	2	
MOTOROLA, Scottsdale, Ariz.								
LPA01	ampl	0.18–0.26	1.5mc	16	1.2–1.6	1	1.5	
LPA02	ampl	0.40–0.46	3mc	13	1.4–1.55	1.5	2	
ZENITH RADIO CORP., 6001 Dickens Ave., Chicago 39, Illinois								
	elec. beam	0.4–1	45mc	30	2f	100	1.2–1.7	

Target Map Locator is Being Developed

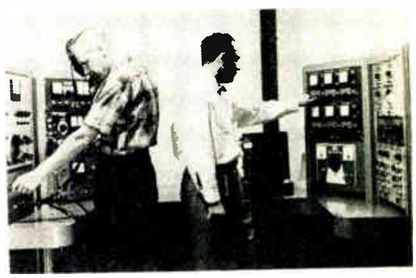
A unique locator, capable of automatically selecting, in only 15 seconds, a target map from a compartment containing more than 11,000 different map microfilms, is being developed by the Fairchild Camera and Instrument Corporation and the U. S. Army Engineers.

Known as the Target Map Coordinate Locator, the unit is basically an optico-electro-mechanical device consisting of a multidecked storage drum holding map transparencies, a movable film pick-up assembly, and a projection-display assembly.

To operate, a number is dialed like a telephone. It is intended that the unit will automatically select the correct target map transparency from the compartment and carry it to a rear screen projector for immediate viewing on a large screen.

An integral part of the equipment is a crosshair system of locating target coordinates. After the map transparency has been projected onto the screen, positioning of horizontal and vertical crosshairs on any target located on the screen will cause the unit to readout the Universal Transverse Mercator coordinates of the target.

"VERTICAL MOTION" TESTS



Instruments that record the pilot's bodily responses are checked by Armour Research Foundation technician, R. Fors and research scientist, E. S. Gordon. Designed by ARF for the Aero-Space Medical Div., Wright-Patterson Field, Ohio, they are used with a vertical accelerator.

Army Opens Longest S/C Radio Circuit on 100th Anniversary

The Army's longest direct high-frequency single channel radio circuit was opened to Australia on the 100th anniversary of the U. S. Army Signal Corps, the Dept. of the Army has announced. It is the only link established by the Army with a foreign government. The Australian Military Forces Director of Signals operates the Australian terminal at Melbourne, Victoria while the American terminal is located at Davis, California.

The circuit ties in to the Army Communication and Administration Network at Davis, ACAN's West Coast Relay Station. Circuit control is centered at the West Coast Relay Station.

1961 Directory of Microwave Equipment Manufacturers

Names and addresses of electronic companies making the principal microwave products for today's markets. Section 1 gives complete alphabetical listing of all active companies. Firms that are asterisked are companies who have provided verified product listings. In Section 2 these firms are again listed and identified with the specific products that they manufacture.

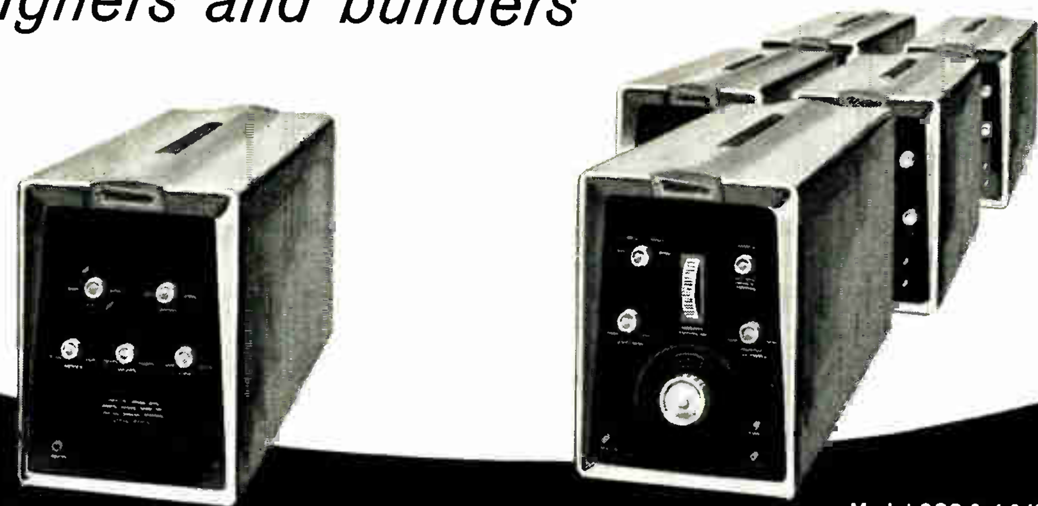
ACDC Electronics Inc 2979 N Ontario St Burbank Calif
★ACF Electronics 48 Lafayette St Riverdale Md
ACF Electronics Div ACF Industries Inc 11 Park Pl Paramus NJ
★Adams Russell Co Inc 200 6th St Cambridge 42 Mass
★Adler Electronics Inc 1 LeFevre Lane New Rochelle NY
Admiral Corp 3800 W Cortland St Chicago 47 Ill
Advance Industries Inc 610 Memorial Dr Cambridge 39 Mass
Ad-Yu Electronics Lab Inc 249 Terhune Ave Passaic NJ
★Aeronca Mfg Corp Aerospace Div Hilltop & Frederick Rds Baltimore 28 Md
Aeronca Mfg Corp Middletown Ohio
Aeronutronic Systems Inc Ford Rd Newport Beach Calif
★Ainslie Corp 531 Pond St S Braintree 85 Mass
Airborne Instruments Lab Div Cutler Hammer Inc Comac Rd Deer Park LI NY
★Aircon Inc 48 Cummington St Boston 15 Mass
★Aircraft Armaments Inc Industry Lane Cockeysville Md
★Aircraft Radio Corp Boonton NJ
★Airtec Inc 139 E 1st Ave Roselle NJ
Air Transport Mfg Co 1114 N Sycamore Ave Los Angeles Calif
Airtron Canada Ltd 349 Carlaw Ave Toronto 8 Ont Canada
Airtronics Inc 5522 Dorsey Lane Bethedsa Md
Airtron Inc Div Litton Ind 200 E Hanover Ave Morris Plains NJ
lexandria Div-AMF 1025 N Royal St Alexandria Va
Alford Mfg Co 299 Atlantic Ave Boston 10 Mass
Alfred Electronics 879 Commercial St Palo Alto Calif
llen Avionics Inc 255 E 2nd St Mineola NY
ll Product Co/Communication Prod Div Box 110 Mineral Wells Texas
lpar Mfg Corp 220 Demeter St Palo Alto Calif
lto Scientific Co 855 Commercial St Palo Alto Calif
merac Inc Dunham Rd Beverly Mass
merican Electronic Labs Inc Colmar Penna

★American Electronics Labs Inc 121 N 7th St Phila 6 Penna
American Lava Corp Sub Minn Mining & Mfg Cherokee Blvd & Mfrs Rd Chattanooga 5 Tenn
American Machine & Foundry Co Gen Eng Labs 11 Bruce Pl Greenwich Conn
American Machine & Foundry Govt Prod Group 1701 K St Washington DC
American Machine & Foundry Co 261 Madison Ave New York NY
American Microphone Mfg Co Div General Cement Mfg Co 400 S Wyman Ave Rockford Ill
★American Radar Components Inc 415 E Main St Denville NJ
★American Super-Temp Wires Inc 32 W Canal St Winooski Vt
American Tube Bending Co 5 Lawrence St New Haven 11 Conn
★Amperex Electronic Corp 230 Duffy Ave Hicksville NY
Amphenol Connector 1830 S 54th Ave Chicago 50 Ill
★Amp Inc Capitron Div 155 Park Ave Elizabethtown Penna
Amtron Corp 17 Felton St Waltham 54 Mass
Analogue Controls Inc 200 Frank Rd Hicksville NY
Andrew Antenna Corp 606 Beech St Whitby Ont Canada
★Andrew Corp PO Box 807 Chicago 42 Ill
★Andrew California Corp 931 Marylind Ave Claremont Calif
★Antenna & Radome Research Assoc 1 Bond St Westbury NY
★Antenna Specialists Co 12435 Euclid Ave Cleveland 6 Ohio
★Antennavision Inc Box 11326 Phoenix Ariz
Antlab Inc 6330 Proprietors Rd Worthington Ohio
APC Electronic Products Div Box 110 Mineral Wells Texas
Applied Electronics Co Sub Raytheon Co 213 E Grand Ave S San Francisco Calif
★Applied Radiation Corp 2404 N Main St Walnut Creek Calif
Applied Research Inc 76 S Bayles Ave Port Washington NY
Arde Engineering Div Arde Associates 75 Austin St Newark 2 NJ
★A R F Products Inc 7627 Lake St River Forest Ill
A R F Products Inc PO Box 57 Ranton NM

Ark Eng'g Co 431 W Tabor Rd Phila 20 Penna
★Arma Div American Bosch Corp Roosevelt Field Garden City NY
★Arnold Eng'g Co Marengo Ill
Arrow Tool Co Inc 36 Mill St Wethersfield Conn
Associated Electrical Industries Ltd 155 Charing Cross Rd London W C 2 England
Associated Electrical Industries Ltd Carholme Rd Lincoln England
★Atlas Eng'g Co 176 Blue Hill Ave Roxbury 19 Mass
Atlas Precision Products Co 3801 Castor Ave Phila 24 Penna
Audicon Electronics Inc 216 Lyon St Paterson 4 NJ
Auerbach Electronics Corp 1634 Arch St Phila 3 Penna
Austin Electronics Div Austin Co 76 9th Ave New York 11 NY
Automatic Metal Products Corp 323 Berry St Brooklyn 11 NY
★Automation Dynamics Corp 255 County Rd Tenafly NJ
Autonetics Div North American Aviation Inc 9150 E Imperial Hwy Downey Calif
Avco Corp Nashville Div Nashville 1 Tenn
★Avco Corp Crosley Div 1329 Arlington St Cincinnati 25 Ohio
★Avionics Div Bell Aerosystems Co Buffalo 5 NY
Avionics Ltd PO Box 200 Niagara-on-the-Lake Ont Canada
Avnet Electronic Supply Co 36 N Moore St New York 13 NY
Babcock Radio Eng'g 1640 Monrovia Ave Costa Mesa Calif
★Baird-Atomic Inc 33 University Rd Cambridge 38 Mass
Baldwin Piano Co 1801 Gilbert Ave Cincinnati 2 Ohio
★Bart Mfg Corp 135 Manchester Pl Newark NJ
Bassett Inc Rex 1314 N E 17th Ct Ft Lauderdale Fla
Beam Instruments Corp 350 5th Ave New York 1 NY
Beauchaine & Sons Inc Lakeport NH
★Bellaire Electronics Inc 62 White St Red Bank NJ
★Belock Instrument Corp 111-01 14th Ave College Point 56 NY
★Belz Industries Inc 89 Union St Mineola LI NY
Benco Television Assoc Ltd 27 Taber Rd Rexdale Ont Canada

NEW from **MELABS-**

seasoned microwave designers and builders



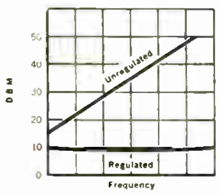
Model SGO-2, common power supply

Model SGL-2, 1-2 KMC
Model SGS-2, 2-4 KMC

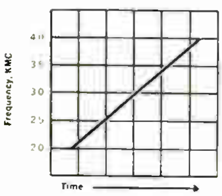
Model SGC-2, 4-8 KMC
Model SGX-2, 8-12 KMC
Model SGK-2, 12-18 KMC

Swept Signal Generators offering Constant Power Output over Entire Band

A common power and sweep supply can be used with any of the new Melabs electronically tuned signal generators covering, respectively, L, S, C, X and K band frequencies.
All five units are compatible with Melabs' radiometer and panoramic display unit.
Addition of a receiver box creates a swept receiver or panoramic analyzer.
TWT amplifiers with power outputs up to 1 watt can be supplied.



Power output



Linear time/frequency characteristic

SPECIFICATIONS

Model SGS-2, S Band, with SGO-2 Power Supply

Power output:	Regulated, 10 mw ± 1 db; unregulated, 10 mw at 2 KMC, rising to 300 mw at 4 KMC; manual adjustment range, 30 db.
Internal modulation:	For regulated power, pulse, 1-10 μsec; square wave. Rep rate, 100-5000 cps.
External modulation:	Any type, unregulated only.
Sweep:	0.3 to 30 cps; cw through 100% of band.
Price:	Model SGS-2, $2,300.00; Model SGO-2, $900.00;
Specifications similar	Model SGL-2, $2,600.00; Model SGC-2, $2,400.00; Model SGX-2, $2,600.00; Model SGK-2, $4,500.00.

Data subject to change without notice. Prices f.o.b. factory.

Employment opportunities at Melabs are exceptional for ambitious engineers and physicists; write in confidence.

Melabs

**(pronounced MEL-LABS) · Dept. M7, 3300 Hillview Ave.
Palo Alto, California · DAvenport 6-9500**

6709

Circle 88 on Inquiry Card

Bendix Corp Bendix Pacific Div 11600 Sherman Way N Hollywood Calif
Bendix Corp Bendix Radio Div Baltimore Md
* Bendix Corp 1104 Fisher Bldg Detroit 2 Mich
* Bendix Corp Red Bank Div RT 35 Eatontown NJ
Bendix Corp Eclipse Div Teterboro NJ
* Birdair Structures Inc 1800 Broadway Buffalo 12 NY
* Blaine Electronetics Inc 14757 Keswick St Van Nuys Calif
* Blaw-Knox Co 300 6th Ave Pittsburgh 22 Penna
* Bogart Mfg Corp 315 Seigel St Brooklyn 6 NY
* Bogue Electric Mfg Co 52 Iowa Ave Paterson 2 NJ
* Bomac Labs Inc Salem Rd Beverly Mass
Boonton Radio Corp Intervale Rd Boonton NJ
Borg-Warner Controls Borg-Warner Corp 3300 Newport Blvd PO Box 1679 Santa Ana Calif
Brach Mfg Corp Div Gen Bronze Corp 200 Central Ave Newark 3 NJ
Breeze Corp 700 Liberty Ave Union NJ
* Brooks & Perkins Inc 1950 W Fort St Detroit 16 Mich
Browning Labs Inc 100 Union Ave Laconia NH
Brubaker Electronics Inc 3652 Eastham Dr Culver City Calif
* Bruno-New York Industries Corp 460 W 34th St New York 1 NY
* Budd Electronics Inc 43-22 Queens St Long Island City 1 NY
Budd Stanley Co 43-01 22nd St Long Island City 1 NY
* Budelman Electronics Corp 375 Fairfield Ave Stamford Conn
Budelman Radio Corp 375 Fairfield Stamford Conn
* Bulova Watch Co Electronics Div 40-01 61st St Woodside 77 NY
* Burndy Corp/Omaton Div Richards Ave Norwalk Conn
Burndy Corp H H Buggie Div Box 817 Toledo 1 Ohio
* Cable Electric Products 234 Daboll St Providence 7 RI
Calif Magnetic Control Corp 11922 Valerio St N Hollywood Calif
Calif Technical Industries Div Textron Inc 1421 Old County Rd Belmont 10 Calif
Calmag Div Calif Magnetic Control Corp 11922 Valerio St N Hollywood Calif
Canadian Applied Research Ltd 750 Lawrence Ave W Toronto Ont Canada
* Canadian Avia Electronics Box 2030 St Laurent Que Canada
* Canadian Marconi Co 2442 Trenton Ave Montreal 16 Que Canada
Canoga Div Underwood Corp 15330 Oxnard St Van Nuys Calif
Canoga Corp of Calif Southern Div 77 Elgin Hwy Ft Walton Beach Fla
Carad Corp 2850 Bay Rd Redwood City Calif
Cardinal Instrumentation Corp 4201 Redwood Ave Los Angeles 66 Calif
* Carol Cable Co 19 Middle St Pawtucket RI
* Cascade Research Div Lewis & Kaufman Electronics Corp 5245 San Fernando Rd W Los Angeles Calif
Cascade Research Corp Div Monogram Precision Industries 53 Victory Lane Los Gatos Calif
* Caswell Electronics Corp 414 Queens Lane San Jose 12 Calif
Central Dynamics Ltd 147 Hymus Blvd Pte Claire Que Canada
Central Electronic Mfrs 2 Richwood Pl Denville NJ
Centronix Inc 4000 NW 28th St Miami Fla
Cermaseal Inc PO Box 25 New Lebanon Center NY
Ceramatronics Inc 364 Highland Ave Passaic NJ
* CG Electronics Corp 15000 Central East Albuquerque NM
Chance Vought Electronics Div PO Box 5907 Dallas Texas
* Chemalloy Electronics Corp Gillespie Airport Santee Calif
* Chu Associates PO Box 387 Whitcomb Ave Littleton Mass
Clegg Labs/Div Clegg Inc Ridgedale Ave Morristown NJ
* Clough-Brengle Co 6014 Broadway Chicago 40 Ill
* Collins Radio Co 2700 W Olive Ave Burbank Calif
Collins Radio Co 855 35th St NE Cedar Rapids Iowa
Collins Radio Co 1930 Hiline Dr Dallas 7 Texas
Columbia Products Co 6625 Shakespeare Rd Columbia SC
Communication Accessories Co US 50 Hwy Lees Summit Mo
Communications Co 300 Greco Ave Coral Gables Fla
Computing Devices of Canada Ltd PO Box 508 Ottawa Ont Canada

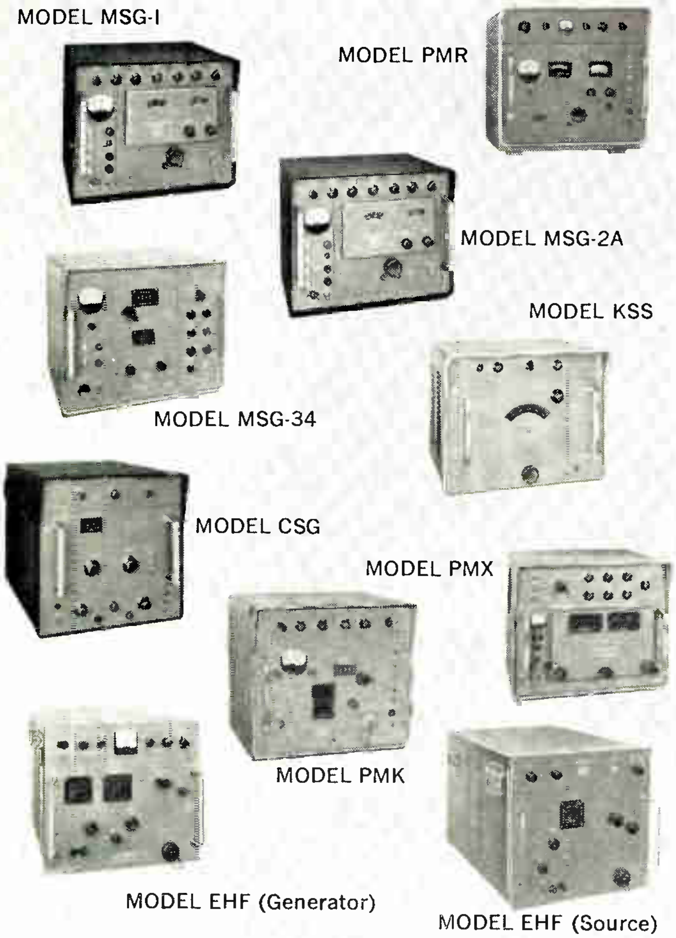
* Connector Corp of America 12959 Sherman Way N Hollywood Calif
Conrad & Moser 2 Borden Ave Long Island City 1 NY
Continental Elec Mfg Co 4212 Buckner Blvd Dallas Texas
* Control Electronics Co Inc 10 Stepar Pl Huntington Sta NY
Convair Pomona Div Gen Dynamics Corp 1675 W 5th Pomona Calif
Convair San Diego Electronics 3165 Pacific Hwy San Diego Calif
Cook Electric Co 2700 N Southport Ave Chicago 11 Ill
Cook Technological Center Div 6401 Oakton St Morton Grove Ill
Co-Operative Industries Inc 100 Oakdale Rd Chester NJ
Corbin Corp 76 Primrose Lane Levittown NJ
* Corning Electronic Components Bradford Penna
Craig Systems Inc 360 Merrimack St Lawrence Mass
Cross County Audio Exchange 583 Gramatn Ave Fleetwood Mt Vernon NY
Cubic Corp 5575 Kearny Villa Rd San Diego 11 Calif
* Custom Components Inc PO Box 248 Caldwell NJ
* CWS Waveguide Corp 301 W Hoffman Ave Lindenhurst NY
* Dage Electric Co Inc Beech Grove Ind
Dahlstrom Metallic Door Co Buffalo & 2nd Sts Jamestown NJ
Daven Co Route 10 Livingston NJ
Davis Electronics Inc PO Box 1247 Burbank Calif
Daystrom Inc Weston Instruments Div 614 Frelinghuysen Ave Newark 12 NJ
DBM Research Corp PO Box 521 Cocoa Beach Fla
Defiance Eng'g & Microwave Co Beverly Airport Beverly Mass
* Demornay-Bonardi Corp 780 S Arroyo Pkwy Pasadena Calif
Deutschmann Corp Tobe Providence Hwy Norwood Mass
* Diamond Antenna & Microwave Corp 35 River St Winchester Mass
Dielectric Products Eng'g Co Raymond Me
Dittmore-Freimuth Corp 2517 E Norwich St Milwaukee 7 Wis
* Don-Lan Electronics Co 1131 W Olympic Blvd Santa Monica Calif
* Dorne & Margolin 29 New York Ave Westbury NY
Double E Products Co 208 Standard St El Segundo Calif
Douglas Microwave Co 252 E 3rd St Mt Vernon NY
* Dow-Key Co PO Box 711 Thief River Falls Minn
Dresser Ideco Co 8909 S Vermont Los Angeles Calif
* Dumont Labs Inc Allen B 750 Bloomfield Ave Clifton NJ
Dunn Eng'g Associates Inc 255 O'Brien Hwy Cambridge 41 Mass
Dwyer Eng'g Co Airport Rd PO Box 452 Nashua NH
* Dymec Div Hewlett Packard Co 395 Page Mill Rd Palo Alto Calif
Dynamic Electronics Inc 87-46 123rd St Richmond Hill NY
* Dynatronic Inc 717 W Amelia Ave Orlando Fla
* Edgerton Germeshausen & Grier Inc 160 Brookline Ave Boston 15 Mass
Edo Corp 13-10 111 St College Point 56 LI NY
Egan Laboratory 107-56 113th St Richmond Hill 19 NY
* Eitel-McCullough Inc 301 Industrial Way San Carlos Calif
Electrend Products Corp Box 110 St Joseph Mich
Electro Contacts Inc Main St Osterville Mass
* Electro Impulse Lab Inc 208 River St Red Bank NJ
Electro Instrument Inc 3540 Aero Court San Diego 11 Calif
Electronic Applications Inc 194 Richmond Hill Ave Stamford Conn
Electronic Associates Inc Long Branch NJ
Electronic Communications Inc 1501 72nd St N St Petersburg 10 Fla
Electronic Control Systems 2231 Barrington Ave Los Angeles 64 Calif
* Electronics Development Co 3743 Cahuenga Blvd N Hollywood Calif
* Electronics & Ordnance Div/Avco Corp PO Box 116 Cincinnati 15 Ohio
* Electronic Specialty Co 5121 San Fernando Rd Los Angeles 39 Calif
* Electron-Radar Products 4806 W Chicago Ave Chicago 51 Ill
Electro-Pulse Inc 11861 Teale St Culver City Calif

Elk Electronics Labs Inc 333 W 52nd St New York 19 NY
Elliott Brothers London Ltd Elstree Way Borehamwood Hertfordshire England
Elliott Brothers London Ltd Radar Div Elstree Way Borehamwood Hertfordshire England
* Elm Labs PO Box 14 Hastings-on-Hudson NY
Elsin Electronics Corp Eileen Way Syosset NY
* Emerson & Cuming Inc 869 Washington St Canton 1 Mass
EMI Cosser Electronics Woodside Dartmouth Nova Scotia
* Empire Devices Products Corp 37 Prospect St Amsterdam NY
Empire Product Sales Corp 37 Prospect St Amsterdam NY
Enflo Corp Fellowship Rd Route 73 Maple Shade NJ
Energy Kontrols Inc 15 S 1st St Geneva Ill
* Englehard Industries Inc D E Makepeace Div Pine & Dunham Sts Attleboro Mass
Englehard Industries Inc 113 Astor St Newark NJ
Engis Equipment Co 431 S Dearborn St Chicago 5 Ill
Entron Inc 4902 Lawrence St Bladensburg Md
Ercona Corp 16 W 46th St New York 36 NY
ESCO Group Div Electronic Specialty Co 5121 San Fernando Rd Los Angeles 39 Calif
Eugene Engineering Co Inc 1217 Hyde Park Ave Hyde Park 36 Mass
Exact Eng'g & Mfg Inc PO Box 668 Oceanside Calif
* E-Z Way Towers Inc 5901 E Broadway Tampa 5 Fla
Fairchild Astronics Div Straight Path Wyandanch LI NY
Farinon Electric Co 416 D St Redwood City Calif
Farnsworth Electronics Co Div ITT 3702 E Pontiac St Ft Wayne Ind
Fecker Inc J W 6592 Hamilton Ave Pittsburgh 6 Penna
Feedback Controls Inc 8 Eire Dr Natick Mass
Ferranti Electronic Inc 30 Rockefeller Plaza New York 20 NY
Ferrotran Electronics Co Inc 693 Broadway New York 12 NY
Filmohm Corp 48 W 25th St New York 10 NY
* Filtron Co Inc Western Div 10023 W Jefferson Blvd Culver City Calif
Filtron Co 131-15 Fowler Ave Flushing 55 NY
Fisher Eng'g Inc PO Box 327 Huntington Ind
* Formcraft Tool Co 2465 S Archer Ave Chicago 16 Ill
Foto Video Labs 36 Commerce Rd Cedar Grove NJ
Fox Co Thomas T 304 Mt Pleasant Ave Newark 4 NJ
* Frequency Standards Div Harvard Industries Inc Box 504 Asbury Park NJ
* FXR Inc 25-26 50th St Woodside 77 NY
* Gabriel Electronics Div Gabriel Co Millis Mass
Gates Electronics Co 1705 Taylor Ave New York NY
* Gavitt Wire & Cable Co 455 N Quince St PO Box 1596 Escondido Calif
* G B Electronics Corp Hook Creek Blvd Valley Stream NY
General Bronze Electronics Corp Hook Creek Blvd Valley Stream NY
* General Cable Corp 730 3rd Ave New York 17 NY
* General Communication Co 677 Beacon St Boston 15 Mass
General Devices Inc PO Box 253 Princeton NJ
General Electric Co Power Tube Dept Palo Alto Calif
General Electric Co Dist Assemblies Dept 41 Woodford Ave Plainville Conn
General Electric Co Missile & Ordnance Dept 100 Plastics Ave Pittsfield Mass
General Electric Ordnance Dept 100 Plastics Ave Pittsfield Mass
* General Electric Power Co Power Tube Dept Bldg 267 Schenectady 5 NY
General Electric Co HMEE Dept Syracuse NY
General Electric Co Technical Products Dept Electronic Park Syracuse NY
* General Electric Co French Rd LMED Utica NY
General Electric Co MSVD 3198 Chestnut St Phila 4 Penna
* General Electric Co Communication Products Dept Lynchburg Va

MICROWAVE GENERATORS

POLARAD
PROVEN RELIABILITY

500 mc to 50,000 mc



		MOST FEATURES
MODEL PMR	500 to 1,000 mc	Complete modulation capabilities — internal pulse modulator or FM modulator
MODEL MSG-1	950 to 2,400 mc	Complete modulation capability including square wave modulation
MODEL MSG-2A	2,000 to 4,600 mc	Complete modulation capability including square wave modulation
MODEL MSG-34	4,200 to 11,000 mc	Widest frequency range in a single instrument
MODEL KSS	1,050 to 11,000 mc	Compact high power signal source with plug-in tuning units — internal modulation
MODEL PMX	4,450 to 11,000 mc	Calibrated 1 milliwatt signal generator with complete modulation capability
MODEL CSG	1,000 to 16,000 mc	Higher power sweep generator
MODEL PMK	10,000 to 21,000 mc	Wider modulation capabilities — calibrated 10 milliwatt output
MODEL EHF (generator)	18,000 to 39,700 mc	High frequency signal generator — operates on fundamentals
MODEL EHF (source)	18,000 to 50,000 mc	Widest and highest continuous frequency range — operates on fundamentals

POLARAD ELECTRONICS CORP. EI-11

Please send me information and specifications on

- ☐ Model PMR
- ☐ Model MSG-1
- ☐ Model MSG-2A
- ☐ Model MSG-34
- ☐ Model KSS
- ☐ Model PMX
- ☐ Model CSG
- ☐ Model PMK
- ☐ Model EHF (generator)
- ☐ Model EHF (source)
- ☐ A copy of "Notes on Microwave Measurements."

My application is______

Name______

Title______ Dept.______

Address______

City______ Zone______ State______

MAIL THIS COUPON FOR MORE INFORMATION...

FREE LIFETIME SERVICE

POLARAD
ELECTRONICS CORPORATION
43-20 34th Street, Long Island City 1, N. Y.
Representatives in principal cities.

1961 Directory of Microwave Manufacturers (cont.)

*General Electric Co Ltd of England 80 Shore Rd Port Washington NY
*General Magnetics Inc 135 Bloomfield Ave Bloomfield NJ
General Mills Inc 1620 Central Ave Minneapolis 13 Minn
General Precision Lab Inc 180 N Vinedo Ave Pasadena Calif
*General Radio Co 22 Baker Ave West Concord Mass
Geotechnical Corp 3401 Shiloh Rd Garland Texas
Glasser Steers Corp 155 Oraton St Newark 4 NJ
Glasply Corp 70 Lyons Pl Mount Vernon NY
*Gombos Inc Co John Webro Rd Clifton NJ
Goodrich Sponge Products B F Div B F Goodrich Co Canal St Shelton Conn
Gorham Electronics Div Gorham Mfg Co 333 Adelaide Ave Providence 7 RI
*GPL Div General Precision Inc 63 Bedford Rd Pleasantville NY
Granger Associates 966 Commercial St Palo Alto Calif
Gray Mfg Co 16 Arbor St Hartford 1 Conn
Great Eastern Mfg Co 163-165 Remsen Ave Brooklyn 12 NY
Gruen Industries Inc/Electronic Products Div 9701 Reading Rd Cincinnati 15 Ohio
Gulton Industries Inc 212 Durham Metuchen NJ
Hallamore Electronics Co 714 N Brookhurst St Anaheim Calif
Hallicrafters Co 4401 W 5th Ave Chicago 26 Ill
Hammarlund Mfg Co 460 W 34th St New York 1 NY
Hazeltine Electronics Div/Hazeltine Corp 59-25 Little Neck Pkwy Little Neck 62 NY
Hermes Electronics Co 75 Cambridge Pkwy Cambridge 42 Mass
Hermes-Sonic Corp 13-19 University Pl New York NY
*Hermetic Seal Transformer Co Special Products Div 2925 Merrill Rd Dallas Texas
*Hewlett-Packard Co 275 Page Mill Rd Palo Alto Calif
Hilger & Watts Ltd 80 Shore Rd Port Washington NY
*High Voltage Eng'g Corp Box 98 Burlington Mass
*Hitemp Wires Co/Div Simplex Wire & Cable Co 1200 Shames Dr Westbury NY
Hoffman Electronics Corp 3761 S Hill St Los Angeles 7 Calif
Holland Electronics 772 E 53rd St Brooklyn NY
Honeywell Controls Ltd Vanderhoof Ave Toronto 17 Ont Canada
*Houston Fearless Corp 11801 W Olympic Blvd Los Angeles 64 Calif
Howard Foundry Co 1700 N Kostner Ave Chicago 39 Ill
HRB Science Inc Science Park State Park Penna
Hughes Aircraft Co-El Segundo Int'l A/P PO Box 90426 Los Angeles 45 Calif
Hughes Aircraft Co Electronic Mfg Div Box 90426 Los Angeles 45 Calif
*Hughes Components Div Bldg 20- Room 1372 Culver City Calif
Hughes Semiconductor Div 500 Superior Ave Newport Beach Calif
*Hycon Mfg Co 1030 S Arroyo Pkwy Pasadena Calif
Hy-Gain Antenna Products Co 1135 N 22nd St Lincoln Neb
Hyson Mfg Co PO Box N Pasadena Calif
Illumitronic Eng'g Co 680 E Taylor Ave Sunnyvale Calif
Industrial Development Eng'g Assoc 7900 Pendleton Pk Indianapolis Ind
Industrial Prod-Danbury Knudsen Div 33 E Franklin Danbury Conn
Infrared Industries Inc 62 4th Ave Waltham 54 Mass
Infrared Standards Lab Div Infrared Ind Inc 10555 Magnolia Ave Riverside Calif
Instruments Div W L Maxson Corp 475 10th Ave New York 18 NY
Instruments for Industry Inc 101 New South Rd Hicksville LI NY
Insulating Fabricators Inc 150 Union Ave E Rutherford NJ
*Intaspace Corp 135 Orange St Bloomfield NJ
Intercontinental Electronics Corp 1551 Franklin Ave Mineola NY
Int'l Electronics Mfg Co 2nd St Ext Greenwood Acres Annapolis Md
*ITT Labs 500 Washington Ave Nutley NY
ITT Federal Div ITT Corp 100 Kingsland Rd Clifton NJ
Interstate Electronics Corp 707 E Vermont Ave Anaheim Calif
Isolantite Mfg Corp 337 Warren Ave Stirling NJ
*I-T-E Circuit Breaker Co 601 E Erie Ave Phila 34 Penna
ITEK Corp 1605 Trapelo Rd Watham Mass
Jacobs Instrument Co Bethesda 14 Md
*Jones Electronics Co Inc M C 185 N Main St Bristol Conn
Jones Optical Works A D 2400 Massachusetts Ave Cambridge 40 Mass
J-V-M Microwave Co 9300 W 47th St Brookfield Ill
*Judd Wire Mfg Corp 22 Avenue A Turners Falls Mass
Kahn & Co 885 Wells Rd Wethersfield Hartford Conn
Kaiser Aircraft & Electronics Div Kaiser Ind PO Box 1828 Oakland 4 Calif
Kaiser Electronics Inc 13 Monroe St Union NJ
*Kay Electric Co Maple Ave Pine Brook N J
Kay-Townes Antenna Co Box 593 Rome Ga
Kearfott Div General Precision Inc 253 N Vinedo Ave Pasadena Calif
*Kearfott Div General Precision Inc 14844 Oxnard St Van Nuys Calif
*Kearfott Div General Precision Inc 1150 McBride Ave Little Falls NJ
Kelsey-Hayes Co 3600 Military Ave Detroit 32 Mich
Kemtron Electron Products Inc 14 Prince Pl Newburyport Mass
*Kennedy & Co D S 432 S Main St Cohasset Mass
*Kent Corp F C/Div Bart Mfg 135 Manchester Pl Newark 4 NJ
*Ken-Tron Corp 395 Lynnway Lynn Mass
Kepco Inc 131 38 Sanford Ave Flushing 55 NY
Kings Electronics Co Inc 40 Marbledale Rd Tuckahoe NY
Kost Products Co 2335 N Cicero Ave Chicago 39 Ill
Kulka Electric Corp 633 S Fulton St Mt Vernon NY
K-W Engineering Works N50 W16328 Pin Oak Court Butler Wis
*Laboratory for Electronics Inc 719 Beacon St Boston 15 Mass
*Lab-Tronics Inc 3656 N Lincoln Ave Chicago 13 Ill
Lambda Electronics Corp 11-11 131st St College Point 56 NY
Lambda Pacific Eng'g Corp PO Box 70 Van Nuys Calif
Lance Antenna Mfg Corp 1730-1802 1st St San Fernando Calif
Land-Air Inc 7444 W Wilson Ave Chicago 31 Ill
*LaPoint Industries Inc 155 W Main St Rockville Conn
*Lavoie Labs Inc Matawan-Freehold Rd Morganville NJ
Leach & Garner Co Industrial Div Leach & Garner Bldg Attleboro Mass
Lear Inc 3171 S Bundy Dr Santa Monica Calif
LEE Inc 625 N Y Ave NW Washington 1 DC
Leitch Eng'g Corp 326 Lincoln St Manchester NH
Lel Inc 380 Oak St Copiague NY
*Lenkurt Electric Co Sub General Telephone & Electronics 1105 County Rd San Carlos Calif
*Lenz Electric Mfg Co 1751 N Western Ave Chicago 47 Ill
Levinthal Electronic Products Inc 3180 Hanover St Palo Alto Calif
*Lewis Eng'g Co 339 Church St Naugatuck Conn
Librascope Div General Precision Inc 808 Western Ave Glendale 1 Calif
*Lieco Inc 130 Eileen Way Syosset LI NY
Ling Electronics Inc 9937 Jefferson Blvd Culver City Calif
Ling Systems Inc 11949 Vost St N Hollywood Calif
Litton Industries Electron Tube Div 960 Industrial Rd San Carlos Calif
Litton Industries Maryland Div 4900 Calvert Rd College Park Md
*Lockheed Electronics Co U S Route 22 Plainfield NJ
Loewy - Hydropress Div Baldwin - Lima - Hamilton Corp 111 5th Ave New York 3 NY
*Loral Electronics Corp 825 Bronx River Ave New York 72 NY
*Luhrs & Co C H 297 Hudson St Hackensack NJ
Lynmar Engineers Inc 1432 N Carlisle St Phila 21 Penna
*McMillan Industrial Corp Brownsville Ave Ipswich Mass
*McMillan Laboratory Inc Brownville Ave Ipswich Mass
Madigan Corp 200 Stonehinge Lane Carle Place NY
*Magnavox Corp 2131 Bueter Rd Ft Wayne Ind
*Magnesium Products of Milwaukee Inc 740 N Plankinton Ave Milwaukee 3 Wis
Magnetic Research Corp 3160 W El Segundo Blvd Hawthorne Calif
*Magnetic Shield Division Perfection Mica Co 1322 N Elston Ave Chicago 22 Ill
Mallory & Co Inc P R 42 S Gray St Indianapolis 6 Ind
Mallory & Co Inc 3029 E Washington St Indianapolis 6 Ind
*Manson Laboratories Inc 375 Fairfield Ave Stamford Conn
March Associates 145 Cortland St Lindenhurst NY
Marconi Instruments Ltd 111 Cedar Lane Englewood NJ
Marconi Wireless Telegraph Co Ltd 750 3rd Ave New York 17 NY
*Mark Products Co 5439 Fargo Ave Skokie Ill
Marquardt Corp Pomona Div 2709 N Garey Ave Pomona Calif
Master Mobile Mounts Inc 1306 Bond St Los Angeles 15 Calif
Mathis Co G E 6100 S Oak Park Ave Chicago 38 Ill
*Maxson Corp W L 460 W 34th St New York NY
Measurements McGraw-Edison Inc Interstate Rd Boonton NJ
Measurements Div McGraw-Edison Box 180 Boonton NJ
Mechanical Engraving Co Inc 10 Van Cortlandt Ave New York 68 NY
Mechanical Products Inc 1824 River St Jackson Mich
Mectron Co 166 Ridge Ave North Plainfield NJ
*Melabs Dept M7 3300 Hillview Ave Palo Alto Calif
*Melpar Inc Special Products Dept 3200 Arlington Blvd Falls Church Va
*Menlo Park Eng'g 711 Hamilton Ave Menlo Park Calif
*Meridian Metalcraft Inc 8739 S Millergrove Dr Whittier Calif
Merrimac Research & Development Inc 517 Lyons Ave Irvington NJ
Metal Fabricators Corp 63 Pond St Waltham 54 Mass
*Metavac Inc 45-68 162nd St Flushing 58 NY
*Metcom Inc 76 LaFayette St Salem Mass
*Metropolitan Telecommunicators Ames Court Plainview LI NY
Micacraft Products Inc 701 McCarter Hwy Newark 5 NJ
*Mico Instrument Co 80 Trowbridge St Cambridge 38 Mass
*Microfleet Co 2300 S 25th St Salem Ore
*Microlab 570 W Mt Pleasant Ave Livingston NJ
Microphase Corp Box 1166 Greenwich Conn
*Microtech Inc 1400 Milldale Rd Cheshire Conn
*Microwave Associates Inc South Ave Burlington Mass
*Microwave Chemicals Laboratory Inc 282 Seventh Ave New York 1 NY
*Microwave Components Doylestown Pa
*Microwave Development Labs 92 Broad St Babson Park Wellesley 57 Mass
*Microwave Electronics Corp 4061 Transport St Palo Alto Calif
*Microwave Tube Div Hughes Aircraft Co 11105 Anza Ave Los Angeles 45 Calif
*Miller Associates PO Box 369 Lakeville Conn
Minn-Honeywell Regulator Co Aeronautical Div 2600 Ridgway Ave Minneapolis 13 Minn
*Miratel Inc 1080 Dionne St St Paul 13 Minn
*Missile Systems Corp 11949 Vose St North Hollywood Calif
Missileonics Inc PO Box 716 Melbourne Fla
Missouri Research Laboratories Inc 2109 Locust St St Louis 3 Mo
Model Eng'g & Mfg Inc 50 Frederick St Huntington Ind
Monaghan Co J J 500 Alcott St Denver 4 Colo
Monitor Systems Inc Fort Washington Penna
Monrovia Aviation Corp 801 Royal Oaks Blvd Pasadena Calif
Moran Instrument Corp 170 E Orange Grove Blvd Pasadena Calif
*Motorola Communications & Electronics Ind 4501 W Augusta Blvd Chicago 51 Ill
Motorola Inc 4501 W Augusta Chicago 51 Ill
Motorola Inc 1400 N Cicero Ave Chicago 51 Ill
Mullard Equipment Ltd Torrington Pl London WC 1 England
Multronics Inc Box 1539 4130 Washington Blvd Sarasota Fla
*Narda Microwave Corp 118-160 Herricks Rd Mineola NY

*Nat'l Beryllia Corp 1st Ave Haskell NJ
*Nat'l Beryllia Corp 4501 Dell Ave N Bergen NJ
*National Company Inc 61 Sherman St Malden 48 Mass
New London Instrument Co Inc 82 Union St New London Conn
New-Tronics Corp 3455 Vega Ave Cleveland 13 Ohio
*Nichols Products Co 325 W Main St Moorestown NJ
NJE Corp 20 Boright Ave Kenilworth NJ
*Norden Div United Aircraft Corp 58 Commerce Rd Stamford Conn
Northeast Electronics Corp Airport Rd Concord NH
*Northeast Scientific Corp 30 Wetherbee St E Acton Mass
Northeastern Eng'g Inc 25 S Bedford St Manchester NH
*N R K Mfg & Eng'g Co 4601 W Addison St Chicago 41 Ill
*Nuclear Corp of America 2 Richwood Pl Denville NJ
*Okonite Co 220 Passaic St Passaic NJ
Olympic Radio & TV Div Siegler Corp 34-01 38th Ave Long Island City 1 NY
*Omega Labs Inc Haverhill St Rowley Mass
*Pacific Universal Products Corp 168 Vista Ave Pasadena 8 Calif
Packard Bell Electronics Corp 12333 W Olympic Blvd Los Angeles 64 Calif
*Panoramic Radio Products 520 S Fulton Ave Mt Vernon NY
Panseal Inc 10 Main St Little Ferry NJ
*Parker Seal Co Div Parker-Hannifin Corp 10567 Jefferson Blvd Culver City Calif
Paul & Beekman 1801 W Courtland St Phila 40 Penna
Pearce Simpson Inc 2295 NW 14th St Miami 35 Fla
Peer Inc Professional Electronic Eng'g Res Inc 2924 Shelby St Dallas 19 Texas
Perfection Mica Co 1322 N Elston Ave Chicago 22 Ill
Perkin Eng'g Corp 345 Kansas St El Segundo Calif
Peschel Electronics Inc Towners Rt 216 Paterson NJ
*Phalo Plastic Corp 530 Boston Tpk Shrewsbury Mass
*Phelps Dodge Copper Products Corp 300 Park Ave New York 22 NY
Philco Corp Tioga & C Sts Phila 24 Penna
Philco Corp G & I Group 4700 Wissahickon Ave Phila 44 Penna
Philco Corp G & I Div 4700 Wissahickon Ave Phila 44 Penna
*Phoenix Precision Instrument Co 3805 N 5th St Phila 40 Penna
Pioneer Industries Inc 2700 Hawkeye Dr Sioux City Iowa
*Pitometer Log Corp 237 LaFayette St New York 12 NY
*Plastoid Corp Hamburg NJ
*Polarad Electronics Corp 43-20 34th St Long Island City 1 NY
*PRD Electronics Inc 202 Tillary St Brooklyn 1 NY
Polytronic Research Inc 7326 Westmore Rd Rockville Md
Potter & Brumfield 1200 E Broadway Princeton Ind
Power Designs Inc 89-25 130th St Richmond Hill 18 NY
Power Supplies Inc 1005 Olive St Highland Ill
Pratt Albert 114 W Lake View Ave Milwaukee 17 Wis
*Precision Tube Co Church Rd & Wissahickon Ave North Wales Penna
*Premier Instrument Corp 33 New Broad St Port Chester NY
Press Wireless Labs Inc 25 Prospect Pl W Newton 65 Mass
*Prodelin Inc 305 Bergen Ave Kearny NJ
Production Research Corp Thornwood NY
Pye Canada Ltd 82 Northline Rd Toronto 16 Ont Canada
Pye Telecommunications Ltd Newmarket Rd Cambridge England
Q-Line Mfg Corp 1562 61 St Brooklyn 19 NY
Q O S Corp Bronx Blvd at 216th St New York 67 NY
Radar Design Corp PO Box 38 Pickard Dr Syracuse 11 NY
Radar Measurements Corp 190 Duffy Ave Hicksville LI NY
Radiation Eng'g Labs Main St Maynard Mass
Radiation Inc Melbourne Fla
Radio Activities Inc 119 Dawson Ave Boonton NJ
*Radio City Products Co Centre & Glendale Sts Easton Penna
Radio Corp of America Broadcast & TV Div Somerville NJ
*Radio Corp of America Communications Products Dept Bldg 1-5 Front & Cooper Sts Camden NJ
Radio Corp of America Commercial Electronic Products Front & Cooper Sts Camden NJ
Radio Corp of America Defense Electronic Pro Bldg 15-2 Front & Cooper Sts Camden NJ
*Radio Corp of America Electron Tube Div Harrison N J
*Radio Eng'g Labs Inc 29-01 Borden Ave Long Island City 1 NY
Radioplane Div Northrop Aircraft Inc 8000 Woodley Ave Van Nuys Calif
*Ramage & Miller Inc 3221 Florida Ave Richmond Calif
Ramo-Wooldridge Corp PO Box 8405 Denver 10 Colo
Rauland-Borg Corp 3535 W Addison St Chicago 18 Ill
Raytheon Mfg Co Maynard Labs Thompson St Maynard Mass
Raytheon Mfg Co 1415 Boston & Providence Tpk Norwood Mass
*Raytheon Co Commercial Equipment Div 100 River St Waltham 54 Mass
*Raytheon Co Microwave & Power Tube Div Foundry Ave Waltham 54 Mass
Raytheon Co 100 River St Waltham 54 Mass
Reed & Reese Retron Corp 717 N Lake Ave Pasadena Calif
*Reeves Instrument Corp East Gate Blvd Roosevelt Field Garden City NY
Remanco Inc 1805 Colorado Santa Monica Calif
Renfrew Electric Co Ltd 349 Carlaw Ave Toronto 9 Ont Canada
Republic Aviation Corp Farmingdale LI NY
*Resdel Eng'g Corp 330 S Fair Oaks Ave Pasadena Calif
*Resitron Labs Inc 2908 Nebraska Ave Santa Monica Calif
Reynolds Metals Co PO Box 2346-ZF Richmond Calif
*R F Products Div Amphenol-Borg Electronics Corp 33 E Franklin Danbury Conn
Rheem Mfg Co-Electronics Div 7777 Industry Ave Rivera Calif
Rich Electronics Inc 212 NW 8th Ave Miami 36 Fla
*Rockbestos Wire & Cable Div Cerro de Pasco Corp 285 Nicoll St New Haven Conn
Roflan Co Topsfield Mass
Rogers Corp Windham County Rogers Conn
*Roston Corp 5660 59th St Maspeth 78 LI NY
Royal Communications Systems 4501 Prospect Ave Cleveland 3 Ohio
R S Electronic Corp PO Box 368 Sta A Palo Alto Calif
*Sage Laboratories 3 Huron Drive East Natick Industrial Park Natick Mass
Sanders Associates 95 Canal St Nashua NH
Saratoga Industries Congress & Ballston Aves Saratoga Springs NY
*Sarkes Tarzian Inc East Hillside Dr Bloomington Ind
*Saxton Products Inc 4320 Park Ave New York NY
*Scatter-Communication PO Box 551 Leesburg Va
*Schaevitz Eng'g PO Box 505 Camden NJ
Scientific-Atlantic Inc 2162 Piedmont Rd NE Atlanta 9 Ga
Servo Corp of America 111 New South Rd Hicksville NY
Servomechanisms Inc Los Angeles Div 12500 Aviation Blvd Hawthorne Calif
*SFD Laboratories Inc Union NJ
Shallcross Mfg Co Preston St Selma NC
Shell Electronic Mfg Corp 112 State St Westbury NY
Short Bros & Harland Ltd Castlereagh Belfast Northern Ireland
*Sierra Electronic Corp Div Philco Corp 3885 Bohannon Dr Menlo Park Calif
Sierra Electronics Corp 250 E 3rd St Mount Vernon NY
*Silicone Insulation Inc Seabury Ave & Butler Pl Bronx 61 NY
Sivers Lab Kristallvagen 18 Hagersten Sweden
Skiatron Electronics & TV Corp 180 Varick St New York 14 NY
Solartron Electronic Group Ltd Queens Rd Thames Ditton Surrey England
*Specialty Automatic Machine Corp 80 Cambridge St Burlington Mass
*Specialty Electronics Development Corp 115 Eileen Way Syosset NY
*Spectralab Inst Co 608 Fig Ave Monrovia Calif
Sperry Farragut Co Div Sperry Rand Corp Farragut Rd Bristol Tenn
Sperry Electronic Tube Div Sperry Rand Corp PO Box 652 Gainesville Fla
*Sperry Gyroscope Co Air Arm Div Great Neck NY
Sperry Gyroscope Co Electronic Tube Div Great Neck NY
*Sperry Gyroscope Co Div Sperry Rand Corp Great Neck NY
Sperry Gyroscope Co Marine Div Roosevelt Field Mineola NY
*Sperry Microwave Electronics Co PO Box 1828 Clearwater Fla
Sperry Semiconductor Div Sperry Rand Corp Wilson Corp South Norwalk Conn
Spincraft Inc 4122 W State St Milwaukee 8 Wis
*Spinform Div Antenna Systems Inc 369 Lincoln St Hingham Mass
Stainless Inc 3 St North Wales Penna
Standard Electronics Farmingdale NJ
*Stewart Engineering Co 467 Bean Creek Rd Santa Cruz Calif
*Stewart Warner Electronics Div 1300 N Kostner Ave Chicago 51 Ill
*Stoddart Aircraft Radio Co 6644 Santa Monica Blvd Hollywood 38 Calif
Stromberg-Carlson-San Diego 1895 Hancock St Box 2449 San Diego 12 Calif
*Stromberg-Carlson Div General Dynamics Corp 100 Carlson Rd Rochester 3 NY
Stromberg-Carlson Div Gen Dynamics Corp 1400 N Goodman St Rochester NY
Suffolk Products Corp Woodbine & Scudder Ave Northport NY
Summit Industries Inc 2104 W Rosecrans Ave Gardena Calif
*Sunnyvale Development Center Sperry Gyroscope Co Div Sperry Rand Corp PO Box 697 Sunnyvale Calif
*Sylvania Electric Products Inc Special Tube Operations 500 Evelyn Ave Mountain View Calif
*Sylvania Electric Products Inc 100 Sylvan Rd Woburn Mass
Sylvania Electric Products Inc Electronic Systems Plant 175 Great Arrow Ave Buffalo 7 NY
*Sylvania Electric Products Inc E 3rd St Williamsport Penna
*Sylvania Electronic Systems Div Sylvania Electric Products Inc 63 2nd Ave Waltham 54 Mass
Tamar Electronics Inc 2045 W Rosecrans Ave Gardena Calif
Tapco Group Thompson Ramo Wooldridge Inc 23555 Euclid Ave Cleveland 17 Ohio
Taurus Corp 8 Corvell St Lambertville NJ
Tech Labs Bergen & Edsall Blvd Palisades Park NJ
*Technical Appliance Corp 1 Taco St PO Box 38 Sherburne NY
Technical Materiel Corp 700 Fenimore Rd Mamaroneck NY
Technical Oil Tool Corp 1057 N LaBrea Los Angeles 38 Calif
*Technicraft Div Electronic Specialty Co Thomaston Conn
Techniques Inc 40 Jay St Englewood NJ
Telco Electronics Mfg Co 400 S Wyman St Rockford Ill
Telcon Metals Telcon Works Manor Royal Crawley Sussex England
Tele-Beam Industries Atlas Peak Rd Napa Calif
Telechrome Mfg Corp 28 Ranick Dr Amityville LI NY
*Telecomputing Corp 915 N Citrus Ave Los Angeles Calif
Telecomtrol Corp 20 Diller Ave Newton NJ
Telectro Industries Corp 35-18 37th St Long Island City 1 NY
*Tele-Dynamics Div American Bosch Arma 5000 Parkside Ave Phila 31 Penna
Telerad Mfg Corp 1440 Broadway New York 18 NY
Televiso Corp 1415 Golf Rd Des Plaines Ill
Telewave Labs Inc 43-20 34th St Long Island City NY
*Telonic Engineering Corp 773 Broadway Laguna Beach Calif
*Telonic Industries Inc 60 N 1st Ave Beech Grove Ind
*Telrex Labs Asbury Park NJ
Temco Aircraft Corp PO Box 6191 Dallas 22 Texas
Tenatronics Ltd 1011 Power Ave Cleveland 14 Ohio
*Texas Instruments Inc/Apparatus Div 6000 Lemmon Ave Dallas 9 Texas
*Thermal Wire of America Keeler's Bay South Hero Vt
*Thwing-Albert Instrument Co 5351 Pulaski Ave Phila 44 Penna
*Topatron Inc 942 E Ojai Ave Ojai Calif
Topp Industries Inc 8907 Wilshire Blvd Beverly Hills Calif
*Torngren Co C W 236 Pearl St Somerville 45 Mass
*Torotel Inc 5512 E 110th St Kansas City 34 Mo
*Tower Construction Co 2700 Hawkeye Dr Sioux City 2 Iowa

Trad Electronics Corp 1001 First Ave Asbury Park NJ

* Trak Microwave Corp Sub Trak Electronics Co 5006 N Coolidge Tampa Fla

* Transco Products Inc 12210 Nebraska Ave Los Angeles 25 Calif

Transdyne Corp 43 Albertson Ave Albertson NY

Transline Electronic Communication Co 304 Mt Pleasant Ave Newark 4 NJ

Transonic Inc 808 16th St Bakersfield Calif

* TRG Inc 2 Aerial Way Syosett LI NY

Tri-Ex Tower Corp 127 E Inyo St Tulare Calif

* Tru-Connector Corp 416 Union St Lynn Mass

* Turbo Machine Co Lansdale Penna

* Ucinite Co 459 Watertown St Newtonville 60 Mass

Underwood Corp Canoga Div 150 Elgin Hwy Ft Walton Beach Fla

Union Electronics & Machine Corp 71 Broadway Wakefield Mass

United Aircraft Products Inc 1116 Bolander Ave Dayton 8 Ohio

United Transformer Corp 150 Varick St New York 13 NY

* Universal Transistor Products Corp 36 Sylvester St Westbury LI NY

Univox Corp 4301 W Jefferson Blvd Los Angeles Calif

* Univox Corp 102 Warren St New York 7 NY

* Uniwave Inc 109 Marine St Farmingdale NY

* United States Wire & Cable Corp Progress & Monroe Sts Union NJ

U S Testing Co 1415 Park Ave Hoboken NJ

Utility Brass & Copper Corp 255 Conover St Brooklyn 31 NY

1961 Directory of Microwave Manufacturers (cont.)

* Valor Electronics Co 13214 Crenshaw Blvd Gardena Calif

Van Norman Industries Inc Electronics Div 186 Granite St Manchester NH

* Varian Associates 611 Hansen Way Palo Alto Calif

Vectron Inc 1611 Trapelo Rd Watham 54 Mass

Victor RF & Microwave Co 36 N Water St Wakefield Mass

* Virginia Electronics Co 5211 River Rd Washington 16 DC

* Wacline Inc 35 S St Clair St Dayton 2 Ohio

Waltham Electronics Corp 751 Main St Waltham Mass

Ward Products Corp Edson St Amsterdam NY

Warren Mfg Co Newtown Rd Littleton Mass

* Waveguide Inc 1769 Placentia Costa Mesa Calif

* Waveline Inc PO Box 718 W Caldwell NJ

Wave/Particle Corp PO Box 252 Menlo Park Calif

* Wayne Kerr Corp 1633 Race St Phila 3 Penna

Webcor Inc-Electronics Div 816 N Kedzie Chicago 51 Ill

Webster Mfg 317 Roebling Rd S San Francisco Calif

* Weinschel Eng'g 10503 Metropolitan Ave Kensington Md

* Wells Industries Corp 6880 Troost Ave N Hollywood Calif

Westbury Electronics Inc 300 Shames Dr Westbury NY

* Western Int'l Co 45 Vesey St New York 7 NY

* Westgate Lab Inc PO Box 63 Yellow Springs Ohio

* Westinghouse Electric Co Div Air Arm Div PO Box 746 Baltimore Md

* Westinghouse Electric Corp Box 284 Elmira NY

Westinghouse Electric Corp 3 Gateway Center PO Box 2278 Pittsburgh 30 Penna

Westrex Corp Div Litton Industries 111 8th Ave New York 11 NY

Weymouth Instrument Co 1440 Commercial St E Weymouth 89 Mass

* White & Son James L 374 Verona Ave Newark 4 NJ

* Wiley Electronics Co Div Savage Industries 2045 W Cheryl Dr Phoenix Ariz

* Wincharger Corp E 7th & Division St Sioux City 2 Iowa

Winder Aircraft Corp Fla PO 8 Dunnellon Fla

Wright Equipment Corp Lukach Court Milltown NJ

Young Spring & Wire Co Gonset Div 801 S Main St Burbank Calif

* Zenith Plastics Co Box 91 Gardena Calif

* Zenith Radio Corp 6001 W Dickens Ave Chicago 39 Ill

Products & Manufacturers

Listing microwave firms and the specific products they manufacture

AMPLIFIERS

Amplifiers, bolometer	1
Amplifiers, klystron	2
Amplifiers, maser	3
Amplifiers, parametric	4
Amplifiers, radar	5
Amplifiers, TWT	6

ACF Electronics	2-3-4-5-6
Aeronca Mfg Corp/Aerospace Div	4-5
Aircom Inc	1
Airtron Div Litton Industries	4
Alfred Electronics	6
Applied Radiation Corp	2
Belock Instrument Corp	5
Bendix Corp (Detroit)	2-3-4-5-6
Bendix Corp (Eatontown)	4-6
Bogart Mfg Corp	4-5
Canadian Aviation Electronics Ltd	4-5
Canadian Marconi Co	2-6
Control Electronics Co Inc	4-5
Dynatronic Inc	3-5
Eitel-McCullough Inc	2-6
Electronics & Ordnance Div Avco Corp	2-5-6
FXR Inc	1-2-5-6
General Communication Co	5
General Electric Co/Power Tube Dept	2-6
General Electric Co/LMED	2-3-4-5-6
Hewlett-Packard Co	6
High Voltage Engineering Corp	2
Hughes Components Div	4
Hycon Mfg Co	4
ITT Laboratories (500 Washington Ave)	2-3-4-5-6
Lockheed Electronics Co	5
Manson Laboratories Inc	2-5-6
Maxson Corp W L	4-5
Melpar Inc (Special Products Dept)	6
Menlo Park Engineering	6
Microtech Inc	1-5
Microwave Associates Inc	4
Microwave Electronics Corp	3-6
National Company Inc	2
Norden Div United Aircraft	4-5
PRD Electronics Inc	1
Radio Engineering Laboratories	2-4-6
Ramage & Miller Inc	6
Raytheon Co/Commercial Equipment Div (100 River St)	2
Resdel Engineering Corp	5
Sage Laboratories Inc	4
Schaevitz Engineering	5
Sierra Electronic Corp Div Philco Corp	2
Sperry Gyroscope Co Div Sperry Rand Corp	2-6
Sperry Microwave Electronics Co	1-4
Sylvania Electronic Systems (Waltham)	5
Telecomputing Corp	6
Texas Instruments Incorporated/Apparatus Div	4-5
TRG Inc	3-4-6
Varian Associates	2-6
Weinchel Engineering	1
Westgate Laboratory Inc	1-4
Westinghouse Air Arm Div (Baltimore)	2-3-4-5-6
Zenith Radio Corp	4

ANTENNAS & ACCESS.

Antennas, bedspring	1
Antennas, mounts	2
Antennas, parabolic	3
Antennas, radar	4
Antennas, scatter propagation	5
Horns, microwave	6
Joints, rotating	7
Radomes	8
Repeaters, passive	9

ACF Electronics	1-2-3-4-5-6-7-9
Adams-Russell Co Inc	4-5
Aeronca Mfg Corp/Aerospace Div	3-4
Ainslie Corp	1-2-3-4-5-6-7-9
Aircom Inc	6-7
Aircraft Armaments Inc	3-4
Airtec Inc	4-6-7
Airtron Div Litton Industries	6-7
American Electronic Laboratories Inc	6
Andrew California Corp	2-3-4-5-6-8-9
Andrew Corp	2-3-4-5-6-8
Antenna Specialists Co	2-4
Antenna & Radome Research Associates	3-4-6-7-8
A R F Products Inc (River Forest)	6
Automation Dynamics Corp	2-3
Bart Mfg Corp	2-6
Bellaire Electronics Inc	6
Belz Industries Inc	6
Bendix Corp (Detroit)	2-3-4-5-6-7-8
Blaine Electronetics Inc	3-6
Birdair Structures Inc	8
Blaw-Knox Co	3-4-5
Bogart Mfg Corp	6-7
Brooks & Perkins Inc	2-3-4-6
Cascade Research Div Lewis & Kaufman Electronics Corp	6
CG Electronics Corp	2-3-7
Chu Associates	1-2-3-4-6-7-8
C W S Waveguide Corp	6-7
DeMornay Bonardi	6-7
Diamond Antenna & Microwave Corp	3-4-5-6-7-8
Don-Lan Electronics Inc	3-4-5-6-7
Dorne & Margolin Inc	4-6-7
Electronics & Ordnance Div/Avco Corp	3-4-6
Electronic Specialty Co	1-2-3-4-6-8-9
Electron-Radar Products	4-6
Elm Mfg Co Inc	2
E-Z Way Towers Inc	2
FXR Inc	2-6-7
Gabriel Electronics Div Gabriel Co	1-2-3-4-5-6-7-8-9
GB Electronics Corp	2-3-4-5-6-7
General Communication Co	6
General Electric Co/LMED	3-4-5-6
Gombos Co Inc John	6
Houston Fearless Corp	2-3-4-5-8
Hughes Components Div	4-8
Hycon Mfg Co	4
I-T-E Circuit Breaker Co	1-2-3-4-5-6-7-8
ITT Laboratories (500 Washington Ave)	6
Kearfott Div General Precision Inc (Van Nuys)	3-4-6
Kennedy & Co D S	2-3-4-5-6-7-8
Kent Corp F C	2-6
Lieco Inc	4-6-7
Lockheed Electronics Co	3-4-7
McMillan Industrial Corp	8
McMillan Laboratory Inc	8
Magnavox Co	4
Magnesium Products of Milwaukee Inc	2
Mark Products Inc	2-3-5-6-8
Maxson Corp W L	1-2-3-4-5-6-9
Melpar Inc (Special Products Dept)	3-4-6-7-9
Meridian Metalcraft Inc	4-6-7
Microflect Co Inc	2-9
Microtech Inc	6-7
Microwave Associates Inc	6-7
Microwave Components	6
Microwave Development Labs	6-7
Narda Microwave Corp	6
Nat'l Beryllia Corp (Haskell)	8
Nat'l Beryllia Corp (N Bergen)	8
Nichols Products Co	6
Norden Div United Aircraft	3-4-6-7-9
NRK Mfg & Eng'g Co	6-7
Polarad Electronics Corp	3-6
Premier Instrument Co	4-5-6

Prodelin Inc 1-2-3-4-5-6-8
Reeves Instrument Corp 2-7
Rostan Corp 2
Sage Laboratories Inc 6-7
Scatter Communication 1-2-3-4-5-7
Schaevitz Engineering 4
Silicon Insulation Inc 8
Specialty Electronics Development Corp 8
Sperry Gyroscope Co Div Sperry Rand Corp 4
Sperry Microwave Electronics Co 4-6-7
Spinform Div Antenna Systems Inc 1-2-3-4-5-6-7-8-9
Sylvania Electronic Systems (Waltham) 1-3-4-5-6-7
Technical Appliance Corp 2-3-4-5-6-8
Technicraft Div Electronic Specialty Co 4-6-7
Telecomputing Corp 3-4-8
Telrex Labs 4-5
Texas Instruments Incorporated/ Apparatus Division 4-7
Torngren Co Inc C W 3
Tower Construction Co 8-9
Transco Products Inc 6
TRG Inc 1-2-3-4-5-6-7-8
Turbo Machine Co 3-4-6
Uniwave Inc 6
Virginia Electronics Co Inc 1
Waveline Inc 6-7
Westinghouse Air Arm Div (Baltimore) 2-3-4-7-9
White & Sons James L 2
Wiley Electronics Co 6
Zenith Plastics Co 3-4-8

1961 Directory of Microwave Manufacturers (cont.)

COMPONENTS

Absorbers, microwave 1
Attenuators 2
Cavities 3
Circulators, ferrite 4
Crystal mounts 5
Discriminators 6
Duplexers 7
Filters 8
Filters, waveguide 9
Hybrid junctions 10
Isolators 11
Mixers 12
Modulators, ferrite 13
Modulators, phase 14
Modulators, magnetic 15
Modulators, pulse 16
Multiplexers 17
Phasers 18
Probes 19
Power supplies, microwave 20
Power supplies, radar 21
R-F Heads 22
Shutter 23
Sliding loads 24
Terminations 25
Tuners 26
Tuners, klystron 27

ACF Electronics 1-2-3-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-25-26-27
Adams-Russell Co Inc 3-7-8-17-18
Adler Electronics Inc 3
Aeronca Mfg Corp/Aerospace Div 6-13-16-20-21
Aircom Inc 1-2-3-5-6-7-8-9-10-12-17-19-20-22-24-25-26-27
Airtron Inc Div Litton Industries 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-22-23-24-25
Alford Mfg Co 7-10-17-25-26
Alfred Electronics 8-20
American Electronics Laboratories Inc 5-8-9
AMP Inc/Capitron Div 8-16-20-21-25
Andrew California Corp 3-7
Andrew Corp 3-7
Antenna & Radome Research Corp 2-5-12-25-26
Antennavision Inc 20
Applied Radiation Corp 16-18-19
Airtec Inc 1-2-3-4-5-7-9-10-11-12-13-22-23-24-25-26-27
A R F Products Inc (River Forest) 8-22
Arnold Eng'g Co 11
Atlas Eng'g Co Inc 8-21
Avionics Div Bell Aerosystems Co 20
Baird-Atomic Inc 9-14-16
Bart Mfg Corp 3-10
Bellaire Electronics Inc 2
Belock Instrument Corp 2-21-27
Belz Industries Inc 2-7-12-22
Bendix Corp (Detroit) 3-4-5-6-7-8-9-10-11-12-13-15-16-17-18-19-20-21-22-25-26-27
Bendix Corp (Eatontown) 2-4-13
Bogart Mfg Corp 1-2-7-8-9-12-17-18-19-25
Bogue Electric Mfg Co 20-21

Bomac Labs Inc 2-3-6-7-8-10-11-12-17-23
Bruno-New York Industries Corp 2-22
Budelman Electronics Corp 3-7-8-17
Burndy Corp/Omaton Div 25
Bulova Watch Co Electronics Div 5-6-8
Canadian Marconi Co 12-17-20
Cascade Research Div Lewis & Kaufman Electronics Corp 2-4-11-13-14
Caswell Electronics Corp 1-2-4-11-13-25-26
CG Electronics Corp 8-17
Chemalloy Electronics Corp 1-2
Collins Radio Co/Western Div (Burbank) 8
Control Electronics Co Inc 2-3-4-5-7-8-9-11-12-14-17-20-21-25
Corning Electronic Components 26
Custom Components Inc 1-2-4-24-25-26
C W S Waveguide Corp 2-5-9-10-24-25-26
DeMornay Bonardi 1-2-3-5-8-9-10-11-12-19-24-25-26
Diamond Antenna & Microwave Corp 2-3-5-7-8-9-10-12-17-18-19-22-24-25-26-27
Don-Lan Electronics Inc 1-2-23
Dorne & Margolin Inc 12-17
Edgerton Germeshausen & Grier Inc (Boston) 2-16-20-21
Electro Impulse Lab Inc 1-2-25
Electronics & Ordnance Div/Avco Corp 2-5-10-12-16-20-21-23-25
Electronic Specialty Co 3-5-6-7-8-9-10-12-15-17-18-19-20-21-22
Electron-Radar Products 2
Elm Mfg Co Inc 5
Emerson & Cuming Inc 1
Empire Devices Products Corp 5-12-22-26-27
Filtron Co Inc 8
Frequency Standards 3-6-7-8-9-10-12-17-20
FXR Inc 2-5-11-12-14-16-19-20-21-22-25-26-27
GB Electronics Corp 8-24-25
General Cable Corp 8
General Communication Co 2-3-22-25
General Electric Co/Power Tube Dept 8
General Electric Co/LMED 3-6-7-8-9-12-14-16-17-20-21-22-26
General Electric Co Ltd of England 3-5-7
General Magnetics Inc 15
General Radio Co 2-8-12
Gombos Co Inc John 2-3-5-7-8-9-10-12-22-24-26
Hermetic Seal Transformer Co Special Products Div 15-20-21
High Voltage Engineering Corp 16-18-20
Hewlett-Packard Co 2-5-8-9-19-24-25-26
Houston Fearless Corp 10-16-22-26
Hughes Components Div 1-4-11-13
Hycon Mfg Co 4-5-7-8-10-11-12-13-22-23-25
I-T-E Circuit Breaker Co 7-8-9-10-24-25-26
ITT Laboratories (500 Washington Ave) 3-7-13-14-15-16-17-20-21-22-27
Jones Electronics Co Inc M C 5-25-26
Kay Electric Co 2
Kearfott Div General Precision Inc (Van Nuys) 2-3-4-5-7-8-9-10-11-12-13-14-17-22-23-25
Kearfott Div General Precision Inc (Little Falls) 11
Kent Corp F C 3-10
Laboratory for Electronics Inc/Instrument Div 6-12
LaPoint Industries Inc 2-4-13-14-15
Lieco Inc 2-3-5-7-9-10-12-18-19-22-24-25-26-27
Lockheed Electronics Co 6-7-8-9-12-16-21
Luhrs & Co C H 11-13-14
McMillan Industrial Corp 1-8
McMillan Laboratory Inc 1-8
Magnavox Co 16
Manson Laboratories Inc 16-20-21
Maxson Corp W L 3-16-17-20-21-22
Melabs 20
Melpar Inc (Special Products Dept) 5-8-9-10-16-17
Menlo Park Engineering 20-21
Meridian Metalcraft Inc 2-5-6-7-9-10-12-18-22-24-25
Metavac Inc 1-2-25
Metcom Inc 3-7-12
Metropolitan-Telecommunicators 8-10-14-15
Microlab 2-5-8-12-18-19-24-25-26
Microtech Inc 2-3-5-6-7-8-9-10-12-16-20-21-22-24-25-26
Microwave Associates 1-2-3-4-5-7-8-9-10-11-12-14-16-20-23-24-25-26
Microwave Chemicals Laboratory Inc 4-8-11
Microwave Components 2-5-19-20-25-26
Microwave Development Labs 2-3-4-5-7-9-10-11-12-13-25
Microwave Electronics Corp 8-14
Miratel Inc 26
Narda Microwave Corp 8-10-11-12-16-19-20-24-25-26

Nat'l Beryllia Corp (Haskell) 2
National Company Inc 2-20
Nichols Products Co 3-19
Norden Div United Aircraft 3-6-8-9-12-13-14-16-20-21-22-26-27
Northeast Scientific Corp 20
NRK Mfg & Engineering Co 7-9-10-12-26
Omega Laboratories Inc 2-3-5-9-10-12-16-19-23-24-25-26
Pacific Universal Products Corp 2
Pitometer Log Corp 3-12
Polarad Electronics Corp 8-22-26-27
Premier Instrument Co 1-2-3-4-5-6-7-8-9-10-11-12-18-19-22-23-24-25-26
PRD Electronics Inc 2-3-5-8-10-11-12-20-24-25-26-27
Prodelin Inc 7-8-9-10
Radio Engineering Laboratories 3-6-12-14-20-22-26-27
Raytheon Co Commercial Equipment Div (100 River St) 4
Raytheon Co M & P T Div (Foundry Ave) 2-4-11-13
Resdel Engineering Corp 3-12
RF Products Div Amphenol Borg Electronics Corp 25
Sage Laboratories Inc 2-3-5-8-9-10-11-12-19-22-25
Scatter Communication 24
Schaevitz Engineering 2-14-15-16-17-21-26
Sierra Electronic Corp/Div Philco Corp 8-9-25
Specialty Electronics Development Corp 2-3-7-12-17
Spectralab Instruments 3-22
Sperry Microwave Electronics Co 2-3-4-5-7-10-11-12-13-18-19-20-22-24-25-26-27
Stewart-Warner Electronics 3-22
Stoddart Aircraft Radio Co Inc 2
Sylvania Electric Products Inc (Mt View) 4-11
Sylvania Electric Products Inc (Williamsport) 4-11
Sylvania Electronic Systems (Waltham) 20-21
Technicraft Div Electronic Specialty Co 2-3-5-7-8-9-10-11-12-23-24-25
Telecomputing Corp 8-16
Telonic Engineering Corp 2-3-5-8-26
Telonic Industries Inc 2-8
Texas Instruments Incorporated/ Apparatus Div 8
Torotel Inc 6-8-15
Trak Microwave Corp Sub Trak Electronics Co 3-13-16
Transco Products Inc 2-10
TRG Inc 1-2-3-4-5-6-7-9-10-11-12-13-14-15-16-17-19-22-23-24-25-26
Tru-Connector Corp 22
Turbo Machine Co 2-5-10-12-14-21-22-23-25
Ueinite Co 11-25
Universal Transistor Products Corp 20-21
Uniwave Inc 7
Valor Instruments Inc 2-3-7-8-9-10-12-19-20-21-24-25-26
Varian Associates 3-12-16-20-21-22-25
WaeLine Inc 4-10
Waveline Inc 1-2-3-5-7-8-9-10-12-19-22-24-25-26
Weinschel Engineering 2-5-25-26
Wells Industries Corp 8
Westinghouse Air Arm Div (Baltimore) 13-14-15-16-17-21-22
Westinghouse Electric Corp (Elmira) 3
Wincharger Corp 20-21
Zenith Radio Corp 7

TUBES, MICROWAVE & SEMICONDUCTORS

Amplitron 1
ATR 2
Backward wave 3
Diodes, mixer 4
Diodes, varactor 5
Klystron 6
Klystron, reflex 7
Lighthouse tubes 8
Magnetron 9
TR 10
Traveling wave 11
Triodes, planar 12
Parametric Amplifiers, electron beam 13

Airtron Div Litton Industries 4
Amperex Electronic Corp 6-7-9-11-12
Bendix Corp (Detroit) 3-4-6-7-11-12
Bendix Corp (Eatontown) 3-6-7-11

1961 Directory of Microwave Manufacturers (cont.)

Bomac Labs Inc 2-4-6-7-9-10
Canadian Marconi Co 9-11
Caswell Electronics Corp 8
Central Electronic Mfrs Div Nuclear Corp of America 2-10-12
Dumont Labs Allen B/Div Fairchild Camera & Instrument Corp 11-12
Edgerton Germeshausen & Grier Inc (Boston) 11
Eitel-McCullough Inc 3-6-7-9-11-12
General Electric Co/Power Tube Dept 6-8-9-11-12
General Electric Co of England 2-3-4-5-6-7-8-9-10-11-12
Gombos Co Inc John 12
ITT Laboratories (500 Washington Ave) 3-4-5-11-12
LaPoint Industries Inc 1-4-5-9
Litton Industries (San Carlos) 3-6-9-11
Metcom Inc 2-7-9-10
Microwave Associates Inc 4-5-9-10-11
Microwave Electronics Corp 3-11
Microwave Tube Div Hughes Aircraft Co 3-11
Polarad Electronics Corp 7
Radio Corp of America (Harrison N J) 11
Raytheon Co/Commercial Equipment Div (100 River St) 1-3-6-7-9-11
Raytheon Co M & P T Div (Foundry Ave) 1-3-6-7-9-11
Resitron Laboratories Inc 10-12
S F D Laboratories Inc 1
Sperry Gyroscope Co Div Sperry Rand Corp 6-11
Stewart Engineering Co 3
Sylvania Electric Products Inc (Mt View) 2-3-6-7-9-10-11-12
Sylvania Electric Products (Woburn) 4-5
Sylvania Electric Products Inc (Williamsport) 2-3-9-10-12
Texas Instruments Incorporated/Apparatus Division 5
TRG Inc 11
Ucinite Co 9
Varian Associates 3-6-7-11
Waveline Inc 12
Westinghouse Electric Corp (Elmira) 2-6-7-9-10-11
Zenith Radio Corp 13

TEST EQUIPMENT, MICROWAVE

Analyzers, microwave	1
Bolometers	2
Bridges, bolometer	3
Calibrators	4
Calorimeters	5
Cavities, tuned wavemeter	6
Checker, radar performance	7
Directional couplers	8
Echo boxes	9
Generators, signal	10
Oscillators, cavity	11
Oscillators, klystron	12
Radar test sets	13
Simulators, radar	14
Testers, magnetron	15
Testers, radar	16
Wavemeter	17

ACF Electronics 6-11-12-14-16
Aeronca Mfg Corp/Aerospace Div 7-13-14
Aircom Inc 3-4-5-6-8-11-17
Aircraft Armaments Inc 13-14
Aircraft Radio Corp 10
Airtec Inc 6-8-9-13-16-17
Airtron Inc Div Litton Industries 8-9-11-17
Alfred Electronics 10
Andrew California Corp 17
Antenna & Radome Research Associates 4-8-17
Arma Div/American Bosch Arma Corp 13-14
Automation Dynamics Corp 9
Baird-Atomic Inc 2
Bellaire Electronics Inc 13
Belock Instrument Corp 13-14
Bendix Corp (Detroit) 4-7-8-9-11-12-13-14-15-16-17
Bruno-New York Industries Corp 2-3
Bulova Watch Co Electronics Div 10-11
Canadian Aviation Electronics Ltd 13-14-16
Canadian Marconi Co 10-11-12
Chemalloy Electronics Corp 1-5-16
Clough-Brengle Co 10
Control Electronics Co Inc 4-8-9-13-14-16
C W S Waveguide Corp 8
DeMornay Bonardi 6-8-17
Diamond Antenna & Microwave Corp 6-8-13-17
Don-Lan Electronics Inc 4
Dumont Laboratories Allen B/Div Fairchild Camera & Instrument Corp 10
Dymec Div Hewlett-Packard Co 10-13-14
Dynatronic Inc 10-13
Electro Impulse Lab Inc 2-3-4-5-13-17
Electronics & Ordnance Div/Avco Corp 14
Electronic Specialty Co 13-14
Electron-Radar Products 13
Elm Mfg Co Inc 3
Frequency Standards 6-9-11
FXR Inc 1-2-3-8-10-13-15-17
GB Electronics Corp 8-17
General Communication Co 2-4-6-7-10-11-13-14-16
General Electric Co/LMED 1-7-10-13-17
General Electric Co Ltd of England 11
General Radio Co 10-12
Gombos Co Inc John 6-8-9-11-17
Hewlett-Packard Co 2-3-5-6-8-10-12
Intaspace Corp 17
ITT Laboratories (500 Washington Ave) 8
Jones Electronics Co Inc M C 5-8
Kearfott Div General Precision Inc (Van Nuys) 1-6-10-11-13-17
Laboratory for Electronics Inc/Instrument Div 1-8-11-12-13-14-16
LaPoint Industries Inc 5-6-7-9-10-11-12-13-14-16
Lavoie Laboratories Inc 1
Lieco Inc 6-8-9-17
Lockheed Electronics Co 13-14-16
Magnavox Co 10-13-16
Manson Laboratories Inc 10-12-15
Maxson Corp W L 13-14
Melabs 1-10-16
Melpar Inc (Special Products Dept) 8-13-14
Menlo Park Engineering 12
Mico Instrument Co 1
Microlab 8
Microtech Inc 8-10-13-17
Microwave Associates Inc 1-2-4-5-8-15-17
Microwave Components 17
Microwave Development Labs 8-11-17
Miller Associates 13-14-16
Narda Microwave Corp 2-3-6-8-9-13
National Company Inc 13
Nichols Products Co 13
Norden Div United Aircraft 13-14-16
Northeast Scientific Corp 10
Omega Laboratories Inc 6-8-17
Panoramic Radio Products Inc 1-7-10
Pitometer Log Corp 7-11-13-14-16
Polarad Electronics Corp 1-10-11-12-13-16
PRD Electronics Inc 1-2-3-5-6-8-9-11-12
Radio City Products Co Inc 10
Precision Instrument Co 2-3
Radio Engineering Laboratories 6-11-12
Ramage & Miller Inc 10-15
Raytheon Co/Commercial Equipment Div (100 River St) 8
Reeves Instrument Corp 13-15
Sage Laboratories Inc 8
Schaevitz Engineering 1-4-7-8-10-13-14-16
Sierra Electronic Corp Div Philco Corp 5-8-10
Specialty Electronics Development Corp 10-11-13
Spectralab Instruments 10-11
Sperry Microwave Electronics Co 1-2-3-4-6-7-8-13-14-15-16
Stewart-Warner Electronics 16
Sylvania Electronic Systems (Waltham) 13-14
Technicraft Div Electronic Specialty Co 8-17
Telecomputing Corp 13-14-16
Telonic Engineering Corp 10-11
Telonic Industries Inc 10-13
Thwing-Albert Instrument Co 2
Topatron Inc 16
Trak Microwave Corp/Sub Trak Electronic Co 6
Transco Products Inc 4-8
TRG Inc 6-9-14-17
Turbo Machine Co 8-13-14-16-17
Valor Instruments Inc 2-6-10-17
Varian Associates 5-12-17
Waveguide Inc 17
Waveline Inc 6-8-9-13-17
Wayne Kerr Corp 2-4-6-12
Weinschel Engineering 1-2-3-4-5-11-12
Westinghouse Air Arm Div (Baltimore) 7-13-14-16

SYSTEMS—MICROWAVE

Communication	1
Data	2
Radar	3
Receivers	4
Scatter	5
Transmitters	6

ACF Electronics 1-2-3-4-5-6
Adams-Russell Co Inc 6
Adler Electronics Inc 1-4-6
Aeronca Mfg Corp/Aerospace Div 1-2-3-4-6
Aircom Inc 4
American Electronic Laboratories Inc 2
Antenna & Radome Research Associates 1-3
A R F Products Inc 4
Automation Dynamics Corp 2-6
Avionics Div/Bell Aerosystems Co 3-4-6
Baird-Atomic Inc 1
Belock Instrument Corp 3
Bendix Corp (Detroit) 3-4-5-6
Budelman Electronics Corp 1-4-6
Canadian Aviation Electronics Ltd 1-2-3
Canadian Marconi Co 1-2-3-4-5-6
CG Electronics Corp 2-6
Diamond Antenna & Microwave Corp 1-3
Dynatronic Inc 1-2-3-4-5-6
Electronics & Ordnance Div/Avco Corp 1-3-4-6
Electronics Development Corp 2-3-6
Electronic Specialty Co 1-2-3
Empire Devices Products Corp 4
FXR Inc 3-4-6
General Electric Co/Communication Products Dept 1-4-5-6
General Electric Co/LMED 1-2-3-4-5-6
GPL Div General Precision Inc 3
Houston Fearless Corp 1-2-3-5
Hycon Mfg Co 3
ITT Laboratories (500 Washington Ave) 1-2-3-4-5-6
Kennedy & Co D S 1-3-4-5-6
LaPoint Industries Inc 1-2-3-4-6
Lenkurt Electric Co Inc 1-2-4-6
Lockheed Electronics Co 2-3-4-6
Loral Electronics Corp 2-3-4
Magnavox Co 1-3
Manson Laboratories Inc 1-6
Maxson Corp W L 1-2-3-4-5-6
Melpar Inc (Special Products Dept) 1-2-3-4-5
Miller Associates 3
Missile Systems Corp 1-4-6
Motorola Communications & Electronics 1-2-4-6
National Company Inc 1-4-5-6
Norden Div United Aircraft 1-3-4-6
Polarad Electronics Corp 4
Prodelin Inc 1
Radio Corp of America/Communication Products Dept 1-2-3-4-5-6
Radio Engineering Laboratories 1-4-5-6
Ramage & Miller Inc 3
Raytheon Co/Commercial Equipment Div (100 River St) 1-2-3-4-6
Reeves Instrument Corp 3
Resdel Engineering Corp 2-3-4
Sarkes Tarzian Inc 4-6
Saxton Products Inc 1-2
Scatter Communication 1-5-6
Schaevitz Engineering 3-4-6
Sierra Electronic Corp Div Philco Corp 6
Specialty Electronics Development Corp 1
Spectralab Instruments 1-4-6
Spinform Div Antenna Systems Inc 1-2-3-4-5-6
Stewart-Warner Electronics 3-4-6
Stromberg-Carlson Div Gen Dynamics Corp (100 Carlson Rd) 1
Sunnyvale Development Center 3-4
Sylvania Electronic Systems (Waltham) 1-2-3-4-5-6
Telecomputing Corp 1-2-3-4-6
Tele-Dynamics Div American Bosch Arma Corp 6
Texas Instruments Incorporated/Apparatus Division 1-2-3-4-6
TRG Inc 1-3
Turbo Machine Co 3
Varian Associates 1-3-6
Westinghouse Air Arm Div (Baltimore) 1-2-3-4-6

TRANSMISSION LINES & ACCESS.

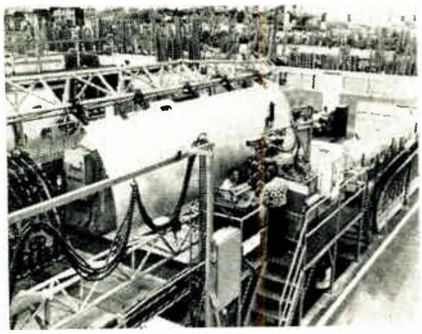
Cable, coaxial	1
Cable, low capacity	2
Coaxial-switches	3
Coax-waveguide adapter	4
Couplers, coaxial	5
Flanges	6
Slotted Lines	7
Waveguide, flexible	8
Waveguide, rigid	9
Waveguide stands	10
Waveguide, switches	11
Waveguide windows	12
Waveguide bends	13

Adams-Russell Co Inc 3
Ainslie Corp 6-9-13
Aircom Inc 4-5-7-9-10-11-13
Aircraft Armaments Inc 4
Airtec Inc 4-5-6-7-8-9-10-11-13

1961 Directory of Microwave Manufacturers (cont.)

Airtron Div Litton Industries	3-4-5-6-8-9-11-12-13
Alford Mfg Co	3-7
American Electronic Labs Inc	3
American Radar Components Inc	6
American Super Temp Wires Inc	1-2
Andrew California Corp	1-3-4-5-6-7-8-9-10-12-13
Andrew Corp	1-3-4-5-6-9-11-12-13
Antenna & Radome Research Associates	4-5-6-9-13
A R F Products Inc (River Forest)	5
Bart Mfg Corp	13
Belz Industries Inc	4-6-9-13
Bendix Corp (Detroit)	3-5-6-7-9-11
Bogart Mfg Corp	4-5-11
Canadian Marconi Co	1-2-3-4-5-6
Carol Cable Co	1-2
Cable Electric Products Inc	1-2
Central Electronic Mfg Div Nuclear Corp of America	11-12
CG Electronics Corp	1
Connector Corp of America	6
C W S Waveguide Corp	1-4-6-9-10-11-12-13
Dage Electric Co Inc	4
DeMornay Bonardi	4-6-7-9-10-11-12-13
Diamond Antenna & Microwave Corp	3-4-5-6-7-9-10-11-13
Don-Lan Electronics Inc	3-4-11-12
Dow-Key Co	3-5
Electro Impulse Lab Inc	4
Eitel-McCullough Inc	12
Electronics & Ordnance Div/Avco Corp	9-13
Electronic Specialty Co	1-3-4-5-8-9-10-11-13
Englehard Industries Inc/D E Makepeace Div	9
Formcraft Tool Co	6
FXR Inc	4-6-7-10-11-13
Gavitt Wire & Cable Co	1
GB Electronics Corp	7-9-11-13
General Cable Corp	1-2
General Communication Co	3
General Radio Co	1-7
Gombos Co Inc John	4-7-9-13
Hewlett-Packard Co	4-5-7-10-11
Hitemp Wire Co Div Simplex Wire & Cable Co	1-2
Houston Fearless Corp	5
Hughes Components Div	11
Hycon Mfg Co	5
Intaspace Corp	9-13
ITT Laboratories (500 Washington Ave)	7
Jones Electronics Co Inc M C	5
Judd Wire Mfg Corp	1-2
Kennedy & Co D S	6-7-8-9-10-11-12-13
Kent Corp F C	13
Ken-Tron Corp	4
Lab-Tronics Inc	1-2
Lenz Electric Mfg Co	1-2
Lewis Engineering Co	1-2
Lieco Inc	3-4-5-6-8-9-11-13
Magnetic Shield Div Perfection Mica Co	1-2-5-8-9
Microtech Inc	3-4-5-6-7-8-9-11-12-13
Microwave Associates Inc	6-7-9-10-11-12-13
Microwave Components	1-4-5-7-9
Microwave Development Labs	4-6-7-9-11-12-13
Meridian Metalcraft Inc	4-9-13
Missile Systems Corp	1-2
Narda Microwave Corp	4-5-7-10-13
Nat'l Beryllia Corp (Haskell)	12
Nat'l Beryllia Corp (N Bergen)	12
Nichols Products Co	7
NRK Mfg & Engineering Co	9-11-12-13
Okonite Co	1-2
Omega Laboratories Inc	4-7-9-10-13
Pacific Universal Products Corp	12
Parker Seal Co	13
Phalo Plastics Corp	1-2
Phelps Dodge Copper Products Corp	1
Plastoid Corp	1-2
Precision Tube Co Inc	1
Premier Instrument Co	3-4-5-6-7-9-10-11-12-13
PRD Electronics Inc	4-5-7-10-13
Prodelin Inc	1-2-3-4-5-6-7-9
Resitron Laboratories Inc	11
RF Products Div Amphenol Borg Electronics Corp	1-2-3-4-5-9
Rockbestos Wire & Cable Div Cerro de Pasco Corp	1-2
Sage Laboratories Inc	4-5-7
Schaevitz Engineering	3-4-5
Specialty Automatic Machine Co	9-13
Sperry Microwave Electronics Co	4-5-7-10-11
Sylvania Electric Products Inc (Mt View)	12
Sylvania Electric Products Inc (Williamsport)	12
Technical Appliance Corp	1-6-9-13
Technicraft Div Electronic Specialty Co	1-3-4-6-7-8-9-11-12-13
Telonic Industries Inc	3
Thermal Wire of America	1
Transco Products Inc	3-4-5-11
TRG Inc	4-9-10-11-12-13
Tru-Connector Corp	3-4
Turbo Machine Co	4-6-7-9-10-11-13
Ucinite Co	5
Univox Corp (New York)	2
United States Wire & Cable Corp	1
Uniwave Inc	10-11-13
Valor Instruments Inc	3-5-6-7-8-9-11-12-13
Varian Associates	6-12
Virginia Electronics Co Inc	3
Waveguide Inc	4-9-11-13
Waveline Inc	4-7-9-10-11-13
Western Int'l Co	1-4-6-8-9-13
Wiley Electronics Co	11-13

TV-CONTROLLED RIVETER



Giant Drivamatic Riveter at Douglas Aircraft, Long Beach, Calif. is controlled through use of TelAutovision camera installed by TelAutograph Corp. Entire operation on fuselage assembly of a DC-8 jetliner is viewed through 17-inch TelAutograph monitor, connected to a camera in a blind position, where the rivet cam is located. Operator can adjust machine manually if rivet holes are out of alignment.

Drivamatic Riveter Developed by Douglas

Precision alignment of large automated machine tools at Douglas Aircraft Co. in Long Beach, Calif., is now possible with the installation of industrial TV by Tel-Autovision Closed Circuit TV, a Div. of TELautograph Corp. Douglas facilities engineers in the DC-8 Jetliner assembly plant worked with the General Electro-Mechanical Corp. engineers on plans for a Drivamatic Riveter for the fuselage assembly. The specially designed Riveter is programmed by tape prepared in advance by means of a digital to analog converter. It will position to a non-accumulative tolerance of 30 thousandths-of-an-inch. Fuselage panels of 31-foot length, held within a 40-foot tooling frame, travel longitudinally along a 90-foot floor mounted track, while being automatically riveted. Tack rivets every five feet are used as synchronization points to check the precision of the programming.

Amperex Introduces 6BL8 and 6FY5 Tubes

Two new tube types—the 6BL8 and 6FY5, which together comprise a TV front end of low noise and high gain and reliability, have been introduced by Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N. Y.

The 6BL8 is a miniature triode pentode with separate cathodes, especially designed for use as an oscillator-mixer in TV receivers. It also can be used as a horizontal oscillator, a video and sound IF Amplifier, and in sync circuits.

The 6FY5 is an "Ampliframe" triode with remote cutoff characteristics, an improved version of the type 6ER5, having 1 db less noise and 2 db higher gain. It is especially designed for service in VHF tuners for TV receivers. It is controlled for low noise figure at 220MC and is operational at lower supply voltage.

WESTINGHOUSE REDESIGNS TRADEMARK AND LOGOTYPE

Westinghouse has redesigned its trademark and logotype, modernizing symbols and improving corporate identity. The traditional Circle W trademark has been retained, but changed in dimensions. Small solid circles have been added to the peaks of the W. Type has been changed from Caslon to semi-condensed Gothic in the logotype.

Canadian Radar Volunteers Disbanded

Volunteers comprising the Royal Canadian Air Force's 14 Auxiliary and Warning Squadrons, manning the radar stations of the Pinetree Line, will be disbanded over a two-year period beginning next year. Their duties will be taken over by the Semi-Automatic Ground Environment (SAGE) System, upon its installation at North Bay, Ontario.

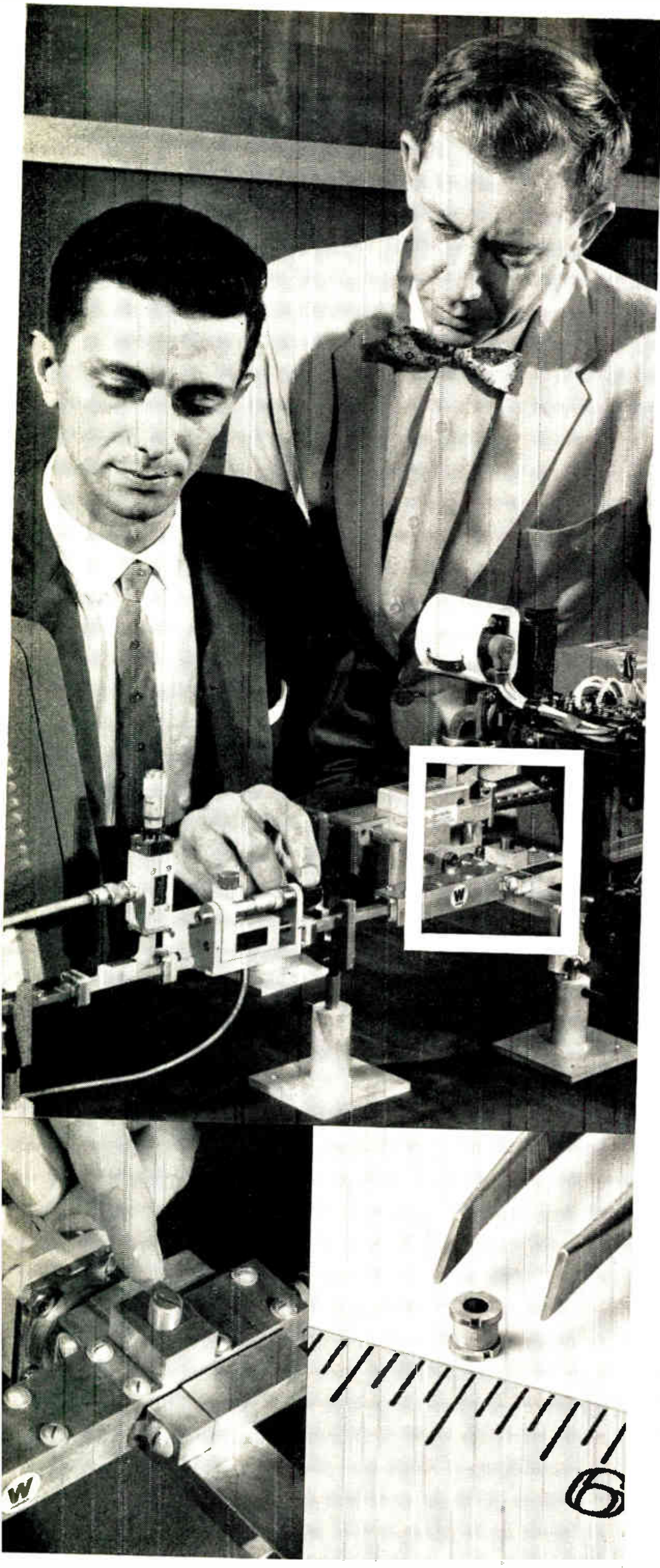


Photo: Courtesy Westinghouse Air Arm Division

Congratulations!

to WESTINGHOUSE for an exciting breakthrough.

A RADAR RECEIVER NOISE FIGURE of 2.8 db at an X-band operating frequency has been achieved by engineers of the Westinghouse Air Arm Division. Dr. Robert Rampolla (left), and Mr. Thomas Hollis (right), using a true non-degenerate X-band parametric amplifier and a Microwave Associates "pill" varactor (MA-4253), achieved a 20 db gain with excellent stability and ample bandwidth.

This remarkable accomplishment in low-noise amplification at X-band resulted from research on a program sponsored jointly by Westinghouse and the U. S. Navy.

Sophisticated Varactor technology at Microwave Associates which made these results possible has produced the most complete line available of advanced varactors in standard, miniature "pill", and glass packages.

Write for detailed information and performance data on varactor techniques.

MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS
Western Union FAX
TWX — Burlington, Mass. 942
Phone BRowning 2-3000

Circle 91 on Inquiry Card

Gridded traveling wave tubes with broad-band frequency response sometimes have "dips" in their frequency response. The r-f power regulator described is an automatic gain control device that samples the r-f output and levels the frequency response by varying the tube's gain.

Eliminating Frequency "Dips" in TWT's

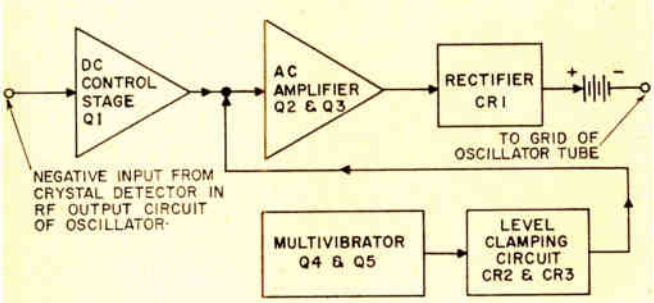
By IRVING M. GOTTLIEB

Calif. Registered E. E.
931 Olive
Meno Park, Calif.

AN annoyance often encountered with traveling wave amplifiers is that the so-called "broad-band" frequency response is actually plagued with perturbations, some of such violence as to suggest the presence of high Q wave traps coupled to the slow wave structure. The r-f power regulator to be described is an automatic gain control device which samples a portion of the r-f output and varies the grid bias in such a way as to level the frequency response.

This device is not only applicable to gridded traveling wave tubes, it is also useful with conventional electron tube oscillators and amplifiers, providing that the operating mode is restricted to the class "A" region (that is, the grid must not draw current). When so used, a flat frequency response is attainable over a much wider spectral range than would otherwise be the case.

Fig. 1: Block diagram shows the power regulator for TWT's



The block diagram of the r-f power regulator is depicted in Fig. 1. An ac amplifier is supplied with a constant amplitude audio-frequency signal from a multi-vibrator and level-clamping circuit. The gain of the ac amplifier is controlled by a dc amplifier which receives its actuating signal from the rectified r-f derived from a portion of the r-f output circuit. The most straightforward way of accomplishing this is by means of an attenuating directional coupler and a crystal detector. The output of the ac amplifier is rectified so that a positive dc voltage is obtained. However, the *net voltage* applied to the grid of the traveling wave tube is *negative* by virtue of battery B2.

Suppose that, as a result of manual or automatic tuning of a microwave oscillator driving the traveling wave amplifier, a dip in frequency response occurs. Decreased dc signal voltage is thereby applied to the dc control stage. This changes the bias applied to the ac amplifier in such a direction as to *increase* amplification. The audio frequency signal applied to the ac amplifier now receives higher gain. Subsequent rectification of this signal then results in a more positive (less negative) dc grid bias applied to the traveling wave tube. In this way the tendency for the response to dip is counteracted. In the event of a tendency for the r-f output level to rise, the converse sequence of events occurs. As a consequence of this regulating action, the r-f output of the traveling wave amplifier is maintained relatively flat with respect to frequency.

The schematic diagram of the r-f power regulator is shown in Fig. 2. Q1 is the dc control stage. Re-

Frequency Dips

(Continued)

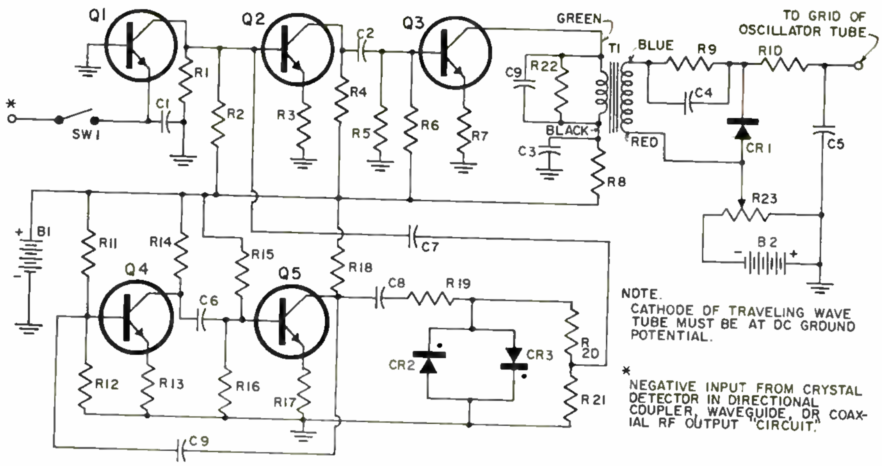


Fig. 2: Schematic diagram of the r-f power regulator. Parts list is given in the article.

sistance R1 is simultaneously the plate load of Q1 and part of the bias network for ac amplifier stage, Q2. Inasmuch as Q1 is an npn transistor connected in the grounded base configuration, its collector does not draw appreciable current when no negative dc voltage is received at the emitter. Under this condition, sufficient forward bias is available from resistance R1 and R2 to enable transistor Q2 to develop high amplification of the audio frequency signal derived from the multivibrator (Q4 and Q5).

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

When a negative signal is applied to the emitter of Q1, this transistor conducts; in so doing, it deprives ac amplifier stage Q2 of forward bias. The current (and voltage) gain of Q2 is thereby reduced. As a result, the second ac amplifier stage Q3 receives a signal of lower amplitude level than would be the case if Q2 was permitted to develop its maximum gain. In turn, the positively polarized dc output voltage developed across shunt rectifier CR1 is *decreased.* The dc voltage appearing at the output terminal is the *resultant* of this voltage and a portion of battery voltage derived from B2. Battery B2 causes the net polarity of the dc voltage at the output terminal to be negative with respect to ground. Thus, the rectified r-f which applies forward bias to Q2 produces the ultimate result of making dc voltage at the output terminal *more negative.* Actually, a very small increase in negative voltage applied to Q1 suffices to produce a relatively large increase in output negative voltage, that is, in the grid bias of the traveling wave tube. The voltage amplification involved here is on the order of several hundred to one.

When initially placing the r-f power regulator in operation, switch SW1 should be set in its open position. Adjust potentiometer R23 to provide about three volts of negative bias to the grid of the traveling wave tube. This measurement should be made with respect to the cathode of the traveling wave tube and a vacuum tube voltmeter should be used for the purpose. Closure of SW1 should then make the circuit operative.

For best results, the emitter-base voltage of input stage Q1 should never fall below about 0.6 volt. If difficulty is experienced here, it may be possible to remedy the situation by using a directional coupler with less attenuation. Between six and ten db attenuation was found suitable for traveling wave tubes having output ratings between 0 and 20 dbm. It is imperative that the frequency response of the directional coupler and associated crystal mount be reasonably flat over the desired frequency range. Otherwise the dc voltage applied to the input diode of Q1 will convey erroneous information and will provoke unwarranted corrective action. For optimum results, use the transistor with highest beta in the Q1 circuit position. It is also desirable that transistor Q2 has a relatively high beta. For the circuit functions served by Q3, Q4, and Q5, beta is not an important consideration.

Parts List

R1, R4, R5, R12, R14, R16, R18, R21	12 K, ½ w, composition
R2, R6	1.2 Megohm ½ w, composition
R3	220 ohm ½ w, composition
R7	18 ohm ½ w, composition
R8	1000 ohm ½ w, composition
R9	180 K ½ w, composition
R10, R11, R15	510 K ½ w, composition
R13, R17	220 ohm ¼ w, composition
R19	1.2 K ½ w, composition
R20	2.7 K ¼ w, composition
R22	27 K ½ w, composition
R23	100 K, 1 w potentiometer
CR1	Sarkes Tarzian 40K Silicon Junction Diode
CR2, CR3	Hoffman 1N470 Zener Diodes
C1, C7	0.1 mfd paper tubular capacitors
C2, C3	2.0 mfd paper capacitors (200 v)
C4	.006 mfd mica or ceramic capacitor
C5	0.5 mfd paper capacitor (200 v)
C6, C7, C8, C9	.002 ceramic capacitors
T1	C.S.T. TA-36 (Chicago-Standard Transformer)
Q1, Q2, Q3, Q4, Q5	Sylvania 2N35 NPN Transistors
B1	15 volt battery
B2	22½ volt battery
SW-1	SPST Toggle Switch

Page from an Engineer's Notebook

#58 — Cancellation of Sine Waves

By JAMES J. DAVIDSON
RCA Victor Record Division
501 North La Salle St.
Indianapolis 1, Ind.

SUCCESSFULLY cancelling two signals often depends on how close the signals are in amplitude, waveform, and phase. Phase differences are often the most troublesome because of the tight tolerances which must be maintained. Information regarding cancellation of two identical sine waves with slight phase differences is here summarized and tabulated.

Consider two sine waves of unit amplitude, but with a small phase difference:

$$e_1 = \sin \omega t$$
$$e_2 = \sin (\omega t \pm \alpha) = \sin \omega t \cos \alpha \pm \cos \omega t \sin \alpha.$$

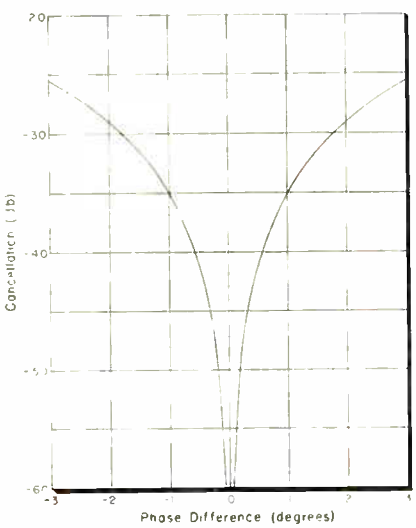


Fig. 1: Cancellation of equal sine waves as the phase is shifted.

Subtracting, the resultant output will be:

$$e_r = e_1 - e_2 = (1 - \cos \alpha) \sin \omega t \pm (\sin \alpha) \cos \omega t.$$

The resultant can be considered a sine wave of two components: an in-phase part of magnitude $(1 - \cos \alpha)$, and a quadrature part of magnitude $(\sin \alpha)$. But if α is small, $\sin \alpha$ is very much larger than $(1 - \cos \alpha)$, and the in-phase component can be neglected. Under these conditions:

$$e_r = \pm (\sin \alpha) \cos \omega t.$$

Using this approximation, the values of Table I were calculated, and Fig. 1 was drawn from the results. The approximation is accurate to within 0.1% at 4°.

The cancellation is tabulated and plotted in decibels because this represents the most useful form.

References

1. J. J. Davidson, "A Suggested Method for Measuring Tape Modulation Noise," *Journal of the Audio Engineering Society*, Vol. 8, No. 1, pp. 23-28, Jan. 1960.

* Formerly with RCA Victor Home Instruments.

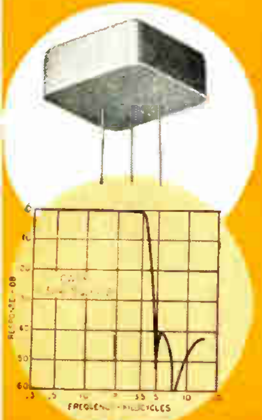
Table 1

Cancellation of Equal Sine Waves with a Phase Difference

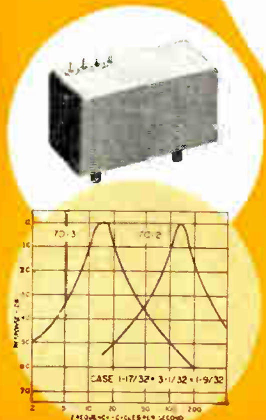
Phase Difference α — Decimal Degrees	Phase Difference α — Degrees & Minutes	Resultant Cancellation (Decibels)
0	0	−∞
0.05	0° 3′	−61.18
0.1	0° 6′	−55.16
0.15	0° 9′	−51.64
0.2	0° 12′	−49.14
0.25	0° 15′	−47.20
0.3	0° 18′	−45.62
0.4	0° 24′	−43.12
0.5	0° 30′	−41.18
0.75	0° 45′	−37.66
1.0	1° 0′	−35.16
1.5	1° 30′	−31.64
2.0	2° 0′	−29.14
2.5	2° 30′	−27.20
3.0	3° 0′	−25.62
3.5	3° 30′	−24.29
4.0	4° 0′	−23.13

SPECIAL FILTERS

TO YOUR REQUIREMENTS

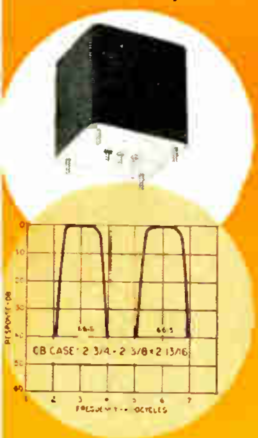


Miniaturized 3.5 KC low pass filter. 10K ohms to 10K ohms. Within 1 db up to 3500 cycles. Greater than 40 db beyond 4800 cycles.

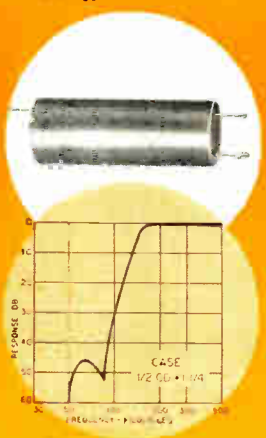


Fifteen cycle and 135 cycle filters for Tacan. 600 ohms to high impedance. Extreme stability —55°C. to + 100°C.

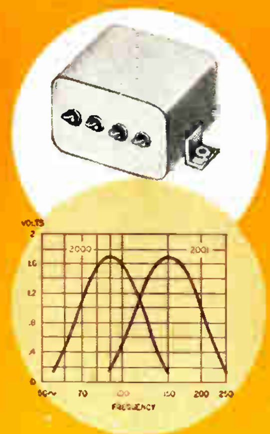
Almost thirty years of experience in the design and production of special filters have resulted in UTC being a first source for difficult units. Present designs incorporate a wide variety of core structures, winding methods, and capacitors to provide maximum performance, stability, and reliability. The units illustrated show a few of the thousands of specials produced by UTC, to customers' requirements, and only slightly indicate the possibilities in present special filter design. Range of frequencies on special units is from .1 cycles to 400 MC.



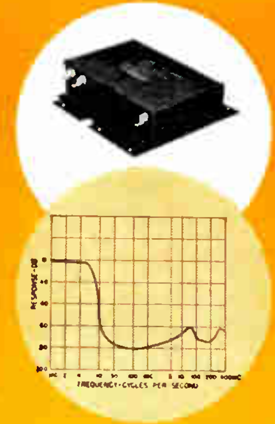
Three KC and 6 KC flat top band pass filters 400 ohms to 20K ohms MIL-T-27A; each filter 1.7 lbs.



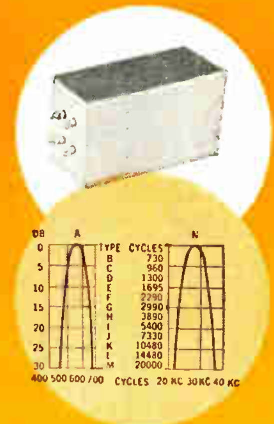
High frequency Mini-filters, .33 oz. MIL-T-27A Grade 5. 150 KC High Pass 3 db to 150 KC, down 45 db below 85 KC. 7500 ohms.



Curves of our miniaturized 90 and 150 cycle filters for glide path systems. 1¼" x 1¾" x 1⅝".



Power line filter from sources of 50 to 400 cycles . . . attentuation from 14 KC to 400 MC . . . 29 cubic inches.



Multi-channel telemetering band pass filters for 400 cycle to 40 KC. Miniaturized units for many applications.

Plus over 1,000 STOCK ITEMS with UTC High Reliability from your local distributor

write for catalog

UNITED TRANSFORMER CORP.

150 VARICK STREET, NEW YORK 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

Circle 134 on Inquiry Card

ALPHABETICAL LISTING OF

CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

62 ADC Incorporated — Transformers, filters, jacks and plugs.
126 Aircraft Armaments, Inc.—Waveguide quick disconnect.
108 Alford Manufacturing Company—Slotted lines.
58 Alite Division, U. S. Stoneware—Ceramic-to-metal seals.
114 Allegheny Ludlum Steel Corporation—Molybdenum permalloy nickel-iron strip.
81 Allen-Bradley Company — Composition resistors.
148 Allied Chemical, General Chemical Div.—Electronic-grade chemicals.
151 Allied Radio Corporation — Electronic supply catalog.
328 Alpha Metals, Inc.—Flux filled solder washers.
122 American Electrical Heater Company—Electric wire stripper.
82 American Electronic Laboratories, Inc.—Solid state microwave commutator.
135 American Time Products, Inc.—Frequency standards.
38 AMP Incorporated—Wire terminations.
322 Amperite — Thermostatic delay relays and ballast regulators.
66 Amphenol-Borg Electronics Corporation, Borg Equipment Div.—Precision potentiometers.
47 Amphenol-Borg Electronics Corporation, RF Products Div.—Coaxial connectors.
341 Amplifier Corp. of America—Flutter meter.
100 Andrew Corporation—Radome equipped antennas.
316 Anton Machine Works—Electron tube parts.
46 Arnold Engineering Company, The—Magnets for microwave applications.

157 Associated Research, Incorporated—Insulation resistance tester.
37 Automatic Timing & Controls, Inc.—Timers.

147 Babcock Relays, Inc.—Relays.
42 Beckman Instruments, Inc., Berkeley Div.—Frequency meter.
117 Beckman Instruments, Inc., Helipot Div.—Trimming potentiometers.
40 Bendix Corporation, The, Electron Tube Products—Ceramic-metal terminal.
354 Bendix Corporation, The, Pioneer Central—Sonic energy cleaning equipment.
140 Bendix Corporation, The, Semiconductor Products—Switching transistors.
346 Biwax Corporation—Asphalt base compounds.
156 Boonton Electronics Corporation — RF voltmeter.
21 Bourns, Inc., Trimpot Div.—Humidity-proof trimming potentiometer.
36 Bourns, Inc., Trimpot Div.—Trimmer potentiometer.
48 Bourns, Inc., Trimpot Div.—Trimmer potentiometers.
344 Brinkmann Instruments, Inc. — Micro manipulators.
360 Bruno-New York Industries Corporation—Pig-tailoring machine.
50 Brush Instruments, Div. of Clevite Corp.—Printed circuit transistor switches.
132 Brush Instruments, Div. of Clevite Corp.—Portable recorders.
347 Burnell & Company, Inc.—Crystal filters.
70 Bussmann Mfg. Division McGraw-Edison Company—Fuses and fuseholders.
116 CBS Electronics, Semiconductor Operations—Power transistors.

25 Centralab, The Electronics Div. of Globe-Union, Inc.—Ceramic capacitors.
356 Centre Circuits, Inc.—Printed circuit equipment.
363 Century Electronics & Instruments, Inc.—Strain Gauges.
337 Chicago Dynamic Industries, Inc.—Thumbwheel switches.
51 Cinch Manufacturing Corporation—Subminiature connectors.
330 Clare & Company, C. P.—Printed circuit relays.
18 Clevite Transistor Div. Clevite Corp.—Silicon switching diodes.
12 Computer Measurements Company—Solid state 20 mc universal counter-timer.
78 Conrac, Inc.—Video monitors.
27 Consolidated Vacuum Corporation—Vacuum pumping system.
79 Controls Company of America, Control Switch Div.—Precision switches and actuators.
149 Curtiss-Wright Corporation—Ultrasonic delay lines, digital motors, and time delay relays.
355 Custom Components, Inc.—Permeable dielectric.
68 Dage Electric Company, Inc.—Coaxial cable connectors.
128 Dale Electronics, Inc.—Miniature deposited carbon resistors.
142 Daven Company, The—Rotary switches.
320 Davies Molding Company, Harry—Plastic knobs, handles, and appliance feet.
115 Delta Coils, Inc.—Miniature R. F. chokes.
23 Deutsch Company, The—Hermetic connectors.
31 Du Pont, Electrochemicals Dept.—Conductive cements.
348 Dynatran Electronics Corporation—Semiconductor test equipment.
345 Elastic Stop Nut Corporation of America—Time/delay/relay.
112 Electra Manufacturing Company—Carbon-film resistor.
80 Electrical Industries — Glass-to-metal seals.
323 Electro Impulse Laboratory, Inc.—Calorimeter bridge.
340 EICO, Electronic Instr. Company, Inc.—Electronic supply catalog.
131 Elgin-National Watch Company—Power type relays.
11 Fairchild Controls Corporation — Pressure transducer.
138 Fairchild Semiconductor Corporation—Switching transistors and diodes.
145 Fairmount Chemical Company, Inc.—Soldering flux.
33 Fansteel Metallurgical Corporation—Tantalum capacitors.
34 Fansteel Metallurgical Corporation—Silicon power rectifiers.
15 Formica Corporation — Thermosetting molded plastic parts.
357 Freed Transformer Company, Inc.—Toroidal inductors and audio transformers.
104 FXR, Inc.—Ferrite isolators.
106 FXR, Inc.—Waveguide switches.
107 FXR, Inc.—Broadband fixed coaxial attenuators.
26 General Electric, Receiving Tube Dept.—Amplifier tubes.
60 General Electric, Semiconductor Dept.—Switch and amplifier transistors.
109 General Products Corporation—Terminal boards.
39 General Motors, Delco Radio Div.—Power transistors.
153 Gertsch Products, Inc.—AC/DS ratio standard.
336 Globe Industries, Inc.—Vaneaxial blowers.
99 Gombos Company, Inc., John—Pulsed triode oscillator.
359 Graphic Systems—Visual control board.
125 Gremar Manufacturing Company, Inc.—RF connectors.
52 G-V Controls, Inc.—Thermal relay.
146 Handy & Harman—Silver for electronic applications.
351 Harrel, Incorporated—Temperature controls.
28 Hewlett-Packard Company—Clip-on milliameter probe
103 Hewlett-Packard Company—Power supplies.
17 Hill Electronics, Inc.—Band elimination filter.
150 Howard Industries, Inc.—Motor parts sets.
5 Hughes Aircraft Company, Industrial Systems Div.—Cable, connectors, and harness systems.
362 Hughes Aircraft Company, Microwave Tube Div.—Traveling-wave tubes.

OUR NAME ....TITLE.................. **NOV. 1960**

RM ....

RM ADDRESS ....

ITY OR TOWN.................................ZONE..............STATE................

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
01	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
21	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
41	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
61	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
81	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
01	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
21	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
41	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
61	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
81	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
01	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
21	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
41	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
															361	362	363	364	365

stcard valid 8 weeks only. After that use own letterhead describing item wanted.

lease send me further information on the items I have circled above.

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center
P. O. Box 8221
Philadelphia 4, Pennsylvania

ADVERTISERS IN THIS ISSUE

ADVERTISERS FROM WHOM YOU DESIRE FURTHER INFORMATION

3 Hughes Aircraft Company, Semiconductor Div.—Nanosecond diodes and germanium diodes.
4 Hughes Aircraft Company, Vacuum Tube Products Div.—Direct view storage and cathode ray tubes.

358 Ideal Precision Meter Company, Inc.—Precision panel meters.
324 Industrial Electronic Engineers, Inc.—Digital readout indicators.
118 ITT, Federal Div. Laboratories—Communications research and development.
24 ITT Industrial Products Div.—Vibration exciter.
61 Industrial Test Equipment Company—Electronic generators.

PROFESSIONAL ENGINEERING OPPORTUNITIES

Circle number of company on card at right from whom you desire further information.

502 Boeing Airplane Company, Wichita Div.
501 National Cash Register Company, The
503 Philco, Techrep Div.

333 Institute of Radio Engineers, The—IRE computer issue.
49 International Electronic Research Corporation—Transistor heat dissipators.
155 International Resistance Company—Trimmer potentiometers.

63 Jeffers Electronics Division of Speer Carbon Company—Fixed composition capacitors.
20 Jennings Radio Manufacturing Corporation—Vacuum relays.
141 Jettron Products, Inc.—Special sockets and connectors.
92 JFD Electronics Corporation — Fixed miniature metalized inductors.
152 Johnson Company, E. F. — Variable capacitors.
158 Jones, Howard B., Div. of Cinch Mfg. Company—Fanning strip.
96 Jones Electronics Company, Inc., M. C. —Microwave test equipment.

332 Kay Electric Company—High frequency attenuators.
102 Kearfott Division, General Precision, Inc.—Coaxial broad band ferrite isolators.
110 Kemet Company, Div. of Union Carbide Corporation—Solid tantalum capacitors.
121 Kester Solder Company — Resin-core solder.
56 Keystone Carbon Company—Thermistors.
22 Klein & Sons, Mathias — Electronic pliers.
127 Knights Company, The James — Frequency standard.
139 Krengel Manufacturing Company, Inc. —Peg stamps.

321 Lel, Inc.—Telemetry preamplifier.
80 Lenz Electric Manufacturing Company —High voltage lead wire.
83 Litton Industries, Electron Tube Div.—Microwave tubes.

119 Magnecraft Electric Company—General purpose relay.
59 Magnetics, Inc.—Powder cores.
136 Marconi Instruments—Q-Meter.
88 Melabs—Swept signal generators.
316 Microflect Company, Inc.—Passive repeater antennas.
97 Microlab—Microwave components catalog.
91 Microwave Associates, Inc. — Voltage variable capacitors.
364 Microwave Chemicals Laboratory, Inc.—Ferrimagnetic line width spheres.
90 Microwave Components, Inc. — "X" Band microwave components.
187 Midwest Foam Products Company—Polyether or Polyester foams.
29 Minnesota Mining and Manufacturing Company, Magnetic Products Div.—Precision reels.
64 Minnesota Mining and Manufacturing Company, Mincom Div.—Instrumentation recorder/reproducer.
317 Motorola Semiconductor Products, Inc. —Power transistors.
144 Mucon Corporation—Capacitors.

111 Newark Electronics Corporation—Electronics catalog.
41 Nothelfer Winding Laboratories, Inc.—Air core reactor.

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 255 of this issue.

Postcard valid 8 weeks only. After that use own letterhead describing item wanted. **NOV. 1960**

PROFESSIONAL ENGINEERING OPPORTUNITIES

Please send me further information on the engineering position I have circled below.

501	506	511	516	521
502	507	512	517	522
503	508	513	518	523
504	509	514	519	524
505	510	515	520	525

YOUR NAME .... TITLE ....

HOME ADDRESS ....

CITY or TOWN .... ZONE .... STATE ....

NOV. 1960

NEW Subscription Order

Please enter a new complimentary subscription to ELECTRONIC INDUSTRIES

Company Name: ....

Name: .... Position ....

Company Address: ....

City: .... Zone ...... State ....

Specific Products Manufactured ....

YOUR NAME .... TITLE .... **NOV. 1960**

FIRM ....

FIRM ADDRESS ....

CITY OR TOWN .... ZONE .... STATE ....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
															361	362	363	364	365

Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

Please send me further information on the items I have circled above.

327 Ogilvie Press, Inc.—Preprinted tracing paper.
326 Ohmite Manufacturing Company—Precision resistors.

95 Panoramic Radio Products, Inc.—Spectrum analyzer.
105 Philbrick Researches, Inc., George A.—Amplifier.
18 Philco, Lansdale Div.—Switching transistors.
6 PIC Design Corporation—Master electronic catalog.

89 Polarad Electronics Corporation—Microwave generators.
325 Power Designs, Inc.—Voltage regulators.
93 PRD Electronics, Inc.—Attenuators.

130 Radio Cores, Inc.—Powdered iron toroids.
1 Radio Materials Company—Disc capacitors.
14 Raytheon Company, Industrial Components Div.—Subminiature tubes.
84 Raytheon Company, Microwave and Power Tube Div.—Miniature infra red detectors.
318 Reeves-Hoffman, Div. of Dynamics Corp. of America—Crystal oscillator.
35 Reeves Instrument Corporation—Electronic multiplier.
69 Revere Corporation of America—Wire and cable.
339 Rohn Manufacturing Company — Communication tower.

54 Sangamo Electric Company—Mica capacitors.
44 Saratoga Semiconductor Div. of Espey Mfg. & Electronics Corp.—Silicon zener regulators and power rectifiers.
55 Sarkes Tarzian, Inc.—Silicon cartridge rectifiers.
154 Schweber Electronics — Tantalum capacitor distribution.
45 Scientific-Atlanta, Inc. — Antenna pattern analyzer.
159 Shure Brothers, Incorporated — Rugged communications microphone.
331 SIFCO Metachemical, Inc.—Printed circuit repair equipment.
113 Specialty Automatic Machine Corporation—Precision waveguide bending.
124 Spectrol Electronics Corporation—Ultraminiature trimmer potentiometer.
133 Sperry Semiconductor Div. of Sperry Rand Corp.—Semiconductor devices.
2 Sprague Electric Company — Deposited carbon resistors.
98 Sprague Electric Company—Micro-alloy diffused-base transistors.
8 Sprague Electric Company—Pulse-forming networks.
19 Stackpole Carbon Company — Magnetic ceramic ferrites.
335 Stainless, Inc.—Towers.
319 Stanpat Company — Preprinted acetate sheets.
10 Stevens Manufacturing Company, Inc.—Thermostats.
850 Stromberg-Carlson Company—Telephone relays.
32 Struthers-Dunn, Inc.—Dry reed relays.
7 Superior Tube Company—Miniature disc cathodes.
16 Sylvania Electric Products, Inc., Electronic Tubes — Electroluminescent-Photoconductive devices.
143 Sylvania Electric Products, Inc., Semiconductor Div.—Mesa transistors.
842 Sylvania Electric Products, Inc., Semiconductor Div. — Microminiaturized Transistors.
85 Sylvania Electric Products, Inc., Special Tube Operations—Coaxial isolators.

834 Taylor Fibre Company—Laminated plastics.
838 Telonic Industries, Inc.—Sweep generators.
120 Texas Instruments, Incorporated—Microwave varactor diodes.
123 Thomas & Betts Company, The—Flat conductor cable.
58 Times Wire & Cable Div., The International Silver Company — Coaxial cables.
861 Tinsley Laboratories, Inc. — Corning glass filters.
358 Tower Construction Company—Towers, reflectors, and buildings.
94 Trak Microwave Corporation, Trak Electronics Co.—Microwave oscillator cavities.
71 Transitron Electronic Corporation—Switching transistor.
72 Transitron Electronic Corporation—Silicon rectifier.
73 Transitron Electronic Corporation—Silicon controlled rectifier.
74 Transitron Electronic Corporation—Silicon rectifier, 10 amp.
75 Transitron Electronic Corporation—Silicon rectifier, 50 amp.
76 Transitron Electronic Corporation—Switching transistor.
77 Transitron Electronic Corporation—Switching transistor.
852 Tung-Sol Electric, Inc.—Voltage regulator tubes.
843 Turbo Machine Company — Microwave antennas.

129 U. S. Components, Inc.—Electronic connectors.
134 United Transformer Corp. — Special filters.

57 Vapor Heating Corporation—D.C. power supply.
86 Varian Associates—Klystrons.
43 Victoreen—Corona type voltage regulators.

101 Waveline, Inc.—Triode oscillators, wavemeters, tunable filters.
9 Westinghouse Electric Corporation—Silicon power transistors.
65 White, S. S.—Air abrasive tool.
349 Williams & Co., C. K.—Pure ferric oxides, magnetic iron oxides, magnetic iron powders.

329 X-Acto, Inc.—Pen knife.

87 Zenith Radio Corporation — Electron beam parametric amplifier.

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center
P. O. Box 8221
Philadelphia 4, Pennsylvania

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

CHESTNUT & 56th STS.
PHILADELPHIA 39, PA.

Chilton Company

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center
P. O. Box 8221
Philadelphia 4, Pennsylvania

PRD *previews/ reviews/ design notes*

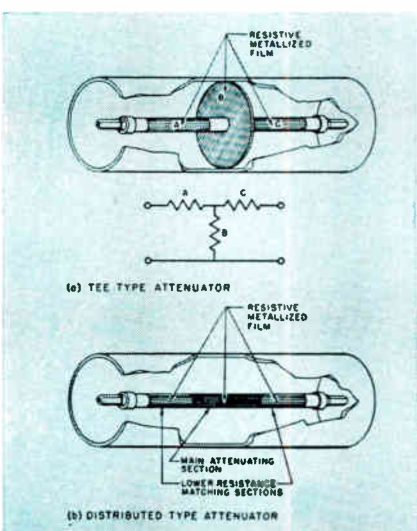
Design Considerations of Attenuators

The end use of an attenuator—whether as a standard in power or attenuation measurements, a power or signal level adjuster, an isolator or buffer pad—will, of course, bear on its design. But certain design and construction needs also remain constant. Here are some of the considerations that go into a PRD attenuator.

Attenuating Elements

We have found that metallized glass or ceramic generally make the best resistive elements. They are smooth, chemically inert, non-hygroscopic, and will not warp or change shape. We apply an extremely thin metal film to the element in two ways: by "paint" coating and baking, and by high vacuum deposition. The baked-on film method proves best for coaxial attenuators, and the vacuum deposition preferable for waveguide.

Fixed Coaxial Attenuators

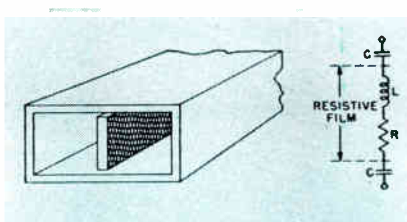


PRD 1100

PRD 130

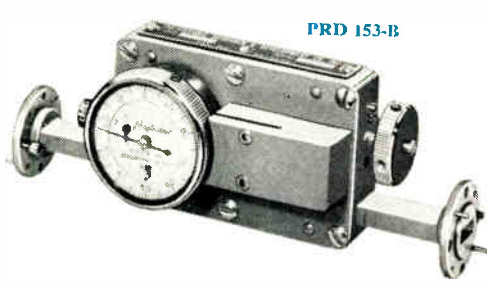
The two basic types of coaxial attenuators produced by PRD are shown above, in schematic drawing and photographs. The first, represented by the PRD 1100, uses one or more T sections with lumped resistive elements. The distributed type, illustrated by the PRD 130, uses an inner conductor of an electrically long resistive film. The T section PRD 1100 operates best at low frequencies, from dc to 4 KMC; the PRD 130 ranges from 2 to 10 KMC. Both dissipate one watt and are calibrated to ±0.2 db accuracy. The PRD 130 can attenuate up to 20 db; PRD 1100 up to 10 db.

Waveguide Attenuators

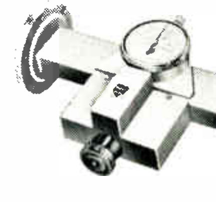


The drawing above gives a schematic presentation, with equivalent circuit, of a resistive film parallel to the electric lines in a waveguide. Attenuation is varied by moving the metal-coated glass panel in two usual ways: (1) by lowering it into the waveguide through a slot, as in the PRD 153-B, known as a "flap" type (Freq. range 18.0 to 26.5 KMC; Attenuation to 35 db; Max. VSWR 1.10; Max. insertion loss 0.5 db; Calibration accuracy ±0.2); or (2) by moving the lossy element from the side wall toward the center of the waveguide ...known as the "vane" technique, and illustrated by PRD 178-B (Freq. range 5.4 to 7.2 KMC; Attenuation to 45 db; Max. VSWR 1.15; Max. insertion loss 0.5 db; Accuracy to ± 0.2).

PRD 153-B



PRD 178



Another version of the vane method of attenuation is exemplified by our level set attenuators, such as the PRD 171-B (Freq. range 2.6 to 3.95 KMC; Max. attenuation to 40 db; Max. VSWR 1.15).

PRD 171-B

These are only a few of more than one hundred attenuators produced by PRD and a brief review of the broad design principles involved. For more specifications on these and other units, write for the PRD Attenuator brochure. For design information, write our Applications Engineering Department.

We have many interesting openings for engineers...contact Mr. John R. Zabka

PRD ELECTRONICS, INC.

A Subsidiary of Harris-Intertype Corporation

Formerly, Polytechnic Research & Development Co., Inc.

202 Tillary Street, Brooklyn 1, N. Y. ULster 2-6800

1608 Centinela Ave., Inglewood, Cal. ORegon 8-6922

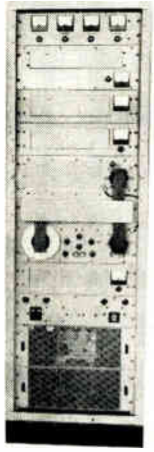
HARRIS INTERTYPE CORPORATION

Circle 93 on Inquiry Card

New Products

RELAY EQUIPMENT

Heterodyne Microwave Relay equipment for TV video relay interconnection. Designed primarily for multi-hop requirements, is available in 3 basic configurations: a terminal transmitter, terminal receiver, and heterodyne repeater. It is completely crys-

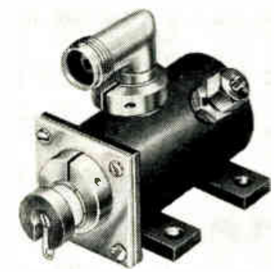


tal controlled, power output is 8 w at 2000 MC. The video bandwidth is flat to 8 MC, down 2 lb at 10 MC. The heterodyne microwave relay is capable of handling wide band TV video signals while simultaneously handling 15 KC audio channels. Suitable sound diplexing equipment is available for either single or dual sound channel operation. Sarkes Tarzian, Inc., Broadcast Equipment Div., East Hill Dr., Bloomington, Ind.

Circle 257 on Inquiry Card

"C" BAND OSCILLATOR

Model 151C Miniature Triode Oscillator has a power output 65 mw min. at 4200 MC. Only 4½ ounces in weight, it covers from 4200 MC to 6000 MC in 50 MC min. steps. Each is designed for max. stability having temperature stability of ±10 KC°C, min. size, max. output and has a vernier (50 MC) control of frequency. Plate voltage is 200 v nominal and 6.3



v for filaments. It features preset tuning and may be applied as a local oscillator, CW signal source and driver for crystal harmonic generators. John Gombos Co., Inc., Webro Rd., Clifton, N. J.

Circle 258 on Inquiry Card

New Products

COAXIAL WAVEMETERS

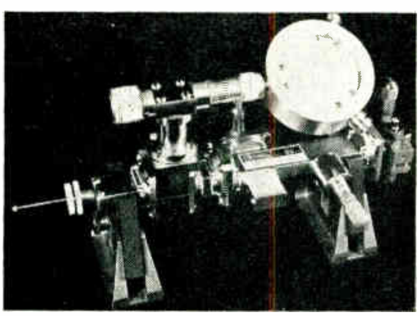
A new line of transmission type coaxial wavemeters cover from 2300 to 8200 MC. Units equipped with oversized 2-in. micrometers directly readable to 0.001 in. Meters are calibrated every 50 MC. Standard models available with female type N

input and output connectors or with a direct dc output through a female type BNC connector. The crystal output models are adjusted to give a min. of 20 μa dc output with 1 mw input power. Specs (Model No.; Freq. Range; Accuracy; Loaded Q): 951—2300-3600, 0.02%, 1000; 951CR—2300-3600, 0.02% 1000; 952—3600-4500, 0.02%, 4000; 952CR—3600-4500, 0.02%, 4000; 953—4500-5900, 0.02%, 4000; 953CR—4500-5900, 0.02%, 4000; 954—5900-8200, 0.02%, 3000; 954CR—5900-8200, 0.02%, 3000. Waveline, Inc., Caldwell, N. J.

Circle 259 on Inquiry Card

PARAMETRIC AMPLIFIERS

First of a line of parametric amplifiers, the S-band Model S1000. Typical specifications include a tuning range of 100 MC, operating gain of 17 db, bandwidth of 20 MC (at 3-db points), and a system noise figure of 2.5-3.0 db (operating into a mixer with a noise figure of 10 db). The assembly consists of a 3-port ferrite circulator, a reflection-type diode amplifier, a pump klystron, a variable attenuator and a directional coupler



monitor. For some applications, ferrite isolators may be necessary between the antenna and the circulator and/or between the circulator and the mixer. Mircomega Corp., Venice, Calif.

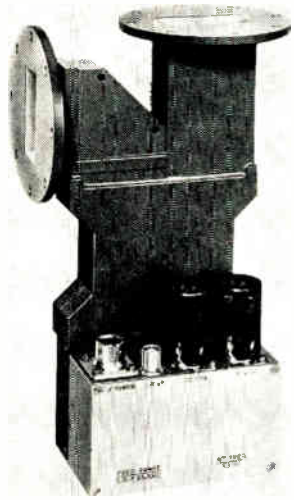
Circle 260 on Inquiry Card

Circle 96 on Inquiry Card

New Products

MIXER—PREAMPLIFIER

New 5.15 to 5.85 KMC combination mixer-preamplifier for microwave and guidance systems eliminates the problem of variable parameters resulting when separate mixers and preamplifiers are combined. Model 187MB-360F1 is a low-noise, wide-



band downconverter for maser and parametric r-f amplifiers. Noise figure is less than 7 db with gain of 25 db. Preamplifier is six-tuned, with a stabilizing circuit that eliminates need for realignment after replacing tubes or crystal. Preamplifier output is matched to 50 ohms, allowing main amplifier to be remotely located. Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.

Circle 261 on Inquiry Card

INDUCTION MOTOR

Addition of A-10-11 unit to line of miniature and subminiature special service motors. Motor operates continuously over an amb. temp. range of −55°C to +125°C. Totally enclosed it exhibits low starting torque and conforms to MIL-M-7969, MIL-E-5272A, and MIL-A-8625. Design features: Horsepower, 1/400; Voltage, 115 v., 400 CPS, 3 phase; Speed (RPM), 10,500; Torque (full load)

(oz. in.), 0.24—(starting oz. in.), 0.20; Pull-Out Torque (oz. in.), 0.35; Efficiency (full load), 35%; Current (full load) (amp.), 0.10; Weight (oz.), 3.5. Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.

Circle 262 on Inquiry Card

MICROWAVE TRIODE

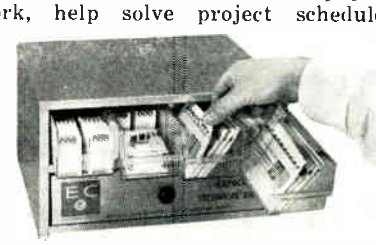
Type DX145A/EC157, a high gain, wide band, disc-seal microwave triode, when operated as a narrow band CW amplifier, will have a gain of 18 to 19 db with a power output of 0.5 w at 4 KMC. As a broadband amplifier at 4 KMC it will have a gain of

12 db with a power output of 0.5 v. Saturation CW power output can be as high as 2.5 w. Expected life is 10,000 hrs—guaranteed for 6000. As an oscillator, it will operate in the 5 KMC region; as a doubler it will provide a useful output at 6 KMC. It operates at 180 v. It can be built into cavities for free air convection cooling at max. power output. Tube is designed with a threaded grid ring for superior anode-cathode isolation and simplified tube replacement. Amperex Electronic Corp., Microwave Tube Dept., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 263 on Inquiry Card

RELAY—CAPACITOR KIT

Engineers Relay and Capacitor Kit for prototype, development and engineering labs. Kit consists of 20 standard microminiature relays (MIL-R-5757 and MIL-C-25018) in 3 header and 4 mounting configurations: 160 hi-temp ceramic capacitors (MIL-C-11015) from 39 $\mu\mu$f to 10,000 $\mu\mu$f; and container with engineering data drawer. Kits save on paper work, help solve project schedule



problems by having essential components immediately available for breadboards and other needs. Electronic Components Div., Telecomputing Corp., 14704 Arminta St., Van Nuys, Calif.

Circle 264 on Inquiry Card

MADT® transistors from Sprague*

- for the highest r-f operating frequency of all mass-produced transistors
- for the fastest switching time of all mass-produced transistors
- for storage temperatures up to 100°C

DESIGN AROUND SPRAGUE
MICRO-ALLOY DIFFUSED-BASE TRANSISTORS

available now at sensible prices you can afford!

Sprague Germanium Micro-Alloy Diffused-Base Transistors, well-known for their rugged vhf performance, are now *priced below other transistors* with comparable electrical characteristics. In many areas, this permits designers to improve circuit techniques without necessarily increasing costs. Expanded production facilities enable us to *ship quantity orders on short notice.* Add to this their *ultra-fast switching time,* and you have three good reasons why Sprague MADT® Transistors have achieved their high level of acceptance.

With Sprague Transistors, circuits in vhf amplifiers and oscillators can now operate with collector currents as high as 50 ma . . . with power dissipation up to 50 mw . . . with collector to base voltages to 15 v. They have been application tested through the entire military electronics vhf spectrum.

The application table may well suggest the use of one or more Micro-Alloy Diffused-Base Transistor types in your latest circuit designs.

● ● ●

MICRO-ALLOY DIFFUSED-BASE TRANSISTOR APPLICATIONS

Type	Application
2N499	Amplifier, to 100 mcs
2N501	Ultra High Speed Switch (Storage Temperature, 85 C)
2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mcs

For complete engineering data on the types in which you are interested, write Technical Literature Section, Sprague Electric Co., 233 Marshall St., North Adams, Massachusetts.

You can get off-the-shelf delivery at factory prices on pilot quantities up to 999 pieces from your local Sprague Industrial Distributor.

SPRAGUE®
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:

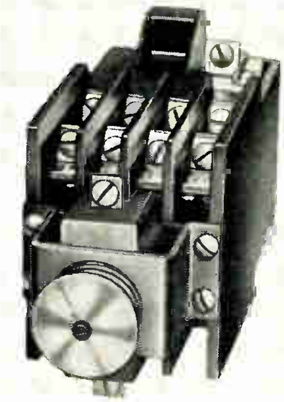
CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable.

New Products

CONTROL RELAY

Industrial control relay, the "Compact 300," is rated at 6 a. 300 v. max. The unit is a fixed circuit device with provisions for 8 independent poles. It is also available in 2, 3, 4 or 6 poles in any combinations of normally open or normally closed contacts. It requires up to 70% less panel area than conventional relays—only 5½ in.^{2} of panel space are required for a relay of from 2 to 8 poles and up to 48 poles can be mounted per linear foot. Bifurcated (split-saddle) contacts provide 4 current paths. The magnet assembly and contact mechanism are completely enclosed in a molded case to protect against accidental damage. Cutler-Hammer, 436 N. 12th St., Milwaukee, Wis.



Circle 231 on Inquiry Card

X-BAND CIRCULATOR

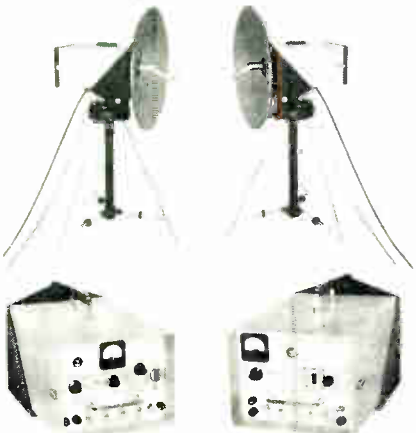
Three ounce X-band circulator has a minimum isolation of 20 db and a max. insertion loss of 0.4 db over a 6 per cent band. Package is less than ¾ in. high and 1½ in. in dia. less TNC coax connectors. The new unit has a VSWR of less than 1.4:1, handles 10 w average power and 10 kw peak power. Input impedance is 50 ohms. It can be designed into a composite strip line circuit thus eliminating connectors between elements. Hycon Mfg. Co., 1030 South Arroyo Parkway, Pasadena, Calif.

Circle 232 on Inquiry Card

New Products

MICROWAVE RELAY SYSTEM

Portable microwave relay system 420A has baseband width or 5 MC power output of 0.1 w and operates in the 10,500 to 13,200 MC range. Transmitter and receiver (self-contained) weigh 31 and 32 lbs. Fea-

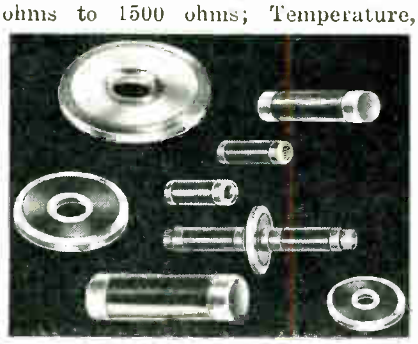


tured: low power consumption (transmitter—70w, receiver—160w); plug-in i-f amplifier; calibrated variable frequency wavemeter allows change in operating freq. without need for wavemeter replacement; a built-in test meter, built-in input signal attenuator; 5 MC bandwidth, flat within 0.5 db; a modulator test output connector, and reliable AFC action with pull-in range over the entire i-f bandpass. Electronic Systems Div., Mechanical Products Inc., 1824 River St., Jackson, Mich.

Circle 233 on Inquiry Card

FILM RESISTORS

Thin-film carbon resistors are designed for use in microwave attenuators, precision coaxial terminations, dummy loads, coupling loops, etc. Specifications include: Frequency, dc to 10,000 MC (useable to 100 KMC); Resistance, disc resistors—0.001 ohms to 400 ohms, rod resistors—0.001 ohms to 1500 ohms; Temperature,



−55 to +150 C; Humidity, 0 to 100% relative humidity. Tight tolerances to ±1% are standard. They are protected with special epoxy resins. Film Resistors, Inc., 242 Ridgedale Ave., Morristown, N. J.

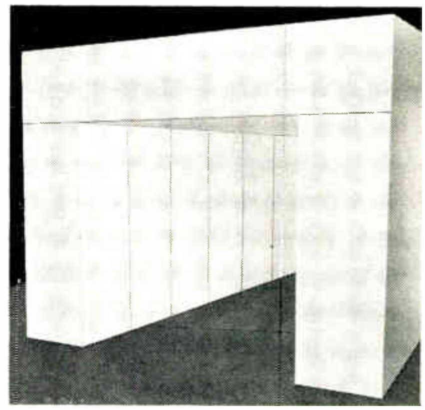
Circle 234 on Inquiry Card

Circle 101 on Inquiry Card

New Products

LOW FREQUENCY ABSORBER

New Types BB and BP broadbanded microwave absorbers provide effective attenuation for free space room testing of radar antennas from 35,000 MC down to 50 MC in the case of the BB-96. Major advantages of

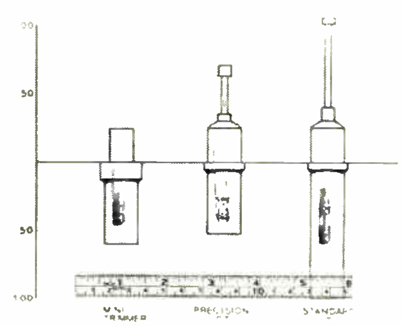


these new absorbers are: (1) elimination of need for supporting structure; (2) a new design principle permitting significant cost reductions per unit volume of absorber; (3) rugged, fire-resistant construction; (4) reduction of shipping and storage space. McMillan Industrial Corporation, Brownville Avenue, Ipswich, Mass.

Circle 235 on Inquiry Card

TRIMMER CAPACITOR

New trimmer capacitor combines moderate cost with short behind-panel lengths. All five models feature linear tuning with a capacitance change of 0.5 μμf per turn. These "Precision Direct Traverse" capacitors fit between Company's standard DT trimmer and the recently-announced miniature trimmer. Capacitance ranges are 0.8 to 4.5, 0.8 to 8.5; 0.8 to 12;

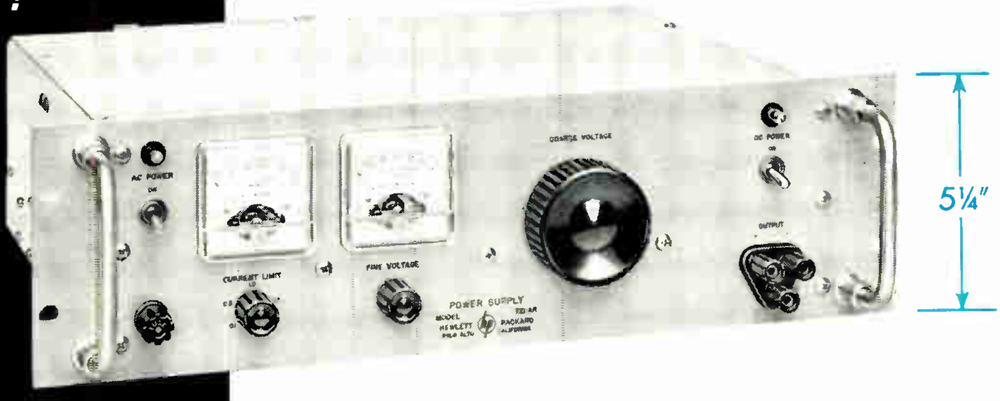


1 to 18; and 1 to 30 μμf. Temperature coefficients are ±50, ±75, and ±100. Q factor at 50 MC is 500, dc voltage is 1,000, dielectric strength is 1500 and insulation resistance is 10^6 megohms. Corning Glass Works, Corning, New York.

Circle 236 on Inquiry Card

Never before a power supply to meet so many of your requirements— so well!

60v-2amp OUTPUT!



hp

120 watt output, fully regulated for high power transistor and other applications!

Fully adjustable output with current limiter for safe low power applications!

Extremely low noise and ripple, less than 250 μv, for more applications!

High order of line, load and temperature regulation for maximum stability!

Meets all specs from 0 to 55°C!

New hp 722AR provides fully regulated output 0 to 60 v, 0 to 2 amps. Noise and ripple are less than 250 μv rms. Continuously adjustable safety circuit limits maximum current flow, prevents overload damage to transistors under test. Remote sensing terminals are provided so that the ohmic resistance of the supply lead does not affect regulation. Temperature-stable components insure dependable, "within spec" performance from 0 to 55°C. Good temperature stability also assures constant, reliable output. Load regulation less than 5 mv for 0 to 2 amps change. Load voltage and current meters and three-terminal output are provided (pos. or neg. to ground or floating). Output terminals duplicated front and rear. Floating output permits series connection for higher voltages. And the hp 722AR costs only $525.00!

OTHER hp REGULATED AND KLYSTRON POWER SUPPLIES:

hp 711A Laboratory Power Supply, 0 to 500 v @ 100 ma, $250.00 (cabinet), $255.00 (rack mount); hp 712B Power Supply, 0 to 500 v @ 200 ma, $365.00 (cabinet), $350.00 (rack mount); hp 715A Klystron Power Supply, Beam 250 to 400 v @ 50 ma, Repeller 0 to 900 v, $300.00; hp 721A Transistor Power Supply, 0 to 30 v, 150 ma, $145.00.

Data subject to change without notice. Prices f.o.b. factory.

SPECIFICATIONS, hp 722AR

Rated Output:	0 to 60 v dc 0 to 2 amps dc
Line Regulation:	Less than 2.5 mv for ± 10% line voltage change; any output between 0 and 60 v.
Load Regulation:	Less than 5 mv for 0 to 2 amps change; any output between 0 and 60 v.
Noise and Ripple:	Less than 250 μv rms
Output Vernier:	Range, 1.3 v; resolution, 5 mv.
Temperature Stability:	Better than 0.02%/°C or 5 mv/°C, whichever is larger
Temperature Range:	0 to 55°C for operation within specifications
Output Impedance:	Dc: Less than 2.5 milliohms Ac: Less than 5 milliohms in series with 4 μh
Output Meters:	Voltage: 0 to 60 v, one range Current: 0 to 2.5 amps, one range
Protection:	Output current limiter continuously adjustable from less than 100 ma to 2.2 amps
Cooling:	Forced air
Size:	19" wide, 5¼" high, 12" deep
Weight:	Net 34 lbs.
Price:	$525.00

hp

HEWLETT-PACKARD COMPANY
1055B Page Mill Road, Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000

HEWLETT-PACKARD S.A.
Rue du Vieux Billard No. 1 Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26.43.36

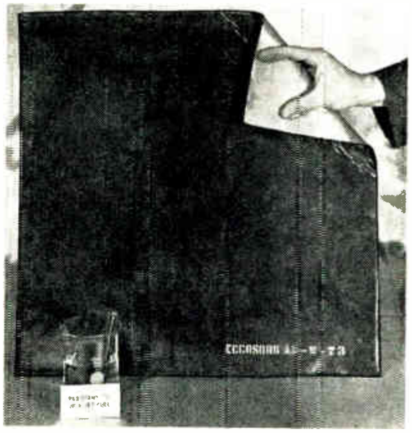
Sales representatives in all principal areas

Circle 103 on Inquiry Card

New Products

MICROWAVE ABSORBER

Exxosorb AN-W is a series of broadband flexible foam microwave absorbers which can be used where it will be in contact with fuel, lubricants, or hydraulic fluids. It is a



truly broadband absorber. Reflectivity remains at a low level even though the frequency is varied and incident angle is varied. (Reflectivity is below 2% even at a 70° incidence angle.) Standard sheets are 2 x 2 ft; thickness is the same as corresponding Eccosorb AN. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Circle 237 on Inquiry Card

RESISTANCE CARDS

Kit contains high stability microwave attenuator material in easy-to-use card form. It includes 11 metal film resistance cards, 2½ x 6 in., and one metallized mica card 2 x 2½ in. plus instructions and tech notes. For microwave applications requiring accurate, reproducible dissipation at low r-f power, they may be punched, drilled, machined or sanded to suit your own needs. Meeting MIL-P-18177 specs, they are available from

25 to 750 ohms/sq. and in standard values of from 50 to 500 ohms. Standard resistance tolerance is ± 10%/sq. While attenuations values up to 70 db are obtainable, the VSWR can be held to less than 1.10 over broad bands. Filmohm Corp., 48 W. 25th St., New York 10, N. Y.

Circle 238 on Inquiry Card

New Products

TUNNEL-DIODE OSCILLATOR

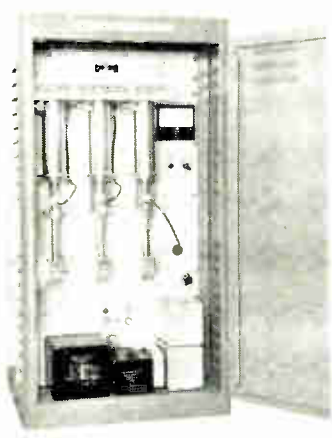
Tunnel-diode oscillator (available on a sampling basis). Developmental Type SS-100, is a package approx. 6 x 3 x 5/8 in. exclusive of tuning dial and connectors, and less than 1 lb. in weight. Application of only 0.2 v. to

the oscillator unit produces a power output of several tenths of a mw, tunable over the 100-1400 MC band. It provides a new type of tunable signal-source component that can be designed to meet the needs of new radar, telemetry, and satellite systems. Radio Corp. of America, Semiconductors Div., Harrison, N. J.

Circle 239 on Inquiry Card

HETERODYNE REPEATER

Microwave system can transmit TV programs through a series of relay hops without degrading viewing quality. The RT-3A Heterodyne Repeater is for continuous, unattended operation in the 2 KMC frequency range. the heterodyne repeater method eliminates demodulation and remodulation at each relay site. Advantages include: 10 w output power for signal reliability over greater path lengths; meets FCC, NTSC and proposed EIA color and monochrome standards; built-in metering and monitoring facilities; unattended operation; vestig-



ial sideband transmission plus crystal-controlled frequency stability permit use of 2 RT-3A systems within assigned 17 MC channels for spectrum conservation; and uses standard high gain parabolic antennas. Adler Electronics, Inc., New Rochelle, N. Y.

Circle 240 on Inquiry Card

New Products

TRANSISTOR POWER SUPPLY

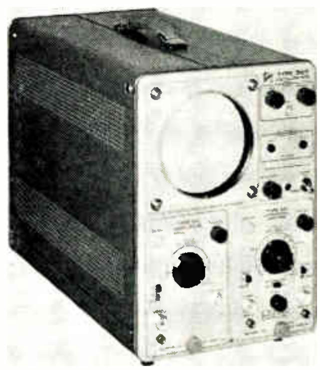
The V-410, All-Transistor power supply provides these TV broadcast voltages and currents: V-410, up to 1.5 a at 280 vdc regulated; V-410-MON, up to 1.5 a at 280 vdc regulated, centering current from a self-contained module; V-410-CAM, up to 1.5

a at 280 vdc regulated, centering current from a self-contained module, up to 100 madc, constant current, for camera focus current. Specs: Load current, 200 ma to 1.5 a; Output voltage, 275 to 285 vdc; max. ripple, 5 mv rms; Regulations vs load, ± 0.5% max.; Regulation vs. line, ± 0.5% max.; Source impedance, 0.5 ohms, 0 to 100 KC; Unregulated output, 350 v. approx. at up to 200 ma. Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N. J.

Circle 241 on Inquiry Card

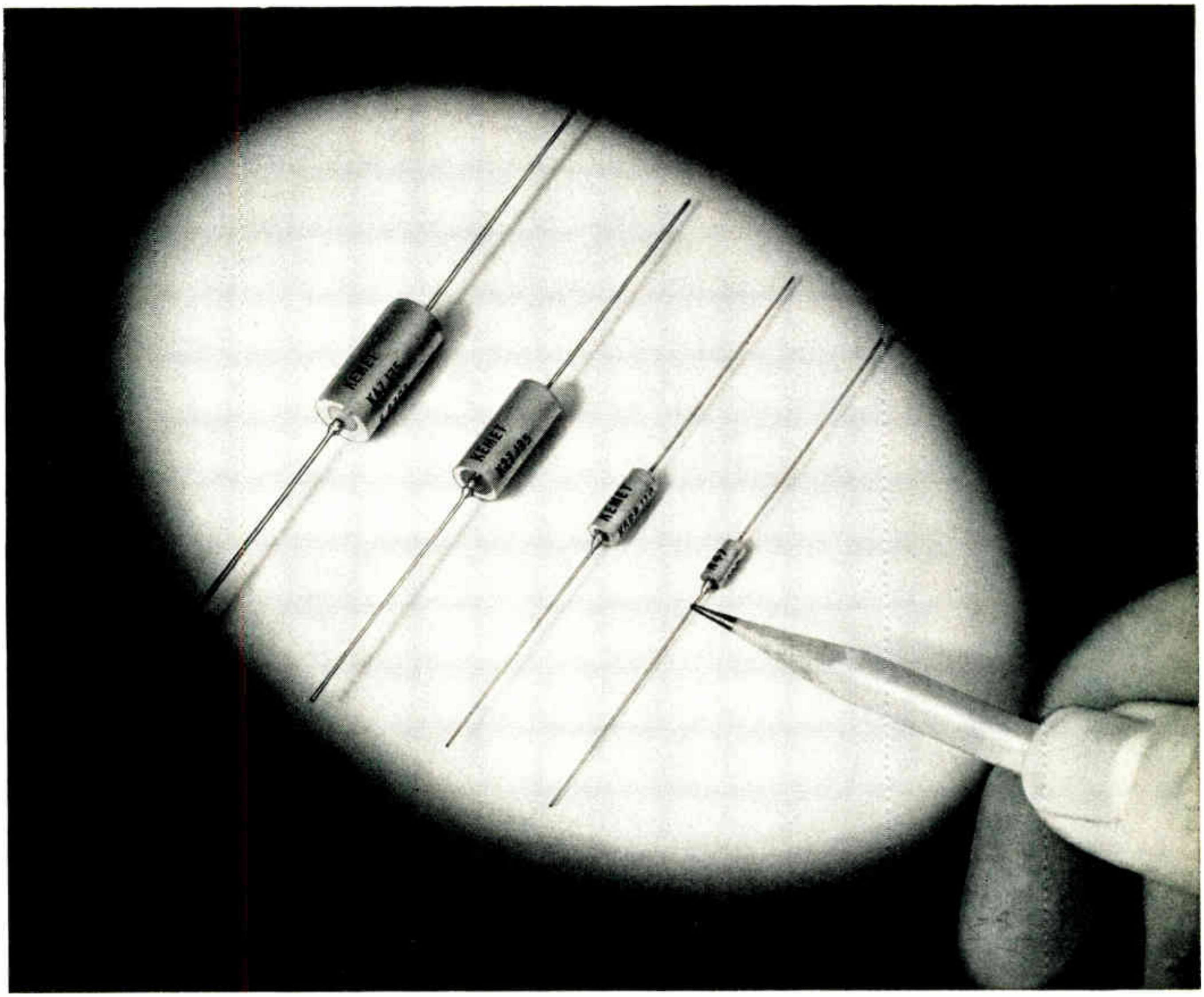
OSCILLOSCOPE

The Type 560 is basically an indicator. It contains a 5-in. CRT with 3.5 kv accelerating pot., an 8 x 10 cm viewing area, an amplitude and sweeptime calibrator, and a regulated dc supply (30 w). Indicator accepts any 2 of 4 plug-in units—which drive the deflection plates directly. It can use a time-base unit, Type 67 (21 calibrated sweep rates—1 μsec/cm to 5 sec/cm with one of those signal-amplifier units: a basic amplifier, Type 59 (1 v/cm, dc to 400 KC); a 1 MC amplifier, Type 60 (50 mv/cm to 50 v/cm, calibrated decade-step at-



tenuator); a differential-input amplifier, Type 63 (100:1 rejection ratio, 1 mv/cm, dc to 300 KC). It can operate as an X-Y Oscilloscope using identical amplifier units in both channels. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 242 on Inquiry Card



KEMET COMPANY EXPANDS ITS SOLID TANTALUM CAPACITOR LINE!

These new, smaller sized J-series capacitors — an addition to the proved and accepted H-series solid tantalum line—comply with and in many instances exceed the requirements of MIL-C-26655A.

For example, these capacitors are available in capacitances up to 22 microfarads at working voltages of 50 volts at 85 degrees C. At 125 degrees C., they operate at two-thirds of the 85 degree C. working voltage. Available with or without insulating sleeves, the new J-series capacitors maintain the excellent low leakage current characteristics associated with the H-series line, even though they occupy about ⅓ of the space of the earlier types.

These new capacitor designs are made possible by the advanced research facilities available at Union Carbide Corporation, plus the fact that "Kemet" is not dependent on other suppliers for the mining or processing of tantalum.

For literature, write Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

KEMET COMPANY

UNION CARBIDE

New Products

TUNEABLE LOAD

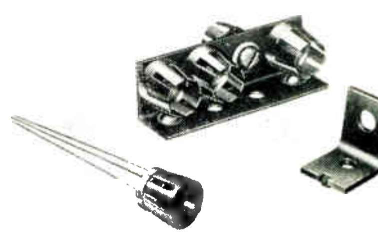
New standard tuneable loads, precision laboratory instruments, provide accuracy and versatility in VSWR measurements. The tuneable loads can reduce their own reactive elements to a negligible value, and the resulting VSWR is the residual VSWR of the

slotted line. USWR of 1.005 can be achieved at single frequencies and 1.02 max. for a full octave. Also once previously calibrated a voluntary mismatch of known phase and magnitude can be introduced without changing the reference plane. Two models available, the TL-2000 from 250 to 2000 MC and the TL-4000 from 2000 to 4000 MC, they are supplied with type N or C connectors. They will handle 1 w, 1 kw peak and have micrometer, calibration resetable to ± 0.001 in. The variable mismatch that can be introduced is 3.0 max. for the TL-2000 and TL-4000. Maury & Associates, 10373 Mills Ave., Pomona, Calif.

Circle 243 on Inquiry Card

HEAT DISSIPATOR

Transistor Heat-dissipating Retainer features all-beryllium copper spring finger construction to accommodate dia. variations from 0.305 in. to 0.335 in. found in TO-5, TO-9, TO-11 and TO-39 transistor cases. It provides max. thermal contact with the transistor case. This results in most efficient transfer of heat from transistor case to the dissipator and heat sink. Methods for mounting are simple and suitable for either printed



circuit boards, chassis and heat sinks. It provides effective thermal benefits and max. retention in extreme shock and vibration environments. IERC Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Circle 244 on Inquiry Card

WHERE
SMALLNESS
IS
IMPORTANT

Designed for use where space is a critical factor, this tiny DC 1/10 resistor measures only ¼″* in length, and yet its solid ceramic core foundation makes it thermally stable, while the use of diamond spiralled carbon film assures higher reliability. Sturdy No. 22 leads 1½″ long (plus or minus ⅛″) with silver plated compression caps provide the resistor with positive termination. Coated with Electra's "R" Coating to resist moisture, impact and high temperatures, it has a resistance range of 10 ohms to 300 K, a wattage rating of 1/10 watt @ 125° C., and a maximum rated voltage of 250 volts. *Actual size: .250″± .010″ length; diameter .093″.

Availability:

Deposited carbon:
Electra DC 1/10..."R" coated epoxy
Electra DCM 1/10...Molded Jacket

Availability:

Metal Film:
Electra MFS 1/10..."R" coated epoxy
Electra MF 1/10...Molded jacket

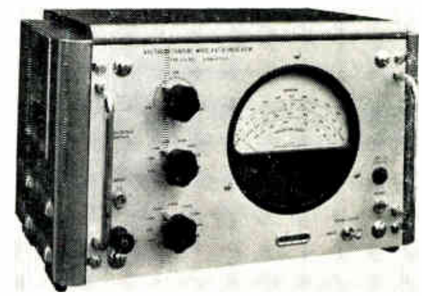
ELECTRA

ELECTRA MANUFACTURING COMPANY—ELECTRONICS DIVISION—4051 BROADWAY, KANSAS CITY, MISSOURI

New Products

VSWR INDICATOR

For microwave instrumentation and testing performance of wave guide assemblies instrument can be used with oscillators using Klystron tubes and especially with the Solartron Klystron Power Supply Unit Type AS 562. For operation from a microwave crystal probe detector ele-



ment, input impedance is 10,000 ohms. It provides a sensitive and selective amplification which gives an indication on a 6 in. dia. meter directly in terms of SWR. By the use of 2 selective amplifiers in series tuned to 3 KC and with a ±50 CPS bandwidth, there is a low noise level on the detector signal applied to the meter, thus max. gain can be used without loss of accuracy. Meter indicator has 4 scales, a linear scale of 50 div., 2 square law scales in direct terms of VSWR, and a scale in terms of reflection co-efficient. Max. sensitivity is approx. 0.3 µv for full scale meter deflection. Solartron Inc., 1743 S. Zeyn St., Anaheim, Calif.

Circle 245 on Inquiry Card

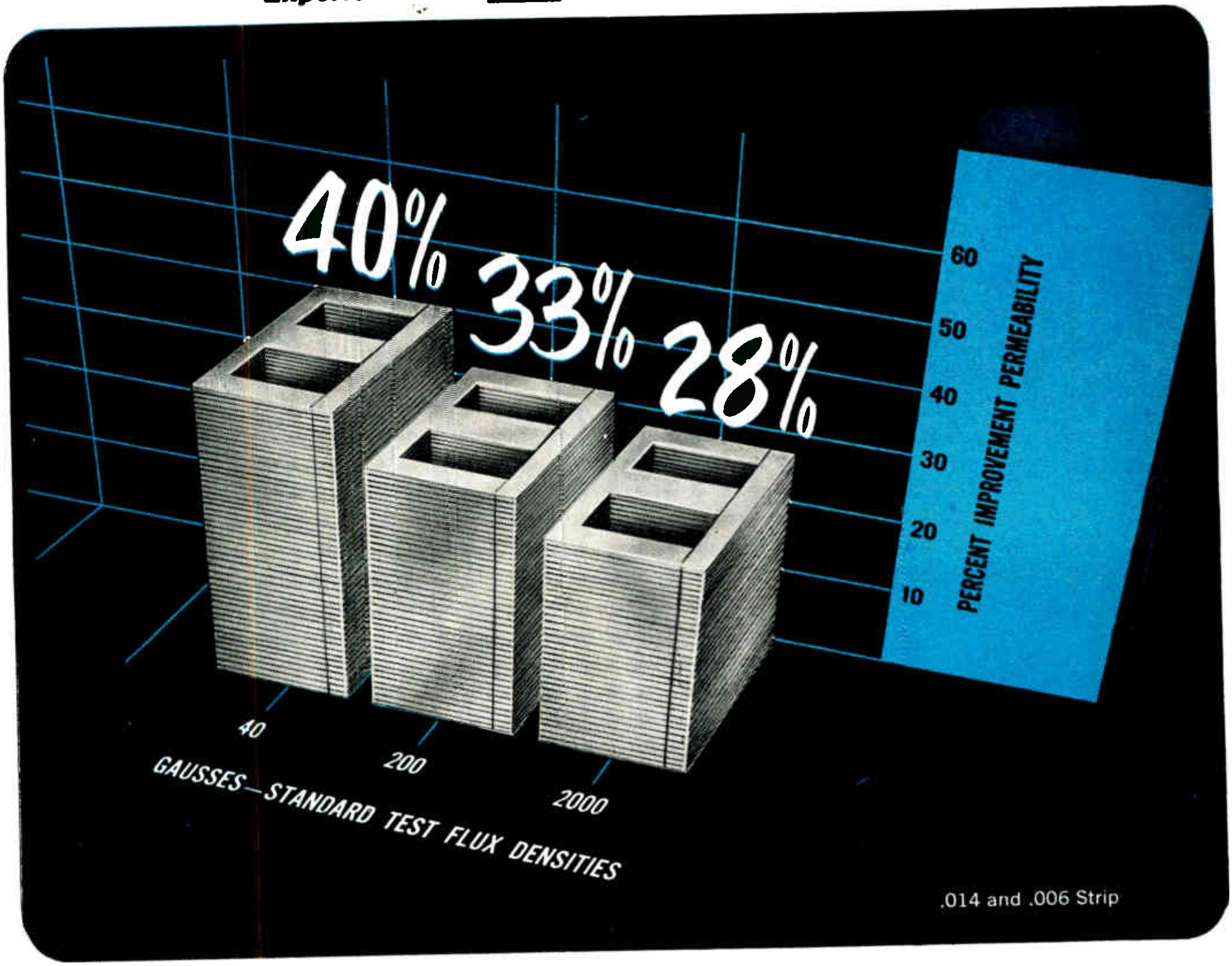
COAXIAL LINE DUPLEXERS

Addition to microwave components line, branched coaxial line duplexers, utilize two cell-type TR tubes and a single cell-type receiver protector tube. In the 3⅛ in. unit, two band pass filters are shown, one in the receiver circuit and one in the AFC pick-up circuit. Visible also are directional couplers used for measuring

transmitter power and antenna circuit VSWR. Unit shown is rated as follows: frequency 406-450 MC; transmitter po 3 mw max.; transmitter po (av), 5 kw max. Bomac Laboratories, Inc., Salem Rd., Beverly, Mass.

Circle 246 on Inquiry Card

Experience—*the added alloy in* **A-L Electrical Steels**



Higher permeability values now guaranteed for Allegheny Ludlum's Moly Permalloy

Means new, consistent and predictable magnetic core performance

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum, with higher guaranteed permeability values than former typical values. For the buyer, this new high quality means greater uniformity . . . more consistent and predictable magnetic core performance.

This higher permeability is the result of Allegheny Ludlum's intensive research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. A-L continues its research on silicon steels, including Silectron, well-known grain-oriented silicon steel, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available from Allegheny Ludlum. In addition, you can be assured of close gage tolerance, uniformity of gage throughout the coil, and minimum spread of gage across the coil-width.

If you have a problem relating to electrical steels, laminations or magnetic materials, call A-L. Prompt technical assistance will be yours. And write for more information on Moly Permalloy. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

Address Dept. EI-11

WSW 7480

ALLEGHENY LUDLUM

STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17
Export distribution, Laminations: AD. AURIEMA, NYC 4

Circle 114 on Inquiry Card

Now Added to Industry's Most Complete Line of Germanium Power Transistors

NEW CBS HIGH-POWER TRANSISTORS

Advantages

- High power output: up to 30 w Class A, 100 w Class B, 1000 w switching
- High voltages . . . high current gains . . . and high working currents
- Low-distortion ring emitter construction
- Hermetically welded JEDEC TO-36 male industrial case

Characteristics

All these CBS high-power transistors have: Max. dissipation, 150 watts* for a typical thermal resistance of 0.5° C/W; max. collector current, 15 amperes; junction temperatures, −65 to +100°C.

Type	Max. W. Diss.*	Max. Thermal Res°C/W	Max. V_{CBO}	Max. V_{CES}	h_{FE} (I_C = 5A) Min.	Max.
2N173	70	1.0	60	50	35	70
2N174	85	0.8	80	70	25	50
2N277	70	1.0	40	40	35	70
2N278	70	1.0	50	45	35	70
2N441	70	1.0	40	40	20	40
2N442	70	1.0	50	45	20	40
2N443	70	1.0	60	50	20	40
2N1100	85	0.8	100	80	25	50

*25°C base mounting temperature.

save costs • space • weight

You can now replace two 40-watt or four 20-watt paralleled power transistors with one CBS PNP high-power transistor. This one design change brings you important transistor . . . component . . . assembly . . . space . . . and weight savings. New economies become possible in power supplies and amplifiers and in high-power switching circuits.

Note the wide line of these CBS PNP high-power transistors, their pertinent characteristics and many advantages. Ask for complete technical data. Order these money-saving units today . . . at factory prices for quantities up to 1000 . . . from your Manufacturers Warehousing Distributor.

CBS semiconductors ®

Reliable products through Advanced Engineering

:BS ELECTRONICS, Semiconductor Operations, Lowell, Mass. • A Division of Columbia Broadcasting System, Inc.

ıles Offices: *Lowell, Mass.*, 900 Chelmsford St., GLenview 2-8961 • *Newark, N. J.*, 231 Johnson Ave., TAlbot 4-2450 • *Melrose Park, Ill.*, 1990 N. Mannheim d., EStebrook 9-2100 • *Los Angeles, Calif.*, 2120 S. Garfield Ave., RAymond 3-9081 • *Atlanta, Ga.*, Cary Chapman & Co., 600 Trusco Way, S. W., PLaza 8-4506 *Minneapolis, Minn.*, The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457 • *Toronto, Ont.*, Canadian General Electric Co., Ltd., LEnnox 4-6311

New Products

SUBCARRIER OSCILLATOR

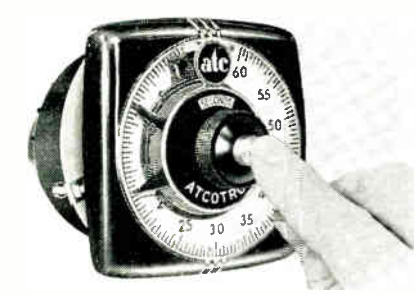
Model 0-20 voltage controlled subcarrier oscillator features data stability for FM telemetering applications from −55 C to +125 C. First of a new series of solid state telemetering components using silicon semiconductors, it is packaged in a die cast alu-

minum configuration that features a captive screw hold down and a removal device. Package measuring 2.25 x 1.875 x 0.875 in. is smallest of 3 packaging modules in the series of telemetering hardware. Adjustment controls for centering, deviation sensitivity, and output provided at top of unit. Available in standard IRIG channels with inputs of either 0 to 5 v., or −2½ v. to +2½ v. Dorsett Electronics Laboratories, Inc., 119 W. Boyd, Norman, Okla.

Circle 247 on Inquiry Card

PUSH-BUTTON TIMER

Push-Button Timer provides automatic shut-off and reset. For ac or dc operation, Model 309 features 0.0025 repeat accuracy; a metal-to-neoprene impingement clutch; one S.P.D.T. snap-action load contact in series with the motor, plus option of additional S.P.D.T. snap-action independent load contact. It can be mounted in 3 ways: one hole mount-



ing with modern ring clamp; surface mounting with bracket; or front-of-panel mounting. Available in 16 standard dial ranges from 6 sec. to 60 hrs. Automatic Timing & Controls, Inc., King of Prussia, Pa.

Circle 248 on Inquiry Card

New Products

LOW PASS FILTER

Model 362A Low Pass Filters are reactive elements facilitating microwave measurements by suppressing harmonics. Measurement accuracy of standing wave ratio and response are increased since transmission is at a single frequency. Specs (M362A and N362A in order): Pass band, 10 to 15.5 KMC-15 to 21 KMC; Standing wave ratio (pass band), 1.5:1-1.5:1; Insertion loss (pass band), less than 1 db-less than 1 db; Stop band, 19 to 47 KMC-28 to 63 KMC; Rejection (stop band), at least 40 db-at least 40 db; Waveguide size WR 75-WR 51; Flange, flat cover-flat cover; Length, 4 15/32 in.-3 1/32 in.; Weight, net 9 oz.-net 5 oz. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 249 on Inquiry Card

DELAY LINES

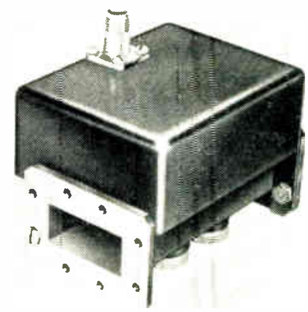
Series of compact and highly accurate delay lines allow broader band operation, lower attenuation, accuracy at higher frequencies and greater stability, incorporating the greatest amount of cable in the least possible space. The delay lines consist of 285 ft. of ½ in., 50 ohm Foamflex cable in each unit. The delay time within each line has a tested accuracy of ± 1 msec. Terminating ends are bent on a 2 in. radius. The size of each unit is 16 in. across (diameter) by 6 in. in height. The Electronics Div., American Tube Bending Co., New Haven, Conn.

Circle 250 on Inquiry Card

New Products

HIGH SPEED SWITCH

New ultra high-speed microwave switch consists of 3 identical switching cells—each capable of 17 db isolation and 1.5 db insertion loss. The 3 cells cascaded together offer conservatively—40 db of isolation and 4.8 db max. insertion loss. Similar

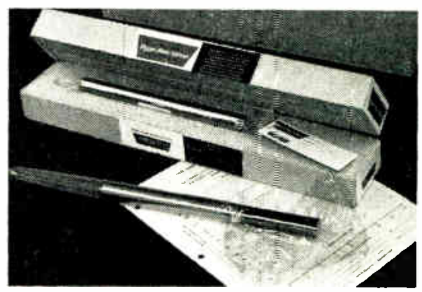


characteristics may be obtained at X and KU band frequencies using the correct number of cells to give the necessary isolation. Featured are: Switching Speed, rise time, 10 mμsec max.; Decay time, 10 mμsec max.; Frequency Band, 5.4 to 5.9 KMC; Isolation, 40 db min.; Insertion Loss, 4.8 db max.; Power Handling, 40 mw; Drive Power required, 150 mw; Length, 4 in. Kearfott Div., Microwave Products, General Precision Inc. 14844 Oxnard St., Van Nuys, Calif.

Circle 251 on Inquiry Card

SEMICONDUCTOR SILICON

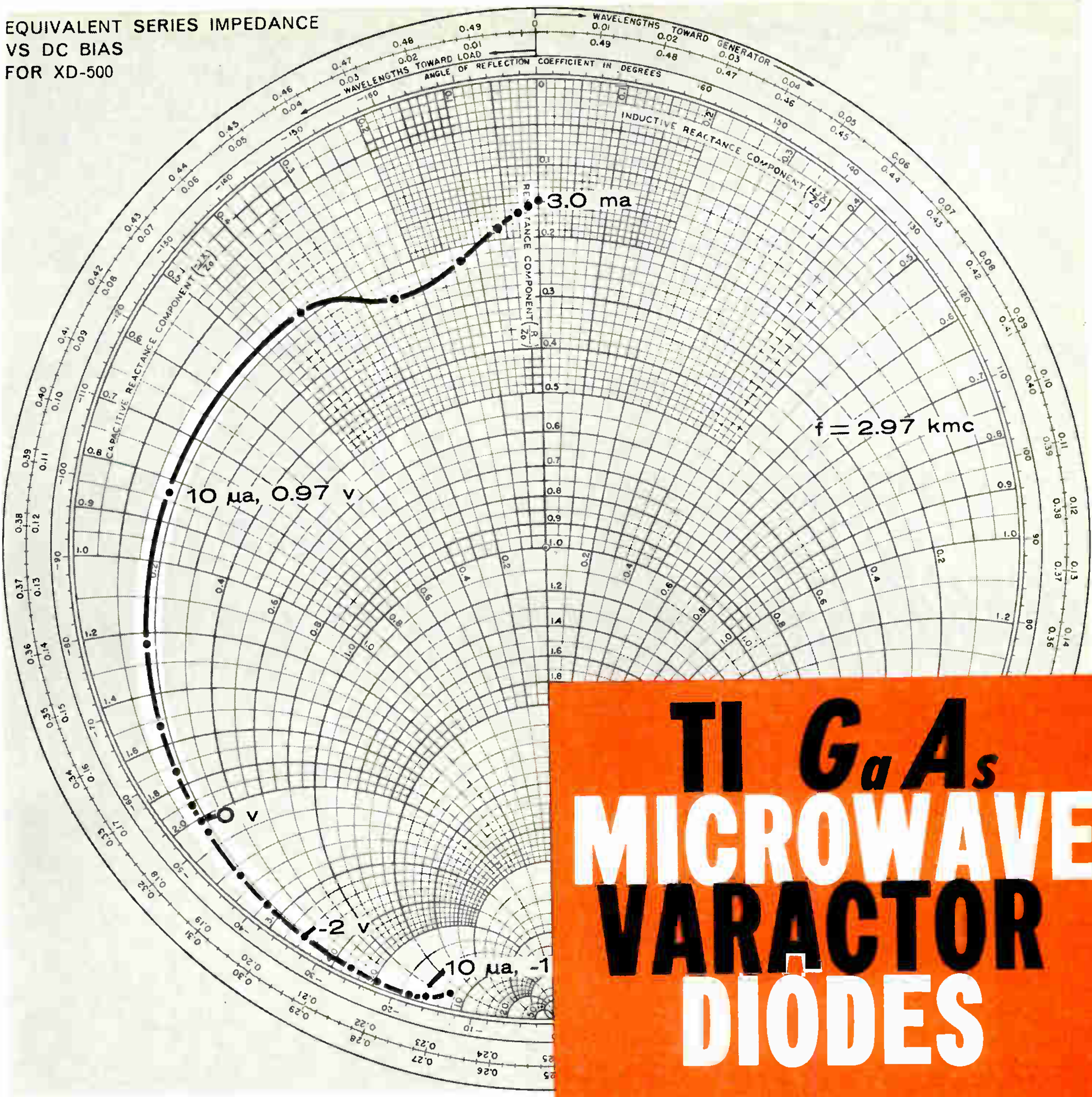
High purity silicon in polycrystalline rod form is above Grade I in quality. Rods are suitable for zone refining to the single crystal silicon used in power rectifiers, transistors, diodes, and other semiconductor devices. By vacuum zone refining, the polycrystalline rod can be converted to single crystal silicon having typical resistivity greater than 1000 ohm-cm, minority carrier lifetime greater than 400 μsec. Available in various



diameters up to 1 in. and lengths to $17\frac{1}{2}$ in., the rods are characterized by a high degree of purity and maximum uniformity to facilitate zone refining. Dow Corning Corp., Midland, Mich.

Circle 252 on Inquiry Card

EQUIVALENT SERIES IMPEDANCE
VS DC BIAS
FOR XD-500



TI G_aA_s MICROWAVE VARACTOR DIODES

Minimum cutoff frequency of 144 kmc at –2 v

DESIGN NOW with the new TI XD-500 series diffused gallium arsenide mesa varactor diodes. Obtain guaranteed high Q/high frequency performance at extremely low noise levels in your parametric amplifiers, harmonic generators, microwave switches, and sub-harmonic oscillators.

By eliminating whisker inductance, Texas Instruments can now provide you with varactors having the lowest series inductance in the industry, typ 0.7 mμh. Packaged in a double-ended beryllium oxide microwave cartridge, the XD-500 series microwave varactors feature matched temperature coefficients for wide operating temperature range. All TI microwave varactors are tested for diode action in liquid nitrogen before being shipped to designers of missile/space vehicles, communications networks, radar sets, telemetry systems, and other microwave applications.

Contact your nearest TI technical sales representative for complete specifications and price information, or your local authorized TI distributor.

ELECTRICAL CHARACTERISTICS AT 25°C AMBIENT

SYMBOL	PARAMETER	TEST CONDITIONS	XD-500 MIN	XD-500 MAX	XD-501 MIN	XD-501 MAX	XD-502 MIN	XD-502 MAX	XD-503 MIN	XD-503 MAX	UNIT
BV_R	Reverse Breakdown Voltage	$I_R = 10μa$	6		6		6		6		v
C	Total Capacitance	f = 1 mc, $V_R = 0v$	0.5	1.4	0.5	1.4	0.5	1.4	0.5	1.4	μμf
Q	Quality Factor	f = 3 kmc, $V_R = 2v$	20		27		36		48		—
f_{co}	Cutoff Frequency	$V_R = 2v$	60		81		108		144		kmc
f_{co}	Typ Cutoff Frequency	Typ $BV_R = 10v$	130		175		215		310		kmc

SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS INSTRUMENTS
LIMITED
DALLAS ROAD · BEDFORD ENGLAND

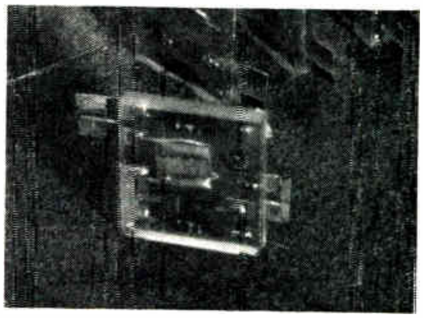
INCORPORATED
13500 NORTH CENTRAL EXPRESSWAY · DALLAS TEXAS

Circle 120 on Inquiry Card

New Products

SHIFT REGISTER ELEMENTS

Magnetic shift register elements, can operate at low power levels, and provide dense packaging of components. Each wafer-like element stores a single binary bit of information, and can be assembled in modules with up to 10 elements/in. Electrical



design of the serial driven, gated transfer element permits operation at an information rate of 100 KC—a peak shift pulse power of 0.1 w. Shifting function is accomplished with a single turn on each magnetic core, reducing connections by 33%, and increasing overall reliability. Each has a single hole molded in the wafer for linking toroidal magnetic cores with a single drive or shift wire. General Electric Co., Heavy Military Electronics Dept., Bldg. No. 3, Court St. Plant, Syracuse, N. Y.

Circle 253 on Inquiry Card

MULTIMETER

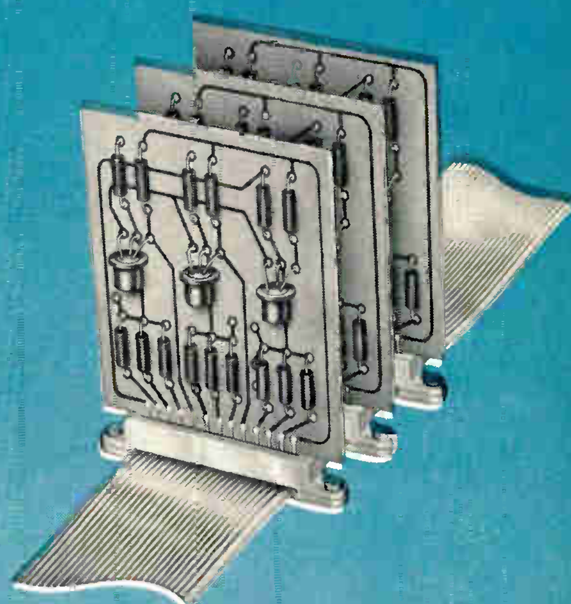
Multi-function current, resistance and voltage meter. Current range is 10^{-9} to 10 a ±2% dc and ±3% ac. Resistance range is 10 ohms to 10 megohms center scale, 5% accuracy. Ac voltages can be measured from 1 mv to 1 kv ±3% over the 20 CPS to 1 MC range, dc 1 mv to 1 kv ±2%. A function changing mechanism shows only the range in use. Two calibrating output voltages are available, 1 vdc and 1 vac RMS: square wave

controlled by a zener reference circuit to an accuracy of 1%. A 1 MC dbm scale is provided for audio measurements. Input impedance is 10 megohms. Smith-Florence, Inc., 4228 23rd Ave. W., Seattle 99, Wash.

Circle 254 on Inquiry Card

POS-E-KON™

the only connectors designed expressly for FLAT CONDUCTOR CABLE



For military and other precision applications, basic connector is custom-adapted for any installation. Interconnect or terminate flat multi-conductor cable or flexible printed circuitry with these completely dependable, easily installed fittings. Designed to your requirements, the Pos-E-Kon Line is as versatile and extensive as your needs. Many standard items to choose from.

PATENTS PENDING

WRITE TO:

THE THOMAS & BETTS CO.
INCORPORATED

POS-E-KON DIVISION

ELIZABETH, NEW JERSEY

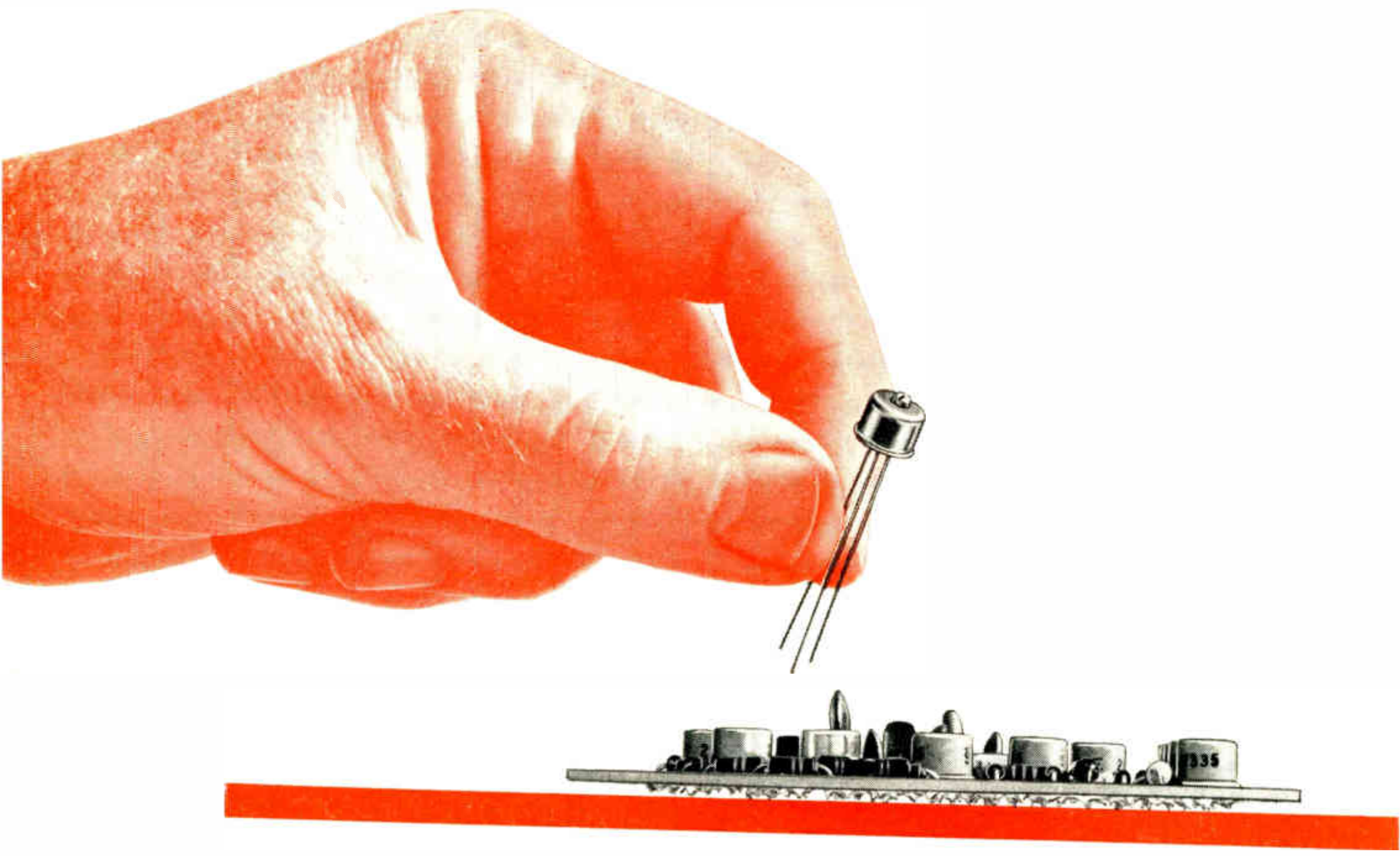
IN CANADA, THOMAS & BETTS LTD. MONTREAL

T&B ENGINEERED

ALL T&B PRODUCTS ARE AVAILABLE THROUGH THE LOCAL T&B DISTRIBUTOR

Circle 123 on Inquiry Card

No, it's not a transistor...



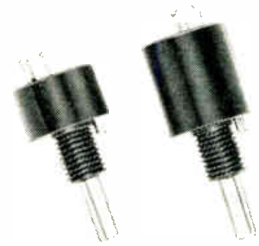
... it's the new Spectrol ultraminiature trimmer ... the smallest trimming potentiometer on the market! Measuring 1/3" in diameter, weighing only 1 gram, and designed specifically for transistor circuits, the Spectrol Model 80 is a remarkable breakthrough in component technology.

Design engineers can now shrink printed circuit packages in all three dimensions. The single turn adjustment is from the top, rather than the side. It is ideal for printed circuit applications. Sealed construction allows complete package encapsulation.

THE MODEL 80 is approximately one-quarter the size of ordinary trimmers, yet it offers greater resolution and resettability because the resistance element is nearly twice as long. These trimmers meet all applicable military and commercial specifications including the most severe humidity cycling and immersion tests.

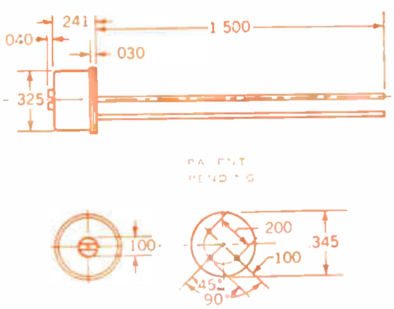
AND TWO NEW MINIATURE POTENTIOMETERS, TOO!

Sturdy construction provides reliable operation at a modest price. Only one-half inch in diameter, the new bantam weight Models 140 and 150 rotary potentiometers are well suited to trimming, control and servo applications where space and environmental conditions are critical. Standard linearity is ±1.0% with ±0.5% available on special order. Servo mount ball bearing type units have standard linearity of ±0.5%. Slotted shafts are standard on all models.



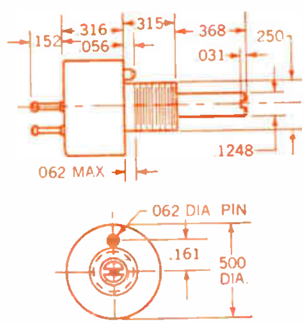
SPECIFICATIONS

MODEL 80



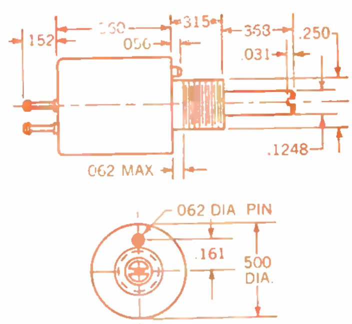
DIAMETER: 0.345″
STANDARD RESISTANCES (ohms): 50, 100, 200, 500, 1K, 2K, 5K, 10K
RESISTANCE TOLERANCE: ±5%
NO. TURNS: ONE
POWER RATING: 1 watt at 70°C
LINEARITY: ±1.0%
NOISE: 100Ω ENR per NAS-710
SHOCK: 50 G
VIBRATION: 30 G to 2,000 CPS
HUMIDITY: MIL-E-5272C, Proced. I (10 days, cycling) and MIL-STD-202A, Method 104, Condition A (immersion in hot water)
SALT SPRAY: MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE: 1000 hours
WEIGHT: 1 Gram
PRICE (1-9 units): $6.00 each

MODEL 140



DIAMETER: 0.500″
STANDARD RESISTANCES (ohms): 50, 100, 200, 500, 1K, 2K, 5K, 10K
RESISTANCE TOLERANCE: ±5%
NO. TURNS: ONE
POWER RATING: 2 watts at 70°C
LINEARITY: ±1.0% standard, ±0.5% special (±0.5% standard on servo mount)
NOISE: 100Ω ENR per NAS-710
SHOCK: 50 G
VIBRATION: 30 G to 2,000 CPS
HUMIDITY: MIL-E-5272C, Proced. I (10 days, cycling)
SALT SPRAY: MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE: 1000 hours
WEIGHT: 0.1 oz.
PRICE (1-9 units): $10.00 each

MODEL 150



DIAMETER: 0.500″
STANDARD RESISTANCES (ohms): 20K, 50K, 70K (50 ohms to 20K also available)
RESISTANCE TOLERANCE: ±5%
NO. TURNS: ONE
POWER RATING: 2 watts at 70°C
LINEARITY: ±1.0% standard, ±0.5% special (±0.5% standard on servo mount)
NOISE: 100Ω ENR per NAS-710
SHOCK: 50 G
VIBRATION: 30 G to 2,000 CPS
HUMIDITY: MIL-E-5272C, Proced. I (10 days, cycling)
SALT SPRAY: MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE: 1000 hours
WEIGHT: 0.15 oz.
PRICE (1-9 units): $12.00 each

The Spectrol name, your assurance of quality. New Spectrol trimmers and miniature potentiometers are produced to the same exacting standards of quality and reliability engineered into the entire Spectrol potentiometer line . . . the largest selection in the industry.

Available now for immediate delivery. Standard models of Spectrol trimmers and miniature potentiometers, as well as other standard precision potentiometers, are available from your nearby Spectrol distributor. For complete technical information, contact your Spectrol engineering representative or write directly to the factory. Please address Dept. 44

SPECTROL ELECTRONICS CORPORATION

26

1704 South Del Mar Avenue • San Gabriel, California
Phone: ATlantic 7-9761

Manufacturers of precision and miniature wirewound potentiometers, trimmers, solid state power supplies, servo mechanisms and other precision electronic components

U. S. Navy pilot, J. H. Bahlman describes reaction during simulated "flame out" at 15,000 ft. (L to R) Rear Adm. R. Bennett; H. Lehne (Sylvania); Col. H. V. Parris (Aerospace Medical Labs); and Capt. E. C. Callahan, Comm. Officer and Dir. of Training Cntr., (U. S. N), Port Washington, N. Y.

Digital Trainer Simulates Flight

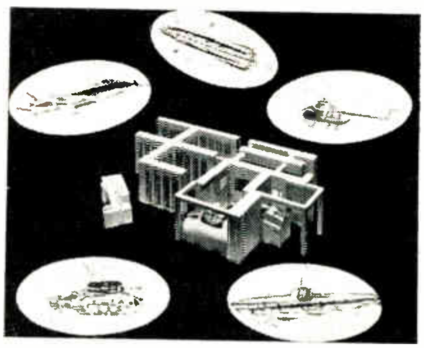
A new digital flight trainer and research device called UDOFTT (Universal Digital Operational Flight Trainer, Tool) has been developed by Sylvania Electric Products, Inc., 730 3rd Ave., N. Y. Built under sponsorship of the Air Force and Navy, it is being considered for simulating hypersonic and orbital flight. A simulation of the Dyna Soar (space vehicle) is being considered.

Mathematical representations of the characteristics of the vehicle to be simulated are transferred through punched cards into the computer's magnetic core memories. Manipulating the controls provides new information to the computer which then computes the equations of motion and activates the instruments in the cockpit to correspond to the plane's "actions".

UDOFTT, which operates at a rate of more than 200,000 operations per second, is the result of intensive research by the Navy and Air Force to develop a flexible computer system with "real-time" capability—the ability to respond instantaneously to the commands of a student pilot within the cockpit or an instructor at an external control panel.

Future uses for the system will include research in engineering techniques, mathematical techniques, and "human engineering" or psychology—such as pilot reaction in coping with abnormal circumstances.

High speed digital electronic processing techniques will be used by UDOFTT for evaluation testing of human reactions to space travel.

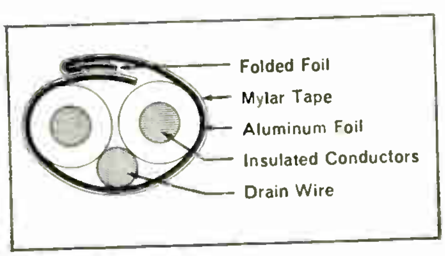


Both shielded cables have the same number of twisted pairs with identical AWG. But . . . the cable with exclusive Belden BELDFOIL is smaller in diameter.

What does this mean to you? It means that when you specify BELDFOIL, you are really buying extra space—extra conduit space, extra raceway space, extra console and rack space.

A new development by Belden—BELDFOIL shielding is 100% effective. It is a major development in quiet cables. BELDFOIL eliminates crosstalk and is superior for stationary or limited flexing at both audio and radio frequencies.

BELDFOIL shielding is a lamination of aluminum foil with Mylar which provides a high dielectric strength insulation that is lighter in weight, requires less space, and is usually lower in cost. For multiple-paired cables, with each pair separately shielded, the Mylar is applied *outside* with an *inward* folded edge.** This gives 100% isolation between shields and adjacent pairs.



For complete specifications, ask your Belden electronics jobber.

*Belden Trademark
Reg. U. S. Pat. Off.
**Patent applied for

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
CHICAGO

power supply cords • cord sets and portable cordage • electric
household cords • magnet wire • lead wire • automotive wi
and cable • aircraft wires • welding cable

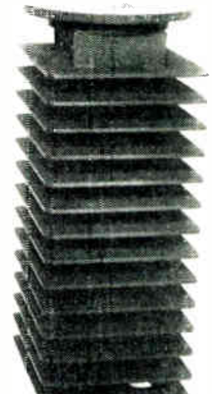
8-5-0

Please write direct to the above advertiser

New Products

DUMMY LOAD

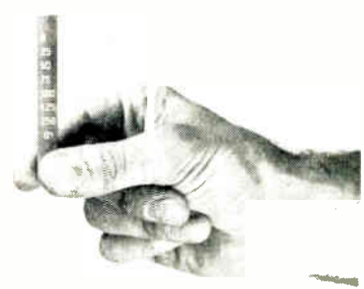
New 11 lb. dummy dissipates 4.5 kw ave. power and 3200 kw peak power without liquid cooling. For use with S-band radar, No. 89075 measures 14 x 4⅞ x 6⅜ in. It is compatible with the RG-75U waveguide, and can be used with any radar operating from 2600 to 3950 MC to dissipate energy when the radar is not transmitting. Use of inert, high-temperature silicon carbide as the absorptive element minimizes water absorption, increases stability, and lengthens trouble-free life. Liquid-cooled versions also available. Smaller and lighter models of dummy loads for lower power were previously introduced. Airtron-Pacific, 5873 Rodeo Rd., Los Angeles 16, Calif.



Circle 255 on Inquiry Card

ACCELERATION INDICATOR

The AI-1 Acceleration Indicator is a light weight direct indicating acceleration sensor. It is for use wherever a record of maximum shock or acceleration received is desired. Some uses are aircraft landing gear, shock testing of equipment and shipping of delicate instruments or other equipment. Specs: Range, 0-150 g; Accuracy, 5% of full scale; Size, ⅜ in. diam. by 2⅞ in. long; Weight, 0.3 oz; Mounting, cable clamp, fuse clip or bracket; Natural Frequency, 30 cps (Nom). Eastern Technical Associates, Inc., Main St., North Acton, Mass.



Circle 256 on Inquiry Card

FREEZE IT!

INHERENT STABILITY
Assured in a DALOHM MC Resistor

The freezing temperature of coils is mild by comparison with the temperature extremes at which Dalohm resistors can operate reliably.

Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision resistors retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

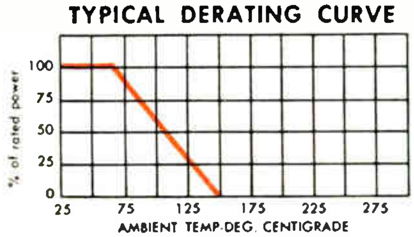
For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

DEPOSITED CARBON • MOLDED • MINIATURE
DALOHM TYPE MC RESISTORS

Made of pure crystalline carbon film with no binder or filler, these resistors offer excellent high frequency characteristics.

A molded housing provides complete electrical insulation and mechanical protection.

TYPICAL DERATING CURVE



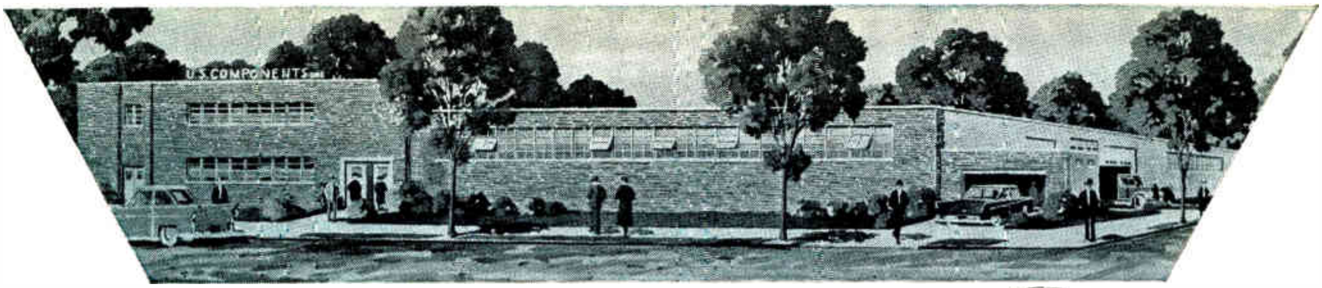
- **Rated at** 2, 1, ½, ¼ and ⅛ watts
- **Resistance range** from 1 ohm to 50 megohms, depending on type
- **Standard tolerance** ± 1%
- **Temperature coefficient** 500 P.P.M. maximum
- **Smallest in size,** ranging from 9/64″ x 13/32″ to ⅜″ x 2¼″
- **Full load operation** to 70° C., derating to 0 at 150° C.
- High heat dissipation
- Meet applicable paragraphs of MIL-R-10509B.

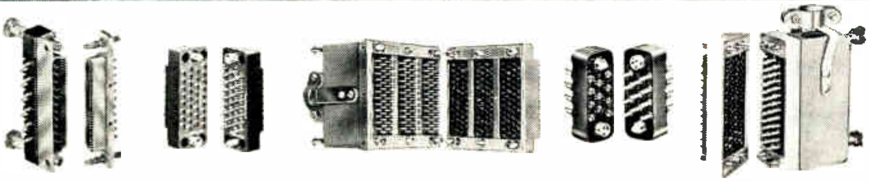
Write for Bulletin R-35, with handy cross-reference file card.

SPECIAL PROBLEMS?

You can depend on Dalohm, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

DALE ELECTRONICS, Inc.
FORMERLY DALE PRODUCTS, Inc.
1304 28th Ave., Columbus, Nebr.
A DIVISION OF
Hathaway INSTRUMENTS, INC.





The ever-increasing growth of the Electronics Industry has meant greater demands on Engineering talent . . . on testing . . . R & D . . . systems . . . quality control. To keep pace with the ever-constant need for more reliable electronic components, USC has added to its facilities—thus increasing, even more, its capacity for the design and production of electronic connectors of optimum dependability. In addition, expanded manufacturing areas will further insure strict adherence to tight "due dates". NOW, MORE THAN EVER, USC PROVIDES THE RAPID, RELIABLE ANSWER TO ANY COMPLEX CONNECTOR PROBLEM

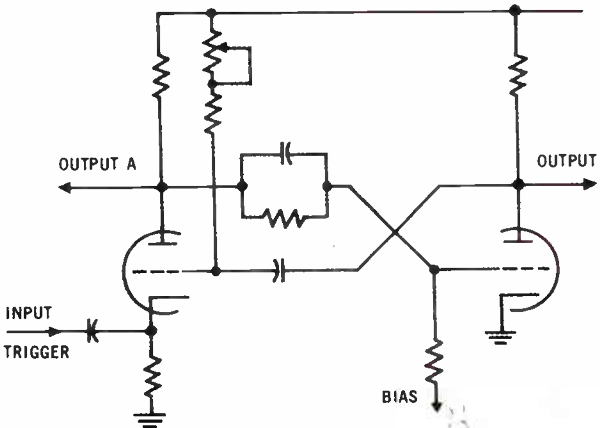
USC

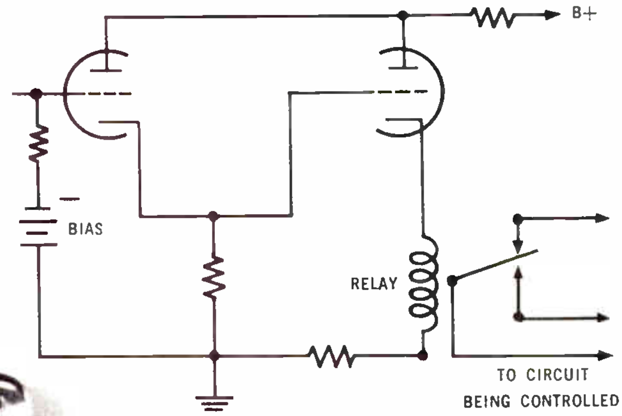
U. S. COMPONENTS, INC. 1320 Zerega Ave., New York 62, N. Y.

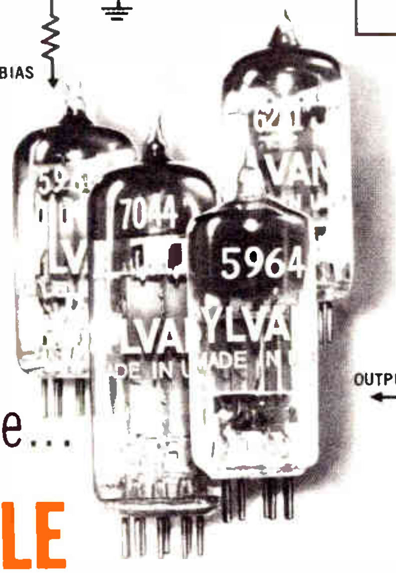
ELECTRON TUBE NEWS

...from SYLVANIA

specifically for "on-off" and control applications...

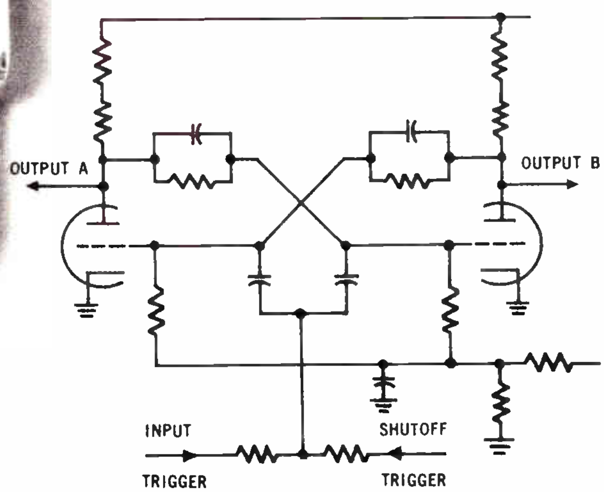






SYLVANIA GOLD BRAND TUBES feature...

- **REMARKABLE RELIABILITY**
- **EXCEPTIONAL STABILITY**
- **LONG LIFE EXPECTANCY**
- **HIGH UNIFORMITY**



More than a decade ago, Sylvania developed the first vacuum tube specifically for computer-type applications . . . the reliable 7AK7. Today, there is a large family of field-proven Sylvania types specifically designed for "on-off" control applications, including eleven premium-quality *Gold Brand Tube* types.

Sylvania *Gold Brand Tubes* for computer applications exhibit highly stable electrical characteristics even under long periods of operation at cutoff conditions — offer high uniformity of characteristics from tube to tube — feature long life and reliability. This is the direct result of stringent material and process controls to assure minimal cathode interface formation, low cathode sublimation, improved plate dissipation capabilities and low interelement leakage.

SYLVANIA MEDIUM-MU TWIN TRIODES
Absolute Maximum Ratings

Sylvania Type	Description	Plate Dissipation (Watts)	DC Cathode Current (mA) (Each Section)
GB-5844	7-pin, T-5½ miniature, relatively high zero-bias plate current and sharp cutoff.	0.50	9.0
GB-5963[1]	9-pin, T-6½ miniature, mid-tapped heater for 6.3V or 12.6V operation. Bulb temperature capability of 120°C. Designed for multivibrator applications.	2.5	20
GB-5964	7-pin, T-5½ miniature. Utilizes "flat" cathode which enables use of "flat" grid wires for exceptional accuracy in grid alignment. Large plate area for excellent heat dissipation. Max. bulb temp. rating is 150°C.	1.5	15
GB-5965[1]	9-pin, T-6½ miniature, mid-tapped heater for 6.3V or 12.6V operation. Offers high zero-bias plate current and sharp cutoff characteristic.	2.2	15
GB-6211[1]	9-pin, T-6½ miniature, mid-tapped heater for 6.3V or 12.6V operation. Especially designed for frequency-divider circuits.	1.0	14
GB-6350[1]	9-pin, T-6½ miniature, offers high zero-bias plate current and sharp cutoff. High perveance type with g_m per unit of 4600 μmhos. Utilizes "flat" cathode, "flat" grid wires, large plate area. Max. bulb temp. rating is 120°C.	3.5	25
GB-7044	9-pin, T-6½ miniature, features g_m per unit of 10,000 μmhos. Uses "flat" cathode, "flat" grid design. Large plate area has "wings" for improved heat dissipation capabilities. Max. bulb temp. rating is 160°C. Designed for cathode-follower applications.	4.5	50

[1] Separate terminals for each cathode

In addition to 100% tests for ac and dc shorts, samples are life-tested for 1000 hours of "on-off" operation and checked at intervals of 40, 200, 500 and 750 hours. Rigid performance requirements are placed on such end points as cathode interface impedance, plate current stability, cutoff stability, heater-cathode leakage, interelement insulation, continuity, grid current. Heater cycling tests are performed for a minimum of 2000 cycles—one minute "on," four minutes "off."

Ask your Sylvania Sales Engineer for full information about Gold Brand Tubes for "on-off," control and other critical industrial-military applications.

SYLVANIA DUAL-CONTROL* MULTIGRID TYPES
Absolute Maximum Ratings

Sylvania Type	Description	Plate Dissipation (Watts)	DC Cathode Current (mA)
GB-7AK7	8-pin, lock-in base, T-9 pentode. Features high zero-bias and sharp cutoff. Designed for gating or driving applications.	8.5	—
GB-5915A	7-pin, T-5½ heptode. Designed for gated amplifier service.	1.0	20
GB-6145	8-pin, lock-in base, T-9 pentode. Features g_m of 9700 μmhos.	10.0	—
GB-6888	8-pin, T-9 pentode. Max. bulb temp. rating is 130°C. Designed for pulse amplifier, core driver and coincidence circuits.	8.0	80

*Grids #1 and #3 can be used as independent control electrodes.

NEW! SYLVANIA-7738, -7803

...feature high electrical stability, high reliability in short continuous service under difficult environmental conditions.

Originally designed for service in expendable sonobuoy equipment dropped by aircraft, these two types are typical of Sylvania capabilities in the design, development and manufacture of tubes for specialized industrial-military applications. If your design requirements demand specialized industrial-military type tubes, draw on the creative engineering and production capabilities of Sylvania. Your Sylvania Sales Engineer is ready to work with you.

DESIGN MAX. RATINGS Continuous Class C Svc at 175 MC	7738	7803	
Plate Voltage	330	200	Volts
Plate Dissipation	5.0	3.5*	Watts
Plate Input	7.5	5.5*	Watts
Cathode Current	40	30*	mAdc
Grid Current	10	2.5*	mAdc
Negative Grid Voltage	50	75	Volts
Grid Circuit Resistance			
Fixed Bias	0.1	0.1	Megohm
Cathode Bias	0.5	0.5	Megohm

*Each section

SYLVANIA-7738... a miniature high-mu triode, 7738 utilizes silver-plated pins and high grid-wire T.P.I. for excellent VHF performance. Lead inductance is optimized by the use of shielding. It is capable of withstanding 450g shock.

SYLVANIA-7803
... a miniature double-triode, it offers high g_m of 12,500 μmhos per unit and low capacitance. 7803 uses the Sylvania-developed, rugged strap frame grid—enabling use of fine grid wire, high T.P.I.

For further information, contact the Sylvania Field Office nearest you. Or for data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. K, 1100 Main Street, Buffalo 9, N.Y.

SYLVANIA

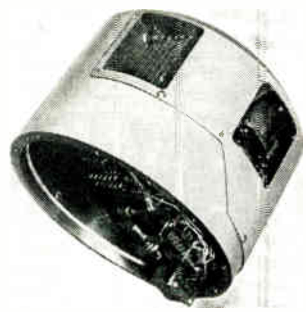
Subsidiary of GENERAL TELEPHONE & ELECTRONICS

N-8637-3

New Products

REFRIGERATION SYSTEM

The U-522477 Mechanical Refrigeration System consists of an aluminum plate type condenser and evaporator, semi-hermetically sealed 400 cycle compressor, blower, and associated controls and chassis. The overall envelope dimensions are 14 in.

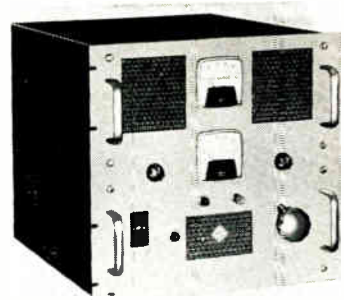


dia. x 10 in. long, with half the dia. occupied by the Mechanical Refrigeration unit. Capacity is 275 w at a max. amb. of 149°F. System is used with a radar system and cools the Vidicon tube of a CCTV system which shows on a television screen, visually the object on a radar screen. The Mechanical Refrigeration System cools and maintains the Vidicon tube and associated electronic components of the closed television circuit at a safe operating temp. United Aircraft Products, Inc., 1116 Bolander Ave., Dayton 8, Ohio.

Circle 265 on Inquiry Card

POWER SUPPLY

The Model HC40-50 is rated at 0-40 vdc, 0-50 amperes continuous duty and is continuously variable over the full range. Regulation is 10 mv for ±10% variations. Riple is less than 2 mv RMS. Overshoot does not exceed 1% of voltage setting and recovery is less than 500 μsec for full current step changes. Output voltage does not rise above the selected setting when the line is interrupted. Automatic overload circuit cuts off supply



when output current exceeds a preset point selected by variable front panel control. Other features: remote load sensing, and plug-in modules. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J.

Circle 266 on Inquiry Card

International Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering journals

ANTENNAS, PROPAGATION

Statistical Distribution of the Degree of Fading in Radio Relay Line Intervals, A. I. Kalinin. "Radiotek" No. 5. 1960. 7 pp. Expressions for integral curves are given for the distribution of the degree of fading in radio relay line intervals, according to normal laws for the values of the effective vertical gradient of the dielectric penetration in air. Limiting expressions for the distribution curves are also given. Examples are presented of integral curves for the degree of fading distribution. (U.S.S.R.)

Transformer Distance Transmission Based on Two-phase Contactless Induction Potentiometers, Yu. M. Pul'er. "Avto i Tel." July 1960. 9 pp. Construction circuit, operation and basic principles of the theory of angular distance transmission realized with the help of contactless two-phase induction linear potentiometers are considered. (U.S.S.R.)

The Power Gain of Multi-Tiered VHF Transmitting Aerials, P. Knight and G. D. Monteath. "BBC Mono." 31 July 1960. 34 pp. (England.)

Some Peculiarities of Audio Wave Propagation Over Areas Covered with Vegetation, F. J. Meister. "Freq." June 1960. 7 pp. Results are reported as gained on grain fields by means of a rotating quasi-spherical radiator. (Germany.)

A Directional Antenna with a Periodic Bent Feed, G. v. Trentini. "Freq." July 1960. 5 pp. The author proposes and investigates by experiment directional antennas made of a conductor that is bent periodically in a plane and arranged before a reflector curtain with a small separation and a parallel of slightly inclined orientation. (Germany.)

CIRCUITS

Transistors in Audio- and Carrier-Frequency Amplifiers, K. Lamont. "El. Tech." Aug. 1960. 8 pp. This paper discusses the characteristics of common-emitter transistor amplifiers in relation to the specific requirements of communication systems. (England.)

Continuously Variable Bandpass in the Audio Range, W. Ohme. "Freq." May 1960. 5 pp. It is shown, how and under which conditions a band-pass filter can be constructed whose bandwidth and lower cut-off frequency can be varied continuously throughout the audio range. (Germany.)

Resonant Circuit Amplifier, S. John. "El. Rund." Sept. 1960. 3 pp. (Germany.)

Generation of High Voltage Pulses, K. D. Moser. "El. Rund." Sept. 1960. 5 pp. (Germany.)

The Insertion Characteristics of Cascaded Circuits, W. Herzog. "Nach. Z." Sept. 1960. 4 pp. A number n of equal four-terminal networks is combined by means of bridge circuits to one four-terminal network. The impedance matrix of the resulting four-terminal network is determined. (Germany.)

Calculation of Electric Circuits with Rectangular-Hysteresis-Loop Core, V. F. Beljavskii, Yu. M. Shamaev. "Avto i Tel." Aug. 1960. 10 pp. (U.S.S.R.)

Approximate Calculation of Transient Processes in Thermistor Circuit, N. P. Udalov. "Avto i Tel." Sept. 1960. 3 pp. (U.S.S.R.)

Millimicrosecond Blocking Oscillator, U. P. Melnikoff, C. Y. Schatz. "Radiotek" 15, No. 6. 1960. 9 pp. The basic distinction of a millimicrosecond blocking oscillator is that the rise time of the pulse is of the same order as the time duration of the peak. It is, therefore, no longer valid to assume that the fast processes responsible for the rising part of the pulse are small compared to the parameters affecting the rest of the pulse, and thus can be neglected. The time duration of all sections of the pulse depend simultaneously on all circuit parameters. This article analyzes the processes which take place in such a blocking oscillator and presents methods for its design and calculations. (U.S.S.R.)

Use of Feedback to Compensate Frequency Response of Wide Band Amplifiers, L. B. Ustinova, Z. N. Luzianina. "Radiotek" 15, No. 6. 1960. 12 pp. In the article, the author presents a design procedure for frequency compensation of two-stage amplifiers by applying feedback in the system. Design parameters are obtained by manipulation of the cubic gain expression. The parameters are analyzed for high and mid-frequency ranges and tabulated. Numerical examples are illustrated. The author also compares qualitatively feedback compensation with other methods of frequency compenation. (U.S.S.R.)

Analytic and Graphic Methods for Low-Frequency Semi-Conductor Triode Amplifier Design. N. S. Nikolayenko. "Radiotek" 15, No. 7. 1960. 9 pp. A method for designing low-frequency semi-conductor triode amplifiers is presented and discussed in this article. Compared to amplifier design methods based on triode parameters, this method offers several advantages. It is characterized by attractive appearance, applicability to design of amplifiers operating in various manners, and good precision and simplicity of design. (U.S.S.R.)

An Investigation of Transient Processes in Class B Amplifiers, Influenced by the Reactive Characteristics of the Power Supply Impedance, A. T. Balanoff. "Radiotek" 15, No. 7. 1960. 8 pp. The reactive characteristics of the power supply's impedance exert a certain influence on the periodically repeating transient processes in class B amplifiers. These processes have been analyzed theoretically and experimentally. The results of the analyses are presented in this article. It is shown in what manner negative feedback affects the amplitude of non-linear distortions caused by the transient processes. Criteria are given for the design of the output capacitors in the filter-rectifier and the design of blocking capacitors in the self-bias circuit. (U.S.S.R.)

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann. de Radio. Annales de Radioelectricite
Bull. Fr. El Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Ubertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad. i Elek. Radiotekhnika i Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR.

- Photocopies of all foreign articles are available at 75 cents per page, remitted with order. Unless otherwise indicated, articles appear in language native to country of origin.
- A reprint of this section, "International Electronic Sources" is available without charge.

Requests for the above should be sent, on company letterhead, to:

Electronic Sources Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts.
Philadelphia 39, Pa.

Selection of Optimum Statistical Parameters of a Trigger Circuit, B. N. Fayzulaev, V. I. Yanushkevitch. "Radiotek" 15, No. 7. 1960. 7 pp. This article discusses and analyzes a typical pentode trigger circuit. It is of primary interest to establish the tolerances of the statistical parameters for a given speed of operation. Also determined is the maximum speed of operation with given tolerances. Optimum relationships of statistical parameters are determined and recommendations are offered to select tubes for the trigger. (U.S. S.R.)

A Process of Frequency Determination at the Output of an Ideal Narrow-band Filter During Phase-Frequency Modulation, L. I. Yaroslavsky, B. I. Iachinson. "Radiotek" 15, No. 7, 1960. 7 pp. This article's objective is to study transient processes — specifically, the processes involved in establishing the instantaneous frequency and the instantaneous amplitude at the output of a narrow-band system, when the input is frequency-phase modulated; i.e. when its frequency and phase is changed by discrete jumps. Pure frequency modulations and pure phase modulations are analyzed as separate particlar cases of phase-frequency modulations. (U.S.S.R.)

Synchronization Stability in an Oscillator Influenced by Modulated Oscillation, Y. I. Samoylenko. "Radiotek" 15, No. 7, 1960. 5 pp. Conditions are obtained for the wave phase stability of the oscillator, synchronized with a small outside signal, amplitude or frequency modulated. An analysis is made of the extent to which maximum allowable detuning depends on the system parameters and parameters of the active waves, without destroying the synchronization stability. (U.S.S.R.)

Improvement of the Phase-Frequency Response of Selective Amplifiers with Feedback, at Great Frequency Separations, V. L. Zmudikoff. "Radiotek" 15, No. 8, 1960. 4 pp. At frequencies far removed from the quasiresonant frequency, the gain of selective amplifiers with frequency sensitive feedback approaches unity, and not zero, as is the case with resonant amplifiers. This results in a decreased selectivity and decreased signal to noise ratio in feedback amplifiers. Two methods are offered to remove this residual gain by adding subtractive networks. (U.S.S.R.)

New Theory on Self-Contained Four-Pole Networks and Their Application in Amplifiers with Distributed Gain, E. V. Zelyach. "Radiotek" 15, No. 8, 1960. 12 pp. New parameters are introduced for self-contained four-pole networks. These parameters are defined as characteristic voltages and currents. A theory is developed for cascaded connection of matched self-contained four-pole networks of similar structure. Formulae are given to calculate voltages and currents at the terminals of the four-pole for various loads. The theory is applied in the analysis of amplifiers with distributed gain. Formulae are obtained for the amplifier gain, taking into consideration mismatching of both ends of grid and plate circuits. (U.S.S.R.)

COMMUNICATIONS

A Method of Reducing the Image and Combination Interference in a Superheterodyne Receiver, B. N. Mityasheff. "Radiotek" 15, No. 7, 1960. 2 pp. A brief decription of a new method to eliminate image and combination interferences produced in superheterodyne reception. This method permits more advanced and perfected design of receivers. Results of an experiment are included. (U.S.S.R.)

Carrying Capacity of Symmetrical Channels with Carying Parameters in Unlimited Frequency Bands, L. M. Finek. "Radiotek" 15, No. 7, 1960. 8 pp. According to Shanon, the definition of the carrying capacity of a channel is the maximum amount of information which can be transmitted through this channel when coded properly and with the least possible error probability. In this article, the carrying capacity is calculated for communication channels with varying parameters. The prescribed signal power relation to white noise spectral density is maintained. The operation takes place in any frequency bandwidth and the coding method is a discrete symmetrical type. (U.S.S.R.)

Concerning Noise-Stability of Width and Time-Pulse Telemetering with Strong Fluctuation Noises, N. V. Pozin. "Avto i Tel." Sept. 1960. 3 pp. (U.S.S.R.)

Ideal Complex Signal Identification System, L. F. Borodin. "Radiotek" 15, No. 8, 1960. 11 pp. An identification system is considered, which will provide maximum probability for a correct reception of correction code combinations for a given receiver. It is shown that the use of such ideal systems and constantly spaced codes permits transmission through channels with prescribed accuracy. Error compensations is indicated using arithmetic operations. Results of a statistical experiment are presented for the purpose of comparing several reception methods with the ideal one. (U.S.S.R.)

Crosstalk in Multichannel FM Communication Systems, Arising in Scattered UHF Propagation, A. V. Prosin. "Radiotek" 15, No. 8, 1960. 10 pp. A method is developed to calculate cross distortions in multichannel systems with FM and frequency multiplexing. The source of these distortions is the multi-beam scattered propagation of ultra short waves. Formulae are obtained for the determination of cross-talk. The dependence of cross distortions on the length of the conduit is established, as are the antenna radiation patterns and several other characteristics. (U.S.S.R.)

Congestion in Automatic Telephone Exchanges, F. Capello. "Alta Freq." April 1960. 8 pp. A sampling method is analized, intended to determine the overall grade of service for an automatic telephone central office, by means of test calls put through the exchange with predetermined frequency and distribution during the most busy hours. (Italy.)

The Optimum Size of Cable Branching Ranges for Local Telephone Systems, H. Kremer. "Freq." May 1960. 6 pp. The calculation of the optimum size of cable branching ranges leads to cable distribution boxes with 150 to 250 main-cable pairs (total capacity about 400 to 600 pairs) in the ultimate stage of expansion. (Germany.)

A Character Reading Device for Typewritten Figures, W. Dietrich. "Nach. Z." July 1960. 4 pp. (Germany.)

High Speed Printer for 3000 Words/Min. "El Rund." July 1960. 3 pp. (Germany.)

Designing a Full-transistorized AM-FM Receiver, R. Wagner. "El. Rund." July 1960. 5 pp. (Germany.)

Magnacard—a Synthesis of Magnetic Tape and Punched Card. "El. Rund." July 1960. 2 pp. (Germany.)

The Transducer Loss of Earphone and Microphone Capsules, K. Braun. "Nach. Z." Aug. 1960. 6 pp. (Germany.)

A Transistorized PPM System for 60 Channels, H. M. Christiansen and M. Schlichte. "Nach. Z." Aug. 1960. 8 pp. (Germany.)

The Radio Conditions in the International Geophysical Year, B. Beckmann and A. Ochs. "Nach. Z." Sept. 1960. 5 pp. (Germany.)

Improvement of the Frequency Stability of a High Frequency Oscillator Frequency Modulated by Means of a Condenser Microphone, H. Maier. "Nach. Z." Sept. 1960. 5 pp. (Germany.)

Modern Problems in the Design of Master Control Systems, L. W. Germany. "Rundfunk." Aug. 1960. 8 pp. This paper surveys the factors governing the choice of a master control system, and describes various methods of switching and program control. (Germany.)

An Electronic Slave Clock Reading Directly in Seconds, Konrad Seiferth. "Rundfunk." Aug. 1960. 4 pp. Various problems of studio operations make the use of direct reading clocks necessary. This article describes an electronic slave clock which displays the time by means of three groups of numbers 15 mm high (hours-minutes-seconds) which are illuminated and easily readable. (Germany.)

Investigations on Some Constructional Materials for Telephone Exchanges as Far as Contact Materials Containing Silver and Palladium Are Affected, H. Lipke and W. Clement. "Nach. Z." Sept. 1960. 5 pp. (Germany.)

The Radio VF-Telegraphy System "Funk WT," a New Transistorized Telegraphy Transmission System with Channels of Different Bandwidth, Ernst A. Fuchs. "Nach. Z." Sept. 1960. 5 pp. (Germany.)

COMPONENTS

Exponential Transformers with Logarithmic Law of Transformation, A. L. Novikov. "Avto i Tel." July 1960. 11 pp. Exponential transformers with logarithmic law of transformation are analyzed. (U.S.S.R.)

Influence of Magnetization Irregularity on Core Static Characteristics, G. D. Kozlov. "Avto i Tel." July 1960. 16 pp. (U.S.S.R.)

Design and Calculation of Induction Clutches, M. S. Mirensky. "Avto i Tel." July 1960. 11 pp. An induction clutch which is more simple and more reliable than induction clutches described in literature before is considered. (U.S.S.R.)

Contactless Magnetic Time Relay, N. M. Tishchenko. "Avto i Tel." Aug. 1960. 12 pp. Time relays using inertia properties of magnetic amplifiers are considered. (U.S.S.R.)

Relays with Flat Protected Contacts, G. Bergstrasser. "Nach. Z." Aug. 1960. 4 pp. (Germany.)

Tantalum Capacitors with Sintered Anode and Solid Electrolyte, W. Mosebach. "El. Rund." Sept. 1960. 3 pp. (Germany.)

COMPUTERS

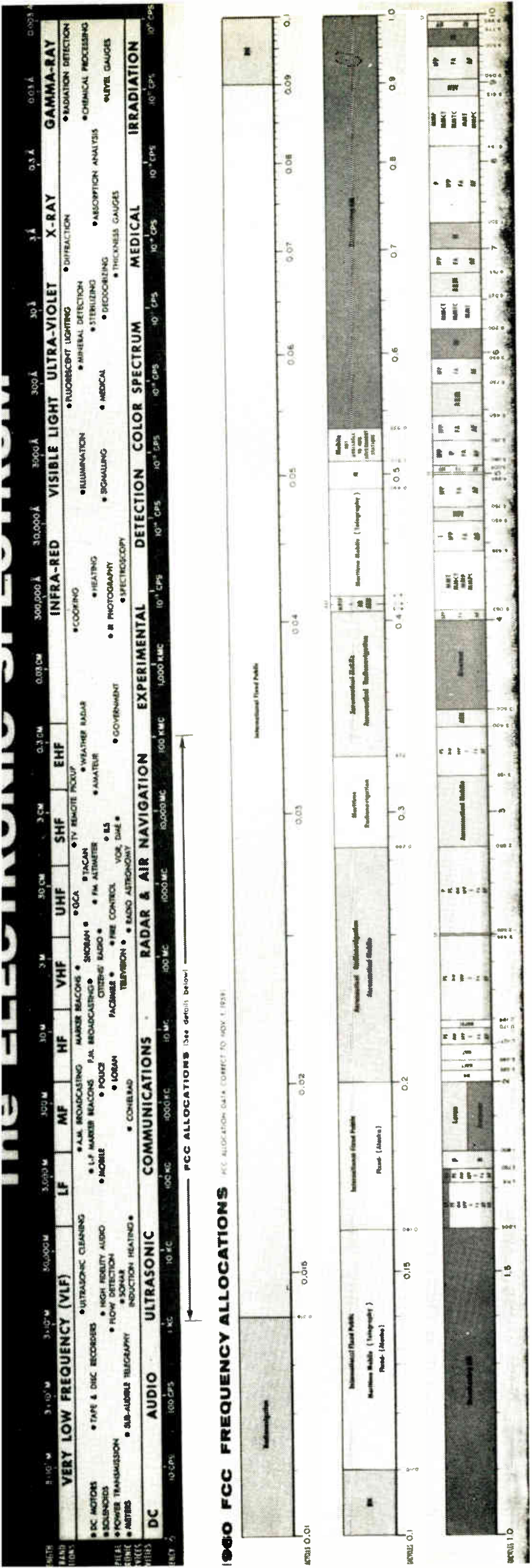
Digit Device Elements of Computation Based on Principle of Integrating Voltage Pulses, E. K. Yuferova. "Avto i Tel." Aug. 1960. 8 pp. (U.S.S.R.)

The Applications of Electronic Digital Computers in the Theory of Networks, H. Hartl. "Nach. Z." July 1960. 4 pp. (Germany.)

The Realization of Square Law Two-Terminal Network Characteristics Using Canonic Circuits without Transformers with the Aid of Program-controlled Computers, R. Unbehauen. "Nach. Z." July 1960. 6 pp. (Germany.)

The Application of Computers in the Chemical Industry, Th. Ankel. "rt." July 1960. 7 pp. (Germany.)

Shift Registers, Generating Maximum-Length Sequences, P. H. R. Scholefield. "El. Tech." Oct. 1960. 6 pp. In this article some examples are given of an improved logical arrangement which enables certain maximum-length shift-



Immediate Delivery!

ELECTRONIC INDUSTRIES'

Exclusive

1960 ELECTRONIC SPECTRUM CHART

ORDER YOURS TODAY

- *All latest revisions and up-dated specs*
- *30 x 22 inches in size*
- *Printed to show service and frequency area in six colors with—*
- *Expensive lacquer proof ink that will not run. Allows you to varnish or shellac chart to prolong its life.*
- *Orders filled and mailed same day.*
- *Suitable for framing and wall mount or,*
- *Under glass desk-top reference.*

Order Yours Today.
Over 5,000 copies already purchased!

Prices:

Individual copies mailed in tubes	$1.00 each
1 to 25 copies	1.00 per copy
26 to 100 copies	0.75 per copy
More than 100 copies	0.50 per copy

Please make remittances payable to Electronic Industries and mail to Reader Service Department, Electronic Industries, Chestnut & 56th Streets, Philadelphia 39, Pennsylvania.

register sequences to be generated with fewer circuit components than in earlier methods. (England.)

CONTROLS

Extremum Intermittent Systems with Random Noises, A. A. Pervozvansky. "Avto i Tel." July 1960. 6 pp. Dynamics of a class of optimum intermittent systems is analyzed. Drift of extremum state and high frequency noises are considered as random time functions. (U.S.S.R.)

Investigation of Periodic Behavior in Extremum Relay Systems, I. S. Morosanov, "Avto i Tel." July 1960. 7 pp. On the basis of the approximate calculation of periodic behavior in extremum relay systems there are determined areas of existence of self-oscillations in such systems for object linear units of any kind. Some ways of increasing frequency of these systems are considered. (U.S.S.R.)

Limited Dynamic Properties of Power Executive Components of Servosystems, G. A. Nadzafova. "Avto i Tel." July 1960. 9 pp. The problem of the shortest transient process in electrical servosystems is considered. A dc electrical executive unit with independent excitation is analyzed. (U.S.S.R.)

Dynamic Characteristics of System Jet Amplifier—Servomotor, B. D. Kosharsky. "Avto i Tel." July 1960. 11 pp. Structural circuits and basic dynamic characteristics of a linearized system jet amplifier—servomotors in the case of using one-stage and two-stage amplifier are considered. (U.S.S.R.)

Investigation of Servosystem with Electromagnetic Induction Clutch Operating with Low Null Current, P. F. Klubnikin. "Avto i Tel." July 1960. 9 pp. (U.S.S.R.)

Optimum-Extremal Systems of Two Kinds, L. N. Fitzner. "Avto i Tel." Aug. 1960. 7 pp. Design of two kinds of the simplest extremal systems with linear units is considered. (U.S.S.R.)

Operating Mode Automatic Optimization Based on Statistical Control Criteria, S. A. Doganovskii. "Avto i Tel." Aug. 1960. 10 pp. (U.S.S.R.)

Choice of Combined Linear Control System Parameters, V. Ya. Rotach. "Avto i Tel." Aug. 1960. 6 pp. (U.S.S.R.)

A Problem of Optimum Control, I. A. Litovchenko. "Avto i Tel." Aug. 1960. 12 pp. An optimization problem (in a certain sense) of the path of pursuing a body controlled according to the law of proportional navigation. (U.S.S.R.)

Remote Control of Spread Objects, V. A. Ilyin. "Avto i Tel." Aug. 1960. 8 pp. New devices of high reliability for selection and remote control of spread objects with double-frequency code are considered. (U.S.S.R.)

Compensation of Servosystems by Means of Discrete Computing Device, L. N. Volgin and L. N. Smoljar. "Avto i Tel." Aug. 1960. 7 pp. (U.S.S.R.)

The Stability of Periodic Motions of Piece-Wise Automatic Control Systems, K. K. Belja. "Avto i Tel." Aug. 1960. 7 pp. (U.S.S.R.)

Motion of Hydraulic Servomotor in Automatic Control Systems with Jet Amplifier, V. J. Goltraf. "Avto i Tel." Aug. 1960. 4 pp. (U.S.S.R.)

Dual Control Theory, I. A. A. Feldbaum. "Avto i Tel." Sept. 1960. 10 pp. Some basic problems of the communication theory are compared with those of the automatic control theory. The idea of the dual control is introduced. The problem of design of an optimum, in statistical sense, closed-loop dual control system is formulated. (U.S.S.R.)

Parametric Phenomena in Simplest Continuous Extremal System, V. S. Baranova and A. A. Pervozansky. Avto i Tel." Sept. 1960. 4 pp. (U.S.S.R.)

Fluctuation Effect on Extremum Relay Systems with Self-Oscillating Regime, I. S. Morosanov. "Avto i Tel." Sept. 1960. 10 pp. (U.S.S.R.)

Extremum Control by Means of Random Scan. L. A. Rastrigin. "Avto i Tel." Sept. 1960. 8 pp. A method of random scan applied to the problems of extremum control of multiparameter systems is proposed. The device realizing the method is described. (U.S.S.R.)

Stability of Control System with Two Nonlinear Elements, Chun Jen-Vey. "Avto i Tel." Sept. 1960. 7 pp. (U.S.S.R.)

Precise Determination of Periodic Regimes in Piece-Wise Automatic Control Systems, E. N. Rozenwasser. "Avto i Tel." Sept. 1960. 14 pp. (U.S.S.R.)

Theory of Two-Channel Servosystems with Relay Element in AC Circuit, A. A. Krasovsky. "Avto i Tel." Sept. 1960. 13 pp. (U.S.S.R.)

Investigation of Some Matrix Decoders with Relay Output, T. P. Belaya. "Avto i Tel." Sept. 1960. 9 pp. (U.S.S.R.)

Theory and Technique in Register Control, K. Anke and C. Kessler. "rt." July 1960. 6 pp. The register stability of today's multicolor rotary printing presses is usually supervised by feedback control. The theory of this type of control and its practice are investigated, comparing a discontinuous, on-off controller with a proportional and lead type controller. (Germany.)

Methods for the Analytical Treatment of Impulse-Regulated Control Systems, J. Piesch. "rt." July 1960. 7 pp. (Germany.)

GENERAL

Explorations of the Ionosphere During the International Geophysical Year Using the Method of Vertical Sounding, N. M. Boyenkova. "Radiotek," 15, No. 4, 1960. 3 pp. This article deals with the vertical probing of the ionosphere, performed as part of the general world effect during the Geophysical Year. With the help of an oscilloscope, having a very long screen persistence, it was possible to obtain panoramic images of frequency response as a function of altitude by sweeping the whole frequency spectrum at a high rate. Typical graphs are also included and the frequency of data taking described and explained. (U.S.S.R.)

A Survey of Electronic Quantum Devices, M. A. Eingorn. "Radiotek," 15, No. 5, 1960. 8 pp. The effort of the author in this article is directed to classify electronic quantum devices according to their operational principles and basic characteristics into three major groups. Some applications of such devices are discussed with the help of a number of block diagrams. (U.S.S.R.)

Cosine—Cube Pulses, M. C. Gurevitch. "Radiotek," 15, No. 5, 1960. 4 pp. The author analyzes pulses formed according to the third power of the cosine, which he calls "Cosine-cube pulses." He shows that these pulses have a shorter settling time and that radiations outside the band fade away faster with increasing frequency as compared with second cosine pulses. (U.S.S.R.)

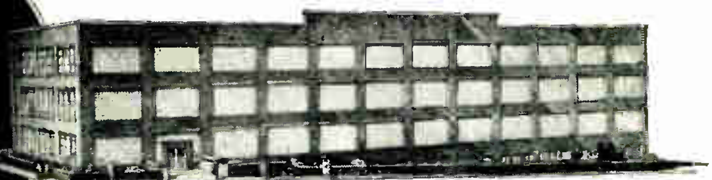
Tendencies in the Development of Modern Operational Calculus, F. H. Lange. "Hochfreq." April 1960. 8 pp. The analysis of linear networks is treated using four different operational methods. All four are discussed and their usage is indicated. The first two methods, the regular Laplace transformation and a modified Laplace transforma-

Precision

FREQUENCY STANDARDS AND FORK OSCILLATOR UNITS

OUR NEW HOME, DOUBLING OUR FORMER CAPACITY

Watch Master ELECTRONICS



Our instruments, 40 to 30,000 cycles, are used extensively by industry and on government projects where enduring accuracy and maximum durability are required. Your inquiries on related products are invited.

PRECISION FORK OSCILLATOR UNITS

TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.

Frequencies: 200 to 4000 cycles

Accuracies:—

Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)

Double triode and 5 pigtail parts required.

Input, Tube heater voltage and B voltage

Output, approx. 5V into 200,000 ohms

TYPE 2007-6

TRANSISTORIZED, Silicon Type

Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 360 to 1000 cycles

Accuracies:

2007-6 (± .02% at —50° to + 85°C
R2007-6 (±.002% at +15° to + 35°C
W2007-6 (±.005% at —65° to + 85°C

Input: 10 to 30 Volts, D. C., at 6 ma.

Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles

Accuracy: ±.001% at 20° to 30°C

Output: 5V. at 250,000 ohms

Input: Heater voltage, 6.3 - 12 - 28

B voltage, 100 to 300 V., at 5 to 10 ma.

ACCESSORY UNITS FOR 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.

D—For low frequencies counter type, 40-200 cy.

H—For high freqs, up to 30 KC.

M—Power Amplifier, 2W output.

P—Power supply.

PRECISION FREQUENCY STANDARDS

TYPE 2005A

Size 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies:
50 to 400 cycles (Specify)

Accuracy:
±.001% from 20° to 30°C

Output, 10 Watts at 115V

Input, 115V. (50 to 400 cy.)

TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt

Accuracy:
±.001% 20° to 30°C

Input,
115V (50 to 400 cy.)

TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cy.

Accuracy:
(±.002% at 15° to 35°C)

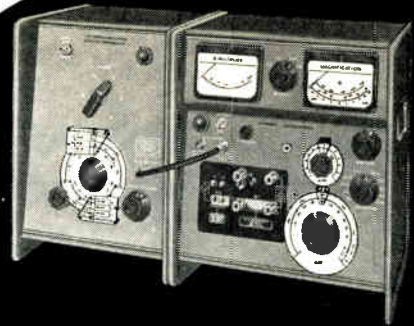
Output: 115V, 75W.

Input: 115V, 50 to 75 cy.

WHEN REQUESTING INFORMATION, PLEASE SPECIFY TYPE NUMBER

ATP

American Time Products Inc.
61-20 Woodside Avenue
Woodside 77, N. Y.



Sources

tion (Carson-Laplace) are function transformations. The third and fourth methods are based on function algebra, one starting with the Duhamel integral and the other with the convolution integral. The novelty of the third and fourth ones is the direct application of the time function itself. (Germany.)

The Entropy of Typewritten Texts, G. A. Kayser. "Nach. Z." May 1960. 6 pp. For various typewritten texts the distribution of groups of linear and heterogenous surface elements up to a length of n = 6 surface elements is determined by means of an evaluation device and the entropy of the n-th order is calculated. (Germany.)

New Discoveries on Biotic Effect by RF, H. Hubner. "El. Rund." June 1960. 2 pp. The author discusses the interesting possibilities resulting from the lately discovered effects. (Germany.)

The Syncardon, R. Marin. "El. & Auto." May 1960. 3 pp. Blood circulation troubles are only too frequent nowadays. They are now amendable to treatment through the use of an original new device the Syncardon. Its function is to help blood circulation in case of deficiency in the operation of blood vessels. It uses a combination of electronic and pneumatic techniques. (France.)

A new Method for Automation, P. Lemenier. "El. & Auto." May 1960. 3 pp. A new method consists in confining the wiring inside depressed areas, previously produced while molding the insulating support itself. A purely chemical dip method is used to produce a rugged nickel-chromium metallization. (France.)

Review and Forecast of Tellurium and Thermoelectricity Research in Canada, S. R. Mester. "El. & Comm." July 1960. 3 pp. Recent research into thermoelectric alloys has provided many significant electronic applications. (Canada.)

Masers or Parametric Amplifiers?, D. C. Laine. "El. Tech." May 1960. 12 pp. This paper surveys two important recent developments in low-noise microwave amplification—the maser and the parametric amplifier. A brief discussion of the principles of operation is followed by a brief outline of the various types of amplifier in each of these two groups. (England.)

The New Electronics, Low Temperatures—1. "El. Tech." June 1960. 3 pp. (England.)

The New Electronics, Low Temperatures—2. "El. Tech." July 1960. 5 pp. (England.)

Unitized Nucleonic Equipment, D. R. Trotman. "Brit. C&E." June 1960. 5 pp. This paper describes the circuitry and application of a new form of pulse counting equipment, built on a standard chassis frame, and employing distributed power supplies for each unit by means of a control shelf. The basic chassis mechanics and system were developed by A.E.R.E., Harwell. (England.)

Determination of Maximum Error of Binary Multiplier, Yan Si-Zen. "Avto i Tel." July 1960. 8 pp. Digital integrator based on a binary multiplier is considered. (U.S.S.R.)

Estimate of Mean-Square Deviation from known Trajectory, E. A. Barbashin. "Avto i Tel." July 1960. 10 pp. New methods of estimating the mean-square deviation from the known trajectory are given. (U.S.S.R.)

Choice of Optimum Number of Pole Pairs and Main Dimensions of Slide Electromagnetic Clutches with Massive Steel Anchor, A. D. Osdeev. "Avto i Tel." Aug. 1930. 8 pp. (U.S.S.R.)

The Indefinite Integral Energy Spectrum of a Stationary Random Process, B. R. Levin. "Radiotek" 15, No. 6, 1960. 3 pp. Certain non-stationary processes are evident when fre-

quencies are modulated by a random process-noise. In the analyses of the energy spectra of such modulated frequencies theories behind stationary random processes are often used. In this article, expressions are derived for the instantaneous spectrum of the indefinite integral of a stationary random process. It is shown that a very widely used energy spectrum integral formula is obtained by averaging these expression with time. (U.S.S.R.)

"Jumps" in Electronic Circuits, S. A. Dobrov. "Radiotek 15, No. 7, 1960. 8 pp. A method is developed to determine the originating time of voltage and current jumps (steps) in circuits containing non-linear two-and-three-terminal networks. It is shown that to obtain the solution to the problem, it is not necessary to write the complete differential equation for the circuit in question. It is sufficient to know certain of its parameters. In conclusion, several examples are given for circuits, widely used in radio systems. (U.S.S.R.)

INDUSTRIAL ELECTRONICS

Transidyn Control Systems for Rolling Mills, D. Strole and H. Vogl. "rt." June 1960. 8 pp. An introduction into the problems typical for rolling mills is followed by an example demonstrating the Transidyn control method and, furthermore by a discussion of the essential Transidyn networks for rolling mill drives. (Germany.)

Improving the Final Vacuum in a Diffusion Pump, P. Opitz and F. Schneider. "Vak. Tech." May 1960. 1 p. (Germany.)

Control of Some Continuous Industrial Processes by Means of Minimum Change of Controlled Inputs, I. A. Burovoj and S. V. Emelyanov. "Avto i Tel." Aug. 1960. 9 pp. (U.S.S.R.)

MATERIALS

Novel Glass Type Material in Electronics, W. Hennig. "El. Rund." June 1960. 2 pp. Fotoform is a novel type of a glass, the structure and properties of which can be varied by ultra-violet or thermal irradiation. (Germany.)

Magnetostrictive Ferrites and Their Applications, Z. Kaczkowski and A. Smolinski. "Roz. Elek." Vol. 6, No. 1-2. 29 pp. Principal definitions for the magnitudes determining magneto-strictive properties of the material are given. (Poland.)

Segregation and Distribution of Impurities in the Preparation of Germanium and Silicon, J. Goorissen. "Phil. Tech." No. 7, 1960. 11 pp. Silicon and germanium are purified by zone melting. Uniform distribution can be achieved by two new processes, whereby as much impurity is added from outside to the zone per second as leaves it via the solid-liquid interface to enter the growing crystal. (Netherlands, in English.)

The Effect of Shearing on the Initial Permeability of Cores with Interlaced Laminations, R. Brenner and F. Pfeider. "Freq." May 1960. 15 pp. (Germany.)

Curves of the Complex Permeability of Thin Strips, R. Boll. "Freq." July 1960. 12 pp. The paper begins with a survey of the locus curves of the complex permeability as expected with classical eddy currents, inhomogeneity of the permeability over the cross-sectional area of the lamination, and consideration of the magnetic domain structure. Also considered are the locus curves with relaxations and those calculated from the motional equation of the Bloch wall. (Germany.)

Piezomagnetic Ferrites, Applications in Filters and Ultrasonics, C. M. van der Burgt. "El. Tech." Sept. 1960. 12 pp. (England.)

MEASURE & TESTING

Comparative Evaluation of Parallel and Series Methods of Frequency Division, Y. H. Bakaev, P. I. Kuznetzov. "Radiotek." 15, No. 4, 1960, 8 pp. The authors evaluate by direct comparison the two methods of frequency division; namely, the series and the parallel methods. They analyze the effects on both systems by smooth noise and also by noise with high occasional peaks and tabulate the results for each method. They show the probability of division for each method and their combinations. Finally, on the basis of their combination, they draw conclusions on the merits of the two methods. (U.S.S.R.)

Linear Distortion During Continuous Wave Sampling, V. A. Vol. "Radiotek," 15, No. 4, 1960. 6 pp. The author analyzes distortion in sampling systems arising from the variation in the converter transconductance and from the fact that the sampling pulses are not of infinitely small duration. It is shown that, if during the sampling period the variation of conversion transconductance is asymmetrical, the output voltage depends not only on the frequency corresponding to the output signal component, but also on its phase. Consequently, the distortion can be regarded as phase-frequency distortion in the first approximation only. (U.S.S.R.)

Development of Simple Test Equipment to Produce and Measure Mechanical Impact, Th. Kuegler. "Freq." July 1960. 5 pp. Modern electron tubes are expected to be immune to mechanical impact and vibration. The paper describes the formation and propagation of mechanical impact in electronic apparatus and derives herefrom demands for the generation of artificial impact, making a comparison with the properties of known impact machines many of which are relatively complicated and expensive. (Germany.)

Analysis of Harmonic Frequency Dividers, I. H. Rizkin. "Radiotek" 15, No. 8, 1960. 9 pp. It is shown that in several cases the analysis of harmonic frequency dividers, described by differential equations higher in order than two, can be reduced to an analysis of a certain equivalent divider whose differential equation is but of the second order. A method is shown to design an equivalent system for two general-type circuits. Formulae are given to determine the amplitude and the phase of the divided frequency wave for two types of dividers, as expressed in the equivalent system parameters. (U.S.S.R.)

Analysis of Noises in Power Lines of 0,4/6 KV, L. B. Venchkovskii. "Avto i Tel." Aug. 1960. 9 pp. The results of analysis of noises in the power line of the oil lease of 0,4/6 kv in the range from 150 c to 100 kc are given. (U.S.S.R.)

Spectrum Analysis of the Amplitude-Phase Modulations, L. E. Klyagin. "Radiotek" 15, No. 8, 1960. 7 pp. Exact design formulae are obtained permitting evaluation of spectra which are produced in amplitude-phase modulated transmitters built according to R. L. Kahn's design. The impossibility to obtain oscillations with optimally an amplitude-phase modulation is shown. The second side band can be suppressed only partially. In this respect, the circuit has no advantages over the well-known circuit with quadrature modulation. (U.S.S.R.)

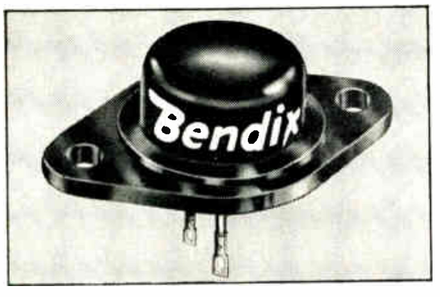
A Leak Detector with a Cold Cathode Ionization Manometer, G. Zinsmeister. "Vak. Tech." May 1960. 4 pp. Sensitivity measurements of

NEW 25-AMP DAP TRANSISTORS SWITCH IN MICROSECONDS

High Current–Fast Switching–High Voltage —give engineers wider design latitude

The new 25-amp germanium PNP Bendix® Diffused Alloy Power DAP® transistor line—with its microsecond-fast, higher-current switching (typically 5 μsec at 25 amperes)—frees engineers from the design restrictions set up by ordinary germanium alloy transistors. *Only* Bendix offers such a high-current, high-speed DAP transistor line.

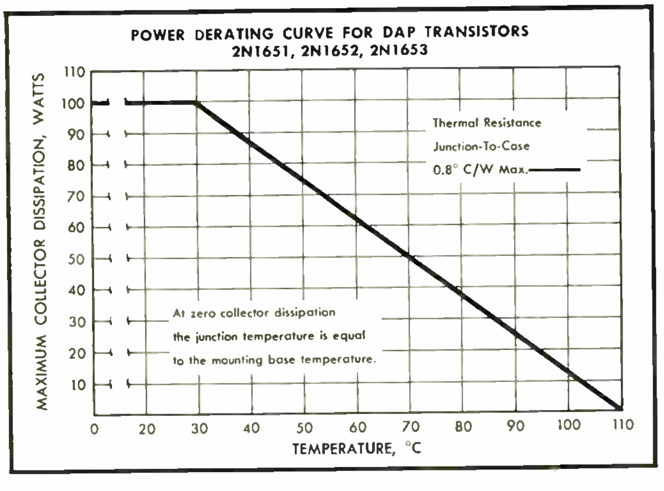
But high current is by no means the whole story. Bendix DAP transistors make possible increased circuit stability over a wider range of temperatures—from −60°C to +110°C. They are also

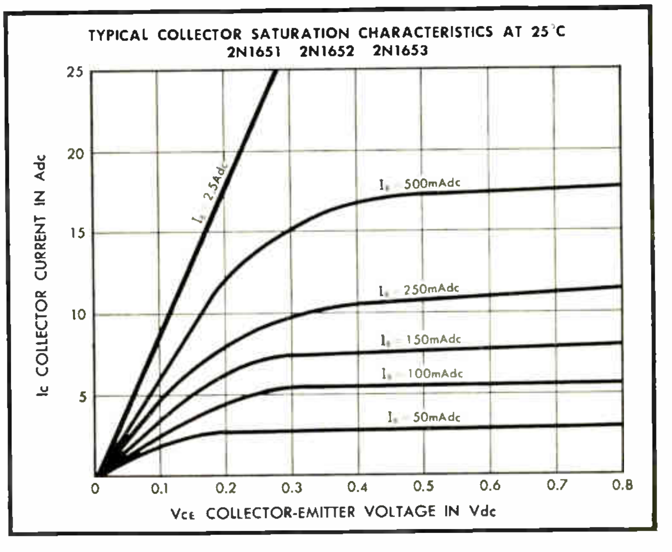


rated at higher collector-to-emitter breakdown voltages, while providing lower input resistance, controlled current gain, and lower saturation voltages. In short, here is a special high-frequency, high-voltage line that opens the door to many new design ideas and applications.

For details on our complete line of power transistors, power rectifiers, and driver and MIL-type transistors, write on your letterhead for your BENDIX SEMICONDUCTOR CATALOG.

ATTENTION ENGINEERS: Write our Employment Manager for information about challenging opportunities we offer in semiconductors.





ABSOLUTE MAXIMUM RATINGS

TYPE NUMBERS	Vce Vdc	Vcb Vdc	Veb Vdc	Ic Adc	Pc W	T Storage °c	Tj °c
2N1651	−60	−60	2.0	25	100	−60 to +110	110
2N1652	−100	−100	2.0	25	100		
2N1653	−120	−120	2.0	25	100		

Ideal for such applications as: ULTRASONICS · HORIZONTAL OUTPUT AMPLIFIERS FOR TV OR CATHODE RAY TUBES · POWER CONVERTERS · HIGH CURRENT AC SWITCHING · CORE DRIVERS · HI-FI

THE Bendix CORPORATION

SEMICONDUCTOR PRODUCTS

Red Bank Division

HOLMDEL, NEW JERSEY

Main Office: South Street, Holmdel, N. J.—Phone: SHadyside 7-5400 TWX Holmdel NJ 1388 • Midwest Office: 2N565 York Road, Elmhurst, Ill.—Phone: BRowning 9-5050 TWX Elmhurst Ill 393 • New England Office: 4 Lloyd Road, Tewksbury, Mass.—Phone: ULysses 1-7495 • West Coast Office: 117 E. Providencia Avenue, Burbank, Calif.—Phone: VIctoria 9-3961 TWX BRB 9808 • Bendix International: 205 East 42nd Street, New York 17, N. Y.—Phone: MUrrayhill 3-1100 TWX NY 1-4800

Circle 140 on Inquiry Card

International ELECTRONIC SOURCES

a leak detector working together with a cold cathode gauge are reported. As the leak detector responds only to changes of pressure, the sensitivity has to be defined in a different way from other leak detectors. (Germany.)

RADAR, NAVIGATION

Certain Aspects in Bearing Determination of Interfering Waves, Y. A. Yeruchimovitch. "Radiotek" 15, No. 6, 1960. 5 pp. In this article processes are analyzed of finding directions of two interfering radio waves using amplitude sensitive direction finders with direct reading. Laws, governing the elliptic form and errors of bearings, are established, as well as their relationship with other parameters of the incident waves. Attention is called upon the important function of the lateral inclination of waves from the circle of their propagation along the earth's surface. The following phenomena are explained: "parallelogramming," "wandering bearings" and "circular reception." A number of practical recommendations are also given. (U.S.S.R.)

Accuracy of Parameter Measurements in a Radar System Used for Observations of Meteorites, E. I. Fialko. "Radiotek 15, No. 6, 1960. 3 pp. Unstable radar parameters are known to distort the meteorite count as a function of time. The important problem is to establish the accuracy with which the parameter stability must be maintained and measured. It is often assumed that the mean rate per hour of meteorite echos is affected very little by such radar parameters as the transmitter power, threshold signal power, etc. However, in this article, the author shows that these assumptions are false, by establishing the extent to which various parameters do effect the meteorite count by radar. (U.S.S.R.)

Influence of the Distance Between the Magnetron and the Discharger on the Characteristics and Losses of a Balanced Duplexer, B. E. Rubinstein. "Radiotek" 15, No. 7, 1960. 5 pp. In contemporary radar technology, two types of duplexers are basically used which permit reception and transmission using the same antenna: branched duplexers and balanced duplexers. The aim of this article is to analyze the operation of a balanced duplexer. In this analysis, the characteristics are analyzed of each of the dischargers of which the doubled ATR consists. (U.S.S.R.)

Helices as Relay Lines, G. Piefke. "Nach. Z." Aug. 1960. 5 pp. (Germany.)

SEMICONDUCTORS

Design of a Semiconductor Relay, C. V. Kulikov. "Radiotek," 15, No. 4, 1960. 8 pp. This article describes the design of semiconductor relays, consisting of transistors, diodes, and thermistors. Such relays have great advantages of compactness, ruggedness in vibration and shock environments, very high switching speeds, absence of mechanical contacts and high-power switching abilities. Methods for temperature compensation of such cascaded relays are presented. Methods are also given, based on an introduced concept of a "self-contained three-pole," to calculate the threshold levels of response, which characterize the insensitive zones and the hysteresis loop. Performance data and results of a typical relay are included. (U.S.S.R.)

Available now for reliable, high-speed switching!

SYLVANIA

2N705

2N710

ACTUAL SIZE

2N711

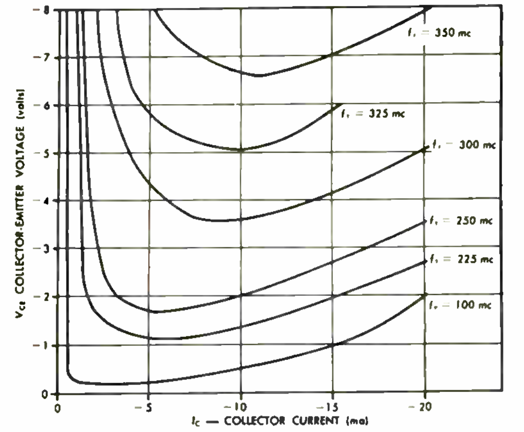
MESA TRANSISTORS

New, PNP diffused-base germanium units . . . designed, produced and controlled specifically for reliable performance in high-speed switching service.

As with all Sylvania computer-type semiconductor devices, rigid quality controls are applied to the manufacturing processes and materials for Mesa Transistors. These assure exceptionally high performance, electrical uniformity and long life. Tests that simulate extreme environments give maximum assurance of reliability.

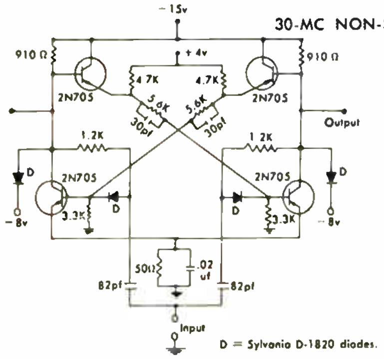
Sylvania Mesa Transistors are available through your Sylvania Field Office or your local Sylvania franchised Semiconductor Distributor. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 1911, Woburn, Mass.

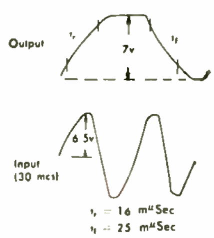
2N705 GAIN BANDWIDTH PRODUCT vs. COLLECTOR-EMITTER VOLTAGE and COLLECTOR CURRENT



Note: *The product of high frequency beta times the frequency of measurement gives the frequency f_T at which beta is unity.*

2N705 30-MC NON-SATURATING FLIP-FLOP





ELECTRICAL CHARACTERISTICS AT 25 C

Characteristics	2N705 Min.	2N705 Typ.	2N705 Max.	2N710 Min.	2N710 Typ.	2N710 Max.	Units
BV_{CBO} $I_C = -100\ \mu A$, $I_E = 0$	−15.0	—	—	−15.0	—	—	V
BV_{EBO} $I_E = -100\ \mu A$, $I_C = 0$	−3.5	—	—	−2.0	—	—	V
BV_{CES} $I_C = -100\ \mu A$, $V_{BE} = 0$	−15	—	—	−15.0	—	—	V
h_{FE}	25 @ $V_{CE} = -3V$, $I_C = -10$ mA			25 @ $V_{CE} = -.5V$, $I_C = -10$ mA			
V_{BE} $I_B = -.4$ mA, $I_C = -10$ mA	−.34	—	−.44	−.34	—	−.50	V
I_{CBO} $V_{CB} = -5V$, $I_E = 0$	—	-	−3.0	—	—	−3.0	μA
V_{CE} $I_B = -.4$ mA, $I_C = -10$ mA	—	—	− 30	—	—	−.50	V
$t_d + t_r$ $I_{B1} = -1.0$ mA, $V_{CC} = -3.5V$, $V_{BE}(off) = 0.5V$, $R_C = 300\ \Omega$	—	60	75	—	60	75	mμSec
t_s $I_{B1} = -1.0$ mA, $V_{CC} = -3.5V$, $I_{B2} = 0.25$ mA, $R_C = 300\ \Omega$	—	75	100	—	75	100	mμSec
t_f $I_{B1} = -1.0$ mA, $V_{CC} = 3.5V$, $I_{B2} = -0.25$ mA, $R_C = 300\ \Omega$	—	80	100	—	80	100	mμSec

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

Circle 143 on Inquiry Card

International ELECTRONIC SOURCES—

Semiconductors—Their Types and Uses, H. J. Thuy. "rt." May 1960. 5 pp. The most important constructional elements of semiconductors are listed and a description is given of their fields of application, their structure and some of their typical properties. (Germany.)

The Junction Transistor Basic Operating Mode, M. K. Achuthan. "El. Tech." June 1960. 3 pp. (England.)

Tunnel Diodes Operation and Application, G. N. Roberts. "El. Tech." June 1960. 6 pp. (England.)

Design of a Diode Rectifier, G. I. Levitan. "Radiotek" 15, No. 6, 1960. 2 pp. The statistical characteristic curve for a diode is generally represented by two straight lines which join on the ordinate. This is an approximation to the true curve of the diode characteristic. The author presents a more accurate method for calculations of the characteristic curve by deriving appropriate equations and supporting graphs. (U.S.S.R.)

Magnetic Semiconductor Amplifier, R. A. Lipman and M. V. Ol'Shvang. "Avto i Tel." July 1960. 11 pp. A magnetic semiconductor amplifier operating as a key with intermittent regulation and based on relaxation generator with pulse-width modulation. (U.S.S.R.)

Semiconductor Contactless Switching Elements, E. V. Miller. "Avto i Tel." July 1960. 11 pp. Contactless switching elements elaborated for replacing contact relays in automatic regulating systems are proposed. The calculation of these elements is described. (U.S.S.R.)

New Transistors and Diodes. H. Lennartz. "El Rund." July 1960. 4 pp. (Germany.)

Tunnel-Diodes, W. W. Gartner. "El Rund." July 1960. 7 pp. The paper deals with the physical basis of the tunneling effect, the dimensioning, manufacture and ratings of the tunnel diode, and its application as oscillator, amplifier and switch. (Germany.)

Photomagnetoelectric Effect and Photoconductivity in Semiconductors, V. Andresciani. "Alta Freq." April 1960. 52 pp. The photomagnetoelectric effect has been examined in semiconductor crystals from a more general point of view than in the former works. (Italy.)

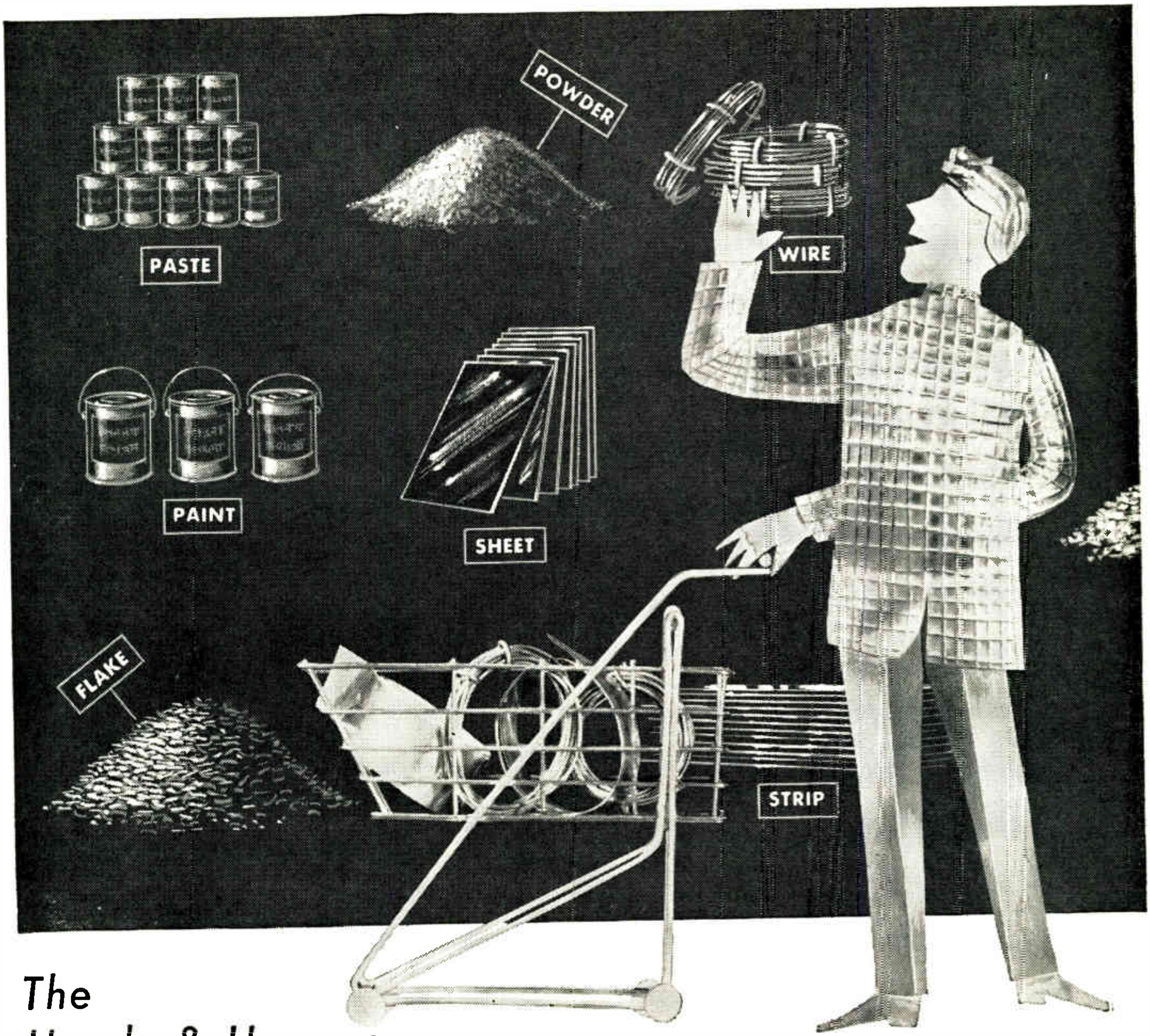
TELEVISION

Signal Formation in an Image Iconoscope with Point Trace Scanning, L. I. Hromov. "Radiotek" 15, No. 6, 1960. 6 pp. In recent years of electronic technology, a scanning technique by point tracing has been introduced widely. In this method, beams of electrons, as they move continuously along horizontal lines, in both the transmitting and receiving tubes, are triggered on and off synchronously with the frequency of the points. Certain effects which are produced as the electrons sweep the image iconoscope target are analyzed. Among these is the electron cloud. Experimental data obtained is given which permits the evaluation of the charge density and afterglow of this electron cloud. (U.S.S.R.)

Modern Viewpoints in Designing Color TV Film Scanners with Light Spot Tubes, P. Neidhardt. "El. Rund." Aug. 1960. 7 pp. (Germany.)

The Test-Line Signals of the French Television Service, A. Pouyferrie and G. Frachet. "Rundfunk." Aug. 1960. 5 pp. (Germany.)

Distortions Due to System and Transmission Faults in Color Television Based on the



The
Handy & Harman
Silver Supermarket

Has every form of silver for your electronics applications

Silver, in many forms and alloys, is a necessity in the electronics and electrical industries. To meet this need on a high quality level, Handy & Harman manufactures powder, flake, paint, paste, sheet, strip, wire, etc., for printed circuits, wiring, resistors, condensers, thermistors, contacts, printed terminal strips on glass, ceramics, plastic laminates, etc.

Another "At Your Service" Division of the Handy & Harman Silver Supermarket is our Research and Engineering Department. Always ready to help you with any problem or project you may have involving silver for *any* application.

VISIT OUR BOOK DEPARTMENT
We have five Technical Bulletins giving engineering data on the properties and forms of Handy & Harman Silver Alloys. We would like you to have any or all of those that particularly interest you. Your request, by number, will receive prompt attention.

Fine Silver .... Bulletin A-1
Silver-Copper Alloys .... Bulletin A-2
Silver-Magnesium-Nickel .... Bulletin A-3
Silver Conductive Coatings .... Bulletin A-4
Silver Powder and Flake .... Bulletin A-5

Your No. 1 Source of Supply and Authority on Precious Metal Alloys

HANDY & HARMAN
General Offices: 82 Fulton St., New York 38, N. Y.

Circle 146 on Inquiry Card

NTSC-System, Helmut Schonfelder. "Rundfunk." Aug. 1960. 15 pp. (Germany.)

A Measuring Unit for Color Television, H. Gorling and J. Lindner. "Nach. Z." Sept. 1960. A measuring unit is described which represents and monitors the color information used in the N.T.S.C. color TV system in the form of vectors (Vectorscope). (Germany.)

Synchronous Demodulator for Television, For Vestigial-Sideband Systems, P. J. Waller. "El. Tech." Oct. 1960. 5 pp. (England.)

Operation and Advantages of Color TV System SECAM, R. Chaste and P. Cassagne. "El. Rund." Sept. 1960. 4 pp. The SECAM system is fully compatible and differs from other color TV methods by radiating the wide-band luminance signal at all times while the chrominance signals are alternately transmitted for every other horizontal line in a frequency band reduced accordingly. (Germany.)

Generation and Elimination of Retrace Noise in Vidicon Cameras, H. D. Schneider. "El. Rund." Sept. 1960. 3 pp. (Germany.)

TRANSMISSION

A Generalized Matrix Theory for Non-Uniform Transmission Line, A. L. Feldstein. "Radiotek" No. 6, 1960. 8 pp. A method is given using matrices for analyses of non-uniform transmission lines. This method allows to consolidate the approach to the solution of various problems in transmission lines at very high frequencies, by the use of the transmission function matrix. The line is represented by a series of cascaded stages and the transmissions function matrices for these stages are combined into summarizing integral equations to give the elements of the overall transmission function matrix of a continuous non-uniform transmission line. (U.S.S.R.)

Influence of Transmission Lines on the Ground Field of Radio Waves, V. N. Krasilnikoff. "Radiotek" 15, No. 7, 1960. 7 pp. In this article the author analyzes the disturbance of the primary field of a ground wave produced by transmission lines. For simplicity, the transmission line is assumed to be a very thin straight conductor parallel to the earth's surface. The analysis of such a problem is of great interest in radio-navigations. The solution is obtained by approximating the problem to a case of a two-wire line and analyzing the wave processes which take place in this line. Simple assymptotic formulae are obtained for various cases, allowing evaluations of basic effects. Conditions are determined in which the transmission lines display some wave guiding properties. (U.S.S.R.)

Applications of Circular Cross-Section Wave-Guides in Radio Relay Systems, A. A. Metrikin, N. S. Tarasov. "Radiotek" 15, No. 7, 1960. 6 pp. The author analyzes basic parameters of the more frequently used circular wave-guides, in the frequency band of 3400-3900 Mgc. A method to increase the number of simultaneously operating trunk lines, is to use horizontal polarization for received signals and vertical polarization for transmitted signals. Antennas can be excited for a double polarization by the use of square or circular wave-guides. (U.S.S.R.)

Development of Parameter Transmission with Optimum Decoding in the Presence of Non-Additive Noise, B. S. Fleishman. "Radiotek" 15, No. 8, 1960. 8 pp. In this article the author describes the design of a decoding system which will provide dependable transmission of a maximally great number of parameter values using definite modulation techniques and in the presence of non-additive noise. The problem is solved using iteration methods. In conclusion, the possibilities for utilizing the obtained results are analyzed and a block diagram of a parameter transmitting system is presented. (U.S.S.R.)

Specifications for TV Long Distance Links and Measurements on Such Equipment, J. Muller. "Nach. Z." July 1960. 8 pp. (Germany.)

Helices as Transmission Lines for Waveguide Modes, G. Piefke. "Nach. Z." July 1960. (Germany.)

Matched and Tuneable Cavities as Circuit Elements for Waveguide Filters. "Nach. Z." Aug. 1960. 9 pp. (Germany.)

Transport of Angular Momentum, G. Toraldo di Francia. "Alta Freq." April 1960. 6 pp. This angular momentum carried by electromagnetic radiation in a wave guide is evaluated by means of the mechanical actions exerted by the wave. (Italy.)

TUBES

Optimum Design of Complex Vacuum-Tube Oscillators According to Plate Dissipation, D. P. Linde. "Radiotek," 15, No. 4, 1960. 4 pp. The article describes a method of determining the operating conditions of vacuum tubes in compound oscillators for the purpose of delivering the maximum power to the load. Since the total power handling capacity of vacuum-tubes is dependent on the allowable plate dissipation, the problem is to find the most efficient operation point of a vacuum-tube. Graphs are presented which allow the determination of the optimum cut-off angles and also given are some fundamental energy relations in the oscillators. (U.S.S.R.)

Thyratron Pulse Generator, S. Rozenstein. "El. Tech." July 1960. 3 pp. In this paper a pulse generator is described which uses a thyratron as an electronic switch in a novel circuit. Short pulses of exponential shape are produced at reasonable output stability within repetition rates from 1 c/s up to 12 kc/s. Simplicity of design and low power consumption suggest its use as a portable laboratory pulse generator. (England.)

Modern Trends in Magnetron Design, A. H. Pickering. "El. Tech." June 1960. 4 pp. (England.)

A Systematic and Technical Comparison of Microwave Tubes, L. Bruek and W. Klein. "Freq." June 1960. 13 pp. (Germany.)

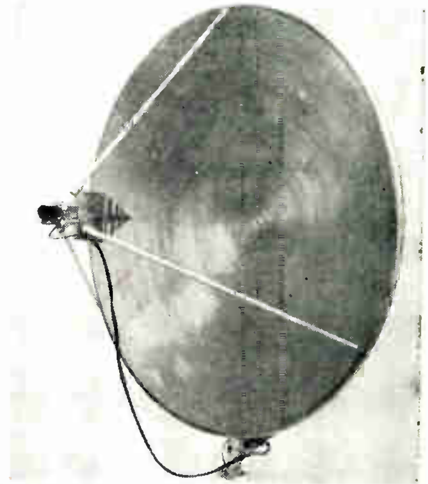
Applications of Convex Pentode Response Curves, M. S. Aralov. "Radiotek" 15, No. 6, 1960. 11 pp. At the present time there exist methods of producing a number of characteristic response curves whose shapes resemble those of some of the basic functions. The use of these methods, however, is limited by their low gain and by the complexity and difficulty of their control. In this article, the author presents a different method which is greatly simplified and effective. He shows that these functional shapes of the response curves are obtained by controlling the current distribution and space-charges in a single pentode circuit. Also shown are several examples where the above properties are used to produce non-linear transformations in radio-technology. (U.S.S.R.)

Evaluation and Selection of Vacuum Tubes for Operation in the Plate-Grid Limiting Range, I. K. Pozdniakoff. "Radiotek" 15, No. 8, 1960. 4 pp. The present method for vacuum tube selection for use in various circuits involves several grapho-analytic steps before the answer is obtained. This, however, prevents direct comparison of the parameters of various tubes. In this article, relations are derived for various tubes, based on fundamental vacuum-tube equations. These relations permit to determine the extent to which the negative front of a pulse and its amplitude depend on various parameters of the vacuum tube. The derived relations are combined into a nomograph. (U.S.S.R.)

New Products

ANTENNA

Model 727 wideband unidirectional antenna features: Freq. Range, 1 to 4 KMC; Antenna Type, 7-ft. spun aluminum parabolic reflector with single log-periodic primary feed antenna; gain, 1 to 4 KMC, 24 to 36 db; Polarization, linear, remotely selected 0°,



45°, 90°; Azimuth Drive, selectable 360° cont at 1 RPM, or servo-controlled manual slewing; Elevation Drive, 0° to ±10° at 2°/sec; Controls, Controls and indicators for both azimuth and elevation accurate to ±1° and switch for selecting polarization; Rotary Joints, satisfactory operation throughout 1-4 KMC band; Connector, Type N; Radome, spherical, neoprene coated nylon inflatable radome including pressurization system; Dim., Radome: spherical dia, 126 in., height 108 in., base dia. 90 in. Environment, 100 mph, ½ in. ice. Granger Associates, 974 Commercial St., Palo Alto, Calif.

Circle 269 on Inquiry Card

CONTROLLED ENVIRONMENT

Meter assembly "White Room" has luminous ceiling which features a lighting level of 300 footcandles at Hickok Electric Instrument Co. in Cleveland, Ohio. This has boosted quality levels 100%, output 50% and cut production costs 20%.

a complete selection of **low cost** standard models

Howard motor parts sets

Ratings from 1/200 to 1 H.P.

Howard standard motor parts include armatures and fields, brushes and brushholders, rotors, stators and fans. If you use motor parts, write Howard for complete information.

POWERED BY HOWARD®

HOWARD INDUSTRIES, INC., 1730 State Street, Racine, Wisconsin
Divisions: Electric Motor Corp., Cyclohm Motor Corp., Boyd Scruggs Co.

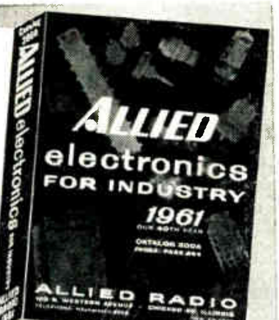
Circle 150 on Inquiry Card

---

free send for the

ALLIED 1961 ELECTRONIC SUPPLY CATALOG

572 PAGES • MOST COMPLETE



BUY AT FACTORY PRICES

WORLD'S LARGEST STOCKS...SPECIALIZING IN:

- Semiconductors
- Connectors
- Relays
- Transformers
- Special-Purpose Tubes
- Test Equipment, Meters
- Resistors, Controls
- Switches, Timers
- Knight-Kit® Instruments in Low-Cost Kit Form
- Electronic Parts for Every Industrial Need

ONE ORDER TO ALLIED FILLS THE WHOLE BILL

Have the world's largest stocks of electronic equipment at your command. No need to deal with hundreds of separate factories—*one order to us fills the whole bill.* You get same day shipment. *You buy at factory prices.* Write today for the FREE 1961 ALLIED Catalog—your one-source electronic supply guide.

your dependable source for everything in electronic supply

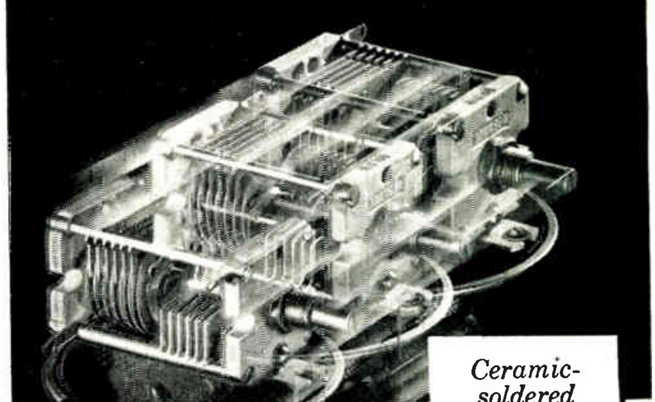
ALLIED RADIO
100 N. Western Ave., Dept. 18-L
Chicago 80, Ill.

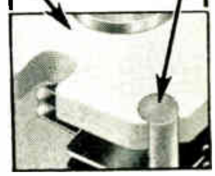
our 40th year

send for FREE CATALOG

Circle 151 on Inquiry Card

THESE RUGGED JOHNSON VARIABLES WITHSTAND TERRIFIC VIBRATION and SHOCK!



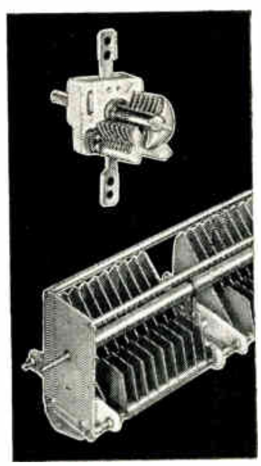


Ceramic-soldered for greater strength!

Parts can't break loose... capacity can't fluctuate!

Set your frequency ... these tough Johnson "L" variables will hold it—even under severe conditions of shock and vibration! Designed to provide outstanding strength, rigidity and operating stability—rotor bearings and stator support rods are actually soldered directly to the heavy 3/16" thick steatite ceramic end frames. Parts can't break loose ... capacity can't fluctuate!

Specially designed split-sleeve tension bearing and silver-plated beryllium copper contact provide constant torque and smooth capacity variation. Plating is heavy nickel—plate spacing .020", .060" and .080" spacing as well as special platings, shaft lengths and terminal locations in production quantities.



A complete variable capacitor line . . . from tiny sub-miniatures to large heavy duty types!

From the tiny Type "U" sub-miniature, which requires less than 0.2 sq. in. for chassis or panel mounting—to the rugged heavy-duty "C" and "D" types . . . the Johnson variable capacitor line is designed for more capacity in less space—offers you one of the widest standard capacitor lines in the industry! For detailed specifications on all Johnson variable capacitors, write for your free copy of our newest components catalog, described below.

New Catalog

8 MAJOR COMPONENT LINES

Write today for our newest electronic components catalog—complete specifications, engineering prints and current prices on:

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

E. F. JOHNSON CO.
2014 Second Avenue S.W. • Waseca, Minnesota

Circle 152 on Inquiry Card

New Products

MAGNETIC REED RELAY

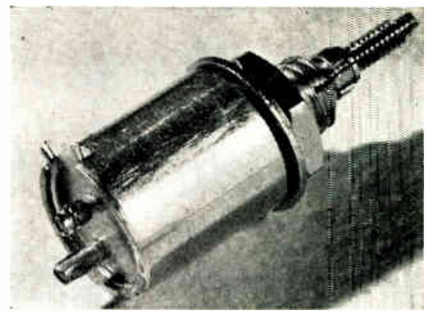
Magnereed Relay, Class 101, combines in a small size a stable contact resistance, long life, and high switching speed. It consists of a magnetically actuated contact assembly inside an actuating coil. Gold contact are hermetically sealed in an atmosphere

of inert gas. Standard contacts are single pole. single throw, normally open; rated 12 w resistive load-1 amp. max. Contact resistance is 50 milliohms, max; breakdown voltage 200 vac RMS min. Coil power; nom, 100 mw; min, 50 mw. Operate time, less than 1 msec; release time, less than ½ msec. Dimensions; Relay body (coil) ⅞ in. long; 7/16 in. dia. Overall length with standard solder terminals, 1½ in. Magnecraft Electric Co., 3352 W. Grand Ave., Chicago 51, Ill.

Circle 267 on Inquiry Card

R-F INDUCTORS

New series of slug-tuned, shielded r-f inductors, the series 900 are for military and high quality commercial applications. The series cover from 0.5 μh to 100 μh in 10 steps and is most useful over the 0.5 to 60 MC spectrum where the ave. Q is 70. The assembly consists of powdered iron cups and core mounted in a plated brass case. The windings are sealed with epoxy. A built in tension device locks the slug in place. For i-f and



r-f amplifiers, they can be used in telemetering, radar, and communications equipment. Mounting is a single threaded ¼-28 bushing. North Hills Electronics, Inc., Glen Cove, L. I., N. Y.

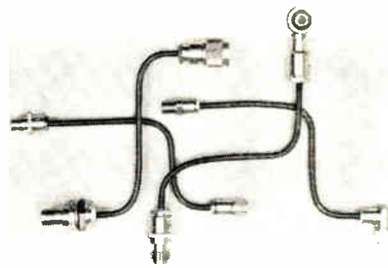
Circle 268 on Inquiry Card

Circle 155 on Inquiry Card

New Products

CONNECTORS

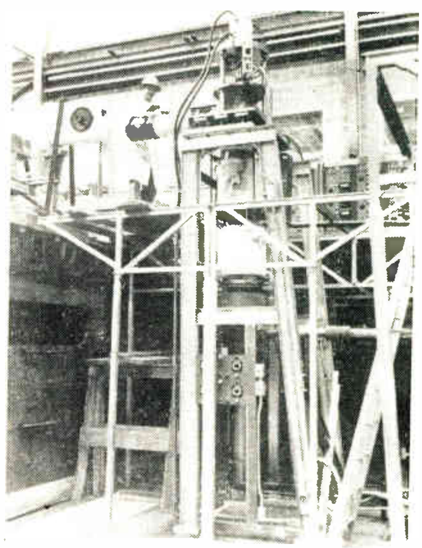
A new series of TNC Coaxitube[R] (Semi-Rigid) Connectors feature Collett clamp construction—a reliable method of positive cable clamping so cables cannot turn or pull out. They are also available in TM series—miniaturized versions of TNC—for



use where size and weight are critical considerations. Weatherproof, the metal parts are silver plated; contacts have gold plate over silver plate. Standard specs include: Impedance matched, 50 ohms; Operating Temperatures, −65°F to +260°F; Voltage, 1500v RMS, 60 cycles (TNC), 500v RMS 60 cycles (TM); Threaded Couplings 7/16-28 UNEF-2 (TNC), 5/16-32 NEF-2 (TM). Other voltages and impedances in other connector types available. General RF Fittings, Inc., 702 Beacon St., Boston 15, Mass.

Circle 270 on Inquiry Card

ULTRA-HIGH-VACUUM VALVE



Giant valve developed by RCA uses sealing technique which permits it to remain vacuum tight at pressures down to 2 x 10^{-10} mm Hg. Directly below the valve are two 2,000 liter liquid nitrogen cold traps supported by a freon baffle nesting on a 10 in. mercury diffusion pump. Hoses on upper manifold of the valve are connected to a hydraulic system that furnishes a 25-ton force to close the valve's seal. Valve was constructed under an AEC contract.

Read INSULATION RESISTANCE

to FIVE MILLION MEGOHMS

VIBROTEST® Megohmmeters provide direct reading resistance measurements to five million megohms of electronic circuits, cable assemblies, transmission lines, motors, generators, servos, components and insulating materials. Push-button operation makes possible high speed production testing. Self-contained high voltage supply eliminates cranking and leveling. Write for complete manual.

Model 250 VIBROTEST Megohmmeter with ranges to 50,000 megohms. Complete $279.50.

HIGH VOLTAGE BREAKDOWN

Insulation Leakage Current

HYPOT Test Sets provide direct reading of insulation leakage current in accord with military and commercial test specifications. Models are available to supply a-c and d-c test potentials to 150 kv and higher. Optional features include automatic rate of voltage rise control, automatic test cycling and others to meet every test application.

Model 424 HYPOT provides 0-5000 v d-c for testing cables, condensers, coils, transformers and assemblies. Measures leakage 0.1 to 100 microamperes over four scale ranges. Rapid charging of capacitors with 5 ma. output. Self-contained power supply. Complete $497.00.

Write for Manual H-66

ASSOCIATED RESEARCH, Incorporated
"Electrical Testing Instruments Since 1936"

3787 W. Belmont Avenue • Chicago 18, Illinois

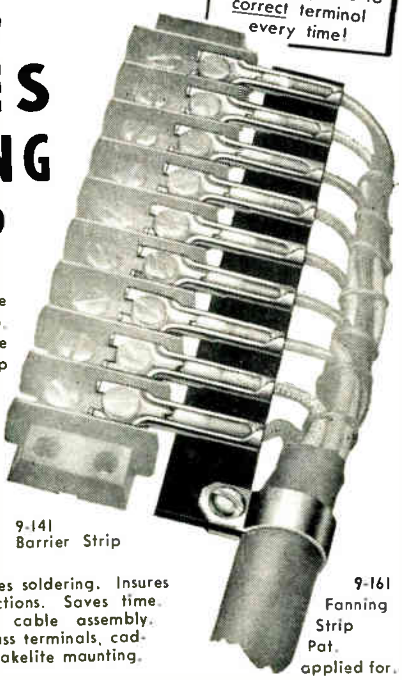
10-35.20

Circle 157 on Inquiry Card

Here's BIG HELP IN TERMINAL WIRING!

The correct wire to correct terminal every time!

The New JONES FANNING STRIP



Connections are made through Fanning Strip on bench or anywhere apart from barrier strip and quickly slipped into assembly.

Designed for use with Jones Barrier Terminal Strips Nos. 141 and 142, for 1 to 20 terminals.

9-141
Barrier Strip

9-161
Fanning Strip
Pat. applied for.

Simplifies and facilitates soldering. Insures positive correct connections. Saves time. Ideal for harness or cable assembly. Strong construction: Brass terminals, cadmium plated. Heavy bakelite mounting.

Send for complete data on this new basic improvement!

Jones

HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
CHICAGO 24, ILLINOIS
DIVISION OF UNITED-CARR FASTENER CORP.

Circle 158 on Inquiry Card

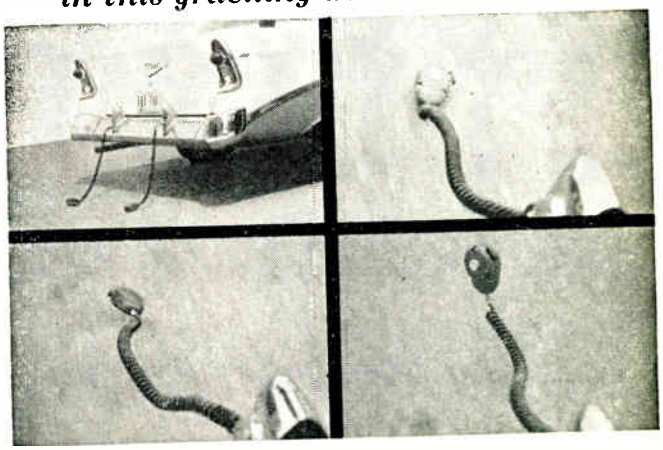
35,000 SMASHING, BATTERING IMPACTS—

and still working perfectly!

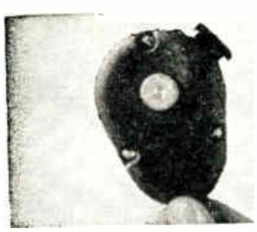
SHURE "TEN-FOUR"

COMMUNICATIONS MICROPHONE

proves its incredible durability in this gruelling destruction test!



New SHURE "TEN-FOUR" MICROPHONE, with exclusive Armo-Dur housing, and another microphone with standard die-cast metal housing were dragged for miles on a test drive over all kinds of pavements at speeds to 30 mph. In a matter of minutes, it was subjected to greater punishment than a lifetime of severest mishandling *and here's the result:*



Ten-Four with Armo-Dur Housing virtually unmarked—*still performed perfectly!*

Standard microphone with die-cast metal housing — cracked, broken, abraded—microphone inoperable.

For the microphone that stands up under severe operating conditions with no loss of high speech intelligibility, be sure to specify the Shure "Ten-Four" when you order your new communications equipment or replacements.

(Can be furnished with "Controlled Magnetic" or carbon cartridge.)

SHURE BROTHERS, INCORPORATED
222 Hartrey Avenue, Evanston, Illinois
HIGHEST QUALITY MICROPHONES — FIXED-STATION AND MOBILE

Circle 159 on Inquiry Card

Recovery Time Tester

Bulletin 60-1 from Contronics, Inc., 37 Leon St., Boston, Mass., describes a unit for the automatic measurement and recording of semiconductor diode recovery time: 1 unit can do the work formerly performed by 6 operators using oscilloscopes and auxiliary equipment by having all time and voltage discriminations performed electronically, providing faster and more accurate readings.

Circle 271 on Inquiry Card

Power Supply

Details on a 100-w-sec. stored energy welding power supply for the electronic component packaging field available from Hughes Aircraft Co., Vacuum Tube Products Div., Marketing Dept., 2020 Short St., Oceanside, Calif. Model VTW-30, delivers a step-free, adjustable range of power of 0.5 to 100 w-sec. A pulse width of less than 1½ msec assures no burning or discoloration of the weld area and no heat damage to the components being welded. Each weld pulse repeats exactly, providing uniformity to eliminate damaged components or reject materials.

Circle 272 on Inquiry Card

Toroids

New catalog (57B) describes the complete line of "Custom-designed" toroids of Cinema Engineering Div., Aerovox Corp., 1100 Chestnut St., Burbank, Calif. Complete specs are given on epoxy encapsulated and wax impregnated styles covering approx. 90% of all toroid inductor requirements. Information is provided on frequency, size and ordering. Encapsulated units meet MIL-T-27. Catalog also covers uncased, and steel cased styles available.

Circle 273 on Inquiry Card

Laminated Plastics

The 1961 edition of Formica Designer's Fact Book, a technical reference book on laminated plastics contains property and application data covering 70 standard, special, and molding grades of high-pressure thermosetting laminating plastics, military specs, a grade comparator chart, tolerance and weight specs (115-pages). Formica Corp., 4550 Spring Grove Ave., Cincinnati, Ohio.

Circle 274 on Inquiry Card

Covering Solar Cells

First in a new series of Technical Reports from the Military Products Div., Bausch & Lomb, Inc., Rochester 2, N. Y., is entitled, "Emissivity Enhancement of Solar Cells for Temperature Control." It discusses various techniques for coating these cells in order to increase cell efficiency by re-radiating heat and reducing operating temperature when they are exposed to direct sunlight. The importance of this coating is directly related to the success of current space research programs, since silicon solar cells are used as an electrical power source for satellites and other space vehicles. Major sections are devoted to: construction of coating, emissivity, solar adsorptivity, reflectance, and temperature determination. Charts and diagrams included.

Circle 275 on Inquiry Card

Terminations

Product bulletins from Sage Laboratories, Inc., 3 Huron Dr., Natick, Mass., feature 50 Ohm Coaxial Terminations (Models 920 & 921). These are wide range, low VSWR matched terminations for field and lab use.

Circle 276 on Inquiry Card

NEW MOTOROLA POWER TRANSISTORS

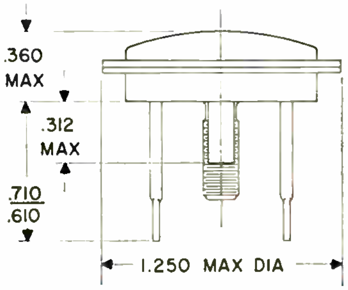
NEW "LOW SILHOUETTE" TO-36 CASE

requires 30% less headroom than other TO-36 packages.

offer 0.5° C/W MAXIMUM THERMAL RESISTANCE 150 WATTS POWER DISSIPATION

NEW MOTOROLA 15 AMP POWER TRANSISTORS

MAXIMUM RATINGS						Electrical Characteristics		
						h_{FE} @ I_C		
Type	P_c watts	T_J °C	BV_{CBO} volts	BV_{CES} volts	I_C amps	min	max	amps
2N441	150	100	40	40	15	20	40	5
2N442	150	100	50	45	15	20	40	5
2N443	150	100	60	50	15	20	40	5
2N174	150	100	80	70	15	25	50	5
2N1358	150	100	80	70	15	25	50	5
2N1100	150	100	100	80	15	25	50	5
2N1412	150	100	100	80	15	25	50	5
2N277	150	100	40	40	15	35	70	5
2N278	150	100	50	45	15	35	70	5
2N173	150	100	60	50	15	35	70	5
2N1099	150	100	80	70	15	35	70	5



Motorola power transistor reliability is now available in a new, improved "low silhouette" TO-36 package. These new devices offer many outstanding design advantages including:

- 150 watt power dissipation
- 0.5°C/W maximum thermal resistance (0.35°C/W typical)
- 100°C junction temperature
- 15 amps
- h_{FE} ranges from 20-70
- Require 30% less headroom than other TO-36 cases
- Rugged internal structure
- Improved cold weld
- 100% lot life tested to assure highest reliability

IMMEDIATELY AVAILABLE IN 1 TO 999 QUANTITIES

from your authorized Motorola Semiconductor Distributor. FOR COMPLETE TECHNICAL INFORMATION and the name of your local distributor write MOTOROLA Semiconductor Products Inc., Dept. LS, 5005 E. McDowell Road, Phoenix, Arizona

118 TYPES AVAILABLE IN TO-3 CASE

In addition to new TO-36 units, Motorola offers over 118 different standard types in TO-3 Case. 3, 5, 10, 15 and 25 amps. 90 watts power dissipation. Up to 120 volts. 0.8°C/W maximum thermal resistance. 100°C junction temperature. Special "Meg-A-Life" units offer military reliability for industrial applications.

MOTOROLA

Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

5005 EAST McDOWELL ROAD, PHOENIX, ARIZONA

Tech Data

for Engineers

Waveguide Switch

Single-page data sheet from Waveguide, Inc., Costa Mesa, Calif., describes the Model WXS waveguide switch, a single pole, double throw, manually operated switch for laboratory use. Switch features low VSWR and high isolation.

Circle 277 on Inquiry Card

Display Device

Four-page, 2-color bulletin from Kearfott Div., General Precision, Inc., Little Falls, N. J., describes the Digistrobe, a digital display device which uses the stroboscopic principle to provide an in-line, in-plane, high-definition, white-on-black display. A single display can be used to sample several inputs on command. Bulletin includes design features, schematics, and specs.

Circle 278 on Inquiry Card

I-F/R-F Microwave Catalog

Catalog describes Company's line of modular i-f amplifiers, automatic frequency controls for klystrons, microwave i-f converters and high temperature transistorized power supplies. The 8-page, 2-color bulletin gives engineering information on all models. Orion Electronic Corp., 108 Columbus Ave., Tuckahoe, N. Y.

Circle 279 on Inquiry Card

Power Oscillator

Tech data sheet from W. L. Maxon Corp., Instruments Div., 475 Tenth Ave., New York 18, N. Y., describes their UHF Wideband Power Oscillator Model M1141. Descriptive data and tech data included. Unit features a frequency range from 200 to 2500 MC (in two bands) and Power output from 10 to 40 watts (varies with frequency).

Circle 280 on Inquiry Card

Ceramics

Technical data sheets from National Beryllia Corp., 4501 Dell Ave., No. Bergen, N. J., describe their Berlox[R] and Berlox EM[R] beryllium oxide ceramic bodies fabricated in vacuum tube envelopes, heat sinks, rods, tubes, washers and other shapes. Information includes physical, thermal, mechanical and electrical properties.

Circle 281 on Inquiry Card

Test Equipment

A 5-page, 2-color Bulletin 400 categorizes products by frequency range, waveguide size and price. Featured are attenuators, isolators, slotted sections, mounts, frequency meters, adapters, klystron power supplies and coaxial equipment. PRD Electronics, Inc., 202 Tillary Street, Brooklyn 1, N. Y.

Circle 282 on Inquiry Card

. . . an infinite variety of standard plastic parts
available without tooling cost

HARRY DAVIES MOLDING CO.
1428 N. Wells Street, Chicago, Ill.

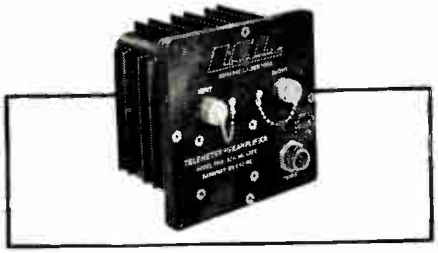
FREE CATALOG
•
samples on request

Circle 320 on Inquiry Card

TELEMETRY PREAMPLIFIER

for Reliable

LOW NOISE RECEPTION



The LEL TP-5 Telemetry Preamplifier is designed to be installed at a telemetry receiving antenna. The unit is weatherproofed for outdoor use. Ceramic tubes are used to provide a low noise figure and stable performance without forced air cooling.

Specifications:

Gain	23db
Bandpass	215-260mc
Noise Figure	3.5db Typical
Weight	6 lbs.
Size	7-7/8" x 8" x 4-3/4"

LEL INC

Send for comprehensive Microwave, IF, RF Amplifier Catalog.

75 AKRON ST., COPIAGUE, N. Y.

Circle 321 on Inquiry Card

Large production gives you low prices!
– that's why...

Over 100 O.E.M.s have standardized on

AMPERITE

Thermostatic DELAY RELAYS

2 to 180 Seconds

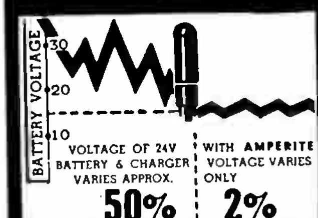
Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
Hermetically sealed. Not affected by altitude, moisture, or climate changes.
SPST only—normally open or closed.
Compensated for ambient temperature changes from —55° to +80° C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived, and—inexpensive!**
TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.**

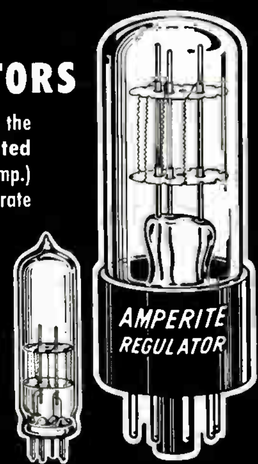
Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to +70° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE

561 Broadway, New York 12, N. Y. . . . CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

Circle 322 on Inquiry Card

Tech Data

for Engineers

DC Power Supplies

"Tung-Sol Tips," No. 11, Sept. 1960, (a monthly publication of Tung-Sol Electric, Inc., 95 8th Ave., Newark 4, N. J.) features an article on dc power supplies. It is illustrated with curves, tables, schematics, and a trouble shooting chart.

Circle 283 on Inquiry Card

Coaxial Hybrid Mixers

Mullard Equipment Ltd., Mullard House, Torrington Pl., London (England) offers a data sheet describing mixers for S and X-band frequencies. Design is based on a coaxial phase-reversal hybrid circuit which will operate over a 3:1 frequency range without tuning, and which can be scaled in dimensions for each band.

Circle 284 on Inquiry Card

Dip-Brazing

Four-page brochure discusses Aluminum Dip-Brazing, a process that allows perfect joining of aluminum to form homogeneous parts. It offers a strength of weld equal to or better than the parent metal. Also: a data sheet describing the company's miniature C band Triode Oscillator. Sheet includes outline drawing, tech data, and curves (frequency vs. power). John Gombos Co., Inc., Webro Road, Clifton, N. J.

Circle 285 on Inquiry Card

Millimicrosecond Data

Wall chart from Lumatron Electronics, 116 County Courthouse Rd., New Hyde Park, L. I., N. Y., includes: frequency-time conversions; attenuator design; capacitive reactance; step function response of line terminations; db-voltage ratio conversions; delay characteristics of coaxial cable; and ratio of inner to outer dia. of coaxial devices.

Circle 286 on Inquiry Card

Power Generators

Series of data sheets from Raytheon Co., 100 River St., Waltham 54, Mass., describe the Company's Power Generators. Included are Models PGM 100 and 101 for laboratory use (power output of 800 w at 2450 MC); they feature variable power from 250 to 800 watts, standard RG 104/U waveguide output; both 120 cycle and 10% modulated dc operation, and peak power as high as 1125 watts.

Circle 287 on Inquiry Card

Indicator

Single page data sheet, bulletin S-259, from Specialties, Inc., Charlottesville-Albemarle Airport, P. O. Box 888, Charlottesville, Va., features the Specialert Signaler, a fast, positive indication of electrical failure or functional information. It offers a printed display and can be used in circuits requiring from 1 to 220 vac/dc.

Circle 288 on Inquiry Card

Optical Maser

(*Continued from page 7*)

Bell Laboratories' scientists R. J. Collins, D. F. Nelson, A. L. Schawlow, W. L. Bond, C. G. B. Garrett, and W. K. Kaiser described their physical experiments with an optical maser in the current issue of "Physical Review Letters." The working substance was synthetic ruby, a material originally proposed for use in optical masers by Schawlow. It was used in the manner originated by T. H. Maiman of Hughes Research Laboratories, who first observed optical maser effects in ruby.

The heart of the Bell Laboratories optical maser is a synthetic ruby rod, 1½ in. long and 1/5 in. in diameter. The two ends were polished until extremely flat and parallel, then covered with a reflecting layer of silver thin enough to be slightly transparent. This ruby rod was held in the center of a spiral photoflash lamp, and illuminated with an intense flash of ordinary white light.

The investigators found that when the power applied to the flash lamp exceeded a certain value, a nearly parallel beam of light was emitted through the silvered ends. This light was red, like the ordinary fluorescent light from ruby, but differed from it in several important ways. First, it was sixty times closer to being "monochromatic" (of a single frequency) than the ordinary fluorescent light from ruby.

Secondly, the light was shown to be "coherent," or of a single phase. This was demonstrated by arranging two fine, parallel slits in a thick silver coating on one end of a ruby rod. The pattern of emerging light showed that the light from one slit was "interfering" with the light from the other, indicating that the emitted light was in phase across the end of the rod.

Thirdly, almost all of this monochromatic light was emitted within a cone angle of only .1°. Within this cone, the intensity of the light was far higher than could be obtained by the ordinary fluorescent process.

The coherent light was found to be emitted in intense short bursts, each in the order of a millionth of a second long. With the present flash lamp, maser action could be sustained for about a thousandth of a second, during which several hundred of these bursts were observed.

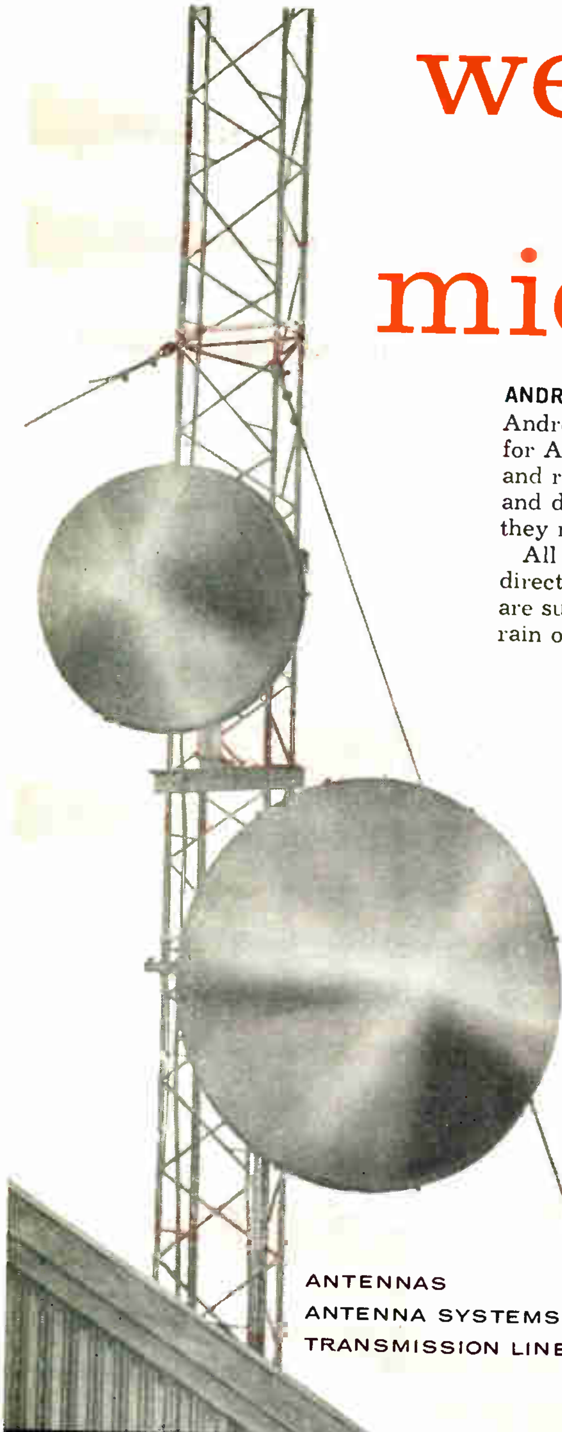
SOCIAL SECURITY RECORDS

Twelve Electronic Data Processing Systems, (five RCA 501's and seven RCA 301's) will be installed on Jan. 1, 1961 by the Bureau of Old Age and Survivor's Insurance in seven payment centers to handle the nation's voluminous Social Security paperwork.

Fighter-Bomber Control System Built by Hughes

A new aircraft electronic system, TARAN (Tactical Attack Radar and Navigation), developed by Hughes Aircraft Co., Culver City, Calif., enables a fighter-bomber to fly hedge-hopping missions in adverse weather and to avoid detection by darting in below an enemy's radar cover. The system makes possible the operation of tactical aircraft by electronic control much as all weather interceptors do. TARAN was especially designed to fit into a small, fast fighter aircraft and would be easily operated. It has three basic capabilities: navigation, air-to-ground attack and air-to-air attack. One of TARAN's features is a "terrain avoidance" mode enabling the radar to "see" only those objects high enough to be dangerous to the aircraft. "Ground mapping" is an added feature, designed to aid blind flying. In this mode the radar scope displays a "picture" of the terrain beneath the aircraft so that the pilot can orient himself and compare the radar picture to the navigational map display. These features were developed to enable to pilot to fly out to a distant target, destroy it and return to base without ever actually seeing the enemy or ground at any time.

The problem of building a high degree of versatility into such a small system was overcome by new miniaturization and packaging techniques, by integrating components in such a way that the same units perform both armament control and navigation functions, and by building a radar of microwave frequency.



weather conditioned microwave

ANDREW RADOME EQUIPPED ANTENNAS DEFY ICE...SNOW...WIND

Andrew radomes provide excellent 2-way year-round protection for Andrew microwave antenna systems. First, they protect feed and reflecting surface against the attenuating effects of snow, ice and debris accumulation. Secondly, for tower mounted antennas they reduce the effects of wind thrust by 35%.

All Andrew radomes are lightweight and easy to install—clip directly to the dish rim of existing antennas. Unheated radomes are suitable for all but exceptional cases. In areas where freezing rain occurs, heated radomes can be provided.

SPECIFICATIONS

STANDARD RADOMES

Dia. Feet	Type No.	Attenuation @ 6 kmc. db	VSWR Contribution @ 6 kmc	Thrust at* 30 psf (Flats), lbs.
10	R10	0.4	0.02	1,990
8	R8	0.4	0.02	1,270
6	R6	0.4	0.02	714
4	R4	0.4	0.02	320
2	R2	0.4	0.02	75

*Including antenna

HEATED RADOMES

Dia. Feet	Type No.	Attenuation @ 6 kmc. db	VSWR Contribution @ 6 kmc.	Thrust at* 30 psf. (Flats), lbs.	Power** Reqmts.
10	HR10	0.7	0.02	1,990	3,400 watts
8	HR8	0.7	0.02	1,270	2,400 watts
6	HR6	0.7	0.02	714	1,200 watts
4	HR4	0.7	0.02	320	550 watts
2	HR2	0.7	0.02	75	150 watts

*Including antenna

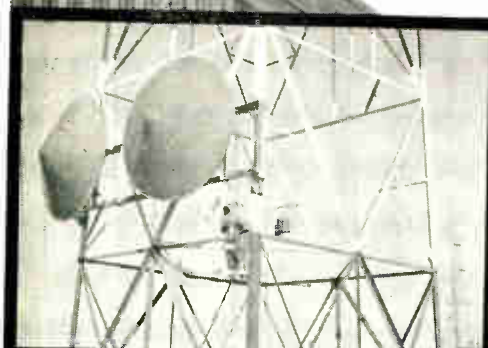
**Power requirements for HR10 and HR8 are 3 wire single phase 60 cycle 220 volts.

Power requirements for HR6, HR4 and HR2 are single phase 60 cycle 115 v.

For further details on ANDREW Microwave Antennas, Radomes, Wave Guides write for new Andrew Catalog M.

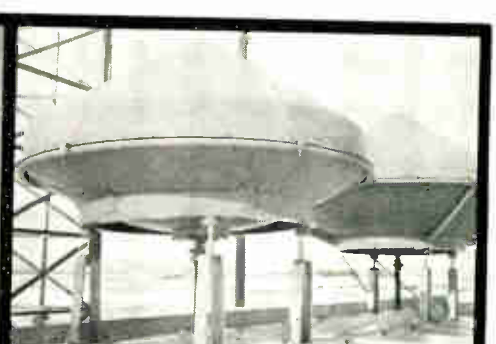
ANTENNAS
ANTENNA SYSTEMS
TRANSMISSION LINES

ANDREW
Andrew CORPORATION
P. O. Box 807, Chicago 42, Illinois
Boston • New York • Washington • Los Angeles • Toronto



"We have paid particular attention to antennas during high wind conditions of gusts up to 40-60 m.p.h. It is very obvious that these radomes quite materially reduce the wind loading on the parabolas—due to their shape factor." *Washington State Patrol, Kennewick, Washington*

"We have had up to four inches of ice on the radome with practically no reduction of antenna effectiveness." *KLIX-AM-TV, The KLIX Corporation, Twin Falls, Idaho*



"Our field forces report that the radomes produce a signal loss of less than 1 db per antenna. Several radomes were removed and antennas inspected following a heavy snow storm and no snow or ice was found in the antennas." *Natural Gas Pipeline Company of America*

Tele-Tech's
ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • NOVEMBER 1960

SYSTEMS—WISE . . .

▶ A new communications system demonstrated by Infrared Industries, Inc., Waltham, Mass. uses infrared radiation as the voice carrier. A hand-held, self-powered Infraphone (about the size of a home movie camera) is "aimed" at another unit anywhere within its line-of-sight. Both phones are identical transmitter-receiver units. Range of operation is hundreds of yards—clarity is comparable to telephone.

▶ NAB contends that the FCC is the final authority in determining whether construction of a radio or TV tower constitutes a hazard to air navigation. The action was taken in answer to a statement by the Federal Aviation Agency seeking final approval by the aviation agency before such towers could be built.

▶ A policy statement by T. Keith Glennan, NASA head, has been hailed by Homer R. Denius, Pres., Radiation Inc., Melbourne, Fla. The statement offered NASA's assistance to private industry for development of radio satellite communications systems. Courier satellite, launched Oct. 5 demonstrated feasibility of these systems. Radiation, Inc. has proposed systems for 24-hr satellite programs.

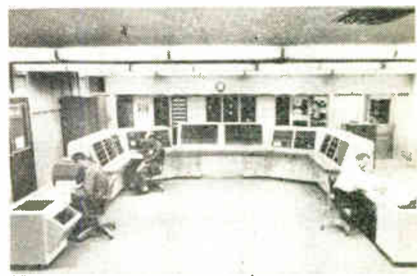
▶ Panel 5 of EIA's National Stereophonic Radio Committee has completed tests several weeks ahead of schedule. Upon correlation, the data collected will be presented for review by the NSRC Coordination Committee prior to submission to EIA for filing with the FCC. Tests measured transmission and stereophonic reception of 6 stereo FM systems and evaluated compatibility of monophonic receivers to the broadcasts.

"NOISIEST" SPOT IN TOWN

Insulated noise room, built by Shure Brothers, Inc., to aid development of better noise-discriminating microphones duplicates loudest sounds man can produce. Though generated sound inside is intense, D. O. Rail's voice is transmitted clearly, with background noise muffled. A. J. Brouns sits at the control panel, monitoring.

▶ IBM's 1009 links magnetic core memories of solid-state IBM 1401 computers over regular local or long distance telephone or telegraph lines allowing two-way communication between computers at the rate of 150 numbers or letters per second. With IBM's 1009, the IBM 1401 can function as either a data transmission or data receiving terminal, as well as a regular data processing system.

ELECTRONIC DATA SYSTEM



Flight testing at G.E.'s Flight Test Facility of its 193-3 turbojet engines, slated for the 2,000 mph B-70 bomber will be speeded up by installation of a data processing system and companion airborne data acquisition system, secured from Radiation Incorporated, Melbourne, Fla. Advanced systems combine analog and digital techniques using pulse code modulation.

▶ NAB's Selection Committee has elected Governor Leroy Collins of Florida as its President, succeeding the late Harold E. Fellows. He was elected for a three-year term, beginning in January, at $75,000 per year.

▶ Electrical signals have been sent for over a hundred miles from a transmitting station deep in a mine shaft. Experiments were conducted by Space Electronics Corp., 930 Air Way, Glendale, Calif. for the Air Force. The Air Force feels the technique can furnish possible communications for buried sites.

▶ An image translator to measure photographic traces of missile trajectories is being developed for the Army by Gilliland Instrument Co., Oakland, Calif. The $100,000 system will measure X and Y co-ordinates of point or line images to within one microm. Trajectory can be measured in minutes. System will be similar to the company's "Franckenstein" Image Translators which are used for satellite orbit computation and nuclear research.

▶ FCC requests that U. S. licensees or applicants with international broadcasting problems refer them to the FCC rather than deal directly with foreign licensees or foreign governments. Unauthorized negotiations involve the risk of violating U. S. laws which prohibit certain types of "correspondence or intercourse" with foreign governments.

▶ The 1960-61 TV Committee on Video Tape Usage has been selected by the Policy Committee of NAB. Willard A. Michaels, WJBK-TV, Detroit, Mich., is chairman.

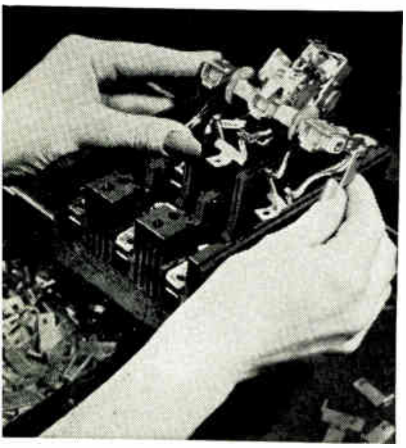
Important facts to know about Laminated Plastics

LAMINATED PLASTICS *What they are, where they can be used*

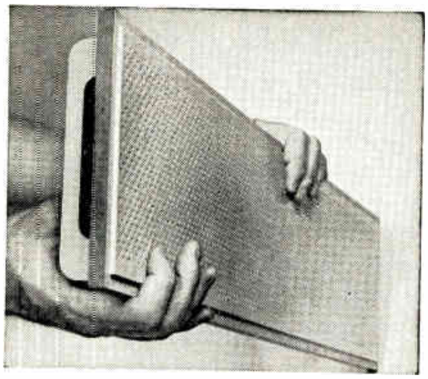
Taylor laminated plastics, also known as reinforced plastics, are thermosetting-type materials formed by impregnating paper, cotton cloth, asbestos, glass cloth, nylon or other base materials with synthetic resins and fusing them into sheets, rods, tubes and special shapes under heat and pressure. These materials exhibit a valuable combination of characteristics, including high electrical insulation resistance, structural strength, strength-to-weight ratio, and resistance to chemical reaction; also adaptability to fabricating operations.

ypes of laminated plastics made by Taylor

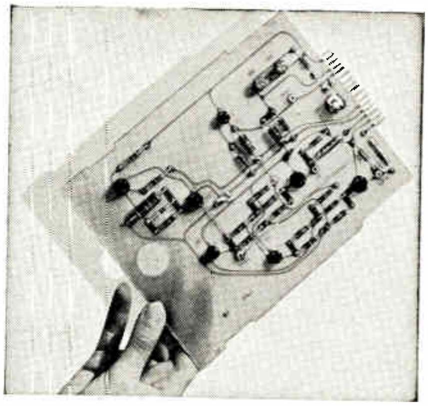
There are four basic types of Taylor laminated plastics commonly specified and used throughout industry today. They are as follows:



henolic Laminates. Paper, cotton fabric or mat, asbestos, glass cloth or nylon bases impregnated with phenol formaldehyde resins. These provide strength and rigidity, dimensional stability, resistance to heat, chemical resistance, and good dielectric characteristics. Some Taylor grades are excellent basic materials for gears, cams, pinions, bearings and other mechanical applications. Others are widely used in terminal boards, switchgear, circuit breakers, switches, electrical appliances and motors. Also in radios, television equipment and other electronic devices; and in missiles as nose cones, exhaust nozzles, and combustion chamber liners.

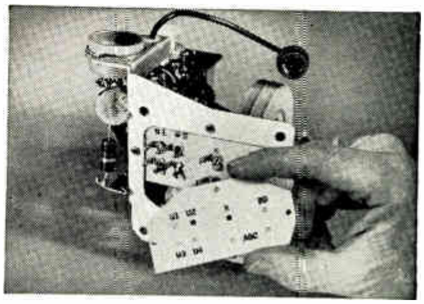


Melamine Laminates. Glass cloth or cotton fabric impregnated with melamine formaldehyde resin. Taylor melamine laminates have superior mechanical strength and are especially desirable for their arc-resistant qualities. Good flame and heat resistance, good resistance to the corrosive effects of alkalis and most other common solvents, besides other favorable characteristics. Typical applications include arc barriers, switchboard panels, and circuit-breaker parts in electrical installations.



Silicone Laminates. Continuous-filament woven glass fabric impregnated with a silicone resin. These laminates combine high heat resistance (up to 500°F. continuous) with excellent electrical and mechanical properties. They are primarily used in high-temperature electrical applications and high-frequency radio equipment.

Epoxy Laminates. Continuous-filament woven glass fabric or paper impregnated with epoxy resin. Glass-fabric grades are designed for use in applications requiring high humidity-resistance, good chemical resistance,



and strength retention at elevated temperatures. Paper grades are used under high-humidity conditions where resistance to acids and alkalis is required. Both grades are characterized by good dielectric strength, low dielectric losses, and high insulation resistance even following severe humidity conditions.

• • •

Recent technical advances in the bonding of various metallic and nonmetallic materials to laminated plastics have opened up new design opportunities. It is now possible to bond virtually any compatible material with a laminated plastic to form a composite which combines the advantages of both. One of the first composite materials was a copper-clad laminate used for printed circuits. More recent composite laminates, usually manufactured to customer specification, include the following: Taylorite® vulcanized fibre-clad, rubber-clad, asbestos-clad, aluminum-clad, beryllium-copper-clad, stainless-steel-clad, magnesium-clad, and silver- and gold-clad. Any one of these materials can be sandwiched between sheets of laminates, too, and can be molded to fit specific requirements.

Send for complete information about any or all of these Taylor laminates. And remember Taylor's new selection guide will simplify your problems in choosing the right laminate for your specific application. Taylor Fibre Co., Norristown 53, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

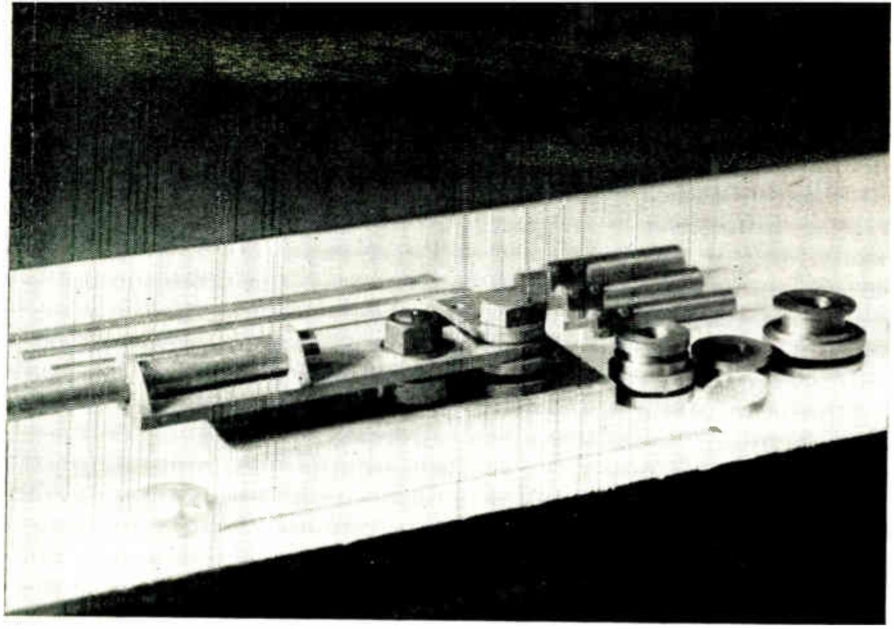


Fig. 1: Waveguide bender and twisting device for shaping small waveguide will cut costs.

By **HARLIN L. BUNN**

Electronic Engineer
University of California
Lawrence Radiation Lab.
P. O. Box 808
Livermore, Calif.

For Custom Installations . . .

Make Your Own Waveguide Bends

Costs can be sharply reduced on custom waveguide installations by bending and twisting your own waveguide. With the simple bender described here relatively unskilled persons can make these bends and twists.

IN the course of providing microwave diagnostic systems for the Sherwood Physics groups, the Microwave Diagnostic Group has had to provide various and sundry waveguide runs. These runs necessitated the use of E- and H-plane bends and waveguide twists for maintaining the correct polarization.

The past practice has been to purchase these units from outside vendors and install them in the system. A typical system might involve the use of a half dozen bends and from two to four waveguide twists. Depending on the band used, the cost of bends range from $30 to $50 each, and twists cost about $50 each. The total cost would amount to perhaps $500 for seemingly insignificant transmission line sections for one system.

The Sherwood activity encompasses frequencies from X-band to 3 mm so that a very sizable amount of money must be invested in waveguide sections. A typical order for bends covering three bands comes to about $1,000. This order was cancelled after the design of the machine to be described was completed. Estimated cost using the machine was $250.

Waveguide flanges cost about $2 each. The cost of RG96/U waveguide per foot is about $4.50, and three or four bends can be made from a foot of waveguide. It is easy to see that if relatively unskilled technicians are used, these bends can be made for no more than $15 each, once an initial set up is made. Small numbers such as two or three pieces of course would not pay as it would be cheaper to buy them. However, many such items are required in the Sherwood work and the author has designed a very simple machine for making bends and twists.

With this machine we can provide a very long run of waveguide which includes many such twists and bends with only two flanges for a standard length of waveguide. An electrical advantage is gained through this practice as there is resistive loss associated with each set of coupling flanges. This can be very important in the 50-100 KMC range. Relatively large losses can be acquired in this frequency range with the use of several sets of flanges.

In addition, there is a theorem which says that we can obtain a standing wave ratio for two com-

Work performed under auspices of the U. S. Atomic Energy Commission.

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

Waveguide Bender
(Continued)

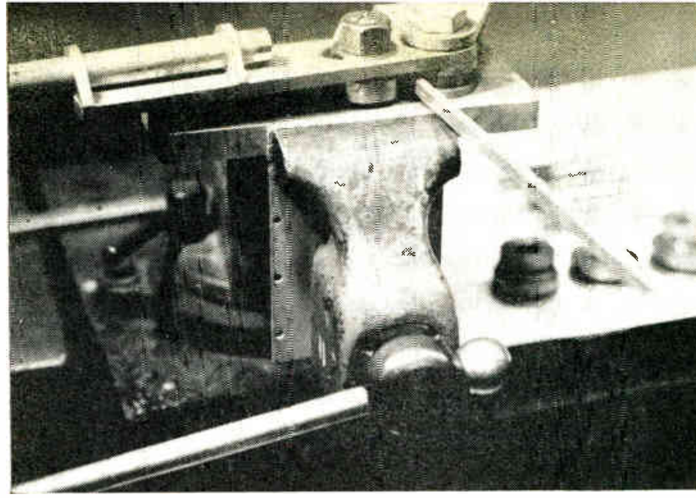


Fig. 2: Waveguide is positioned in device for making a bend.

ponents connected in tandem which can have a value between the dividend and the multiplicand of the individual ratios. It is easily seen that with several components it is possible to obtain relatively high values of standing wave ratio. This can be quite important in receivers used for determining electron temperatures. The elimination of several sets of flanges for a custom installation can be very beneficial in eliminating these two sources of electrical disturbance.

Bending Machine

Figure 1 shows the basic machine. A roller is attached to the base plate at the right hand end by means of a metal plate and a pivoting pin. A rectangular groove is machined in the roller. This groove has the outside dimensions of the waveguide being bent. For example, for an E-plane bend in RG96/U, a groove 0.365 inches high by 0.225 inches deep is machined in the section. Attached to the pivot screw is a bending arm on which is mounted a ball bearing solid roller that presses against the waveguide. A slot is provided in the bending arm for adjusting the position of the roller. Figure 1 shows three sets of rollers for making E- and H-plane bends in the waveguide bands 18-26.5 KMC. 26.5-40 KMC, and 50-75 KMC. Also shown are sections for making twists in these bands.

Forming Bends

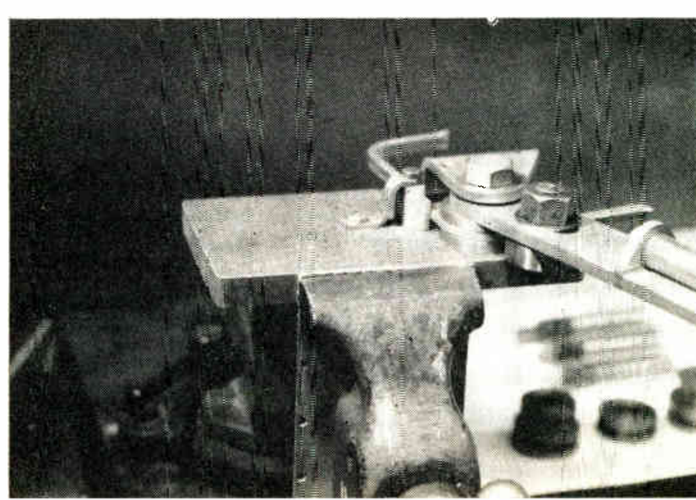
To begin with, the waveguide must be filled with some material which will prevent the inside surface of the guide from collapsing. One end of the waveguide is pinched in the vise and the filler is introduced and packed tightly. This must be done with a hammer and a rectangular section whose dimensions correspond to the inside dimensions of the guide. The packing should be done as the filler is introduced, not after it is completely filled. When the filling is complete, the other end of the guide is pinched tightly and the waveguide is inserted in the machine.

Figure 2 shows the waveguide mounted in the machine ready for bending. The waveguide should be clamped to the base plate by means of a "C" clamp to prevent its moving when pressure is applied for bending. The other end of the guide is left free as seen in the figure. Figure 3 shows the waveguide after the E-plane bend is made. Figure 4 shows the same piece set up with the H-plane roller in preparation for making the H-plane bend. Figure 5 shows the section after the H-plane bend is made.

It is important to use the correct filler in the waveguide. The author's experience has been that low melting point metals such as cerobend are unsuitable as it is practically impossible to remove all the bits and pieces. This shows up in bench measurements as high standing wave ratios and excessive insertion loss. The filler found to be most suitable was a fine type of sand used in foundries and known by the name "San Diego Fine." This packs quite well and does not scratch the surface of the waveguide.

After the bending is complete, the pinched-off ends of the waveguide are sawed off and flanges are soldered on. This completes the op-

Fig. 3: An E-plane bend is shown completed in bender.



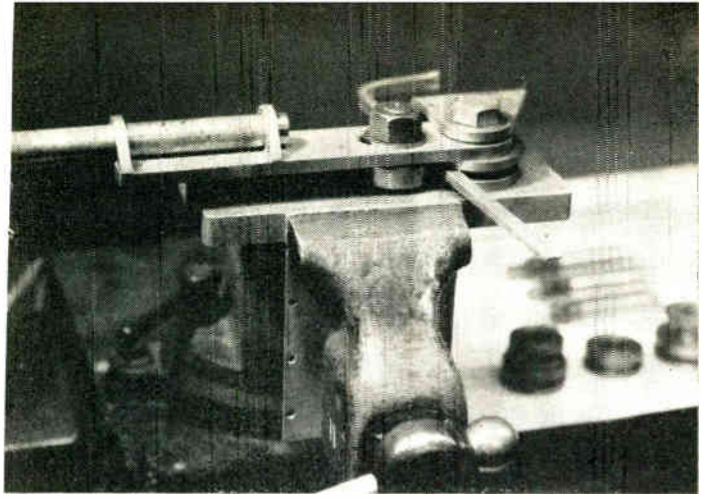


Fig 4: Rollers are changed for an H-plane bend in guide.

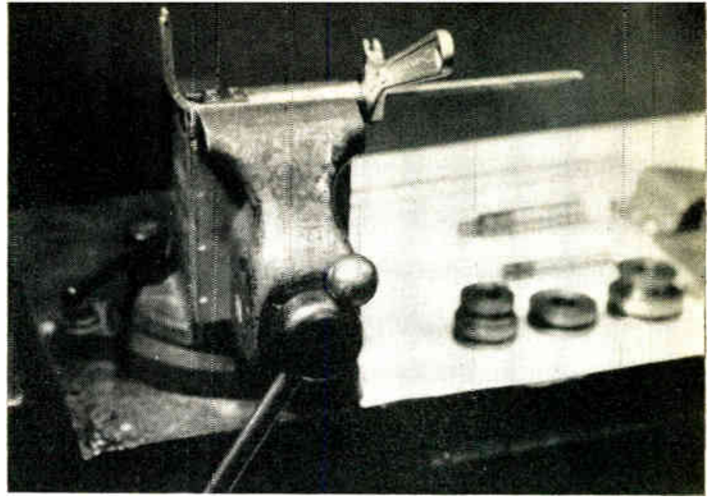


Fig. 6: Waveguide is positioned for making a twist with wrench.

eration. The sand is removed by a fine jet of high pressure air. A vacuum cleaner can be used to catch the sand.

Making Twists

The device for making twists is a length of a cylindrical section whose inside dimensions will just clear the outside diagonal of the rectangular waveguide. On one end of the section, a flat surface is milled away until it is barely touching the top of the inserted waveguide. A flat tab is screwed to this surface to prevent the waveguide from turning in the section. This can be seen clearly in Figures 1, 6, and 7. The same procedure for filling mentioned above is followed.

Figure 6 shows the waveguide section after the E-plane bend has been made with the section attached for twisting. The length of twist is controlled by the length of the cylindrical twisting section. The twist attachment is inserted very simply by sliding it on the straight end of the waveguide with the end of flat tab loose. The tab is then tightened, and a torque is applied with an adjustable wrench as shown in Fig. 6. After the twist was made, the tab was loosened and the twist section slipped off. The H-plane bend was then formed. Figure 7 shows the completed section with the E-plane bend, the twist, and the H-plane bend. Shown also are the three twist sections with short pieces of waveguide assembled to illustrate the procedure.

The completed section was made to illustrate the procedure. In practice, we would probably want to use much longer runs. There is no limitation on the length involved except that the waveguide comes in standard lengths. Allowance must be made for the end sections which are sawed off.

Sample sections were cut open and the dimensions measured after the bends were made. The dimensions had changed about 0.005 to 0.010 inch. A different filler could eliminate this change but it is not serious. A slight change in the cutoff frequency and the waveguide impedance may result. Bench measurements showed the units to have lower standing wave ratios than most of the commercially available units in the possession of the Diagnostics Group.

Acknowledgment

The author wishes to express his thanks to Ralph Senechal, Electrical Engineering Aide, who constructed the machine and formed the guides shown. Previous experience gained in working with certain shop personnel at ITT Laboratories, Nutley, New Jersey, was also very helpful in formulating the design.

Fig. 5: H-plane bend is shown completed in waveguide.

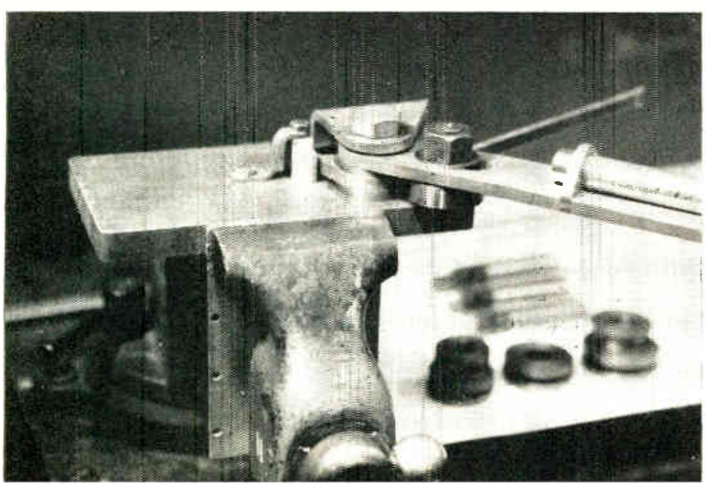


Fig. 7: Complete set of units for shaping waveguides are shown.

CUES for Broadcasters

Electrical Thermometer

SIEGFRIED S. MEYERS, Ph.D

Regents Educational TV Project
N. Y. State Dept. of Ed.
Albany, N. Y.

The increase in electrical resistance of a tungsten filament with rising temperature is used to indicate temperature by employing such resistance changes as a shunt across the movement of a 0-200 range microammeter in a conventional ohmmeter circuit. Fig. 1 shows the circuit of a modified ohmmeter in which a momentary dpst toggle switch is used to first calibrate the scale for cell-voltage deterioration and then to read the unknown temperatures.

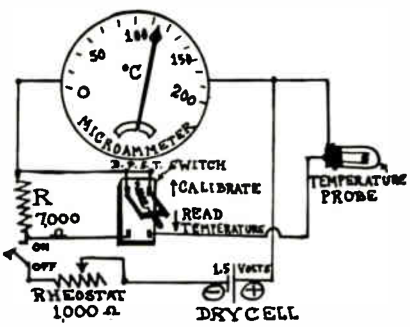


Fig. 1: Tungsten filament bulb is used as a temperature sensing probe in conjunction with a microammeter.

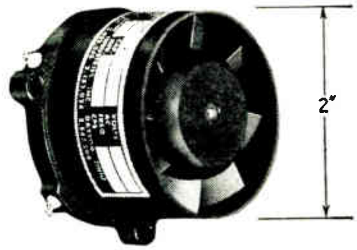
When the switch lies in the normally-released or open position the ohmmeter is zero-adjusted by means of the 1000 ohm rheostat in a conventional ohmmeter circuit. When the switch is manually held down against spring tension to its operated-position the 7000 ohm fixed resistor is short-circuited; and the tungsten temperature probe (G.E. #47 radio pilot lamp) is shunted directly across the microammeter movement. (Fig. 2.)

Fig. 2: Completed electrical thermometer, along with temperature probe is shown.

As the temperature increases, the tungsten's resistance increases. Hence, more current flows from the dry cell through the microammeter across which the tungsten probe is shunted. The scale readings are then calibrated for temperature values by direct comparison with the observed readings of a standard thermometer.

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double spaced text is requested. Our usual rate will be paid for material used.



NEW 2" BLOWERS a.c. or d.c.

Globe's new 2" diameter VAX-2 vaneaxial blowers give you substantial amounts of cooling air in a rugged, compact, lightweight package. Check over these two blowers.

VAX-2-MC. Designed for 50 cfm. @ 2.1" H_2O back pressure, unit operates on 200 v.a.c., 400 cycle, 3-phase or 115 v.a.c., 400 cycle, 1-phase. Variable speed high altitude units available. Length is 1½"; weight is 5 oz. Flange mounting. Designed for MIL specs.

VAX-2-MM. Designed for 41 cfm. @ 1.5" H_2O back pressure, unit operates on 26 v.d.c., but other versions may be wound for up to 115 v.d.c. operation. Length is 2"; weight is 5 oz. Flange mounting. Designed for MIL specs.

Request Bulletin VAX-2 from Globe Industries, 1784 Stanley Avenue, Dayton 4, Ohio.

GLOBE

GLOBE INDUSTRIES, INC.

Circle 336 on Inquiry Card

THUMBWHEEL SWITCHES

TABET U.S. Patent 2,841,660

Binary & Digital

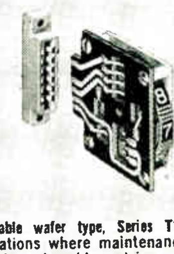
C·D·I

- For Critical Reliability Applications.
- Available with internal lighting MIL-L-25467A.

Permanent wafer type, Series TSD-P. Only ½" panel space needed per module. Also available in multi-deck series TM.

Removable wafer type, Series TSD-R. For continuous operation applications where interruptions must be held to an absolute minimum.

Permanent wafer type, Series TSB-P. Available in 8, 10, 12 or 16 positions, up to 36 switches per assembly.



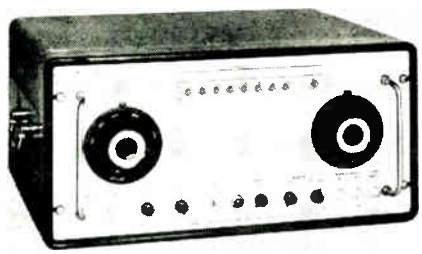
Removable wafer type, Series TSB-R. For applications where maintenance time is valuable and rapid servicing a necessity.

CHICAGO DYNAMIC INDUSTRIES, Inc.

C·D·I PRECISION PRODUCTS DIVISION
1725 Diversey Blvd., Chicago 14, Illinois
Phone: WEllington 5-4600

Circle 337 on Inquiry Card

SWEEP GENERATORS FOR THE MICROWAVE FREQUENCIES 950-2450 mc



Telonic's new ED-1A and ED-4A Sweep Generators provide a flat, stable, swept signal source for operation in the region of 950 to 2450 mc. The ED-1A operates in the 950 to 1800 mc range, and the ED-4A covers 1450 to 2450 mc. Both instruments feature variable sweep width and have an output of over 0.3 volts RMS into 50 ohms.

The instruments use a 6AF4A tube to excite a harmonic generating diode that provides an output, filtered to deliver only the second harmonic. Signal level is well isolated from the source to the load and is held constant by a leveling circuit.

Several accessories such as harmonic markers, fixed markers, and detectors are available to extend usefulness of both instruments in laboratory-type applications.

Model	Center Frequency Range	Swept Range	Swept Width	Price
ED-1A	1000-1700 mc	950-1800 mc	.05-8%	1495.00
ED-4A	1500-2400 mc	1450-2450 mc	.05-8%	1495.00

For complete data on the ED series or other Sweep Generators and accessories write to

Telonic INDUSTRIES INC.
Beech Grove, Indiana

Circle 338 on Inquiry Card

Contour Mapping Process Automated With Digitizer

New Digitizer, built for Lockwood, Kessler & Bartlett, Syosset, L. I., N. Y. by AIL Div. of Cutler-Hammer, Inc., Mineola, N. Y., works from aerial photos, in conjunction with Wild Stereoplotter, key device in Photogrammetric process of mapmaking, recording coordinates from photos on paper, in light signals, and on punched paper

Coordinates, elevations and other data obtained by viewing matched aerial photos in the Stereoplotter go automatically to the Digitizer. Recorded information is then fed to an electronic computer for all necessary calculations.

RCA Boosts Output Of Nuvistor Tubes

RCA's Nuvistor electron tube production is being stepped up with the installation of high-speed machinery at the Harrison, N. J. plant.

A new commercial version of the tube, the RCA-6CW4 high mu triode, is the heart of a "New Vista" tuner used in RCA's black and white TV receivers.

Engineering sampling of a developmental, small-signal general purpose tetrode (A-2654E) has also been successfully tested.

FIRE CONTROL DIRECTOR

Small drive motor used in Polaris Missile Inertial Guidance System is contrasted with new Fire Control Director, MK 73. Used with the AN/SPG-51 Radar to track and illuminate enemy aircraft traveling at supersonic speeds, the gearless power drive is displayed by co-inventor, E. B. Canfield, Advanced Control Engineer, G. E. Ordnance Dept., Pittsfield, Mass.

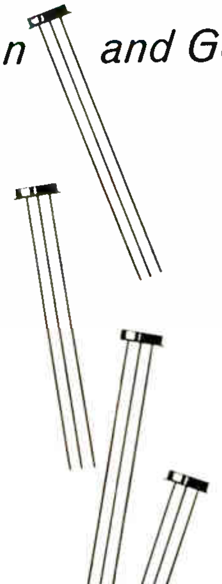
New Sylvania concept in

MICROMINIATURIZATION

wafer thin! feather light!

"PANCAKE" TRANSISTORS

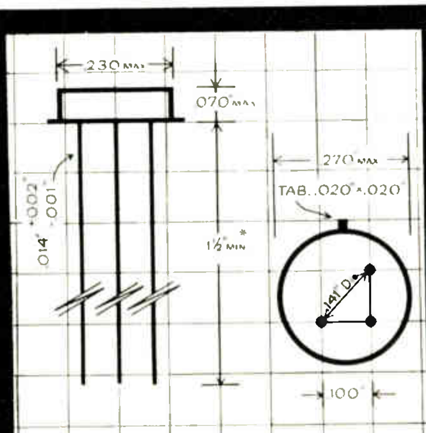
In Germanium Alloy-Junction and Germanium Mesa Structures



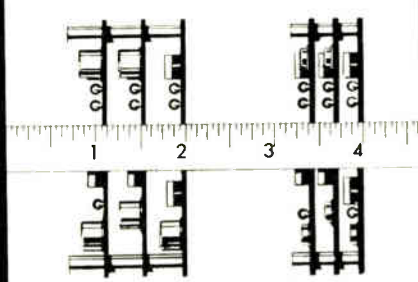
. . . offering exceptional volumetric efficiency (85% smaller, 85% lighter than electrical counterparts) • increased ruggedness • correct pin-circle geometry for 100-mil automation grid system.

Sylvania announces 10 switching transistors in the new "PANCAKE" package – shorter in height than the diameter of conventional ½-watt resistors, flatter than conventional silvered-mica capacitors. All types feature clear glass, stress-free matched seals, true chemical bonds that offer exceptional hermetic reliability and strength, excellent resistance to thermal shock. They withstand atmospheric pressure as high as 200 p.s.i., enabling high-pressure leakage tests for military-industrial quality assurance.

For information on these and other "PANCAKE" types under development utilizing mesa and alloy-junction techniques, contact your Sylvania Representative. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 1811, Woburn, Mass. Sylvania "PANCAKE" TRANSISTORS also available through Sylvania franchised Semiconductor Distributors.



*SYL-2120, SYL-2189 available with .500" leads. 1.50" leads optional



Board at left uses conventional, relatively tall TO-5 transistor package.

Board at right uses the new SYLVANIA "PANCAKE" package. Note the increased volumetric efficiency.

Sylvania "Pancake" Transistors		Electrically Similar Type
Germanium Alloy-Junction Types		
		(TO-5 package)
2N1684	PNP	2N404
2N1685	NPN	2N388
2N1779	NPN	2N377
2N1780	NPN	2N385
2N1781	NPN	2N1605
2N1782	PNP	2N396
2N1783	PNP	2N414
2N1784	PNP	2N428
Germanium Mesa Types		
		(TO-18 package)
SYL-2120*	PNP	2N705
SYL-2189*	PNP	2N711

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

Rotary Joints

(*Continued from page 98*)

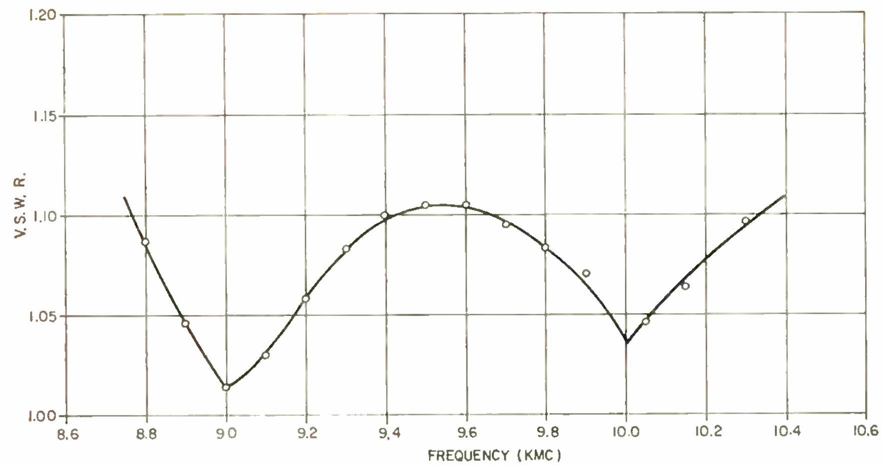


Fig. 10: VSWR vs. frequency for rotary joint shown in Fig. 9

$$\left(\frac{\lambda_1}{\lambda}\right)^2 \simeq \frac{\frac{1}{\epsilon_1}\log_e\frac{d_1}{d} + \frac{1}{\epsilon_2}\log_e\frac{D}{d_1}}{\log_e\frac{D}{d}} \tag{19}$$

The characteristic impedance, Z_1, is given by:

$$Z_1 = 60\frac{\lambda_1}{\lambda}\log_e\frac{D}{d}\ \text{(ohms)}. \tag{20}$$

The impedance at the junction of the coaxial transformer and the rectangular waveguide may be found from Eq. 12.

Besides using two concentric dielectrics, a coaxial transformer may also be designed using a different dielectric or different conductor diameters.

Design of Coaxial Chokes

A choke consists of a short-circuited section of line, one half wavelength long, placed in series with a discontinuity (such as the break in the outer coaxial conductor in the rotary joint shown in Fig. 9.) To minimize frequency sensitivity, the choke is composed of two series connected quarter-wavelength sections of different characteristic impedances. This facilitates the construction of a "folded choke" as shown in Fig. 12. Generally, the first section is made as small as is practical considering the mechanical tolerances involved, and the second section is made approximately four times as wide. More detailed information concerning choke design may be found in the literature.[7]

Miscellaneous Design Considerations

For adequate performance of a rotary joint of the type shown in Fig. 9 at high pulse power levels, a few general precautions should be taken. First, the power capability of the coaxial transformers and the coaxial line should obviously be made greater than the desired operating peak power level by a generous safety margin. Second, to minimize high voltage gradients in the immediate vicinity of the probe-antenna, it is necessary to provide a spherical radius at the ends of the probe and to provide a radius at the junction between the outer conductor of the coaxial line and the wall of the rectangular waveguide. Third, air inclusion between the dielectric (teflon is usually employed because of its low losses at microwave frequencies) and the central metal rod must be avoided.

In addition, care must be taken that the dielectric is homogeneous. Since at high power levels relatively high voltage gradients exist around the central metal rod, these gradients may be high enough to cause breakdown in any small air bubbles existing in this region. This would result in a gradual deterioration of the solid dielectric and finally in breakdown between the rod and the waveguide walls or the outer coaxial conductor. Air inclusion may be avoided by maintaining close dimensional tolerances in the manufacture of the metal rod and dielectric parts, or by packing these items during assembly with a small quantity of silicone compound or a similar substance to fill in any potential air bubbles. Dielectric parts should also be thoroughly cleaned before assembly.

"Wow" or variation of the VSWR or phase with rotation of the rotary joint results from tilting of the dielectric and metal rod during rotation and from the presence of non-rotationally symmetric modes in the coaxial section. It can be minimized by maintaining close concentricity tolerances between the bearing and the coaxial components, by maintaining perpendicularity between the coaxial line and the rectangular waveguide, and by selecting coaxial line dimensions such that the desired operating frequency range is well below the cut-off frequency for the TE_{11} coaxial mode.

(*Continued on page 252*)

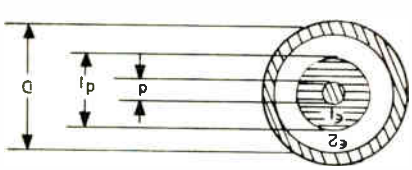
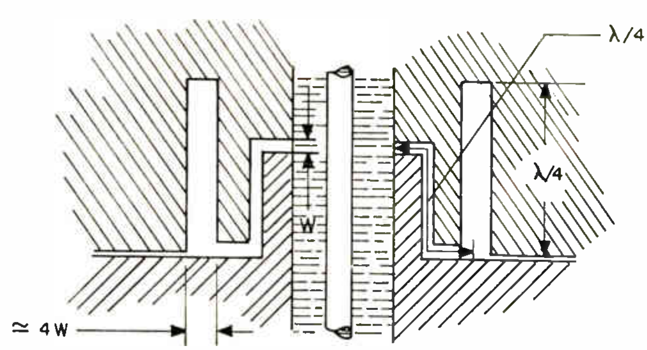
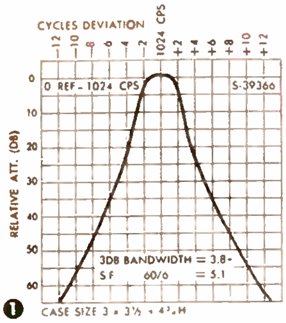


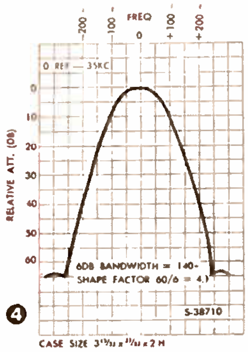
Fig. 11: Coax line with two concentric dielectrics

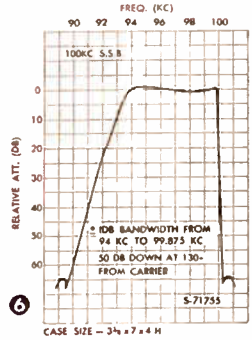
Fig. 12: Coaxial "folded choke."

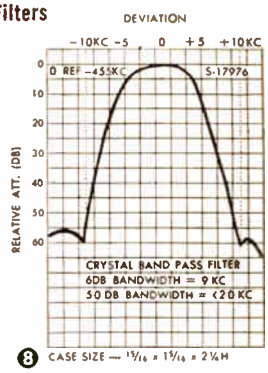


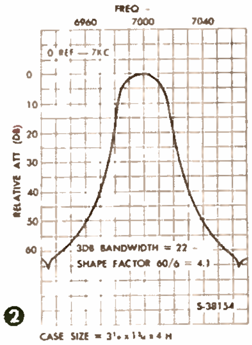
Typical response curves indicating the various shape factors available in standardized Burnell Crystal Filters

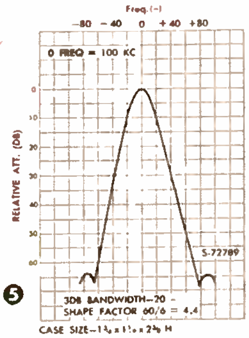


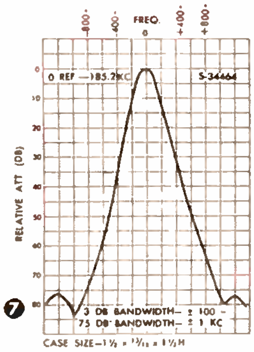


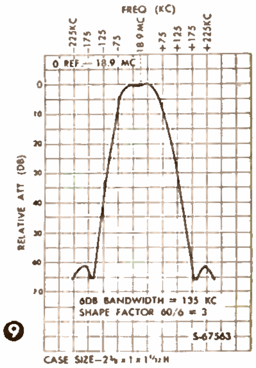


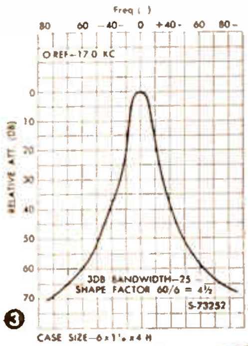


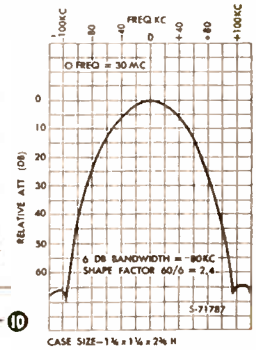


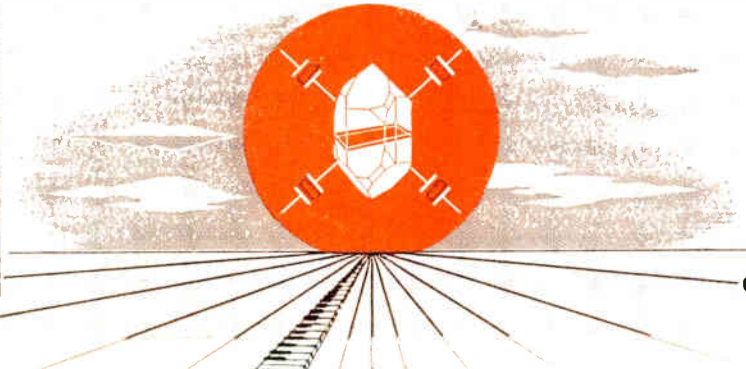












Running the gamut in crystal filters

BURNELL CRYSTAL FILTERS NOW COVER FULLEST RANGE YET POSSIBLE

1 kc to 30 mcs

To its notable achievements in advancing the electronic arts, Burnell & Co. now adds another—the development of moderately priced high attenuation crystal filters covering the extraordinary range of 1 kc. to 30 mc. This represents a range many times broader than previously thought practicable. In addition, the Burnell Crystal Filter line now includes several types heretofore considered impossible.

More than 15 years research, development and experience are represented in the designs illustrated in the response curves shown. Burnell & Co. has taken crystal filters out of the luxury class in applying its experience to their design and manufacturing without incurring developmental and engineering costs.

Whether your crystal filter needs are for standard units or those engineered to center frequency, band width, selectivity and impedance level, call on our Crystal Filter Division for quick delivery. Send now for Crystal Filter Catalog, XT455.

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS & RELATED NETWORKS

EASTERN DIVISION
DEPT. I-38
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
DEPT. I-38
720 MISSION ST.
SOUTH PASADENA, CALIF.
MURRAY 2-2841
TELETYPE PASACAL 7578

Mfd. in Canada by Edo (Canada) Ltd., Cornwall, Ont. • WEllington 2-6774

Rotary Joint *(Concluded)*

Experimental Results

The VSWR as a function of frequency as measured for a typical rotary joint design of the type shown in Fig. 9 (for RG-52/U waveguide) is given in Fig. 10. "Wow" is practically negligible: approximately 0.02 variation in VSWR. The insertion loss was found to be approximately 0.1 db. over the frequency range of 8.8 to 10.4 KMC.

This typical rotary joint was tested at peak power levels in excess of 250 kilowatts without breakdown.

The equivalent circuit presented may also be applied to the design of rectangular and ridged waveguide "doorknob" transitions. Further information concerning these transitions may be obtained from Refs. 2, 3, 10, 11 and 16.

The probe type transition design may be used as a coaxial line to rectangular waveguide adapter as well as in rotary joint designs.

SYMBOLS AND DEFINITIONS

a = width of rectangular waveguide.
α = coupling coefficient of probe-antenna in rectangular waveguide.
b = height of rectangular waveguide.
β = $2\pi/\lambda g$
c = distance along rectangular waveguide from short circuit to center of probe (see Figure 2).
d = diameter of coaxial inner conductor.
d_1 = diameter of dielectric sleeve in coaxial line (see Figure 11).
D = diameter of coaxial outer conductor.
ϵ = relative dielectric constant.
ϵ_o = permittivity of free space, 8.85 x 10^{-12} farad per meter.
l = length of probe - antenna.
L = length of coaxial transformer section.
λ = free-space wavelength.
λ_c = cut-off wavelength.
λ_g = guide wavelength.
λ_1 = wavelength in dielectric-filled coaxial line.
μ_o = permeability of free-space, 1.257 x 10^{-6} henry per meter.
R_r = radiation resistance of probe - antenna.
x = distance from probe - antenna to side wall of waveguide.
X = reactance of probe - antenna.

REFERENCES

1. Chien, W. Z., L. Infeld, J. R. Pounder, A. F. Stevenson, and J. L. Synge, "Contributions to the Theory of Waveguides," Canadian Journal or Research, V. 27 (Section A), Pages 69-129, July, 1949.
2. Cohn, S. B., "Design of Simple Broad-Band Wave-Guide-to-Coaxial-Line-Junctions," Proceedings of the I.R.E., V. 35, Pages 920-926, Sept. 1947.
3. Grantham, J. P., "Microwave Rotating Joints," Electronic Engineering, V. 23, Pages 332-335, September, and Pages 377-381, October, 1951.
4. Marcuvitz, N., *Waveguide Handbook*, Pages 72-80, McGraw-Hill, New York, 1951.
5. Ibid., Pages 396-397.
6. Mumford, W. W., "The Optimum Piston Position for Wide-Band Coaxial-to-Waveguide Transducers," Proceedings of the I.R.E., V. 41, Pages 256-261, February, 1953.
7. Nieman, F. L., "S-Band Coaxial Line to Rectangular Waveguide Transitions," Radiation Laboratory (M.I.T.) Report 802, Pages 35-36, December 7, 1945.
8. Pearcey, T., "An Antenna Theory of the Waveguide Probe," Council for Scientific and Industrial Research, Division of Radio Physics, Sydney, Australia, Report No. RPR72, April, 1947.
9. Ragan, G. L., *Microwave Transmission Circuits*, Page 52, McGraw-Hill, New York, 1948.
10. Ibid., Pages 314-455.
11. Riblet, H. J., and R. L. Williston, "X-band Rotary Joint," Transactions of the I.R.E. Prof. Group on Microwave Theory and Techniques, V. MTT-1, Pages 23-24, March, 1953.
12. Schelkunoff, S. A., *Electromagnetic Waves*, Page 319, D. Van Nostrand, New York, 1943.
13. Ibid., Pages 494-496.
14. Schwiebert, H., "Wideband Waveguide Rotary Joint," I.R.E. Convention Record, Part 8 (Communications and Microwave), Pages 57-60, 1955.
15. Slater, J. C., *Microwave Transmission*, Chapter VII, McGraw-Hill, New York, 1942.
16. Swern, L., "Broadband Coaxial Line to Waveguide Adapters Using Step Ridge Transformers," *Proceedings of the National Electronics Conference*, V. IX, Pages 805-813, 1953.
17. Vellat, T., "Die Abstrahlung von Dipolen in einem Hohlleiter mit rechteckigem Querschnitt," Bulletin Schweizerischer Elektrotechnischer Verein (Zurich, Switzerland), V. 40, Pages 860-869, October 29, 1949.
18. Wheeler, H. A., "The Radiation Resistance of an Antenna in an Infinite Array or Waveguide," *Proceedings of the I.R.E.*, V. 36, Pages 478-487, April, 1948.

Test Station

(Continued from page 77)

sented in several different forms. It features: reduction in test times, reduction of man-hours (unattended operation), lower skill level required for routine testing, elimination of test reports through automatic readout and recording, and elimination of record keeping (done automatically).

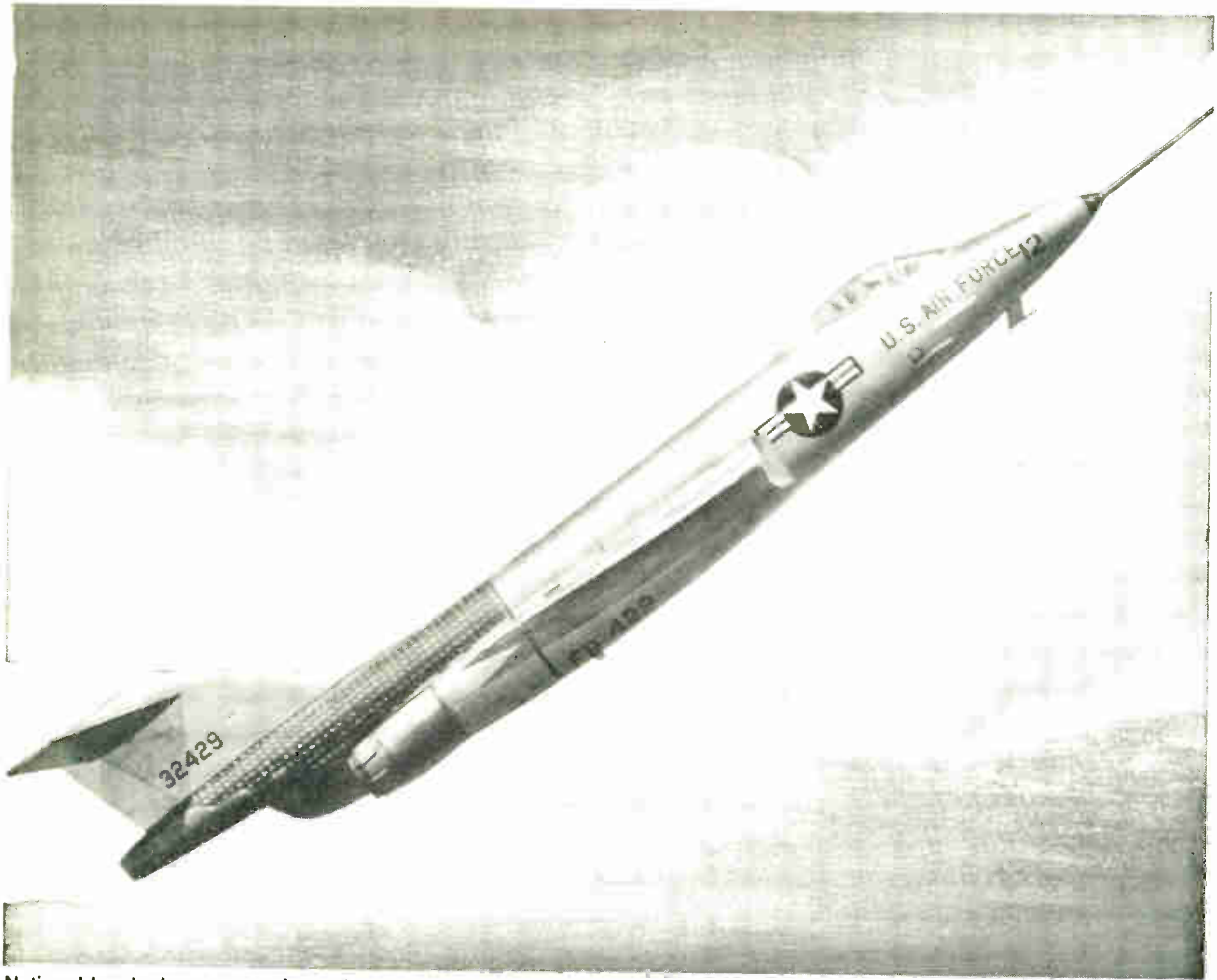
A coded, 8-level perforated tape contains the complete test routine. Stimuli are automatically selected and applied to the unit under test. Response is measured and digitized. The digitized data are then compared against programmed limits and the measured input and output values plus evaluation results are printed and punched onto paper tapes.

Some of the specs and features: programmable signal sources include 2 dc units for from 0.1 to 50 v in 0.1 v steps with currents to 15 a; two dc sources from 1 to 100 v in 1 v steps with currents to 100 ma; two dc sources from 101 to 999 v in 1 v steps with currents to 10 ma; ac source ranging from 10 CPS to 100 KC in 1 CPS steps and from 1 mv to 10 v in 1 mv steps; and a fixed sources of 115 v, 60 and 400 CPS, 15 a ac and 28 vdc, 15 a. Dc sources accurate to 0.1%. AC to 0.01% (freq.) and 0.25% (amplitude — distortion less than 0.1%).

POLARIS INSPECTION

Vice Adm. W. F. Raborn, Dir. Special Projects, U.S.N. and head of Polaris missile program inspects assembly line at Hughes Aircraft Co.'s El Segundo, Calif., plant where guidance system is being produced. Plant Manager, Joe Ferderber is on the left.

(F101, AIR FORCE PHOTO)



National has had many years' experience making significant contributions to the defense effort, including airborne components.

COMPARE THIS OPPORTUNITY
WITH WHAT YOU ARE NOW DOING!

HERE'S WHAT *National's* NEW MILITARY RESEARCH AND DEVELOPMENT PROGRAM OFFERS.

This operation will interest any engineer or scientist possessing enough self-confidence—ability and experience—to develop projects initially and carry them through to completion.

WHO WE'RE LOOKING FOR

National is looking for military-oriented scientists and engineers who hold a B.S. degree or advanced degrees. You should be working in electronic, electro-mechanical, mechanical, physics, optics, mathematics, or other related areas. Preference will be given to those who have had several years' experience dealing with prime contractors and government agencies.

As a member of National's New Military Development Team—you will be working initially with our Military Proposal Group. As proposals become specific projects, your responsibility will continue through the contractual stage for technical liaison, fulfillment of contractual obligations including hardware development, meanwhile retaining sufficient flexibility to continue your proposal efforts.

WHY YOU SHOULD INVESTIGATE

National's new Military Research and Development Program offers you unusual latitude in responsibility. It offers you the chance to participate in military projects from start to finish. Furthermore, you now have the opportunity to join an operation still in its formative stage—yet backed by one of the world's most successful . . . most reputable corporations.

COMPLETE INFORMATION is yours by sending your résumé to Mr. T. F. Wade, Technical Placement Section F9-3, The National Cash Register Company, Dayton 9, Ohio. All correspondence will be kept strictly confidential.

*TRADEMARK REG. U.S. PAT. OFF.

*National**

ELECTRONIC DATA PROCESSING
DIVERSIFIED CHEMICAL PRODUCTS
ADDING MACHINES · CASH REGISTERS
ACCOUNTING MACHINES · NCR PAPER

THE NATIONAL CASH REGISTER COMPANY, DAYTON 9, OHIO

ONE OF THE WORLD'S MOST SUCCESSFUL CORPORATIONS

76 YEARS OF HELPING BUSINESS SAVE MONEY

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

"Man On the Moon By '70" A Practical Goal For U. S.

"We can have and should have men on the moon before 1970," says Dr. Robert W. Buchheim, head of the Aero-astronautics Dept., The RAND Corp., "but, the U. S. space program should be bigger and faster." Dr. Buchheim spoke before the 14th National Conference on the Administration of Research held at the Univ. of Michigan.

He pointed out the abundance of resources and skills that the U. S. has compared to the Soviet Union, and declared that, "our physical and human resources could support a larger space program without real interference with other activities."

From presently available evidence, it looks like the Russians will be first to land on the moon. The U. S. program calls for manned flights to the moon in the 1970's. The weights of the Sputniks are much greater than any of the U. S. efforts, and the U. S.'s "Saturn" won't be operational until after 1963.

Who should bear the cost? The Government, he says, because the cost is too large for any single private organization. "But there is no incompatibility between government space exploration and free enterprise and democratic processes, so long as we retain our faith in free enterprise and democratic processes and use them. To get the most out of astronautics, more science programs generally must be undertaken and private sources can do much to set the direction of astronautics by supporting these related sciences."

New Semiconductor Maker

The Espey Mfg. & Electronics Corp. has established a new division for the manufacture and marketing of semiconductor products. It will be called the Saratoga Semiconductor Div., Saratoga Springs, N. Y. Initial products will be silicon diodes, including power rectifier and zener regulator types.

HONORED

Dr. P. D. Eddy, Pres., Adelphi College (L) presents certification of appreciation to H. Fialkov, Pres., General Transistor Corp., for its "leading role in founding and supporting the Adelphi Research Center, Mineola, L. I., N. Y."

GM Inst. to Award First EE Degrees

General Motors Institute will award baccalaureate degrees in electrical engineering for the first time in 1963. The Institute presently awards degrees in mechanical and industrial engineering.

The new curriculum, resulting from a demand from GM plants for EE's, is directed toward three important areas of need for electrical engineers by General Motors: product design, plant engineering, and process engineering. EE's can study in one of two fields, electrical machinery power distribution, and process equipment or in "light" electrical equipment such as controls, instrumentation, and product design and development.

Measure Radio Waves From Saturn and Nebula

University of Michigan scientists have measured radio waves from the planet Saturn and from a planetary nebula—a remote, gas-surrounded, dying star. Measurements were made with U-M's high precision 85 ft. radio telescope and their new, highly-sensitive ruby maser amplifier.

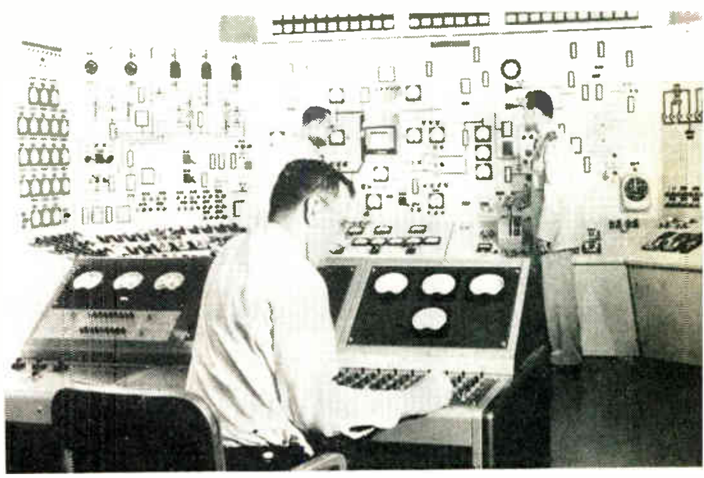
Saturn's atmospheric temperature was found to be 100° K (—283°F). The findings were accurate within 10%. Measurement of the planetary nebula — 3,000 light years away—is significant because these sources are small and very distant. The measurements can help determine electron densities in the gas envelope which surrounds the central star in these nebulae.

The measurements, made by Jerald J. Cook, and Lloyd G. Cross, may help in understanding the evolutionary processes of stars, the physical characteristics of planetary nebulae, and perhaps detect both the existance of magnetic fields in nebulae and cosmic ray electrons surrounding these nebulae.

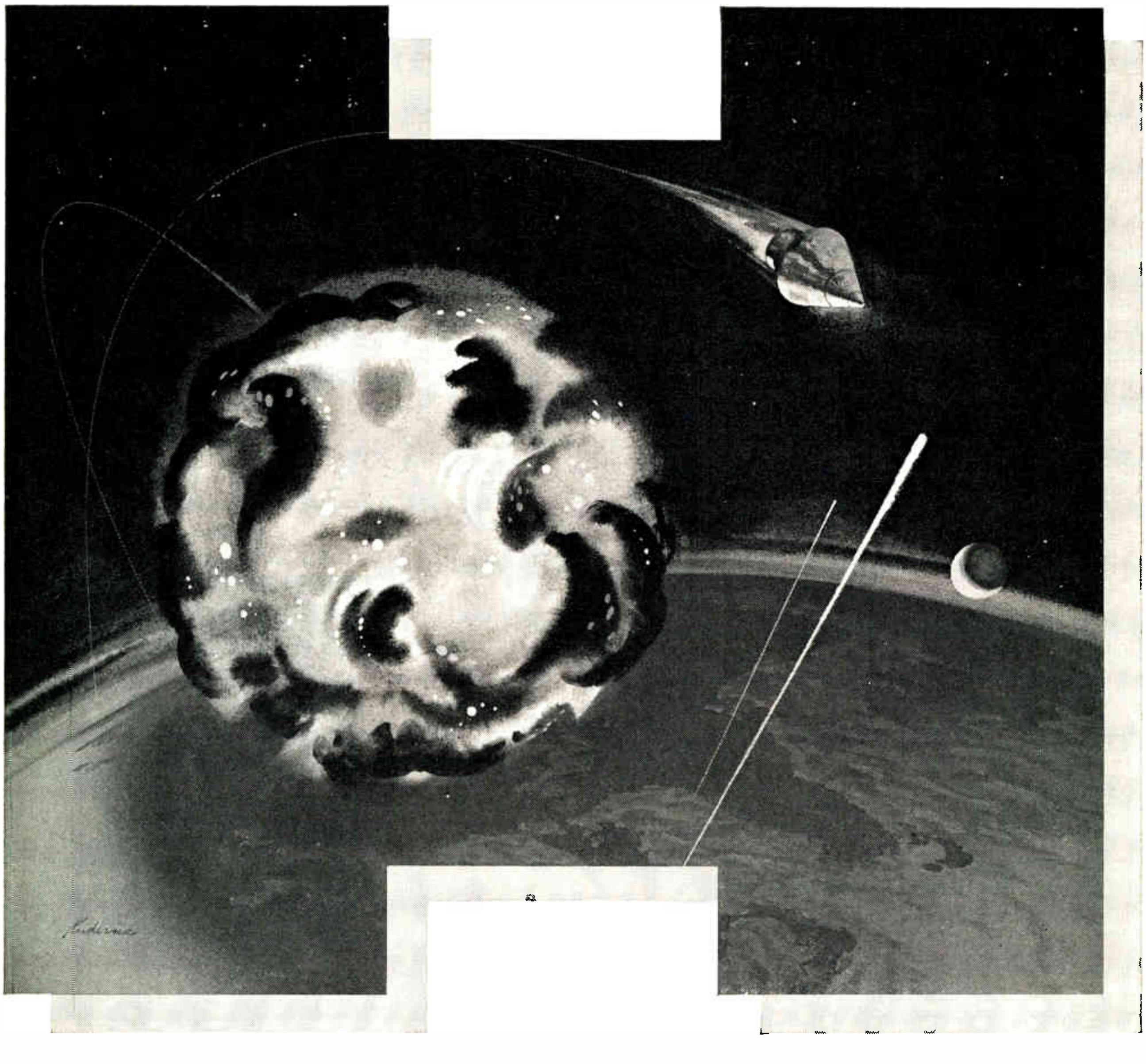
FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 169.

SHIP SIMULATOR

Students simulate operation of N.S. Savannah, world's first nuclear ship with an analog computer. Instructor flips switches to simulate special operating conditions. Westinghouse built the Simulator—Borg-Warner the instructor's console.



Ballistic missiles: the ultimate



Industry News

Warren S. Jones appointed Distributor Sales Manager, Times Wire and Cable Div., International Silver Co., Wallingford, Connecticut.

George Kappelt appointed Director of Engineering Laboratories, Bell Aerosystems Co., Buffalo, N. Y.

Walter H. Eichelberger, Jr. named Merchandise Manager, Philco Corp's Radio and High-Fidelity Dept., Consumer Products Div., Phila., Pa.

Edgar C. Barnes appointed Manager of Radiation Protection, Westinghouse Electric Corp's Atomic Power Group, Forest Hills, Pittsburgh, Pa.

Andrew J. Chitiea appointed Assistant to Allan R. Shilts, Vice President and General Manager, Stromberg-Carlson, a division of General Dynamics.

A. J. Chitiea

M. D. Lockwood

Myron D. Lockwood appointed Vice President, Sperry Gyroscope Company, Great Neck, N. Y.

Emmanuel P. Courtillot named Director of European Planning, Varian Associates, Palo Alto, Calif. He will work from his office in Zug, Switzerland, headquarters of Varian's European subsidiary, Varian A.G.

Frank J. Shannon, Sr. appointed Manager, Washington, D. C. District, The W. L. Maxson Corp., N. Y., N. Y.

Duane C. Manning appointed Marketing Manager, Electronics Div., Elgin Watch Co., Burbank, Calif.

J. N. Koys appointed Division Sales Manager and F. J. Kadlec appointed Division Manufacturing Manager, Amphenol-Western Connector Division, Amphenol-Borg Electronics Corp., Chatsworth (Los Angeles suburb), Calif.

Donald D. Mallory named Manager of Product Operations, Components Div., Hughes Aircraft Co., Los Angeles, Calif.

WHAT GOES ON UP THERE?

This question has been asked and answered a thousand different ways at BOEING/WICHITA . . . however in flight testing, both in the air and in simulators, you never run out of "Whys?" and "Hows?".

BOEING/WICHITA needs more experienced flight test engineers right now in the following areas:

Electrical Instrumentation
Ground Operations
Test Operations

Boeing also has requirements for Senior Engineers in:

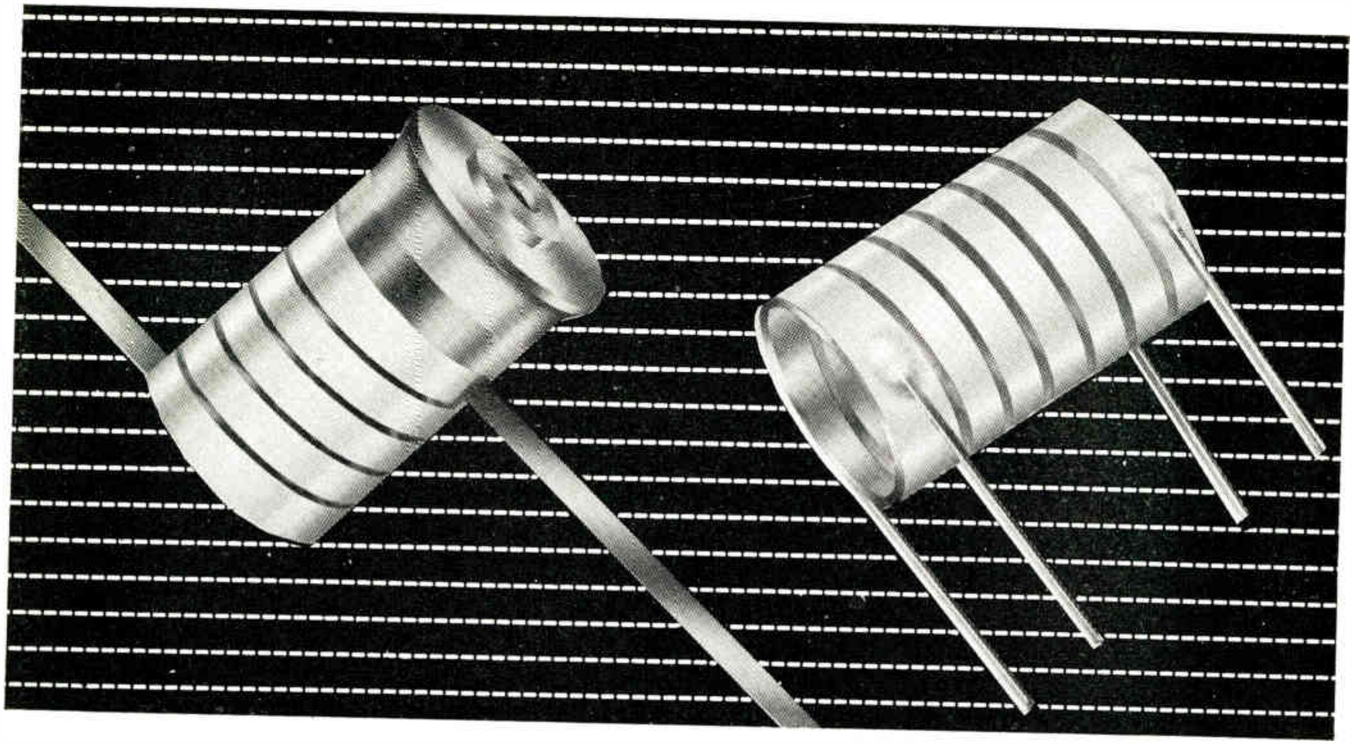
Electronics / Propulsion / Structures
Mechanical Equipment / Aerodynamics

Write in confidence to: Mr. Melvin Vobach, Dept. OEN
Boeing Airplane Company, Wichita 1, Kansas

BOEING/WICHITA

Please send me complete information about Boeing/Wichita and your new "Opportunities Brochure."

NAME ____________________
ADDRESS ____________________
CITY ____________ STATE ____________
I have a degree(s) in the following: ____________________



NEW FROM JFD FIXED MINIATURE METALIZED INDUCTORS

JFD now offers a complete line of fixed-value miniature Metalized Inductors in inductances to cover a wide variety of circuit application requirements

MODEL LF-1P010
ACTUAL SIZE

MODEL LF-2W008
ACTUAL SIZE

TYPICAL PANEL MOUNT JFD METALIZED INDUCTORS

Model	Inductance μh (± 5%)	Q Min.
LF-1P010	0.10	145
LF-1P025	0.25	135
LF-1P040	0.40	105
LF-1P070	0.70	120
LF-1P100	1.00	135
LF-1P200	2.00	180

Listed above are only six of 23 standard JFD Metalized Inductors available in panel mount and printed circuit types from .05 μh to 2.00 μh.

The new JFD Inductor series employs silver film permanently fused to a low loss dielectric glass cylinder. This lightweight monolithic construction achieves a new high in stability, durability and economy; a new low in temperature coefficient of inductance and distributed capacitance. Assures you of utmost reliability for critical circuit operation in severe environment.

JFD Metalized Inductors can also be designed to help solve any development, design, or production problem. The number of turns, types of windings, size and distributed capacitance, Q and other parameters can be designed to suit individual circuit requirements. Write for bulletin 223 for full specifications.

Features

1. Rugged construction affords unusually high stability under conditions of severe shock and vibration.
2. Use of glass dielectric assures low temperature coefficient of inductance and operation without derating over a wide range of extreme environmental conditions.
3. Low distributed capacity.
4. Special alloy plating protects metal parts from corrosion.
5. A high Q over a broad frequency range.
6. Silver plated copper leads.
7. Available in panel mount and printed circuit mount types.

JFD

PRECISION COMPONENTS FOR PRECISION PERFORMANCE

JFD ELECTRONICS CORPORATION

6101 Sixteenth Avenue, Brooklyn 4, New York

JFD WESTERN REGIONAL DIVISION
7311 Van Nuys Boulevard, Van Nuys, California

JFD CANADA LTD.
51 McCormack Street, Toronto, Ontario, Canada

JFD INTERNATIONAL
15 Moore Street, New York, N.Y.

VARIABLE TRIMMER PISTON CAPACITORS • FIXED METALIZED INDUCTORS • LC TUNERS.
FIXED AND VARIABLE, DISTRIBUTED AND LUMPED CONSTANT DELAY LINES • PULSE FORMING NETWORKS • DIPLEXERS

Circle 92 on Inquiry Card

News of Mfrs' Representatives

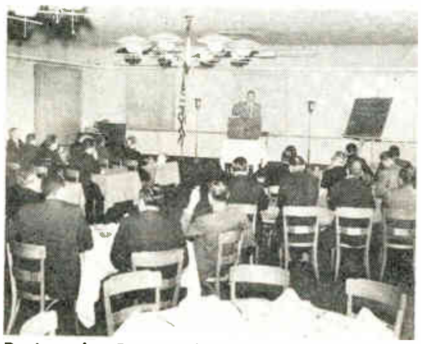
REPRESENTATIVES WANTED

Manufacturer of Microwave Test and Production Components wants Engineering Reps in the following areas: (1) Canada; (2) New York City & Long Island; (3) Texas, New Mexico; (4) Chicago area; (5) Florida; (6) Northern California, Oregon, Washington. Box 11-1, Editor, Electronic Industries.

Electronic Connector Manufacturer seeks sales reps in Southern Maryland, Washington, D. C. area, and Northern Virgintia. Box 11-2, Editor, Electronic Industries.

Manufacturer of Microwave Components is seeking Jobber Reps throughout the U. S. to handle its complete line especially designed for use as training aids in manufacturing plants, military installations, and in engineering colleges. Box 11-3, Editor, Electronic Industries.

S. CALIF. ERA SEMINAR



During the Personnel and Selection Seminar held by the Southern California Chapter of the Electronic Representatives Association, Dr. Joics B. Stone dealt with the problems faced by the representative when hiring new sales and office personnel. He introduced new testing and evaluation methods to guide the representative in his selection.

International Resistance Co. has appointed Midwest manufacturer's reps for its Control Components Div. products, namely: **Koehler-Pasmore**, Detroit (Detroit area); **Pan-Technical Engineering & Supply Co.**, Houston (Gulf coast area of Texas and Louisiana); **Jack F. McKinney**, Dallas (most of Texas, Louisiana, Oklahoma).

New England Communications, Inc., 572 Washington St., Wellesley, Mass. has been appointed a manufacturer's rep. for the RCA LD-150 transistorized two-way mobile radio and equipment.

Jaeger-Cordray, Inc., Orlando, Fla., has been appointed representative for Southwestern Industrial Electronics Co. (SIE), Dresser's Electronics Div., in the Southeastern region of the U. S.

ESC Electronics Corp., Palisades Park, N. J., has appointed **Perrott Assoc.** as sales representatives in Florida, Georgia and Alabama.

George F. Bohman, Orlando, Fla., has been appointed sales representative for Rotron Cooling Equipment in Florida; **Fred F. Sylvester Assoc.**, Bayshort, L. I., N. Y., is representative in Metropolitan New York including Long Island and Northern New Jersey.

The Schaffer Engineering Co., Detroit, Mich., has been appointed Michigan sales representatives for Cincinnati Sub Zero Products, Cincinnati, Ohio.

Michael F. Olah, Jr., has been named midwest representative for the Litton Industries' Electron Tube Div., Dayton, Ohio.

Industrial Electronic Engineers, Inc,. North Hollywood, Calif., has appointed **McGill & McGill** as their exclusive sales representative in the San Francisco Bay area.

The Hainge Co., Inc., Houston, Tex., has been appointed representative in the Southwest for F. J. Stokes Corp., Philadelphia, Pa.

ELECTRONIC INDUSTRIES Advertisers—November 1960

This index is published as a convenience. No liability is assumed for errors or omissions.

News of Mfrs'
Representatives

Two new sales reps for Motorola's Solid State Electronics Dept. have been appointed, namely: **Dayton Assoc.** of Dayton, Cincinnati and Cleveland, Ohio; and **Southgate,** Michigan in Ohio, Michigan, West Virginia and western Penna. and **The L. L. Schley Co.** of Watertown, Mass. and Syracuse, New York in the New England and upper New York State territories.

Len-Bar Co., Electronics has been appointed sales rep for Potter & Brumfield, a Div. of American Machine & Foundry Co. in Southern California.

Land-C-Air Sales, Tuckahoe, N. Y. has appointed **Jerry Balash** its rep in the Phila. trading area. He will work from the LCA office at 32 Rittenhouse Road, Ardmore, Pa.


J. Balash


R. H. Hilderbrand

Speer Carbon Co., St. Marys, Pa. has appointed **Robert H. Hilderbrand** its Onondaga Electronics Div. sales rep in the Baltimore/Phila. area.

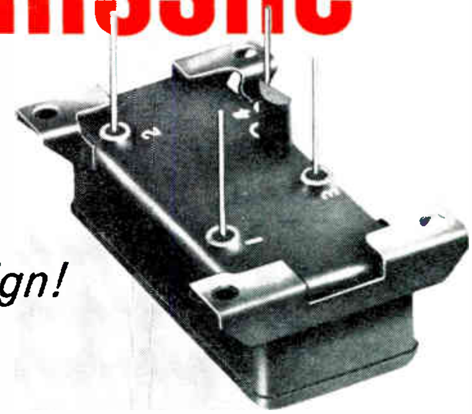
Semiconductor Div. of Syntron Co., Homer City, Pa. has appointed the Danco Corp., Fairview Village, Pa. its East coast sales rep.

H. H. (Pete) Seay has been named a rep. by Astron Corp., East Newark, N. J. He'll work out of headquarters at 3850 Fairlington Drive, Columbus, Ohio, covering Ohio and West Virginia.

Elgin Labs, Inc., subsidiary of Erie Resistor Corp., Waterford, Pa. has appointed **George K. Egelston,** senior salesman in Chicago, to cover Michigan including the Detroit metropolitan area. He also has supervision over Illinois, Indiana, Western Ohio, Michigan and the St. Paul-Minneapolis, Minnesota area.

A. D. Stone, Jr., with headquarters at 10234 Lakewood Blvd., Downey, Calif., has succeeded R. J. Hedberg as West coast sales rep. for GE insulating materials.

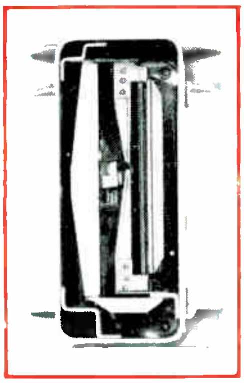
The most precise, sturdiest thermal relay ever built... best for missile applications



...from the leader in thermal relay design!

Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most **precise** thermal relay ever built!

And the PT's **sturdiness** is unequalled in thermal relays. It withstands missile vibration and shock far better than any other thermal relay.



SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)

Setting Tolerance: ±5% (±¼ sec. min.)

Temperature Compensation: Within ±5% over −65°C. to +125°C. range (±¼ sec. min.)

Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.

Power Input: 4 watts. Rated for continuous energization at 125°C.

Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

Write for Product Data Bulletin #PD-1015

Insulation Resistance: 1,000 megohms

Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.

Vibration: Operating or non-operating, 20 g up to 2000 cps

Shock: Operating or non-operating, 50 g for 11 milli-seconds

Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.

Weight: 2 to 2¼ ounces.

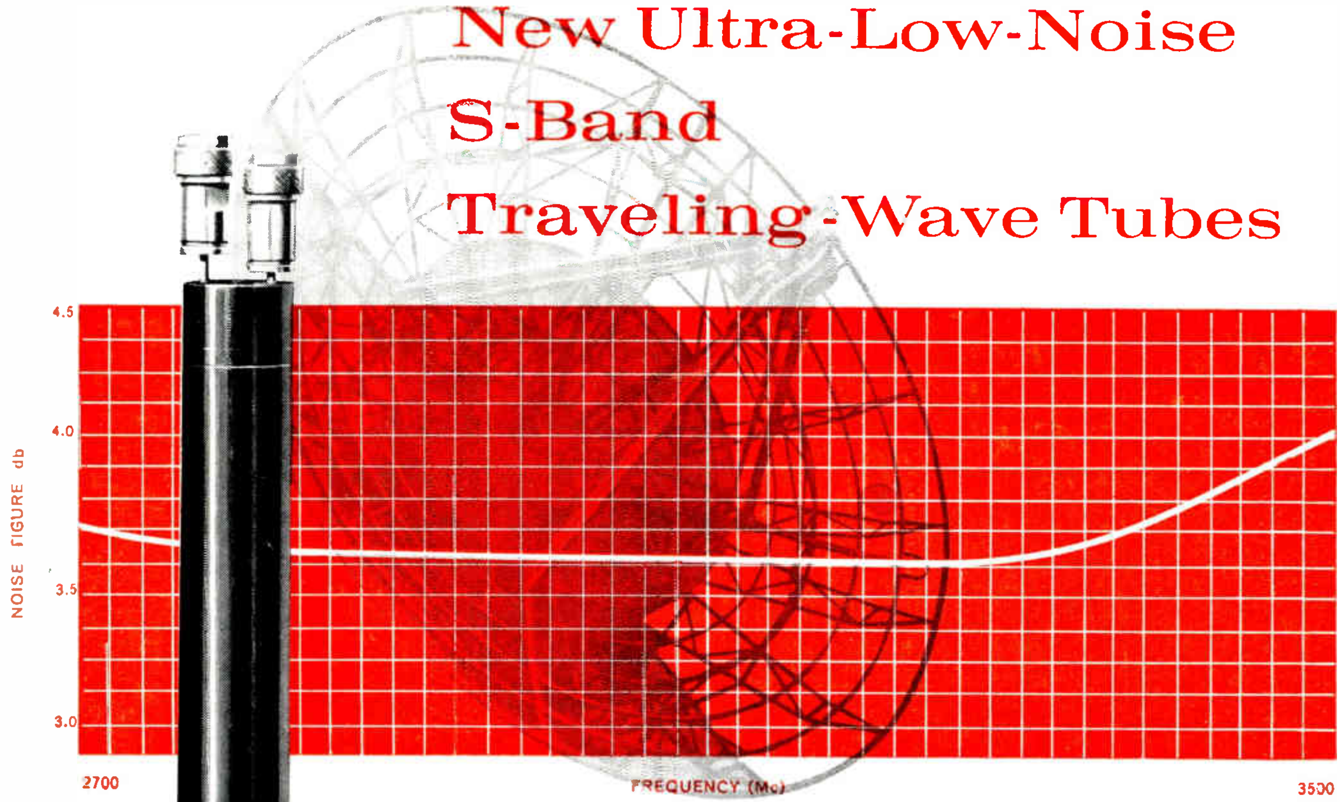
G-V CONTROLS INC.
Livingston, New Jersey

G-V

Circle 52 on Inquiry Card

From RCA's microwave designers

New Ultra-Low-Noise S-Band Traveling-Wave Tubes



With a Terminal Noise Figure as Low as 2.8 db.

Here are the dramatic facts about the new RCA developmental type A-1207 series of Ultra-Low-Noise Traveling-Wave Tubes.

4.5 db Maximum Terminal Noise Figure. This is a realistic value of noise figure because it includes coupler losses. Because this is a maximum value, the average noise figure for tubes in this series is considerably less than 4.5 db. Laboratory tests of tubes of this series have shown terminal noise-figure values as low as 2.8 db.

Advanced Proven Design. The design of the developmental type A-1207 series is based on that of the well known RCA-6861. Only recently Zurich Airport reported 19,200 hours of service from a 6861.

Complete S-Band Coverage. The developmental type A-1207 series offers coverage in bandwidths of 200 Mc to 800 Mc for S-band frequencies between 2200 Mc and 4100 Mc.

1 Milliwatt Minimum Power Output. You'll obtain an output of over 1 milliwatt with a minimum gain of 20 db from any tube in this remarkable series.

Most important of all, the RCA developmental type A-1207 series is a firm design, ready for immediate production and delivery to meet your schedules. Get full details about this unusual new line of ultra-low-noise traveling-wave tubes today. Contact the RCA Field Office nearest you. RCA Electron Tube Division, Harrison, N. J.

RCA ELECTRON TUBE DIVISION FIELD OFFICES . . . INDUSTRIAL TUBE PRODUCTS SALES: Detroit 2, Michigan, 714 New Center Building, TRinity 5-5600 • Newark 2, N. J., 744 Broad St., HUmboldt 5-3900 • Chicago 54, Illinois, Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900 • Los Angeles 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361 • Burlingame, Calif., 1838 El Camino Real, OXford 7-1620. **GOVERNMENT SALES:** Newark 2, N. J., 744 Broad Street, HUmboldt 5-3900 • Dayton 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366 Washington 6, D. C., 1725 "K" St., N.W., FEderal 7-8500.

RCA

The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA