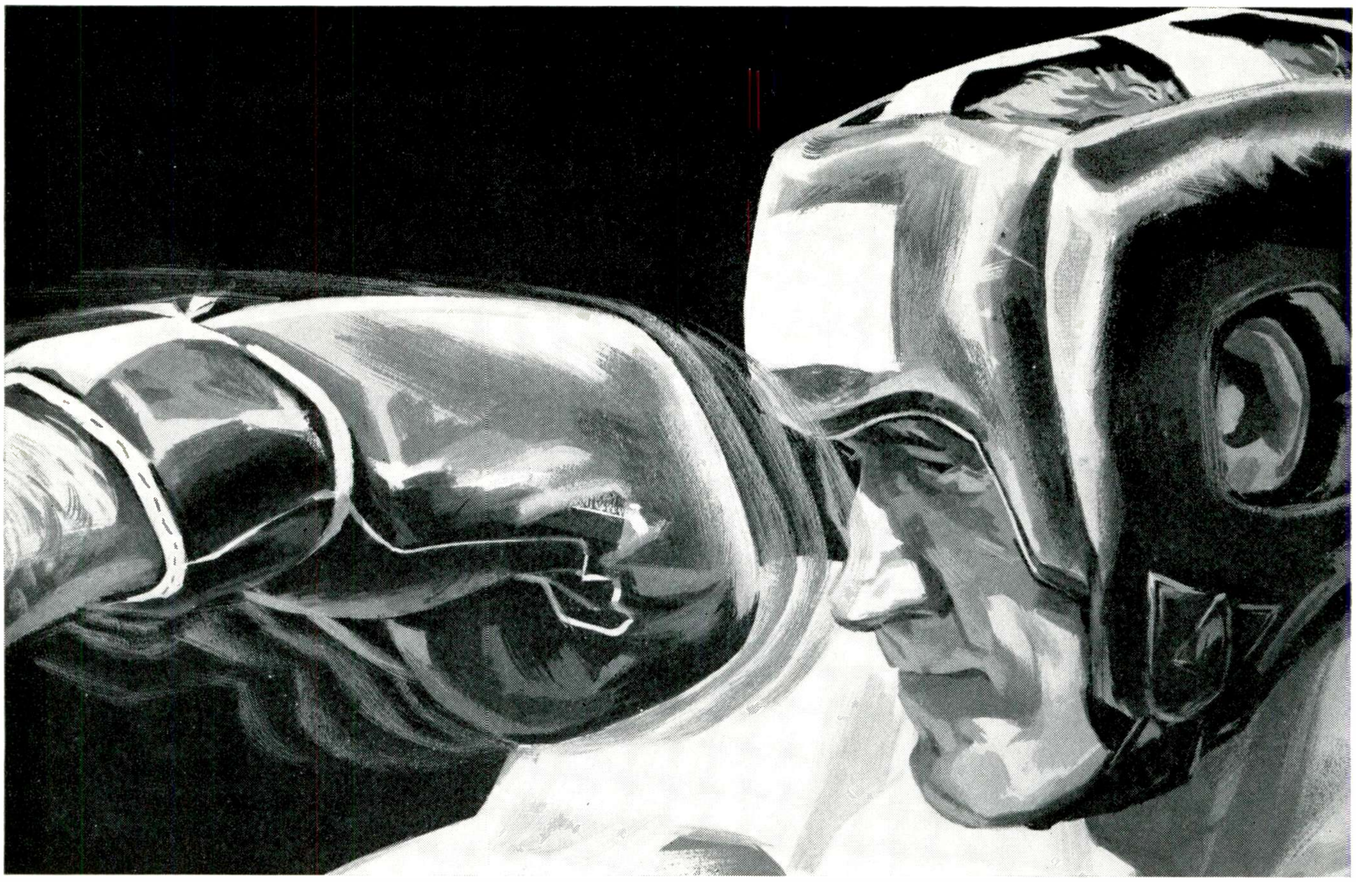
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

November
1959

7th Annual Microwave Issue



RMC type JF Discaps

can take it!

SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)
POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ± 10% ± 20% at 25° C

Type JF DISCAPS exhibit a "frequency stability" characteristic that is superior to similar types of capacitors. These DISCAPS show a change in capacitance of only ±7.5% over the range between +10° C and +85° C. Type JF DISCAPS extend the available capacity range of the E.I.A. Z5F ceramic capacitor between +10°C and +85° C and meet all Y5S specifications between —30°C and +85°C. Applications requiring a capacitor with "frequency stability" call for RMC Type JF 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

A New Spectrum Chart

The April 1957 issue contained as a Part II a four color chart which graphically portrayed The Electromagnetic Spectrum. This chart illustrated what electronic services were operating at the different frequencies from 0 cps to 100,000 MC. In spite of a fairly heavy over-run of reprints on this feature, it went completely out of print early in 1959. Yet as each day passes we continue to receive reader requests for copies of this chart. Many readers have found the chart prominently displayed on the walls of research and development laboratories and in the engineering departments of many electronic manufacturers. Others have become aware of its existence through personal contact with other readers.

In response to these many reader requests, it has been decided to again re-issue this feature. The new chart will also be in four colors, but it will be twice the size of the old one. It will also contain a considerably greater amount of technical information on the electromagnetic spectrum. The exact date of publication and availability details will be announced in the December issue of ELECTRONIC INDUSTRIES. Since the editors are putting finishing touches to this project now, and because of the great interest in this feature we thought it best to bring this to your attention now. We will seek to process the requests from readers that we have on hand first and then to acknowledge others on a first-come-first-served basis.

Thanks!

LAST February, in an editorial entitled "Perforated" we announced a new service whereby the feature editorial pages in subsequent issues of ELECTRONIC INDUSTRIES would be perforated. We also asked for some reader feedback on the value of this new service. The results to date have been startling. From the hundreds of letters that have come in the vote is about 3 to 1 in favor of perforated pages!

In the letters received that favored perforated editorial pages, two suggestions for improvement were frequently mentioned. The first was to move the perforation further back into the binding to allow extra space in the margin so that pages removed for reference could be punched for a standard three-ring binder. The second was to alter layout procedures so that the last page of a given article would not be backing the first page of another multi-page article. We are happy to announce that arrangements are being made to accommodate both these provisions.

By pushing the perforation back further into the binding and by moving the entire text page slightly toward the outside edge of the magazine we can achieve sufficient space in the gutter margins to allow readers to punch desired pages for subsequent notebook reference. This is to become a regular service starting with our next (November) issue.

The second item is a bit more difficult to achieve. In making up future issues, however, we shall endeavor to place only one-page stories (such as our Page from an Engineer's Notebook series) between feature articles where a back-to-back situation would ordinarily be involved. However, in such a fast moving industry as this, it is not always easy to obtain material of this type. If you, as our reader and contributor, have any such short story suggestions, we'd be delighted to hear from you and work with you as to future publication.

We hope these changes will receive the approval of all our readers and we take this opportunity to thank all those who wrote and offered their suggestions as to how ELECTRONIC INDUSTRIES could serve them better in their engineering activities.

We hope, too, that you will continue to write and let us know how else we can be of further service to you.

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ELECTRONIC INDUSTRIES

Vol. 18, No. 11 **November, 1959**

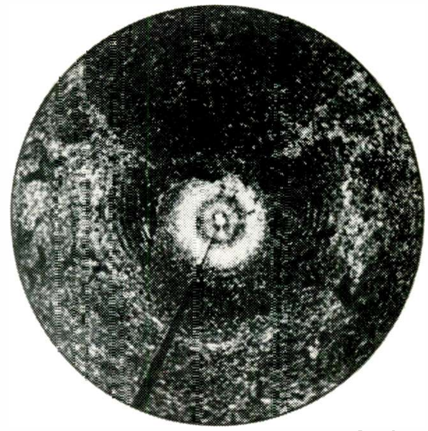
MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

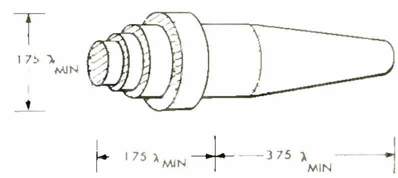
DEPARTMENTS

BPA NBP

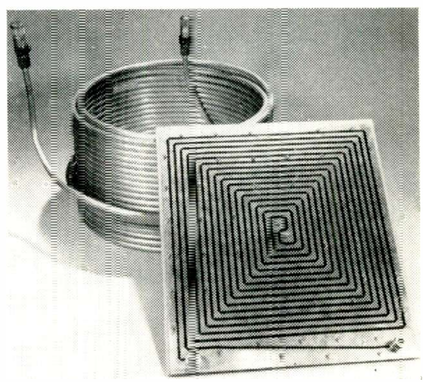
Highlights of this issue



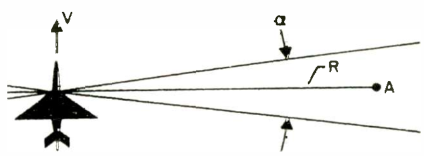
PPI Shading



Dielectric Lens

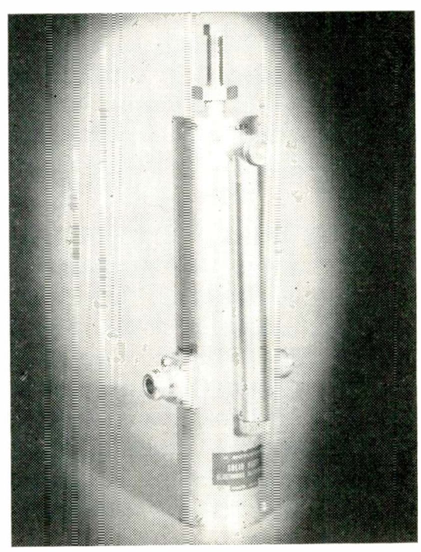


Microwave Printed Circuits



Side-Looking Radar

Parametric Amplifiers



RADARSCOPE

NEW CERAMIC MATERIAL

Lucalox, new polystrystalline ceramic developed at G.E., is claimed to have "the composition of ceramic, the structure of metal, and a light-transmitting ability approaching that of glass." It is made from fine-grain, high-purity aluminum oxide, or "alumina," and will withstand up to 3,600° F.

TOTAL APPROPRIATION for the Defense Dept. for the fiscal year of 1960 amounts to $39,248 million—a net decrease of $20 million from the President's 1960 budget request and a decrease of about $640 million from the amount appropriated for the fiscal year 1959.

RADIO INTERFERENCE from fluorescent lamps can be grounded out by new glass panels made by Corning Glass Works. Designed principally for laboratories and hospitals, the panels are coated on one side with thin transparent and electrically conductive film that intercepts radiated interference and grounds it through a ¼ in. wide silver strip around the edges of the glass.

THE TWO-COLOR TV suggested a few months back by Dr. Land of Polaroid Land Camera fame has kicked off a great deal of comment, mostly adverse, from industry engineers and scientists. A number of experiments have been demonstrated at various scientific gatherings, none very successful, and consensus seems to be that while the two-color technique can produce quite an outstanding full-color picture under controlled conditions, it holds little promise for the work-a-day requirements of color TV broadcasting.

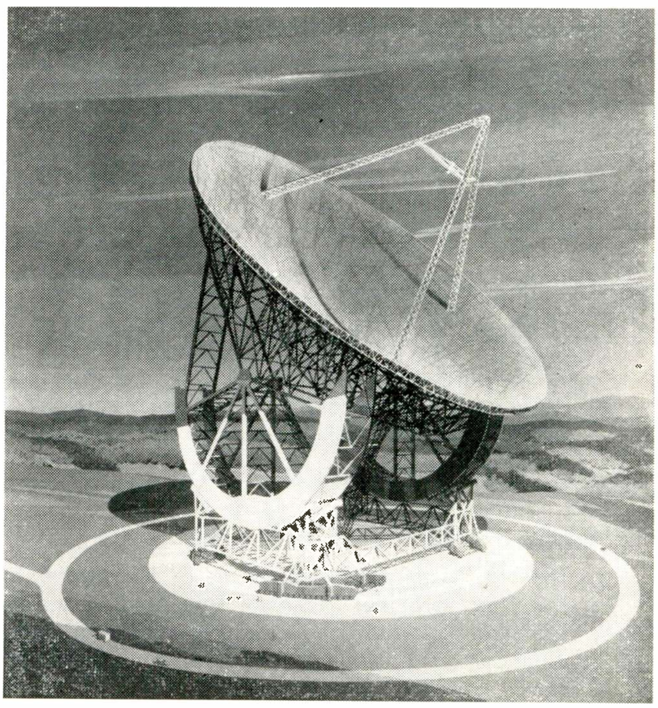
FEDERAL AVIATION AGENCY (FAA) is preparing to assume the operations of about 2,095 military air traffic control facilities at 337 global locations. To handle the job, the agency will need an additional 9000 air traffic controllers and 6000 maintenance technicians.

NBS is drafting plans for a special computing facility that will be used by the Air Force, Navy, and NASA for processing aircraft flight load data. The need for adequate design criteria based on actual experience has become increasingly acute with the accelerated demands for high performance.

METEOR BURST COMMUNICATIONS can provide a daily average communications rate of 40 wpm, reports the National Bureau of Standards, on the basis of 3 years of tests. The 40 wpm can be expected with a character error rate of 0.35% based on a burst transmission rate of 2400 words per minute. Error rates as low as 0.004% has been achieved over an 800-mile range at 30 wpm for periods of several weeks. The error rates have gone up as high as 10% under thunderstorms and precipitations static conditions.

NAVY'S "BIG DISH"

Under construction on a 1,500-acre site in Sugar Grove, W. Va. is this 600-ft. diameter dish which will enable scientists to pick up radio signals from astral bodies as far as 38 billion light years out in space. Scheduled for completion in 1962, the 20,000-ton facility will be called "Naval Radio Research Sta."



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

THE JAPANESE ELECTRONIC INDUSTRY is stepping up its activities in the United States by fantastic leaps. Japanese electronic imports during the first six months of 1959 in the U. S. was valued at $22.1 million, exceeding the total for the entire calendar year of 1958, and nearly tripling the total for the calendar year 1957. The U. S. is by far the most important single foreign market for Japanese electronic products, accounting for more than 50% during the first half of 1959; 46% during the year 1958; 39% in 1957; 34% in 1956. Consumer-type radio receivers represent the largest part of this trade.

THE JAPANESE THREAT prompted Rep. Gross (Republican of Iowa) to blast IUE President James Carey for his threats against the House of Representative members who voted for the Griffin-Landrum labor bill. Carey, he said, should devote his time and effort instead to protecting his union's members from cheap Japanese TV's and radios. He told the House that Japan is getting ready to ship large quantities of "$50.00 TV sets, $19.00 transistor radios to the U. S. Carey's problem, said Cross, is Japan's 10-cents-an-hour labor, not new U. S. labor legislation.

RELIABILITY being so important in the overall electronic effort, it will be interesting to see the influence of Fansteel's new program of pre-tested components. Each of their new Gold Cap capacitors is sold with a "pedigree" that details the written results of tests covering a total of 27 days. Further testing by the user is unnecessary. But certified reliability such as this calls for considerable effort and expense on the part of the component manufacturer. Can this technique be extended to other components as well, with any reasonable degree of accuracy?

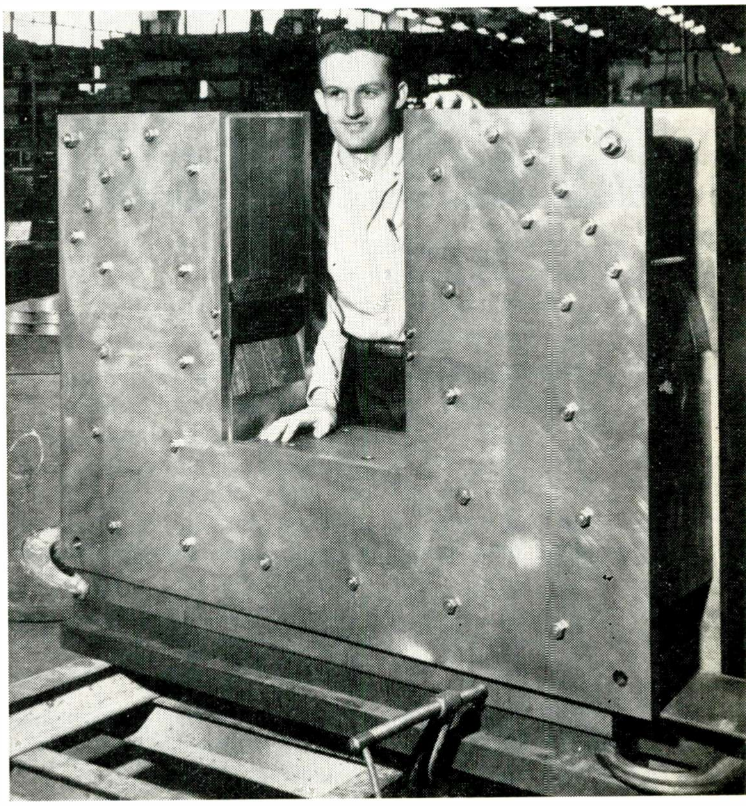
IMPORTS OF TRANSISTORS AND RELATED PRODUCTS are being investigated by the Office of Civil Defense Mobilization in response to a request from Electronic Industries Association. EIA charges that the volume of imports is threatening to impair national security. The investigation will cover all semiconductor products, including diodes, rectifiers, transistors imported as separate units, as accommodations of units or assemblies of finished products. While the OCDM is directing their investigation at all transistor imports, the EIA requests cited specifically the growing volume of Japanese transistors. Japanese production of transistors skyrocketed from 560,000 in 1956 to 14,967,000 in the first quarter alone in 1959. Imports of diode units has increased almost tenfold from 1956 to 1958. More than 60% of all the transistors being manufactured in Japan this year are destined for the United States.

RESEARCH SPENDING on the part of the Defense Dept. is expected to zoom up by an estimated $1.1 billion. The money reportedly will come out of cuts in defense procurement. Washington sources estimate that about $2 billion will be lopped off defense procurement, with about $800 million of that being shifted to R & D. Total expenditure for R & D is expected to approximate $3.8 billion.

NEW COMPUTER COMMITTEE is being set up under the American Standards Assoc. to study the possibility of establishing a standard coding and indexing system that could be used by computers for machine searching of technical and scientific information. The new committee on coding and indexing is a sub-committee of the ASA sectional committee on library work, documentation. The purpose of the conference is to exchange information and experience on the possibility of establishing a standard, common "machine language," or at least compatible languages, so that information compiled by one machine will be interchangeable with that compiled on another. With such a standardization the value and use of the computers would be greatly enhanced.

LARGEST MAGNET

This, the world's largest permanent magnet, is being fabricated at the Arnold Engineering Co., subsidiary of Allegheny Ludlum Steel Corp., for the AEC's Argonne National Laboratory. Weighing 1,720 lbs., it will be used to pump liquid sodium for the laboratory's breeder reactor.



As We Go To Press . . .

Telemetering Checks Hot Power Line Stress

Preformed Line Products Company of Cleveland, Ohio, showed publicly a versatile system designed for general purpose telemetering applications. A special feature of this system is its adaptability to measurements of stress in high tension power lines.

The system was developed in cooperation with Radiation, Inc. It consists of two parts: A battery powered telemetry transmitter and transducer fastened to the line under test; and a telemetry receiving station located in a vehicle stationed near the wire.

The specially-equipped vehicle measures high tension power line stress with the power-on by utilizing telemetering units.

In use, the transmitter is fastened securely to the line under test. A vibration-sensitive bridge transducer modulates the transmitter output, producing an FM/FM signal which is transmitted to the ground.

The receiving facility consists of two telemetry receivers and a dual channel recording oscillograph, permitting stress measurements on two lines simultaneously. In addition, line vibration may be observed on an oscilloscope, or with a modulated audio note.

Since there is no direct connection from the power line to the measuring and observation point, stress measurements may be made with high voltage on the line.

Antenna Manufacturer Installs Test Range

An antenna test range, extending more than 3000 ft. between receiver and transmitter location, is now included as a facility of the Technical Appliance Corporation, Sherburne, N. Y., manufacturers of commercial and military antenna systems. The test range is located on two hills, approximately 300 ft. elevation above a valley separating the hills. Test transmissions across the valley are electronically clean, showing a minimum of reflected, or delayed signals.

The test range is used for both development and check-out of commercial and military antennas. Complete transmitting, receiving and measuring equipment is available for all frequencies from VHF up through the X-band region.

Mechanical facilities at the receiving station permit complete field performance tests of antennas ranging in size to 60 ft. in diameter, with present test tower equipment. Larger sizes can be accommodated through modification and extension of present equipment.

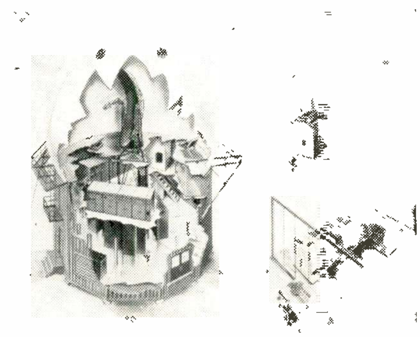
Dr. Ridenour Memorial Fellowship Created

Creation of a Dr. Louis N. Ridenour memorial fellowship, in honor of one of the principal architects of the Space Age, was announced by the Massachusetts Institute of Technology and the Lockheed Leadership Fund.

Dr. Ridenour, an internationally known nuclear physicist and first Chief Scientist of the U. S. Air Force, was vice president of Lockheed Aircraft Corp. and General Manager of its Electronics and Avionics Div. at the time of his death last May.

M.I.T. has awarded the fellowship for 1959-60 to Joseph Pedlosky, an M.I.T. graduate who held a Lockheed Leadership Fund scholarship and, like Dr. Ridenour, was born in New Jersey. Pedlosky this summer has been carrying out research in fluid mechanics at M.I.T. His home is in Fairlawn, N. J. The fellowship is valued at approximately $3,200.

THREE-STORY RADAR



Crosley Div., Avco Corp., Cincinnati, Ohio, is building this 3-story radar, one of the largest ground-based radar units ever designed. The radome is almost 50 ft. in dia. The FPS-26 radar unit, weighs 70 tons and has over 300,000 parts including 3500 tubes and diodes.

New Method Cuts Resistor Size

A new method of manufacturing deposited carbon resistors has been developed by the International Resistance Co. in Philadelphia. The resistor makes use of a new deposited carbon alloy.

Use of this new alloy, however, required a redesign of almost every other element in the resistor. An insulating spiral path, which determines the resistance value, is now diamond-cut in a much harder alloy film, rather than sandblasted as formerly. The result is said to be a more precise incision, with consequent improvement in stability and reliability. The highly conductive terminating point, which bonds the end-cap connections to the film, is still another new development. Over the resistance element are two new types of moisture resistant undercoat, also especially developed for this product.

The new method will cut size and weight of resistors by more than 50 per cent. These resistors will be available in sizes up to 1 w. with tolerances as close as 0.5 per cent.

More News on Pages
8, 14, 40, 45 & 48

ELECTRONIC SHORTS

▸ A "three-D" submarine-fighting system—"dip, detect and destroy"—that can give a sonar fine-tooth combing to hundreds of square miles of ocean per hour was announced jointly by the U. S. Navy, Sikorsky Division of United Aircraft Corp. and Pacific Div. of Bendix Aviation Corp. The system uses a transducer, periodically "dunked" by a long cable from a helicopter, to spot submarines by sonar echo ranging, and the latest type of homing torpedoes, launched from the Sikorsky HSS-2 'copter, officials explained.

▸ The first steerable radio telescope in this country designed specifically for solar research was dedicated recently by the University of Michigan. The new instrument, an 85-foot parabolic antenna, which ranks first in the world in its ability to resolve fine detail, was built with Navy support to study solar and galactic radio sources. It is also the largest solar research radio telescope in this country.

▸ The Air Force Special Weapons Center, which made measurements of radiation discharged by the high-altitude Argus nuclear explosions, is rocketing more advanced counters to altitudes ranging up to 2,000 miles in an attempt to obtain a clearer picture of the mysterious Van Allen radiation belt. Lockheed Missiles and Space Division is providing the radiation-measuring instruments for the scientific project known by the code name "Javelin."

▸ A fascinating new device which will "read" newspapers and books aloud has recently made its debut in Japan. This is the Synchroreader, a kind of type-recorder, which promises to be a boon to the field of recorded messages of all kinds. The new machine uses a sheet of paper rather than the magnetic tape of conventional recorders. This Synchrosheet is coated on one side with a mixture of ink and magnetic iron dust on which voices and sounds can be recorded. To hear the recorded message, the sheet is placed on the Synchroreader and by pressing a button, the message is read aloud.

▸ An evaporative cooling system to prevent airborne radar equipment from burning up in heat generated in hypersonic flight is being developed for the U. S. Navy by the Convair (San Diego) Division of General Dynamics Corporation. The cooling unit, designed for radar receiver-transmitters used in aircraft traveling at more than three times the speed of sound, is being tested at Convair's thermodynamics laboratory.

▸ Scientists and science teachers in colleges, universities, and nonprofit organizations are invited by the National Science Foundation to submit proposals for the design of better laboratory equipment for use in the Nation's schools. Proposals judged meritorious will be supported by the Foundation under a program designed to encourage the development of inexpensive and practical tools for use in the laboratory phases of science instruction.

▸ The National Stereophonic Radio Committee (NSRC), has appointed three task forces for the Committee's Panel 1 on System Specifications. The three task forces are: (1) Resolution or clarification of the differences between the three FM systems proposed using an AM subcarrier; (2) Resolution or clarification of the differences between the three FM systems proposed with FM subcarrier; and, (3) A theoretical analysis of the relative advantages of AM subcarrier modulation vs. FM subcarrier modulation.

▸ New England's first building to draw its heat from the atmosphere is under construction at Sudbury, Massachusetts. An airborne electronic equipment engineering laboratory for Raytheon Company's Government Equipment Div., the 160,000 sq. ft. structure will be minus furnace or boilers, but will be completely heated and air-conditioned. It is scheduled for completion in January 1960.

▸ At the Second International Conference on Medical Electronics, held in Paris from 24th to 27th June, 1959, an official organization was formed to consolidate activities in this new and important field of applied science. The organization will be known as the International Federation for Medical Electronics, and its object will be to encourage the development and dissemination of knowledge in medical electronics throughout the various countries.

As We Go To Press

British to Market TV Camera Here

The Ampex Corp. will market the British-made Marconi TV camera here in the U. S. The Marconi camera makes use of a 4½ in. image—orthicon tube, claimed to be the first used in a television camera in the United States. The picture produced is said to be more life-like than TV viewers are accustomed to at present.

Tom Davis, Marketing Manager for Ampex Corp.'s Professional Products Div. said that the Marconi camera in conjunction with Ampex Videotape® recorder with interswitch modifier has considerable implication insofar as international programming is concerned, explaining that they work equally well on any world TV standard. The camera and recorder are easily convertible from 525 lines (American) to 405 lines (British) or 625 lines (European Continental) standards.

The 4½ in. image-orthicon tube used in the Marconi Mark IV camera is produced by Marconi's Wireless Telegraph Co. Ltd.

Navigation System For Polaris Uses Computer

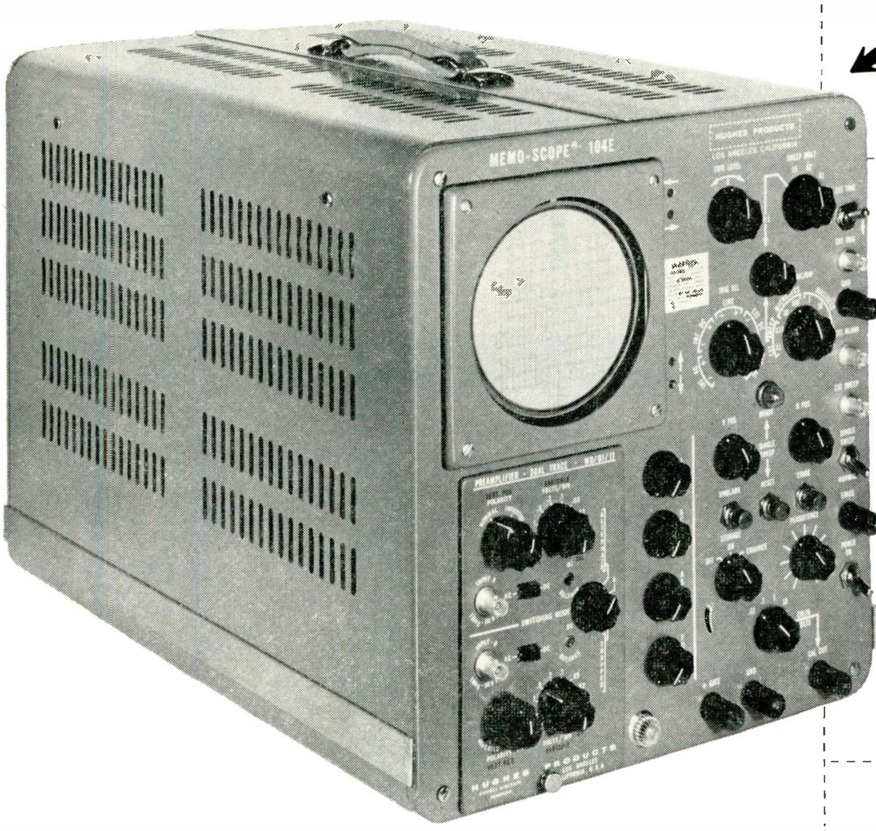
Autonetics, a division of North American Aviation, Inc., has successfully completed laboratory testing of an inertial navigation system that will assist in precisely fixing the underwater launching position of the Navy's Polaris ballistic missile. The autonavigator, known as the N7A, will give the Polaris guidance system precise pre-launching position information so that the missile may follow a ballistic trajectory to its target. The system uses precision gyroscopes, acceleration-sensing instruments and two-in-one digital computer known as VERDAN.

VERDAN is designed so that its power may be interrupted without loss of stored information. It automatically marks its place in a computation whenever a power failure is detected. It retains the information indefinitely or until power is restored and the computation resumed. Further testing is scheduled at sea aboard the USS Compass Island.

new improved "Memo-Scope®" oscilloscope

Still using "old-fashioned" methods for measuring non-recurring transients? If so, now is the time to investigate the easy way to solve your most difficult transient measurement problems with the latest model Hughes "Memo-Scope" oscilloscope.

Why? Because *new* features, *new* advanced circuitry, *new* panel layout and *new* mechanical design now assure maximum accuracy in all your transient measurements—*plus* higher performance, greater dependability and easier operation!



The Hughes "Memo-Scope" oscilloscope (Model 104E) stores nonrepetitive events for an indefinite period—hours, or days—keeping them available for thorough study until intentionally erased.

new improved features

- Simplified panel layout, redesigned trigger circuit...assure easier operation.
- Advanced mechanical design gives:
  - Better cooling for longer component life.
  - Far greater accessibility for maintenance.
  - Increased ruggedness; resistance to vibration.
- Built-in single-sweep circuit ("1-shot" trigger) at no extra cost.
- Available for either 110 v. or 220 v. operation.

applications

- Data reduction equipment trouble-shooting
- Physical testing: shock, stress, strain
- Ultrasonic flaw detection
- Semiconductor testing
- Ballistics and explosives research

...and many others.

For complete information on the new improved Hughes "Memo-Scope" oscilloscope (Model 104E), detailed data sheets and application analysis of your transient measurement problems, write or wire: HUGHES PRODUCTS Industrial Systems Division, International Airport Station, Los Angeles 45, California

INDUSTRIAL SYSTEMS DIVISION

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HUGHES FAMILY OF DIRECT-VIEW STORAGE TUBES

World's most complete line of storage tubes!

TONOTRON® TUBE: displays full range of grey scale images for daylight viewing. Ideal for weather radar, PPI presentations, "B" scan projections and other complex radar systems.

MEMOTRON® TUBE: displays successive transients until intentionally erased. Permits direct comparison and analysis of wave forms without photography.

TYPOTRON® TUBE: displays any combination of 63 symbols or characters at speeds to 25,000 per second. Retains presentation until intentionally erased.

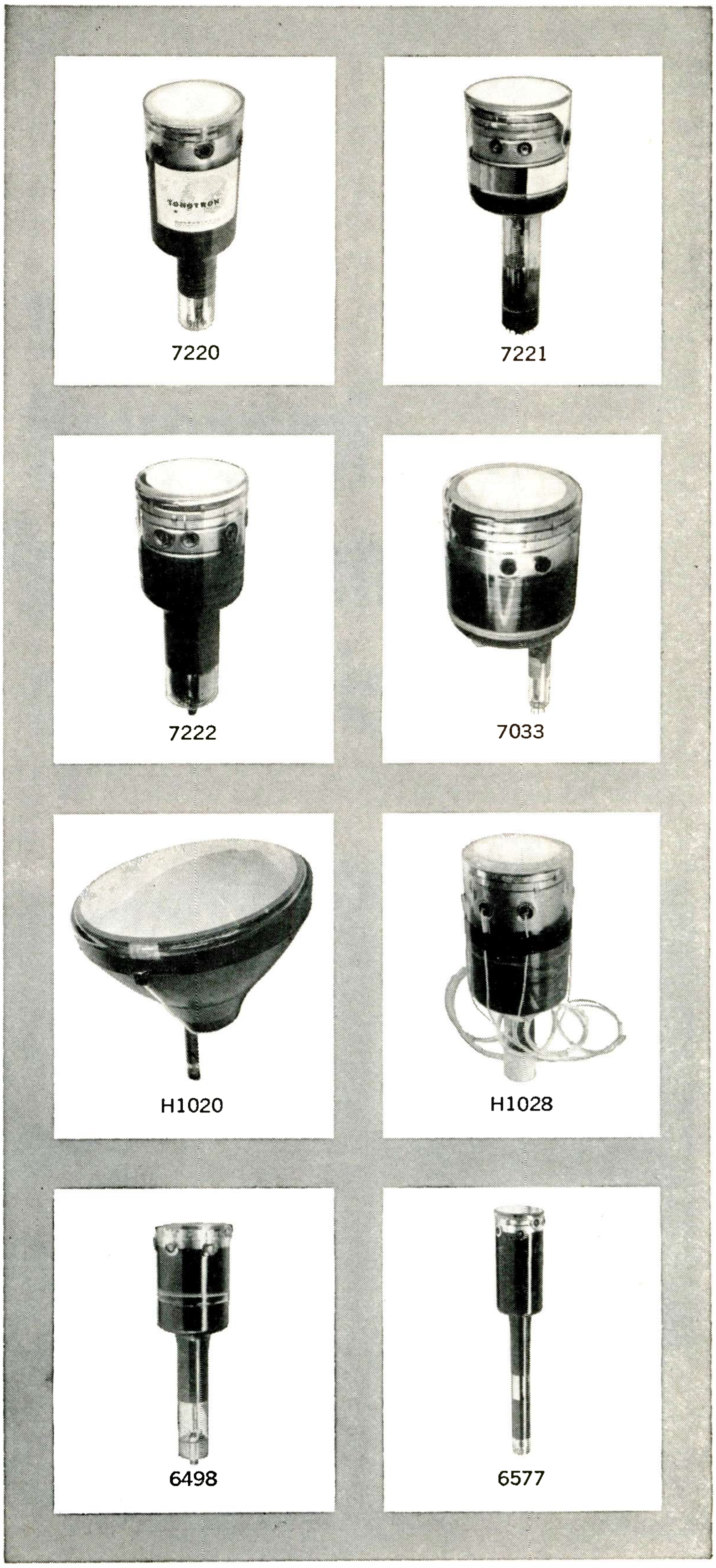
STORAGE TUBE CHARACTERISTICS

7220 TONOTRON TUBE Screen diameter: 3″ Standard phosphor: P1 Deflection: Electrostatic	7221 TONOTRON TUBE Screen diameter: 5″ Standard phosphor: P20 Deflection: Electrostatic
7222 TONOTRON TUBE Screen diameter: 5″ Standard phosphor: P20 Deflection: Electrostatic	7033 TONOTRON TUBE Screen Diameter: 5″ Standard phosphor: P20 Deflection: Electromagnetic
H1020 TONOTRON TUBE Screen Diameter: 21″ Standard phosphor: P20 Deflection: Electromagnetic	H1028 TONOTRON TUBE Screen diameter: 4″ Standard phosphor: P1 Deflection: Electrostatic
6498 MEMOTRON TUBE Screen Diameter: 5″ Standard phosphor: P1 Deflection: Electrostatic	6577 TYPOTRON TUBE Screen diameter: 5″ Standard phosphor: P1 Deflection: Electrostatic

9 additional TONOTRON tubes and 4 additional TYPOTRON tubes available.

For full and complete information on how Hughes storage tubes may fill your particular needs and applications, write or wire: HUGHES PRODUCTS, Electron Tube Division, P.O. Box 90427, International Airport Station, Los Angeles 45, California.

For export information, write: HUGHES INTERNATIONAL, Culver City, California.



ELECTRON TUBE DIVISION

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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VTP's FAMILY OF SPECIALIZED CRTs

World's finest special-purpose tubes in production quantities!

Do you need tube characteristics which will enable you to tighten your "specs"? Or, have you a particular tube application demanding high operating performance with extreme reliability under difficult environmental conditions? If so, Vacuum Tube Products can supply you with specialized CRTs in production quantities to fill your most exacting requirements.

VTP's broad experience, unmatched "know how" and excellent facilities guarantee you custom-designed tubes in the quantity needed ... tailored to your environmental specifications:

- Shielded or unshielded,
- with or without special mountings,
- potted or unpotted,
- with the exact phosphor you require.

TUBE CHARACTERISTICS

VTP 3ABP Screen diameter: 2.68" Deflection: Electrostatic Overall length: 10.75"	VTP 5XP-11 Screen diameter: 5¼" Deflection: Electrostatic Overall length: 17⅝"
VTP 5ACP4 Screen diameter: 4.25" Deflection: Electromagnetic Overall length: 11⅛"	VTP 12GP Screen diameter: 12" Deflection: Electrostatic Overall length: 22"
VTP P1XP-11 Screen diameter: 1.0"+ Deflection: Electrostatic Overall length: 7.5"	VTP 16AFP-19 Screen diameter: 14.738" Deflection: Electromagnetic Overall length: 19.146"
VTP 5BC Screen diameter: 4.95" Deflection: Electromagnetic Overall length: 7 7/16"	VTP 928006-2E Screen diameter: 4.5" Deflection: Electrostatic Overall length: 18.38"

For detailed specifications and data sheets on VTP's specialized CRTs as well as specific application information, write: VACUUM TUBE PRODUCTS, P.O. Box 90427, International Airport Station, Los Angeles 45, California.

For export information, write: HUGHES INTERNATIONAL, Culver City, California.

VTPCO

VACUUM TUBE PRODUCTS
a division of HUGHES AIRCRAFT COMPANY

Coming Events in the electronic industry

A listing of meetings, conferences, shows, etc., occurring during the period November-December that are of special interest to electronic engineers

Oct. 29-30: 1959 Electron Devices Meeting, IRE (PGAC); Shoreham Hotel, Washington, D. C.

Oct. 29-30: Meeting, National Assoc. of Broadcasters; Dinkler-Plaza Hotel, Atlanta, Ga.

Nov. 2-4: Annual Conference, Atomic Industrial Forum; Sheraton-Park Hotel, Washington, D. C.

Nov. 2-4: Midwestern Meeting on New Frontiers in Aviation, IAS; Hotel Kassem, Wichita, Kansas.

Nov. 2-5: 11th Annual Exposition of the ARI, Air-Conditioning and Refrigeration Institution; Atlantic City, N. J.

Nov. 2-6: Fall Meeting, Metallurgical Society of AIME; Morrison Hotel, Chicago, Ill.

Nov. 3-4: Annual Convention, Ultrasonic Manufacturers Assoc.; Hotel Sheraton, Chicago, Ill.

Nov. 3-5: Mid-American Electronics Conf. (MAECON), IRE (Kansas City Section); Kansas City, Mo.

Nov. 4-5: 5th Annual EER Instrument Show, Electronic Engineering Representatives; Suburban Hotel, Summit, N. J. (Traveling Show—See Nov. 12-13.)

Nov. 4-6: National Automatic Control Conf., IRE; Sheraton - Dallas Hotel, Dallas, Tex.

Nov. 5-6: 8th Annual Instrumentation Conf., Louisiana Polytechnic Institute; Ruston, Louisiana.

Nov. 5-6: Control Systems Components Conference and National Automatic Controls Conference, IRE, AIEE, SAE, ISA, ASME; Sheraton Hotel, Dallas, Texas.

Nov. 8-13: International Rubber Tech. Conf., ASME; Washington, D. C.

Nov. 9-11: Radio Fall Meeting, IRE, EIA; Hotel Syracuse, Syracuse, N. Y.

Nov. 9-11: 4th Instrumentation Conf. & Exhibit, IRE; Atlanta Biltmore Hotel, Atlanta, Ga.

Nov. 9-13: Annual Meeting, National Electrical Manufacturers Assoc.; Traymore Hotel, Atlantic City N. J.

Nov. 10-11: Meeting, National Assoc. of Broadcasters; Hotel Texas, Fort Worth, Texas.

Nov. 10-12: Tri-Annual Products of Industry Exhibit, Milwaukee Assoc. of Purchasing Agents; Milwaukee Auditorium, Milwaukee, Wis.

Nov. 10-12: 12th Annual Electronic Techniques in Medicine and Biology Conference, IRE, AIEE, ISA; Penn-Sheraton Hotel, Phila., Penna.

Nov. 12-13: Meeting, National Association of Broadcasters; Brown Palace, Denver, Colorado.

Nov. 12-13: 5th Annual Instrument Show, Electronic Engineering Representatives; Sylvania Hotel, Phila., Penna.

Nov. 12-13: National Industrial Research Conference, Armour Research Foundation; Sherman Hotel, Chicago, Ill.

Nov. 12-13: Meeting, American Society of Industrial Designers; Statler Hilton Hotel, New York, N. Y.

Nov. 16-17: Meeting, National Association of Broadcasters; Ambassador Hotel, Los Angeles, Calif.

Nov. 16-19: Conference on Magnetism and Magnetic Materials, IRE, AIEE, APS, AIM, ONR; Sheraton-Cadillac Hotel, Detroit, Mich.

Nov. 16-20: 5th International Automation Congress & Exposition, ASME participating, New York Trade Show Building, New York, N. Y.

Nov. 16-20: Meeting, American Rocket Society; Washington, D. C.

Nov. 17-18: National Turbine Powered Air Transportation Meeting, IAS; Fairmont Hotel, San Francisco, Calif.

Nov. 17-18: Seminar—Some Problems of Machining Space Age Metals, ASTE; Philadelphia, Penna.

Nov. 17-19: NEREM, New England Research and Engineering Meeting, IRE; Commonwealth Armory, Boston, Mass.

Nov. 17-20: Packaging Machinery Manufacturers Institute Show; New York Coliseum, New York, N. Y.

Nov. 18-20: 9th National Conference on Standards, American Standards Association; Hotel Roosevelt, New York, N. Y.

Nov. 19-20: 6th National Meeting of Professional Group on Nuclear Science, IRE; Commonwealth Armory, Boston, Mass.

Nov. 19-20: Meeting, National Association of Broadcasters; Olympic Hotel, Seattle, Washington.

Nov. 23-24: Symposium on Solid State Techniques in Instrumentation, IRE, ISA, AIEE; Benjamin Franklin Hotel, Phila., Penna.

Nov. 24-25: Fall Meeting, Fluid Controls Institute, Inc.; Drake Hotel, Chicago, Ill.

Dec. 1-3: Eastern Joint Computer Conference, IRE, AIEE, ACM; Hotel Statler-Hilton, Boston, Mass.

Dec. 1-2: 4th Midwest Symposium on Circuit Theory, Marquette Univ., Milwaukee, Wis.

Dec. 2-4: Electric Furnace Conference, AIME; Cleveland Hotel, Cleveland, Ohio.

Dec. 17: Wright Brothers Lecture, IAS; Natural History Building Auditorium, Smithsonian Institute, Washington, D. C.

Abbreviations

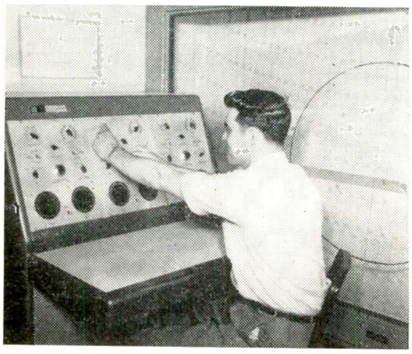
- **AIEE**: American Institute of Electrical Engineers
- **AIME**: American Institute of Mining & Metallurgical Engineers
- **AIP**: American Institute of Physics
- **APS**: American Physical Society
- **ARF**: Armour Research Foundation
- **AEC**: Atomic Energy Commission
- **ASME**: American Society for Mechanical Engineers
- **ASTM**: American Society for Testing Materials
- **EIA**: Electronic Industries Association
- **IRE**: Institute of Radio Engineers
- **ISA**: Instrument Society of America
- **ODR**: Office of Director of Defense Research
- **ONR**: Office of Naval Research
- **SAE**: Society of Automotive Engineers
- **SMPTE**: Society of Motion Picture & TV Engineers
- **IAS**: Institute of Aeronautical Sciences

As We Go To Press . . .

(Continued)

Target Simulator Is Developed for DEW Line

An accurate radar target simulator has been developed by Philco Corp.'s Government & Industrial Div. to meet the specifications of the Federal Electric Corp., Paramus, N. J. The unit cost is about $10,000.



Philco's radar target simulator is used as a training device for operation of the Distant Early Warning line by ITT.

This new type target simulator was designed for the training and practice of radar operators. Federal is using the new Philco simulators at its training headquarters in Streator, Ill., and on the DEW line, which stretches across northern Canada and Alaska.

The simulator does not interfere with normal operation of the radar equipment. Both real and synthetic radar returns may be displayed simultaneously. When operated in conjunction with an early warning radar system, the simulator generates azimuth, range and video information for separate targets which will maneuver realistically under the precise control of the operator.

EIA Holds Fall Conference

A complete reorganization of the Parts Div. was approved by its executive committee during the three-day EIA Fall Conference at the Traymore Hotel, in Atlantic City on Sept. 22-24, according to division chairman William S. Parsons, President of Centralab, a Division of Globe-Union Inc. A second Vice Chairman for the division also was approved as well as 10 subdivision chairmen, division committee chairmen and members, and a new member of the executive committee.

Allen K. Shenk, Vice President, Marketing, of Erie Resistor Corp., was made second vice chairman. He joins Parsons and vice chairman W. Myron Owen, President of Aerovox, Inc., in administering the activities of the reorganized Parts Div.

Each of the vice chairmen is assigned responsibility for 5 of the 10 ne wsub divisions, and it is anticipated that within the subdivisions approximately 50 sections will be organized to deal with the management problems relating to specific components. In many cases, Parsons said, parallel engineering committees and working groups will be organized to handle the engineering activity requested by management.

While the conference was going on, EIA President David R. Hull reappointed H. Leslie Hoffman, President of Hoffman Electronics Corp., Chairman of the EIA Spectrum Committee for the fiscal year ending July 31.

Microwave Techniques Aid I-R Detectors

An ultra-sensitive microwave infrared detection system has been developed by GB Electronics Corp. of Garden City, L. I., to detect enemy submarines, atomic installations, missile launching sites and underground industrial and military installations at great distances.

The detector incorporates photosensitive semiconductor materials in conjunction with microwave techniques and assemblies. As a result, electrical contacts to the semiconductor are eliminated and a "noiseless" electronic amplification is achieved. Work already accomplished demonstrates the marked improvement in sensitivity of this technique over that of conventional detectors.

This detection system couples an infrared detector with a parametric amplifier and parametric harmonic generator. This completely solid state system boasts light weight, small size and reliability. It is expected to make feasible a series of monitoring satellites to keep a watchful eye on possible aggressive activity throughout the world.

Radar with 1,000-Foot Antenna Authorized

Construction of a radar, equipped with a 1,000 ft. diameter spherical antenna, to be directed vertically, for use in ionospheric measurements, has been authorized by the Advanced Research Projects Agency.

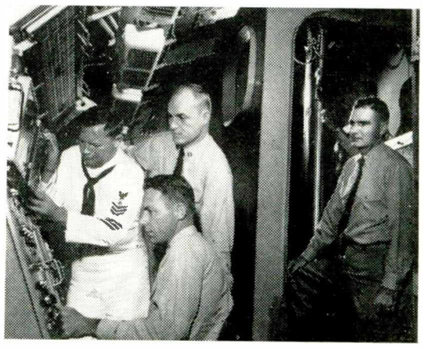
The Air Research and Development Command has been directed to let a contract to Cornell University, Ithaca, N. Y., for the design and construction of such a radar for installation in Puerto Rico, and to administer the contract in behalf of ARPA.

The Army's Corps of Engineers will be responsible for land acquisition (approximately 70 acres), development of the site, and installation of the radar. Total cost of the installation, including the land and site development, is estimated at $4.5 million. It is expected that installation will be completed within two years.

The radar, with its 1,000 ft. dish antenna, will be funded by ARPA as a means of studying the midcourse effects of atmosphere on ballistic missiles. It will be available, however, for use by other scientific agencies.

Called a "vertically directed ionospheric radar probe" the device can use incoherent backscatter radar to measure electron density and temperatures as a function of height and time to a distance exceeding one radius of the earth; to measure auroral ionization; to detect transient streams of charged particles coming from outer space; to explore the existence of a ring current; to obtain radar echoes from Mars and Venus; and to map areas of the moon and sun.

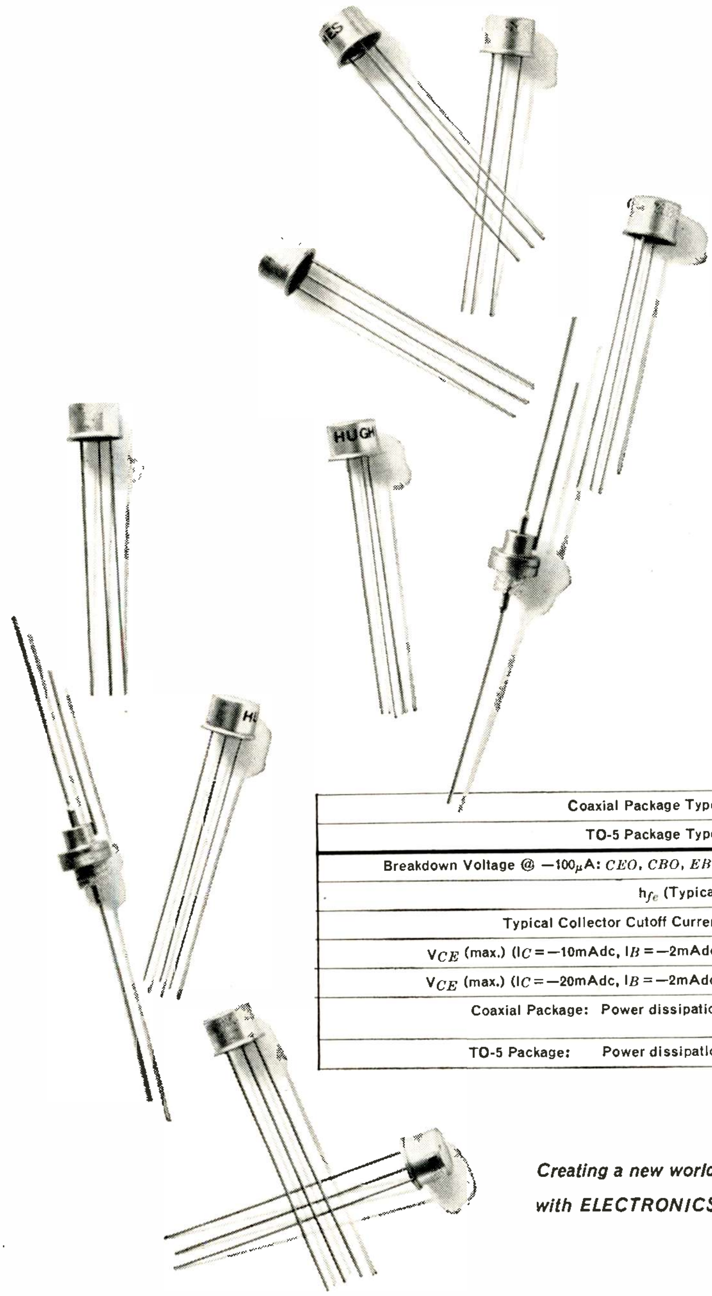
"LAUNCH" LAND-BOUND LAB



Replica of navigational center of Polaris subs, assembled at Sperry Gyroscopes, Syosset, N. Y. plant is inspected by Cdr. H. E. Shear (right), prospective Commanding Officer, Quartermaster J. T. Parsons, CPO E. Beyers, Navigator Lt. W. Williams, and Exec. Lt. Cdr. C. Grojean.

how to get ultra-uniformity

in a Silicon PNP fused alloy transistor



Through precise manufacturing techniques, Hughes PNP fused-junction silicon transistors give you uniformity of parameters by type. Result: Circuit interchangeability no longer is a problem.

Designed for switching and amplifying applications at low and medium current levels, these Hughes transistors offer you a number of advantages:

- **useful Beta over a wide range of collector currents**
- **high punch-thru voltage (BV_{CEO} in excess of 100 volts in types 2N1244 and 2N1234)**
- **low collector cutoff current**

These devices, now available in production quantities, are housed in TO-5 (single ended) and coaxial packages (double ended). Engineered for reliability, they meet MIL-T-19500A specifications.

*Your inquiry regarding these transistors will be given prompt attention. Just write Marketing Department, **HUGHES SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA**... or contact the Hughes Semiconductor Sales Office or distributor nearest you.*

Coaxial Package Type:	2N1238	2N1239	2N1240	2N1241	2N1242	2N1243	2N1244
TO-5 Package Type:	2N1228	2N1229	2N1230	2N1231	2N1232	2N1233	2N1234
Breakdown Voltage @ —100μA: *CEO, CBO, EBO*	—15V	—15V	—35V	—35V	—65V	—65V	—110V
h_{fe} (Typical)	22	40	14	25	14	25	14
Typical Collector Cutoff Current	—.01μAdc	—.01μAdc	—.01μAdc	—.01μAdc	—.01μAdc	—.01μAdc	—.01μAdc
V_{CE} (max.) (I_C=—10mAdc, I_B=—2mAdc)	—0.2Vdc		—0.2Vdc		—0.2Vdc		—0.2Vdc
V_{CE} (max.) (I_C=—20mAdc, I_B=—2mAdc)		—0.4Vdc		—0.4Vdc		—0.4Vdc	
Coaxial Package: Power dissipation	1 watt in free air (derate 7.4 mw/°C) 5 watts with heat sink (derate 37 mw/°C)				Collector current limited by power dissipation. Operating and storage temperature range —65°C to +160°C		
TO-5 Package: Power dissipation	400 mw (derate 3.0 mw/°C)						

Creating a new world with ELECTRONICS

SEMICONDUCTOR DIVISION

HUGHES PRODUCTS

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS

Electronic Industries' News Briefs

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

EAST

BENDIX AVIATION CORP. has started construction of their new semiconductor products plant in Holmdel, N. J. The 72,000 sq. ft. plant will be located on a landscaped 118-acre tract.

AMERICAN MACHINE & FOUNDRY CO. has been awarded a contract for $42,600,000 by the Air Force. The contract was let to build, install and test the first 18 operational underground launching systems for the top-priority Titan Intercontinental Ballistic Missile, at Lowry Air Force Base, near Denver, Colo.

FXR, INC. has received a half million dollar contract through the approval of the award by Cornell Aeronautical Laboratory, Inc., of Buffalo, for the design and manufacture of a high powered radar transmitter. The transmitter is expected to have a peak power of 50 million watts.

WAVELINE, INC. expects their $150,000 plant expansion to be completed by the middle of this month. This expansion will double their present facility size.

HERMETIC SEAL CORP. has established their Corporation Executive Offices at 213 Chestnut St., Nutley, N. J.

RAYTHEON CO. have been awarded contracts totaling $30 million to develop and produce a new submarine sonar device. The new device will combine sophisticated searching, electronic control of underwater firepower, and advanced communications techniques. The entire system will be an integral part of the hull design, a new concept in submarine construction. In the past, sonars were fitted into existing hulls.

MICROWAVE ASSOCIATES, INC. has started construction of a plant addition and a new plant located in Northwest Industrial Park, Burlington, Mass. A 17,000 sq. ft. wing is being added to the present plant and the second building is being constructed adjacent to the present plant. It will contain 32,000 sq. ft. to house WAVECO Corp., a subsidiary.

MELPAR, INC. has awarded a $2,400,000 building contract to construct a 120,000 sq. ft., 3-story addition to the Falls Church headquarters plant. Completion has been set for September 1960.

RADIO CORP. OF AMERICA has announced plans for a major expansion of transistor and rectifier manufacturing facilities. Plans call for construction of a 120,000 sq. ft. plant in Mountaintop, Pa. The plant is being designed with a view toward future expansion.

GENERAL ELECTRIC CO., Ordnance Dept., has received a contract for $2,166,420 for long range search radar antennas. The antennas will be used for the AN/FPS-7 radar system. The complete radar system contract was awarded to the company's Heavy Military Electronics Dept.

CORNELL-DUBILIER ELECTRIC CORP., manufacturer of electronics components, will convert to a modern research and development laboratory, its 100,000 sq. ft. plant near Route 128 at Norwood, Mass. The laboratory will be devoted to basic and applied research.

SYLVANIA ELECTRIC PRODUCTS INC. has received a contract from the U. S. Naval Bureau of Ordnance for special switching transistors for use in the Polaris Weapons System. The amount of the contract was not revealed. The transistors, designated R 212, are high speed pnp types capable of 150 mw dissipation.

Du PONT CO. has announced that "Teflon" fluorocarbon resins will soon be available commercially in the form of thermoplastic film. Up to the present time it has been available only in development quantities. It should be available commercially by late this year. When production begins the price will be about half of the present price.

UNI-SEAL, INC.'s new Garwood, N. J. plant is completed and running at full production capacity. The newly-formed company is now making delivery of its line of transistor mounts, multi-headers, complete header and cover assemblies, individual terminals, crystal bases, diode housings, condenser end seals, and terminal strips.

HOFFMAN ELECTRONICS CORP., Semiconductor Div., has announced price cuts up to 30% on 1N429 Zener reference diodes.

SHIELDING, INC., has completed their manufacturing expansion move to their new Plant No. 2. The 16,500 sq. ft. building is located in Riverton, N. J.

PHILCO CORP. and **GENERAL TRANSISTOR CORP.** have jointly announced the signing of an engineering service and license agreement covering the manufacture and sale of transistors. Under the agreement, Philco provides General Transistor with a non-exclusive license to make, use and sell transistors embodying Philco inventions. They also agreed to furnish General Transistor with technical and engineering information and equipment needed in the manufacture of these transistors. General Transistor will provide Philco with similar license rights and engineering services.

CAMBRIDGE THERMIONIC CORP. has announced a plant expansion program now under way which will provide a total of 30% additional floor space for manufacturing, experimental, and testing facilities.

MID-WEST

MOTOROLA, INC., was awarded a multi-million dollar contract to produce an important part of the electronics equipment for the new Air Force B-70 Triple-sonic global bomber. The actual dollar figure was not announced.

VICTOREEN INSTRUMENT CO., Cleveland, Ohio, has acquired the Standard Felt Co. of Alhambra, Calif. Standard Felt's products are used largely as shock and vibration dampers in a wide range of equipment.

THOMPSON RAMO WOOLDRIDGE INC., has acquired a controlling interest in Magnetic Recording Industries of New York City. MRI produces electronic equipment for educational purposes.

C. P. CLARE & CO. recently broke ground for an 18,000 sq. ft. addition to the general offices and factory at Chicago. The latest expansion move will double present laboratory space and add to office and production facilities.

KLEINSCHMIDT DIV. of SMITH-CORONA MARCHANT INC., has started expansion of their production and assembly facilities in Deerfield, Ill. This is the sixth time this plant has been expanded since it was built in 1950.

BURROUGHS CORP. announced the acceptance of a new operational guidance computer for the Atlas ICBM by the Air Force Ballistic Missile Division. This one is scheduled for Warren Air Force Base, Cheyenne, Wyo.

WEST

THE MAGNAVOX CO. has started construction of its new multi-million dollar research center located in West Los Angeles, Calif. The building will be erected at a cost of $1.5 million. They expect to eventually spend $5 million on this 10-acre site.

RHEEM SEMICONDUCTOR CORP., a subsidiary of Rheem Mfg. Corp., has completed building No. 2 located near its present headquarters and plant at Mountain View, Calif. A third plant costing $1,800,000 is now under construction near building No. 1 and building No. 2. Completion is set for Feb. 1, 1960.

TEXAS INSTRUMENTS INCORPORATED announced that construction has begun on expansion of their Versailles, Ky. plant.

CONVAIR has announced the award of $142 million contract for production of inertial bombing-navigation systems and ground support equipment for the U. S. Air Force's first SAC wing of 36 B-58 supersonic bombers has been given to Sperry Gyroscope Co.

THE DEUTSCH CO.'s Electronic Components Div. new plant, located in Banning, Calif., has been officially opened. The new building is being used for completely integrated production, engineering, research and administrative facility for their connectors.

HOFFMAN ELECTRONICS CORP., Hoffman Laboratories Div. has announced receipt of a contract for the development of a large area solar-electric power system for use in space satellites. The $600,000 contract was awarded by Wright Air Development Center, Air Research and Development Command, U. S. Air Force. The power system will be capable of producing 100 watts of electricity continuously and 500 watts peak and will utilize silicon solar cells.

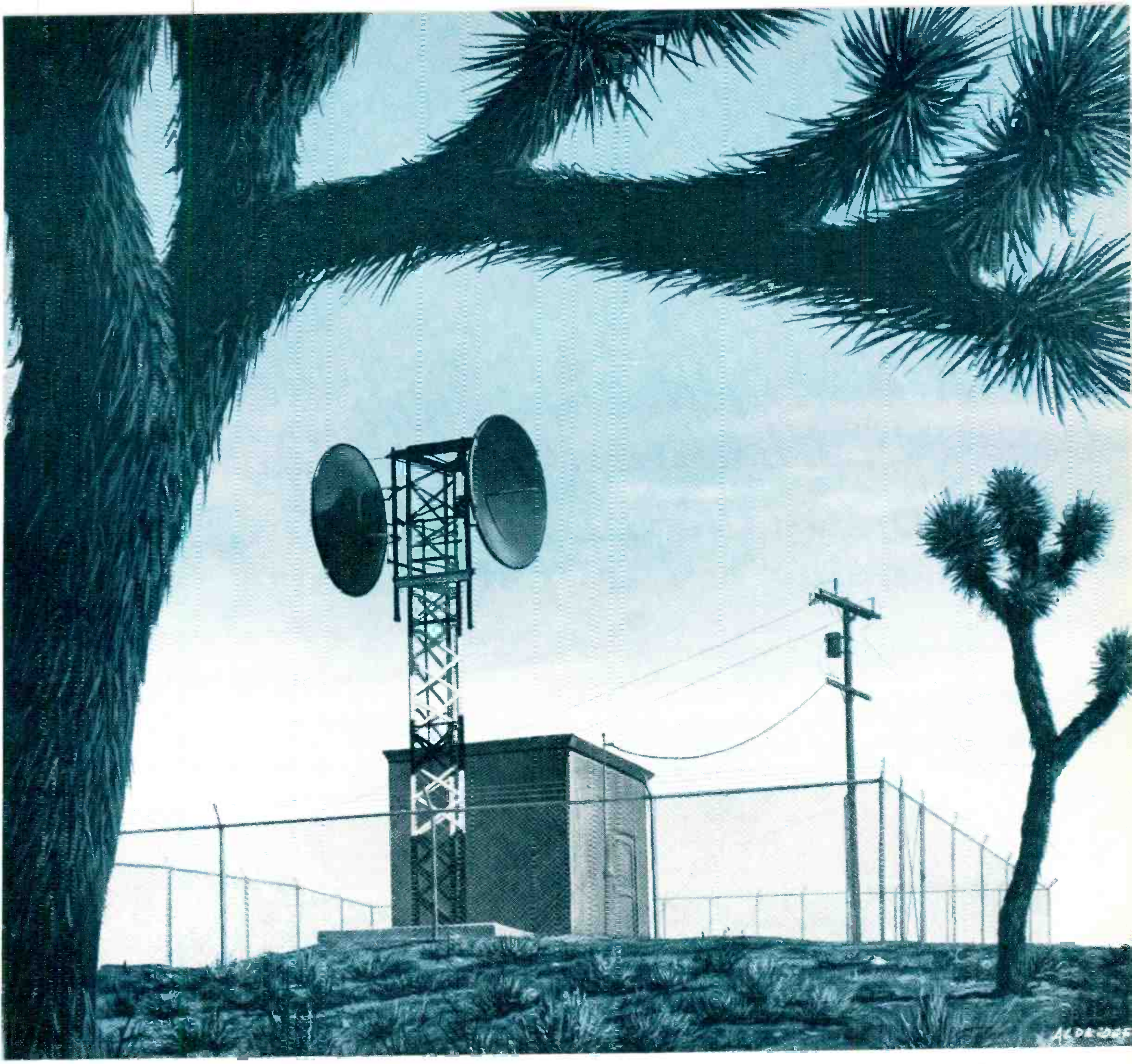
HUGHES AIRCRAFT CO. is now producing new diode types combining high current capabilities with exceptionally fast recovery times for application to computer switching operations. The new silicon-diode types, 1N837 through 1N845, generally follow the specifications of the widely used family of diodes represented by type 1N643. However, the forward current capability has been sharply increased.

PACKARD BELL ELECTRONICS CORP. has broken ground in Newbury Park, Ventura County, Calif., for a new 50,000 sq. ft. plant.

LOCKHEED MISSILES and SPACE DIV. has announced the transfer of all of the major functions of its 3 advanced satellite programs into its newly-activated $8 million satellite production building. In activating the new satellite production building, Lockheed has moved in nearly 2,500 scientists, engineers, technicians, and administrative support people. The building contains 346,000 sq. ft. and is located on the front portion of its 645-acre site.

SERVOMECHANISMS, INC.'s Santa Barbara Research Center is conducting research on high efficiency thermoelectric materials and on magnetic domain computing techniques for the Army-Navy Instrumentation program. Work is being ponsored by the El Segundo Div. of Douglas Aircraft Co., Inc., through funds allocated by the Office of Naval Research.

CONRAC, INC. has, in less than 6 weeks after fire leveled their plant No. 2 and stopped all production, made their first shipment of television monitors.



A COLLINS MICROWAVE INSTALLATION NEAR KRAMER HILLS IN THE CALIFORNIA INTERSTATE TELEPHONE COMPANY SYSTEM.

COLLINS MICROWAVE AND CARRIER

Quality engineered by telephone communication specialists

Bridging remote areas with dependable, all weather communication, microwave is the economical backbone of an expanding telephone system. Collins' leadership in the field of communication qualifies the organization to supply your every microwave need—planning, site selection, equipment manufacture, installation, training and field service. Consult Collins for a system tailored to your individual needs. It will be reliable, flexible and readily adapted to tomorrow's expansion.

Write or call Collins Radio Company, Texas Division Sales, 1930 Hi-Line Drive, Dallas 7, Texas.

COLLINS

COLLINS RADIO COMPANY • DALLAS, TEXAS • CEDAR RAPIDS, IOWA • BURBANK, CALIFORNIA

Circle 9 on Inquiry Card

Introducing a NEW FAMILY OF

MICROWAVE DIODES

PHILCO sets the pace with outstanding crystal performance

Announcing a new family of low-noise microwave diodes. Here is a major step forward in the development and control of germanium and silicon crystal diode performance. Philco microwave diodes are designed to meet the most stringent military environmental and electrical requirements for shock, vibration, torque and strain. Each of these new diodes is unsurpassed for performance. When only the best will do . . . the experts choose Philco.

- **Exceptionally Low Noise Figure**
- **Outstanding Performance at 150° C**
- **High Resistance to Burn-Out**
- **Absolute Hermetic Seal**

1N1838

The first and only Germanium Mixer Diode specifically designed for ultra-low noise performance in Doppler receivers. Through Philco's exclusive anchor whisker construction the practical elimination of microphonics is assured. The 1N1838 is hermetically sealed and has been uniquely engineered for Doppler equipments operating at 8,800 and 13,500mc.

1N263

Here's a Hermetically Sealed Germanium Crystal Diode designed for exceptionally low noise mixer performance at X-band. It has been engineered to such a degree that its tightly controlled characteristics assure that *any* two 1N263's will be a matched pair; its symmetrical construction allows easy polarity reversal in balanced mixers. The crystal may be used fixed-tuned over the range 8600 to 9600mc. IF impedance (Z_{if}) . . . 140 to 210 ohms; RF impedance (VSWR) . . . 1.3 max; Overall noise figure (NF_{rec}) . . . 7.5db max.

1N26
1N26A
1N26B

These Silicon Mixer Diodes bring tremendously improved performance to this family designed for high reliability operation in the 24,000mc region. As a result of Philco's unparalleled engineering activity in this area, existing performance limits in the 1N26 series have been greatly extended: by addition of the 1N26B . . . maximum operating temperature more than doubled (to 150° C.); VSWR reduced to 1.5; IF impedance range narrowed (400 to 600 ohms). All members of this family have a metal-to-ceramic hermetic seal guaranteeing reliable performance under extreme environmental conditions.

1N78
1N78A
1N78B
1N78C

These Silicon Mixer Diodes offer new and unsurpassed performance characteristics to this established family designed for maximum sensitivity operation in the 16,000mc region. The new member of this family is unilaterally interchangeable with existing types while incorporating strikingly superior features: conversion loss (L_c) reduced to 6.0db max; IF impedance (Z_{if}) range tightened (400 to 565 ohms); RF impedance (VSWR) reduced to 1.5; temperature range extended (150° C.). Engineered to meet the most demanding military applications, all the members of this series are packaged in a hermetically sealed case.

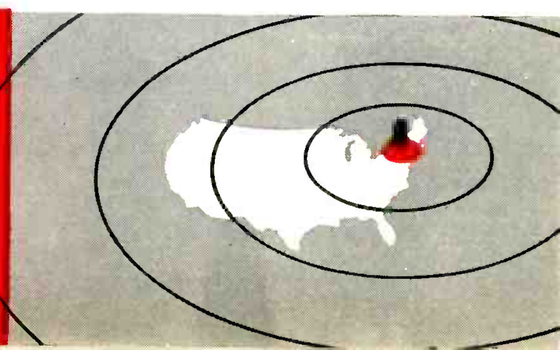
Write* Special Components Dept. EI 1159, *Lansdale Tube Company Division, Philco Corporation, Lansdale, Pa.

PHILCO®

LANSDALE TUBE COMPANY DIVISION

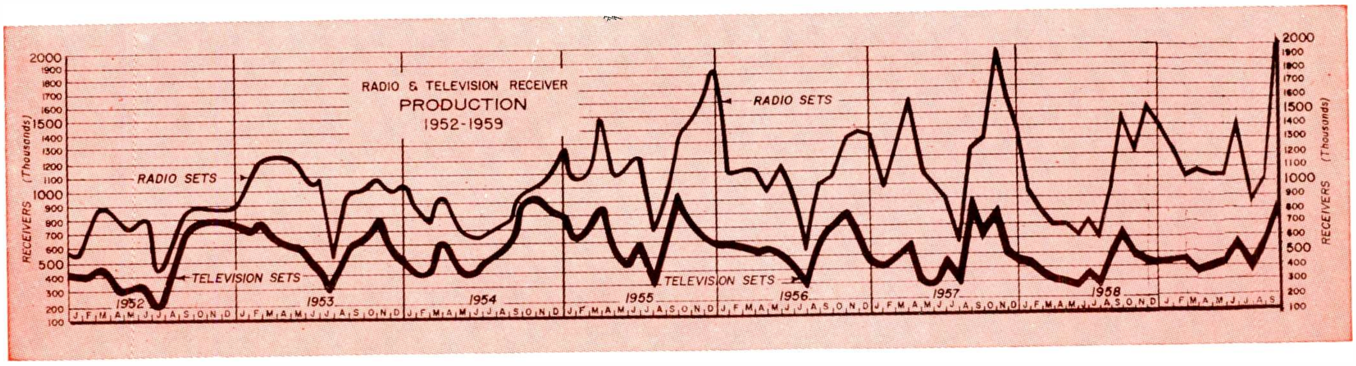
LANSDALE, PENNA.

Circle 10 on Inquiry Card



Facts and Figures Round-Up
November 1959

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, 1959.

Amplifiers	538,474
Amplifiers, traveling wave tube	34,600
Antennas	145,019
Batteries, dry	1,453,260
Batteries, primary	234,757
Batteries, storage	151,656
Beacon, radar	54,650
Bridge, impedance	64,800
Cable assemblies	218,690
Cable, electronic	33,120
Cable, telephone	93,066
Computer, digital	76,175
Connectors	697,927
Crystal units	127,884
Delay lines	450,890
Direction finder sets	1,531,855
Filters, band-pass	77,128
Handsets	64,142
Insulators	25,130
Inverters	333,340
Meters	25,553
Meters, radiac	115,220
Meters, volt	49,439
Oscillators	318,201
Potentiometers	37,040
Radar sets	850,000
Radiosonde	494,538
Receivers, radio	1,576,561
Receiver/transmitter sets	790,107
Recorder, video tape	150,570
Recorders/reproducers	194,137
Relay, armature	568,336
Relay assemblies	95,603
Resistors	188,115
Semiconductor devices	115,691
Signal generators	566,158
Simulator, radar signal	596,423
Solenoid	112,476
Standards, frequency	49,228
Switches	441,474
Test sets, radar	168,131
Thermocouple assemblies	35,000
Tower, radar	25,890
Transformers	29,842
Transistors	46,761
Transmitters, coordinate data	9,000,000
Tropospheric scatter systems	10,071,000
Tubes, cathode ray	36,631
Tubes, electron	2,258,697
Tube, klystron	50,000
Wire	46,685

RADIO & TELEVISION STATIONS

There are 4580 broadcasting stations on the air compared to 1750 daily newspapers. After making allowances for adjustments or multiple ownership and duplication of facilities (mostly in the FM portion of the broadcast spectrum), there are still approximately 4000 single ownership of radio and TV stations.

There are approximately 1300 metropolitan communities with only one newspaper; about 90 metropolitan communities with 2 newspapers; and only 10 communities with 3 or more newspapers. Compared to radio, there are 1287 communities with one radio station; 271 communities with 2 radio stations; 97 communities with 3 radio stations; and 151 communities with 4 or more radio stations. So, to repeat, there are but 10 metropolitan communities with 3 or more newspapers compared to 248 metropolitan communities with 3 or more radio stations.

With respect to communities grouped as television markets, 127 communities have one station; 65 have 2 stations; 53 have 3 stations; and 22 have four or more television stations on the air. The competitive aspect is enhanced when consideration is given to the wide coverage by most TV stations. Coverage of radius from 40 to 80 miles is quite common. This accounts for a good number of additional communities with multiple services.

In the top 100 television markets, there are approximately 33 with less than 3 competitive outlets (that is, 3 VHF or 3 UHF-type stations. But notwithstanding this shortage, and the strenuous efforts on the part of the Commission to obtain frequencies from the government to alleviate this shortage, there is substantial penetration of TV services throughout the populous areas of this country. Ninety-eight percent of the homes have at least one TV signal; 83% have 2 or 3 television signals; and 81% have at least 4 or more TV signals.

—*John C. Doerfer, Chairman FCC*

TRANSISTOR SALES

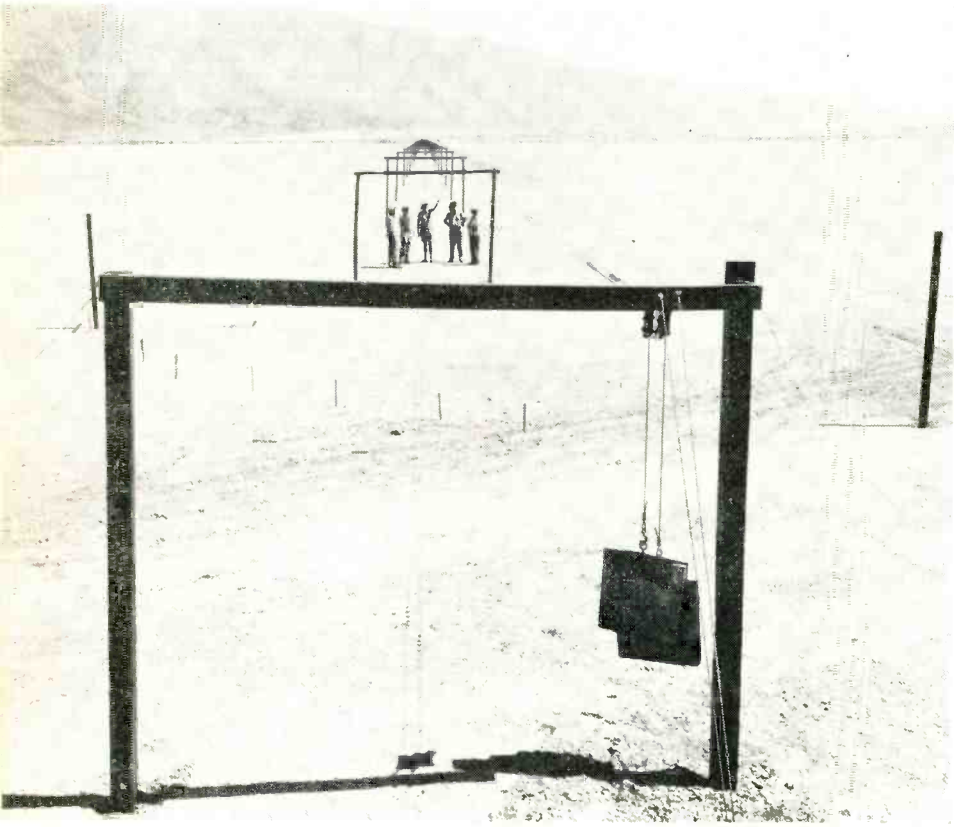
	Units	Dollars
Jan.	5,195,317	13,243,224
Feb.	5,393,377	14,550,056
March	6,310,286	18,117,560
April	5,906,736	16,864,049
May	6,358,097	19,007,293
June	6,934,213	18,031,593
July	6,030,265	15,618,315
Aug.	7,129,696	18,054,138
TOTAL	49,257,987	133,486,228

—*Electronic Industries Association*

DOD PRIME CONTRACT AWARDS TO SMALL AND OTHER BUSINESS FIRMS

(Amounts in Millions)

		Aircraft & Missiles ($10,000 or More)		
	Total	Amount	% of Total	All Others
FY 1956				
All Business Firms	$17,750	$ 6,783	38.2%	$10,967
Small Business, Amount	3,475	101	—	3,374
Percent	19.6%	1.5%	—	30.8%
FY 1957				
All Business Firms	$19,133	$ 6,883	36.0%	$12,250
Small Business, Amount	3,783	149	—	3,634
Percent	19.8%	2.2%	—	29.7%
FY 1958				
All Business Firms	$21,827	$10,253	47.0%	$11,574
Small Business, Amount	3,729	165	—	3,564
Percent	17.1%	1.6%	—	30.8%
FY 1959				
All Business Firms	$22,744	$10,977	48.3%	$11,767
Small Business, Amount	3,783	237	—	3,546
Percent	16.6%	2.2%	—	30.1%



WIRE STRETCHER

Two miles of transmission line are held taut by these thousand-pound lead weights at the world's largest radio telescope, Clark Dry Lake, San Diego County, Calif. The grid of eight parallel rows of north-south dipole elements was constructed by Convair Div. of General Dynamics Corp.

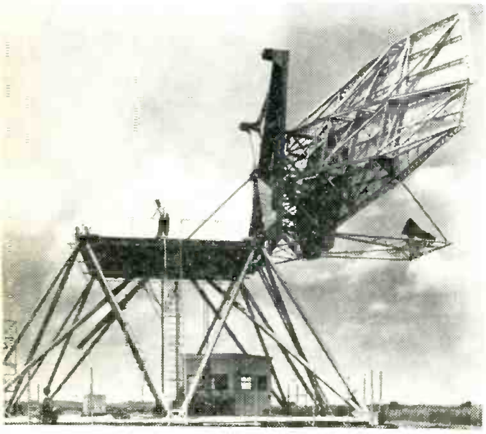
Snapshots of the Electronic Industries

NOSE CONE MATERIAL

Supersonic flame at more than 5000° F is blasted at sample of the protective material developed at GE's Missile and Space Vehicle Lab. Ear coverings protect scientist's ears from deafening sound of flame. Material has withstood more than 15,000° F.

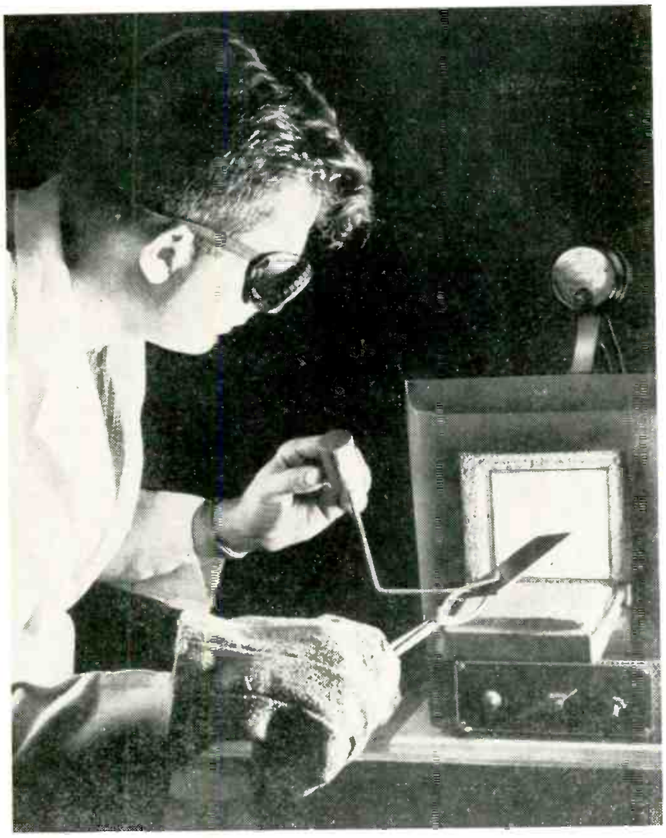
SPACE EXPLORER

This welder at General Electric looks more like a space man as he puts finishing touches on tank that will house a pulse transformer for the FPS-7 radar system.



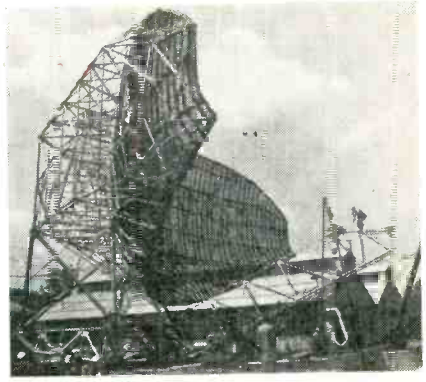
MORE DEW

Giant radar antenna slated for use on the DEW Line eastward extension undergoes final testing at I-T-E Circuit Breaker Co.'s new antenna test range in Trevose, Pa.



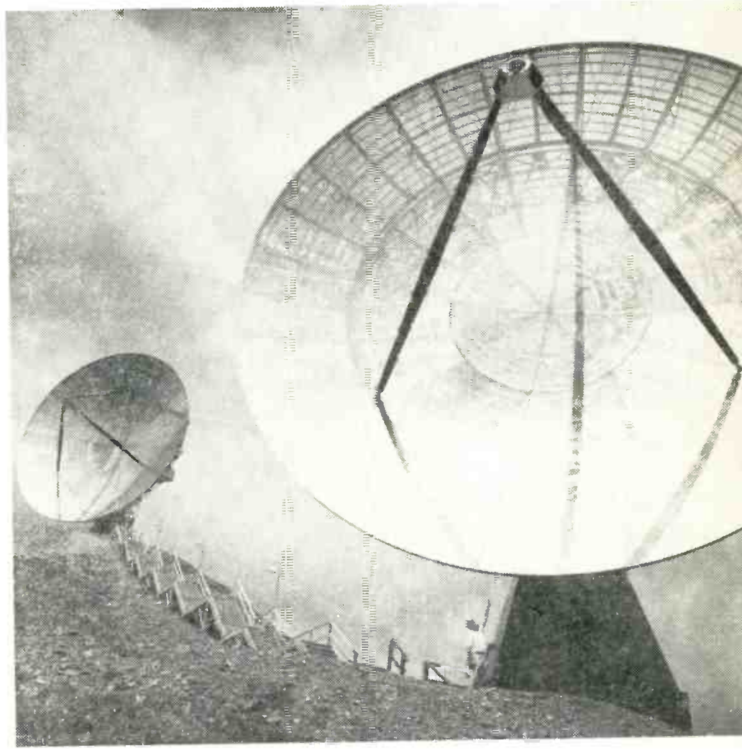
BLISTERLESS PLASTIC

Engineering aide at Riverside Plastics Corp. demonstrates absence of blistering and delamination when new reinforced plastics material TRC-X is thrust into 1000° F furnace.



AIRCRAFT CONTROL

Shown during fabrication at Blaw-Knox Co.'s plant at Blawknox, Pa., is radar antenna that will be positioned on an 85-foot high concrete tower at Thomasville, Ala., Aircraft Control and Warning Station.



PRECISION ANTENNAS

NBS has installed three elevation azimuth paraboloidal antennas, similar to this 60-foot dish shown, to use in a radio propagation research program for the USAF. Built to close tolerances to narrow the beam width, thus increasing the resolving power, they will be used to measure the refraction of radio waves through the earth's atmosphere.

"WOLLEY SEGAF"

The shoe is on the other foot now as RCA 501 Data Processor helps the "yellow pages" in their plight to find a home. Mr. J. J. Jordan of N. Y. Tel. Co. examines model of system which will be used to increase efficiency of telephone book delivery.

INSTRUMENT CHECK

Scale model of NASA's man-carrying satellite has its instruments checked by ARO, Inc., technician prior to hypervelocity tests in Tunnel Hotshot II. The firm operates the wind tunnel at Arnold Engineering Development Center for AEDC.

INFRARED TRACKER

Satellites travelling across the sky can be tracked by the faint "heat rays" they emit. An infrared tracker, developed by ITT Labs, San Fernando, uses a reflector system within the upright tube to focus the radiation onto a detector cell mounted midway up the tube.

NEW RAYTHEON SILICON TRANSISTORS

Diffused-Base "MESA" Construction

NPN High Speed, High Gain Switches

NPN High Frequency and Video Amplifiers

Close parameter control

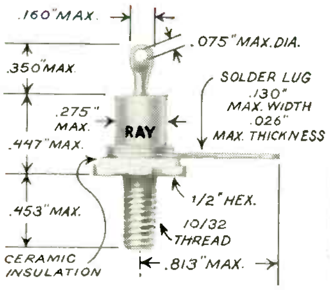
Up to 50 megacycles minimum f_{ab}

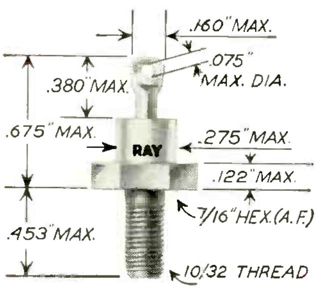
High Voltage PNP Fusion Alloy Transistor

$V_{CBO} = -100$ volts max.

$V_{CEO} = -80$ volts max.

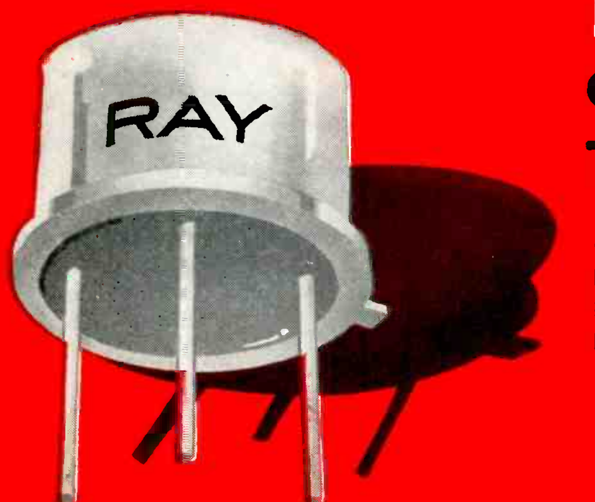
$V_{EBO} = -60$ volts max.





New 4 Amp Silicon Rectifiers (Temperature Range −65°C to +165°C)

NON-INSULATED Cathode to Stud	NON-INSULATED Anode to Stud	INSULATED STUD	Peak Operating Voltage −65°C to +165°C volts	Ave. Rectified Current 25°C amps.	Ave. Rectified Current 150°C amps.	Reverse Current max. µA at Specified Voltage 25°C	Reverse Current 150°C	Reverse Current volts
1N2512	1N2512R	1N2518	100	4.0	1.0	2.0	250	100
1N2513	1N2513R	1N2519	200	4.0	1.0	2.0	250	200
1N2514	1N2514R	1N2520	300	4.0	1.0	2.0	300	300
1N2515	1N2515R	1N2521	400	4.0	1.0	2.0	300	400
1N2516	1N2516R	1N2522	500	4.0	1.0	2.0	350	500
1N2517	1N2517R	1N2523	600	4.0	1.0	2.0	400	600



NEW RAYTHEON GERMANIUM TRANSISTORS

Complementary circuitry with Raytheon PNP types

Highest reliability

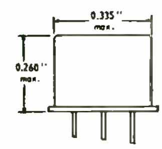
Excellent fast switching characteristics

Low saturation voltage

High Speed Switches (Temperature Range −65°C to +175°C)

Type	V_{CB} max. volts	I_{CO} V_{CB} = 6 volts max. μA	V_{EB} max. volts	H_{FE} I_C = 10 ma V_{CE} = 5 volts min.	V_{SAT} I_C = 5 ma I_b = 2.5 ma max. volts	f_{ab} I_E = 1 ma V_{CE} = 6 volts ave. Mc	R_b' ave. ohms	C_{ob} ave. μμf
2N1386	25	.1	3	30	.6	60	60	3.5
2N1387	30	.1	3	20	.6	50	60	3.5

TO-5

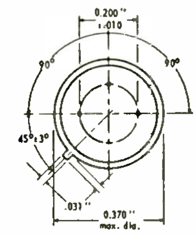


High Frequency and Video Amplifiers (Temperature Range −65°C to +175°C)

Type	V_{CB} max. volts	I_{CO} V_{CB} = 15 volts max. μA	F_t V_{CE} = 6V I_E = 1 ma Mc	R_{in}* at 10 Mc ave. ohms	R_{out}* at 10 Mc ave. ohms	Power Gain at 10 Mc ave. decibels	Gain-Bandwidth Product ave. Mc
2N1388	45	.5	60	500	5000	20	75
2N1389	50	.5	30	500	5000	15	45
2N1390	20	.8 @ 6V	12	400	6000	12	—

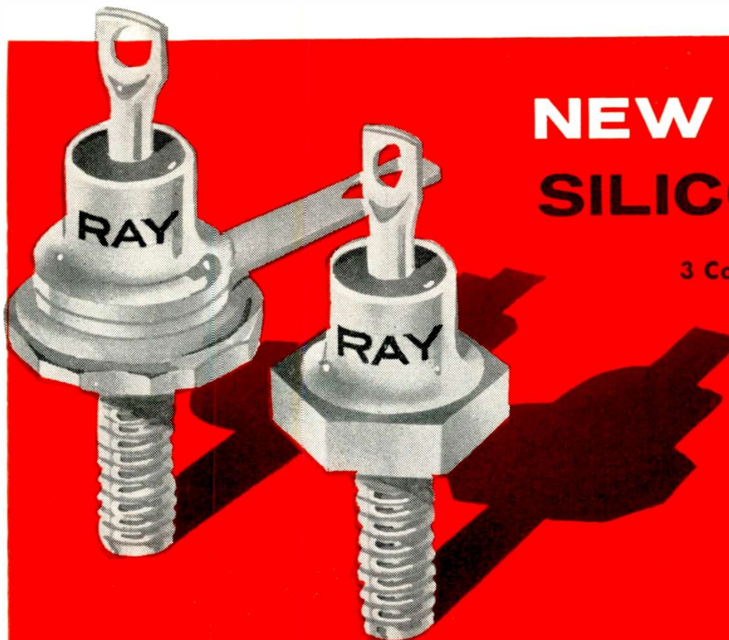
*Measured resistive component of the impedance

E3-44



High Voltage PNP (Temperature Range −65°C to +160°C)

Type	V_{CB} max. volts	V_{CE} max. volts	I_{CO} max. μA	H_{FE} I_B = 0.1 mA V_{CE} = −0.5 V ave.	R_{SAT} max. ohms	V_{EB} max. volts
2N1275	−100	−80	1.0	15	60	−60



NEW RAYTHEON 4 AMP SILICON RECTIFIERS

3 Constructions for design and operating convenience

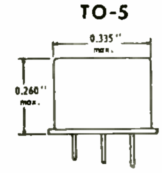
STUD INSULATED
STUD CONNECTED TO CATHODE
STUD CONNECTED TO ANODE

Low reverse current
High forward conductance
Fast reverse recovery
Exceptional stability

NPN Switches — Medium Current High Frequency, High Gain (Temperature Range −65°C to +85°C)

Type	V_{CB} max. volts	f_{ab} min. Mc	H_{FE} ave. I_C = 50 mA V_{CE} = 1.0 V	R_{SAT} ave. ohms
2N438	25	2.5	25	2
2N439	20	5.0	45	2
2N440	15	10.0	70	2

TO-5

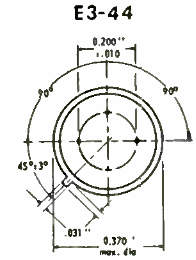


NPN High Gain IF and Converter For Broadcast and Auto Radio (Temperature Range −65°C to +85°C)

Type	Circuit Usage	V_{CE} max. volts	I_{CO} max. μA	C_{ob} f = 1 Mc ave. μμf	Gain 455 Kc db
2N1366	Converter	12	20	11	28*
2N1367	IF	12	20	11 ± 3	38

*Conversion Gain

E3-44



Circle 330 on Inquiry Card

EI's International News

EUROPE

Data Processing Exhibit

A U. S. exhibit describing the historical development and use of high speed computers in information processing has begun a tour of French Universities and other European educational centers.

The exhibit, "Progress in Information Processing," was prepared by the National Science Foundation in cooperation with other Government agencies and industry groups. It was displayed in Paris at the International Conf. on Information Processing, organized under the auspices of UNESCO. Sponsored by the U. S. Information Services, the exhibit will tour the U. S. later. Featured is a library on computers and data processing.

Doppler System for French Bomber

Marconi's Wireless Telegraph Co., Ltd., Chelmsford, Essex, England, has received an order from Generale Aeronautique Marcel Dassault for AD2300 doppler equipment and navigation computers for the Mirage IV, a new French Supersonic bomber.

Traffic Control System

The L. M. Ericsson Telephone Co., Stockholm, Sweden, has announced a $600,000 contract to supply and install the first centralized traffic control system in Portugal. The system, ordered by the Portuguese State Railways, will be used as a safety mechanism to control train movements from a central location.

TI Expands Marketing Program

Texas Instruments Incorporated, Dallas, Texas, has appointed new Danish, French, Swedish, and Swiss distributors for its semiconductor products. Headquarters for the several countries will be located in Bedford, England, and Paris, France.

The newly appointed distributors are: Ditz Schweitzer, Copenhagen; France Nucleaire Electronique, Paris; A. B. Bosta Backstrom, Stockholm; and Fabrimex A.G., Zurich.

Says Cecil Dotson, Chairman of the Board of Texas Instruments Limited, "With war recovery virtually complete and aided by the stimulus of the European Common Market, Europe is fast becoming receptive to greater specialization and mass production which will create many new markets for TI transistors and other allied semiconductor products."

ITALY

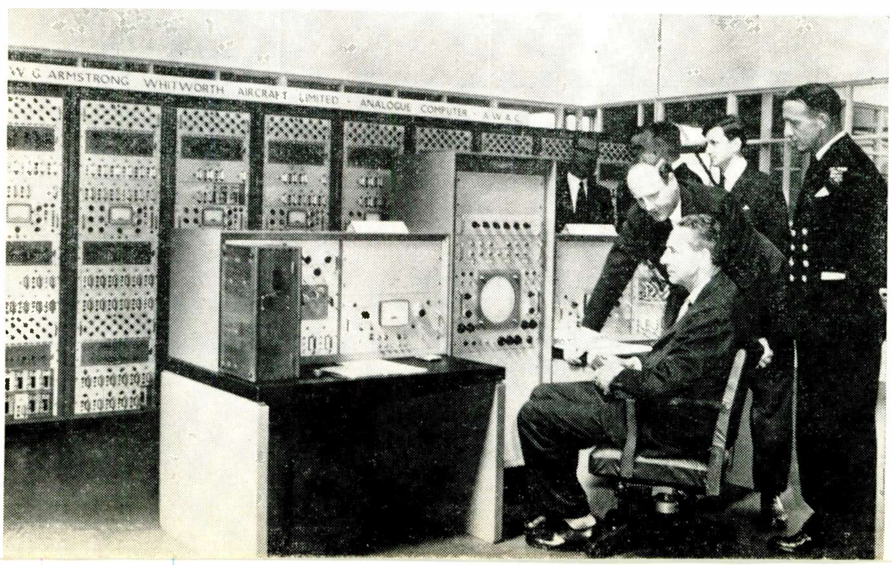
Sylvania Buys Stock in Italian Firm

Sylvania Electric Products, Inc., a subsidiary of General Telephone & Electronics Corp., has bought 50% of the capital stock of Fabbrica Italiana Valvole Radio Elettriche S.p.A. (FIVRE), Italy's leading manufacturer of transmitting and receiving tubes.

Don G. Mitchell, Chairman of Sylvania, said, "the acquisition is part of Sylvania's expanding activity in the European market, a program undertaken because of the increasing economic strength of Western Europe, as well as the promising opportunities for the electronics industry in the "European Common Market."

Computer to Study Weapons Systems

First Lord of the Admiralty, the Earl of Selkirk, is at the controls of a large analogue computer recently installed at the Sir W. G. Armstrong Witworth Aircraft, Ltd. plant in Baginton, Coventry. C. Bayly, Executive Director and Ch. Eng'r., explains the computer.



JAPAN

Eye U. S. Instrument Market

Japan is making a concerted effort to penetrate the U. S. market with transistorized scientific and industrial instruments and equipment. Japan's leading electric company, Tokyo Shibaura Electric Co., Ltd., Toshiba, exhibited 10 newly developed transistorized measuring instruments during the Instrument Society of America's 14th Annual Instrument Automation Conference and Exhibit in Chicago last Sept.

The company is currently surveying the U. S. market to determine the extent of sales possibilities for such equipment, for which exports to date have been practically non-existent. Sales of this company's transistor radios in the U. S. amounted to $5,000,000 in 1958; should exceed $10,000,000 this year; and are expected to top $15,000,000 in 1960.

URUGUAY

U. S. Loan to Expand Telephone System

The U. S. has signed an agreement under the Development Loan Fund to lend up to $8,800,000 to help finance the expansion of telephone facilities in the Montevideo area of Uruguay. The loan is being made to the Administration General de las Usinas Electricas y los Telefonos del Estado, an autonomous Uruguayan Government enterprise which operates the country's electric power and telephone services.

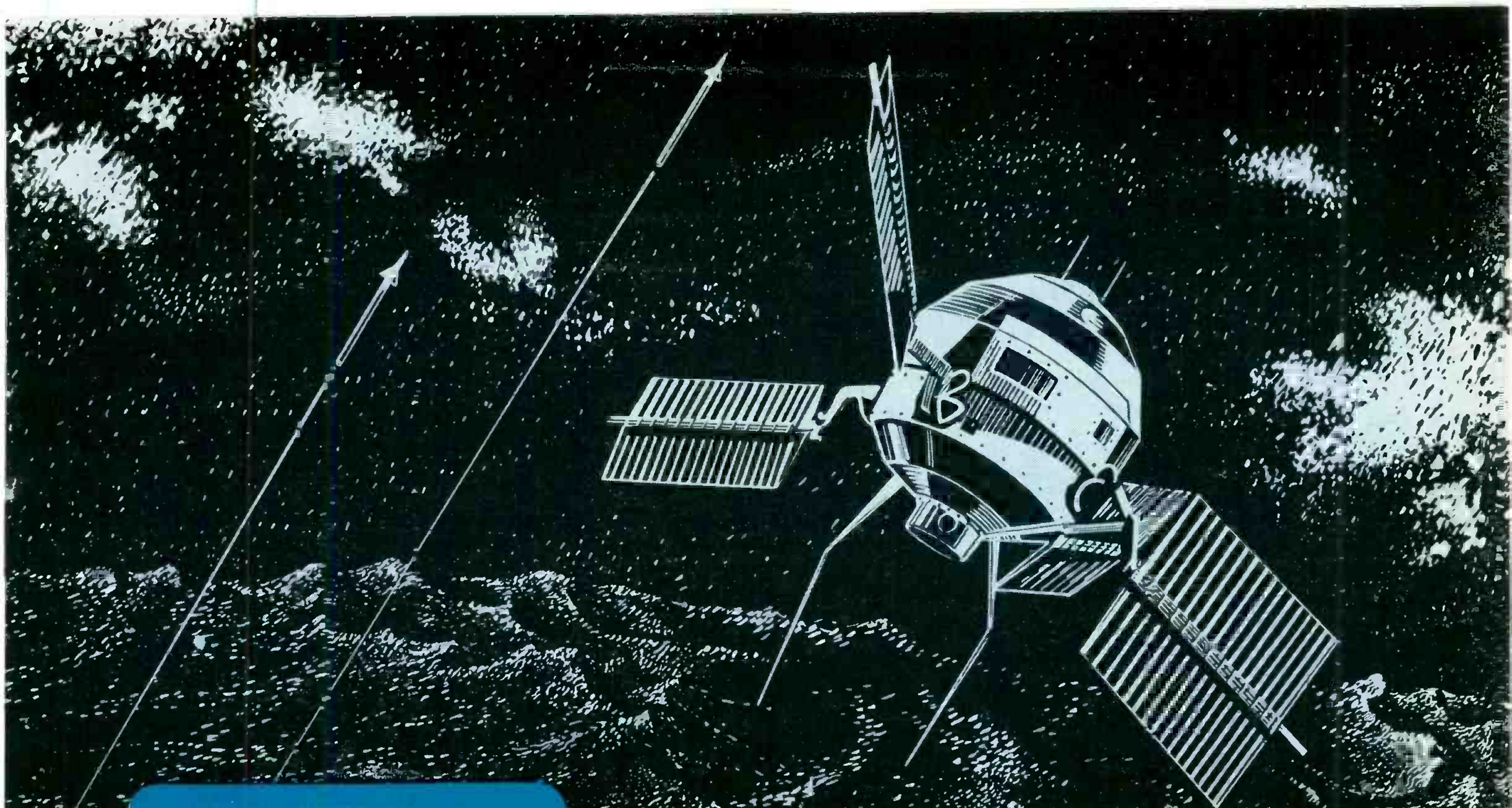
The loan will finance purchases of central office equipment and spare parts, power equipment, cables, telephone sets, underground conduits, and other necessities. Unsatisfied demands for new telephones in Uruguay now total 52,000.

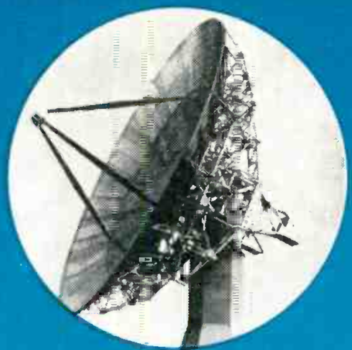
AUSTRALIA

U. S. Firm to Supply Teleprinting Equipment

The Kleinschmidt Div., Smith-Corona Marchant, has been selected by the Australian Government as prime supplier of teleprinting equipment. The company has franchised Amalgamated Wireless, Ltd., Australia, to handle limited manufacture and final assembly. Parts and sub-

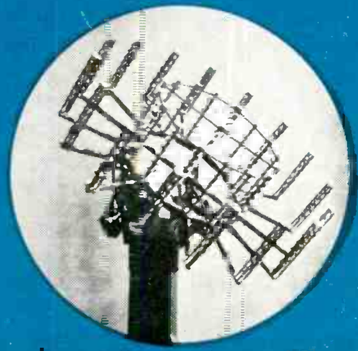
(*Continued on page 36*)





National Bureau of Standards Integrated antenna system

MIT's Lincoln Lab 120' Search Radar Antenna



NASA Satellite Tracking Antenna

INTEGRATED ANTENNA SYSTEMS

. . . for Satellite and High Speed Missile Tracking . . . Scatter Propagation . . . Radar . . . Radio Astronomy . . . Telemetering and Space Vehicle Communication functions . . . designed, developed, manufactured and installed by **General Bronze** antenna specialists.

The reliability and high precision necessary to develop the reference standard for the industry has become a **General Bronze** hall-mark.

Write TODAY FOR ILLUSTRATED TECHNICAL BULLETIN.

GB ELECTRONICS CORPORATION

VALLEY STREAM, LONG ISLAND, N. Y.

SUBSIDIARY OF

GENERAL BRONZE CORPORATION

Circle 12 on Inquiry Card

Printed in U.S.A.

ANOTHER GB ACHIEVEMENT

Tele-Tips

A "VIDIOT" is defined by Kimble Glass Co. as the person who pays the new price for a rebuilt TV picture tube. He is the key character in a new advertising campaign that Kimble is launching this month to warn the public that there are now two types of picture tubes being marketed, new tubes and rebuilts, and that they should make sure that they are getting what they pay for.

OUR TECHNICAL KNOWLEDGE is being systematically looted by foreign countries, and there is every sign that the pace will be even increased in the future. In Japan nearly all high schools are offering English instruction, and 8 out of 10 pupils study English.

CLOSED-CIRCUIT TV is being used by Wright Air Development Center to study the icing conditions within the engines of a C-133 cargo aircraft. The big four-engine transports follow KB-29 tanker planes that spray water into the air. The TV camera, mounted on the outside of the nacelle of the No. 3 turboprop engine, faces downward into the engine. Inside the C-133 a project engineer watches as the ice forms, builds up and then breaks off.

PATENTS are now being issued at the rate of about 1,000 each week. Approximately 350 patent applications are being deposited at the Patent Office each working day.

"RULY ENGLISH" is an unambiguous language being developed to aid machines for searching information. The research includes analyzing existing words which show relationships, and the creation of "ruly" words which have a single relationship or meaning. For instance the word "about" in the phrase "toys strewn about the room," the word "over" in "pebbles scattered over the floor" and "with" in "mixing with the crowd" all have the same mean-

(Continued on page 32)

For Portable Communication...

NEW RAYTHEON CK7246

1.25 VOLT SUBMIN TRIODE

OPERATES TO 500 MC.

This Raytheon filamentary subminiature triode was developed under U. S. Signal Corps contract, and is now commercially available for use in battery-operated communications equipment. Circuit applications include:

- **Superregenerative detector**
- **High frequency oscillator**
- **Class C amplifier**
- **Frequency multiplier**
- **Mixer**

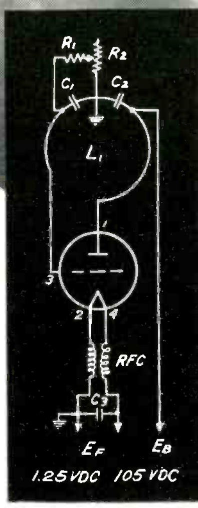
TYPICAL OPERATING CHARACTERISTICS

Class A Amplifier

Filament voltage (dc)	1.25 v.
Filament current	150 ma.
Plate voltage	105 v.
Plate current	4.5 ma.
Grid voltage	−2.5 v.
Transconductance	2700 μmhos
Amplification factor	22

Class C Oscillator (465 mc.)

Filament voltage (dc)	1.25 v.
Filament current	150 ma.
Plate voltage	105 v.
Plate current	6 ma.
Grid current	0.9 ma.
Power output	60 mw.



Typical CK7246 Circuit
465 mc. Class C Oscillator

L_1: 1 turn No. 12 copper, ¾ inch O.D.

RFC: bifilar wound 8 turns #26 En. ⅛" I.D., 1" long

C_1, C_2, C_3: 250 μμf feed-thru button type

R_1: 4.7K ½ w.

R_2: 10K 2w pot.

RAYTHEON®

INDUSTRIAL TUBE DIVISION

55 CHAPEL STREET, NEWTON 58, MASSACHUSETTS

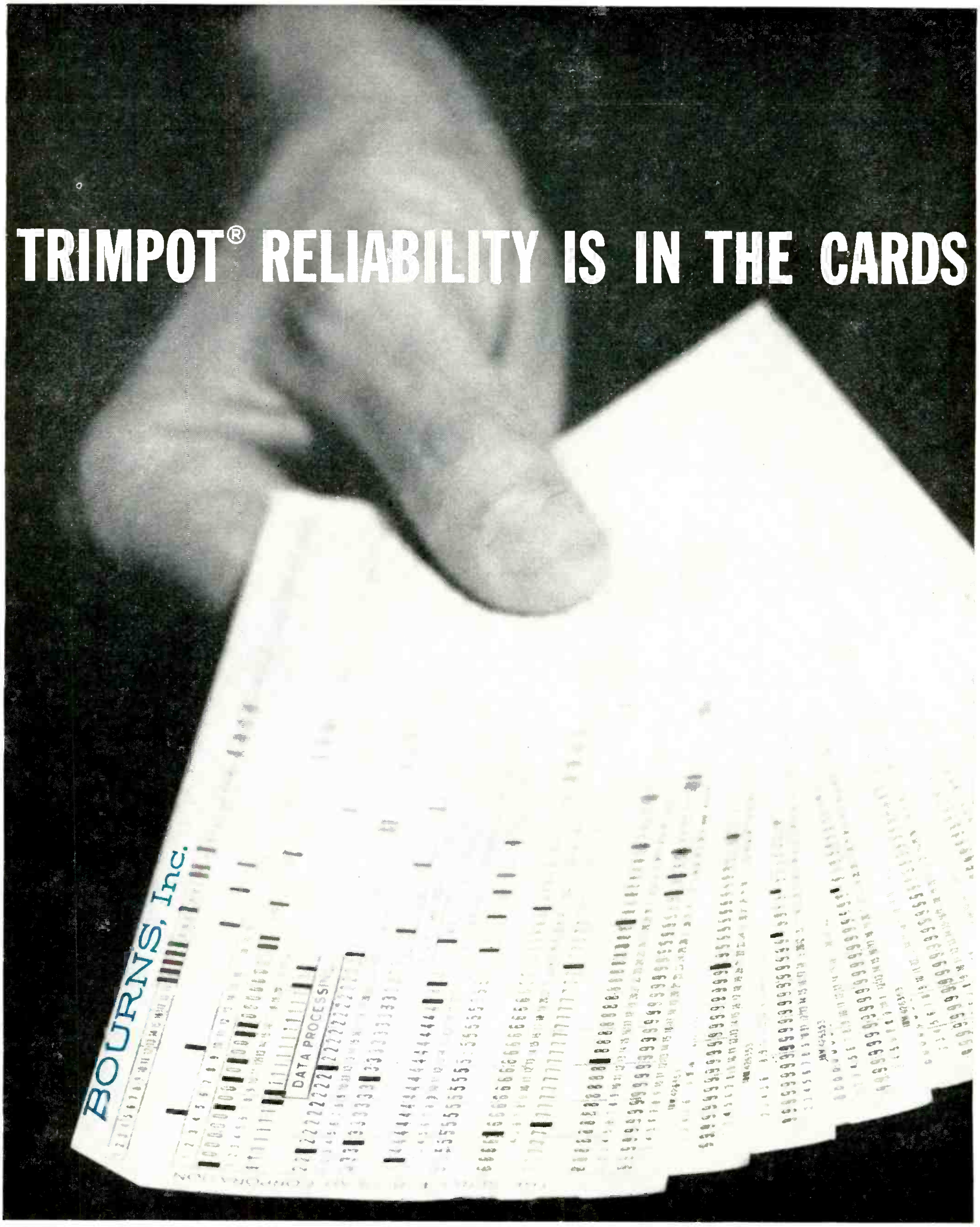
RELIABLE MINIATURE & SUBMINIATURE TUBES • GAS & VAPOR TUBES • CATHODE RAY TUBES • HARD-GLASS POWER TUBES

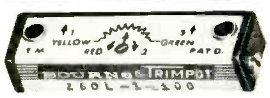
BOSTON: BIgelow 4-7500 • NEW YORK: PLaza 9-3900 • CHICAGO: NAtional 5-4000 • LOS ANGELES: NOrmandy 5-4221

BALTIMORE: SOuthfield 1-1237 • CLEVELAND: WInton 1-7716 • KANSAS CITY: PLaza 3-5330

GOVERNMENT SALES . . . BOSTON: BIgelow 4-7500 . . . WASHINGTON, D. C.: MEtropolitan 8-5205 . . . DAYTON: BAldwin 3-8128

Small order and prototype quantities available directly from your local Raytheon electronic parts distributor





Test information punched in these cards can provide detailed performance reliability statistics on Trimpot production. The cards summarize extensive environmental tests which Bourns regularly conducts above and beyond regular quality control. In Bourns' own Reliability Assurance Laboratory, monthly samples are taken at random from factory stocks and completely tested for conformance to all environmental and electrical specifications on Trimpot catalog sheets. Results can then be fed into IBM computers which analyze performance data with corrective action taken immediately, if required!

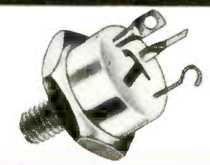
This program is the only one of its kind in the industry. Only Trimpot potentiometers are tested so thoroughly, so frequently. In short, Trimpot reliability is a fact—one you can put in your next circuit.

Circle 15 on Inquiry Card

5 EXCITING NEW SILICON TRANSISTOR

1. HI-POWER STUD-MOUNTED SILICON TRANSISTOR

A rugged package — easier to mount, with greater strength and lower thermal resistance. Has good beta linearity and switching characteristics good high frequency betas, low saturation voltage. Ratings up to 100 volts available.



Type	V_{cb} Max. Volts	I_c max. Amps	B Typical	R_{cs} Typical (Ohms)
2N1208	60	5	35	1.5
2N1209	45	5	40	1.5
2N1212	60	5	25	2.5

APPLICATIONS Regulated Power Supplies . . . High Current Switching . . . High Frequency Power Amplifiers

Circle 146

2. CORE SWITCH

Improved switching speed and input characteristics. High-current capabilities with good power handling ability (5w @ 100°c). Rated and tested at 60v.

Type	V_{cb} Max. Volts	(β) Min.	Typ. Input Voltage (Volts)	Typ. Saturation Resistance (Ohms)	Switching Characteristics (μsec)
ST4100	60	15	2.5	10	t_r .2
					t_s .2
					t_f .2

APPLICATIONS . . . magnetic core memory . . . high level multivibrators . . . buffer amplifiers . . . clock source

Circle 147

3. 150mc VERY HIGH FREQUENCY TRANSISTOR

New silicon logic transistor with speed surpassing the fastest silicon types, plus unusual power handling ability. Technical breakthrough now provides minimum and typical DC current gains of 20 and 40 respectively.

TYPE 2N1139

		Min.	Typical	Max.	Test Conditions
D.C. Current Gain	h_{FE}	20	40	—	I_C = 10ma, V_{CE} = 10V
D.C. Collector Saturation Voltage	V_{CE}	—	.5	0.7V	I_C = 10ma, I_B = 1ma
Collector Cutoff Current	I_{CO}	—	2	5 μa	V_{CB} = Rating
Output Capacitance	C_{ob}	—	8	12 μμf	V_{CB} = 10V, I_E = 0 mA
High Frequency Current Gain	h_{fe}	5	7.5	—	F = 20mc, V_{CE} = 10V I_E = 10 mA
Delay Time	t_d	—	6		mμsec.
Rise Time	t_r	—	12		mμsec.
Fall Time	t_f	—	10		mμsec.

Circle 148

4. UNIVERSAL 50mc LOGIC TRANSISTOR

This transistor features universal application (replaces 2N337, 2N338, 2N1005, 2N1006) and high frequency response, with low saturation resistance, low input impedance, low capacitance.

Type	Typ. Alpha Cutoff (Mc)	Beta Typical	Co (Typical) (μμf)	Max. (Volts)	Typ. Saturation Resistance (ohms)
ST3031	70	50	2	20	40

APPLICATIONS . . . flip-flops . . . IF and video amplifiers . . . transistor logic . . . pulse amplifiers

Circle 149

5. STABISTOR COUPLED LOGIC TRANSISTOR

Designed to provide minimum storage times under severe base overdrive conditions in transistor logic circuitry. Tightly controlled input characteristics provide interchangeability; low R_{cs} assures reliable operation at high temperature.

Type	Beta Typical	V_c max. (Volts)	Typical Saturation Resistance (ohms)	Typ. Alpha Cutoff (Mc)	Switching Characteristics (μsec)
ST3030	12	15	40	50	t_r .05
					t_s .20
					t_f .10

APPLICATIONS . . . designed specifically for SCTL and DCTL circuits (write for descriptive paper on SCTL)

Circle 150

DEVELOPMENTS FROM TRANSITRON . . . *added to* THE INDUSTRY'S MOST COMPLETE LINE

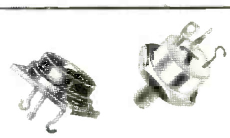
SILICON TRANSISTORS

JAN TRANSISTOR		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	JAN-2N118	10	30	10	1	• Only Jan Silicon Transistor

SMALL SIGNAL		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	2N333	18	45	7	50	• Low I_{co} • Operation to 175°C • 200 mw Power Dissipation
	2N335	37	45	10	50	
	2N480	40	45	11	.5	
	2N543	80	45	15	.5	
	ST905	36	30	10	10	

HIGH SPEED SWITCHING		Typical Cut-off Freq. (Mc)	Maximum Collector Voltage (Volts)	Maximum Collection Saturation Resistance (ohms)	Max. Power Dissipation @ 100°C ambient (mw)	FEATURES
	ST3030	50	15	60	50	• High Frequency Operation • Low Saturation Resistance • Low I_{co}
	ST3031	70	20	65	50	
	2N1139	150	15	70	500	
	2N337	20	45	150	50	
	2N338	30	45	150	50	

MEDIUM POWER		Max. Power Dissipation @ 25°C Case (Watts)	Maximum Collector Voltage (Volts)	Minimum DC Current Gain (β)	Typical Rise Time (μsec)	Typical Storage and Fall Time (μsec)	FEATURES
	ST4100	5	60	15	.2	.4	• Fast Switching • High V_c • Rugged Construction
	2N545	5	60	15	.3	.5	
	2N547	5	60	20			
	2N498	4	100	12			
	2N551	5	60	20			
	2N1140	1	40	20	.2	.2	



HIGH POWER		Maximum Power Dissipation . . 25°C Case (Watts)	Minimum DC Current Gain (β)	Typical Collector Saturation Resistance (Ohms)	Maximum Collector Voltage (Volts)	FEATURES
	ST400	85	15 @ 2 Amps	1.5	60	• High Current Handling Ability • Low Saturation Resistance • Rugged Construction
	2N389	85	12 @ 1 Amp.	3.5	60	
	2N424	85	12 @ 1 Amp.	6.0	80	
	2N1208	85	15 @ 2 Amps	1.5	60	
	2N1209	85	20 @ 2 Amps	1.5	45	
	2N1212	85	12 @ 1 Amp.	2.5	60	

Write for Bulletins: TE-1353 and TE-1355

Your local authorized TRANSITRON DISTRIBUTOR now carries in-stock inventories for immediate delivery.

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"Leadership in Semiconductors"

Tele-Tips

(Continued from page 26)

ing of "scatter-around." All of these meanings are expressed by the Ruly word RANDOMLOC. Details on the latest developments in this project are described in "Analysis of Prepositionals for Interrelational Concepts—Preliminary Study," issued as Research and Development Report No. 16, from the Sales and Distribution Office, Rm. 6323, Dept. of Commerce Bldg., Washington 25, D. C. at 50¢ per copy.

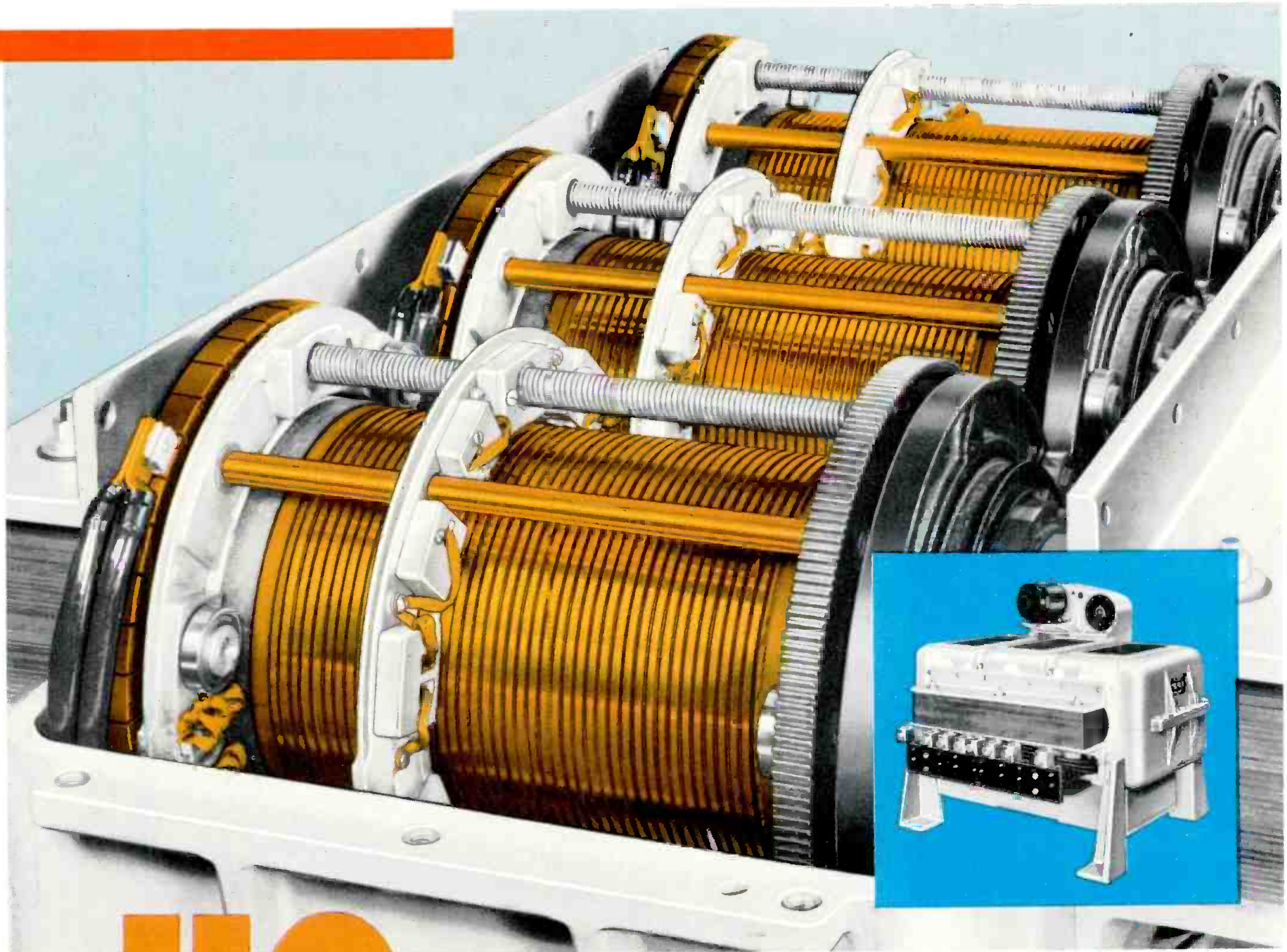
NEW POWER CABLE being developed by Cornell Univ. will be able to handle enough power to supply the city of Toledo, plus Grand Rapids. Eventually the extra-high-voltage cables are expected to have a nominal rating of 350,000 volts and 500,000,000 volt-amperes.

WORLD TV OWNERSHIP is now estimated at 85,225,582, in 59 countries, according to Television Factbook. This is an increase of 7,745,637 sets in the six months since March 1. Breakdown is: U. S.—51,500,000; United Kingdom—10,000,000; Canada—5,534,000; Russia—3,000,000; Japan—2,949,000, and West Germany—2,900,000.

SWIMMING POOL TV. Dage TV div. of Thompson Ramo Wooldridge is offering closed-circuit TV as a swimming pool accessory. The idea is that with the camera trained on the pool parents can keep an eye on their children from the air-conditioned comfort of the house.

COMPUTING TECHNIQUE developed by Autonetics Div. of North American Aviation Inc. predicts the operational reliability of ballistic missiles from early R&D test failure data. Prediction is based on computing the failure rate of components observed for only a short period of time. The method is called "RECIPE," from Recomp Computer Interpretive Program Expediter.

A COMPLETELY NEW CONCEPT *in variable transformer design!**



the **HC** *series* **POWERSTAT®** *variable transformers*

HIGH CURRENT CAPACITY
— The use of a helical wound coil design instead of the conventional toroidal wound coils permits current capacities much higher than previously available in variable transformers.

EXTREMELY FINE ADJUSTMENT
— Patented re-entry rings permit continuously-adjustable control of 1600 increments over the range of zero to maximum output voltage. Resolution is better than 1/10 of 1% of the input voltage.

HIGHEST EFFICIENCY
— Low resistance brushes are always in contact with only one turn of the helical wound coil resulting in very low voltage drop.

PLUS:

ZERO WAVEFORM DISTORTION, EXCELLENT REGULATION, SMOOTH CONTROL, CONSERVATIVE RATINGS, LINEAR OUTPUT VOLTAGE, LOW COST PER KVA.

THE
SUPERIOR ELECTRIC
COMPANY

Bristol, Connecticut, U.S.A.

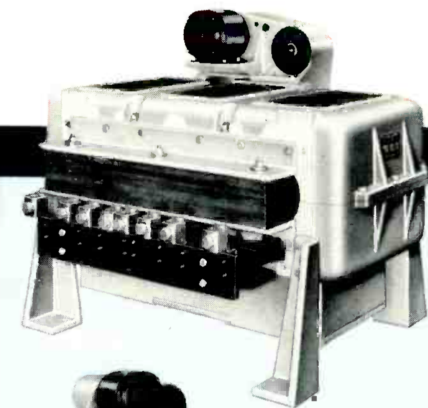
* The Superior Electric Company's U.S. Patent No. 2,864,992.

NEVER BEFORE

• such high efficiency • such fine adjustment • such high current capacity

the HC *series* POWERSTAT® *variable transformers*

for heavy duty applications requiring cool, efficient operation



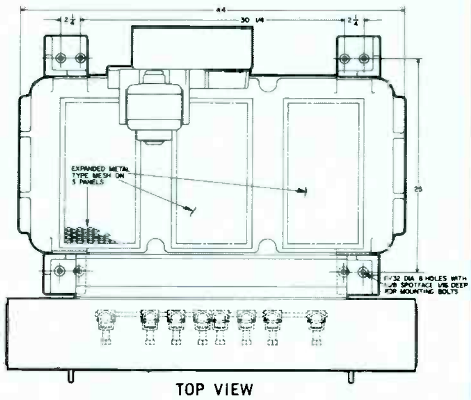
TYPE 2HCB200-3Y (FORCED AIR COOLED)

INPUT:	240 VOLTS	60 CYCLES	3 PHASE
OUTPUT:	0-270 VOLTS	360 AMPERES	168 KVA

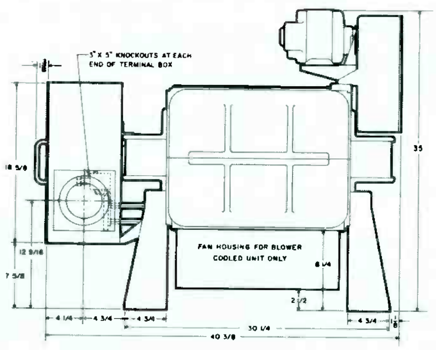
TYPE 2HC200-3Y (CONVECTION COOLED)

INPUT:	240 VOLTS	60 CYCLES	3 PHASE
OUTPUT:	0-270 VOLTS	200 AMPERES	93.5 KVA

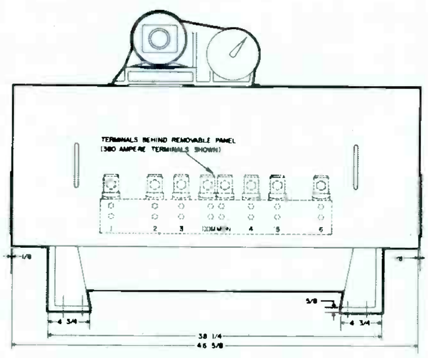
OUTLINE DIMENSIONS



TOP VIEW



SIDE VIEW



FRONT VIEW

TYPES

Two 240 volt, 3-phase types are offered. Type 2HC200-3Y is cooled by normal convection. Type 2HCB200-3Y is similar in construction but incorporates fans for forced air cooling of the coils. Output rating of the forced air cooled type is nearly double that of the convection cooled type. Types for 480 volt, 3-phase duty are available also.

POWERSTATS *of the H-C Series can be remotely operated from a control unit mounted either on the POWERSTAT frame or at any other convenient location. Raise-lower signals from the control unit operate the adjustable speed motor driving the contact brush assembly. Full range travel speed is fully adjustable between 15 seconds and 10 minutes. Travel is smooth with fast starting and stopping at any voltage setting. Integrally mounted travel limit switches provide stops and unit protection.*

THE SUPERIOR ELECTRIC COMPANY, Bristol Connecticut

☐ Please send H-C Series POWERSTAT Bulletin.

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Request H-C Series Bulletin giving full technical information, ratings and specifications.

THE SUPERIOR ELECTRIC COMPANY

Bristol, Connecticut, U.S.A.

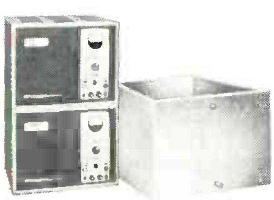
SE-L85911

Model BC60
Capacity 1¼ gal. **$350**

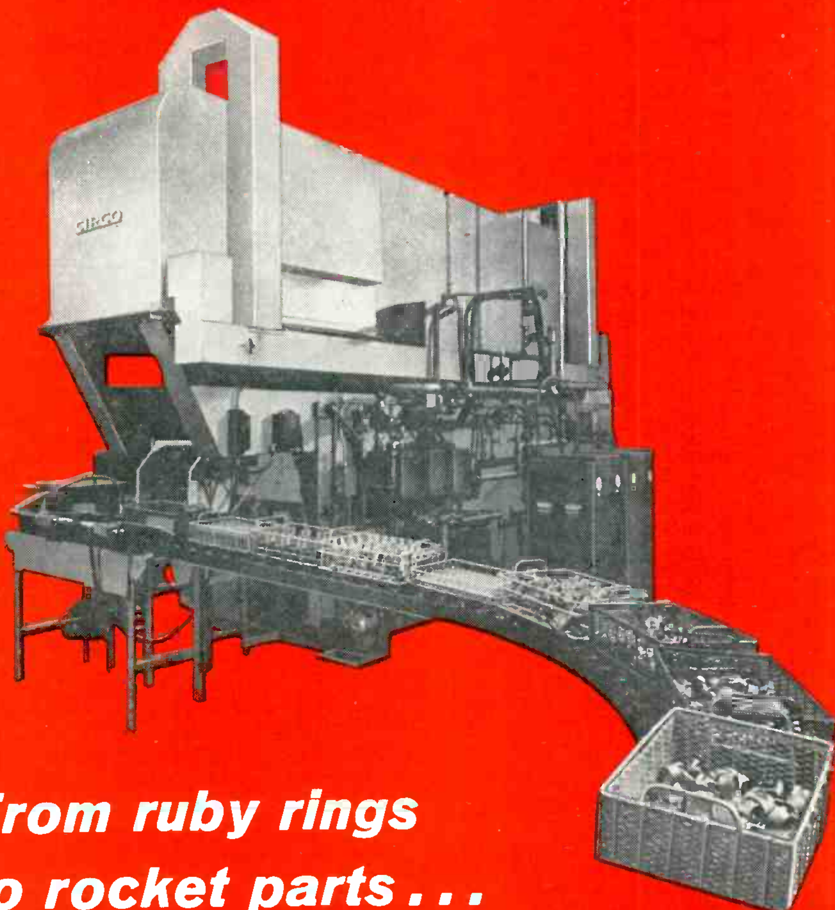
Model BC125
Capacity 2 gal. **$575**

Model BC250
Capacity 5 gal. **$750**

Model BC500
Capacity 12 gal. **$1375**



Model BC1000
Capacity 25 gal. **$2750**



From ruby rings to rocket parts... CIRCO ultrasonic cleaning units achieve precision cleaning ...in seconds!

Whenever *absolute* product cleanliness is a critical factor . . . whenever cleaning is a production bottleneck . . . CIRCO ultrasonics offer you the widest range of precision engineered ultrasonic cleaning units available anywhere.

CIRCO ultrasonics blast dirt loose, yet never harm your products . . . ideal for removing solder flux, fingerprints, lint, waxes, polishing compounds and other contaminants. Ultrasonic cleaning reduces solution consumption and eliminates laborious hand operations.

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International News

(*Continued from Page* 24)

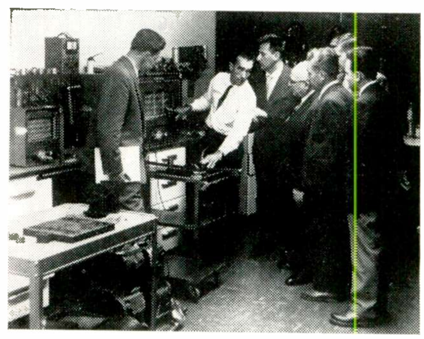
assemblies will be manufactured at the company's plant in Deerfield, Illinois.

Buy British Firm

General Controls Co. has purchased Wirepots, Ltd., a British firm specializing in precision potentiometers and dials. The new subsidiary will be known as General Controls Ltd. Headquarters will be at 13/15 Bowlers Croft, Honywood Road, Basildon, Essex, England.

Manufacturing of the parent company's entire line of precision potentiometers, formerly made in the firm's Electronic Controls Div., Burbank, Calif., is being shifted to the British factory.

See Ultrasonic Equipment



R. V. Harris, supervising engineer, Branson Instruments, Inc., demonstrates the company's Vidigage for a group of touring Yugoslav visitors. The Yugoslavs are visiting equipment manufacturers, foundries, and trade associations in several U. S. cities.

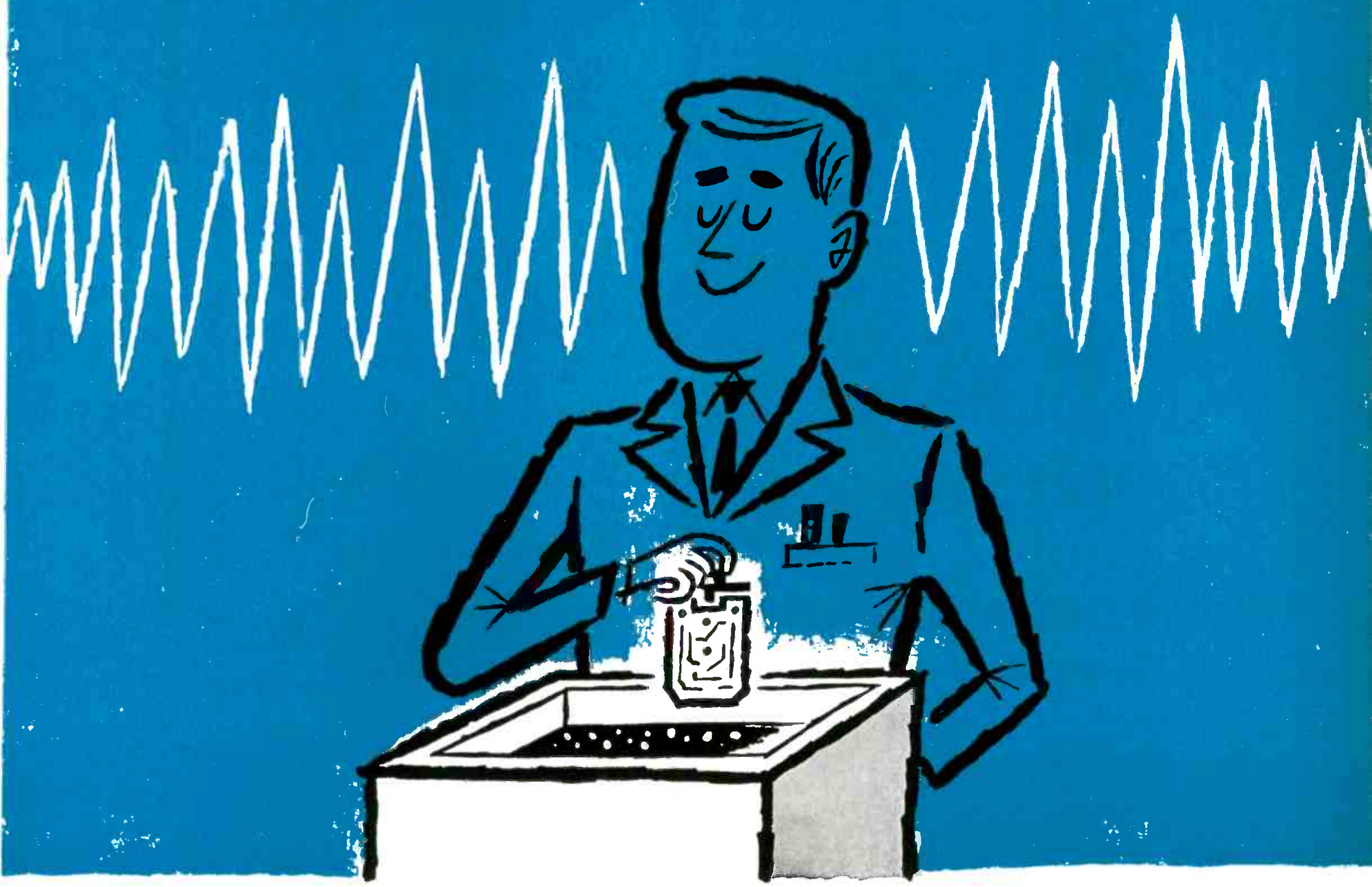
ITALY

International Group Forms Italian Firm

A new company, Philco Italiana, S.p.A., headquartered in Milan, has been formed to manufacture and distribute Philco products in Italy under license from Philco Corp., S.A., Switzerland. Production will start with a complete line of TV receivers. A radio and TV plant is in full production in Rho, a Milano suburb.

Financing was provided by Ing. Carlo Pesenti, Milan; Dr. Franco Palma, Rome, Bendix Home Appliances-France; Dr. Luiz Campello, Sao Paulo, Brazil; Dr. Renzo di Piramo, Milan, and Philco Corp., S.A., Fribourg, Switzerland. President of the new firm is Harvey Williams. Vice President is Francois Ollive. James Segre is permanent secretary to the Board of Directors.

CLEAN ELECTRONIC PARTS CLEANER ULTRASONICALLY!



Save labor, save time—*blast* away dirt and dust by the remarkable ultrasonic method that Acoustica has developed to a fine point of efficiency. The hard-to-get-at parts in the most intricate electronic instruments are cleaned as easily as the most exposed parts. The powerful "cavitational" action of an Acoustica ultrasonic tank radiates to the innermost places, removes the most stubborn dirt or dust. Transistors, potentiometers, vacuum tubes, and scores of other products are thoroughly cleaned and decontaminated this modern, efficient way. Many leaders in the electronic industry have changed to Acoustica ultrasonic cleaning!

Acoustica is the recognized leader in quality ultrasonic cleaning equipment, the sole producer of the *Multipower* transducer. An Acoustica *certified* ultrasonic application is your assurance of maximum cleaning efficiency!

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NEW

HIGH-VOLTAGE SILICON MESA TRANSISTORS

FAIRCHILD'S 2N699
OFFERS ANOTHER UNIQUE COMBINATION

120 VOLTS collector to base voltage, permits greater voltage swings in amplifier and oscillator circuits and more protection in inductive switching circuits. Maximum base-emitter turn-on voltage is only 1.3 volts for I_C=150 mA and I_B=15 mA.

120 MEGACYCLES typical gain-bandwidth product means excellent broad-band video performance. In addition the units will provide typically 18 db neutralized gain at 30 mc and 30% efficiency in a 70 mc oscillator circuit.

300° C SURVIVAL has been assured. Every transistor produced at Fairchild has been preaged a minimum of 60 hours at 300° C before test. This provides extra reliability at their recommended maximum operating junction temperature of 175° C.

2 WATTS dissipation at 25° C – the combination of power with high frequency that is available only in double diffused silicon transistors.

In Fairchild's recent succession of new transistor announcements, each has offered some exceptional combination of characteristics previously unattainable. The 2N699 combines high collector voltage rating with high-frequency performance, medium power capabilities and low saturation resistance. Its applications range from low-current high-frequency I-F circuits to high-current, low-frequency relay drivers. Other products nearing production at Fairchild promise even greater advances in the state of the art.

2N699 — ELECTRICAL CHARACTERISTICS (25° C)

Symbol	Characteristic	Min.	Typ.	Max.	Test Conditions	
h_{FE}	D.C. pulse current gain	40		120	I_C = 150ma	V_C = 10v
V_{BE} (sat)	Base saturation voltage		1.0	1.3	I_C = 150ma	I_B = 15ma
V_{CE} (sat)	Collector saturation voltage			5v	I_C = 150ma	I_B = 15ma
h_{fe}	Small signal current gain at f = 20 mc	2.5	5.0		I_C = 50ma	V_C = 10v
C_{ob}	Collector capacitance		14µµf	20µµf	I_E = 10ma	V_C = 10v
I_{CBO}	Collector cutoff current			2µa	V_C = 60v	T = 25°C
				200µa	V_C = 60v	T = 150°C

A new plant of nearly ten-times increased capacity opened in June 1959 to fill demand created by new products introduced in less than a 12-month period.

For full information, write Dept. J-11.

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As We Go To Press

Microwave Relaying Aids Meteor Study

At Havana, Ill., southwest of Peoria, astronomers from Harvard College Observatory are using two Raytheon microwave relay systems in the study of meteor particles and their effect on radio transmission. The electronic equipment will provide line-of-sight transmission of microwave pulse trains, and operators at the huge "antenna farm" hope that from analysis of these pulses they may: 1. Discover the origin of meteors. 2. Study the physical processes involved when a meteor particle impinges on the upper atmosphere. 3. Study upper atmospheric winds.

When the scientists finish bouncing radio signals off meteor trails, their findings may eventually help to extend the range of radio broadcasts. The program, sponsored by the National Bureau of Standards, is under the direction of Dr. Fred Whipple, Director of the Smithsonian Astrophysical Observatory and Professor of Astronomy, Harvard University, and Harvard's Dr. G. S. Hawkins, formerly with the Jodrell Bank Observatory, England.

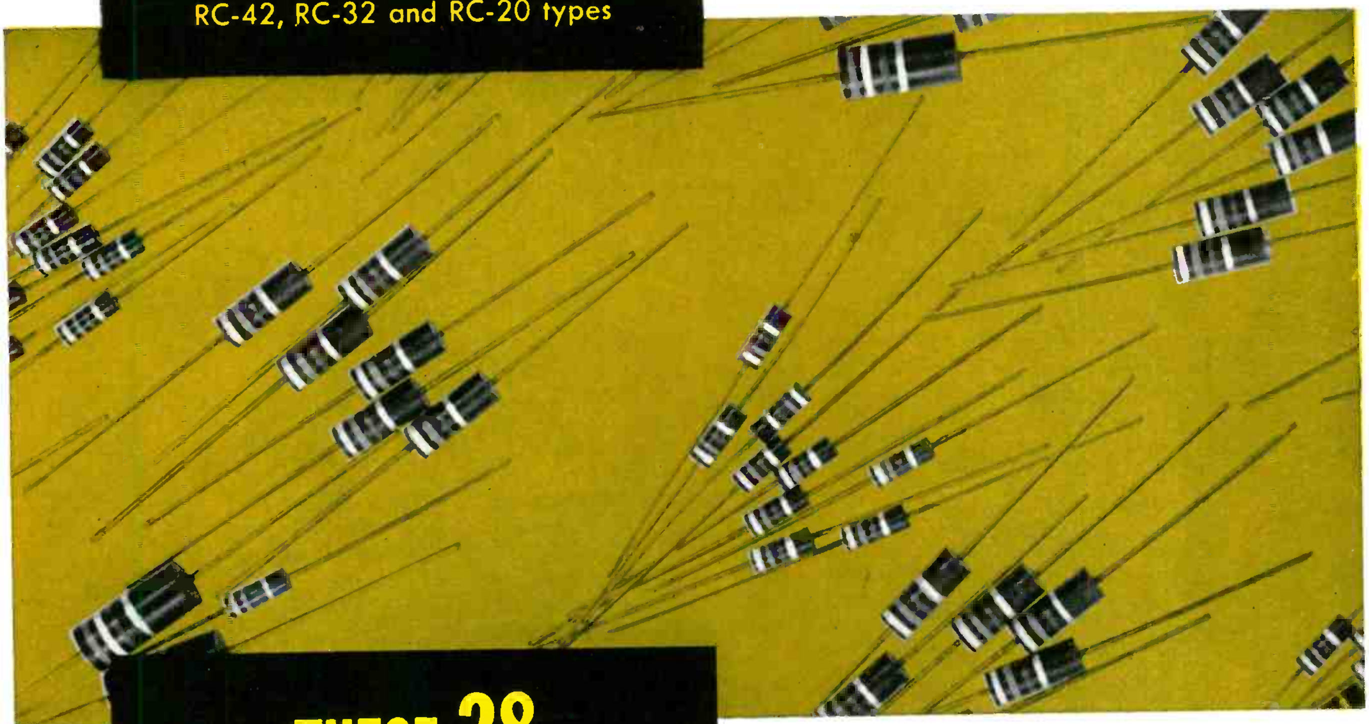
Using ultra-sensitive radar equipment, the team of scientists expects to record and analyze meteor showers with twice the accuracy previously obtained. To help do this, a series of cathode ray tube displays and a camera using 70 mm film will be used.

FOR DATACENTERS

At IBM's Endicott, N. Y. plant, engineers test completely transistorized 7070 data processing systems scheduled for the 25 to 30 metropolitan Datacenters that IBM is setting up in major U.S. cities.

STACKPOLE
Coldite 70+®
FIXED COMPOSITION
RESISTORS
RC-42, RC-32 and RC-20 types

Today's best looking resistors—and every bit as good as they look! Easiest to solder. Unmatched for load life and moisture resistance. The first approved resistors, from a MIL-R-11 approved manufacturer, to be supplied across the board in RC-42 (2-watt); RC-32 (1-watt) and RC-20 (½-watt) styles from distributors' stocks.



THESE 28 DISTRIBUTORS CAN FILL YOUR ORDERS *from stock!*

For small runs, military prototypes, production emergencies or for hurry-up design and engineering projects . . .

You can get Stackpole Coldite 70+ resistors in any standard value or tolerance from the 28 distributors listed below. And prices are the lowest available for purchases up to 1,000 resistors of a value!

BALTIMORE, MD.
Kann-Ellert Electronics, Inc.

BATTLE CREEK, MICH.
Electronic Supply Corp.

BIRMINGHAM, ALA.
MG Electrical Supply Co.

BOSTON, MASS.
Sager Electrical Supply

BROOKLYN, N. Y.
Electronic Equipment Corp.

CLEVELAND, OHIO
Pioneer Electronic Supply Co.

DALLAS, TEXAS
Wholesale Electronics Supply Co.

DAYTON, OHIO
Srepco, Inc.

DENVER, COLO.
Denver Electronics Supply Co.

GLENDALE, CALIF.
R. V. Weatherford Company

INDIANAPOLIS, INDIANA
Radio Distg. Co.

KANSAS CITY, MO.
Burstein-Applebee Co.

MELBOURNE, FLORIDA
Electronic Supply

MIAMI, FLORIDA
Electronic Supply

NEW YORK, N. Y.
Harvey Radio Co.

PHILADELPHIA, PA.
Almo Radio Co.

SAN DIEGO, CALIF.
Radio Parts Co.

SCRANTON, PA.
Fred P. Pursell

SEATTLE, WASH.
C & G Radio Supply Co.

ST. LOUIS, MO.
Interstate Supply Co.

SYRACUSE, N. Y.
Morris Electronics of Syracuse

TACOMA, WASH.
C & G Radio Supply Co.

WASHINGTON, D. C.
Electronic Wholesalers, Inc.

WATERBURY, CONN.
Bond Radio Supply Co. Inc.

WEST PALM BEACH, FLA.
Goddard Distributors, Inc.

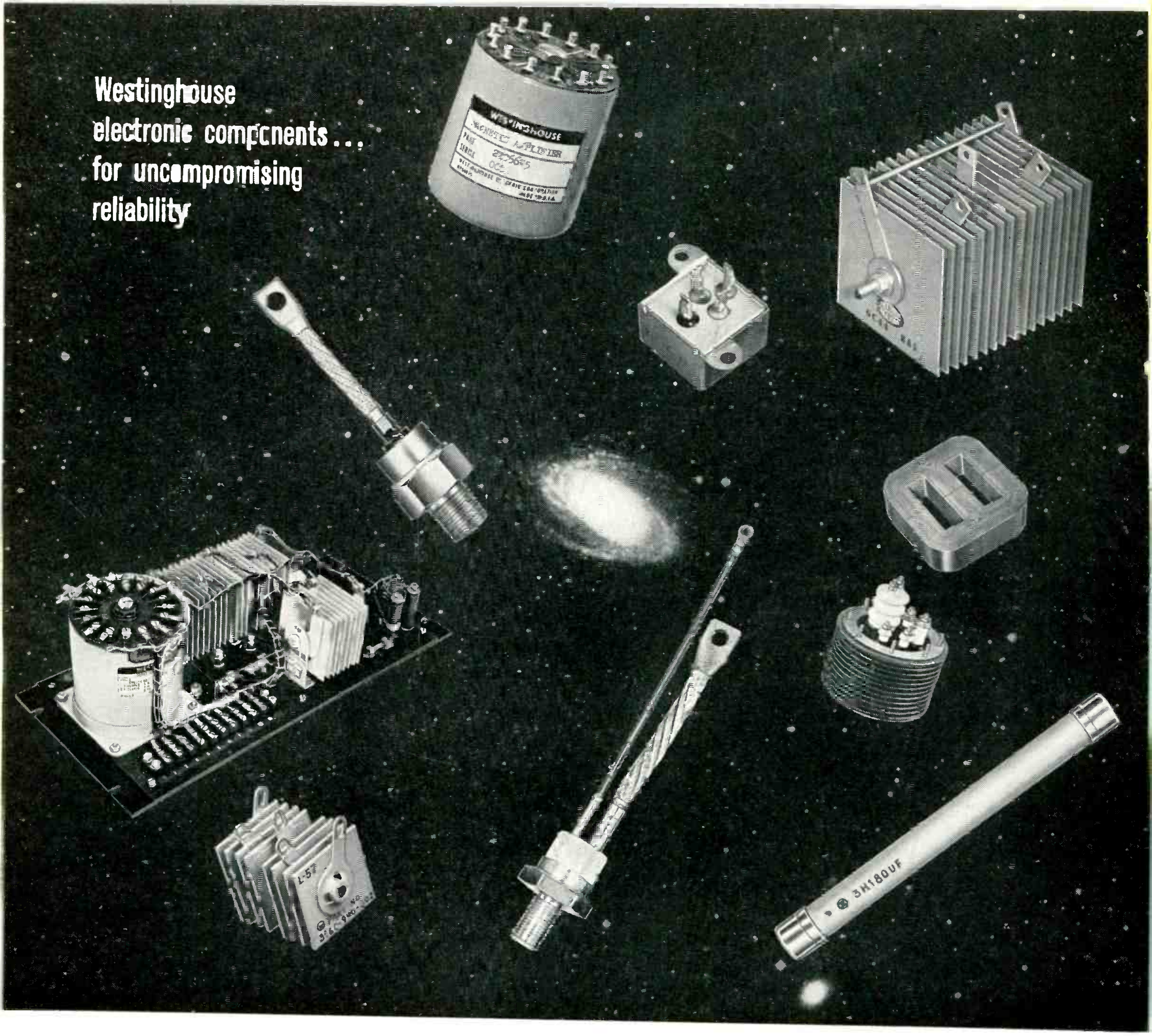
WICHITA, KANSAS
Interstate Electronic Sup. Corp.

WILBRAHAM, MASS.
Industrial Components Corp.

WINSTON-SALEM, N. C.
Dalton-Hege Radio Supply

. . . and G-C/STACKPOLE, TOO!

Attractively packaged by G-C Electronics for service replacement uses, Coldite 70+ Resistors are also available through over 800 G-C distributors.



Airborne components that guarantee circuit reliability

In the airborne electronics field—plane, missile or space program—the paramount requirements are: reliability, durability, light weight and small size. Westinghouse combines these product characteristics with engineering talent and breadth of line to offer you an exceptional source for a greater variety of electronic components and subassemblies than any other manufacturer.

Weapons systems like THOR, TITAN, FALCON, TARTAR, BOMARC, and many still classified have specified "Westinghouse" for this reason.

However demanding your requirements may be, your best insurance to protect your circuit designs is the Westinghouse line of high-reliability components. For assistance call your Westinghouse sales engineer or write: Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa.

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Control Devices • Instrumentation • Laminated Plastic Forms (Micarta®) • Magnetic Amplifiers • Magnetic Materials • Power Supplies • Static Inverters • Semiconductors • Transformers and Components • Tubes: Cathode-Receiving-Power-Nuclear Control

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OLD FAITHFUL

Built-in reliability inspires devotion everywhere for the new **Mincom Model CV-100 Video Band Magnetic Tape Recorder/Reproducer.** Only 12 moving parts, four simple adjustments. No mechanical brakes. Seven 1-megacycle video channels on a single half-inch tape. Tape speed of 120 ips, coupled with specialized circuitry, produces a reliable frequency response from 400 cycles to 1.0 megacycle (each track). Signal-to-noise ratio: 30 db, peak signal to rms noise. All plug-in assemblies, carefree maintenance. Interested? Write Mincom today for specifications.

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MINCOM DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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NOW from INDIANA STEEL

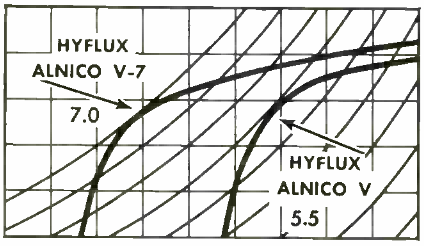
NEW HIGH ENERGY ALNICO V-7 PERMANENT MAGNETS ACHIEVE TYPICAL ENERGY VALUES OF 7 MILLION FOR THE FIRST TIME!

For the design engineer with a special application problem

Hyflux Alnico V-7 is a new high energy material now available for special applications requiring either *greater energy* per unit weight or volume, or *equal energy* from a lighter or smaller magnet.

Compared with the previous energy leader — Alnico V, new Hyflux Alnico V-7 represents a significant advance in the energy level of permanent magnets. To show this, a portion of the Demagnetization and Energy Product Curve has been enlarged and depicted here.

The curve for Hyflux Alnico V-7 shows a typical energy value of 7.00



million. By comparison, Alnico V has a typical value of only 5.50 million.

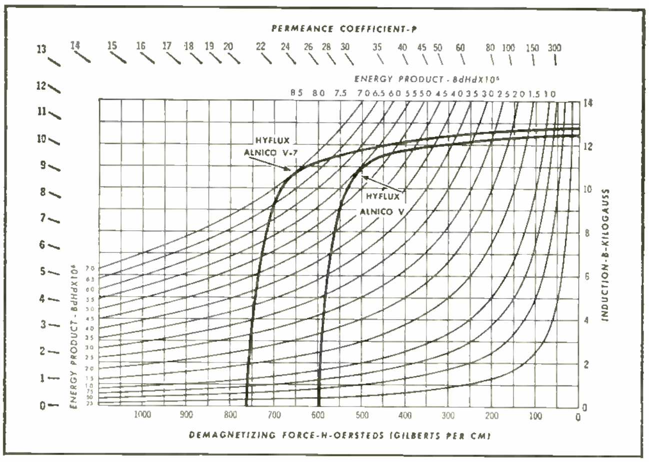
The reason for this remarkable performance lies in the very high degree of crystal magnet orientation found in the material. As a result, Hyflux Alnico V-7 produces *more magnetic energy per unit volume or weight* than any other permanent magnet material presently available.

Other characteristics of Hyflux Alnico V-7 are equally impressive. For example, residual induction (B_r) is 12,750 gausses, and the coercive force (H_c) is 765 oersteds. For Alnico V the B_r is only 12,500 gausses and the H_c 600 oersteds. Improvements such as these point the way to important design breakthroughs in many fields.

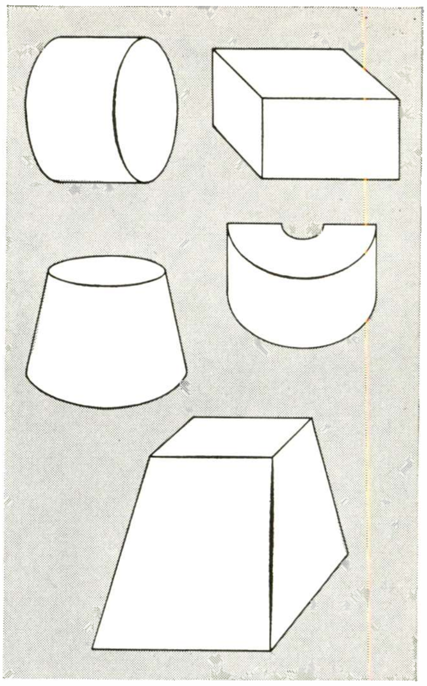
When To Use Hyflux Alnico V-7

A premium material, Hyflux Alnico V-7 is particularly suited for use in space age or other critical equipment requiring a greater level of energy, or where smaller size and weight without loss of energy is needed.

1. **Military Electronics.** Use Hyflux Alnico V-7 for light-weight ground and airborne generators and alternators (in a full range of frequencies).
2. **Testing Equipment.** Use Hyflux Alnico V-7 in meters, recording instruments, oscillographs, magnetometers and galvanometers.
3. **Miniature and Sub-miniature Components.** Use Hyflux Alnico V-7 for missile-borne guidance and recording equipment.



DEMAGNETIZATION AND ENERGY PRODUCT CURVE



Designing With Hyflux Alnico V-7

The nature of the material is such that orientation (and magnetization) must be straight, eliminating the familiar horseshoe shape. Cylinders, rectangles and other prismatic shapes, however, are possible, as are certain conic or pyramidal frustums. Pole faces may be ground quite easily. Side surfaces may also be ground, but somewhat slower than normal.

TYPICAL CHARACTERISTICS OF HYFLUX ALNICO V-7
(in comparison with Alnico V)

PROPERTIES	Hyflux Alnico V-7	Alnico V
Residual Induction (minimum) B_r Gausses	12,750	12,500
Coercive Force (minimum) H_c Oersteds	765	600
Peak Energy Product $B_dH_d$max x 10^6	7.00	5.50
Peak Magnetizing Force Oersteds	3,000	3,000
Weight (lb per cu in)	0.265	0.265
Mechanical Properties	Hard-Brittle	Hard-Brittle

For more information on new Hyflux Alnico V-7 and its role in the design future of your firm, write Dept. N-11

THE INDIANA STEEL PRODUCTS COMPANY
Valparaiso, Indiana
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS
In Canada: The Indiana Steel Products Company of Canada Limited, Kitchener, Ont.

INDIANA PERMANENT MAGNETS

As We Go To Press

Atlas Countdown Now Measured in Minutes

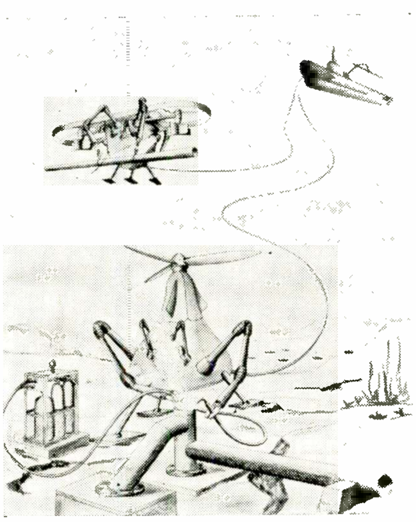
Electronic checkout and launch control equipment, developed and manufactured by the Radio Corporation of America under contract to Convair Div., General Dynamics Corp., allows a rapid countdown prior to the launching of the Atlas ICBM.

Previous countdown and checkout systems required as much as an entire day. With this system, accidental firing of the missile is made practically impossible.

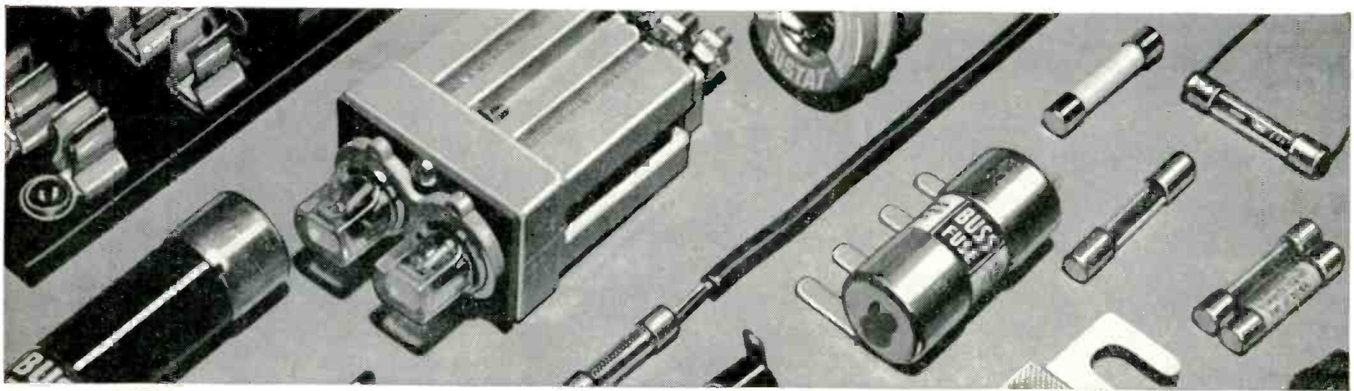
The system is divided into two major categories: the first checks out the missile and ground support equipment; the second starts the launching. Checkout is with an Automatic Programmed Checkout Equipment, called APCHE, which checks both itself and the launch control system. Used on a programmed basis, it insures proper pre-countdown conditions at all times.

The equipment that actually launches the missile has a "permissive progression" system which requires 14 buttons to be pushed before a launching and prevents any accidental firing. In case of a "no-go" condition the equipment returns to the pushbutton point preceding the malfunction rather than the start of countdown. The fault can then be cleared without back-checking to the start.

UNDERWATER "MOBOT"



Possible adaptation of Hughes Aircraft Co's remote handling device works underwater. Co's scientists predict uses for "Mobot" in working sea crops, fighting oil fires or in rescue work in dangerous areas.



Specify BUSS Fuses!

Because there's a BUSS or FUSETRON fuse to fit Your Every Electrical Protection Need.

With the world's largest fuse research laboratory plus 44 years of experience in solving electrical protection problems — it isn't surprising that BUSS has the most complete line of fuses in the industry.

The BUSS and FUSETRON fuse lines includes:

- Single-element fuses for circuits where quick-blowing is needed, such as for instrument protection.
- Single-element fuses for normal circuit protection.
- Dual-element, slow-blowing fuses for circuits where harmless current surges occur.
- Indicating fuses where signal must be given when fuses open, or to activate an alarm.

BUSS and FUSETRON fuses range in size from 1/500 amperes up — and there's a companion line of fuse clips, blocks and holders. Whatever your fuse requirements, the chances are more than good there's a BUSS or FUSETRON fuse to satisfy them.

If you have a special protection problem . . . extensive BUSS laboratory facilities and a large engineering staff are at your disposal to help you save money and engineering time.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders, write today for BUSS bulletin SFB.

BUSSMANN MFG. DIVISION,
McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

1159

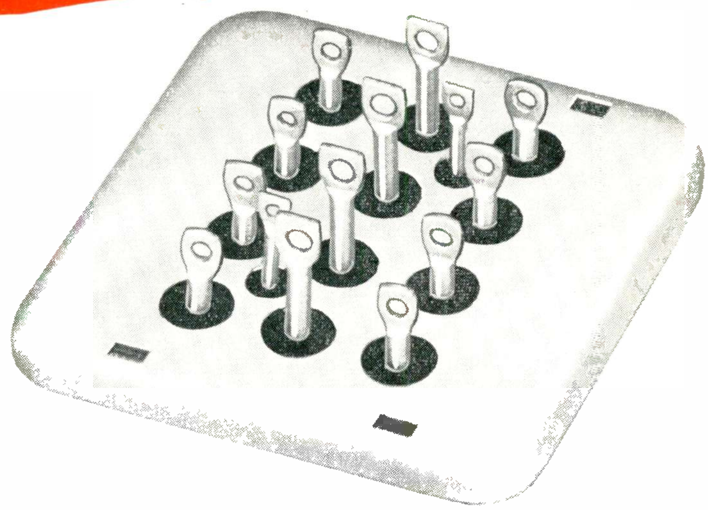
BUSS fuses are made to protect - not to blow, needlessly.

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

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS

McGRAW-EDISON

Need Better Electrical and Thermal Conductivity in a Glass-to-Steel Hermetic Terminal?



For most applications, solid 446 stainless alloy electrodes are best suited to our users needs. They are ideally suited to the perfect mating between our V24M glass and the pin. This fusion of glass and metal together with compression accounts for the rugged leak-proof character of Fusite Terminals under rough production handling and makes for easy solderability.

CONSIDER THE PLUS OF COPPER CORED ELECTRODES

When your application indicates the need for greatly improved electrical or thermal conductivity, you still need not sacrifice these inherent Fusite advantages. At slight additional cost, any of our terminals can be ordered with electrodes that have a copper core of as much as 25% of the total electrode area. Copper cored wire has up to 10 times increased current carrying capacity, yet, you maintain nearly all the advantages of solid 446 stainless.

Would you like to make tests?

Write Department G-6

INSULATE ELECTRICALLY · GLASS TO METAL · FUSITE · TERMINALS · PROTECT PRODUCT PERFORMANCE · SEAL HERMETICALLY

THE FUSITE CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

Woodford Mfg. Co., Versailles, Kentucky.

In Europe: FUSITE N. V. Königsweg 16, Almelo, Holland

As We Go To Press

New Tape System Extends L-F Range

Highlight of a new system for magnetic tape recording/reproducing systems developed by Mincom Div., Minnesota Mining & Mfg. Co., is an extended low frequency range achieved by the use of FM lows. This is provided by the inclusion of three FM tracks which will accommodate frequencies ranging from ½ CPS to 100 KC. The three tracks operate simultaneously with four analog tracks with a frequency response ranging from 400 CPS to 1.0 MC.

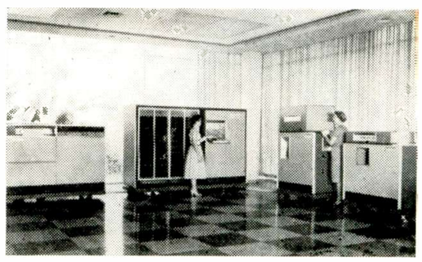
The new system, Model CV-107, was developed for the Sandia Corp. It will serve two major functions: the measurement of time intervals in the MC range, and the recording of transient wave forms.

Designed to provide a three-mode operational capability, the equipment will accommodate: 7 direct-recording and playback channels with a frequency on each track ranging from 400 CPS to 1.0 MC; 4 analog tracks from 400 CPS to 1.0 MC; plus 3 FM tracks from ½ CPS to 100 KC; and 3 channels of FM lows and analog highs giving full band-widths ranging from ½ CPS to 1.0 MC, plus 1 additional track with a frequency response ranging from 400 CPS to 1.0 MC.

Reflex Amplifier Patent

A patent on an amplifier which can chop, amplify, rectify, and re-amplify its own dc signal has been awarded to Blanchard D. Smith, Engineering Staff Assistant to the President of Research and Engineering, at Melpar, Inc., a sub. of Westinghouse Air Brake Co., Falls Church, Va.

SOLID-STATE COMPUTER



Remington Rand Corp. is now making deliveries of this computer, called the Univac Solid State. It has a central processor, a card reader, a read-punch unit up to 10 magnetic tape units, and a high speed printer that prints at the rate of 600 lines a min. "Memory" storage capacity is 50,000 characters of information.

TYPE 321

TRULY PORTABLE

Battery Powered.
Weighs only 13½ lbs. without batteries.
Batteries weigh 2 to 4 lbs.
Size only 5¾" x 8¼" x 16".

HIGH PERFORMANCE

Vertical Response: DC to 5 MC, 0.07 μsec risetime.
Calibrated Sensitivity: 0.01 v/div to 20 v/div in 11 calibrated steps. Continuously adjustable from 0.01 v/div to 50 v/div.
Calibrated Sweeps: 0.5 μsec/div to 0.5 sec/div in 19 calibrated steps. Accurate 5x magnifier extends calibrated range to 0.1 μsec/div. Continuously adjustable from 0.1 μsec/div to 1 sec/div.
Simplified Triggering: Fully automatic, or amplitude-level selection with preset stability control.
4-KV Accelerating Potential on 3" crt.
6-div by 10-div Display Area.
Amplitude Calibrator.

NO POWER SOURCE PROBLEMS

Operates from:

1. Ten size D Flashlight cells, ½ hour continuous, more with intermittent, operation.
2. Ten rechargeable cells, 2.5AH—3 hours continuous operation. Ten rechargeable cells, 4.3AH—5 hours continuous operation.
3. 11 to 35 v dc (aircraft, auto, boat, etc.).
4. 105 to 125 v ac or 210 to 250 v ac, 50 to 800 cps.

Price	**$775.00**
Built-in Battery Charger	**35.00**
Complete Set of 2.5AH Batteries	**36.50**
	f.o.b. factory

It's so easy to take the Type 321 wherever an oscilloscope is useful. It's a convenient solution to many difficult situations, too . . . for example: Where power cords are apt to be a nuisance—where isolation from ground is desirable—where power-line fluctuations are troublesome—where hum pick-up is a problem. The Type 321 is sure to satisfy your portable oscilloscope needs.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

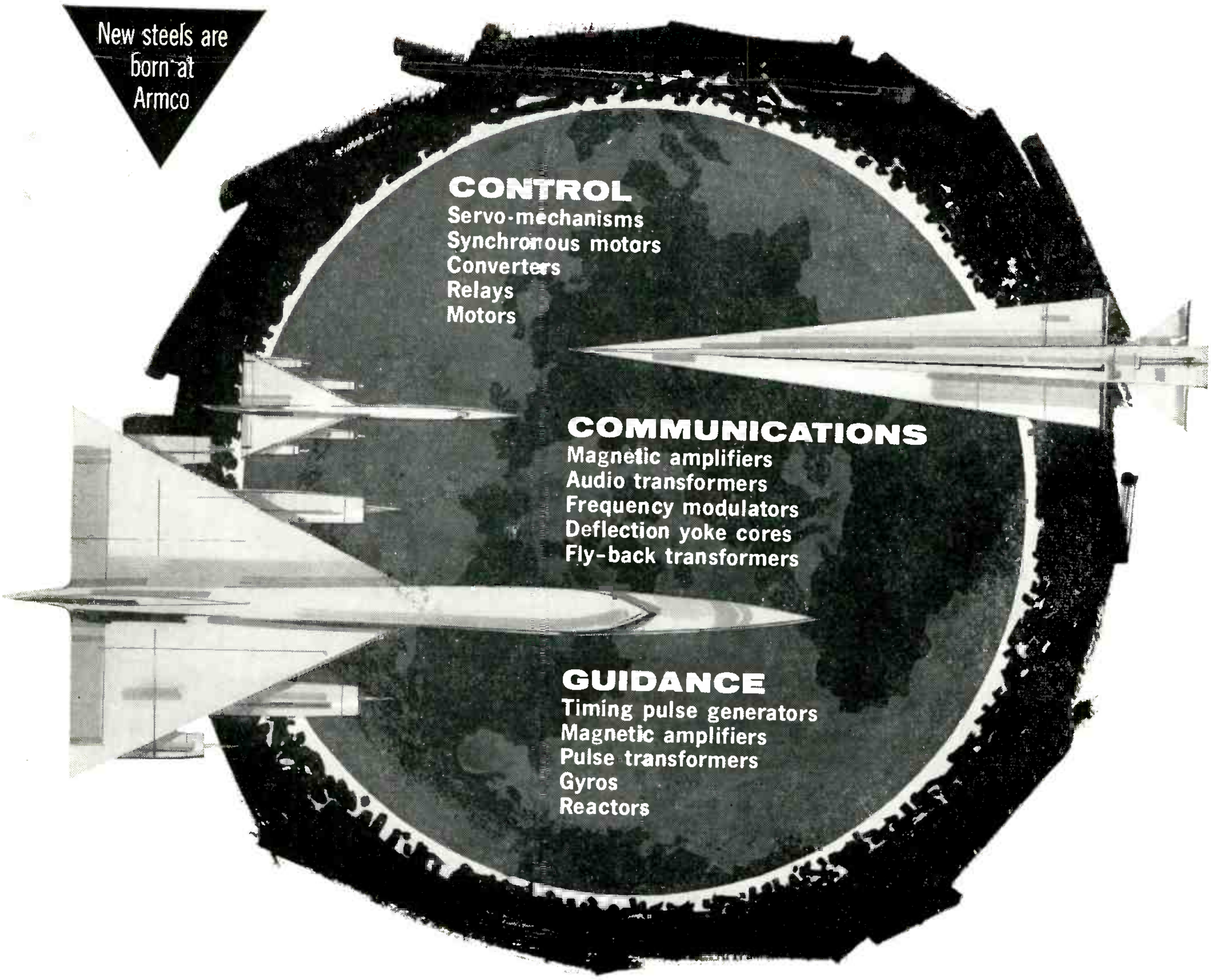
TEKTRONIX FIELD OFFICES: Albertson, L. I., N.Y. • Albuquerque • Annandale, Va. • Atlanta Ga. • Buffalo • Cleveland • Dallas • Dayton • Elmwood Park, Ill. • Endwell, N.Y. • Houston Lathrup Village, Mich. • Lexington, Mass. • East Los Angeles • West Los Angeles • Minneapolis Mission, Kansas • Orlando, Fla. • Palo Alto, Calif. • Philadelphia • San Diego • St. Petersburg, Fla. Scottsdale, Ariz. • Stamford, Conn. • Syracuse • Towson, Md. • Union, N.J. • Willowdale, Ont.

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon, Seattle, Wash.; Hytronic Measurements, Denver, Colo., Salt Lake City, Utah.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

ENGINEERS—Interested in furthering the advancement of the oscilloscope? We have openings for men with creative ability in circuit and instrument design, cathode-ray tube design, and semiconductor research. Please write Richard Ropiequet, V. P., Eng.

Circle 34 on Inquiry Card



HOW TO IMPROVE EFFICIENCY, CUT COST OF AIRBORNE MOTORS, CONVERTERS AND TRANSFORMERS

Armco Thin Electrical Steels and Nickel-Iron Magnetic Alloys provide properties that facilitate design of light-weight, high quality, reliable components for control, communications and guidance units.

Armco Thin Electrical Steels—Three different grades—Armco TRAN COR® T, Oriented T, and Oriented TS—in thicknesses from 1 to 7 mils have exceptionally high permeability and low hysteresis loss. Advantageous for 400-cycle and higher equipment such as servo-mechanisms, specialty transformers, motors and magnetic amplifiers.

Armco Nickel-Iron Magnetic Alloys—Armco 48 Ni combines very high permeability at low to moderate inductions with extremely low coercive force and hysteresis loss. It is produced in 2 to 14-mil strip specially processed for laminations or wound cores.

Armco 48 ORTHONIK® offers the advantages of a rectangular hysteresis loop combined with very low coercive force. A highly oriented material, produced in thicknesses from ¼ to 6 mils, 48 ORTHONIK has proved highly useful for components of computer and control circuits.

Applications for these special Armco magnetic alloys include magnetic amplifiers, reactors, bi-stable elements, audio and pulse transformers, gyro and synchronous motors and other specialty, high quality devices.

Give the airborne electronic or electrical equipment *you* make the advantages obtained with Armco's Thin Electrical Steels and Nickel-Iron Magnetic Alloys. Write us for complete information and design data. Armco Steel Corporation, 3379 Curtis Street, Middletown, Ohio.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

now... Streamliner service on fabricated parts

FIF

Fabricator of Industrial Formica laminated plastics

Formica® Field Fabricating better 3 ways:

1 Faster delivery on a totebox-ful or a truckload

2 Highest quality assured by fabricating specialists and modern equipment

3 24-hr. delivery on standard Formica sheets and rods

Need a part fabricated quickly for prototype development? Need a truckload of parts to keep your production lines running? Call your local Fabricator of Industrial Formica laminated plastics. One or one million, he'll *fabricate and deliver* your Formica laminated plastic parts on a Streamliner schedule—within 24 hours in some cases.

He's located near you, offers more frequent contact. In many cases he stocks standard Formica sheets and rods for Streamliner delivery in a matter of hours.

The new Formica field fabricating service is without equal. It can save you time and money in more efficient parts procurement. Write us for complete information and the name of the fabricator nearest you. Formica Corporation, subsidiary of American Cyanamid, 4536 Spring Grove Ave., Cincinnati 32, Ohio.

FORMICA® Laminated Plastic *a product of* CYANAMID

FI-2076

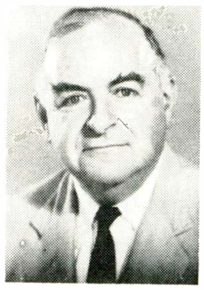
Circle 36 on Inquiry Card

Industry News

Dr. Harold Eugene Edgerton, Professor of Electrical Measurements at MIT has been named recipient of the Progress Medal Award of the Soc. of Motion Pictures & Television Engineers for his work in the development of the stroboscope and related electronic flash photographic equipment.

James E. Pitman has been named Manager of Product Planning for point-to-point communication equipment in General Electric's Communication Products Dept., Lynchburg, Va.

Frederick R. Lack has been elected Director of the Sprague Electric Co. He is a former Director and Vice-President of Western Electric Co.



F. Lack

E. Carter

Everitt A. Carter is now President of Oak Mfg. Co. He was formerly Vice-President and General Manager of Canadian Curtiss-Wright Corp., Ltd.

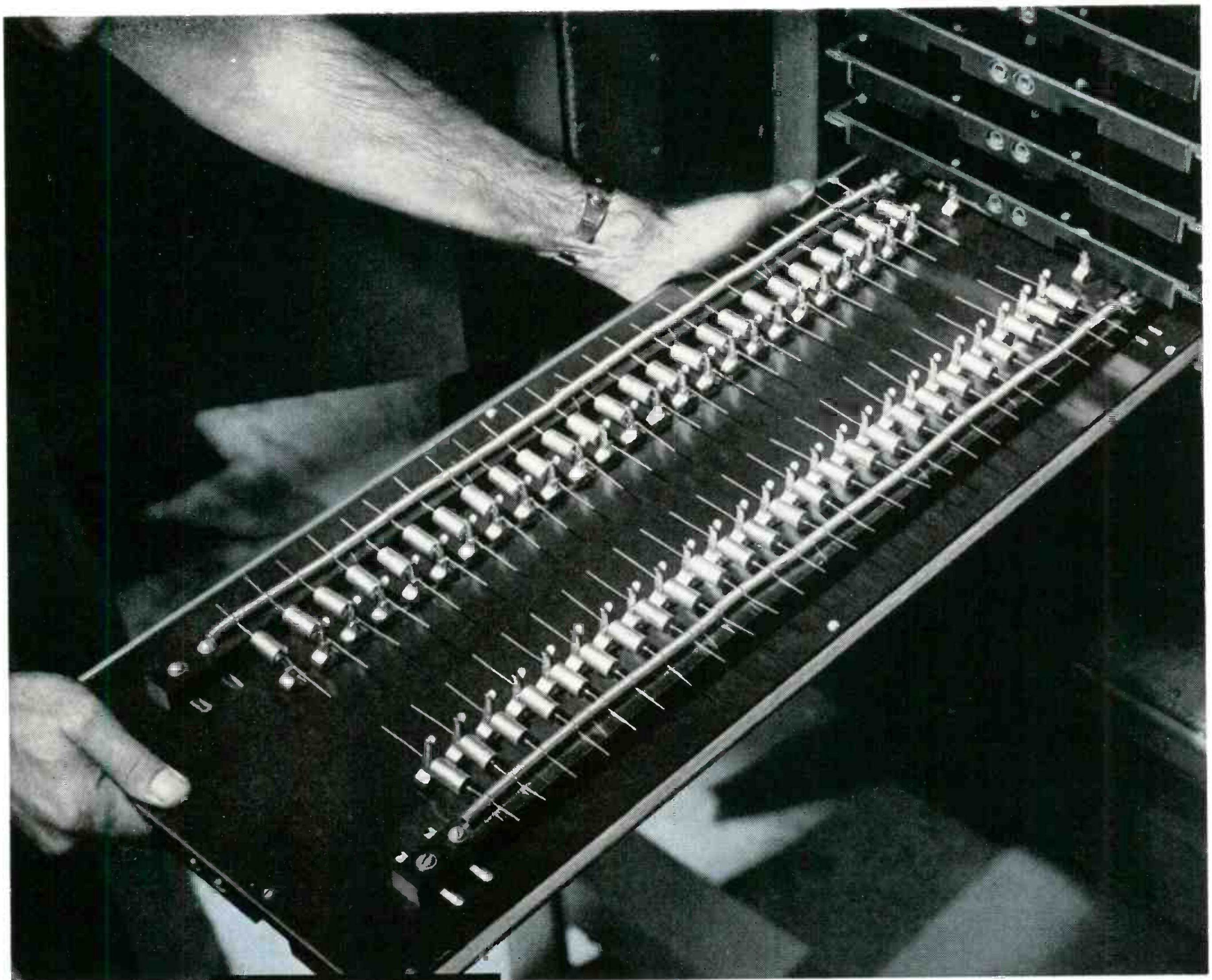
Melpar, Inc. has promoted **Ira Apter, Thomas G. Walkinshaw,** and **Walter G. Heffron, Jr.,** as Section Heads in the Simulation and Training Systems Engineering Dept.

Jack G. Anderson has been promoted to the new position of Vice President—Marketing at the Hoffman Labs. Div., Hoffman Electronics Corp. He previously was Director of Military Marketing.

David F. Brower is now Assistant Manager of the Engineering Dept., Rheem Semiconductor Corp.

Albert D. Unetic has been elected to Assistant Vice President of Robertshaw-Fulton Controls Co. He is General Manager of the firm's Acro Div.

Richard M. Ross has been named to the newly-created post of Manager of Marketing Services for the Semiconductor Div., Sylvania Electric Products, Inc.



Inserting a rack of "Kemet" capacitors in an oven for testing at 125°C.

EVERY KEMET CAPACITOR SHIPPED HAS BEEN LIFE TESTED FOR AT LEAST 250 HOURS!

TRADE-MARK

...and more than 90% of regular production capacitors have been life tested for at least 300 hours.

There is no one simple test to assure product quality in the manufacture of solid tantalum capacitors. Only a series of rigid tests can achieve this goal. At Kemet Company this program starts with 100% life testing.

Every capacitor shipped has passed a 250 to 300 hour life test at its rated voltage in a 125°C. oven. This test includes leakage, capacitance and dissipation measurements. From each test batch, two statistical samples are subjected to additional testing. One group is life tested for 1000 hours; other groups are slated for environmental tests.

Kemet Company has always conducted life tests with very low series resistance...no more than 100 ohms. In compliance with Air Force Specification MIL-C-26655, tests are now conducted without resistors.

Write today for NEW EXPANDED
"ELECTRONICS PRODUCTS ENGINEERING BULLETIN"
This six-page folder provides performance curves, operating characteristics and specifications. In addition, it offers a decade series of capacitance values.

"Kemet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

KEMET COMPANY

DIVISION OF UNION CARBIDE CORPORATION

OFFICES: 11901 Madison Avenue, Cleveland 1, Ohio

AIR LIFT

for mobile teleprinter center

Interior view of mobile teleprinter center

Kleinschmidt super-speed teletypewriters provide world's fastest printed combat communications for the U.S. Army!

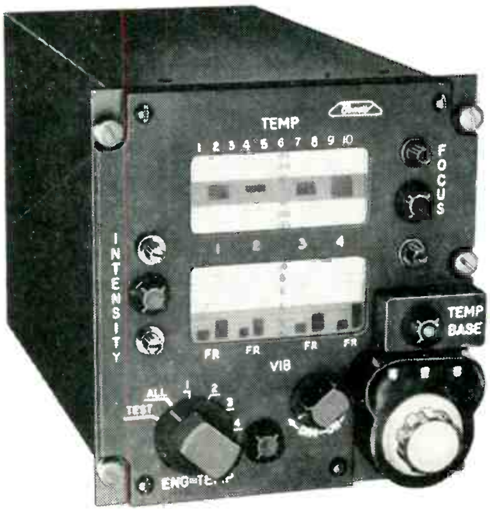
Taking the jolts and jars of movement by air in stride, the new Kleinschmidt telecommunications units handle *printed* messages at speeds up to 750 words a minute! Using these machines, developed in cooperation with the U. S. Army Signal Corps, information on enemy movements could move accurately and rapidly to friendly units widely dispersed under nuclear battlefield conditions. In recognition of Kleinschmidt's high standards of quality, equipment produced for the U. S. Army is manufactured under the Reduced Inspection Quality Assurance Plan. Today, the advanced commercial application of electronic communications is unlimited.

KLEINSCHMIDT

DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILLINOIS

Pioneer in teleprinted communications systems and equipment since 1911

ANNOUNCING A NEW DEVELOPMENT BY BENDIX



TEMPERATURE VIBRATION MONITOR *

FOR TURBINE ENGINES

Provides a continuous condensed display of turbine engine vibration and temperature conditions

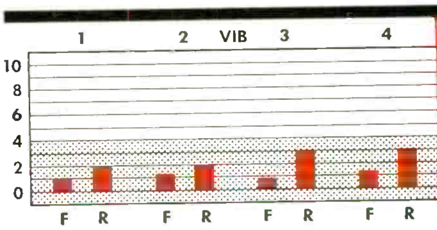
A landmark in engine instrumentation progress is the Bendix* Temperature-Vibration Monitor which simultaneously displays the findings of 40 temperature and 8 vibration sensors strategically located on all 4 engines of a turbine powered aircraft. This data is presented on the flight deck of the aircraft in bar graph form so that it can be continuously monitored and easily read.

The average displacement of 8 vibration pickups is displayed continuously on the lower cathode ray tube with the top of the bar graph indicating vibration displacement on the grid scale. This continuous monitoring of vibration immediately indicates excessive unbalance on the jet engine.

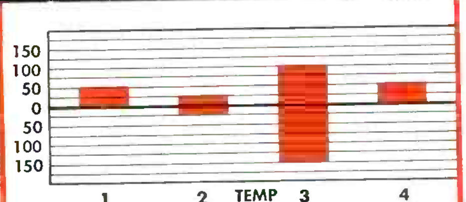
The temperature analysis normally associated with the exhaust gas thermocouples will locate faulty burners, bad combustion distribution and plugged nozzles or any unusual hot or cold conditions around the turbine engine exhaust. The temperature display in the "all" position presents maximum and minimum temperatures on the upper cathode ray tube continuously for the four engines as reference to a temperature datum set in by the operator. The individual engine temperatures can be displayed as 10 bar graphs whose deflection can be read on the tube scale as deflections above or below the temperature datum, and individual degrees may be accurately and easily read from the digital read-out dial.

The equipment, initially developed for BOAC, is applicable to all airline and military turbine powered aircraft. The equipment for the four engine installation is approximately 30 lbs. and includes the Temperature-Vibration Monitor pictured above and a remotely mounted ½ ATR short box.

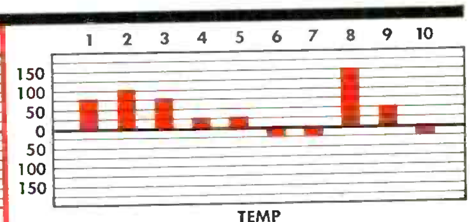
*TRADEMARK



Vibration indication for four engines with front and rear pickups on each. Height of display indicates total vibration displacement.



Temperature "all" display indicating maximum and minimum temperatures above and below temperature datum for four engines.



Temperature for single engine indicates all thermocouples indicating temperature above or below temperature datum reference.

Scintilla Division
SIDNEY, NEW YORK

Bendix
AVIATION CORPORATION

Circle 40 on Inquiry Card

Industry News

Networks Electronic Corp. has named **Sheldon T. Schreiber** Marketing Manager for the firm's Special Products Div.

Edwin J. Deadrick has been appointed Plant Manager of Audio Devices, Inc. Most recently he was Plant Manager of Howard Plastics, a div. of W. R. Grace.

The W. L. Maxson Corp. has appointed **Robert A. Lombard** Sales Manager of its Langevin Div.

Victor Severin has been elected Vice President of Smith-Corona Marchant, in charge of the International Div.

Erwin A. Stuebner, a Partner of Kidder, Peabody & Co., Chicago, was elected a Director of Moog Servocontrols, Inc.

Orville E. Orbom has been appointed by Epsco Inc., to head a new division specializing in Medical Electronics Diagnosis.

O. Orbom

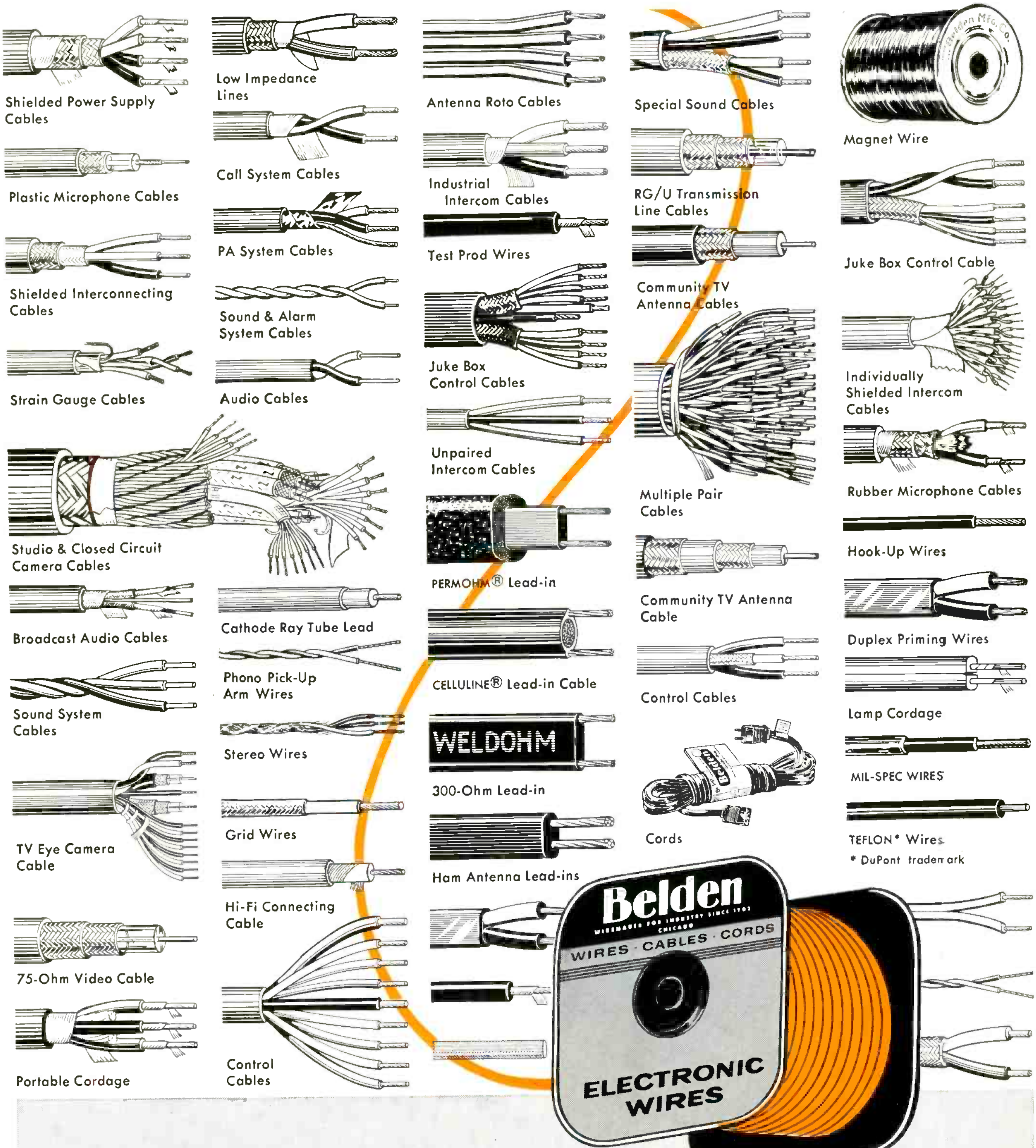
M. Schilling

Dr. Martin Schilling, has been promoted by Raytheon Co. to the newly created Corporate Staff Post of Assistant for Program Planning.

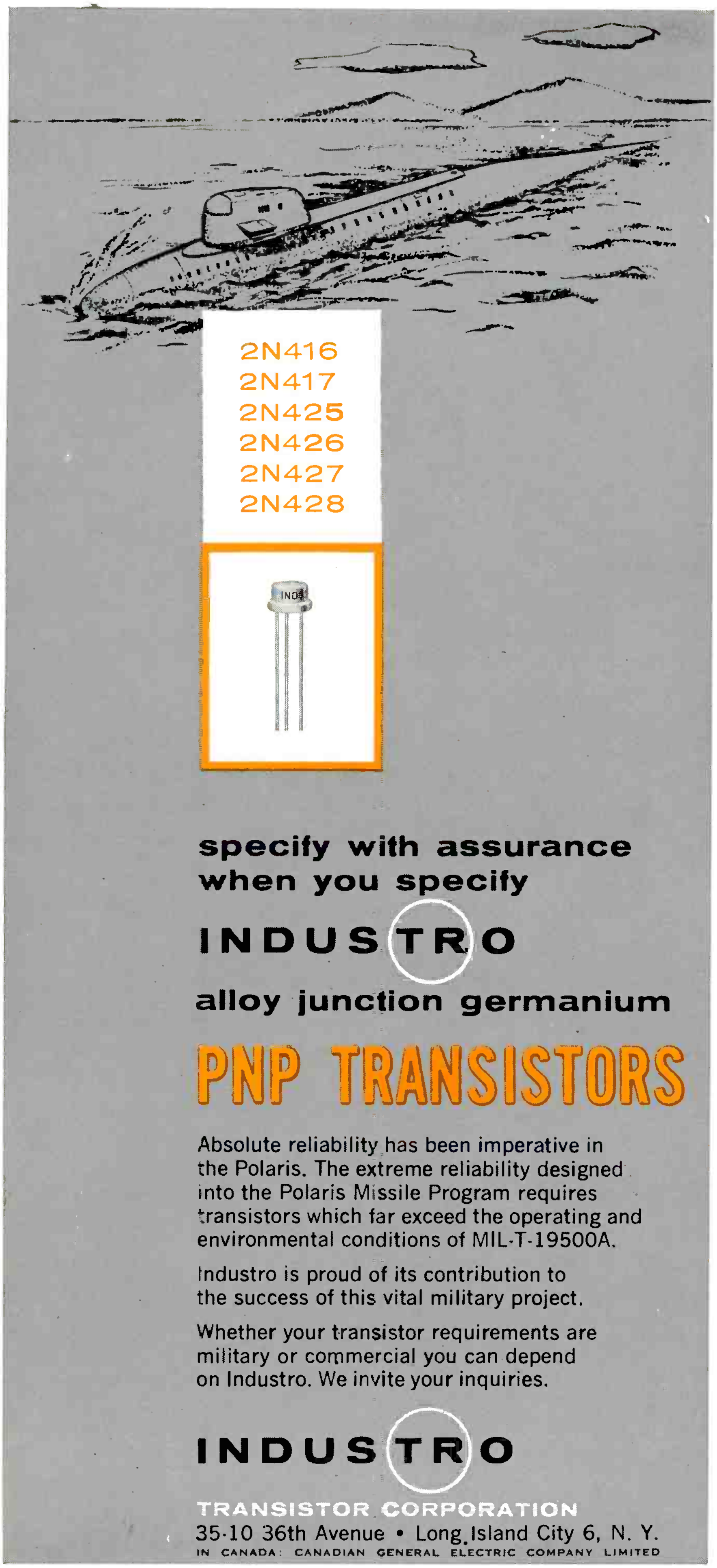
David T. Kimball has joined Telecomputing Corp. as Vice President and General Manager of the Whittaker Gyro Div. He was formerly at the Autonetics Div., North American Aviation.

Two new appointments have been announced by Phillips Control Corp. **Merle A. Hayard** is now Executive Vice-President and General Manager. **George B. Zeigler** has been appointed to Vice-President in Charge of Administration.

W. Paul Smith has been appointed Vice President of American Bosch Arma Corp. Since 1954 he has been President of Control Instrument Co., subsidiary of Burroughs Corp.



Circle 42 on Inquiry Card



Industry News

Officers of Ultek Corp., 920 Commercial St., Palo Alto, Calif., a newly formed electronic organization specializing in electronic vacuum pumps and related equipment are: **Lewis D. Hall**, President; **Reid W. Dennis**, Vice President; and **J. William Sugg**, Secretary-Treasurer. Other present staff department heads include **Charles F. Brothers**, **Charles A. Piercey**, **Victor H. Soules**, and **Buck W. Wong**.

T. C. Wisenbaker has been appointed Manager of Raytheon Co.'s Missile Systems Div. Succeeding him as Assistant Manager is **Thomas L. Phillips**.

A new Manager of the Nuclear Ordnance Projects Operation in the General Electric Co.'s Missile and Space Vehicle Dept. has been named. He is **Robert J. Kirby**, formerly Manager of the Aerophysics Engineering Operation.

Frank E. O'Brien has been appointed to the newly created post of Director of Public Relations at Pacific Semiconductors, Inc.

Arnold L. Boyce has been appointed Superintendent of Indox at The Indiana Steel Products Co.'s new plant in Valparaiso, Ind.


A. Boyce

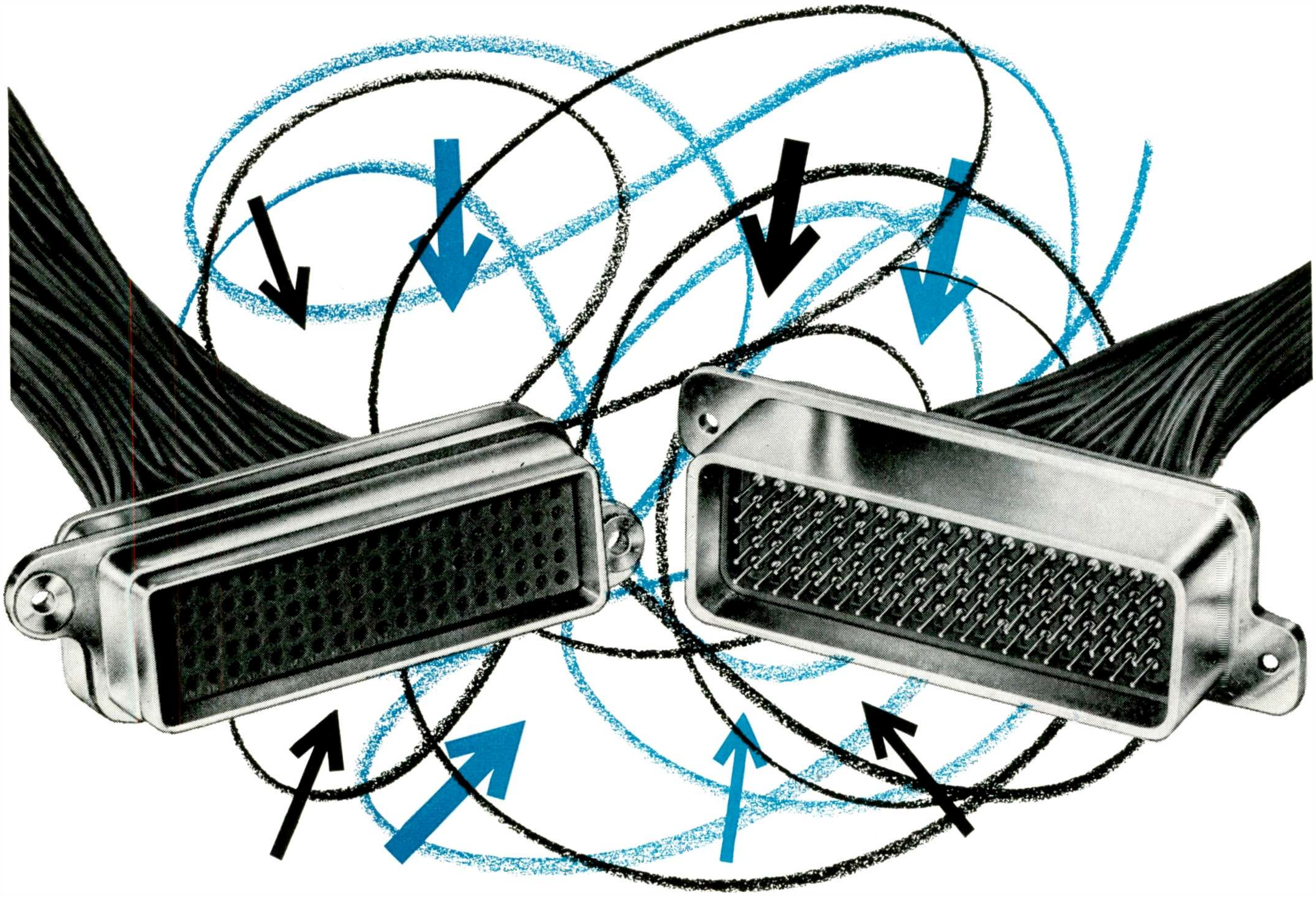

G. Hildebrand

Appointment of **George A. Hildebrand** as Administrator, Micromodule and Rectifier Sales, RCA Semiconductor and Materials Div. has been announced.

Jacob B. Taylor has been elected Executive Vice President—Finance and **Leon G. Guest, Jr.** has been elected Vice President and Controller of General Telephone & Electronics Corp.

Brig. Gen. John C. Monahan is now Chief of the Research & Development Div., Office of the Chief Signal Officer. He was previously Deputy Chief, U. S. Army Security Agency.

WHEN THE DUTY'S ROUGH AND THE CIRCUITS ARE CRITICAL



AMPin-cert RACK AND PANEL CONNECTORS—Here's a rack and panel connector that can really take a beating and keep right on going . . . performs like a champion in the toughest environments, with the roughest treatment yet gives enduring critical-circuit performance.

Environmentally sealed or unsealed, *AMPin-cert* connectors are made in 50 and 100 position units and have a number of unusual features including: single or dual circuit leads per contact (in the 50 position unit) . . . crimp-on snap-in contacts with extra wire insulation support against vibration . . . aluminum shells for shock . . . cadmium plating for corrosion resistance . . . extended alignment skirts plus alignment bushings on shells to prevent coupling damage to contacts . . . alpha-numerical coding of all cavities.

Get reliable performance under vibration and shock . . . in arid climates . . . in excessively humid conditions . . . in extreme cold or heat. No solder, naturally. Current rating of 5 amperes.

If you need a rugged connector with dry circuit sensitivity, the *AMPin-cert* Rack and Panel Connector is your answer. Send for more information today.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Japan

Circle 46 on Inquiry Card

Industry News

IBM has appointed **Robert W. Hubner** as Executive Assistant to the President. He was formerly Regional Manager of Marketing Services for the company's Data Processing Div.

Thomas C. Shreve is now Chief, Production Control, at the Norden Div., Milford Dept.

William L. Vandal has joined Aeronutronic, a Div. of Ford Motor Co. as Manager, Central Environmental Test. Prior to joining Aeronutronic, he was an Engineering Group Leader at Autonetics Div., North American Aviation, Inc.

Appointment of **Michael York** as Corporate Manager of Advertising for Beckman Instruments, Inc., has been announced. He was formerly Advertising and Sales Promotion Manager for Beckman's Helipot Div.

Six new Directors have been named to the board of Bulova Research & Development Labs., Inc. They are: **Dr. Theodore K. Steele,** Vice President of Engineering and Research; **Oscar B. Brockmeyer Jr.,** Vice President of Engineering Sales; **John J. Carpenter,** General Manager of Bulova's Electronics and Photographic Divisions; **William O. Bennett,** Director of Engineering and Research for the watch company; **David C. Stambaugh,** Vice President of Manufacturing for the parent company; and, **Sol E. Flick,** Secretary and General Counsel for both organizations.

Walter B. Claus has been named Staff Assistant to the Director of Manufacturing at Burroughs Corp.'s ElectroData Div.

Appointment of **Pat J. Morrisey** to the post of Sales Manager, Electronics Div., DeJur-Amsco Corp. has been announced. He was formerly General Sales Manager of Chester Cable Corp.

Anthony Easton, former President of Commonwelath Research Corp., has joined Westrex Corp., a Div. of Litton Industries as General Manager of its communications equipment activities.

William P. Morrison has joined Servo Corp. of America as Sales Manager of the Railroad Products Div.

INHERENT STABILITY
Assured in a DALOHM WW or HW Resistor

Salt — a preservative in some instances and a gnawing destroyer in others — has no effect at all on the inherent stability that is standard in Dalohm resistors.

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.

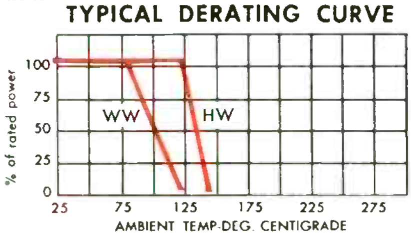
For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

WIRE WOUND • BOBBIN TYPE • ENCAPSULATED
DALOHM TYPE WW & HW RESISTORS

High resistance value, wire wound resistors designed for non-inductive requirements demanding the closest tolerances. Encapsulated in carefully compounded material, selected for matching coefficient of expansion to that of wire.

Configurations: WWA—axial leads; WWP—parallel leads; WWR—radial leads; WWL—lug style terminals; WW-RB—military style with lug terminals; HW—high temperature applications.

TYPICAL DERATING CURVE



- **Rated at** 0.1 watt to 2 watts, with a wide selection of sizes
- **Resistance range** from 0.6 ohm to 6 megohms, depending on type
- **Tolerance** ± 0.05%, ± 0.1%, ± 0.25%, ± 0.5%, ± 1%, ± 3%
- **Temperature coefficient** 20 P.P.M. per degree C.
- **Operating temperature range** from −55° C. to + 125° C. for WW Type and −55° C. to + 145° C. for HW Type
- **Smallest in size,** ranging from ⅛" x ⅜" to ⅞" x 2⅛"
- Surpass MIL-R-93B, characteristics A and C and MIL-R-9444 (USAF).

Write for Bulletin R-26, 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.

from **DALOHM**
Better things in smaller packages

DALE PRODUCTS, INC.
1304 28th Ave., Columbus, Nebr.

FREQUENCY STANDARDS

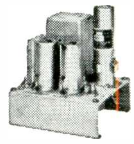
*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L



Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
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 and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

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 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2007-6 **NEW**
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 400 — 500 or 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 +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

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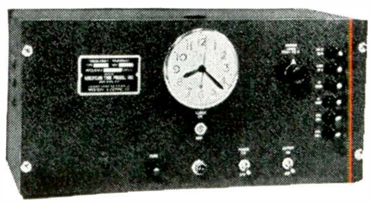
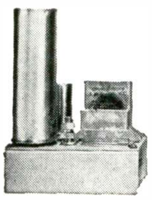


Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

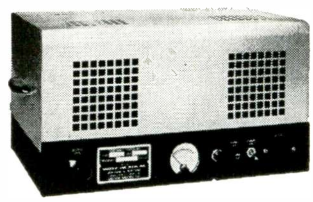


FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

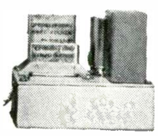
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
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 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.



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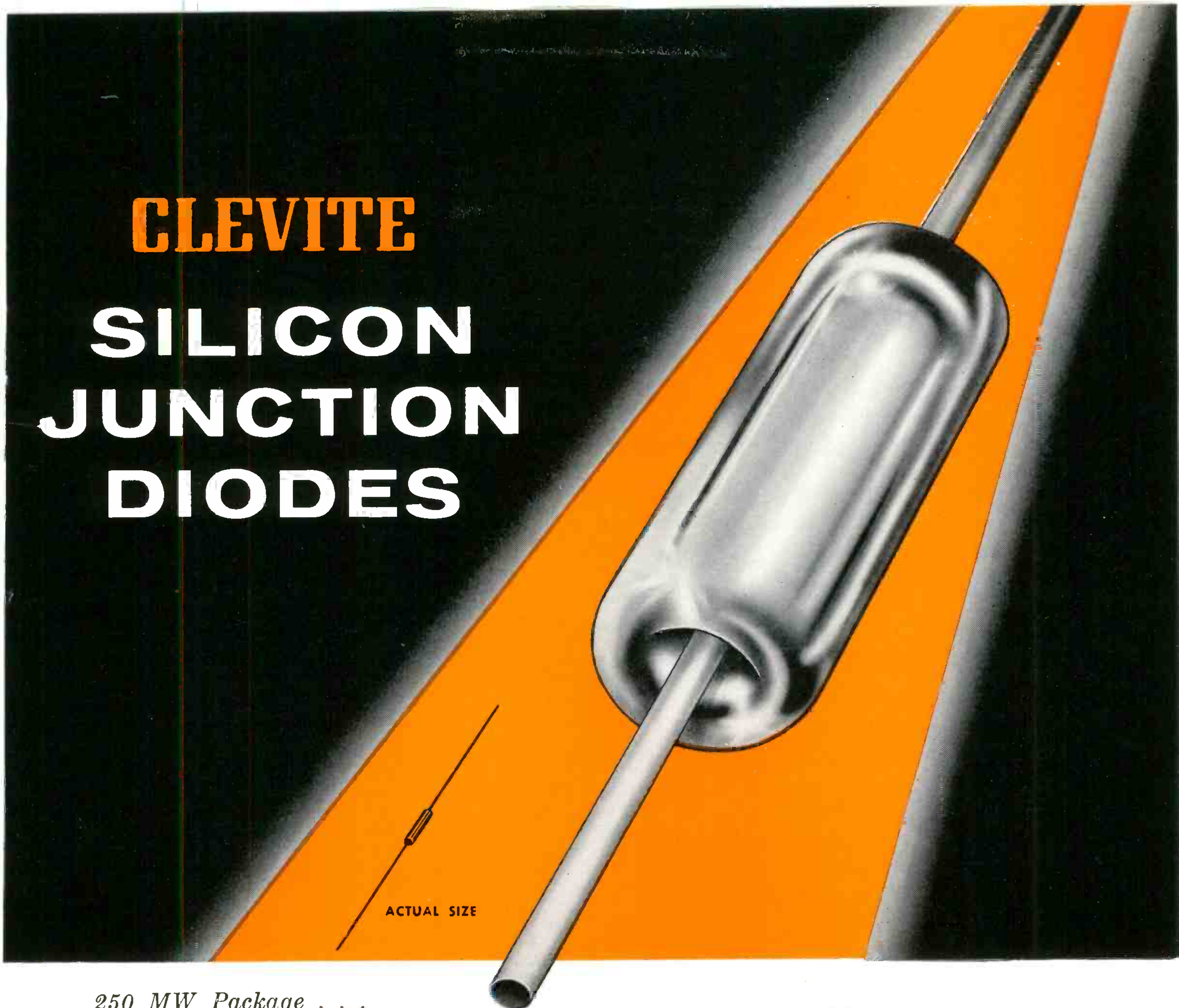

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TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current		Test Volts
			@ 25°C	@ 150°C	
IN457	60 V	20 ma @ 1.0 V	0.025 μa	5.0 μa	60 V
1N458	125 V	7 ma @ 1.0 V	0.025 μa	5.0 μa	125 V
1N459	175 V	3 ma @ 1.0 V	0.025 μa	5.0 μa	175 V
1N662	90 V	10 ma @ 1.0 V	20 μa	100 μa (@ 100° C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 μa	50 μa (@ 100° C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	175 V

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Personals

Henry G. Kuhn is now Chief Engineer at Lynch Carrier Systems, Inc. He was formerly with Lenkurt Electric Co.

James A. Erdle has joined Servo Corp. of America as Facilities Planning Engineer.

Carl Oestricher, formerly with Emerson Research Labs., is now Electronics Engineer for Brimberg Assoc., Inc.

Dr. Paul S. K. Chen has been appointed a senior engineer by the Semiconductor Div., Hoffman Electronics Corp.

Dr. J. Robert Spraul becomes Acting Manager of the Research and Development Dept. of Rheem Mfg. Co., N. Y. He was formerly Supervisor of the Physical Chemistry Group of Armour Research Foundation, Chicago.

J. Spraul

G. Weiler

George W. Weiler has been promoted to Chief Electronic Engineer, at Bendix Products Div. Missiles, Bendix Aviation Corp.

Dr. Hans K. Ziegler, has been named Chief Scientist of the U. S. Army Signal Research & Development Laboratory. He was previously Director of the Astro-Electronics Div. which consolidates work on all national space projects assigned to the U. S. Army Signal Corps.

Oxford Electric Co. has named **Vaughn A. Bernier** Chief Engineer for their Best Mfg. Div.

Dr. Beaumont Davison has joined the staff of Industrial Electronic Rubber Co. as Vice President and Director of Research. He was formerly Assistant Professor of EE at Case Institute of Technology.

George W. Reitwiesner has joined the Computation Section of the National Bureau of Standards. He was formerly Chief of the Computing Methods Section of the Ballistic Research Labs., Aberdeen Proving Ground.

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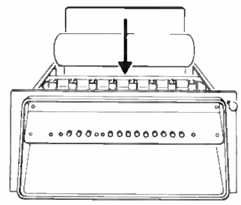

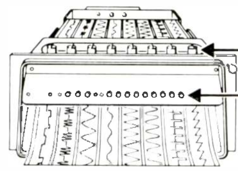

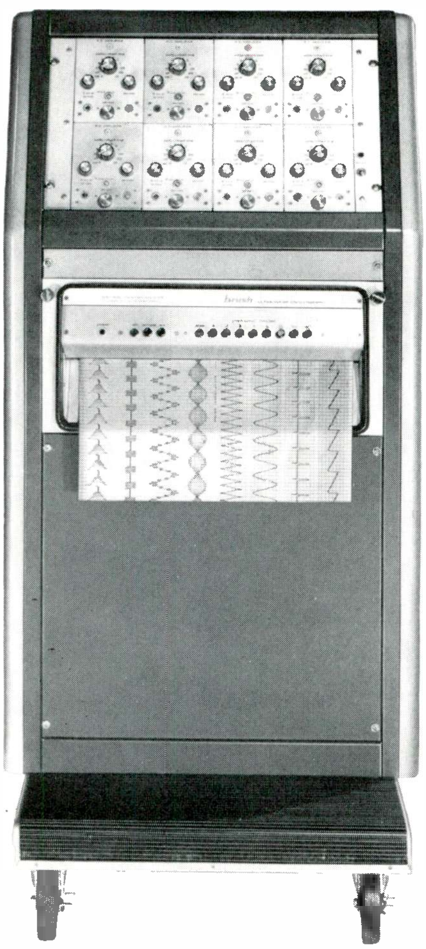

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Next month

CALENDAR OF 1960 COMING ELECTRONIC EVENTS

The number of technical conventions and symposiums occurring throughout the year continue to mount. For the busy engineer, this editorial presentation will have year-round reference value. This multi-page chart illustratively depicts engineering events, trade events, avionic events, and electronic meetings and shows.

ELECTRONIC HARDWARE—PART III

Part I of this series presented data on pins, rivets, eyelets and panel fasteners. Part II covered lock nuts, weld nuts, anchor nuts, basic clinch nuts, threaded inserts, self-locking inserts, etc. In Part III, last in the fastener group, self-locking and miscellaneous clinch nuts, screws and studs, retaining rings and washers will be described. Future issues will contain similar reference series on other items of electronic hardware.

PRINTED DIODE AND RESISTOR MATRICES

Compact matrices of low cost and high reliability are one of the most powerful building elements in data handling systems. To accomplish this, printed circuit techniques are contemplated for manufacturing these diode or resistor networks. A report on progress and state of the art.

RATE GYRO CHARACTERISTICS

With a mounting interest in rotating electronic component items, this article which narratively and mathematically discusses what rate gyros are and how they are employed will be of considerable interest.

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, Rep News, International Electronic Sources, Personals, Industry News, etc.

COMING SOON:

A NEW ELECTROMAGNETIC SPECTRUM CHART

For over a decade the publishers of Electronic Industries have periodically issued this chart which graphically depicts the frequencies throughout the electromagnetic spectrum and their uses. The last chart was issued in 1957. Now, in response to hundreds of reader requests, a completely new chart in four colors, twice as large as those previously issued, is being prepared. It will contain much new information and will be especially designed for constant use either as a wall chart or as a desk-top type reference source. The new chart will be printed and available soon. Watch for this announcement!

Watch for these coming issues

***JANUARY** Industry Review

***FEBRUARY** Space Electronic Issue

***MARCH** Annual IRE Issue

***JUNE** • 18th Annual Directory & All Reference Issue

Mathematical computations required to design a dielectric lens with broadband characteristics are quite complex. A practical design approach is described which requires a minimum of engineering time and yields a lens design that meets broadband requirements.

For Wideband Radar Antennas . . .

Design for the Dielectric Lens

By WILLIS E. JUNKER
Electronic Engineer
Convair, Div. of General Dynamics Corp.
San Diego 12, Calif.

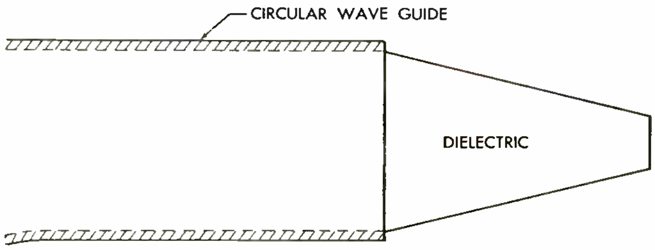

Fig. 1: A simple tapered polyrod mounted in a circular waveguide

A PRIMARY consideration in designing a feed for a radar dish is the bandwidth of frequencies over which the antenna system will operate. If the bandwidth is for a conventional system, the band of operating frequencies will be in the nature of a few percent and any one of several standard solutions is available to the engineer.

One of these solutions currently in use is a dielectric lens or polyrod as illustrated in Fig. 1. The dimensions of this type of lens are based on criteria which establish the taper and length of the dielectric portion of the feed as a function of the desired radiation pattern. The maximum and minimum rod diameters may be determined from the following empirical relationship developed by Kiely[1]:

$$d_{max} = \frac{\lambda_g}{\sqrt{\pi (\epsilon - 1)}}$$

$$d_{min} = \frac{\lambda_g}{\sqrt{2.5 \pi (\epsilon - 1)}}$$

where λ_g is the circular guide wavelength for any particular mode and ϵ is the dielectric constant. It is readily seen that the ratio of the diameters varies as the reciprocal of the square root of 2.5 and, hence, once the guide diameter is established along with the required beamwidth, the exterior dimensions of the dielectric are fixed since pattern considerations determine the length of the rod. The data for the rod length is obtained from curves in the source previously mentioned.

Ordinarily, the operational band of conventional radar is relatively narrow in contrast to the operational band required of this antenna development and the ordinary tapered rod is often entirely satisfactory. However, when a large range of frequencies is involved, there is a tendency for the radiation pattern to deteriorate toward the upper end of the band. The resulting radiation pattern from the dish, i.e., the secondary pattern, will also deteriorate. In Fig 2 an H plane pattern is shown for a simple tapered polyrod which operates out of a guide which has a nominal cutoff for the open pipe at frequency f. The vestigals, which are shown in this pattern taken at 1.5f, make their first appearance at a frequency slightly below mid-wavelength.

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The Editor
ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

As the frequency is increased, the vestigals tend to deepen and become true nulls so that at 2f the energy beyond the nulls will be 180° out of phase with the main lobe. It is interesting to note that the second nulls correspond quite closely to the first nulls of the open ended pipe at the same frequency. The source of the energy from which these first side lobes arise will be considered below.

The early appearance of the vestigals may be attributed largely to the fact that normal design parameters for the rod take into consideration the guide diameter which was not done in this case. Only the optimum ratio of the rod diameter at the metallic aperture to the diameter at the end of the rod was considered. This limitation actually arose from a system requirement which established the guide diameter. So, in order to avoid the inclusion of an additional element in the system, that is a transition from large to smaller sized guide with the characteristic VSWR increase, and also to avoid any additional complexity in the lens design, it was decided that the all-around design would be made as simple as possible and yet meet the system requirements.

Design Considerations

In considering a design of a polyrod or lens, some attention must be given to the direct radiation at the metallic aperture. The incident wave going down the guide produces a wave which travels along the guiding

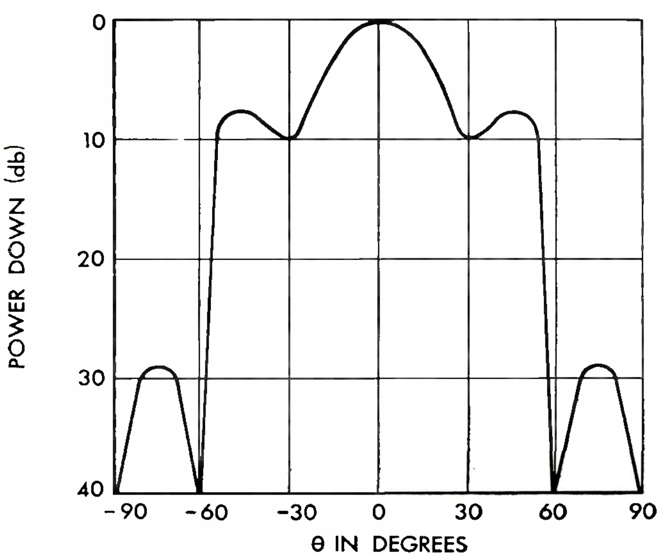


Fig. 2: H plane pattern of an ordinary tapered rod illustrating the appearance of the vestigals at 1.5 f

structure, a small reactive field at the metallic aperture, the usual reflected wave and in addition, a unique field at the metallic junction which corresponds quite closely to the field of an open pipe.[2] This field comprises a sizeable proportion of the total radiated energy and must be investigated. In our initial experiments on this phase of the design, we found that the first nulls shown coincide with the first nulls of an open pipe as mentioned previously. The question

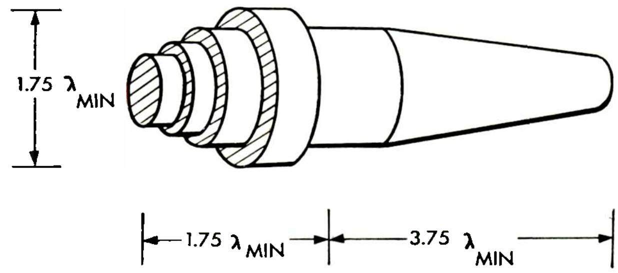


Fig. 3: Sketch of dielectric lens antenna with dimensions

then arises, why not use the open pipe if it will produce a satisfactory pattern? Of course, the answer is that the lower end of the band will be characterized by a pattern which will not provide sufficient taper. It is clear then that any polyrod must provide a phase shift for the so-called open pipe energy so that it will be in phase with the main lobe. This will eliminate the vestigals for a satisfactory radiation pattern.

Basically, there were three requirements which had to be met in the design and these were as follows:

First—a useable main lobe pattern should be obtained for a full octave of operation.

Second—the beamwidth should undergo as small a change as feasibly possible over the band.

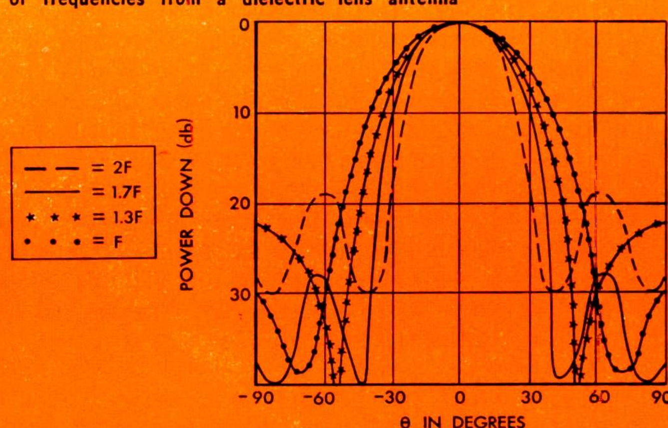
Third—the side lobe level should be down at least 15 db.

Actually, these are rather stringent requirements in a sense and an almost entirely new attitude in the design of a polyrod antenna, having the capabilities outlined above, had to be evolved. The problem presented extreme difficulties with regard to the mathematical computations which would be needed. It was decided that a strictly empirical approach would be the most practical method of handling the problem.

Basic Development Technique

The basic development technique, which was evolved from our experimentation, is straightforward. It may be carried out in a logical sequence to yield the best results in a short period of time. The first step is to choose a dielectric cylinder of approximately four free space wavelengths. This is inserted in the

Fig. 4: A family of E plane patterns for an octave of frequencies from a dielectric lens antenna



Dielectric Lens *(Concluded)*

guide to an appropriate reference point and then a pattern is cut. The rod is then shifted and patterns are cut until an optimum position with regard to the side lobe level is found. The best test point is at the maximum frequency in the band. This is true of the succeeding steps also. Choice of the maximum frequency as a reference point is based on the fact that it is at this point that the worst side lobe levels generally occur.

We used paraffin wax as our dielectric, primarily because of its flexibility in being shaped and its dielectric constant is almost equal to that of polystyrene or teflon. This greatly reduced the time required for technicians and there was a large reduction in shop time since only the deliverable product was made in the shop.

The second step is to taper the inner portion of the rod so that the termination of the taper is made in a spherical radius. Again the governing factor is the side lobe level. In addition, there appears to be a small margin of control of the main lobe beamwidth which is, from a practical standpoint, negligible. The effect of the control on the side lobe level may be explained in terms of amplitude and phase phenomena. Again the results were checked by means of the pattern recorder.

The third and final step is finding the correct combination of discs on the outer end of the rod which will yield the desired pattern. In Fig. 3 an early model is shown. It was found, and this may be utilized as a guide, that the discs of the largest diameter control the side lobe structure as well as the beamwidth. The adjacent smaller discs control almost exclusively the beamwidth of the main lobe. A further observation may be made that the relationship of all discs is one of interdependence. This effect may be noted by adding one disc at a time and cutting a comparative pattern for each addition.

Radiation Patterns

In Fig. 4 the radiation patterns are shown for the E plane of the model (Fig. 3) at the ends and two intermediate points of the band. As can easily be seen by these plots, the poorest side lobe level is 18 db at the high end of the band. These levels are more than satisfactory for most radar feed applications. Actually, these are not the best results which are obtainable in terms of side lobe level. In other types of models which had small refinements, almost the entire range of frequencies were characterized by side lobe levels which were better than 30 db down.

The patterns for the H plane are similar in structure and almost of identical beamwidth, the difference being less than 2% at the 10 db points. This symmetry makes the pattern particularly suitable for a fixed feed operating into a rotating dish, as well as the conventional type dish.

The frequency response curve shown in Fig. 5 is typical for all of the dielectric lens feeds. It should be noted that the 2.5:1 ratio at the end of the band

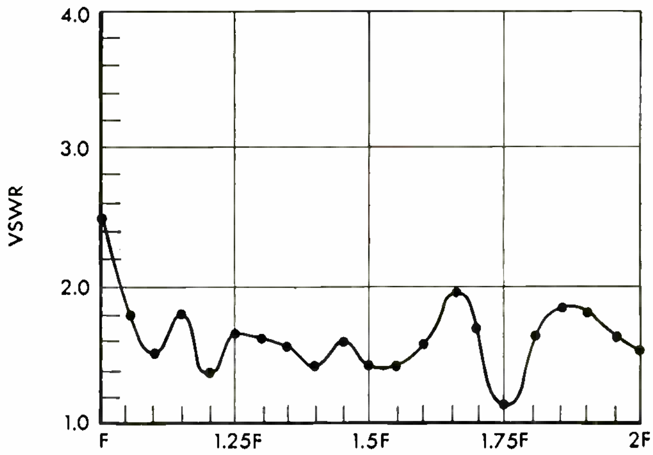


Fig. 5: Frequency response for a dielectric lens antenna

was the highest value found in any of the models. In most cases the highest VSWR was found to be 2.0:1, and this appeared at the low end of the band. It should be noted that the VSWR shown includes the effect of the waveguide to coax adapter, the transition from rectangular to circular guide, as well as the aperture impedance.

The author would like to acknowledge the assistance of Glenn L. Regnier, Convair Technician, in preparing the data for this paper.*

References

(1) Kiely—"Dielectric Aerials"
(2) Brown and Spector—"The Radiating Properties of End-Fire Aerials," Vol. 104, Part B, No. 13, IEE.

* The work described was done on Contract AF30(602)-1719 under the sponsorship of Rome Air Development Center (Procurement Agency) and Stromberg-Carlson, A Division of General Dynamics Corporation (Prime Contractor).

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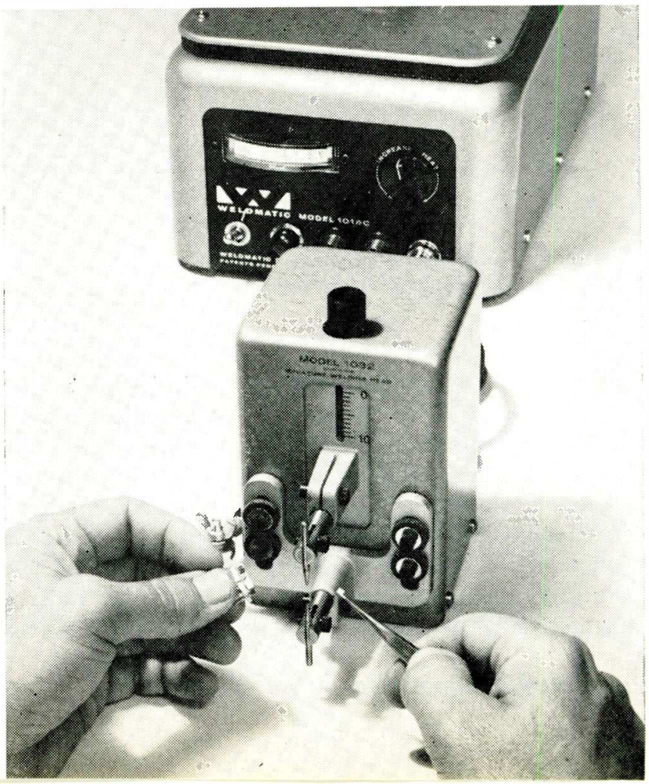


Vacuum-tube amplifiers have achieved low-noise performance comparable with solid-state devices and even masers. And they excel in bandwidth and stability. The advantages can best be seen by comparing the operation of diode amplifiers and the new electron beam devices.

Electron-Beam Parametric Amplifiers

Dr. C. B. Crumly

Dr. R. Adler

By DR. C. BURTON CRUMLY and DR. ROBERT ADLER,

Research Dept.,
Zenith Radio Corp.
Chicago 39, Ill.

SOLID-STATE microwave amplifying devices have made rapid progress in recent years. Where electron tubes reigned unchallenged only a short time ago, the maser and the varactor diode have become powerful contenders. The diode amplifier in particular has had an almost hypnotic effect: Here is a simple, tiny device capable of producing gain with extremely low noise. It does not merely replace some vacuum tubes; it does the job better than the old tubes did.

This seems a strange time for anyone to come along with a new tube. Are not tubes becoming rather old-fashioned? Are they not horse-and-buggy stuff, still useful for awhile but hardly an investment in the future?

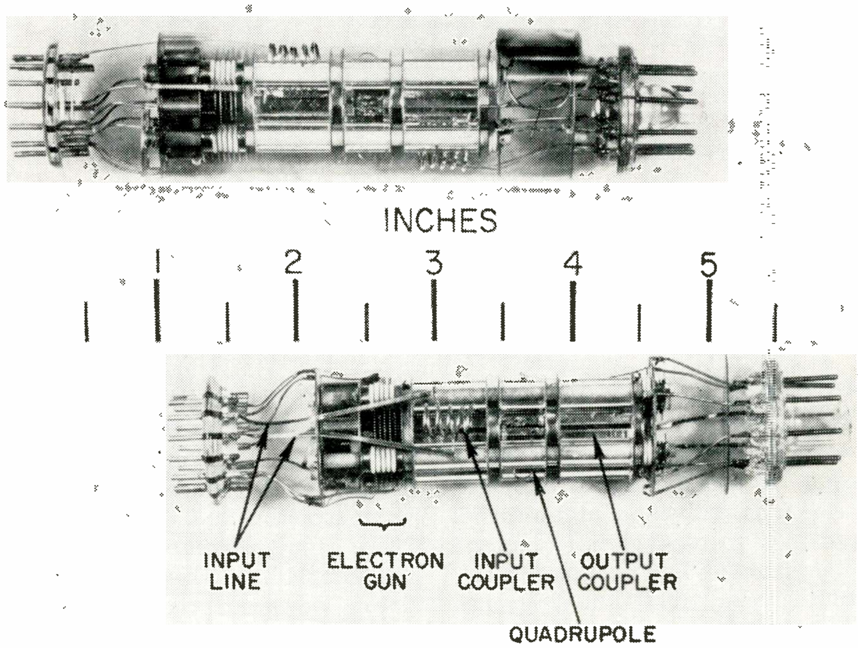
A state of hypnosis, delightful though it may be, is perhaps not the best environment for engineering decisions. Such decisions should be based on available information and on reasonable extrapolation.

In the following, a comparison is drawn between two parametric amplifying systems—the negative-resistance varactor amplifier and the fast-wave electron-beam amplifier. There are points of similarity between the two systems, but also many important differences. This comparison is illustrated in Figs. 2 and 3.

Varactor-diode Amplifiers

First a few words to describe very briefly the negative-resistance varactor amplifier which is now quite well-known. The capacity across the depletion layer of a back-biased diode is varied by the

Fig. 1: A developmental UHF quadrupole amplifier



Parametric Amplifiers

(Continued)

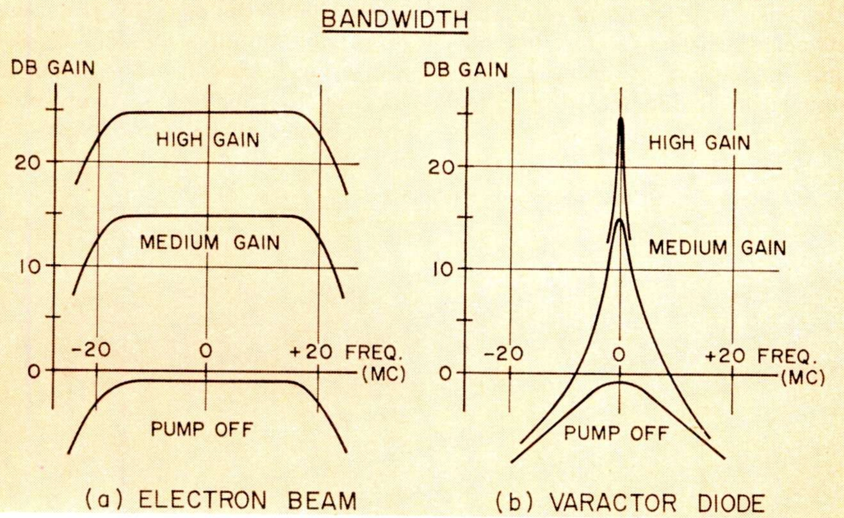
application of high-frequency power from an auxiliary microwave source called the pump. The diode forms simultaneously part of the reactance of two tuned meshes, the signal circuit and the so-called idler circuit. Pumping causes a negative conductance to appear across both circuits, provided that the pump frequency equals the sum of signal and idler frequencies. This negative conductance is proportional to pump power. It offsets a portion of source, load and circuit loss conductance, thus producing signal gain. As pump power is increased at a uniform rate, the gain rises first slowly, then more rapidly. Oscillation sets in when the negative conductance becomes numerically equal to the sum of source, load and circuit loss conductances. This situation must, of course, be avoided.

Electron Beam Amplifiers

The fast-wave electron - beam parametric amplifier is not so well-known. It uses wave-like motions of electrons, traveling at uniform speed in a focused beam, to carry signals from an input coupler to an output coupler. While the electrons are enroute between the two couplers, they pass through a non-homogeneous alternating electric field energized by an auxiliary microwave source, again called the pump. During this passage, the wave-like motion which represents the input signal grows at an exponential rate. The mechanical process by which the periodic motion of each electron grows is quite analogous to the exponential growth of the signal in a diode amplifier which occurs if the pump is suddenly turned on with substantial power.

A profound difference between this device and the lumped-circuit diode device is immediately apparent: while in the diode the negative conductance appears across a stationary circuit, in the beam device the pump field works on passing particles. Each electron stays within the pump structure just for a certain time. During this time, if the pump field is weak, the signal-induced motion which an electron brings from the input coupler may just double in amplitude; if the pump field is strong, it may grow to a hundred times its original size; but no matter how strong the pump field may be, the process can never become unstable. Each electron must eventually leave the pump structure and cannot return. There is no chance of oscillation. The simple fact that the electron stream flows one way only makes the device strictly unilateral and unconditionally stable.

Fig. 2: Passband characteristics of electron beam and varactor-diode amplifiers at three gain levels. Electron-beam tube passband is seen to be independent of gain.



Operating Principles

Let us now proceed with the description. Similar to a metallic transmission line, an electron stream can carry signals of any frequency in the form of wave-like patterns. A metallic transmission line can carry waves in either direction, and normally these two waves travel at equal velocities. But if a low-velocity line were placed on a fast-moving train, the two velocities would appear different to a stationary observer; if the train moved fast enough, the backward wave might even be turned forward, thus becoming a slow forward wave while the other one would be a fast forward wave. Similarly, a stream of rapidly moving electrons can carry signals in the form of either a slow or a fast wave motion.

It turns out that the fast wave can be coupled into the stream and out of it just as if the stream were a metallic transmission line. (The same is not true for the slow wave but this does not concern us here.) Thus we can put an input signal from a coupler onto the stream and let the stream carry the signal power away. This power can later be taken off the stream by a second similar coupler. The input coupler, while impressing the desired signal upon the stream, must of necessity strip off any signal which was there before. We note that each coupler acts like a three-port circulator, as illustrated in Fig. 4. This non-reciprocal behavior is a dividend which again results from the one-way motion of the stream.

Normally, random motion of the electrons has a component at the signal frequency which represents noise. This noise is stripped off by the input coupler. No beam noise is passed on to the output, and an amplifier of this type should add no noise to the signal.

The electron beam impartially carries wave patterns corresponding to any signal frequency. Passage through the pump structure augments all electron motions regardless of the signal frequency pattern they represent. Thus the bandwidth of this amplifier is simply the bandwidth of its couplers. This may be very wide. It is quite independent of gain.

Because of the circulator-like action of input and output coupler,

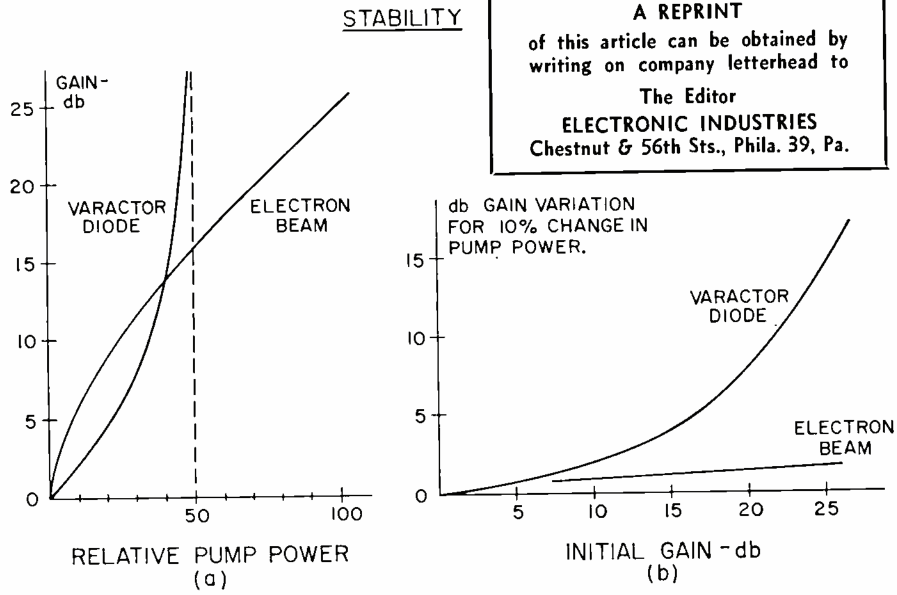


Fig. 3: Stability vs. changes in pump power. (A) shows where the diode amplifier becomes unstable and oscillates; there is no such point for the electron-beam amplifier. (B) shows that for 10% change in pump power the electron-beam tube is superior at all levels.

these couplers present to antenna and mixer unvarying impedances, substantially resistive across the signal frequency band. Turning the pump on or off does not affect these impedances at all.

It is desirable to have reasonably good match at the input—VSWR of 1.5 or better—for best noise figure. Output match is unimportant. Mismatch at either end has no effect on gain or stability. This contrasts sharply with the critical behavior of varactor diode amplifiers, where minor changes of source or load impedance produce large gain fluctuations and may even cause the circuit to break into oscillation.

Present Tubes

Successful electron-beam parametric amplifiers are based on transverse orbital motion of an electron stream which travels forward parallel to the flux lines of a homogeneous magnetic field. This field is so adjusted that the cyclotron frequency coincides with the center of the signal frequency band (350 gauss per Kmc). The signal couplers are pairs of closely-spaced deflection electrodes. The pump structure is a quadrupole arrangement, shown in cross section in Fig. 5. A complete tube is shown in Fig. 1.

Developmental tubes of this type have been available for about one year. They operate with voltages and currents characteristic of small receiving tubes, with low cathode loading, and their life expectancy should be many thousands of hours. Their couplers are tuned internally to center frequencies of 400-900 MC, with a bandwidth of about 40 MC. The pump frequency is usually set within a few mc of the double center frequency. Pump power required for 20 db gain is of the order of 50 mW; doubling this power increases the gain to about 30 db.

The noise figure of these developmental tubes, measured with conventional broadband noise sources, is normally between 1.2 and 1.7 db, corresponding to an excess noise temperature of 80 to 130°K. These figures include input circuit losses of about .5 db.

Recently a noise figure of only .6 db (corresponding to 40°K) has been achieved with a new electron gun. Input circuit loss accounts for most of this figure, indicating that beam noise has been reduced to just a few degrees Kelvin.

Tubes for the 1300 MC band are now working in the laboratory. Tubes for much higher frequencies up to 10 KMC are in various stages of planning. Analysis shows that the 40 MC bandwidth of present tubes can be tripled at center frequencies below 1300 MC; at higher frequencies, bandwidths of 10% should be obtainable.

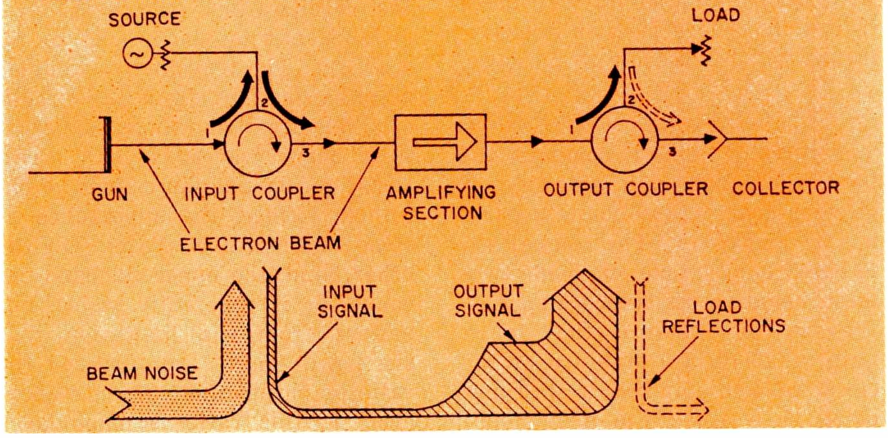
Idler Effects

In every parametric amplifier, an idler appears as an unavoidable by-product. Usually this is the difference between pump and signal frequency. In the electron-beam device described above, pump frequency is close to twice the signal frequency; therefore the idler frequency falls near the signal frequency and into the signal frequency band. Amplified output appears at idler and signal frequencies. Perhaps more important, spurious signals or noise entering at the idler frequency are also amplified and converted to signal frequency output.

In many cases this does no harm: in radar or communication systems where synchronous detection is used, the pump oscillator may also be synchronized so as to make signal and idler cooperate. In radio astronomy and radiometry, on the other hand, the desired signal is of the nature of broadband noise, so that signal and idler outputs can combine additively.

But there are many systems in

Fig. 4: The electron-beam parametric amplifier operates as if it contained two internal circulators. The input coupler impresses the signal on the beam, simultaneously removes the noise from the beam. No noise or signal from the load can reach the input.



Parametric Amplifiers

(Concluded)

which the appearance of an idler near the signal would cause confusion. In such cases the pump frequency is shifted so as to place the idler 10, 20 or 30 MC away from the signal. If the antenna looks at the sky, the noise it picks up on the idler channel is usually small; this causes only a moderate impairment of the single-channel noise figure. Only in systems where the antenna looks at the ground, or where an input filter is used to separate the idler channel and terminate it at room temperature, the effective single-channel noise figure increases by 3 db.

Varactor-diode amplifiers are usually pumped by a 10 KMC source. Hence, if the signal frequency is much less than 5 KMC, the idler frequency becomes much higher than the signal frequency. It has been shown that this leads to a substantial reduction of idler noise. Can a similar method be used with electron beams?

It can indeed. The structure of either the couplers or the pump section must be changed. Work along these lines is now in progress. Experimental amplifiers have operated with a pump frequency equal to about five times the signal frequency.

It should be quite evident that the development of electron-beam parametric amplifiers has only begun. Higher frequencies and wider bands are on the way. For applications where the idler frequency is harmful, it will be removed. Noise temperature, very low even now, seems well on its way down to a point where further improvements will be difficult to measure.

Comparison

Figures 2 and 3 compare the bandwidth and gain stability of electron-beam and solid-state parametric amplifiers. The comparison is based on a simple one-diode two-mesh negative resistance amplifier. We see, for instance, that for a gain of 20 db the stability of the electron-beam amplifier is six times better than that of the diode amplifier, and its bandwidth twenty times greater. Thus, the electron-beam device will give superior performance in the many applications where gain stability and bandwidth are important.

Efforts to improve the bandwidth and stability of solid-state amplifiers have proceeded along three lines: 1) by the use of circuit broadbanding techniques, in which multiple-mesh circuits are used with a single diode (Seidel, Herrmann, Closson, BTL; Lombardo, Sard, AIL); 2) by the use of traveling-wave circuits with many diodes, each of which is required to supply only a little gain (Englebrecht, BTL; Wade, Bell, Stanford); and 3) by utilizing only the sum-frequency mode of operation, the "upper-sideband up-converter," thus avoiding negative-resistance effects altogether.

While these methods have had varying degrees of success, they also have their limitations, and the solid-state panacea has not yet emerged. Circuit broadbanding techniques, while making possible a substantial increase in the gain-bandwidth product attainable with a single diode, have not eliminated the regeneration and negative-resistance effects which lead to instability. The traveling-wave diode amplifier suffers from the practical difficulty that the transmission lines carry waves in both directions, and large gain cannot be obtained without the appearance of some regenerative effects. On the other hand, the upper-sideband up-converter is inherently stable, but suffers from the limitation that the power gain cannot exceed the ratio of output and input frequencies. If this ratio is made large enough, the signal frequency is limited to the UHF and low microwave bands, by the requirements for a low-noise high-frequency postamplifier and for a high-frequency pump. Furthermore, it becomes increasingly difficult to suppress the lower sideband and its regenerative effects.

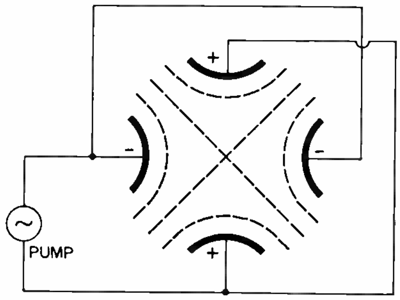


Fig. 5: Quadrupole pumping structure, supplied by group source at twice the cyclotron frequency, produces field component rotating at the cyclotron frequency, expanding the signal induced motion, and amplifying.

Conclusion

Considering the large number of engineers who have worked on the varactor-diode amplifier in recent years, compared to the tiny groups in three or four laboratories who developed electron-beam parametric devices, one might well expect that the performance of the varactor diode should have left its electron-beam counterpart far behind. Yet —it's a draw on noise temperature; the diode is far behind the electron tube in gain, bandwidth and stability, and it seems that at higher frequencies this gap is more likely to grow than to shrink. What is the underlying reason?

It is simply that no substitute has yet been found for the most fundamental property of electrons in a beam: their rapid, uniform, unidirectional motion.

References

1. J. M. Manley and H. E. Rowe, "Some general properties of nonlinear elements—Part I. General energy relations," *Proc. IRE*, vol. 44, pp. 904-913; July, 1956.

1a. C. L. Cuccia, "The Electron Coupler," *RCA Review*, vol. 10, pp. 270-303, June 1949.

2. P. K. Tien and H. Suhl, "A traveling-wave ferromagnetic amplifier," *Proc. IRE*, vol. 46, pp. 700-706; April, 1958.

3. H. E. Rowe, "Some general properties of nonlinear elements—Part II. Small signal theory," *Proc. IRE*, vol. 46, pp. 850-860; May, 1958.

4. A. Uhlir, Jr., "The potential of semiconductor diodes in high-frequency communications," *Proc. IRE*, vol. 46, pp. 1099-1116; June, 1958.

5. R. Adler, "Parametric amplification of the fast electron wave," *Proc. IRE*, vol. 46, pp. 1300-1301; June, 1958.

6. D. Leenov, "Gain and noise figure of a variable-capacitance up-converter," *Bell System Tech. J.*, vol. 37, pp. 989-1008; July, 1958.

7. R. S. Englebrecht, "A low-noise nonlinear reactance traveling-wave amplifier," *Proc. IRE*, vol. 46, p. 1655; September, 1958.

8. R. Adler, G. Hrbek, G. Wade, "A low-noise electron-beam parametric amplifier," *Proc. IRE*, vol. 46, pp. 1756-1757; October, 1958.

9. H. T. Closson, G. F. Herrmann, H. Seidel and L. B. Wetzel "Optimum circuits for parametric amplification," paper presented at Conference on Electron-Tube Research," Mexico, D. F.; June, 1959.

10. C. V. Bell and G. Wade, "Circuit considerations in traveling-wave parametric amplifiers," *1959 IRE WESCON Convention Record*, Part 2 — Circuit Theory, pp. 75-82; August, 1959.

11. H. Seidel and G. F. Herrmann, "Circuit aspects of parametric amplifiers," *1959 IRE WESCON Convention Record*, Part 2—Circuit Theory, pp. 83-90; August, 1959.

12. R. Adler, G. Hrbek, G. Wade, "The quadrupole amplifier, a low-noise parametric device," *Proc. IRE*, vol. 47, pp. 1713-1723; October, 1959.

A conventional reflex klystron, originally designed for an oscillator, is used as a positive gain detector for weak signals. The operating principle is introduced and experimental results given.

Detector Uses Reflex Klystron

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THE schematic diagram of an experimental reflex klystron detector is shown in Fig. 1.

Tube 723 A/B is mounted on a conventional tube mount.

The incident wave, amplitude modulated with a square wave of 1000 CPS, is introduced into the cavity resonator of the reflex klystron through three screw matching tuners and the coaxial cable.

Principle

The repeller of the reflex klystron is connected to the cathode and dc potential of the repeller is equal to the cathode. Therefore, if no microwave signal exists on the grid, electrons can reach the repeller.

But, if the cavity resonator is excited by resonant frequency signals, then, electrons receive velocity modulation and two groups of electrons, one accelerated the other decelerated, can be formed.

The accelerated group of electrons can reach the repeller and give the detected output signal to the repeller. The decelerated group can not reach the repeller and goes back to the grid.

If the phase of the microwave signal on the grid is properly adjusted so that the grid can take the energy from the returning group of electrons, then the microwave signal is amplified by the regenerative action of the electron beam. It is the same mechanism as the conventional case of building up oscillation.

The amplified signal can accelerate the "accelerated group" more, and a large detected output can be obtained. The returning "decelerated group" of electrons behaves just like regenerative amplification or ordinary oscillation.[1, 2]

Then, the optimum anode voltage which gives the optimum gain can be calculated from the reflex klystron theory equations.

DR. KORYU ISHII was affiliated with the Dept. of Electrical Engineering, Univ. of Wisconsin, when this article was prepared.

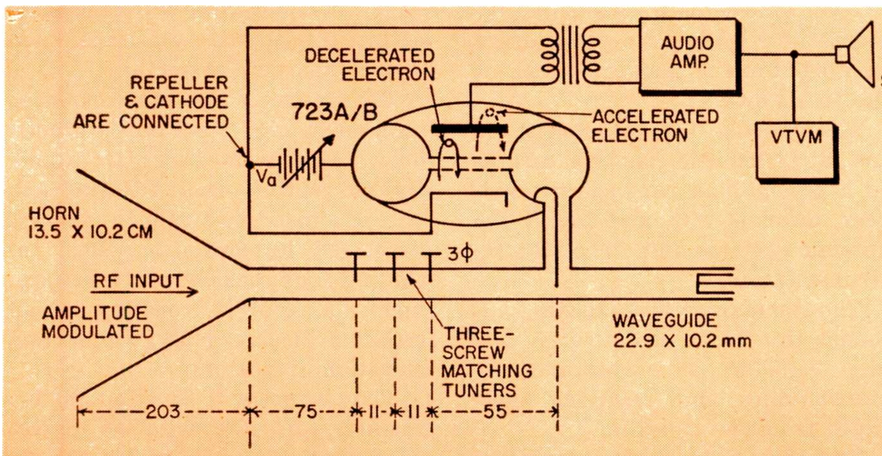
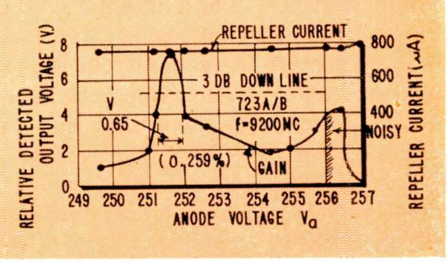


Fig. 1 (left): Schematic diagram of experimental detector of reflex klystron.

Fig. 2 (below): The characteristic of gain vs. anode voltage for this detector.



Regenerative Detector *(Continued)*

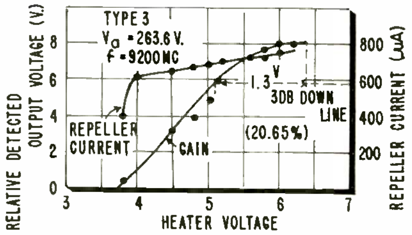


Fig 3: The gain is not as critical for the heater voltage as for anode voltage.

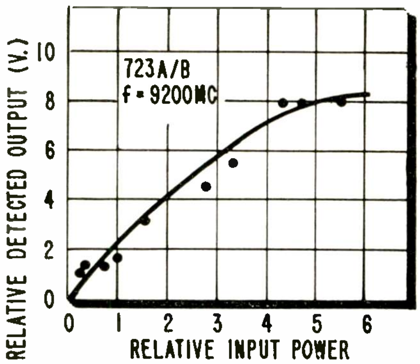


Fig. 4a: Linearity of the detector described in this article.

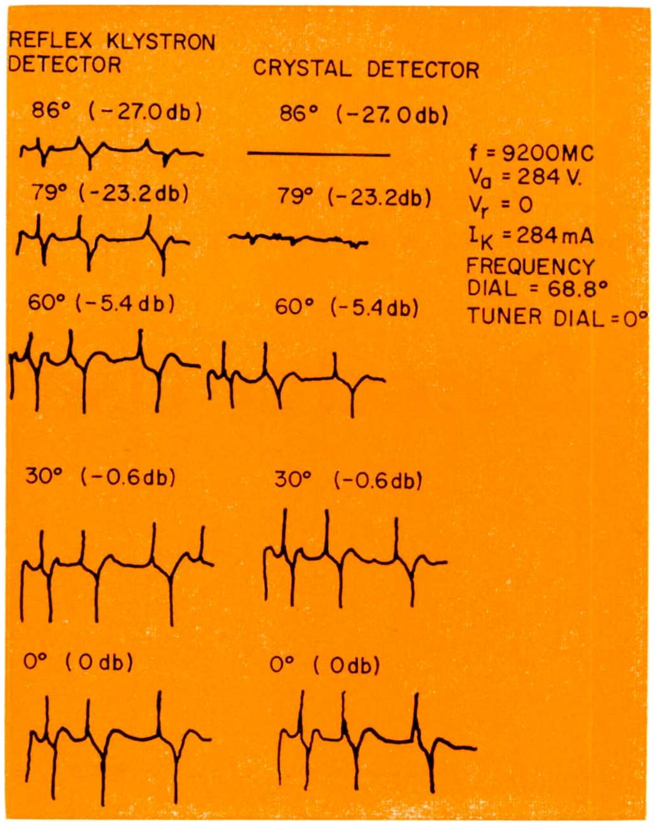


Fig. 4b: Observed waveform through differential amplifier.

Table 1

Peaking Anode Voltage

Drift Cycle N	Calculated Va	Measured Va
11¾	329	300
12¾	279	275
13¾	240	255
14¾	209	205
15¾	183	182
16¾	162	172
17¾	143.9	140
18¾	129.6	124
19¾	116.5	116

Table 1 shows the calculated optimum and measured voltage values. Calculated and Experimental results agree with each other.

Gain and Stability

Fig. 2 shows a characteristic of gain vs. anode voltage for this detector. Gain is rather critical for anode voltage in this case. But if a cutoff type variable reactor[1] is employed at the opposite side of the tube's coaxial output, effectively extending the center conductor, then, 2.17% of the anode voltage regulation, which keeps gain variation within 3 db, can be obtained.

Tracking Antennas for Courier

A new network of communications-tracking antennas will be utilized by the communications satellite *Project Courier* of the Advanced Research Projects Agency (ARPA). Up to 6 million bits of information will be transmitted within 4 min. between satellite and ground stations. The parabolic antennas will simultaneously transmit and receive messages from the orbiting 500 lb. communications satellite, similar to the system successfully used for ARPA's *Project Score*, the "talking satellite" provided by the Army Signal Corps late in 1958.

Purpose of the experimental *Project Courier* is to develop a prototype of a global communications network for the Armed Forces of the free world.

The Florida Div. of Radiation, Inc., at Melbourne, has been awarded a $1.3-million contract to engineer, develop, test, and install the antenna systems and associated instrumentation.

The communications-tracking antennas are 28 ft in diameter, and are capable of simultaneously transmitting and receiving messages from the satellite.

Two presently contemplated locations for *Project Courier* antennas are Hawaii and Puerto Rico. The antennas are scheduled for an early delivery date set by the Army. The network will be capable of integration with existing global communications systems.

The antennas are each mounted on a 40-ft. high steel pedestal built on a 20-ft. by 20-ft. concrete pad. Housed within each pedestal will be an instrumentation complex, developed by Radiation, Inc., including four racks of control equipment, a control console, signal tracking display, plus azimuth and elevation indicators.

The system will function in this fashion: As the satellite passes over Station A, it is "acquired"

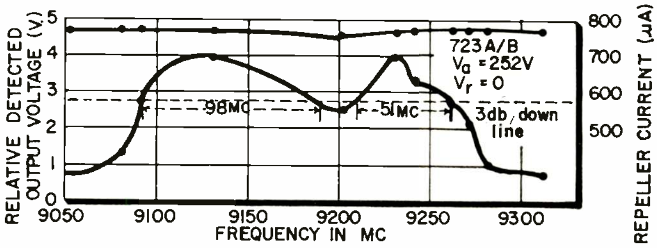


Fig. 5: Frequency characteristic curve; input frequency only varied.

Fig. 3 is a plot of gain vs. heater voltage. For heater voltage, the gain is not as critical. Detector gain is dependent upon the incident signal level. For small signals, the gain of this reflex klystron detector is 10-30 db above a matched crystal detector.

Linearity

Fig. 4 shows linearity of this detector. For large signals, the gain is saturated. At this saturated level, the gain above the matched crystal mount is almost 0 db or below. But for small signals, the gain is 10-30 db above the crystal detector.

Frequency Characteristics

Frequency characteristics of this detector are shown in Fig. 5. All conditions of the detector circuit were fixed during this measurement, and only the input frequency was varied. Detected output voltage was plotted.

Frequency band width of 3db down of the gain was more than 50 MC.

Ease of Adjustment

Gain of this detector is controlled by adjustment of the anode voltage, screw tuners, frequency screw of the cavity resonator of the reflex klystron, and the piston plunger of the waveguide. These are not so critical; hand adjustment is satisfactory. No complex mechanical fine adjustment system is necessary.

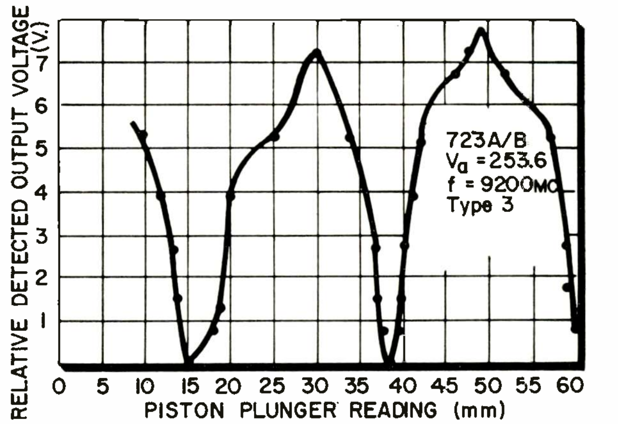


Fig. 6: Adjustability of piston plunger; hand adjustment suffices.

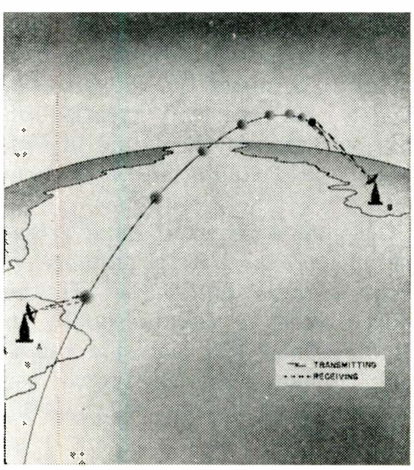
This regenerative detector is very highly sensitive to small signals, compared with conventional crystal detectors. Being different from the superregenerative type, no quenching circuit is needed. It is electrically and mechanically stronger than conventional semiconductor crystal detector.

The author wishes to acknowledge the helpful discussions with Dr. Mito of Osaka City University, Dr. Yokochi, Dr. Owaki, and Dr. Nakamura of Nihon University, Japan, and Mr. Mine's experimental assistance.

Reference

1. Koryu Ishii: "X—Band Receiving Amplifier." *Electronics*. April, 1955, p. 202.
2. Koryu Ishii: Japanese Patent No. 24710.
* Koryu Ishii: Japanese Patent Pending No. 25439 (Sho 30).

The communications-tracking system for Project Courier will transmit and record 6-million bits of information in 4 minutes.



and a microwave communications link is established. Station A then commands a "readout" of information on storage tape A in the satellite. This information is recorded and processed by the ground complex.

In addition, a second "command" is transmitted from the ground to the satellite. Station A broadcasts the information destined for Station B to the B tape, and then for Station C to the C tape. The over-all process is repeated at the other two ground stations during subsequent satellite passes and information is readily exchanged among the stations.

The system is designed to provide 20 continuously available 100-word-a-minute teletype channels to repeat messages transmitted between ground stations.

The servo system includes provision for fast, accurate control of the antenna in local, remote, and automatic tracking modes, and for "coasting" at a memorized rate when a temporary signal loss occurs. Provision is included for slaving other equipment to the antenna. Sector scan is provided in either remote or local modes of operation, and secant correction is supplied for near-zenith tracking. High tracking velocities, accelerations, and positional accuracies are possible.

The problems associated with the computation of radar detection range have not yet been completely solved, but relatively simple methods do exist for predicting these ranges that are comparable with experimental accuracy, in most cases. The application of these methods to an airborne intercept radar is described here.

Predicting Radar Detection Range

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IN radar detection, knowledge of the presence of a target is acquired by the transmission of electromagnetic energy and the subsequent examination of the reflected energy (echo). Detection of a target is considered to be accomplished when the operator identifies a return signal as a target; the range at which this occurs is the detection range.

Since the location of the target is seldom known accurately, it is necessary to locate the target as a part of the detection process. AI radar sets are usually equipped with an automatic scan pattern which continuously searches a preset solid angle, with an aircraft target appearing essentially as a point within this pattern. As the interceptor and the target close in range, a burst of return pulses is received as the pattern scans past the target, a second burst of pulses is received on the next scan, and so forth until detection is accomplished.

A block diagram of a typical airborne radar system is shown in Fig. 1. In its simplest form, the major elements are a transmitting system, a receiving system, and an output system.

Radar Range Problem

The phrase "detection range of a radar" is not self-sufficient. Fundamentally, there exists no such simple entity, i.e., a range for which detection always occurs and beyond which targets cannot be detected. A probabilistic statement is necessary to define adequately radar performance, as "the range for 50% cumulative probability of detection." Further, each tactical situation, each target characteristic, each closing rate, etc., must be treated separately i.e., a different characteristic detection capability must be given to each combination of parameters.

This necessary association of a probability with range arises from the unavoidable presence of noise in the receiving system. An observer can never be certain whether a given signal is the desired signal. The measure of his certainty is the probability that a signal identified as a target really is a target. This leads naturally to the definition of the single-look probability of detection.

Actually, because of the high closing rates encountered in aircraft problems, the cumulative probability of detection, which is derived simply from the single-look probability of detection, is of more immediate interest, although interesting and useful information can often be obtained from the latter.

Method of Visibility Factor

Radar Range Equation

Some minimum signal power is required for detection. System noise prevents the detection of arbitrarily small signals. It is necessary to obtain an expression for the signal power return from a target in terms of the range to the target. An excellent treatise on this problem may be found in Vol. I of the MIT Radiation Laboratory Series.

Consider a target of radar cross-sectional area σ at a distance R from a radiating source. If the source were to radiate equally in all directions (an isotropic radiator), the power density (power per unit area) at the target would be simply

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 a standard three-hole-punch without obliterating any of the text. They can then be filed in standard three-hole notebooks or folders.

$$p = \frac{P_T}{4 \pi R^2} \qquad (1)$$

where P_T = total radiated power. In general, AI radars are equipped with parabolic reflectors which distribute the power anistropically. Defining the gain, G, of a parabolic reflector in terms of the power density of an isotropic radiator, the power density at the target is

$$p = \frac{P_T \, G_T \, (\theta)}{4 \pi R^2} \qquad (2)$$

where G_T is the gain of the transmitting antenna, and θ is the angle subtended by the target in the gain pattern. The impinging power is scattered from the target in all directions, so that the power density at the receiving antenna is

$$p = \left(\frac{P_T \, G_T}{4 \pi R^2} \right) \left(\frac{\sigma}{4 \pi R^2} \right) \qquad (3)$$

By the same reasoning, using the standard relation for the effective receiving aperture of an antenna, the signal power at the antenna is

$$S = \frac{P_T \, G_T \, G_R \, \lambda^2 \, \sigma}{(4 \pi)^3 \, R^4} \qquad (4)$$

If S is now set equal to the minimum detectable signal, an equation for the maximum detection range is obtained.

$$R^4_{max} = \frac{P_T \, \lambda^2 \, G_T \, G_R \, \sigma}{(4 \pi)^3 \, S_{min}} \qquad (5)$$

To use this equation, some criterion to determine the value of S_{min} must be established. An oft-used one is to require S_{min} to be equal to the root-mean-square noise power in the system. In this case, a signal is considered to be detectable when its value is greater than rms noise and undetectable when it is less than rms noise. The rms noise power can be written (assuming a rectangular i-f passband) as

$$N = \overline{NF} \, k \, T \, \beta \qquad (6)$$

where

$\overline{NF}$ = overall system noise figure
k = Boltzmann's constant
T = absolute temperature
β = intermediate-frequency bandwidth

Setting S_{min} equal to rms noise,

$$R^4_{max} = \frac{P_T \, \lambda^2 \, G_T \, G_R \, \sigma}{(4 \pi)^3 \, \overline{NF} \, k \, T \, \beta} \qquad (7)$$

This equation is widely known as the "radar range equation."

Visibility Factor

Equation (7) is much too simple to account for such a complex phenomenon, although the concept of a minimum signal is obviously a correct one.

Correcting Eq. (7) to include a factor to take into account the variation from simple theory gives an equation of the form

$$R = \left[\frac{P_T \, \lambda^2 \, G_T \, G_R \, \sigma}{(4 \pi)^3 \, \overline{NF} \, k \, T \, \beta} \cdot \frac{1}{V} \right]^{1/4} \qquad (8)$$

where V is the "visibility factor" or the minimum detectable signal referred to rms noise, and R is no longer the maximum detection range, but is expressed in terms of a probability.

The researches of Payne-Scott, Haeff, Lawson, Ashby, et al. during the mid-1940's showed that V was generally a function of the pulse repetition frequency and pulse-length of the radar. This dependance is not obvious in Eq. (7). Marcum and Goldman separately, and at approximately the same time in 1947, developed a statistical theory of target detection by pulsed radar. The results of these studies generally substantiated the above-mentioned researches. This statistical theory is described below.

As seen from Eq. (8), the use of the visibility factor implies the solution of the radar range equation for the range at a given probability of detection. This constitutes one of the two basically different approaches to the radar range problem. Eq. (8) is discussed below in sufficient detail to permit making a sample calculation. First, the significance of each term appearing in Eq. (8) is examined.

P_T was defined earlier as the total radiated power. Since the discussion is restricted to pulsed systems, P_T must be taken as the peak pulse power. The pulse is never exactly rectangular, and a question arises as to the proper value of P_T to be used. Usually, the average peak power, defined as

$$\overline{P_T} = \frac{1}{\tau} \int_{-\tau/2}^{\tau/2} P(t) \, dt \qquad (9)$$

where τ is the pulselength, is sufficiently accurate. Note that to use Eq. (8) as written, the losses in transmission must be subtracted from the magnetron output peak power.

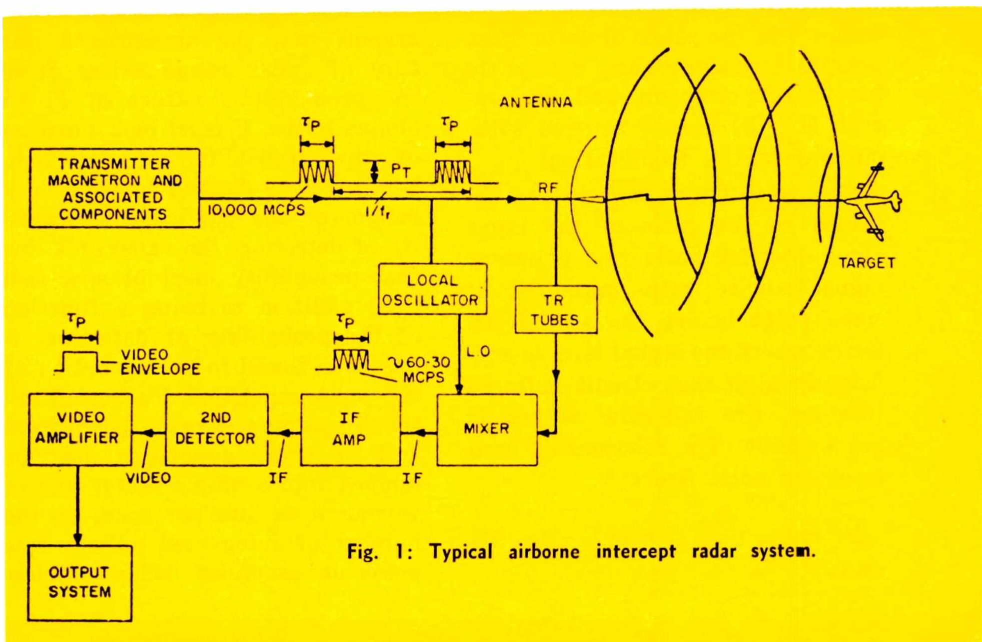


Fig. 1: Typical airborne intercept radar system.

The wavelength needs no discussion, except that it is often helpful to keep in mind that the wavelength is inversely proportional to the frequency, where the proportionality constant is the speed of light.

If antenna gain, G, is not known immediately, it can be determined approximately from the expression for the gain of a parabolic antenna

$$G \cong k_1 \frac{4 \pi A}{\lambda^2} \; ; \; k_1 \sim 0.5 \qquad (10)$$

Detection Range

(continued)

Target radar cross section, σ, is probably the most difficult to determine of all the quantities appearing in Eq. (8). Usually, the results required can tolerate a considerable error in σ. However, if for some reason extremely accurate results are desired, it is usually found that data are either contradictory or not available. In addition, σ depends strongly upon aspect—a small change in aspect often causing a change in σ of 10 to 1. If aspect changes randomly, as in aircraft targets, σ can only be expressed in terms of a probability density. This generally takes the form of an exponential density

$$\omega(\sigma, \bar{\sigma}) = \exp - (\sigma/\bar{\sigma}) \qquad (11)$$

where $\bar{\sigma}$ is the mean cross section. Special techniques are needed to handle this problem, and, in general, Eq. (8) cannot be used without substantial modification.

The noise figure, $\overline{NF}$, can be obtained as the ratio of the input signal-to-noise ratio to the output signal-to-noise ratio measured at some point before the second detector where the signal level is sufficiently high that circuit noise in this and the following stages is not a factor. The relationship used to obtain noise figure is

$$\overline{NF} = L_{RF}\left(\frac{1}{g}\right)(N_{IF} + T - 1) \qquad (12)$$

where

L_{RF} = r-f signal-to-noise loss
g = converter gain
N_{IF} = i-f receiver noise figure
T = converter noise temperature

Note that r-f losses in reception are included in this factor. The temperature, T, is usually taken arbitrarily to be room temperature (290 to 300°K). Boltzman's constant, k, has the value 1.38×10^{-23} watts per °K per cycle, giving kT as 4.0×10^{-21} watts per cycle. Intermediate-frequency bandwidth, β, is usually quoted as the bandwidth of the intermediate-frequency amplifier between 3-db (half-power) points.

Because of the presence of noise in the system, R, must be a statistical variable. An examination of the other quantities in Eq. (8), shows that each term, with the exception of V and possibly σ, has associated with it a unity probability, i.e., this particular value is sure to occur.

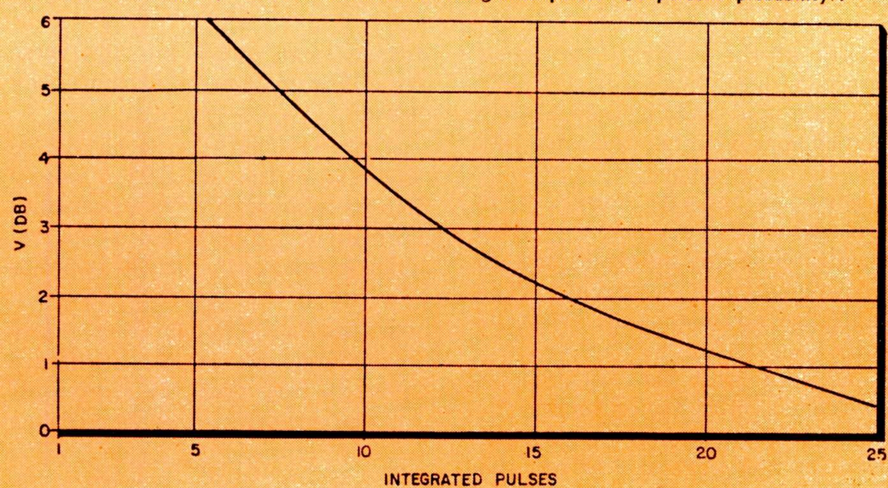
Setting σ aside for the moment, assume that the probabilistic nature of radar range arises from the probabilistic nature of V. In simple terms, V must be a function of the probability of detection. Thus, if it is desired to compute a range for any particular probability of detection, the value of V for that probability must be specified.

In addition to being a function of the probability of detection, V has been found to be a function of the pulse repetition frequency, antenna scanning velocity, beamshape (all of these quantities may be lumped into a single factor known variously as hits per scan, or the number of integrated pulses; this point is amplified below) pulselength, and intermediate-frequency bandwidth. The dependence of V upon hits per scan enters through the process known as integration.

From a study of random functions, it can be shown that if signal addition is present in the detection system, the signal is generally increased over the noise. This is the well-known process of signal-to-noise ratio enhancement by integration. Simply speaking, this is taking advantage of the coherence of the signal in time, as opposed to the randomness of noise. This dependence has approximately a power law characteristic, V being inversely proportional to the square root of hits per scan for a large number of hits per scan and inversely proportional to hits per scan for a small number of hits per scan. The exact value of V, of course, depends upon the probability of detection.

A sample visibility factor curve is shown in Fig. 2. The ordinate gives the visibility factor, V, as a function of the number of pulses integrated, n, in db referred to rms noise, for a probability of detection of 50%. This curve may be interpreted physically as giving the minimum signal-to-rms-noise ratio required so that 50% of the signals presented will be identified as targets. It should be emphasized that the value of this curve may shift considerably for display systems with large parametric deviations from the system used in this experiment. Visibility factor curves should be redetermined when major system design differences are contemplated.

Fig. 2: Visibility factor as function of integrated pulses (50-percent probability).



The dependence of V upon pulselength and i-f bandwidth enters through the dependence of signal-noise ratio upon pulselength-bandwidth match. It is a basic result in signal analysis that the maximum signal-to-noise ratio for a pulse passing through an intermediate-frequency amplifier is obtained if the pulse shape and the amplifier passband are related as a fourier transform pair. For a rectangular pulse and the usual intermediate - frequency amplifier passband characteristic, this reduces to a requirement that the product of the pulselength, τ, and the half-power, intermediate-frequency bandwidth, β, be approxi-

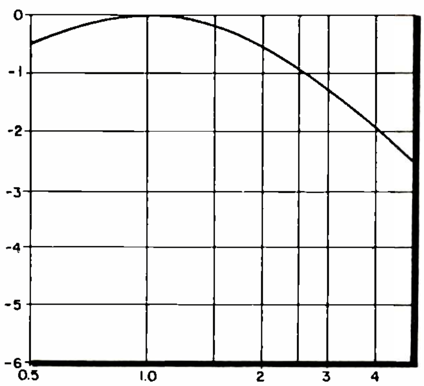


Fig. 3: Signal - to - noise ratio relative to that obtained at Br — 1.2 vs Br.

mately unity. For pulselength-bandwidth products other than unity, the effective signal-to-noise ratio out of the intermediate-frequency amplifier is reduced. This reduction in signal-to-noise ratio as a function of $\tau \beta$ is shown in Fig. 3 and is taken as an increase in the visibility factor over its value when pulselength and bandwidth are matched.

The curve of visibility factor as a function of n then represents a cross section of the surface of V as a function on n and $B\tau$, where the cut is made at $B\tau$ equal to 1.2. To determine the proper value of V, this curve is entered at n, followed to the point represented by the coordinates n and $B\tau$, and this factor is inserted into the radar range equation to obtain the desired range.

No previous mention has been made of the effect of the quasi-continuous or possibly discrete appearance in time of the target caused by the combination of range-closing and scan pattern. This enters into the detection process in two independent ways. The most obvious way is by altering the number of pulses available for integration. As stated in the basic problem, a burst of pulses of signal strength S_1 is received at range R_1, a second burst of pulses of signal strength S_2 is received at range R_1-ΔR, and so on. The number of pulses received, n, is determined by the geometrical characteristics of the scan pattern, whereas the quantity ΔR, the change in range between "looks," is determined by a combination of the scan pattern characteristics and the closing rate.

The determination of n for the types of patterns used in AI radar is seldom simple, and at least 3 separate approaches have been used to compute this number. An approximation to n that is sufficiently accurate for some calculations is obtained by using the expression for the number of pulses received for a linearly scanning beam, which is simply obtained as

$$n = \frac{\theta}{V} \cdot f_r \qquad (13)$$

where

θ = beamwidth

V = linear velocity of beam

f_r = pulse repetition frequency

This relationship is then modified by inserting a constant, as shown below.

$$n = k\frac{\theta}{V} \cdot f_r \qquad (14)$$

where $k = 0.3$ is a typical value for a Palmer scan.

The simplest method that is at all rigorous is to compute an average power gain for the pattern, replace G in Eq. (8) by this term, assume that the beamwidth of the pattern extends to the half-power points of this average power gain, and compute n as for a uniform, linearly scanning beam. A second method is to compute the actual number of pulses received from a target, weight each pulse by the normalized two-way power gain for that pulse, and sum these weighted pulses to give n. The justification for this approach is found in the statistical theory underlying these calculations, since it is shown there that the quantity which determines the probability of detection is the product of this weighted number and the signal-to-noise ratio at peak gain. Here, this problem is treated desultorily, although it is one of the points of greatest difficulty, and considerations of this type are necessary for the statistical approach as well.

The effect of rapid range-closing in general can be treated with reasonable accuracy only by using statistical methods. A loss term can be defined, to be added to the visibility factor, by first obtaining the effect of range-closing for a large number of cases from the statistical method and then determining the functional form of the loss term by inspection. It is found that this loss term is a nonlinear function of signal-to-noise ratio, ΔR, and the probability of detection. This point will be treated in greater detail in connection with the method of range scaling.

Statistical Approach

Single-Look Probability

In the last several paragraphs, the range associated with a selected probability of detection was examined. It is apparent that another approach is at hand; i.e., solving the problem for the probability associated with a given range. It is found that a distinction must be made between cumulative and single-look probabilities for rapidly moving targets. The single-look probability or "blip-to-scan" ratio naturally follows as the first solution, with the cumulative probability a minor extension of simple probability theory.

A simple model has been established to obtain these probabilities. A signal pulse is added to noise and the resultant signal passed through a narrow-band amplifier. After amplification, the signal is rectified in a quadratic detector. The signal plus noise is then required to exceed a bias or threshold voltage for detection to occur. The problem then is reduced to obtaining the probability density of signal plus noise at the output of the second detector. The single-look probability is obtained as the integral of this density function, where the integration limits are from the bias level to infinity.

The density function is the probability per unit amplitude of obtaining a given value of signal plus noise. The density, and hence its integral, is a function of the number of pulses returned from the target and the signal-to-noise ratio of each pulse. In addition, the value of the integral is a function of its lower limit, which is the bias or threshold.

In general, this threshold is selected by placing a value on the number of false alarms that can be tolerated. A false alarm is defined as the identification of a pulse of noise alone as a target.

False alarm probability is obtained by integrating the density function for zero signal-to-noise ratio (noise alone) from the bias level to infinity. Usually, a quantity known as the false alarm time, defined as the time period for

Detection Range

(continued)

which the probability of not obtaining a false alarm is one-half, is used as a parameter to enter these calculations.

The mathematics involved in computing these probabilities are complicated and will not be reproduced here. An understanding of the principles involved is sufficient to permit a person armed with the results of these calculations to handle the statistics of the radar range problem.

An often criticized point is the concept of a definite threshold that must be exceeded for detection to occur. That is, manually operated systems are not thresholding systems in the strict sense of the word, and the comment is often made that it is impossible to assign a threshold to a system that has a human element. However, as noted above, the parameter that takes into account the threshold is the false alarm time, which can be determined experimentally, even for a manually operated system. Fortunately, it is found that detection probabilities are not excessively sensitive to false alarm time, thus allowing a certain tolerance in the determination of this quantity. In this respect, a corroborating statement is often made that an error in false alarm time of less than an order of magnitude results in negligible errors in detection probabilities.

Subject to some not very severe restrictions, the general problem of calculating the probability of detection has been solved (see the unclassified papers of S. Goldman, J. Marcum, and P. Swerling). The results are presented as a set of graphs, giving the probability of detection in terms of normalized range, the number of integrated pulses, and the false alarm time. This is the probability of detecting a target on a single scan, or the single-look probability of detection, where the normalizing factor for range is taken as the range for signal-to-noise ratio equal to unity. A typical set of curves is reproduced in Fig. 4.

Examining the quotient of range and normalized range, it is noted that the following equation can be written

$$R = R_o \left(\frac{1}{V}\right)^{1/4} \qquad (15)$$

where V is the visibility factor of Eq. (8). Thus, the visibility factor method is contained implicitly in the statistical method, and there is a theoretical justification for the use of the visibility factor in addition to the heuristic justification given earlier. Also, it is then possible to check the experimental results cited against the values obtained above to judge the correctness of the theoretical model. In general, this agreement is good, and a reasonable amount of confidence can be placed in theoretical calculations from this fact alone.

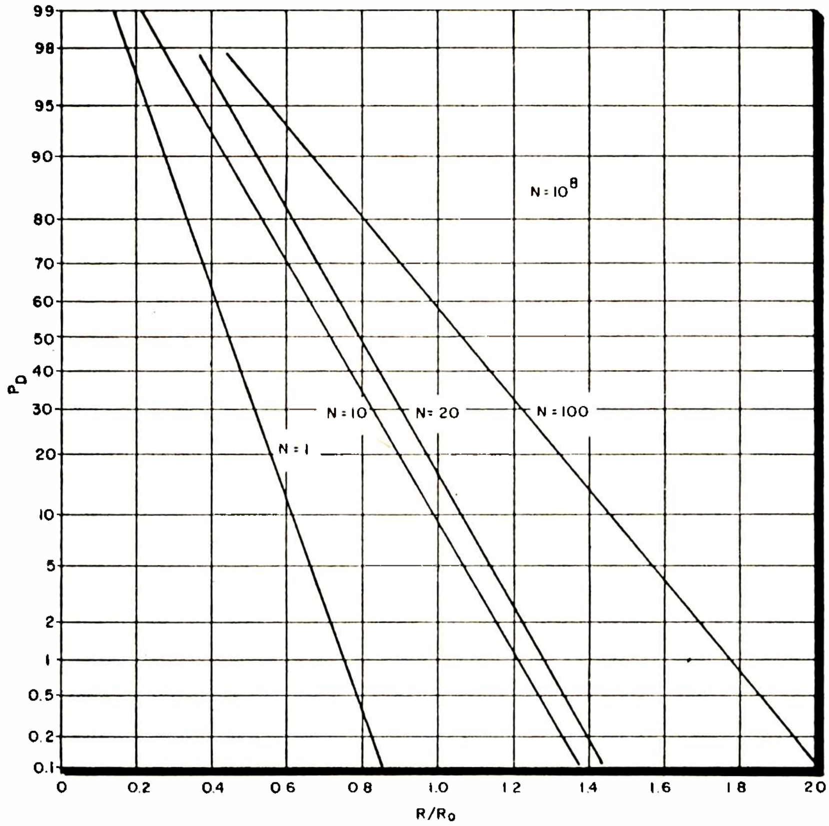


Fig. 4: The probability of detection as a function of N and R/Ro.

Cumulative Probability of Detection

If the target moves an appreciable distance between looks, it can be seen from Eq. (7), by solving for signal-to-noise ratio in terms of range, that the signal-to-noise ratio, and hence the single-look probability of detection, will vary from look-to-look. If the time between appearances of the target in the scan is sufficiently great, the probabilities of detection from one look to the next will be essentially independent. In this case, a simple formula for the probability of detection after n scans can be derived, as follows:

On any given scan, the probability of not detecting a target is

$$P = (1 - P_D)$$

where P_D is the single-look probability of detection on that scan. Applying a basic theorem of statistics, which states that the probability of n independent events is given by the product of the individual probabilities, the probability that a target is not detected on the n^{th} scan is

$$P_{(n)} = (1 - P_{D(n)})\,(1 - P_{D\ (n-1)}) \cdots\cdots = \prod_{i=1}^{n} (1 - P_{Di}) \qquad (16)$$

Then, the probability of detecting a target on the n^{th} scan is:

$$P_c = 1 - P_n = 1 - \prod_{i=1}^{n} (1 - P_{Di}) \qquad (17)$$

This quantity is generally known as the cumulative probability of detection.

Here is found a rigorous method for treating the degrading effect of closing rates and scan pattern. One simple approach would be to standardize the tactical model and examine the degradation associated with a variety of scan patterns. A more convenient approach, one that approaches universality, is in computing a complete set of cumulative probabilities covering the interesting range. Then determine the proper normalizing factors to permit the selection of a set of functional relationships that give a complete picture of the problem.

The number of integrated pulses is simply the n of interest in computing the visibility factor. The difficulties noted there are also present here. In addition, most of the calculations using the theoretical method have assumed linear addition of pulses; i.e., each pulse is of the same weight, so that the sum of n pulses, each of signal-to-noise ratio $\overline{X}$, is exactly $n\overline{X}$. Unfortunately, very few physically realizable systems possess this characteristic. The typical system weights the first few pulses heavily, with the weighting reduced with increasing numbers of pulses, until a saturation point is reached, after which no further addition is accomplished.

It can be shown that linear addition of pulses is the best possible addition scheme, since any weighting reduces the advantages to be gained from pulse addition. The use of the statistical method without taking this factor into account leads to optimistic performance estimates.

Several approximate corrections have been postulated to account for this factor. Of these, the simplest is to assume an "effective number of pulses," which is obtained by analyzing the brightness output of the cathode ray tube as a function of the number of excitations. The basic unit is taken as the brightness increment produced by a single pulse, so that if, for example, 60 pulses add up to a total brightness of only 10 times that of a single pulse, the effect on the probability of detection is taken to be that of 10 pulses added linearly. This is of the nature of a first-order correction and is merely an indication of the way in which these factors are accounted for in practical calculations. The basic problem certainly may be recalculated for this effect, but all indications are that the degree of accuracy required does not justify the added computational labor.

Applications

The statistical method, precisely because relationships are presented analytically, lends itself nicely to generalized sets of relationships and to operational studies. Thus, if it is wished to include some single parameter, as for example is commonly done in taking into account the "operator factor," it is possible to obtain general results for a complete range of operator factors without an inordinate amount of labor. Similarly, if, as discussed previously, the location of the target is unknown, the target can be represented by a probability density and probabilities of detection for this situation determined. Again, it is possible to modify the density functions to take into account the statistical variation of target cross-section. These results can be obtained only with difficulty—if obtained at all—when using the other methods.

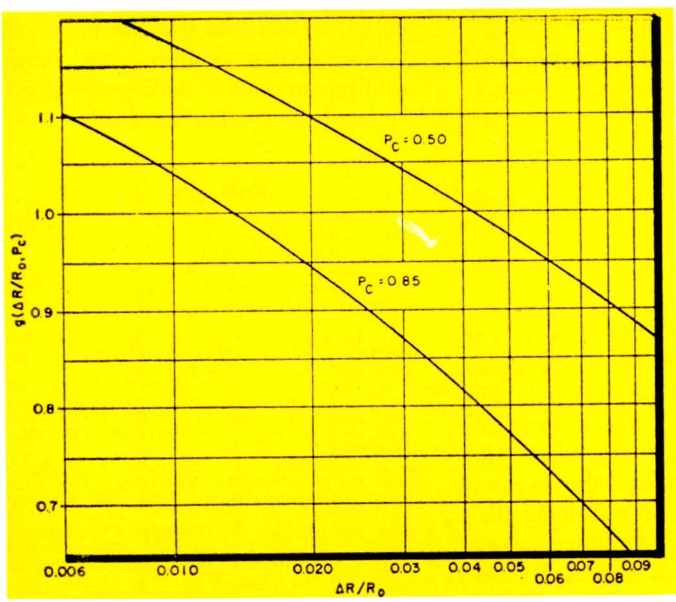


Fig. 5: Correction factor for closing rate vs ΔR/Ro and Pc.

Range Scaling

Synthesis of the Two Methods

As it now stands, two seemingly dissimilar but actually related methods for predicting radar range are available. The first thing that comes to mind is a fusion of these two approaches to produce one that retains the simplicity of the visibility factor method and is capable of direct interpretation in terms of the radar designer's problems. Such an approach is obviously possible if some of the mathematical rigor of the statistical approach can be sacrificed.

As pointed out previously, up to the point where target motion is introduced, the visibility factor can be derived from the statistical approach. It seems reasonable, then, to assume that the effect of target motion can be accounted for by introducing a correction into the visibility factor—in fact, this turns out to be the case. By computing complete sets of cumulative probabilities, the functional form of this correction can be deduced by inspection.

The range equation may then be written

$$R^4 = R_o^4 \left(\frac{1}{X_o}\right)\left(\frac{1}{X_c}\right) \qquad (18)$$

where X_o is the visibility factor as defined previously, and X_c is the correction factor for range-closing. Drawing upon the results of the experimental studies referenced earlier, the form of X_o is established as

$$X_o = k\, n^{-0.7}\left(1 + \frac{1.2}{\tau B}\right)^2; \qquad 5 < n < 40 \qquad (19)$$

where k is a proportionality constant. X_c is found to be a nonlinear function of the cumulative probability of detection, the signal-noise ratio, and the change in range between looks.

$$\frac{1}{X_c} = \left[g\left(\frac{\Delta R}{R_o}, P_c\right)\right]^4 \qquad (20)$$

A curve of g for 85% and 50% cumulative probabilities of detection is shown in Fig. 5. The equation for range is thus

Detection Range
(continued)

$$R^4 = R_o^4 n^{0.7} \left[\frac{1}{k\left(1 + \frac{1.2}{\tau B}\right)^2} \right] \left[g\left(\frac{\Delta R}{R}, P_c\right) \right]^4 \quad (21)$$

In itself, the method outlined here is not suited generally to calculations of radar range, but it is used to scale ranges from experimental data. For example, given experimental data from a particular radar, say radar A, the range of radar B can be determined as

$$R_B = R_A \left(\frac{R_{oB}}{R_{oA}}\right) \left(\frac{n_B}{n_A}\right)^{0.175} \left[\frac{\left(1 + \frac{1.2}{\tau \beta_A}\right)}{\left(1 + \frac{1.2}{\tau \beta_B}\right)} \right]^{1/2} \left[\frac{\left(g_B \frac{\Delta R}{R_o}, P_c\right)}{\left(g_A \frac{\Delta R}{R_o}, P_c\right)} \right] \quad (22)$$

This method, surprisingly enough considering the approximations involved, gives results that are reasonably consistent with experiment.

Several rather subtle modifications may be made to Eq. (22). For example, the "collapsing loss" occasioned by integrating additional samples of noise may be introduced as an additional correction to the visibility factor. Similarly, the effect of operator inattentiveness (the so-called operator factor) may be accounted for. The theoretical justification for introducing such correction factors is found in the same manner as in developing a correction for closing velocities.

Applications

A sample set of ranges will now be computed to provide a comparison of the range-scaling method and the statistical method. A fair comparison can be made by first computing a range using the statistical method with an assumed set of parameters and then changing these parameters and computing a new range using both methods. This comparison of ranges is, of course, a poor way to estimate the validity of either method, which obviously can be done only by comparing the results with experimental data.

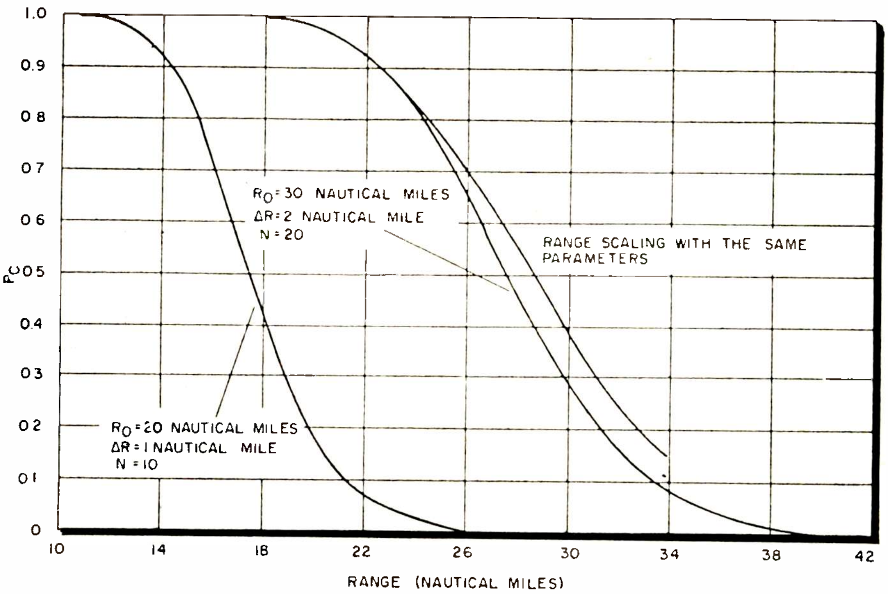


Fig. 6: The cumulative probability of detection vs the range. Use in sample calculation.

Unfortunately, the experimental ranges of most radars are classified and cannot be revealed. Suffice it to say that these methods (particularly range-scaling) actually do work, at least for experimental studies. The ranges obtained in actual service are difficult to obtain and, because most of the variables are not controllable, would be meaningless in most cases, since fairly complete sets of ranges are necessary due to the statistical nature of the problem.

To enter these calculations, the following quantities are assumed.

R_o = 20 nautical miles

n = 10 pulses

t_{fa} = false alarm time = 10^8 pulse-lengths

ΔR = change in range between looks = 1 nautical mile

Next, compute the range for, say, 50% probability of detection, using the statistical method, Fig. 4 and Eq. (17); the answer obtained is 17.5 nautical miles (see Fig. 6). Now, change the parameters so that R_o is 30 nautical miles, n is 20, and the change in range between looks is 2 nautical miles. Using the statistical method, the range for 50% cumulative probability of detection is found to be 27.7 nautical miles. Using the range-scaling method, Eq. (22) and Fig. 5,

$$R_B = R_A \left(\frac{30}{20}\right) \left(\frac{20}{10}\right)^{0.175} \left(\frac{g_A}{g_B}\right) \quad (23)$$

which gives R_B equal to 28.8 nautical miles for 50% probability of detection. A similar calculation for 85% probability of detection gives a range of 23.6 nautical miles, using both methods.

As is seen, the statistical method involves a considerable amount of computational labor with approximately the same results. Hence, the statistical method offers very little advantage in straightforward calculations and is of value primarily in obtaining the manner in which outside factors influence detection range, whereas the range-scaling method is used generally to estimate detection ranges.

Bibliography

1. Payne-Scott, R. "The Visibility of Small Echoes on Radar PPI Displays," *Proc. IRE*, Feb. 1948.
2. Haeff, A. V. "Minimum Detectable Radar Signal and Its Dependence Upon Parameters of Radar Systems," *Proc. IRE*, Nov. 1946.
3. Lawson and Uhlenbeck. *Threshold Signals*, Vol. 24, MIT Radiation Laboratory Series, McGraw-Hill, 1948.
4. Marcum, J. I. "A Statistical Theory of Target Detection by Pulsed Radar and Mathematical Appendix," The Rand Corp., Research Memos RM-754 and RM-753, 1 Dec. 1947.
5. Swerling, P. "Probability of Detection for Fluctuating Targets," The Rand Corp., Research Memo RM-1217, Mar. 17, 1954.
6. Goldman, S. "Some Fundamental Considerations Concerning Noise Reduction and Range in Radar and Communications," *Proc. IRE*, May 1948.

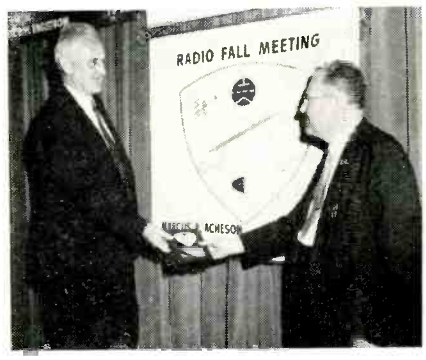
500 leading engineers expected to discuss reliability, tubes, and transistorization of consumer products

Scene of the 1958 Radio Fall Meeting Banquet showing banner replicas of the plaques presented over thirty years.

31st Annual Radio Fall Meet, Nov. 9-11

The thirty-first annual Radio Fall Meeting takes place this month, November 9th to 11th, at the Hotel Syracuse in Syracuse, N. Y. This is the outstanding event each year for electronic engineers concerned with the development of consumer type products. Stephen L. Levy of the Philco Corp. in shaping this year's technical program has focused principal attention on transistorized equipment design. The annual attendance at this event numbers about 500 of the senior design engineers in the industry and one of the principal highlights is the presentation of the coveted Radio Fall Plaque at the annual banquet. Photos on this page show some of the activities at last year's meeting, which was unusual in that for the first time two plaques were awarded. Following is also a complete program listing for the Radio Fall Meeting.

Well known engineers in attendance at the 30th annual meeting. (l to r) Don Fink, Philco Corp. Captain D. R. Hull, EIA; Dr. W. R. G. Baker, ex GE; and Virgil Graham, Assoc. Director of Engineering, EIA.



Radio Fall Meeting plaque winners for 1958. Marcus A. Acheson, Sylvania left and Virgil Graham, Associate Director of Engineering, EIA at right.

TECHNICAL PROGRAM

MONDAY, NOVEMBER 9, 1959
BALLROOM

10:00 A.M. EIA Engineering Department Session

J. R. Whitney, Presiding

National Stereophonic Radio Committee, C. G. Lloyd, Chairman, "NSRC," General Electric Company

Value Analysis and Engineering Activities R. S. Mandelkorn, Chairman, "VE" Staff Committee, Philco Corporation

Parts Standardization, Leon Podolsky, Chairman, "P" Panel, Sprague Electric Company

2:00 P.M. Reliability and Quality Control Session

(Arranged by the IRE Professional Group on Reliability and Quality Control)

J. R. Steen, Presiding

Reliability of Germanium Transistors, O. H. Somers, Raytheon Manufacturing Company

Aspects of Reliability in Transistorized Home Radios, John J. Corning, General Electric Company

Proper Application of Transistors in Battery Portable Receivers, R. M. Cohen, Radio Corporation of America

Automation for Quality Control Testing of Electron Tubes, R. A. McNaughton, Sylvania Electric Products Inc.

8:30 P.M. Stag Party*, East Room

Courtesy of Sprague Electric Company

* Admission only by ticket obtainable at time of registration.

TUESDAY, NOVEMBER 10, 1959
BALLROOM

9:00 A.M. Electron Tube Session

(Arranged by the IRE Professional Group on Electron Devices)

W. Massey, Presiding

New Oscillator—Mixer Circuits for TV and FM Tuners, E. H. Hugenholtz, Amperex Electronic Corporation

A Composite Base Metal for Oxide Coated Cathodes, W. T. Millis, General Electric Company

The Sarong Cathode, D. R. Kerstetter, Sylvania Electric Products Inc.

The 6EV5, A New VHF Tetrode, Robert Pear, Westinghouse Electric Corporation

(Continued on page 248)

The basic unit in microwave printed-circuit design is the modified transmission line, since all the other components—transformers, coupling elements, attenuators, filters—can be constructed from this element. Dielectric loss of the base materials assumes particular significance at the microwave and UHF frequencies.

Designing

Microwave Printed Circuits

By **ALLAN H. LYTEL**
Avco Corporation
Crosley Division
Cincinnati, Ohio

MICROWAVE and UHF applications of printed transmission lines, components, and antennas have successfully been demonstrated in many types of electronic equipment.

Fig. 2 illustrates a microwave RF section of a receiver showing both the conventional plumbing and the newer printed-circuit version.

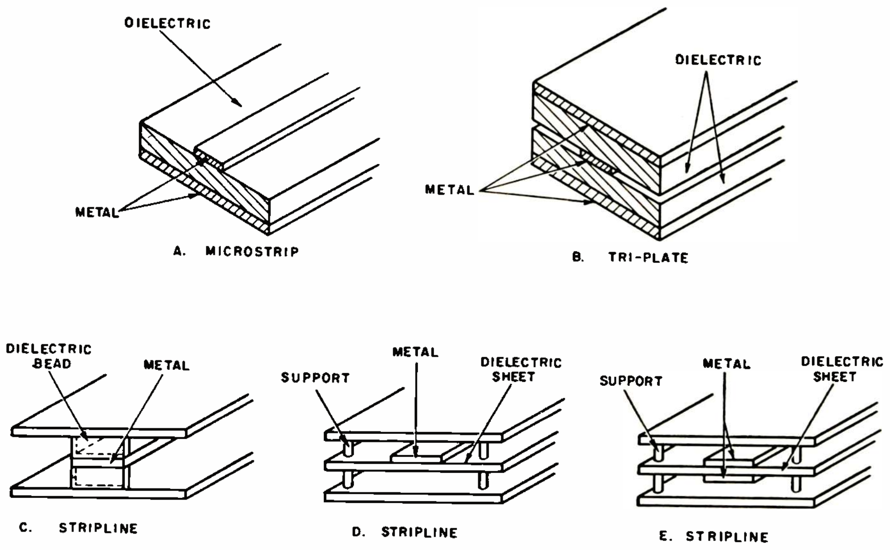
Because many components can be constructed from modified line sections, the printed-circuit transmission line is the basic element.

Three printed-circuit transmission lines are shown in Fig. 1. Microstrip,[1] part A, is a printed-wire two-wire transmission line. The conductor is printed on one side of the Teflon-fiberglass base. The other surface of the dielectric also has a printed surface which acts as a conducting plane.

Tri-Plate [2] as in B is the printed equivalent to coaxial transmission line. A single conductor positioned between two ground planes produces a Tri-Plate transmission line.

Stripline [3] as in C, D, and E may be formed so that a flat conductor is centrally placed between two ground planes in several ways. The flat conductor can be either a solid copper strip or a dielectric sheet with a printed conductor.

Fig. 1: Printed Circuit transmission lines. A is a two-wire transmission line. B is the printed equivalent to coaxial transmission line. C, D, & E show how flat conductor may be placed between two ground planes.



In C, the ground plane is bound to a dielectric sheet, and the flat center conductor is supported by dielectric beads. This structure has no significant dielectric loss or radiation leakage because of the air spacing.

In D, a dielectric sheet between the two ground planes carries a single copper conductor and the dielectric sheet is supported by either metal or dielectric posts.

The double metal clad line, part E, has even lower losses because, if the two strips are connected in parallel at the input and output of the circuit, the electric fields exist from each strip conductor to its corresponding ground plane and only fringing fields exist in the dielectric sheet. In a resonant structure, however, strong fields exist at the voltage maxima and the dielectric is removed from these regions.

The losses of the bead line, as in C, and the double metal clad line, as in E, are then comparable and very low; the losses of the single metal-clad line (D) are somewhat greater but still low.

Dielectric Materials

The material used for the dielectric base of printed-circuit transmission lines must have superior electrical properties. Low dielectric losses are important for efficient lines, but the physical properties are also significant. Mechanical strength and chemical stability are also required for this application to avoid warping or distortion of the transmission lines and other microwave components.

Electrically the important properties are low dielectric constant, low dissipation factor, and high dielectric strength. Teflon* is a useful UHF material for dielectric applications. It may be used directly or as a glass-filled laminate. New cementable forms are available so that teflon can be bonded directly to other surfaces. Pure teflon has remarkable UHF properties. It can be operated over the range from —110°F to 500°F and has a dielectric constant of about 2.1.

Glass-filled teflon are available with greater strength. One commercial product has a dielectric constant of 2.6 and a dissipation factor of 0.0015. Quartz filled teflon has even lower losses than glass-filled teflon and is used in some special applications.

Another low-loss UHF material is Rexolite[5] 1422 which is a rigid thermosetting plastic insulating material. It is a cross-linked styrene co-polymer with greater heat resistance and better machining qualities than Polystyrene. Among its unusual properties are a dielectric constant of 2.5 from 100 CPS to 10,000 MC and a dissipation factor of 0.00011 at 100 KC. This plastic has no filling. The max operating temperature is 230°F.

This material is used as the plastic for a glass

* DuPont trade-mark for Polytetrafluoroethylene resin.

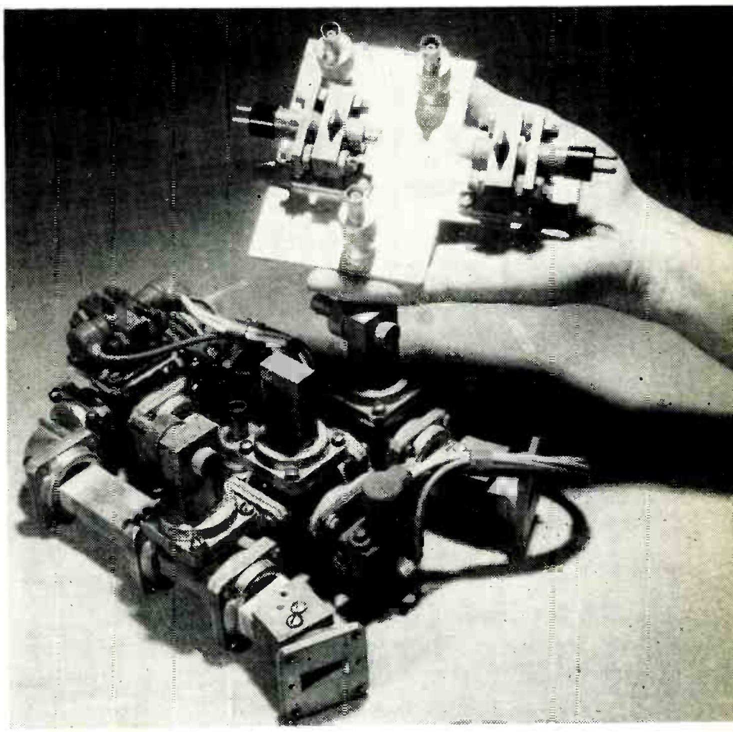
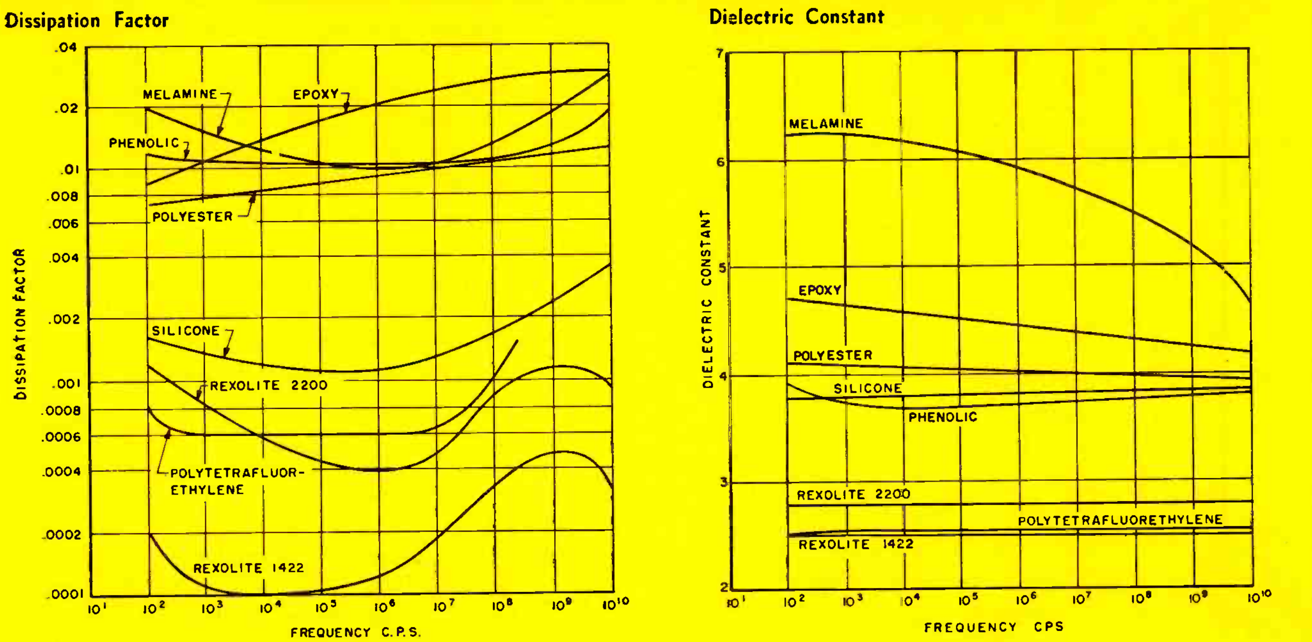


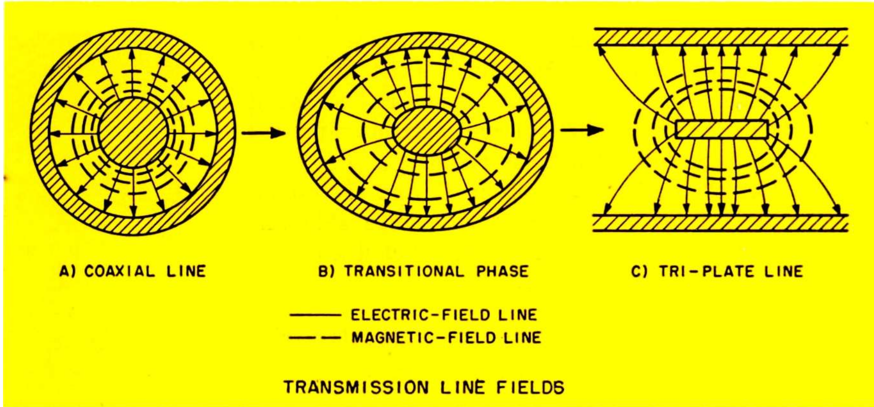
Fig. 2: Printed circuit techniques reduce size, weight and complexity.

Figs. 3 & 4: Material used as dielectric base have superior electrical properties. Low dielectric losses are important but physical properties are also significant.



Printed Circuits

(Continued)



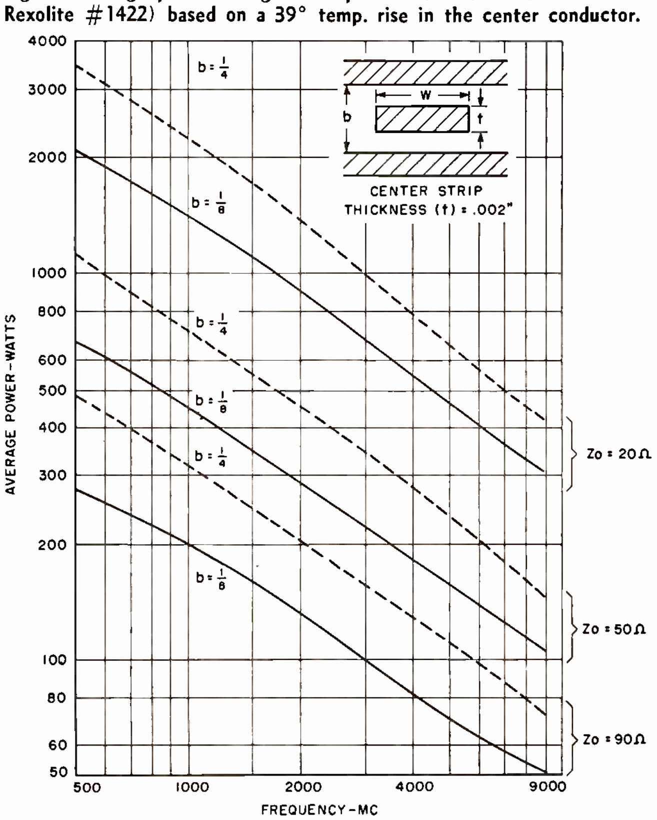
fibre board for use as UHF printed circuits. The laminate (Rexolite 2200) has a dielectric constant of 2.77 from 10 CPS to 10,000 MC. Fig. 3 and 4 compare its characteristics with other plastic laminates.

Tri-Plate[6]

The flat transmission line evolved from and is related to the ordinary coaxial line. Relations of the electric and magnetic fields in both of these lines may be seen from Fig. 5. The transition is from A to B to C. Magnetic lines surround the center conductor and the electric field extends from the inner to outer conductor. With the Tri-plate line, as in C, the outer conductor is divided into two parallel ground planes.

Tri-plate is made from two sheets of laminates, each of which is copper-clad on both sides. On one of these sheets a copper surface is etched to form a center conductor. The other copper surface is a ground plane. When each of the two copper-clad laminates is etched one is a mirror image of the other.

Fig. 6: Average power-rating of Tri-plate line (dielectric medium of Rexolite #1422) based on a 39° temp. rise in the center conductor.



The two center strips are placed together forming a single center conductor.

UHF Components

Transmission lines are the basis of the many and varied components for UHF and SHF. Characteristic impedance of flat or printed lines is a function of the parameters of the line components. Values over a wide range are possible.

Power capability is dependent upon the heating of the conductors because of attenuation losses. Coaxial lines and Tri-plate lines with the same attenuation and impedance have about the same power ratings. Average power ratings for Tri-plate with three different values of impedance are illustrated in Fig. 6, based upon a 39°C temperature rise in the center conductor of a line with a Rexolite 1422 dielectric.

Transformers

Flat transmission lines are quite like coaxial lines in many of their electrical characteristics but there are some important differences. In Fig. 7, for example, a discontinuity is shown. With the coaxial line, as in A, there is a change in the electric field hence the equivalent circuit is a shunt capacity. But, with the Tri-plate line there is a change in the magnetic field, not the electric field, hence the inductance is the equivalent circuit for a change in width from W_2 to W_1.

If the discontinuities are a quarter-wavelength long the equation for impedance matching apply. Where Z_1 is to be matched to Z_2 by a section of this length the impedance for the matching section is given by:

$$Z_3 = Z_1 Z_2$$

This is useful for matching two different impedances or to match a line to an input. By tapering the center conductor from one width to another, over a distance of one wavelength or more, a transformer with a low VSWR can be easily constructed.

Coupling Elements

Coupling from a flat line to a wave-guide may be done by either electric or magnetic coupling. Tri-plate magnetic coupling is shown in Fig. 8. The center conductor is tapered to a smaller width and terminates in a small loop. Both ground planes terminate before the end of the probe. The end of the loop is connected to the ground planes by a soldered rivet.

As shown, the loop extends into the waveguide opening.

Attenuators

Attenuators are made using resistive materials in the Tri-plate line. Absorbing resistive tapes or cards or metallized films, used for attenuators also can provide matched terminations. By tapering the center conductor into the absorbing material, tapered in the opposite sense, a good match can be obtained with a VSWR of 1.10 or less over a wide frequency range. Variable attenuators are available where the card of absorbing material is rotated to change the degree of attenuation.

Filters

Tri-plate has been applied to filter designs of several types. Many published works are available describing specific designs.[7] A gap in the center conductor, as shown in Figure 9A is the equivalent of the capacitor and inductor T and values are a function of spacing s and width w. A round hole of diameter

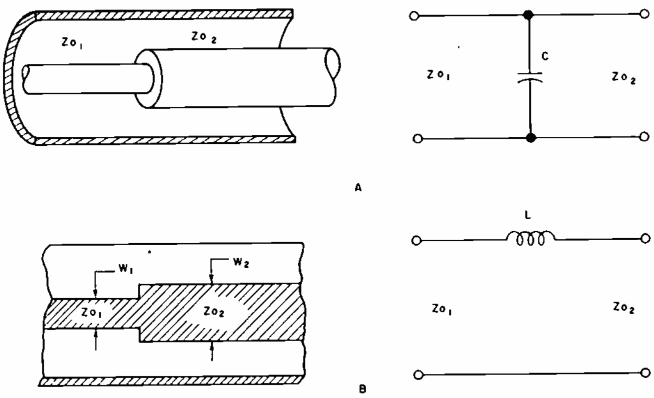


Fig. 7: With coax line (top) the equivalent circuit is a shunt capacity. With the Tri-plate line, the inductance is the equivalent circuit for a change in width from W_2 to W_1.

d, as in B, is the equivalent of the inductor T circuit.

Stubs or short sections of lines act as inductors or capacitors and can be used in filter applications.[8] Considering lengths of open or shortened lines either may be an inductance or capacitance.

For a shorted line.

$$Z_{in} = j\, Z_o \tan \theta$$

and for an open-ended line,

$$Z_{in} = -j\, Z_o \cot \theta$$

where θ is the electrical length of the line segment, in degrees.

Printed transmission line sections can be used as filters just as ordinary transmission line sections. The impedance is a function of the section termination, length, and operating frequency. If the stubs are less than one quarter wave-length, an open-ended stub will be capacitive and a shorted stub will be inductive. As the length is decreased from about 90° (this is measured in electrical degrees of travel, which is the velocity in free space adjusted by dielectric effects), the capacitive reactance increases. At 45° the capacitive reactance is equal to the characteristic impedance of the line and this reactance becomes very large for a line stub less than 10° long.

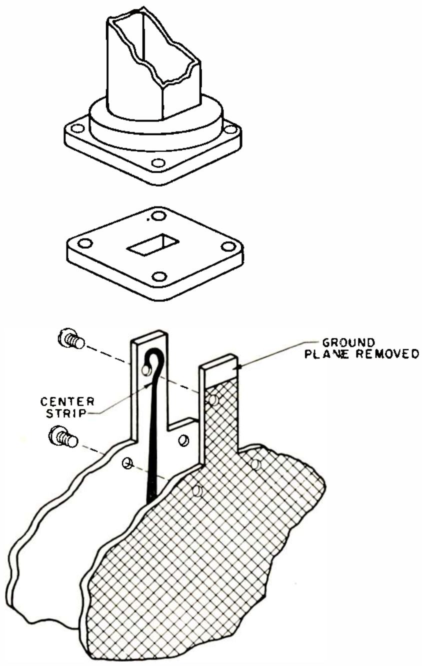


Fig. 8: X-Band Tri-plate to waveguide transition employing magnetic coupling.

A shorted line is quite different; at a 90° length, it is a parallel resonant circuit. As the line length is decreased toward zero, the inductive reactance decreases until the value for a 10° line is close to zero. All of the filters required for an r-f system can be made using the proper combination of these stubs as capacitors and inductors.

Several interesting techniques are used in construction of these filters. The line elements are grounded at the outside edge act as inductances. Series capacitors are formed by breaking the top and bottom strips in the main line at slightly different points. These strips overlap each other and form a small capacitor with base-material dielectric.

Fig. 10 illustrates a Tri-plate ladder network. Series capacitors as C or C_1 are formed by small gaps and overlapping lines. The three center sections L, are shorted and hence inductive.

Tuning Stubs

Tuning elements are made by variations of the transmission line stub lengths. A shorted line need be only one quarter wavelength long for parallel reso-

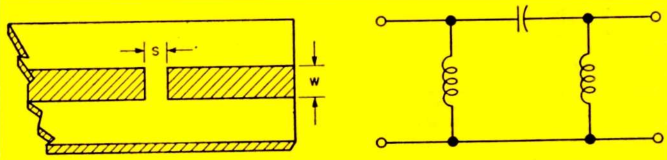
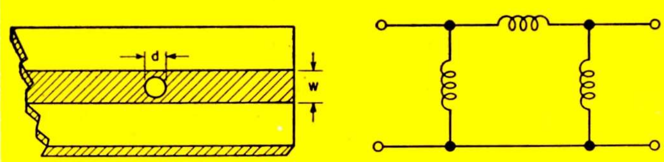


Fig. 9: (Top) Gap in tri-plate center-conductor and equivalent circuit. (Bottom) Round hole in tri-plate center-conductor and equivalent circuit.



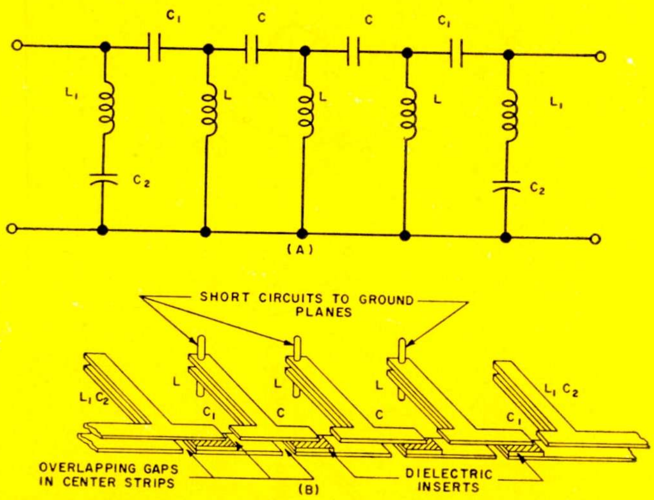


Fig. 10: Typical low-frequency ladder network for a high-pass filter with the equivalent center-conductor configuration in tri-plate line. C and C_1 are formed by small gaps and overlapping lines. The three center sections L, are shorted and hence inductive.

Printed Circuits *(Continued)*

nance at the output but an open-ended line must be one half wavelength long for the same input condition. Both open-ended and shorted stubs are used in tuners. Changing the line length varies the operating frequency thus these variable-length stubs can be used for tuners.

A Tri-plate line stretcher is illustrated in Fig. 11. This device is used to change the length of the Tri-plate line. In some applications, as with antenna feed lines, the length of the line is critical. Moving the center disc changes the length of the line.

This, and other methods, can be used to make open and shorted variable length tuning stubs.

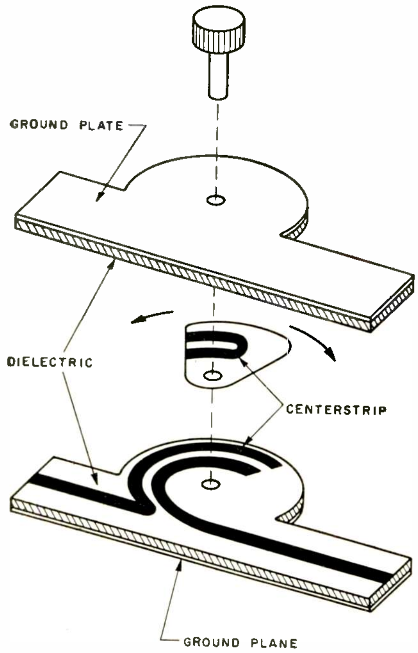


Fig. 11: Stretcher is used to change the length of the Tri-plate line. Moving center disc changes the length of the line.

Power Dividers

Power dividers are made by splitting a single center conductor into two or more lines using tapers or other methods for matching.

Bridge circuits for microwaves such as hybrids or the magic-tee can be made simply and directly with flat transmission lines.

Printed Antennas

Etched radiators have been made and demonstrated for different antenna systems. Complex arrays made up of several elements are easily constructed by printed-circuit techniques. Fabrication of accurate, high-precision antenna systems are quite feasible by any of several methods.

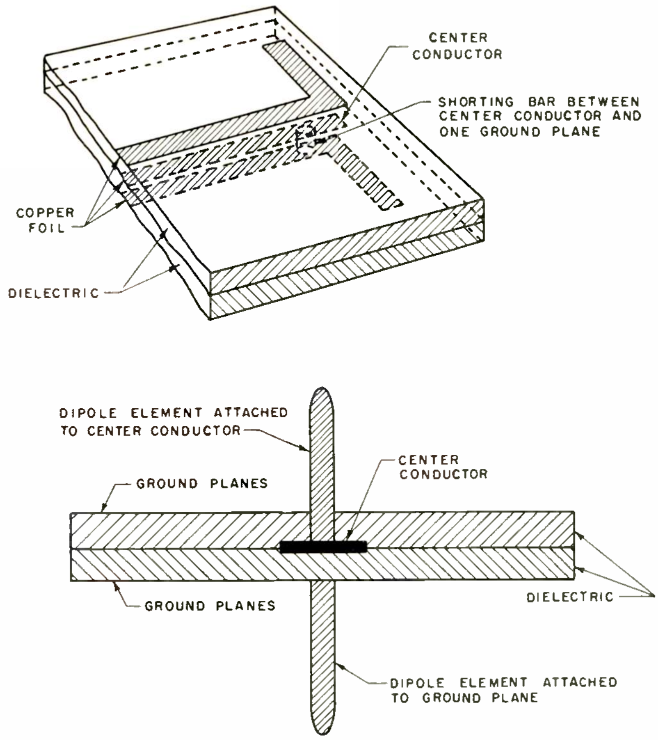


Fig. 12: Dipole radiating device. Complex arrays made up of several elements are easily constructed by printed circuit techniques.

Two of these methods are illustrated in Fig. 12. Both have been developed from Tri-plate. In A, both ground planes are etched to form quarter-wave radiators. The inner conductor is shorted to one of the radiating elements; the second element is part of the other ground plane. This is an unbalanced feed as from a standard coaxial line. B shows a variation. The radiators are not part of the ground planes. Dipole elements are at right angles to the ground planes. One radiator connects to the center conductor, the other is attached to the ground plane.

Slot antennas can be arranged in directive arrays which may be fed by power dividers.

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 a standard three-hole-punch without obliterating any of the text. They can then be filed in standard three-hole notebooks or folders.

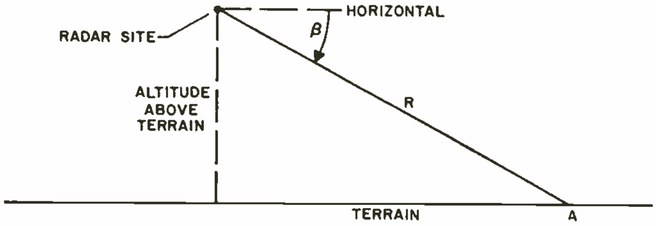


Fig. 2: Sketch illustrates how power P is received at A

The video from the radar return is an intensity-modulated trace which is recorded on film. The film moves always very slowly across the recording slit with respect to the interpulse interval. During the time it takes the film to displace the width of one trace T_i, up to 500 traces may have been recorded upon it. Because of the nature of photographic film, T_i is an integration time. During T_i the reflected power from a target at range R represents an energy

$$W_{(rf\ energy)} \propto nP_r \propto \frac{P_T G^2(\beta) C(PRF)\alpha}{VR^3}$$

Introducing $R = h \csc \beta$ and solving for $G(\beta)$:

$$G(\beta) \propto \sqrt{\frac{nP_r V h^3 \csc^3\beta}{P_T C(PRF)\alpha}} = \sqrt{\frac{nP_r V h^3}{P_T(PRF)\alpha}} \csc^{3/2}\beta$$

For an even density recording of the video trace it is required that nP_r be constant. The quantity under the square root sign is a constant and can be lumped together with all the other constants of proportionality. The resulting equation is:

$$G(\beta) = K \csc^{3/2}\beta$$

This is a new and unexpected result that the antenna gain of a side-looking airborne radar should vary as the three-halves power of the (negative) elevation angle.

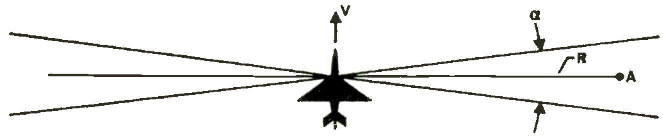


Fig. 3: Target transit time in beamwidth is illustrated.

As a fitting concluding remark it may be of interest to compare the new gain pattern with the classic cosecant-square pattern.

ANGULAR INCREMENTAL GAIN COMPARISON OF CSC² AND CSC³/² PATTERNS

Values of β (degrees)	Directional gain with $\csc^{3/2}\beta$ pattern	Directional gain with $\csc^2\beta$ pattern
5	39.0	132.0
10	13.8	33.0
15	7.6	14.9
20	5.0	8.55
25	3.64	5.6
30	2.82	4.0
35	2.3	3.04
40	1.94	2.42
45	1.69	2.00
50	1.49	1.7
55	1.35	1.49
60	1.25	1.34
65	1.16	1.22
70	1.10	1.12
75	1.055	1.07
80	1.02	1.03
85	1.01	1.01

In practice, β will vary from 15 to 85 degrees, a little more or less depending on the pulse width and the resolutional requirements of the entire radar system. For a β = 15 degrees, the long range gain required is only ½ of that which would be dictated by the cosecant-square law. The new formula shows that power would be wasted illuminating distant targets. Furthermore distant targets would become emphasized yielding an apparent, out of proportion return, and a falsification of the photographic recording.

Speech Aid Produces Vocal Tones

INTELLIGIBLE speech immediately after a laryngectomy is now possible with a new speech aid. This new device uses transistors, sub-miniature components and printed circuitry, to produce the vocal tones needed for understandable speech. Produced by the Medical Department of the Rand Development Corp., 13600 Deise Ave., Cleveland 10, Ohio, it is equally valuable for persons suffering from temporary loss of speech.

Connected to the compact, 7 oz. unit, is a wire which leads to a slender plastic tube. This tube is placed in the corner of the mouth while the patient uses tongue and lips to enunciate the sound into words. Most persons talk easily with it without practice. Telephone conversations are simple. It is considered less awkward and embarrassing to use than apparatus that must be held against the throat.

The Speech Aid fits readily into a shirt pocket, and is self-powered, operating on miniature batteries an average of 30 days without replacement.

This new speech aid is considered less embarrassing to use than apparatus that must be held against the throat to produce tones.

Discussing, among other subjects, the effect of discharge resistance upon the operate time of a relay; time delay—and the modifications or adjustments that can be made for slow operate, or slow release; and "contact chatter"— what causes it, and what can be done to minimize it.

The Dynamics of Relays

By CHARLES F. CAMERON, Prof. and D. D. LINGELBACH, Asst. Prof.

Oklahoma State University, Stillwater, Okla.

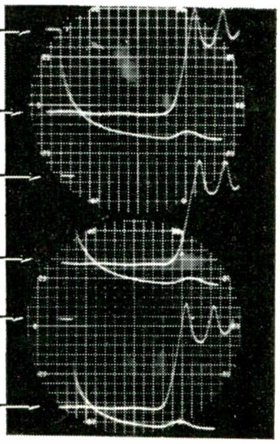
Part Three of Three Parts

Discharge Resistance

IN an earlier section we discussed the effect of series resistance upon the operate time of a relay. For release conditions the resistance which effectively shunts the relay coil determines in part the release time. The resistance which shunts the relay coil is called discharge resistance. In some cases the existence of the discharge resistance is intentional in order to protect the contacts of the device controlling the relay. In other cases the existence of the discharge resistance is accidental but in any case this discharge resistance influences the release condition of the relay.

The effect of discharge resistance is shown by the oscillogram in Fig. 18. Discharge resistance during release has an effect similar to a slug or sleeve placed on the core of a relay. But the discharge resistance has no effect upon the operate condition of a relay as does the sleeve or slug. The lower the discharge resistance the greater the effect which delays the release. Reducing the value of discharge resistance increases the release time of a relay. The top trace in the oscillogram of Fig. 18 was recorded for the smallest discharge resistance. The top two traces show simultaneously the coil current decay and the armature motion during release. The armature remains stationary for some time after the coil was de-energized. The horizontal portion of the armature motion trace shows that the armature had not started to move. Movement of the armature is shown by the rapid rise in the traces. Considerable armature rebound is shown by the damped oscillatory portion of the armature motion trace. The value of discharge resistance for the top pair of traces was about one-half that of the coil.

Fig. 18: The effect of discharge resistance



The middle two traces are again coil current decay and armature motion but for a value of discharge equal to about 75% of the coil resistance. The release time is decreased. The time scale for this oscillogram in Fig. 18 was 15 msecs for each horizontal inch on the scope tube. The decrease in holding time between the top and middle cases is about 4 msecs. The holding time is referred to as the time the armature remains stationary after the coil has been de-energized. Holding time is used since it is the part of the release time that is primarily influenced by the discharge resistance. Study of the end portions of the armature motion traces in each case will show little or no change in the travel time or time the armature is actually moving during its opening.

The bottom two traces are for a discharge resistance equal in value to the coil resistance. Since the discharge resistance for the bottom traces is greater than the other cases the release time is decreased. This decrease in holding time results from the more rapid decrease in the coil current caused by an increase in the discharge resistance.

Time Delay

Circuit requirements may be such that a time delay becomes necessary in a particular relay. Modifications or adjustments may be made on existing relays to secure a time delay for (a) slow operate, or (b) slow release.

Oscillograms show that operate time is a function of the length of the air-gap and spring tension. Within limits these adjustments may be used to change the operate time of a relay. When the time delay which may be secured by this method is not sufficient other schemes must be used.

A "slow operate" relay may be made by placing a slug on the armature end of the core of the relay. More time delay may be obtained by increasing the size of this slug. Obviously, there are limits to this arrangement.

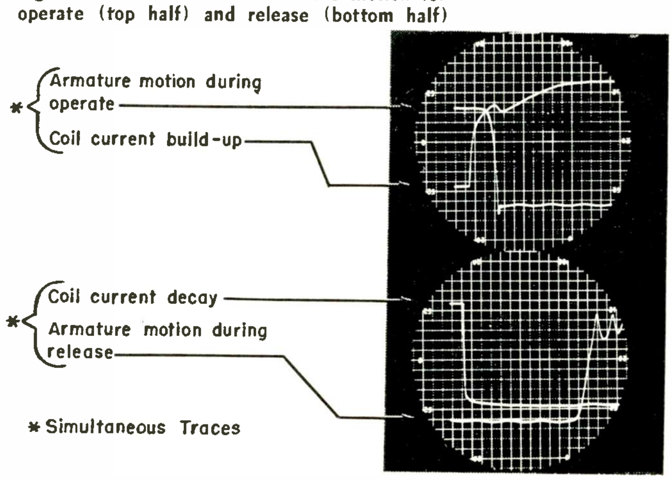
A "slow release" relay may be obtained by placing a slug on the heel end of the core. A relay adjusted for the minimum operate time may have the release time near the maximum value for that particular relay. In most cases, minimum operate time and minimum relay time cannot be designed into a given relay.

Copper sleeves are used on the core when it is desired to obtain a "slow operate" and a "slow release" relay. This copper sleeve builds up an opposing mmf in the magnetic circuit when there is a tendency for a change in the flux.

Sleeves and slugs react in a similar manner to delay the change in flux. When the flux is trying to increase the sleeve or slug opposes the increase. When the flux is trying to decrease the sleeve or slug opposes the decrease. The amount at delay is proportional to the coupling between the sleeve or slug and the coil, and inversely proportional to the resistance of the sleeve or slug.

Sleeves are shorted one-turn coils that are placed between the coil and core while slugs are shorted one-turn coils placed at the end of the coil on the core.

Fig. 19: Coil current and armature motion for operate (top half) and release (bottom half)



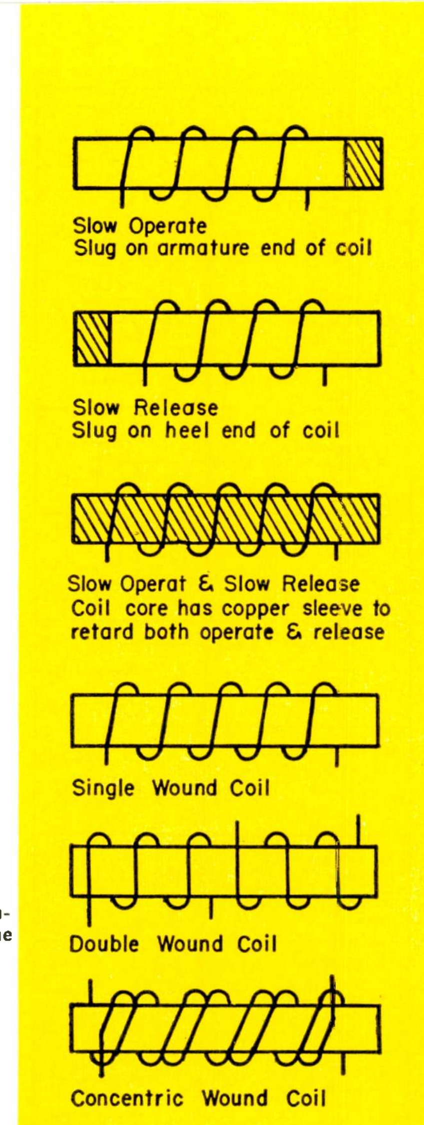


Fig. 20: Various configurations for time delay relays

The oscillogram shown in Fig. 19 shows the coil current and armature motion for operate (top half) and release (bottom half). One characteristic of a relay with a slug or sleeve is the rapid rise in coil current when the coil is energized. The sleeve will cause a much steeper slope in the current trace than the slug, and both cause a steeper slope in the current trace than that of a relay without time delay. There is some delay in the operate time caused by a slug or sleeve but the greatest effect occurs during release. An examination of coil current decay and armature motion in the lower half of the oscillogram shows that the coil current reduced to practically zero long before the armature started to move.

When a sleeve or slog is used, the magnetic circuit is acted upon by two mmf's. The driving mmf caused by the coil and the delaying mmf caused by the changing of the flux through the slug or sleeve. This double mmf acting on the core causes a smoothing effect in the change of the coil current. This effect is most obvious in the cusp of the coil current build-up shown in the top half of the oscillogram. A relay without a delaying action usually shows a sharp cusp in the coil current build-up.

Relay Contacts

The purpose of a relay is to close and open electrical circuits or contacts. It is usual to consider the contact circuit as an independent circuit which has

Relay Dynamics *(Continued)*

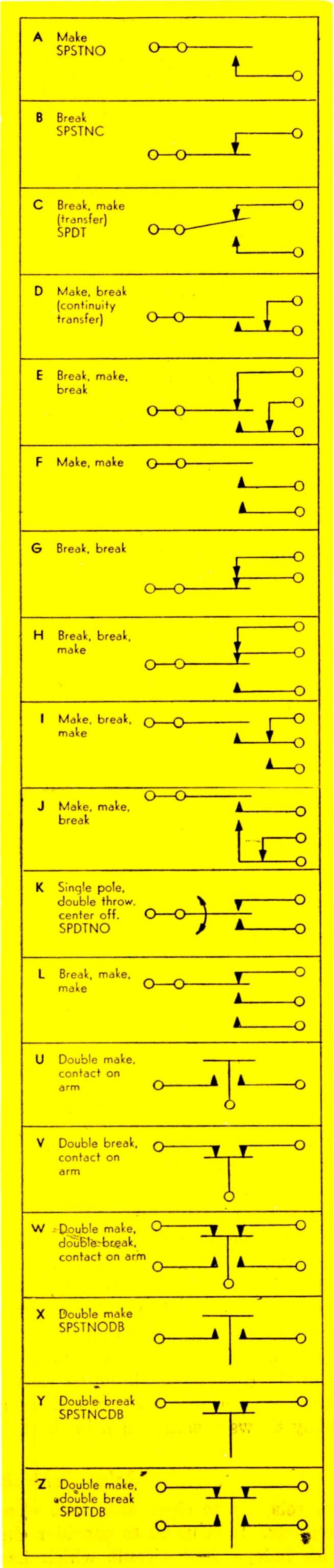


Fig. 21: Nomenclature for the basic contact forms

no electrical connection with the coil circuit. This simplifies some of the problems in the study of relays, but it is not always the case. A relay is an entity which functions as a unit and not as separate components which make up the relay. The same thing is true of the switching circuit. While there are certain phenomena which may be analyzed separately, the entire relay and circuit must, in many instances, be considered as a functioning unit.

Contact problems in a relay are related in some respects to some of the other parameters or characteristics of the relay. If these inter-relationships are neglected, electrical contacts still offer many puzzling situations. This is still more complicated when it became desirable to hermetically seal a relay in a can. The organic material used in a sealed enclosure gives off organic vapors which cause increased arcing and increased contact erosion. This takes place after repeated closure and opening of a pair of contacts in an atmosphere which contains organic vapor. It seems that this is a cumulative process and gives rise to greater arcing when the relay contacts are closed or opened.

The next step was to design a relay with no organic materials. It also became necessary to clean the parts of the relay before final assembly. Filtered air in the work area became necessary. With all of these precautions, it was found that extremely small particles could cause this activation process.

Carbon may be formed on the contact surfaces by the decomposition of organic materials. When this contamination of the contacts has taken place, the contact separation increases at which arcing occurs. Likewise, the minimum arcing current is decreased. These factors give rise to increased contact erosion.

An ideal contact for a relay would "make" or "break" an electrical circuit instantaneously and without arcing. Practically, of course, such is an impossibility. The relay contacts do close in a very short length of time and to achieve this short "operate" time, the movable contact must be travelling at a high velocity at the instant of closure. The contact and the armature to which it is attached possesses a definite amount of kinetic energy which is proportional to the square of the velocity. This energy must be given up or absorbed if the contacts are not t "chatter."

This brief discussion illustrates that the prop functioning of the contacts of a relay is an extremely sensitive situation. Many factors enter into the design of the completed relay, and the contacts of the relay are no small part of the problem. It is seen that the understanding of the chemistry of the contact materials; the physical, electrical, thermal, and mechanical properties of these contact materials are related to the mechanics of the armature structure, the transient electrical characteristics and the environment to which the relay is subjected.

In some specifications, the maximum contact resistance is given. The value may be given in ohms or a millivolt drop for a given current. If it is possible to neglect the film resistance of the contacts, the contact resistance will decrease as the contact force is increased. When contact materials are used which have higher electrical conductivity, the contact resistance will be lower. Contact follow and wipe are usually given consideration in the overall design of the relay.

Again, it is seen that the mechanical system of the relay is actuated by the electrical system. The contacts are attached to the mechanical system. These contacts are influenced by the physical properties of the contact material, and the electrical parameters of the contact circuit also have a pronounced effect upon the functioning of that part of the relay.

Contact Nomenclature

A combination of a movable contact and a stationary contact which completes the circuit or are engaged when the coil is not energized is referred to as a "Form B" or normally-closed contacts. This is abbreviated as "NC". Each of the movable contacts of a relay constitutes a pole of the relay. A combination of a stationary contact and a movable contact which are engaged when the coil is energized is referred to as front, make, "Form A," or normally-open contacts and is abbreviated "NO". A normally-closed contact combination has also been called back or break.

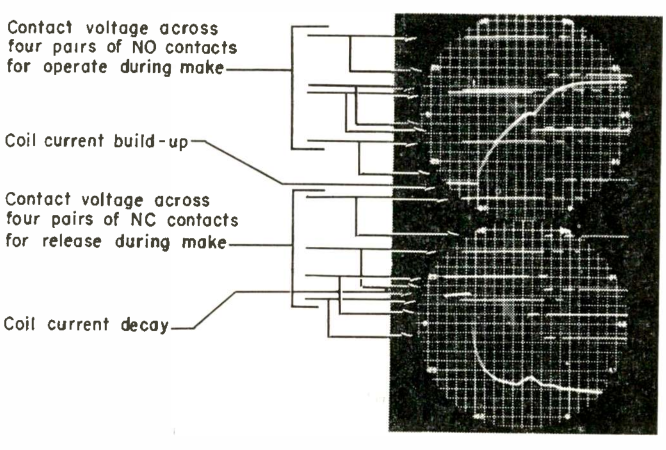
A combination of two stationary contacts and a movable contact which engages one of them when the coil is energized and engages the other when the coil is not energized is called "Form C". Other designations which have been used are: transfer switch, or double-throw contacts and is abbreviated "DT".

The normally-open and normally-closed contacts may be called single-throw contacts, abbreviated "ST" contrasted with double-throw contacts.

When there is a combination in which a movable contact simultaneously makes and simultaneously breaks connection between two stationary contacts, this is called double-break contacts and is abbreviated "DB". For normally-open contacts, this combination is called double-make contacts.

Relay contact notations are given in the following order:

Fig. 22: Relay damaged by handling (shaft shoved out of line) showed these signs of internally caused contact chatter



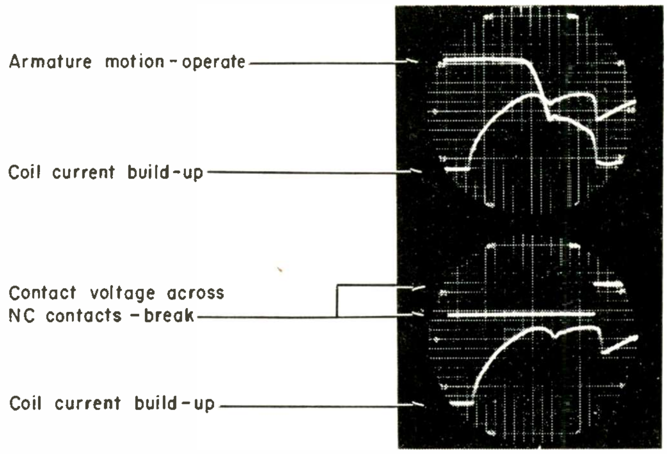


Fig. 23: Traces from relay previously hermetically sealed

1. Poles
2. Throws.
3. Normal.
4. DB, if double-break or double-make contacts.

Example: SPST NO DB designates single pole, single throw, normally-open, double-break contacts.

All contacts are single break except when noted as double-break (DB).

Relays having several sets of differently functioning contacts will have the contact forms listed in alphabetical order of their letter symbols as given the Nomenclature for Basic Contact Forms.

Example: 1A2B refers to SPST NO contacts and DPST NC contacts.

For a relay on which the moving contact engages more than two stationary contacts during its cycle of operation, the contact arrangement is described as MPNT, where M is the number of poles and N is the number of throws, e. g., 8P20T.

Contact Chatter

Contact chatter is frequently called "contact bounce". Bounce implies motion which is caused by impact of the contacts and this is a special case under the general term "chatter". Contact chatter may be called the intermittent closure of open contacts or the opening of closed contacts from either interval or external sources. The most likely cause of internally caused chatter would result from relay actuation.

The transient reopenings of closed contacts and reclosures of open contacts which is another description of contact chatter are undesirable in many relay applications. There are many contributing factors which will influence contact chatter. External shock and vibration are the most important causes which may be external to the relay. The chatter which results from relay actuation or release are more difficult to remedy. In some instances, the adjustments can be changed so as to reduce the chatter to a value which will not be detrimental in the circuit in which the relay functions.

Contact chatter may increase the erosion of the contact material which would, in many instances, give a great reduction in contact life. A reduction in contact life means that the life of the relay has been reduced. Therefore, any improvement in this area is of great importance. The time during which the

Relay Dynamics *(Continued)*

relay contacts chatter is charged to the operate time of that relay. In most relays this is of minor significance.

Extreme variation of contact resistance could be called another form or manifestation of chatter. The change in compression of the two metallic buttons used for the contacts will give a corresponding change in the contact resistance. The range of this resistance could be comparatively large and where high contact resistance in the contact circuit would cause unsatisfactory functioning of the circuit, this could be called a form of contact chatter.

An interesting example of internally caused contact chatter is shown by the oscillogram of Fig. 22. In this case, a relay had been damaged by handling. The shaft had been shoved out of line by some external force.

The oscillogram shows eight pairs of traces of contact voltage. Four pairs of traces of contact voltage of the NO set during operate and four pairs of traces of the NC set during release are shown in the oscillogram in Fig. 22.

The top half of the oscillogram is for operate and shows together with the contact voltage the coil current build-up. Three of the four pairs of contact voltage traces show considerable contact chatter. Contact chatter is shown here by the series of broken traces one above the other. When the trace appears at the lower level a blank occurs at the upper level. This observation make it more convenient to follow

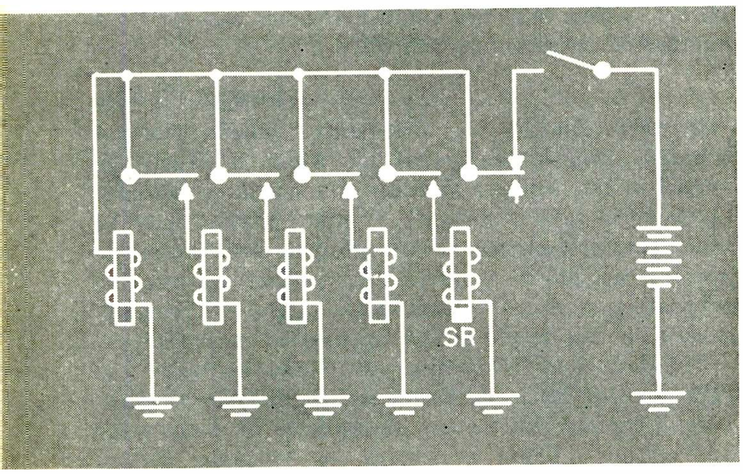


Fig. 24: "Iterative relay test circuit" for life-testing relays

the contact voltage variation of the contacts. The third pair of traces of contact voltage of the NO contacts shows no contact chatter. The second pair of traces shows the most contact chatter while the first and fourth pair show two separations after initial make.

The lower half of the oscillogram is the release condition and shows the coil current decay and the contact voltage across the NC contacts during make. The bottom trace of the top half and the seven traces in the lower half compose the four pairs of traces of contact voltage across the NC contacts. This first and second pair show two separations after initial make while the third and fourth pair show only one separation after make.

This oscillogram probably contains more traces than are convenient to study but it presents an overall picture of the contact chatter observed on a relay that was misaligned. This large amount of contact chatter is not generally found but cases have been observed where this amount did exist.

Realignment and/or rearrangement of the contact structure will help to reduce or in some cases eliminate internally the causes of contact chatter.

Temperature

The coil of the relay is wound with copper wire. The resistance of copper increases with an increase of temperature. This increase in temperature may be caused by the I^2R of the wire, or by the ambient temperature, or both. When the temperature of the surrounding media changes, the temperature of the copper wire will change.

It is important to know how to determine a change in resistance which is caused by a temperature change since this will cause a change in the coil current. If it is assumed that the voltage which is impressed across the coil is held constant, this change of coil current will result in an increase or decrease in the effective ampere-turns of the coil of the relay.

With a comparatively small change in temperature, this change in resistance may be neglected; however, for applications where a wide variation in temperature is expected, this effect is quite important. If it is assumed that the temperature variation will be from -65°C. to 185°C., the coil resistance would be approximately two and one-half times greater at the higher temperature than at the lower temperature. This would result in a coil current which would decrease by the same amount.

Except at very low temperatures, it has been found that the resistance-temperature relationship may be expressed by:

$$\frac{R_{t_1}}{234.5 + t_1} = \frac{R_{t_2}}{234.5 + t_2}$$

where

R_{t_1} = resistance in ohms at a temperature of tiC.
t_1 = temperature in degrees Centigrade.
t_2 = temperature in degrees Centigrade.
R_{t_2} = resistance in ohms at a temperature of t_2 °C.

It is assumed that the pull which is exerted on the armature of the relay by the coil is proportional to the square of the current. In the paragraph which compared the coil resistance at -65°C. and 185°C., the current would be decreased by a factor of approximately 2.5 and the resultant pull under these conditions would be approximately one-sixth. In other words, a wide temperature change makes a profound change in the relay. These factors cannot be ignored.

Hermetically Sealed Relays

Final testing of hermetically sealed relays to determine proper adjustments presents a difficult problem. A destructive test is out of the question, so the tests are limited to those that can be accomplished by making measurements outside of the case.

The tests to determine the transient response are limited mainly to coil current and contact voltage and current. The traces shown in the oscillogram of Fig. 23 were taken from a relay that was originally an hermetically sealed relay. A coil current trace was recorded of the relay when it was sealed and then the case removed and another coil current trace recorded. The two traces were identical and were the same as that shown in Fig. 23 except of scale.

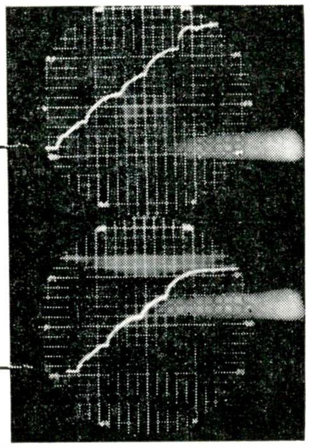


Fig. 25: Sample of the combined transient current

The traces shown at the bottom of Fig. 23 are coil current build-up and contact voltage across the NC contacts. The current shows a double cusp which was unusual and was the reason we removed the case. To find out what caused the peculiar shape of the coil current, two additional traces were taken similar to those shown in the top half of Fig. 23. The two traces in the top half of Fig. 23 show coil current build-up and armature motion simultaneously. Comparison of the two traces shows that the armature apparently hit something and its change in motion caused a change in the coil current. This demonstrates that it is possible to use the coil current to detect the motion of the armature under certain conditions.

Mechanical inspection of the relay, after it was opened, indicated the armature buffer or contact lifter touched the movable spring of the NC contacts causing the armature to momentarily slow down. After sufficient magnetic pull had been established, the armature then completed its travel to the closed position causing the second cusp in the coil current build-up trace.

Iterative Relay Test Circuit

There are probably a number of schemes that could be used to life test relay contacts, and each one has certain advantages. One possible method using a sequential circuit is shown in Fig. 24. This figure shows only four relays each using a NO contact being tested. Any number of relays each using a NO contact could be connected in the circuit and tested. All relays must operate before the cycle is repeated so too many relays would require too long a time for a cycle. For this set up any one contact failing to make would interrupt the cycle. In this manner the particular contact that missed would be on the last relay of the set of operated relays.

The reset relay, which is the relay having the NC contact connected to the battery in Fig. 24, should be of the slow release type. This characteristic is required of the reset relay in order to provide time enough for all the relays under test to release. All test relays are deenergized simultaneously but all of them will not necessarily break at the same time because of variations in each relay. Slow release in this case was obtained by placing a slug on the core of the reset relay.

An interesting result is obtained by observing the combined coil current build-up of all the relays in the circuit. This can be done by recording the transient current delivered by the battery. A resistor of small value can be placed in the ground lead of the battery and the voltage drop across it applied to the Y input of an oscilloscope.

A sample of the combined transient current is shown in Fig. 25. The top trace shows the coil current build-up of the combined set. As each relay is energized a rise occurs in the current trace. The five changes in the shape of the coil current trace can be observed in the top trace of the oscillogram. It will be noticed that the slope of the last rise is greater than the previous four.

This occurs because the first four relays were of the same type, not containing a slug, while the last or reset relay had a slug. This sharp rise in coil current is a characteristic of a relay with a slug as demontrated in another section of this article.

The lower trace in Fig. 25 shows the combined coil current build-up for a failure in the contact operation of the fourth relay. This conclusion is obtained from the fact that only four current rises are observed in the trace indicating the fifth or in this case the reset relay was not energized. Since the contact on the fourth relay controls the energization of the reset relay, this fourth contact must have been the one that failed to make.

Various modifications may be added to this circuit such as a counter operated off another set of contacts on the reset relay. This count would be the number of operations of each relay. Additional NO contacts on a relay may be connected in series with each other and failure of any one would stop the cycling. NC contacts could be tested by a similar circuit which would operate the relay when the contacts open. Faster cycling is obtained by decreasing the number of test relays in the set but the total number of relays tested per reset relay naturally would be decreased.

(*Continued on following page*)

Relay Dynamics *(Concluded)*

Relay Specifications

After the study of numerous relay specifications, it seems that much remains to be accomplished. There is no question but that environmental conditions pose a serious problem. It is well known that a change in temperature changes the resistance of the coil which in turn will reduce the coil current if the supply voltage remains constant. It is surmised that the pull-in and drop-out values will change as the temperature changes. Relay manufacturers have been able to meet these requirements so far but as ambient temperatures are increased these problems will become more vexing.

While environmental conditions are important to the proper functioning of a relay, the characteristics of a relay are of equal or greater significance. An attempt has been made to call attention to some of the peculiar and inherent features which a relay possesses. It seems that these properties of a relay are little understood by the writers of specifications.

In one specification (which was prepared several years ago), the requirements of the contact gap was given as, "the total contact gap shall not be less than 3/32 of an inch." In another section, the "pick-up voltage" and "drop-out voltage" were required to be stated. It seems that the transient performance should be of far more concern than the contact gap of a relay.

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As previously indicated in the section on static characteristics, if three of the five variables are given, then the other two are fixed. This means that the three stated values should not be picked at random, since this could cause the two dependent variables to take on impossible values. At times it may not be obvious that the specified requirements are conflicting. Specifications should be concerned with performance. In the case of a relay it should be the dynamic performance. Since the one who specifies the relay is not a relay designer, difficult situations sometimes exist when too many arbitrary variables are fixed in the specification.

It is believed that transient relay performance and fitting this performance to a given case should be the ultimate goal of a specification writer. Obviously, this chore cannot be delegated to those persons totally unfamilar with the theory of electric relays.

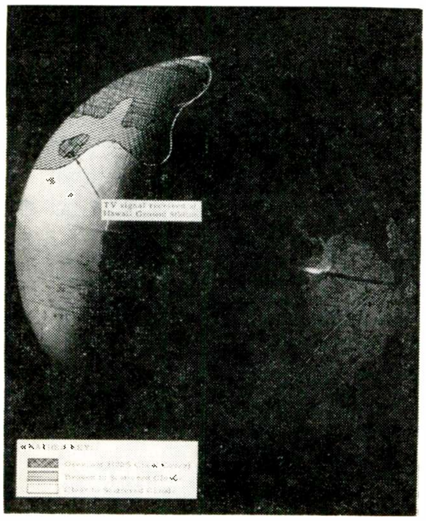
* * *

Satellite Sends Earth Image

EXPLORER VI, the "paddle-wheel" satellite, launched August 7th, 1959 is transmitting information to several receiving stations on earth. This information is obtained from the satellite's observations as it spins through space 20,000 miles over our head.

The satellite is observing gieger counter rates, ionizing power, scintillation counter response, magnetic field measurements, electron density, meteorite strikes, and conducting low frequency radio propagation experiments.

Fig. 1: Lined areas at left represent a cloud-cover map prepared from charts



A telemetering channel is assigned for facsimile equipment use. This equipment permitted us to see, for the first time, crude graphic images of what the satellite installed camera viewed. This system has been referred to by some as a "television" link. But in view of the limited shade gradations (eight steps) and the relatively long time to complete the transmission of one picture (40 minutes), it is evident that the simultaneity of TV in the strict sense, is missing. However, the important point is that we can get a satellite's eye-view of the earth via radio pictures.

How was this scientific advance in the fields of instrumentation and radio propagation accomplished? Before mentioning technical details, let us look at the Fig. 1 and consider the conditions under which it was taken.

Fig. 2: The first crude picture of the earth obtained from Explorer VI satellite

The picture covers a broad area of the central Pacific. It was made from signals received by the South Point, Hawaii tracking station on August 14th. At the time of transmission, Explorer VI was about 17-

(Continued on page 252)

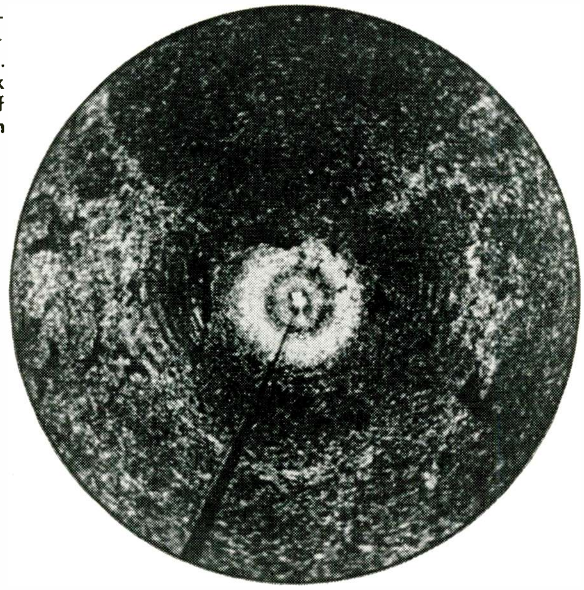


Fig. 1: Radar photo of Arctic ice pack taken with anti-shading circuit shown in Fig. 4. Dark wedge at 7 o'clock results from the closure of the camera during film transport.

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Better Resolution Through PPI Shading

Removing the overly bright center from a PPI eases viewing and permits control adjustments that significantly improve contrast and resolution. A simple circuit modification makes this possible. Flight tested and proven, that circuit is presented here.

THE bright center that is characteristic of many PPI radar displays results from variation in sweep overlap as a function of radius. When a ground-range sweep is employed, the radial variation of phosphor excitation is greatly modified by the ever-changing sweep speed. Both of these cases of PPI shading may be analyzed when the light output of the phosphor is a linear function of the screen excitation, and the film integrates linearly all of the light which is imaged on it. While neither of these requirements is realized in practice, the general behavior of a system does not deviate greatly from the results of the simplified analysis based on these assumed properties.

Slant-Range Sweep

The slant-range to a target when its signal is received t seconds after transmission of the pulse is

$$S = \frac{c\,t}{2} \qquad (1)$$

On the radar display, the distance to the target is

$$x = \frac{r_M}{S_M} S = \frac{c\,r_M}{2\,S_M} t \qquad (2)$$

where r_M is the maximum usable radial sweep length, and S_M is the corresponding value of the maximum slant range on the specific sweep range setting.

If the spot size is w, then the time spent by the sweep in passing the n^{th} spot, i.e., between $x = nw$ and $x = (n + 1)\ w$ is

$$t_{n+1} - t_n = \frac{2\,S_M}{c\,r_M} w \qquad (3)$$

Then the total time that the sweep is over an annulus of width w during a scan is obtained from the time per sweep in Eq. (3) multiplied by the number of sweeps in a scan, PT. Here P is the pulse repetition rate and T is the scan period. The result is

$$\frac{2\,S_M\,w\,P\,T}{r_M\,c}$$

The total time in each annulus as expressed above multiplied by the beam current, i_b, is the total charge delivered to each annulus during a scan:

$$Q = \frac{2\,S_M\,P\,T\,i_b\,w}{r_M\,c} \qquad (4)$$

PPI Shading *(Continued)*

The area of the n^{th} annulus is

$$\pi\left[(n+1)^2 w^2 - n^2 w^2\right] \equiv \pi(2n+1)w^2 = 2\pi r w \qquad (5)$$

where the radius is defined at the middle of the annulus:

$$r \equiv \left(n+\frac{1}{2}\right)w, \quad r \geq \frac{w}{2} \qquad (6)$$

Consequently, the average charge density in the annulus of width w centered about radius r is

$$\sigma_a(r) = \frac{Q}{\text{area}} = \frac{P\,S_M\,T\,i_b}{\pi\,c r_M\,r}, \; r \geq \frac{w}{2} \qquad (7)$$

The subscript a is employed to emphasize that this result applies to the average charge density. This point is raised because the peak excitation along a sweep line significantly exceeds the average excitation when adjacent sweep lines are spaced more than half a spot apart, i.e.,

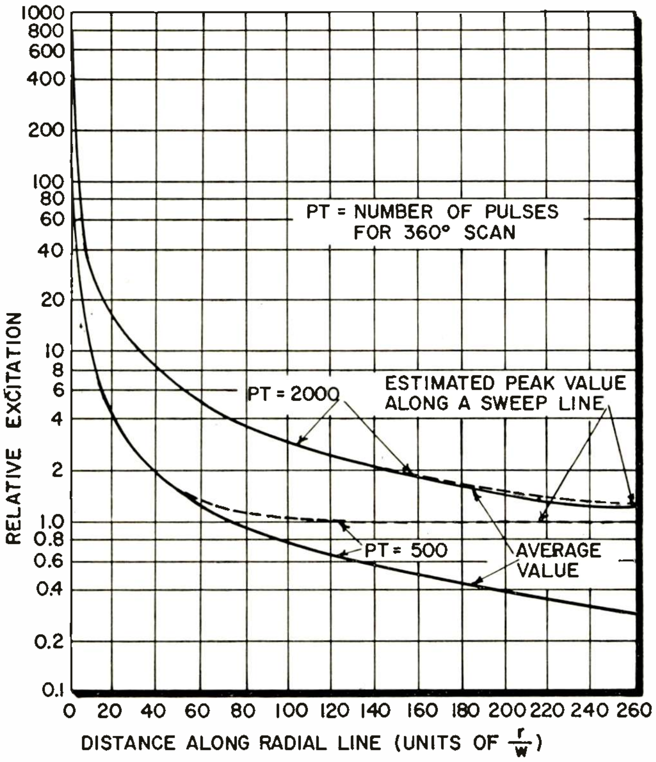
$$\frac{r}{w} \geq \frac{P\,T}{4\pi} \qquad (8)$$

The peak excitation along a single sweep line is obtained by dividing the total current by the area swept out in unit time, $w\,v$:

$$\sigma_L = \frac{i_b}{w\,v} = \frac{2\,i_b\,S_M}{w\,c\,r_M} \qquad (9)$$

where the velocity, v, is obtained by differentiating Eq. (2). For plotting purposes it is convenient to form the ratio of the average charge density to σ_L, which results in

Fig. 2: PPI shading on a slant-range display. Charge density values near center are several hundred times greater than at outer edge of display.



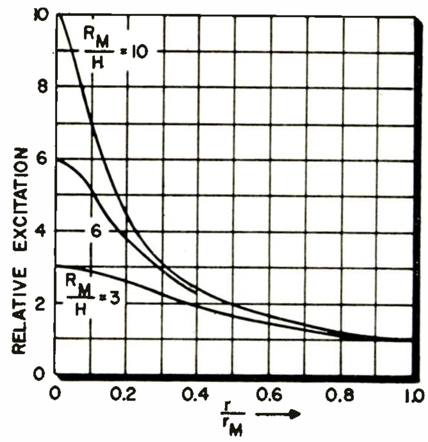


Fig. 3: PPI shading on a ground-range display. Excitation at center is only 3 to 10 times as great as at outer edge of display.

$$\frac{\sigma_a(r)}{\sigma_L} = \frac{P\,T}{2\pi\,(r/w)} \qquad (10)$$

The curves of Fig. 2 serve to illustrate the distinction between the peak and average charge densities. Of additional interest is the indication of very rapid increase of charge density near the center of the display, where values are several hundred times greater than at the outer edge of the tube.

Ground-Range Sweep

The derivation of the average charge density for a slant-range sweep was presented in detail because the analysis of the ground-range sweep follows an identical sequence of steps. For an aircraft altitude, H, the ground range, R, is

$$R^2 = S^2 - H^2 = \left(\frac{c\,t}{2}\right)^2 - H^2 \qquad (11)$$

and the distance to a target on the display is

$$x^2 = \left(\frac{r_M\,R}{R_M}\right)^2 = \left(\frac{r_M}{R_M}\right)^2\left[\left(\frac{c\,t}{2}\right)^2 - H^2\right] \qquad (12)$$

whence

$$t = \frac{2}{c}\left[\left(\frac{R_M}{r_M}\,x\right)^2 + H^2\right]^{1/2} \equiv A\,(x^2 + B)^{1/2} \qquad (13)$$

where

$$A \equiv \left(\frac{2\,R_M}{c\,r_M}\right) \qquad (14)$$

$$B \equiv \left(\frac{r_M\,H}{R_M}\right)^2 \qquad (15)$$

Then the time interval required to sweep past the n^{th} spot, i.e., between $x = nw$ and $x = (n+1)\,w$ is

$$t_{n+1} - t_n = A\left\{\left[(n+1)^2 w^2 + B\right]^{1/2} - (n^2 w^2 + B)^{1/2}\right\}$$

$$\equiv A\,(n^2 w^2 + B)^{1/2}\left\{\left[\frac{(n+1)^2 w^2 + B}{n^2 w^2 + B}\right]^{1/2} - 1\right\}$$

$$\equiv A\,(n^2 w^2 + B)^{1/2}\left\{\left[1 + \frac{(2\,n+1)\,w^2}{n^2 w^2 + B}\right]^{1/2} - 1\right\} \qquad (16)$$

The series expansion yields

$$t_{n+1} - t_n \doteq \frac{A\,(2\,n+1)\,w^2}{2\,(n^2 w^2 + B)^{1/2}}$$

$$= \frac{A\,w\,r}{\left[\left(n+\frac{1}{2}\right)^2 w^2 - \left(n+\frac{1}{4}\right)w^2 + B\right]^{1/2}}$$

$$= \frac{A\, w\, r}{\left(r^2 - r\, w + \frac{w^2}{4} + B\right)^{1/2}} \qquad (17)$$

When the maximum radar range is between 3 and 10 times the altitude, and a 5-in. scope radius is employed, B is between 0.25 and 3 sq. in. Therefore, if the spot size is one-thousandth inch, the omission of the second and third terms of the denominator in Eq. (17) is justified; then with the substitution for the constants, the time spent by the sweep in an annulus becomes

$$t_{n+1} - t_n = \frac{2\, R_M\, w}{c\, r_M} \quad \frac{r}{\left[r^2 + \left(\frac{r_M\, H}{R_M}\right)^2\right]^{1/2}} \qquad (18)$$

Consequently the total time in the annulus for all sweeps is obtained by mutiplying by PT, and the further product by the screen current, i_b, furnishes the total charge delivered to the annulus. Finally, division by the area, Eq. (5), provides the average charge density:

$$\sigma_a(r) = \frac{P\, T\, i_b}{2\, \pi\, r\, w} \cdot \frac{2\, R_M\, w}{c\, r_M} \quad \frac{r}{\left[r^2 + \left(\frac{r_M\, H}{R_M}\right)^2\right]^{1/2}}$$

$$= \frac{P\, T\, R_M\, i_b}{\pi\, c\, r_M^2} \cdot \frac{1}{\left[\left(\frac{r}{r_M}\right)^2 + \left(\frac{H}{R_M}\right)^2\right]^{1/2}} \qquad (19)$$

This function is plotted in Fig. 3, where it may be observed that for the range-to-altitude ratios commonly used, the excitation at the center of the display is only 3 to 10 times as great as at the outer edges.

Compensation

Several methods of compensating for the large value of central excitation have been proposed. The only electronic means of real technical merit is "variable video compression," i.e., variation of the video gain as a function of range.[1] A simple means of accomplishing this objective is indicated in Fig. 4. The tube used in a video amplifier, shown in Fig. 4a as a 6AK5, has a transconductance that varies rapidly with bias. Normally, it operates with a negative bias supplied by a voltage divider from the −300 volt supply except during sweeps when the range gate, Fig. 4c, is applied to raise the grid above cutoff. Introducing the circuit of Fig. 4b by connecting points A-A causes the grid bias variation to take the form of Fig. 4d.[2]

1. Shaping of the antenna pattern for uniform PPI presentation of closely packed isotropic targets is described by R. W. Clapp in "A Theoretical and Experimental Study of Radar Ground Return," M.I.T. Rad. Lab. Rep. 1024; April 10, 1946.

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A variable resistor is included in the compensation circuit so that the waveform can be adjusted when either sweep range or aircraft altitude is changed. The dependence on altitude is a factor only when ground-range sweeps are employed, since the variable speed of a ground-range sweep modifies the amount of compensation required.

The simple circuit described here was used in flight tests over a four-year period both at the Aerial Reconaissance Laboratory, Wright Air Development Center, and by the Goodyear Aircraft Corp. An example of its performance is given in Fig. 1, which is a radar photograph taken over the ice pack north of Alaska in 1952. The uniformity of return over a poor reflector such as ice is strong evidence of the value of shading compensation.

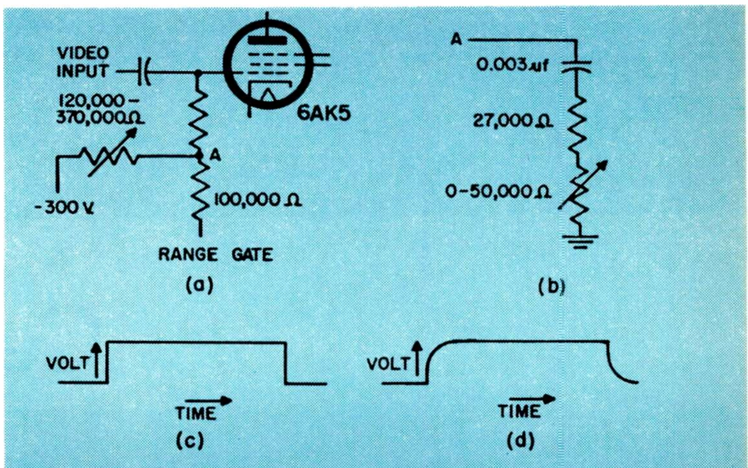


Fig. 4: Anti-shading circuit: (a) Range-gated video amplifier, (b) compensation network, (c) original bias waveform, and (d) final bias waveform.

The operational evaluation of this technique indicated that elimination of the overly bright center improved the operator's ease of viewing the display and permitted adjusting the CRT bias, the antenna tilt, and the gain controls to achieve a significant improvement in both the contrast and the resolution of detail in the display. Since better settings of the above-mentioned controls were inserted, the entire display was improved rather than merely its center. Some of this gain is evident in Fig. 1 despite its being several steps removed from the original negative.[3]

2. At the input to the cathode-ray tube, the wave form of Fig. 4d appears as a base on which the radar video signal rides. A more elaborate circuit that eliminates this effect is described in the "Final Engineering Report on Radar Plan Position Recorder OA-(SA-27)/APS-23," General Precision Laboratory, Inc., Pleasantville, New York, pp. 39-41; January, 1956.

If the radar receiver is linear, it may be easier to use established methods of sensitivity time control. However, for a lin-log or other receiver employing dynamic compression, sensitivity time control is not equivalent to variable video compression.

3. This evaluation was performed by a half dozen operators, who took several hundred thousand photographs. For security reasons, only the ice pack could be reproduced here, so that before-and-after pictures of terrain could not be presented.

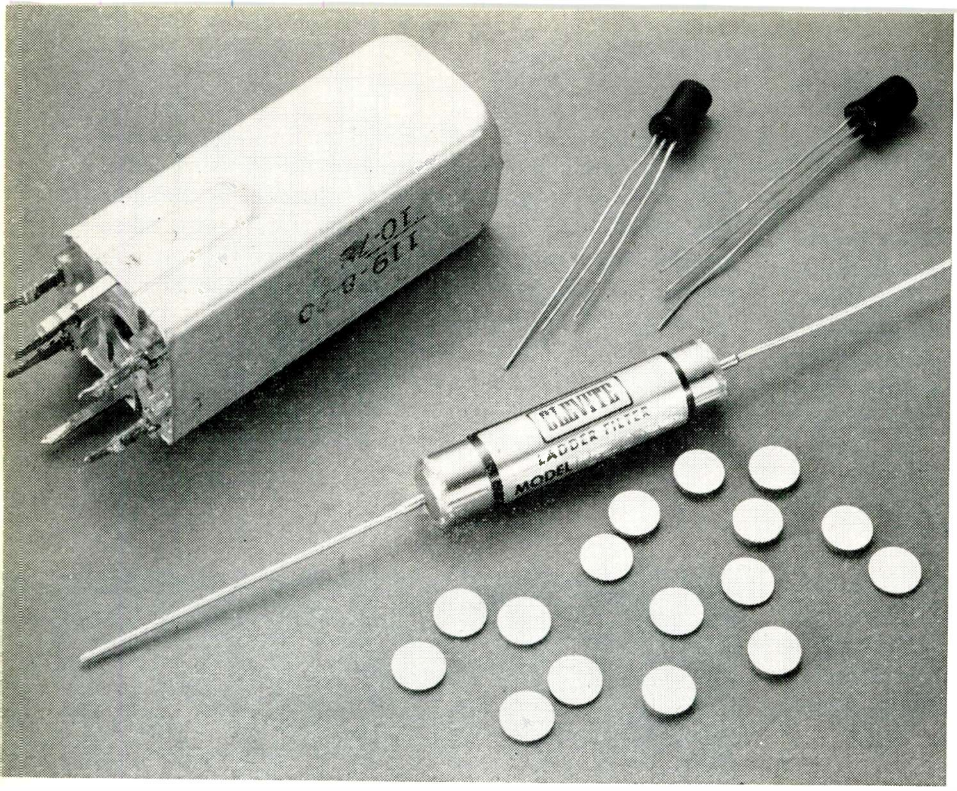


Fig. 1: A typical miniature disc ceramic filter is shown with an i-f transformer and two transistors.

Ceramic Filters Aid

The demand for small electronic components makes the ceramic ladder filter desirable for communications receivers, Many i-f stages can be eliminated while obtaining increased sensitivity. These filters are well suited for transistorized circuits.

SOLID state devices offer a simple solution to the requirements of the electronic communications field. Ceramic filters enable circuit designers to depart from conventional design-limiting considerations such as shielding and miniaturization. The increased demand for small electronic components has made the miniature ceramic ladder filter very desirable. No magnetic shielding is required with these filters.

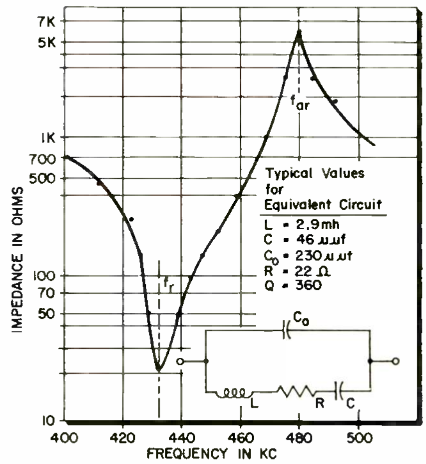
Design is simplified in receivers when ceramic filters are employed. Many space consuming i-f stages can be eliminated and improved selectivity still be obtained. In single-sideband communications ceramic ladder filters are very effective in rejecting the carrier frequency and the undesired sideband. Piezoelectric bandpass filters often eliminate an extra stage of conversion.

Piezoelectric Effect

Ceramic ladder filters make use of the piezoelectric effect in lead-zirconate-titanate ceramics. When the frequency of an electrical signal imposed on a piezoelectric element is equal to the natural resonant frequency of the element, the element undergoes a maximum dimensional change. This phenomenon is used in the filters to obtain desired results.

The filters are made of round flat discs with silver electrodes on both faces. There is no mechanical coupling between the discs. Connection between them is wholly electrical. Spring elements between the ceramic discs dampen any mechanical vibration which might be transmitted to adjacent discs.

Fig. 2: Impedance variation vs. frequency and the equivalent circuit for a fundamental ceramic disc resonator are shown.



By ANTHONY LUNGO

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Miniaturization

Anthony Lungo

The flat discs permit operation in the radial mode which is a relatively spurious-free mode. The overtone responses are also not harmonically related.

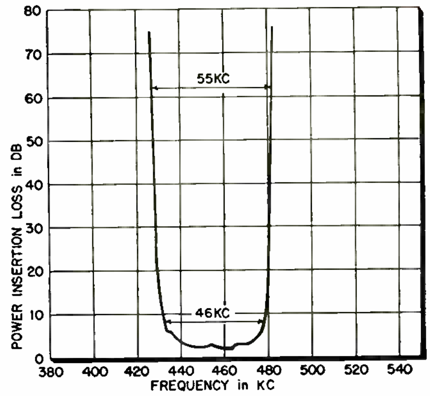
Because of their physical simplicity, the ceramic ladder filters are rugged. They are unaffected by shocks exceeding 100 G. Their small size permits the miniaturization of both military and commercial equipment without affecting selectivity.

Disc Elements

The value of ceramic discs as tuned circuit elements depends upon their resonant and anti-resonant frequencies remaining stable with respect to temperature and time. Over the temperature range from —40°C to +85°C the resonant frequency for a disc will vary by only ±0.1% while the anti-resonant frequency will hold its position with respect to resonant frequency within 0.04%. The properties of these discs age very slowly with time in an approximately inverse exponential manner.

The fabrication of these discs is similar to the manufacture of aspirin tablets. They are pressed into

Fig. 3: Response curve for typical ceramic filter is shown. Bandwidth is approximately 10% of center frequency.



shape from a powder at high pressures. Characteristic frequencies are accurately reproducible with this technique. Additional steps in the manufacture of the discs are firing, electroding, and polarization.

The fundamental radial resonator is free of spurious responses in the vicinity of its fundamental resonance. The nearest overtone response is 2.6 times the fundamental resonance. For a disc which is resonant at 455 KC, the first overtone frequency is approximately 1.18 MC—far removed from the fundamental response.

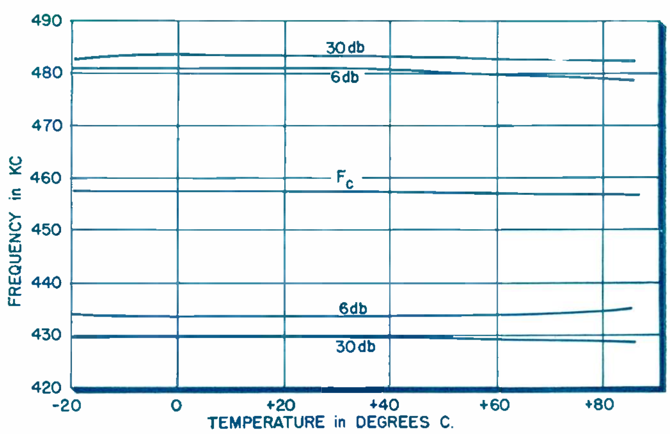
Ceramic Disc Impedance

The impedance of ceramic resonators is determined by the area of the electrodes, the thickness of the resonator, and the dielectric constant of the material. Although the natural resonance of piezoelectric ceramics is dependent on the dimensions, geometry of the resonator can vary considerably for a given resonant frequency.

Maximum electrode area is inversely proportional to the resonant frequency. This places a limit on the minimum impedance that can be designed into a fundamental resonator. The impedance can be increased by making the electrode area less than the total area of the disc. However, there is a limit to this approach. This occurs when the electrode is made so small that the disc cannot be excited efficiently. For good excitation the minimum electrode area should not be less than approximately one quarter of the total area of the resonator.

The thickness provides a second effective parameter for control of the impedance. The minimum thickness

Fig. 4: Effect of temperature on bandpass frequency at the 6 db and 30 db points of a ceramic filter is shown.



is limited by fabrication techniques. At the present time, this is 0.013 inch. As fabrication techniques improve, this minimum will be lowered. The maximum thickness is limited by the diameter of the resonator. A minimum ratio of diameter to thickness is 4 to 1. If this ratio is made smaller, other modes of vibration will interfere with the radial mode.

For proper operation, the ceramic discs must be permanently polarized by an electric field. Such a field is applied between electrodes while the material is heated in an oil bath. A procedure is to apply a dc electric field for the prescribed time with the unit heated to a temperature below the Curie temperature of approximately 350°C. The Curie temperature establishes the upper operating limit of these filters. Exposure to a higher temperature would destroy the effect of polarization with consequent loss of the piezoelectric properties.

Composite Filters

From an analysis of the equivalent circuit and a knowledge of the characteristics of the individual resonators, considerable work was done in designing composite filters with specific characteristics.

The center frequency, bandwidth, and filter skirt selectivity of a composite ceramic filter are a function of element sizes, spacing and number of elements used.

Input and output impedances of ceramic filters are directly proportional to the area of the disc electrodes and inversely proportional to their thickness. A different range of impedance will exist for every frequency of operation that is selected.

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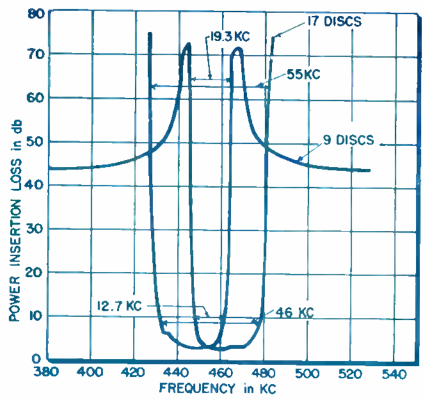
The impedance transformations achieved with the varied filter configurations investigated indicate that ceramic filters are ideally suited to transistor applications where filter impedance must be in the order of 1000 to 2000 ohms. Since effective Q of piezoelectric materials is higher than that obtained with electrical components, it is possible to transmit energy through ceramic filters over a band of frequencies with a lower insertion loss. Using materials having Q's ranging from 50 to 2,000, bandwidths of the designs built to date range from 1 to 10% of center frequency. The power insertion loss of these designs, which is dependent on both Q and bandwidth, ranges from 0.5 to 15 db. Insertion loss of ceramic filters is lower and skirt selectivity improved over that of electrical filters.

Spurious Response

Since resonators in filters are distributed elements, they have a number of natural vibration frequencies in addition to the frequency utilized for operation of the filter. These undesired resonances give rise to spurious responses only outside the pass band.

Fig. 5: Comparison of a stopband rejection is made between a 17-disc and a 9-disc ceramic filter. Output and input Z = 1500 ohms.



Although numerous filter structures have been built to minimize spurious responses, the ceramic disc type ladder filter design suppresses spurious responses to a greater degree. Spurious responses with this design have been reduced to 60 to 100 db below the pass band level. Thickness expander and thickness shear modes of operation have been discarded because they are susceptible to excessive spurious resonant effects.

Test Results

Performance of a typical 17-disc ceramic ladder filter is shown in Fig. 3. This filter has a 6 db bandwidth of 46 KC and a 60 db bandwidth of 55 KC. Nominal input and output impedance of the unit is 1500 ohms.

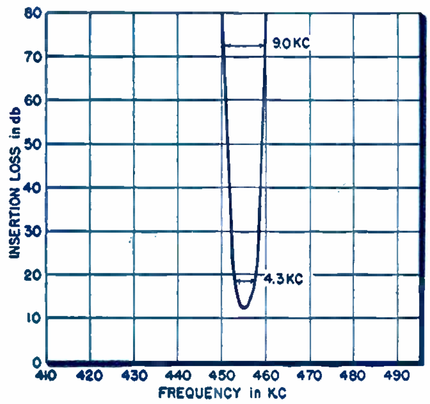
Bandwidth of ceramic filters is a function of the electro-mechanical coupling of the discs and the processing of the ceramics. Bandwidths can range from 1 to 10% while center frequencies cover the range from 100 KC to 1000 KC.

Effect of temperature on filter characteristics is shown in the series of curves, Fig. 4. Bandpass characteristics of a 17-element filter are shown for temperatures of —40°C, +25°C and 85°C. Insertion loss for the operating temperature range varies about 2 db while frequency shift is about 0.1% from +25 to +85°C and 0.05% from +25°C to —40°C.

The more elements there are in a filter, the greater will be the stop band rejection. Filters with 9, and 17 elements are compared in Fig. 5.

Phase relationship between input and output volt-

Fig. 6: The response curve shown is for a ceramic ladder filter used in narrow band applications.



age of a ceramic filter is linear between the 6.0 db point. This is shown in Fig. 7.

It is coincidental that optimum size for ceramic filters occurs for filters operating at a mid-frequency of 455 KC. The size of ceramic filters is only 1½ inches long and 5/16 inch diameter—less than 1 cu. in. Comparative size of the ceramic filter and other common electronic components is shown in Fig. 1.

Applications

It is possible to tailor a filter to a specific application. Ceramic filters may be employed for most bandpass filtering requirements in the frequency range from 100 to 1000 KC. They are especially applicable to carrier systems and single-sideband equipment, as well as communications receivers with high performance requirements.

Ceramic filters are well suited to transistor circuit applications because of physical size and low impedance.

In radio receiver applications, a piezoelectric filter fulfills the need for selectivity in a fashion superior to that usually provided by a multiplicity of i-f transformers. Not only is the ceramic filter capable of providing a flatter passband curve and steeper skirts on the selectivity curve, but also its availability as a lumped selective network allows the designer considerably more freedom in providing an optimum receiver design.

Stability of the ceramic filter makes it more desirable in communications receivers. In mobile communications receivers using electrical filters, characteristics change at the end of one year due to aging so that the set has to be re-aligned and a new frequency crystal placed in the circuit. Ceramic filters would require ten years of aging before any such re-alignment might be necessary.

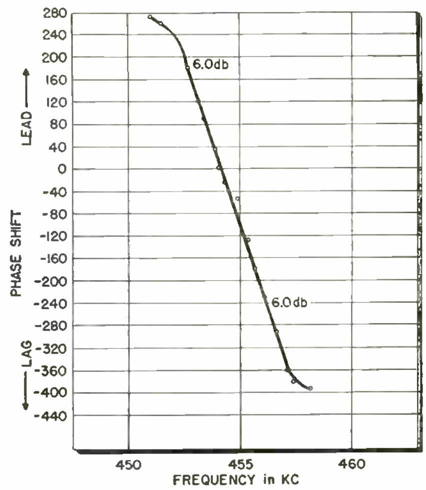


Fig. 7: Shown is the measured phase shift curve for a ceramic i-f bandpass filter.

Limiting Factors

At 455 KC, development has now reached the stage where the temperature and aging properties of the ceramic materials are the limiting factors in their use for military applications. As the work on temperature stability of materials progresses, the upper temperature extreme can be increased to 150°C without modification of design criteria. For higher operating temperatures (200° to 250°C) further work may be necessary to improve the stability of ceramics at these increased temperatures.

Manufacturing processes used in the fabrication of these resonators lend themselves to low cost production. Already they are less expensive to produce than electrical filters. With large scale production and continuing improvements in techniques, the cost of ceramic tuned circuits should decrease appreciably.

* * *

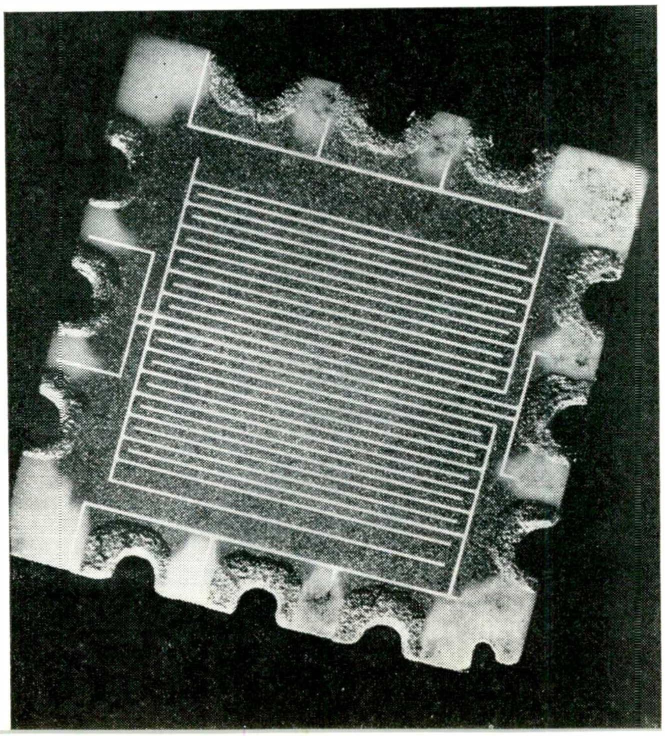
Micro-Element Resistors

THE U. S. Army Signal Corps has approved the first micro-element resistor prototypes submitted by the Weston Instruments Div. of Daystrom, Inc.

Designed and developed under a government - sponsored Industry Preparedness Program, the micro-miniature resistor prototypes are now in quantity production.

Basically, the modular resistors are produced by microscopically inscribing a series of isolation lines on a ceramic wafer measuring approx. 0.010 in. thick and 0.35 in. square to obtain the desired resistor characteristics.

Approximately 10 times smaller and lighter than present resistance components, the tiny modular resistors average 40,000 to a pound, or 600,000 per cubic foot.



This micro-thin wafer element, 0.35 in. square and 0.010 in. thick, contains two resistors; two more may be inscribed on the reverse side.

What's New . . .

Fighting Flux Contamination

PRINTED circuitry, tested functionally perfect at the time of manufacture, later failed under operating conditions in the field. The failures were caused by short-circuiting. When it was thought that moisture, absorbed by unremoved soldering flux, could be the cause, it was decided to evaluate (1) the cleanliness of printed circuit boards after use of existing cleaning techniques and (2) the effectiveness of other flux removal methods.

The Sonic Energy Applications Laboratory of the Pioneer-Central Division, Bendix Aviation Corporation, Davenport, Iowa, attacked and successfully completed the program.

The team directed its first attention to existing methods and materials.

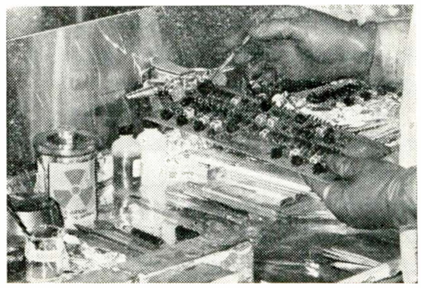
The trouble-causing circuits were printed on phenolic impregnated laminates and the printed circuits were coated with resinous flux prior to soldering. Following soldering, the boards were subjected to a vigorously agitated bath of 100% chlorinated solvent, after which visual inspection indicated apparently complete cleanliness.

Functional tests manifested symptoms of contamination, however, so the boards were subjected to both microscopic examination and chemical analysis. Neither revealed positive identification, but the suspicion of flux contamination persisted.

To determine with finality whether a residue of flux remained on the boards, and to determine accurately the amount of contamination, if any, it was decided to utilize the radioisotope tracer technique regularly practiced by the laboratory.

This decision was logical, radiologists in the laboratory pointed out, because the tracer technique makes possible the detection—and accurate measurement—of extremely minute quantities of contamination.

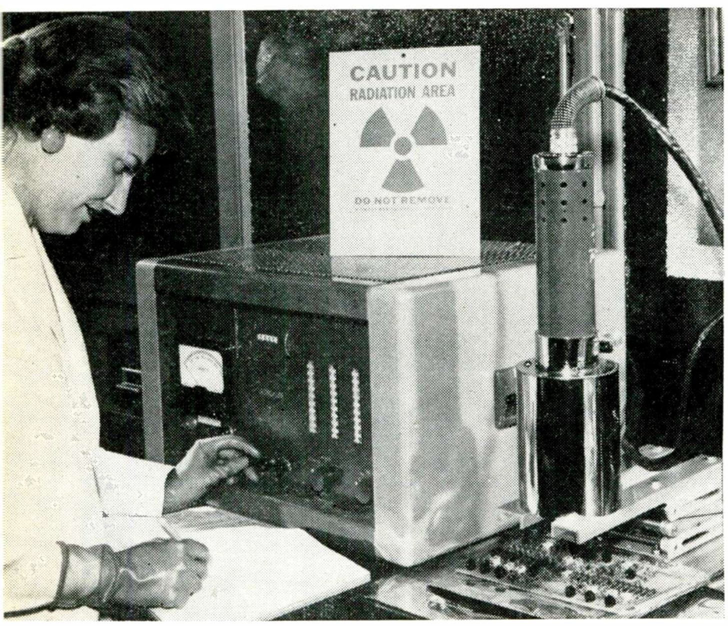
As the first step in the tracer test, radioisotopes were added to a standard resinous soldering flux. Using the radioactive flux, the printed circuit boards were soldered and then cleaned under simulated production conditions. Before-and-after scintillation counts of radioactivity furnished positive measurement of the amounts of flux contamination remaining after each of several cleaning methods and solutions were used. Results were significantly revealing, as the following step-by-step report shows:



Soldering flux to which controlled amount of radioisotopes has been added is brushed on printed board prior to soldering. Radioactive counts taken after cleaning provide accurate measurement of cleaning effectiveness.

1. Radioactive flux was brushed onto the boards to be tested and allowed to dry at room temperature for five minutes.
2. Boards were dipped in 60/40 solder at 520° F. for 5 sec.
3. Boards were then cleaned by the following methods:
   a. Mechanical agitation in 100% chlorinated solvent.
   b. Sonic energy agitation in 100% chlorinated solvent.
   c. Mechanical agitation in water based detergent solution.
   d. Sonic energy agitation in water based detergent solution.
4. Scintillation counts showed results of the various cleaning methods as follows:
   a. *Mechanical* agitation is chlorinated solvent removed only 82% of contaminating flux.

(*Continued on page* 246)

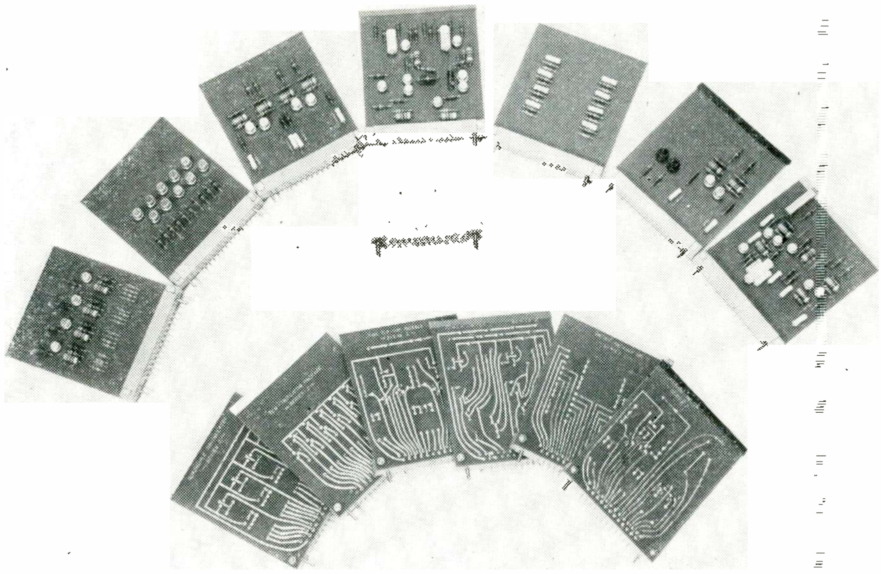


Flux contamination on printed circuits was so minute only scintillation count of radioactive flux could detect it. Radioactive tracer techniques were used to evaluate all types of cleaning processes.

Abstracted from a paper by T. J. Bulat, Ph.D., Manager, Sonic Energy Applications Laboratories, Pioneer-Central Div., Bendix Aviation Corp., Davenport, Iowa.

For further reading on this problem see page 95, *Electronic Industries*, Oct. 1959.

Packaged Switching Circuits



Special-purpose computer packages perform logical operations required for electronic data processing and recording tasks. Lower row shows reverse sides of some of the packages.

THE NBS has developed a number of special-purpose transistorized computer packages. They are expected to help automatize many of the data recording and preliminary processing tasks encountered in its scientific operations. These versatile building blocks can be connected together systematically to accept raw data from experimental equipment and to transpose these data into a form suitable for input to a high-speed electronic computer.

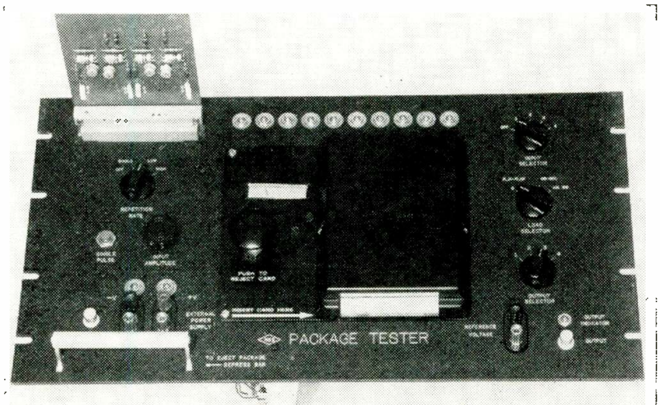
Each assembly of packages can be tailored to fit the special requirements of the project. It can also be used at the site of the experiment. The output from the system can be fed directly to a computer, recorded on a suitable medium for computer input at a later time, or used to drive display equipment that will keep the scientists informed of the progress of his experiment.

The accelerating pace of current scientific effort and the need for conserving technical manpower both emphasize the value of automatically recording and computing experimental data. Much human effort is spent in the simple repetitious tasks of taking data during an experiment; then, performing large volumes of hand calculations. By automatizing the routine data-handling aspects, savings of time and labor, as well as increased quantity and reliability of work output, can be realized.

In surveying its own data-handling instrumentation problems, NBS decided that it could best meet its needs with a series of flexible logical building blocks. These would record and perform preliminary processing of much of its data. The blocks can be used where (1) data are produced in large volumes; (2) data taking is extremely fast, extremely slow, or extremely precise; (3) a need exists to minimize human error, tedium, and eyestrain; or (4) computation is extensive.

So far, 7 specialized major building blocks have been developed: A flip-flop, gating circuitry, a "one-shot" pulse generator, a logical OR-inverter, an indicator, an analog switch, and a power gate driver. They are, of course, compatible with each other and all operate at the same 50-KC pulse repetition rate.

Each package is constructed on a 4 in. by 5 in. plug-in printed board, and uses electronic components that are common stock items to avoid replacement problems. Most of the packages contain type 2N414 transistors, and some contain types 2N363 or 2N123 transistors. Power supply requirements are (1) —12 v., (2) +12 v., (3) a reference voltage for the analog switch, and (4) any other special voltages that drive external electro-mechanical devices. In most of the packages, some components or subassemblies are left unconnected, and must be wired externally to the package. Connecting these components externally allows greater flexibility in combining them.



This instrument tests all of the various special-purpose packages under simulated operating conditions.

ELECTRONIC INDUSTRIES

1960 Directory of Microwave Equipment Manufacturers

Latest compilation provides names and addresses of companies who make the principal microwave products for today's markets.

AMPLIFIERS & POWER SUPPLIES

ACDC Electronics
2979 N Ontario St Burbank Calif
Admiral Corp
3800 W Cortland St Chicago 47 Ill
Aeronca Mfg Corp
Middletown Ohio
Airborne Instruments Lab Div Cutler Hammer Inc
160 Old Country Rd Mineola N Y
Aircom Inc
354 Main St Winthrop Mass
Airtron Inc Div Litton Industries
200 Hanover Ave Morris Plains N J
Alfred Electronics
897 Commercial St Palo Alto Calif
American Electronic Labs Inc
121 N 7th St Phila Penna
Amerac Inc
Dunham Rd Beverly Mass
American Machine & Foundry Co Gen Eng'g Labs
11 Bruce Pl Greenwich Conn
American Rectifier Corp
95 LaFayette St New York 13 N Y
American Research & Mfg Corp
920 Halpine Ave Rockville Md
AMP Inc Capitron Div
155 Park Ave Elizabethtown Penna
Avion Div ACF Industries Inc
11 Park Pl Paramus N J
Avionics Ltd
P O Box 200 Niagara-on-Lake Ont Can.
Calif Magnetic Control Corp 11922 Valerie St N Hollywood Calif
Canoga Corp of Calif Southern Div
77 Elgin Hwy Ft Walton Beach Fla
Canoga Div Underwood Corp
15330 Oxnard St Van Nuys Calif
Clegg Labs/Div Clegg Inc
Ridgedale Ave Morristown N J
Collins Radio Co
855 35th St N E Cedar Rapids Iowa
Collins Radio Co
1930 Hiline Dr Dallas 7 Texas
Convair San Diego Div Gen Dynamics Corp
3165 Pacific Hwy San Diego Calif
Cook Electric Co
2700 N Southport Ave Chicago 11 Ill
Creative Electronics Corp
94 Lincoln Ave Stamford Conn
Deltron Inc
2905 W Leithgow St Phila 33 Penna
Dynamics Electronics Inc
87046 123rd St Richmond Hill N Y
Electronic Specialty Co
5121 San Fernando Rd Los Angeles 39 Calif
Emerson Electric Mfg Co
8100 Florissant Ave St Louis 21 Mo
EMI Cosser Electronics
Woodside Darthmouth Nova Scotia
Empire Devices Products Corp
37 Prospect St Amsterdam N Y
Farnsworth Electronics Co Div ITT
3702 E Pontiac St Ft Wayne Ind
Federal Mfg & Eng'g Co
1055 Stewart Ave Garden City N Y
General Electric
High Voltage Specialty Transformer Dept Holyoke Mass
General Electric Co Technical Products Dept
Syracuse N Y
Granger Associates
966 Commercial St Palo Alto Calif
Grem Eng'g Co
923 Longview Rd King of Prussia Pa
Hazeltine Electronics Div Hazeltine Corp
59-25 Little Neck Pkwy Little Neck 62 N Y
Hermetic Seal Transformer Co
555 B 5th St Garland Texas
Hoffman Electronics Corp
3761 S Hill St Los Angeles 7 Calif
Laboratory for Electronics Inc
1079 Commonwealth Ave Boston 15 Mass
LEE Inc
625 N Y Ave NW Washington 1 D C
Madigan Corp
200 Stonehinge Lane Carle Place N Y
Magnavox Corp
2131 Bueter Rd Ft Wayne 4 Ind
Magnetic Research Corp
3160 W El Segundo Blvd Hawthorne Calif
Manson Laboratories Inc
375 Fairfield Ave Stamford Conn
Maxson Corp W L
460 W 34th St New York 1 N Y
Menlo Park Eng'g
721 Hamilton Ave Menlo Park Calif
NJE Corp
345 Carnegie Ave Kenilworth N J
Omega Labs Inc
Haverhill St Rowley Mass
Peebles & Co Ltd
Bruce East Pilson Edinburgh 5 Scotland
Perkins Eng'g Corp
345 Kansas St El Segundo Calif
Peschel Electronics Inc
13 Garden St New Rochelle N Y
Polarad Electronics Corp
43-20 34th St Long Island City 1 N Y
Power Designs Inc
89-25 130th St Richmond Hill 18 N Y
Power Supplies Inc
1005 Olive St Highland Ill
Radio City Products Co
Centre & Glendale Sts Easton Penna
Radio Corp of America Commercial Electronic Products
Front & Cooper St Camden N J
Resdel Eng'g Corp
330 S Fair Oaks Ave Pasadena Calif
RS Electronics Corp
P O Box 368 Sta A Palo Alto Calif
Sarkes Tarzian Inc
East Hillside Dr Bloomington Ind
Sierra Electronics Corp
3885 Bohannon Dr Menlo Park Calif
Spectralab Instrument Co
608 Fig Ave Monrovia Calif
Technical Oil Tool Corp
1057 N LaBrea Los Angeles 38 Calif
Telechrome Mfg Corp
28 Ranick Dr Amityville N Y
Telectro Industries Corp
35-18 37th St Long Island City 1 N Y
Telerad Mfg Corp
1440 Broadway New York 18 N Y
Temco Aircraft Corp
P O Box 6191 Dallas 2 Texas
Texas Instruments Inc
6000 Lemmon Ave Dallas 6 Texas
Underwood Corp Canoga Div
150 Elgin Hwy Ft Walton Beach Fla
Varo Mfg Co
2201 Walnut St Garland Texas
Wave-Particle Corp
P O Box 252 Menlo Park Calif
Wincharger Corp
E 7th & Division St Sioux City 2 Iowa
Winder Aircraft Corp Fla
P O Box 8 Dunnellen Fla

COAXIAL CABLE & CONNECTORS

Aerolite Electronics Corp
2207 Summit Ave Union City N J
Aeromotive Eng'g Products Ltd
147 Humus Blvd Montreal 33 Que Can
Airtec Inc
130 E 1st Ave Roselle N J
Airtron Inc Div Litton Industries
200 Hanover Ave Morris Plains N J
Alpha Wire Corp
200 Varick St New York 14 N Y
American Electric Cable Co
181 Appleton St Holyoke Mass
American Super Temp Wires Inc
32 West Canal St Winooski Vt
Amphenol Connector Div Amphenol-Borg Electronics
1830 S 54th Ave Chicago 50 Ill
Amphenol Cable & Wire Div Amphenol-Borg Electronics Corp
S Harlem Ave 63rd St Chicago Ill
Amphenol Electronics Corp
1830 S 54th Ave Chicago 50 Ill

Anaconda Co
25 Broadway New York 4 N Y
Andrew Antenna Corp
606 Beech St Whitby Ont Canada
Andrew California Corp
941 E Marylind Ave Claremont Calif
Andrew Corp
363 E 75th St Chicago 19 Ill
Ansonia Wire & Cable Co
111 Martin St Ashton R I
Anton Electronic Labs
1226 Flushing Ave Brooklyn 37 N Y
Appleton Co Inc Harry
136 San Fernando Rd Los Angeles 31 Calif
Atlantic & Pacific Wire & Cable Co
137 Grand St New York N Y
Automatic Metal Products Corp
323 Berry St Brooklyn 11 N Y
Avnet Corp
5877 Rodeo Rd Los Angeles 16 Calif
Avnet Electronic Supply Co
36 N Moore St New York 13 N Y
Barker & Williamson Inc
Canal & Beavers Sts Bristol Penna
Beam Instruments Corp
350 5th Ave New York 1 N Y
Belden Mfg Co
415 S Kilpatrick Chicago 44 Ill
Birnbach Radio Co
145 Hudson St New York 13 N Y
Boston Insulated Wire & Cable Co
65 Bay St Boston Mass
Brand & Co Wm
41 North St Willimantic Conn
Buggie Inc H H
P O Box 817 Toledo 1 Ohio
Burndy Corp Omaton Div
Norwalk Conn
Cable Electric Products
234 Daboll St Providence 7 R I
Calcon Mfg Co
100 Oakland Ave Washington Penna
Cal-Connector Co
7360 Varna Ave N Hollywood Calif
Cannon Electric Co
3208 Humboldt St Los Angeles 31 Calif
Cannon Electric Co Eastern Div
Pingree & Leavitt Sts Salem Mass
Cannon Electric Canada Ltd
160 Bartley Dr Toronto Ont Canada
Carol Cable Div/Crescent Co Inc
20 Central Ave Pawtucket R I
Chester Cable Corp
1000 Top St Chester N Y
Cinch Mfg Corp
1026 S Homan Ave Chicago 24 Ill
Coaxial Connector Co Inc
37 N 2nd Ave Mt Vernon N Y
Coleman Cable & Wire Co
3919 Wesley Terr Schiller Park Ill
Columbia Wire & Supply Co
2850 Irving Park Rd Chicago 18 Ill
Connector Corp of America
12959 Sherman Way N Hollywood Calif
Consolidated Wire & Associated Cos
1635 S Clinton St Chicago 16 Ill
Continental Connector Corp
34-63 56th St Woodside 77 N Y
Continental Wire Corp
322 N Cherry St Ext Wallingford Conn
Continental Wire Corp
560 Maryland Ave York Penna
Copperweld Steel Co Wire & Cable Div
Glassport Penna
De-Jur Amsco Corp Electronic Sls Div
45-01 Northern Blvd Long Island City 1 N Y
Deutsch Co
7000 Avalon Blvd Los Angeles 3 Calif
Dielectric Materials Co
5317 N Ravenswood Ave Chicago 40 Ill
Dittmore-Freimuth Corp
2517 E Norwich St Milwaukee 1 Wis
Don-Lan Electronics Co
1101 Olympic Blvd Santa Monica Calif
Dow-Key Co
P O Box 711 Thief River Falls Minn
Dresser-Ideco Co
8909 S Vermont Los Angeles Calif
Electrical & Physical Instrument Corp
42-19 27th St Long Island City N Y
Electro-Physics Labs
2-65 Huntington Dr San Marino Calif
Entron Inc
4902 Lawrence St Bladenburg Md
Eronca Corp
16 W 46th St New York 36 N Y
Gavitt Wire & Cable Co
455 N Quince St Escondido Calif
Gavitt Wire & Cable Co
Central St Brookfield Mass
General Cable Corp
420 Lexington Ave New York 17 N Y
General Insulated Wire Works
69 Gordon Ave Providence 5 R I
General Radio Co
West Concord Mass
Gremar Mfg Co
7 North Ave Wakefield Mass
Gulton Industries Inc
212 Durham Ave Metuchen N J
Hallett Mfg Co
5910 Bowcraft St Los Angeles Calif
Haveg Industries Inc
900 Greenbank Rd Wilmington 8 Del
Hitemp Wires Inc
1200 Shames Dr Westbury N Y
Holyoke Wire & Cable Corp
720 Main St Holyoke Mass
Industrial Products Div Amphenol-Borg Electronics Corp
79 E Franklin St Danbury Conn
Instruments Inc
3102 San Springs Rd P O Box 556 Tulsa Okla
Jefferson Wire & Cable Corp
Pleasant Valley Rd Sutton Mass
JFD Electronics Corp
6101 16th Ave Brooklyn N Y
Judd Wire Mfg Corp
22 Ave A Turners Falls Mass
Kaiser Aluminum & Chemical
919 N Michigan Ave Chicago Ill
Kings Electronics Co Inc
40 Marbledale Rd Tuckahoe N Y
Lab-Tronics Inc
3656 N Lincoln Ave Chicago 13 Ill
Lenz Electric Mfg Co
1751 N Western Ave Chicago 47 Ill
Lewis Eng'g Co
339 Church St Naugatuck Conn
MB Communications Co
4626 Walnut St Phila 39 Penna
Mectron Co
166 Ridge Ave North Plainfield N J
Microdot Inc
220 Pasadena Ave S Pasadena Calif
Mohawk Wire & Cable Corp
320 River St Fitchburg Mass
Mutual Electronic Industries Corp
85 Beechwood Ave New Rochelle N Y
Mutual Electronic Industries Inc
50 Aleppo St Providence R I
Nichols Products Co
325 W Main St Moorestown N J
Okonite Co
220 Passaic St Passaic N J
Organic Development Corp
10052 Larson Ave Garden Grove Calif
Phalo Plastics Corp
530 Boston Twpk Shrewsbury Mass
Phelps Dodge Refining Corp
300 Park Ave New York 22 N Y
Philadelphia Insulated Wire Co
200 N 3rd St Phila 43 Penna
Plastic Wire & Cable Corp
Box 486 Jewitt City Conn
Plastoid Corp
42-61 24th St Long Island City 1 N Y
Precision Tube Co
Church Rd & Wissahickon Ave North Wales Penna
Prodelin Inc
305 Bergen Ave Kearney N J
Progress Electronics Co
107 Franklin St New York 13 N Y
Pye Canada Ltd
82 Northline Rd Toronto 16 Ont Canada
Radio Corp of America Commercial Electronic Products
Front & Cooper Sts Camden N J
Raytherm Corp
Oakside at Northside Redwood City Calif
Rego Insulated Wire Co
830 Monroe St Hoboken N J
Renfrew Electric Co Ltd
349 Carlaw Ave Toronto 9 Ont Canada
Revere Corp of America
N Colony Rd Wallingford Conn
Rex Corp
Hayward Rd W Acton Mass
Rockbestos Products Corp Sub Cerro De Pasco Corp
Nicoll & Canner Sts New Haven Conn
Royal Electric Corp
95 Grand Ave Pawtucket R I
Sanders Associates
95 Canal St Nashua N H
Saxton Products Inc
4320 Park Ave New York N Y
Sequoia Wire
2201 Bay Rd Redwood City Calif
Sequoia Wire & Cable Co
1630 Euclid Ave Santa Monica Calif
Standard Wire & Cable Co
3440 Overland Ave Los Angeles 34 Calif
Superior Insulated Wire Co
Washburns La Stony Point N Y
Suprenant Mfg Co
172 Sterling St Clinton Mass
Ta-Mar Inc
2339 Cotner Ave Los Angeles 64 Calif
Technical Oil Tool Corp
1057 N LaBrea Los Angeles 38 Calif
Tensolite Insulated Wire Co Inc
W Main St Tarrytown N Y
Thermal Wire Co of America
Keeblers Bay South Hero Vt
Times Electronic Sales
373 Broadway New York 13 N Y
Times Wire & Cable Co Aff Int'l Silver Co
358 Hall Ave Wallingford Conn
Transco Products Inc
12210 Nebraska Ave Los Angeles 25 Calif
Tru-Connector Corp
416 Union St Lynn Mass
Union Electronics & Machine Corp
71 Broadway Wakefield Mass
Univox Corp
102 Warren St New York 7 N Y
U S Wire Cable Co
Progress & Monroe Sts Union N J
Victor Electric Wire & Cable Corp
618 Main St Warwick R I
Victor Mfg Co
5616 Lawndale Houston 23 Texas
Waltham Horological Corp
395 Lynnway Lynn Mass
Walworth Co Electronics Div
89 Union St Mineola L I N Y
Warren Wire Co
1601 Chestnut St Alhambra Calif
Warren Wire Co
Pownal Vt
Westbury Electronics Inc
300 Shames Dr Westbury N Y
Western Insulated Wire Co
2425 N Victory St Burbank Calif
Western Int'l Co
45 Vesey St New York 7 N Y
Wirecraft Products Inc
10 Lake St Brookfield Mass
Zippertubing Co
752 S San Pedro St Los Angeles 14 Calif

MICROWAVE COMPONENTS

ACDC Electronics
2979 N Ontario Burbank Calif
Aeromotive Eng'g Products Ltd
147 Humus Blvd Montreal 33 Que Can
Ainslie Corp
321 Quincy Ave Quincy 69 Mass
Airborne Instruments Lab Div Cutler Hammer Inc
160 Old Country Rd Mineola N Y
Airtec Inc
130 E 1st Ave Roselle N J
Airtron Inc Div Litton Industries
200 Hanover Ave Morris Plains N J
Airtronics Inc
5522 Dorsey Lane Bethedsa Md
Alford Mfg Co
299 Atlantic Ave Boston 10 Mass
Allen-Bradley Co
136 W Greenfield Ave Milwaukee 4 Wis
All Products Co Communication Products Div
Box 110 Mineral Wells Texas
Alto Scientific Co
855 Commercial St Palo Alto Calif
American Electronic Labs Inc
121 N 7th St Phila Penna
Air Transport Mfg Co
1114 N Sycamore Ave Los Angeles Calif
Amerac Inc
Dunham Rd Beverly Mass
American Lava Corp Subs Minn Mining & Mfg
Cherokee Blvd & Mfrs Rd Chattanooga 5 Tenn
American Machine & Foundry Co Gen Eng'g Labs
11 Bruce Pl Greenwich Conn
American Radar Components Inc
415 E Main St Denville N J
American Transformer Div Standard Electronics
29-01 Borden Ave Long Island City 1 N Y
Amphenol Electronics Corp
1830 S 54th Ave Chicago 50 Ill
Amtron Corp
17 Felton St Waltham 54 Mass
Andrew Antenna Corp
606 Beech St Whitby Ont Canada
Andrew California Corp
941 E Marylind Ave Claremont Calif
Andrew Corp
363 E 75th St Chicago 19 Ill
Antenna & Radome Research Assoc
1 Bond St Westbury N Y
Antlab Inc
6330 Proprietors Rd Worthington Ohio
APC Electronic Products Div
Box 110 Mineral Wells Texas
Applied Radiation Corp
2404 N Main St Walnut Creek Calif
Applied Research Inc
76 S Bayles Ave Port Washington N Y
A R F Products Inc
7627 Lake St River Forest Ill
A R F Products Inc
P O Box 57 Ranton N M
Ark Eng'g Co
431 W Tabor Rd Phila 20 Penna
Arnold Eng'g Co
Marengo Ill
Atlas Coil Corp
63 Main St Ansonia Conn
Atlas Eng'g Co
176 Blue Hill Ave Roxbury 19 Mass
Atlas Precision Products Co
3801 Castor Ave Phila 24 Penna
Audicon Corp
216 Lyon St Paterson 4 N J

Automatic Metal Products Corp
323 Berry St Brooklyn 11 N Y
Automatic Switch Co
Hanover Rd Florham Park N J
Automation Dynamics Corp
255 Old Country Rd Tenafly N J
Avco Mfg Corp Crosley Div
1329 Arlington St Cincinnati 25 Ohio
Avion Div ACF Industries Inc
11 Park Pl Paramus N J
Avionics Div-Bell Aircraft Corp
P O Box 1 Buffalo 5 N Y
Avionics Ltd
P O Box 200 Niagara-On-Lake Ont Can
Avnet Electronic Supply Co
36 N Moore St New York 13 N Y
Bart Mfg Corp
Manchester Pl Newark N J
Basler Electric Co
Box 269 Rt 143 Highland Ill
Bendix Aviation Corp
Research Labs Div Southfield Mich
Berkshire Transformer Corp
Route 341 Kent Conn
Birdair Structures Inc
290 Larkin St Buffalo 10 N Y
Blaine Electronetics Inc
14657 Keswick St Van Nuys Calif
Bogart Mfg Corp
315 Seigel St Brooklyn 6 N Y
Bogue Electric Mfg Co
52 Iowa Ave Paterson 3 N J
Bomac Labs Inc
Salem Rd Beverly Mass
Brooks & Perkins Inc
1950 W Fort St Detroit 38 Mass
Budd Stanley Co
43-01 22nd St Long Island City 1 N Y
Budelman Radio Corp
375 Fairfield Ave Stamford Conn
Cable Electric Products
234 Daboll St Providence 7 R I
Calif Technical Industries Div Textron Inc
1421 Old Country Rd Belmont 10 Calif
Canadian Marconi Co
2442 Trenton Ave Montreal 16 Ont Can
Canoga Corp of Calif Southern Div
77 Elgin Hwy Ft Walton Beach Fla
Canoga Div Underwood Corp
15330 Oxnard St Van Nuys Calif
Carad Corp
2850 Bay Rd Redwood City Calif
Cascade Research Div Monogram Precision Industries Inc
5245 San Fernando Rd W Los Angeles Calif
Cascade Research Corp
53 Victory Lane Los Gotos Calif
Caswell Electronics Corp
414 Queens Lane San Jose 12 Calif
Central Electronics Mfrs
2 Richwood Pl Denville N J
Central Transformer Co
900 W Jackson Blvd Chicago 7 Ill
Ceramaseal Inc
P O Box 25 New Lebanon Center N Y
Cermatronics Inc
364 Highland Ave Passaic N J
CGS Labs Inc
Route 7 & 35 Ridgefield Conn
Chemalloy Electronics Corp
Gillespie Airport Santee Calif
Clegg Labs/Div Clegg Inc
Ridgedale Ave Morristown N J
Coaxial Connector Co Inc
37 N 2nd Ave Mt Vernon N Y
Coil Winders Inc
New York Ave Westbury L I N Y
Collins Radio Co
1930 Hiline Dr Dallas 7 Texas
Communications Accessories Co
U S Hwy 50 Lee's Summit Mo
Connector Corp of America
12959 Sherman Way N Hollywood Calif
Control Electronics Co Inc
10 Stepar Pl Huntington Sta N Y
Convair San Diego Div Gen Dynamics Corp
3165 Pacific Hwy San Diego Calif
Corning Glass Works
Bradford Penna
Cubic Corp
5575 Kearny Villa Rd San Diego 11 Calif
Custom Components Inc
P O Box 248 Caldwell N J
Defiance Eng'g & Microwave Co
Beverly Airport Beverly Mass
DeMornay-Bonardi Corp
780 S Arroyo Pkwy Pasadena Calif
Designers for Industry
4241 Fulton Pkwy Cleveland 9 Ohio
Diamond Antenna & Microwave Corp
7 North Ave Wakefield Mass
Dittmore-Freimuth Corp
2517 E Norwich St Milwaukee 1 Wis
Don-Lan Electronics Co
1101 Olympic Blvd Santa Monica Calif

Douglas Microwave Corp
252 E 3rd St Mt Vernon N Y
Dymec Inc
395 Page Mill Rd Palo Alto Calif
Dynatronic Inc
717 W Amelia Ave Orlando Fla
Dwyer Eng'g Co
Pine St Ext Nashua N H
Electro Impulse Lab Inc
208 S Archer Ave Chicago 16 Ill
Electro Impulse Lab Inc
208 River St Red Bank N J
Electronic Specialty Co
5121 San Fernando Rd Los Angeles 39 Calif
Electron Radar Products
4806 W Chicago Ave Chicago 51 Ill
Electro Contacts Inc
Main St Osterville Mass
Electro-Physics Labs
2-65 Huntington Dr San Marino Calif
Electro Tec Corp
4 Romanelli Ave S Hackensack N J
Electronics Development Co
3743 Cahuenga Blvd N Hollywood Calif
Elm Labs
10 Washington Ave Hastings-On-Hudson N Y
Elsin Electronics Corp
Eileen Way Syosset N Y
Emerson & Cuming Inc
869 Washington St Canton 1 Mass
EMI Cosser Electronics
Woodside Darthmouth Nova Scotia
Empire Devices Products Corp
37 Prospect St Amsterdam N Y
Engle Corp
Fellowship Rd Route 73 Maple Shade N J
Englehard Industries Inc
113 Astor St Newark N J
Essex Wire Corp Magnetic Winding Inc
Easton Penna
E-Z Towers Inc 5901 E Broadway Tampa 5 Fla
Farnsworth Electronics Co Div ITT
3702 E Pontiac St Ft Wayne Ind
Federal Telecommunication Labs Div ITT
500 Washington Ave Nutley N J
Filmohm Corp
48 W 25th St New York 10 N Y
Filtron Co
10023 W Jefferson Culver City Calif
Fisher Eng'g Inc
P O Box 327 Huntington Ind
Formcraft Tool Co
2465 S Archer Ave Chicago 16 Ill
Fox Co Thomas J
95 Summit St Newark N J
Freed Transformer Co
1718-36 Weirfield St Brooklyn 27 N Y
FXR Inc
26-12 Borough Pl Woodside N Y
Gabriel Electronics Div Gabriel Co
135 Crescent Rd Needham Heights 94 Mass
Gar Precision Parts
36 Ludlow St Stamford Conn
Gates Electronic Co
1705 Taylor Ave New York N Y
G B Electronics Corp
Hook Creek Blvd Valley Stream N Y
General Cable Corp
420 Lexington Ave New York 17 N Y
General Communication Co
677 Beacon St Boston 15 Mass
General Devices Inc
P O Box 253 Princeton N J
General Electric Co Apparatus Sls Div
1 River Rd Schenectady N Y
General Electric Co Power Tube Div
Bldg 267 Schenectady 5 N Y
General Electric Co Communications Products Dept
Lynchburg Va
General Electric Co of England Ltd
80 Shore Rd Port Washington N Y
General Magnetics Inc
135 Bloomfield Ave Bloomfield N J
General Radio Co
West Concord Mass
Geotechnical Corp
3401 Shiloh Rd Garland Texas
Glaser Steers Corp
2 Main St Belleville 9 N J
Gombos Inc John
Webro Rd Clifton N J
Goodrich Sponge Products B F Div B F Goodrich Co
Canal St Shelton Conn
Gulton Industries Inc
212 Durham Ave Metuchen N J
Haller Raymond & Brown
Science Park State College Penna
Hallicrafters Co
4401 W 5th Ave Chicago Ill

Hermetic Seal Transformer Co
555 N 5th St Garland Texas
Hewlett-Packard Co
275 Page Mill Rd Palo Alto Calif
Hilger & Watts Ltd
80 Shore Rd Port Washington N Y
Holland Electronics
772 E 53rd St Brooklyn N Y
Houston Fearless Corp
11801 W Olympic Blvd Los Angeles 64 Calif
Howard Foundry Co
1700 N Kestner Ave Chicago 39 Ill
Hycon Eastern Inc
75 Cambridge Pkwy Cambridge 42 Mass
Indiana Steel Products Co
Valparaiso Ind
Industrial Products Div Amphenol-Borg Electronics Corp
79 E Franklin St Danbury Conn
Industrial Transformer Corp
Gouldsboro Penna
Intaspace Corp
135 Orange St Bloomfield N J
Itek Inc
1611 Trapelo Rd Waltham 54 Mass
I-T-E Circuit Breaker Co
601 E Erie Ave Phila Penna
Jones Electronics Co Inc M C
185 N Main St Bristol Conn
J-V-M Microwave Co
9300 W 47th St Brookfield Mass
Kaiser Aircraft & Electronics Div Kaiser Industries
P O Box 1828 Oakland 4 Calif
Kay Electric Co
14 Maple Ave Pine Brook N J
Kearfott Co Inc
14844 Oxnard St Van Nuys Calif
Kearfott Co Inc
1500 Main Ave Clifton N J
Kelsey-Hayes Co
3600 Military Ave Detroit 32 Mich
Kemtron Electron Products Inc
14 Prince St Newburyport Mass
Kennedy & Co D S
155 King St Cohasset Mass
Kent Corp F C
135 Manchester Pl Irvington 11 N J
Keystone Products Co
904-6 23rd St Union City N J
King Electronics Co Inc
40 Marbledale Rd Tuckahoe N Y
Kost Products Co
2335 N Cicero Ave Chicago 39 Ill
Kulka Electric Corp
633 S Fulton St Mt Vernon N Y
Laboratory for Electronics Inc
1079 Commonwealth Ave Boston 15 Mass
Langevin Div W L Maxson Corp
47-37 Austell Pl Long Island City N Y
LaPoint Industries Inc
155 W Main St Rockville Conn
Lavoie Labs Inc
Matawan-Freehold Rd Morganville N J
Leach & Garner Co
Industrial Div Leach & Garner Bldg Attleboro Mass
Leeds Co Inc Gerard G
12 Crampton Lane Great Neck N Y
LEL
380 Oak St Copiaque LI N Y
Levinthal Electronic Products Inc
3180 Hanover St Palo Alto Calif
Lewyt Mfg Corp
43-22 Queens St Long Island City 1 N Y
Lieco Inc
3610 Oceanside Rd Oceanside N Y
Ling Systems Inc
11949 Vose St N Hollywood Calif
Litton Industries of Calif
336 N Foothill Rd Beverly Hills Calif
Litton Industries of Md
4900 Calvert Rd College Park Md
Luhrs & Co C H
297 Hudson St Hackensack N J
McMillan Industrial Corp
Brownsville Ave Ipswich Mass
Magnavox Corp
2131 Bueter Rd Ft Wayne 4 Ind
Magnesium Products of Milwaukee Inc
748 W Virginia St Milwaukee 4 Wis
Magnetic Research Corp
3160 W El Segundo Blvd Hawthorne Calif
Makepeach Div D E Englehard Industries Inc
Pine & Denham Sts Attleboro Mass
Manson Laboratories Inc
375 Fairfield Ave Stamford Conn
March Associates
Bldg 7 Commercial St Box 234 Hicksville N Y
Mark Products Co
6412 W Lincoln Ave Morton Grove Ill
Mathis Co G E
6100 S Oak Park Ave Chicago 38 Ill
Maxson Corp W L
460 W 34th St New York N Y
Mectron Co
166 Ridge Ave North Plainfield N J
Meridian Metalcraft Inc
8739 W Millergrove Dr Whittier Calif

Metal Fabricators Corp
63 Pond St Waltham 54 Mass
Metavac Inc
45-68 162nd St Flushing 58 N Y
Microflect Co
2300 S 25th St Salem Ore
Microlab
71 Okner Pkwy Livingston N J
Microphase Corp
Box 1166 Greenwich Conn
Microtech Inc
2975 State St Hamden 17 Conn
Microtran Co
135 E Mineola Ave Valley Stream N Y
Microwave Associates Inc
Burlington Mass
Microwave Chemicals Labs Inc
282 7th Ave New York 1 N Y
Microwave Development Labs
92 Broad St Babson Park Mass
Microwave Eng'g Labs Inc
943 Industrial Ave Palo Alto Calif
Mullard Equipment Ltd
Torrington Pl London WC 1 England
Narda Microwave Corp
118-160 Herricks Rd Mineola N Y
Nat'l Beryllia Corp
4501 Dell Ave N Bergen N J
Nichols Products Co
325 W Main St Moorestown N J
Northelfer Winding Labs Inc
P O Box 455 Dept EI Trenton 8 N J
N R K Mfg & Eng'g Co
4601 W Addison St Chicago 41 Ill
Nuclear Products-Erco Div ACF Industries Inc
Riverdale Md
Omega Labs Inc
Haverhill St Rowley Mass
Osborne Electronic Corp
712 S E Hawthorne Blvd Portland 12 Ore
Paul & Beekman
1801 W Courtland St Phila 40 Penna
Philco Corp
Tioga & C Sts Phila 24 Penna
Philco Corp G & I Div
4700 Wissahickon Ave Phila 44 Penna
Polarad Electronics Corp
43-20 34th St Long Island City 1 N Y
Polytechnic Research & Development Co
202 Tillary St Brooklyn 1 N Y
Precision Tube Co
Church Rd & Wissahickon Ave North Wales Penna
Premier Instrument Corp
333 New Broad St Port Chester N Y
Press Wireless Labs Inc
25 Prospect Pl W Newton 65 Mass
Prodelin Inc
305 Bergen Ave Kearny N J
Production Research Corp
Thornwood N Y
Pye Canada Ltd
82 Northline Rd Toronto 16 Ont Canada
Pye Telecommunications Ltd
Newmarket Rd Cambridge England
Q-Line Mfg Corp
1562 61st St Brooklyn N Y
Q O S Corp
Bronx Blvd at 216 St New York 67 N Y
Radar Design Corp
P O Box 38 Pickard Dr Syracuse 1 N Y
Radar Measurements Corp
190 Duffy Ave Hicksville N Y
Radiation Eng'g Labs
Main St Maynard Mass
Radiation Inc
P O Box 37 Melbourne Fla
Radio Corp of America Communications Products Dept
Bldg 1-5 Camden N J
Radio Eng'g Labs
29-01 Borden Ave Long Island City 1 N Y
Radioplane Div Northrop Aircraft Inc
800 Woodly Ave Van Nuys Calif
Ramo-Wooldridge Corp Electronic Instrumentation Div
P O Box 8405 Denver 10 Colo
Raytheon Co Commercial Equip Div
100 River St Waltham 54 Mass
Raytheon Co
100 River St Waltham 54 Mass
Rea Co J B Electronics Div
2202 Broadway Santa Monica Calif
Reeves Instrument Corp
Roosevelt Field Garden City N Y
Renfrew Electric Co Ltd
349 Carlaw Ave Toronto 9 Ont Canada
R S Electronics Corp
P O Box 368 Sta A Palo Alto Calif
Sage Labs Inc
159 Linden St Wellesley 81 Mass
Sanders Associates
95 Canal St Nashua N H
Sarkes Tarzian Inc
East Hillside Dr Bloomington Ind
Scientific-Atlanta Inc
1262 Piedmont Rd NE Atlanta 6 Ga
Sierra Electronic Corp
2885 Bohannon Dr Menlo Park Calif
Specialty Automatic Machine Corp
80 Cambridge St Burlington Mass
Sperry Microwave Electronics Co Div Sperry Rand
P O Box 1828 Clearwater Fla
Spincraft Inc
4122 W State St Milwaukee 8 Wis
Spinform Inc
65 Mechanic St Attleboro Mass
Sprague Electric Co
Marshall St North Adams Mass
Stackpole Carbon Co
St Mary's Penna
Stainless Inc
3rd St North Wales Penna
Standard Electronics Div Radio Eng'g Labs
30th & Borden Sts Long Island City N Y
Stoddard Aircraft Radio Co Inc
6644 Santa Monica Blvd Hollywood Calif
Stromberg-Carlson Div Gen Dynamics Corp
100 Carlson Rd Rochester 3 N Y
Summit Industries Inc
2104 W Rosecrans Ave Gardena Calif
Sylvania Semiconductor Div
100 Sylvan Rd Woburn Mass
Sylvania Electric Products Inc
E 3rd St Williamsport Penna
Ta-Mar Inc
2339 Cotner Ave Los Angeles 64 Calif
Taurus Corp
8 Corvell St Lambertville N J
Technical Appliance Corp
1 Taco St Sherburne N Y
Technical Oil Tool Corp
1057 N LaBrea Los Angeles 38 Calif
Technicraft Labs Inc
Thomaston-Waterbury Rd Thomaston Conn
Techniques Inc
40 Jay St Englewood N J
Telectro Industries Corp
35-18 37th St Long Island City 1 N Y
Telegraph Construction & Maintenance Co Ltd
Mercury House Theobalds Rd—Metals Group—London WC 1 England
Telerad Mfg Corp
1440 Broadway New York 18 N Y
Temco Aircraft Corp
P O Box 6191 Dallas 2 Texas
Texas Instruments Inc
6000 Lemmon Ave Dallas 6 Texas
Thermador Electrical Mfg Co
715 S Raymond Ave Alhambra Calif
Thordorson Meissner Mfg Div Maguire Industries Inc
7th & Bellmont Mt Carmel Ill
Titeflex Inc
Hendee St Springfield Mass
Topp Industries Inc
8907 Wilshire Blvd Beverly Hills Calif
Torotel Inc
5512 E 110 St Kansas City 34 Mo
Tower Construction Co
2700 Hawkeye Dr Sioux City Iowa
Transco Products Inc
12210 Nebraska Ave Los Angeles 25 Calif
Transonic Inc
808 16th St Bakersfield Calif
Transval Eng'g
10401 W Jefferson Culver City Calif
Tresco Inc
3824 Terrace St Phila 28 Penna
Triad Transformer Corp
4055 Redwood Ave Venice Calif
Tri-Ex Tower Corp
127 E Inyo St Tulare Calif
Tru-Connector Corp
416 Union St Lynn Mass
Turbo Delay Lines
Turbo Machine Co Lansdale Penna
Ultradyne Eng'g Labs
P O Box 308 Albuquerque N M
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 N Y
Universal Microwave Corp
1172-EI Grove St Irvington N J
Uniwave Inc
109 Marine St Farmingdale N Y
U S Dielectric Products Inc
98 Adams St Leominster Mass
Utility Brass & Copper Corp
255 Conover St Brooklyn 31 N Y
Van Norman Industries Inc Electronics Div
186 Granite St Manchester N H
Varo Mfg Co
2201 Walnut St Garland Texas
Vectron Inc
1611 Trapelo Rd Waltham 54 Mass
Victor RF & Microwave Co
36 W Water St Wakefield Mass
Wacline Inc
35 S St Clair St Dayton 2 Ohio
Waltham Horological Corp
395 Lynnway Lynn Mass
Walworth Co Electronics Div
89 Union St Mineola LI N Y
Waveguide Inc
1769 Placentia Costa Mesa Calif
Waveline Inc
P O Box 718 Caldwell N J
Wayne-Kerr Corp
2920 N 4th St Phila 33 Penna
Weinchel Eng'g
10503 Metropolitan Ave Kensington Md
Westbury Electronics Inc
300 Shames Dr Westbury N Y
Western Int'l Co
45 Vesey St New York 7 N Y
Westinghouse Electric Corp
P O Box 231 Greenville Penna
Westinghouse Electric Co
P O Box 868 Pittsburgh Penna
Weymouth Instrument Co
1440 Commercial St E Weymouth 89 Mass
Wheeler Labs Inc
122 Cutter Mill Rd Great Neck N Y
Zenith Plastics Co
1600 W 135th St Gardena Calif

SYSTEMS

Acme Model Eng'g Co
6224 15th Ave Brooklyn N Y
Admiral Corp
3800 W Cortland St Chicago 47 Ill
Advance Industries Inc
640 Memorial Dr Cambridge 39 Mass
Aeromotive Eng'g Products Ltd
147 Humus Blvd Montreal 33 Que Canada
Aeronca Mfg Corp
Hilltop & Frederick Rds Baltimore 28 Md
Aeronca Mfg Corp
Middletown Ohio
Ainslie Corp
321 Quincy Ave Quincy 69 Mass
Airborne Instruments Lab Div Cutler Hammer Inc
160 Old Country Rd Mineola N Y
Aircom Inc
354 Main St Winthrop Mass
Aircraft Armaments Inc
Cherry Tree Rd Box 126 Cockeysville Md
Airtec Inc
130 E 1st Ave Roselle N J
Airtron Inc Div Litton Industries
200 Hanover Ave Morris Plains N J
Alford Mfg Co
299 Atlantic Ave Boston 10 Mass
All Products Co Communication Products Div
Box 110 Mineral Wells Texas
Adler Electronics Inc
1 Lefevre Lane New Rochelle N Y
American Electronic Labs Inc
121 N 7th St Phila Penna
Aeronutronic Systems Inc
Ford Rd Newport Beach Calif
Air Transport Mfg Co
1114 N Sycamore Ave Los Angeles Calif
Ameco Div Antennavision Inc
2449 W Osborn Rd Phoenix Ariz
Amelco Inc
2040 Colorado Ave Santa Monica Calif
American Electronics Inc Taller & Cooper Div
75 Front St Brooklyn 1 N Y
American Machine & Foundry Co Gen Eng'g Labs
11 Bruce Pl Greenwich Conn
American Machine & Foundry Co
261 Madison Ave New York N Y
Amphenol Connector Div Amphenol-Borg Electronics
1830 S 54th Ave Chicago 50 Ill
Analogue Controls Inc
200 Frank Rd Hicksville N Y
Andrew Antenna Corp
606 Beech St Whitby Ont Canada
Andrew California Corp
941 E Marylind Ave Claremont Calif
Andrew Corp
363 E 75th St Chicago 19 Ill
Antennavision Inc
2949 W Osborn Phoenix Ariz
Antenna & Radome Research Assoc
1 Bond St Westbury N Y
APC Electronic Products Div
Box 110 Mineral Wells Texas
Applied Science Corp of Princeton
44 Wallace Rd Princeton N J
Applied Technology Corp
475 5th Ave New York 17 N Y
A R F Products Inc
P O Box 57 Ranton N M
Arizona Telemetering Corp
2923 E McDowell Rd Phoenix Ariz
Arnoux Corp
11924 W Washington Blvd Los Angeles Calif

(*Continued on page* 170)

WASHINGTON

News Letter

RADIO CONFERENCE—A large number of changes in the international frequency agreements reached by the 1947 Atlantic City conference is anticipated in the final international radio regulations. These regulations are slated to be promulgated at the world radio conference at Geneva, Switzerland, in its concluding plenipotentiary sessions during mid-December. There have been between 5000 and 6000 separate proposals, by the 80 countries participating in the conference, for changes in the international radio regulations. The most complex considerations of the conference have been in the areas of aeronautical, space and high frequency broadcast spectrum requirements, but the work of the parley has been channeled along specific frequency areas rather than by radio services.

JAPANESE INROADS—The inroads of Japanese electronic products into the United States were brought out in a recent compilation of the U. S. Business and Defense Services Administration's electronics division. They cited the U. S. is by far the most important single foreign market for Japanese electronic products. During the first six months of 1959, Japanese electronic exports to this nation were valued at $22.1 million. This exceeded the total for 1958 and nearly tripled the total for the calendar year of 1957. Consumer type radio receivers represented the largest part of the Japanese exports, but the 1959 first half also recorded significant gains for recorders, electron tubes, transistors, and phonograph parts and accessories.

EIA-HOUSE CONFERENCE—A conference between the EIA Committee and Rep. Harris and his House body on his measure before the hearings has been requested by the EIA group. President H. Leslie Hoffman of Hoffman Electronics Corp. is chairman of the EIA Committee. Among its members are Chairman Robert C. Sprague of Sprague Electric Co., Motorola Executive Vice President Daniel E. Noble, Paul Chamberlain of General Electric, Litton Industries Vice President W. Preston Corderman, Columbia Broadcasting Chief Engineer William B. Lodge, Donald Fink and David B. Smith of Philco, and F. L. Ankenbrandt and Philip F. Siling of RCA. Mr. Hoffman and EIA President and Raytheon Vice President David R. Hull were leading participants in a panel discussion, staged by Rep. Harris, on his legislation last June.

EXPLOSIVE GROWTH—The increasing importance of communications-electronics to the armed services was recently described by Maj. Gen. Harold W. Grant, U. S. Air Force Director of Communications-Electronics with the statement that in the Air Force alone the 1959 C-E budget was ten times that of 1950. "This explosive growth can be partially attributed to the greater reliance that must be placed on electronic devices as the demands for speed and accuracy exceed human capacity," he said. Top DOD officials, particularly recently retired Assistant Secretary W. J. McNeil who had directed the budget of the armed services for a quarter century, emphatically believe the military forces' requirements will mean huge expenditures for many years to come in face of the Soviet threat.

FULL SUPPORT—By unanimous action, the Spectrum Committee of the Electronic Industries Association has endorsed the legislative plan of the House Interstate & Foreign Commerce Committee Chairman, Oren Harris (D., Ark.), to set up a Freqency Allocation Board to divide spectrum space between government and non-government users and a Government Frequency Administrator to allocate space to government users. Rep. Harris proposes to start hearings on his legislation early next year. The prospects of enactment by Congress are excellent since the situation demands satisfactory solution.

National Press Building
Washington 4

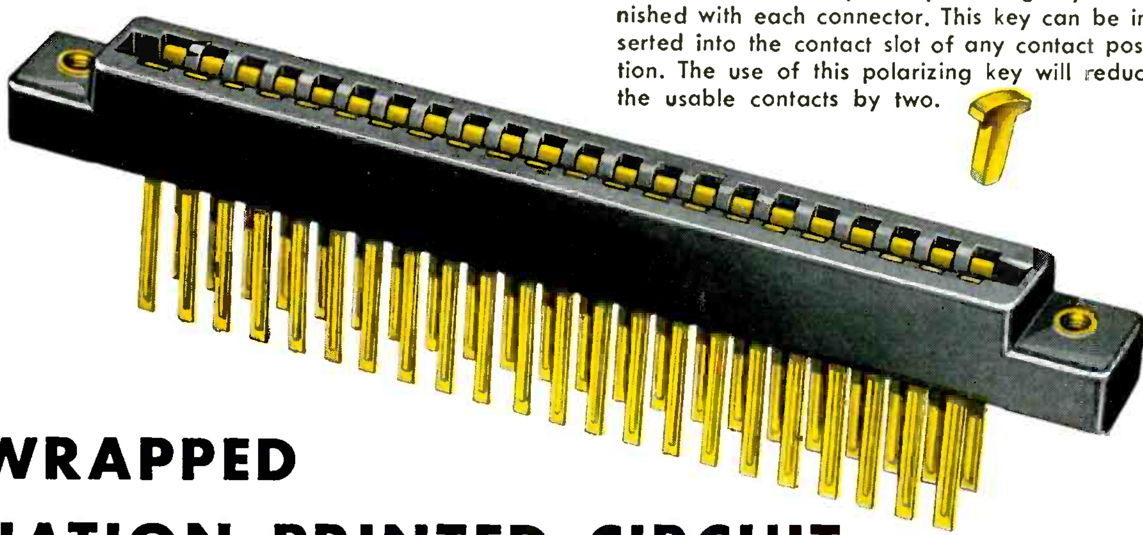
ROLAND C. DAVIES

PROJECT MERCURY—Major General Donald N. Yates, USAF, has been designated DOD representative for Project Mercury support operations. General Yates will also continue his present duties as Commander, Atlantic Missile Range.

EXAMINER-IN-CHIEF—Herbert Magil has been sworn in as Examiner-in-Chief in the U. S. Patent Office. He was appointed to the post by President Eisenhower. This appointment makes him a member of the Board of Appeals of the U. S. Patent Office of the Department of Commerce. This tribunal acts as judges in deciding appeals by inventors from the refusal of an examining division to grant a patent.

NEW

. . . MAINTAINS POSITIVE CONTACT
with a printed circuit board over a dimensional range of .057 - .072.



A No. 20H29401-4 plastic polarizing key is furnished with each connector. This key can be inserted into the contact slot of any contact position. The use of this polarizing key will reduce the usable contacts by two.

No. 29401

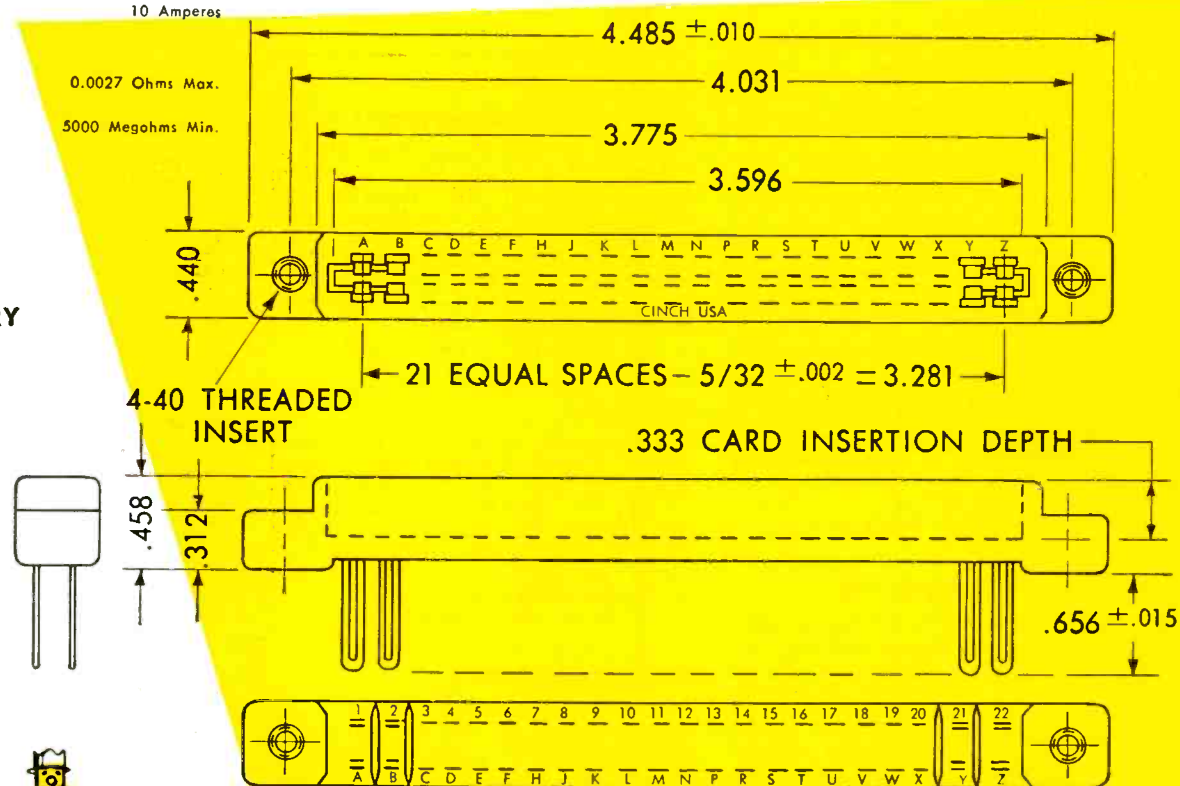
WIRE WRAPPED TERMINATION PRINTED CIRCUIT CONNECTOR

FOR 1/16" COPPER CLAD LAMINATED BOARDS.

Voltage Ratings:	A C RMS	D C
Sea level (Adj. terminals)	1030	1330
Altitude 3.4 H.G. (50,000 ft.)	300	500
Altitude 1.3 H.G. (70,000 ft.)	190	400
Recommended Withstanding Voltage:		
Sea level (Adj. terminals)	2320	1000
Altitude 3.4 H.G. (50,000 ft.)	730	1100
Altitude 1.3 H.G. (70,000 ft.)	425	900
Current Rating	10 Amperes	
Contact resistance at 7.5 amperes measured with nominal thickness printed wire board	0.0027 Ohms Max.	
Insulation resistance	5000 Megohms Min.	

Insulation is glass filled Diall with a flame retardent. The 44 contacts are phosphor bronze with a silver plate of .0002 and .00003 min. gold plate finish. The inventory problem is simplified by providing a single connector that can be polarized in any position.

AVAILABLE FOR IMMEDIATE DELIVERY



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

New Tech Data for Engineers

TW Tube Amplifiers

Catalog from Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif., describes the performance characteristics of traveling wave tube amplifiers and backward wave oscillators. It includes a section of engineering notes providing elementary theory of the traveling wave tube, as well as a detailed discussion of the more practical problems encountered in application work.

Circle 161 on Inquiry Card

Meters & Filters

A 12-page catalog has tech data on a line of microwave meters and filters. Included are frequency meters in the 500-18,000 MC tuning range and tunable band pass filters with tuning ranges from 960 to 9,600 MC. Data covers cavity types, and frequency response and insertion loss information on filters, together with frequency vs KMC, dissipation loss vs db, and rejection vs db curves. Frequency Standards, P. O. Box 504, Asbury Park, N. J.

Circle 162 on Inquiry Card

Antenna Systems

Loose-leaf type brochure from Haller, Raymond, and Brown, Inc., Science Park, State College, Pa., describes their line of antennas ranging from 30 MC on through the microwave region. Included are parabolic antennas, broad-band antennas, precision paraboloids, slotted arrays, and discone antennas. The 2-color brochure also includes specs, Smith chart impedance plots, and general information.

Circle 163 on Inquiry Card

R-F Filters

Four-page bulletin, illustrates and describes multiplexers, harmonic filters, and bandpass filters for communications and space systems. It is illustrated with graphs, schematics, photos, and specs. C. A. Rypinski Co., 2005 N. Fair Oaks Ave., Pasadena, Calif.

Circle 164 on Inquiry Card

Instruments-Components

Instruments and components catalog from Alford Manufacturing Co., 299 Atlantic Ave., Boston 10, Mass., describes the company's Automatic Impedance Plotters, Slotted Coaxial Lines, Tapered Reducers, R-F Loads, Attenuators, Hybrids, Line Stretchers, Hybridges, R-F Transformers, R-F Filters, Antennas, and Coaxial Switches. Includes tech data and drawings of equipment.

Circle 165 on Inquiry Card

Microwave Theory

Catalog C-4 from DeMornay Bonardi, 780 S. Arroyo Pkwy., Pasadena, Calif., contains a section on introductory microwave concepts, a complete catalog of De Mornay-Bonardi precision microwave equipment, a manual of microwave measurements and calibration techniques, a handbook of waveguide reference data, and a section on the less familiar applications of microwaves. Included is a new section on microwave applications.

Circle 166 on Inquiry Card

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna.

Telemetering Components

Series of data sheets from Hoover Electronics Co., 110 West Timonium Rd., Timonium, Md., describe and give tech specs on the Model 10056 Subcarrier Oscillator, Model 10064 Mixer Amplifier, Model 110061 Millivolt Subcarrier Oscillator, and Model 10057, Vernitel, transistorized telemetering system components.

Circle 167 on Inquiry Card

Antennas

Illustrated bulletin SP-200 from I-T-E Circuit Breaker Co., Special Products Div., 601 E. Erie Ave., Phila., Pa., describes the company's capabilities in microwave antenna R & D, design, and production. Featured are antenna systems, components and accessories.

Circle 168 on Inquiry Card

Waveguide Filters

A 4-page technical brochure describes Waveguide Filters, design and operation. Various types of filters are illustrated and factors to be considered in connection with specification of design data are outlined. Waveline Inc., Caldwell, N. J.

Circle 169 on Inquiry Card

Microwave Components

Catalog from FXR, Inc., 26-12 Borough Place, Woodside 77, N. Y., features Model B831A temperature compensated power meter and its required accessory Series 218 temp. compensated thermistor head. The Model B812A standing wave amplifier, an oversized 5 in. mirror-backed meter with 1% linearity; the Model Z817A Universal microwave power supply and its companion, Model Z818A voltage sweeper. Model Z817A is a single power supply for all microwave tubes. The Series 164 direct reading variable attenuators, available in waveguide sizes from 2.60 to 90.00 KMC. Series 155 semiprecision direct reading attenuators; WR-2100 components, precision microwave test instruments and 2-MM components which operate in the range from 140.00 to 220.00 KMC.

Circle 170 on Inquiry Card

VSWR Measurements

Instantaneous presentation and recording of VSWR versus frequency is the subject of a series of data sheets describing the X-band VSWR measuring systems manufactured by California Technical Industries Div. of Textron Inc., Belmont, Calif. Model 160 sweeps all or any portion of the band from 8.4 to 12.0 KMC. A similar unit, the Model 125, covers 8.5 to 9.6 KMC.

Circle 171 on Inquiry Card

Magnetrons

Bulletin PT-1, 26-pages, provides information on 4 S-band package voltage-tunable magnetrons developed by General Electric's Power Tube Dept. Manual includes data on design, typical applications, operation and manufacturing. Some theoretical data also is presented. General Electric Co., Schenectady 5, N. Y.

Circle 172 on Inquiry Card

Filter Data

Data sheet #601 describes a line of high, low, bandpass and telemetering filters in custom or standard designs. A filter spec sheet is also included which gives all possible design parameters for specific applications. Control Electronics Co., 10 Stepar Place, Huntington Sta., N. Y.

Circle 173 on Inquiry Card

UHF TV Rebroadcasting

Illustrated, 12-page, brochure contains tech specs and applications data on UHF TV translators (rebroadcast equipment) and associated UHF antennas. Adler Electronics, Inc., 1 Le Fevre Lane, New Rochelle, N. Y.

Circle 174 on Inquiry Card

utmost in performance

TYPE 33M

MOLDED mylar* CAPACITOR

applications | *computers · instrumentation · test equipment*
filter networks · transistor circuitry · amplifiers

Sangamo Type 33M molded mylar* capacitors combine the excellent electrical performance characteristics of mylar* dielectric material with a molded case of high moisture resistant thermosetting plastic.

Temperature Range: "The Type 33M is designed to operate over the temperature range of —55°C. to +85°C. Satisfactory performance at 125°C. can be obtained by derating the voltage to 50% of the 85°C. value."

Dissipation Factor: The dissipation factor of the Type 33M capacitor does not exceed 1% at normal equipment operating temperature over the complete audio frequency range.

Tolerances: Available in capacitance tolerance values of ±5%, ±10%, ±20%.

Life Test: These units will withstand a life test of 250 hours at 125% of rated voltage at 85°C. Life tests at 125°C. should be made at 125% of the derated voltage.

Dielectric Absorption: Dielectric absorption of Type 33M capacitors is less than half that of oil impregnated paper capacitors.

Moisture Resistance: Type 33M capacitors will successfully withstand the moisture resistance tests specified in Spec. MIL-C-91A.

Insulation Resistance: The insulation resistance of these capacitors will exceed 5,000 meg/mfd. over the normal operating temperature range.

• Write for engineering bulletin SC59-6.

*DuPont's trademark for polyester film.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

SC-59-6

Circle 54 on Inquiry Card

New Tech Data for Engineers

Microwave Measurements

Series of bulletins from Weinschel Engineering Co., 10503 Metropolitan Ave., Kensington, Md., include a General Catalog, and #186—short form catalog, #178—dc returns, #17—coaxial attenuators, 1 to 12.4 KMC, #141—antenna pattern analyzer, #46—coaxial terminations, dc to 10 KMC, #176—precision 1 MW thermistor bridge, #154—application note #4, Dual channel, insertion loss test, and #44—coaxial attenuators, dc to 1 KMC.

Circle 175 on Inquiry Card

Drone Telemetry System

Bulletin from Tele-Dynamics Inc., 5000 Parkside Ave., Phila. 31, Pa., describes a telemetry system for drone battlefield surveillance. It contains a 3-page detailed block diagram and illustrations of the transmitting set in the drone and of the receiving set and read-out equipment in the mobile van. Display equipment provided "quick-look" indication and recording of operational conditions, ground-initiated commands, and all important flight parameters.

Circle 176 on Inquiry Card

Community TV Systems

Brochure from Ameco Div., Antennavision Inc., 2949 W. Osborn Rd., Phoenix, Ariz., describes the Conrac AV-12B Tuner designed for community TV systems. It can be used as head end gear or terminal equipment for microwave installations. The tuner is used with the Ameco-Tran, single channel transmitter with inter-carrier sound. Brochure includes block diagrams and schematics of the systems.

Circle 177 on Inquiry Card

Microwave Power Supply

"New from PRD," describes the PRD 813 Universal BWO/TWT Power Supply which powers and modulates backward wave oscillators, backward wave amplifiers, voltage tuned magnetrons, and traveling wave amplifiers. Included are: performance characteristics, including electrical and modulation specs. Polytechnic Research & Development Co., Inc., 202 Tillary St., Bklyn 1, N. Y.

Circle 178 on Inquiry Card

Delay Lines

Two catalogs from ESC Corp., 534 Bergen Boulevard, Palisades Park, N. J., describe the company's line of pulse transformers and delay lines. Both catalogs contain specs, definitions and measurements, charts, and graphs and ordering information.

Circle 179 on Inquiry Card

Microwave Components

Short form catalog, 59SF, 8-pages, from Microwave Associates, Inc., Burlington, Mass., has information on the company's varactor diodes, parametric amplifiers, magnetrons, waveguide components and test equipment, ferrite duplexers and isolators, duplexer tubes, microwave mixer and video diodes, and pressure windows. Included are tech specs in tabular form.

Circle 180 on Inquiry Card

Ferrite Components

Short-form, loose leaf, catalog from Cascade Research, div. of Monogram Precision Industries, Inc., 5245 San Fernando Rd., W. Los Angeles 39, Calif., features: Uniline ferrite load isolators, gyraline ferrite modulators, circulators, circulator switches, and cutoff switches. Tech data for each model is presented in tabular form.

Circle 181 on Inquiry Card

Antennas

Reflector antennas for celestial study, missile and satellite tracking, and radar control, are highlighted in a booklet, No. 2556, from Blaw-Knox Co., Equipment Div., P. O. Box 1198, Pittsburgh 30, Pa. The 12-page booklet illustrates equatorially mounted, azimuth elevation, and stationary type antennas, and outlines specs for some of these units.

Circle 182 on Inquiry Card

Stability Tester

A 4-page illustrated brochure covers the PITLOG Series 800 Stalo Tester for use where a precise measurement of frequency stability is required . . . its primary purpose being to check the stability of radar systems components such as stalos, cohos, stabilized klystrons and other stable signal sources. Pitometer Log Corp., 237 Lafayette St., New York 12, N. Y.

Circle 183 on Inquiry Card

Microwave Material

Single-page, "Microwave Memorandum," (Vol. 1, #6) from Radar Design Corp., Box 38, Pickard Drive, Syracuse 11, N. Y., describes Radite #75 a plastic-lossy at microwave frequencies which may be cast to shape or readily machined. Included are specs, applications and graphs.

Circle 184 on Inquiry Card

Electron Tubes

Brochure from Hoffman Electron Tube Corp., 804 Newbridge Ave., Westbury, L. I., N. Y., covers the Klystrons, Magnetrons, special purpose cathode ray tubes, photomultipliers, secondary emitters, storage tubes, orthicon and vidicon tubes manufactured by E.M.I. Electronics Ltd., for which the company is the U. S. rep. It contains references, specs, special notes, and ordering information.

Circle 185 on Inquiry Card

Waveguide Components

Illustrated, 20-page catalog from Lieco, Inc., Syosset Industrial Pk., Eileen Way, Syosset, L. I., N. Y., describes the company's line of test equipment and waveguide components. Tech specs are presented in tabular form.

Circle 186 on Inquiry Card

Diodes

Line of diodes designated for microwave mixer application is described in a brochure from Kemtron Electron Products, Inc., 14 Prince Place, Newburyport, Mass. Included are video detector types along with ratings and characteristics.

Circle 187 on Inquiry Card

Microwave Instruments

Data sheets, Nos. 117, 125, and 127 from Sierra Electronic Corp., 3885 Bohannon Drive, Menlo Park, Calif., describe power sources for calibrating wattmeters, measurement of microwave power sources, and the UHF FM Signal Generator. Sheets include tech specs.

Circle 188 on Inquiry Card

Microwave Equipment

Loose-leaf type brochure from Bogart Manufacturing Corp., 315 Seigel St., Brooklyn 6, N. Y., describes the company's lines of waveguide filters, couplers, dummy loads, waveguide switches and antennas. Featured are specs application data, and engineering drawings.

Circle 189 on Inquiry Card

Dialing Systems

Twelve-page bulletin from Secode Corp., 555 Minnesota St., San Francisco, Calif., describes several systems used for selective calling for mobile radio service. Included are specs and block diagrams.

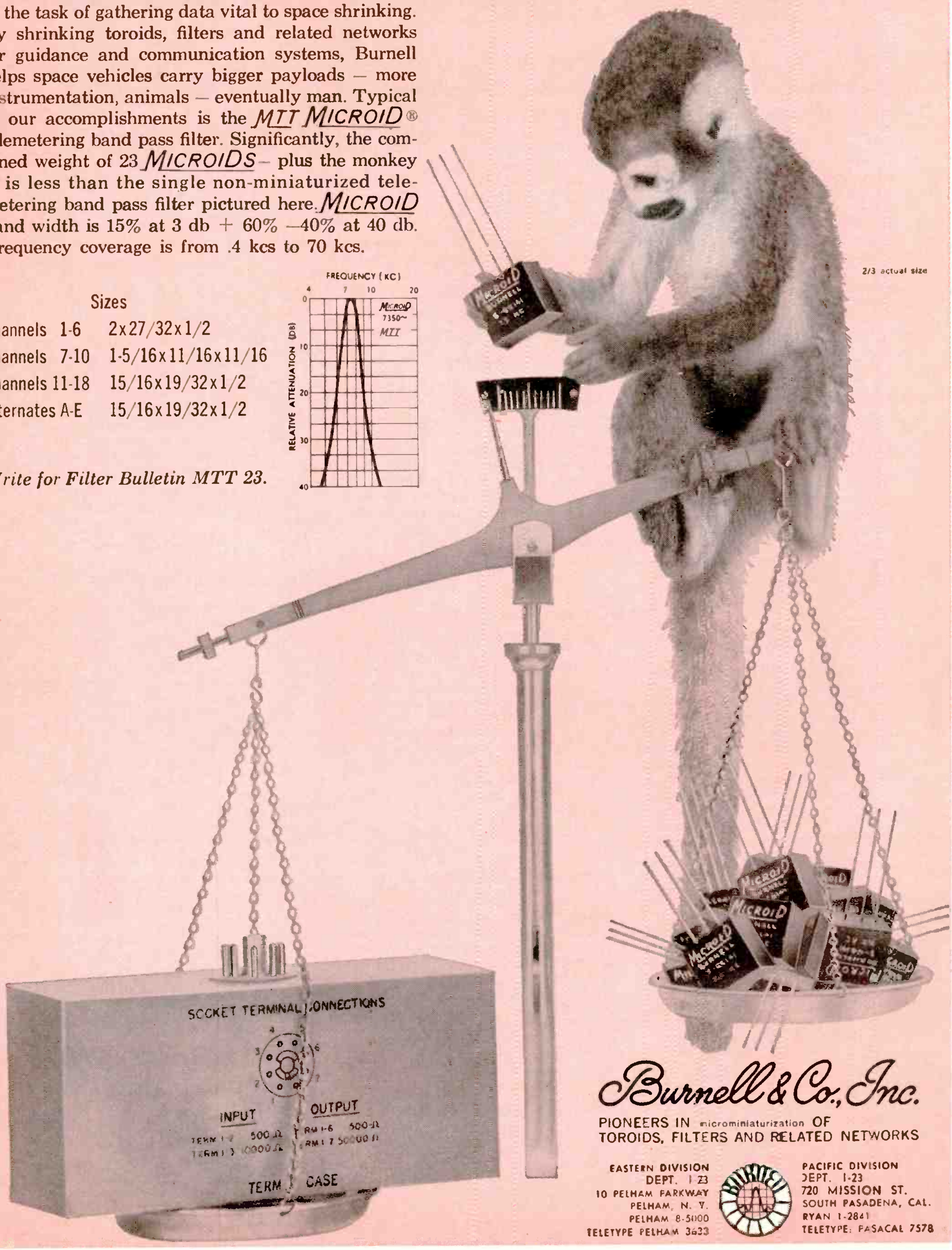
Circle 190 on Inquiry Card

SPACE SHRINKERS

MICROIDS AND MONKEYS—Burnell & Co. welcomes the assistance of their simian friends in the task of gathering data vital to space shrinking. By shrinking toroids, filters and related networks for guidance and communication systems, Burnell helps space vehicles carry bigger payloads — more instrumentation, animals — eventually man. Typical of our accomplishments is the MTT MICROID® telemetering band pass filter. Significantly, the combined weight of 23 MICROIDS — plus the monkey — is less than the single non-miniaturized telemetering band pass filter pictured here. MICROID band width is 15% at 3 db + 60% —40% at 40 db. Frequency coverage is from .4 kcs to 70 kcs.

	Sizes
Channels 1-6	2x27/32x1/2
Channels 7-10	1-5/16x11/16x11/16
Channels 11-18	15/16x19/32x1/2
Alternates A-E	15/16x19/32x1/2

Write for Filter Bulletin MTT 23.



Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
DEPT. I 23
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
DEPT. I-23
720 MISSION ST.
SOUTH PASADENA, CAL.
RYAN 1-2841
TELETYPE: PASACAL 7578

New Tech Data for Engineers

Relay Definitions

Seventy page progress report by the National Assoc. of Relay Manufacturers' Technical Committees on: A. Dry circuits (low energy switching); B. Measurement of electrical characteristics; C. Contact life testing; D. Environmental testing including temperature, humidity, altitude and corrosion; E. Vibration testing; F. Shock, acceleration and tumbling. Included are suggested definitions and test procedures, test equipment and precautions, and work yet to be done. National Assoc. of Relay Manufacturers, P. O. Box 6, Stillwater, Okla.

Circle 220 on Inquiry Card

Pulse Transformers

Three technical brochures, PT-204, 205 & 206, published by Technitrol Engineering Co., 1952 E. Allegheny Ave., Phila. 34, Pa., are designed to help circuit design engineers accurately specify the design of low pulse transformers. They cover blocking oscillator applications, interstage coupling applications, and specific applications where transformer parameters are known.

Circle 221 on Inquiry Card

Semiconductor Graphite

Catalog No. SC-659 from United Carbon Products Co., P. O. Box 747, Bay City, Mich., describes graphite usage in semiconductor production. Illustrated, it covers sections on unique semiconductor graphites, specialized graphite machining problems, methods of graphite quality control, means of planning, scheduling and expediting orders, typical physical properties of various grades of graphite, stock sizes and prices.

Circle 222 on Inquiry Card

Semiconductor Diodes

A characteristics and replacement guide for semiconductor diodes is available from Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y. The 12-page booklet contains data on the ratings and electrical characters of all Sylvania types as well as a replacement guide to virtually all EIA registered diodes.

Circle 223 on Inquiry Card

Potentiometers

Data sheet from Ultronix, Inc., 111 East 20th Ave., San Mateo, Calif., describes the Ultrimmer trimming potentiometer. Included are electrical, mechanical, and environmental specs and dimensional drawings.

Circle 224 on Inquiry Card

Instrument Components

Master Catalog #20a., 416-pp. from PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y., consolidates previous catalogs and supplements. It lists over 10,000 items, including gears, shafts, collars, couplings, speed reducers, differentials and other precision items available from stock. Included are: drawings, complete specs and prices, technical data, and a breadboard kit and precision tool components section.

Circle 225 on Inquiry Card

Electronic Gaging

Brochure on electronic gaging systems gives a complete description of such systems and of each of the modules comprising them and typical applications. Principal advantages of electronic gaging are 100% repeatability, instantaneous response, reliability and accuracy to within 0.000050 in. Radio Corp. of America, Industrial & Automation Div., 12605 Arnold Ave., Detroit 39, Mich.

Circle 226 on Inquiry Card

Carbon-Brush Data

Reprints of "Brush Operating Properties," describing carbon-brush characteristics that affect the performance of electrical machines, cover contact resistance, coefficient of friction, conductivity, abrasiveness, carrying capacity and commutator surface speed. Four ways to measure contact resistance are outlined, and representative data are presented graphically. Carbon Products Div., Speer Carbon Co., St. Marys, Pa.

Circle 227 on Inquiry Card

Ultrasonic Cleaning

A 12-page ultrasonic cleaning primer is for use as a guide by potential users of ultrasonic cleaning equipment. The primer tells what ultrasonic cleaning is, how it works, areas in which it can be employed, and various solvents and detergents available for use with this kind of equipment. National Ultrasonic Corp., 111 Montgomery Ave., Irvington, N. J.

Circle 228 on Inquiry Card

Variable Transformers

Bulletin 151 from Ohmite Mfg. Co., 3649 Howard St., Skokie, Ill., describes their line of cased variable transformers, "overvoltage" and "no-overvoltage" type of transformers. The 8-page publication is illustrated and includes technical data and prices.

Circle 229 on Inquiry Card

Servo Simulator

How to design, breadboard, and analyze servo systems rapidly, without need for fabrication of expensive intermediate prototypes, is detailed in a report from Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y., describing the company's new SERVOLAB (TM) Servo System Simulator.

Circle 230 on Inquiry Card

Synchros

Illustrated catalog, 170-page of synchros, servo motors, servo amplifiers, resolvers, rate gyros and potentiometers contains specs and outline drawings of 200 units. Included are details on synchros manufactured to the newest MIL specs (MIL-S-20708A). Ketay Dept., Norden Div., United Aircraft Corp., Commack, L. I., N. Y.

Circle 231 on Inquiry Card

Tantalum Capacitors

Engineering bulletin, No. 1, from the Kemet Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y., describes the company's solid tantalum capacitor line. Included are applications (transistor amplifiers, analog computers, triggering circuits, power supplies, etc.), performance characteristics, specs, and performance curves.

Circle 232 on Inquiry Card

Tantalum Capacitor

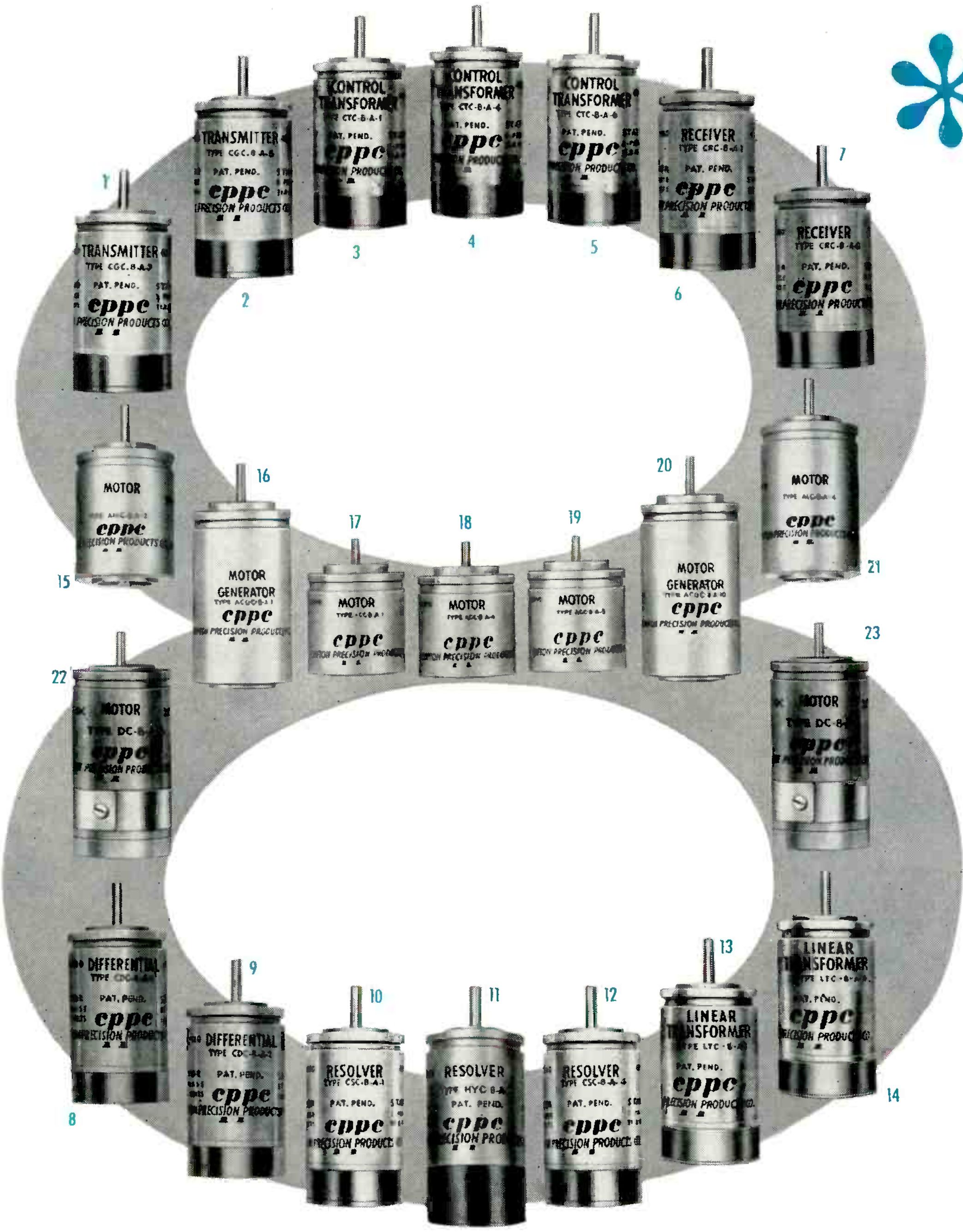
A 16-page catalog, No. 9-169, contains information on the 15 different types of solid, foil and sintered anode tantalum capacitors manufactured by Mallory Capacitor Co., 3029 E. Washington St., Indianapolis 6, Ind. Featured is a table containing over 600 listings arranged by microfarad and voltage ratings. The list extends from 0.25 to 1300 mfd.

Circle 233 on Inquiry Card

Print-and-Plot Scaler

Descriptive bulletin, Form 3027-9, covers the Model ADRS2-5 Print-and-Plot Scaler. It outlines the features of the instrument, gives suggested applications, and details specs and performance data. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 234 on Inquiry Card



A PARTIAL SHOWING. OVER 60 DIFFERENT SIZE 8 ROTARY COMPONENTS AVAILABLE

Clifton Precision's size 8 rotary components have been tried and proven by customers over the past 4 years. More than 50,000 have been shipped. These are the most accurate and best tested (because they are use tested) size 8 rotary components on the market today.

1. Torque transmitter (26v. input) 2. Torque transmitter (115v. input) 3. Control transformer (lo Z) 4. Control transformer (hi Z) 5. Control transformer (very hi Z) 6. Torque receiver (26v. input) 7. Torque receiver (115v. input) 8. Torque differential (lo Z) 9. Torque differential (hi Z) 10. Electrical resolver (.5 t.r.) 11. Precision computing resolver (feedback winding) 12. Electrical resolver (1 t.r.) 13. Linear transformer (115v. input) 14. Linear transformer (26v. input) 15. Servo motor (1" length, .40 in-oz stall torque) 16. Motor generator (10v. input) 17. Servo motor (53/64" long) 18. Servo motor (35v. center tap) 19. Servo motor (26v. center tap) 20. Motor generator (26v. input) 21. Servo motor (.30 in-oz stall torque) 22. D.C. motor (14v. input) 23. D.C. motor (28v. input)

ENGINEERS—Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. P11

CLIFTON PRECISION PRODUCTS CO., INC.

CLIFTON HEIGHTS PA.

cppc

Sales Office: 9014 W. Chester Pike, Upper Darby, Pa.—Hilltop 9-1200, TWX Flanders, Pa. 1122

Circle 56 on Inquiry Card

Tech Data

for Engineers

Telemetering Transmitter

Data sheet from Telechrome Manufacturing Corp., 28 Ranick Drive, Amityville, N. Y., describes the Model 1483-A1 FM/FM Transmitter. Included are characteristics and environmental data.

Circle 266 on Inquiry Card

Pressure Pickup

Bulletin 1620 from Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif., describes the Type 4-326 Pressure Pickup, capable of absolute and gage measurement to 10,000 psi. Included are design features and specs, a schematic drawing and a wiring diagram.

Circle 267 on Inquiry Card

Millimeter Components

"Millimeter Microwave Components," 12 pp., 2-colors, available from TRG Inc., 9 Union Sq., Somerville, Mass. describes 14 types of miniaturized components for the V-Band, 50-75 MC. Includes full technical data on ferrite isolators, ferrite circulators, ferrite high power switch, dual transducers, hybrid ring, and millimeter wave antennas.

Circle 268 on Inquiry Card

Test Instruments

Catalog from Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif., describes the company's line of electronic test instruments including: Oscilloscopes, voltmeters, ammeters, distortion, wave form analyzers, frequency measuring and monitoring equipment, square wave, pulse, and digital delay generators. Included are Standard waveguide and flange specs., accessory cable assemblies, test leads, and microwave equipment for waveguide and coaxial systems. Featured are sections which explain the general type of equipment, typical uses, block diagrams of set-ups and techniques for using the equipment.

Circle 269 on Inquiry Card

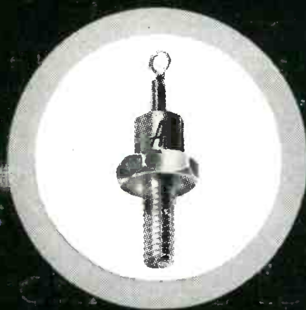
Thermocouples

Revised, illustrated Catalog EN-S2 offers complete information about Leeds & Northrup's line of thermocouples and thermocouple components and accessories. It lists and describes standard assemblies in protecting tubes and wells for general applications; specialized thermocouples and assemblies for laboratory and industrial applications; and an extensive line of bare and insulated thermocouple wires, replacement elements, ceramic insulators, metal and ceramic protecting tubes, wells, terminal heads and extension leadwires. Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle 270 on Inquiry Card

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

NOW...



10 AMPS in a 1 AMP package!

Automatic

DIFFUSED HIGH POWER SILICON RECTIFIERS

COMPLETE RELIABILITY AND TOP EFFICIENCY WITH LOW FORWARD DROP AND PIV UP TO 600V...

ABSOLUTE MAXIMUM RATINGS (FOR 150° C. CASE)	AG 0512	AG 1012	AG 1512	AG 2012	AG 2512	AG 3012	AG 4012	AG 5012	AG 6012
PIV—Volts	50	100	150	200	250	300	400	500	600
Cont. DC Rev. Working Volt.—Volts	50	100	150	200	250	300	400	500	600
Av. DC Output Cur.—Amps	10	10	10	10	10	10	10	10	10
Peak Recur. Fwd. Cur.—Amps	45	45	45	45	45	45	45	45	45
Surge Cur. (1/120 Sec.)—Amps	200	200	200	200	200	200	200	200	200
Fwd. Volt. Drop (DC)*—Volts	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Rev. Cur. @ Rated PIV†—Ma	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

*Measured at 25° C. at 25 amperes.
†Average over one cycle for full wave choke input or resistive circuit, with rectifier operating at full rated current.

A triumph of miniaturization, these AUTOMATIC rectifiers give you a smaller stud package with *ten times* the power you'd normally expect, and can also be supplied with reverse polarity. Rugged, reliable and truly versatile, they fill an important need in the field of semiconductors. Complete data sheets are available upon request.

Semiconductor Division

GENERAL INSTRUMENT CORPORATION

65 Gouverneur Street, Newark 4, N. J.

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

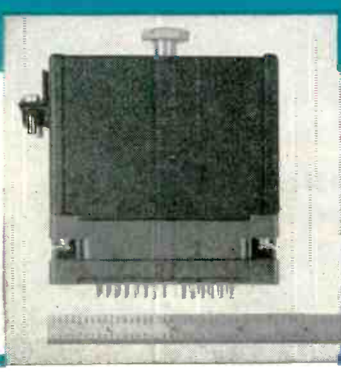
GENERAL INSTRUMENT DISTRIBUTORS: *Baltimore:* D & H Distributing Co. • *Chicago:* Merquip Co. • *Cleveland:* Pioneer Electronic Supply • *Los Angeles:* Valley Electronics Supply Co., Burbank • *Milwaukee:* Radio Parts Co., Inc. • *New York City:* Hudson Radio & Television Corp., Sun Radio & Electronic Co. *Philadelphia:* Herbach & Rademan, Inc. • *San Francisco:* Pacific Wholesale Co. • *Seattle:* Seattle Radio Supply • *Tulsa:* Oil Capitol Electronics

Circle 57 on Inquiry Card

RELIABILITY

you specify RELIABILITY when you specify . . . ELCO'S NEW SERIES 8007-8008 rack-and-panel or cable connectors

NOW! The latest application of the industry's most reliable contact — the Varicon — in a connector which provides the highest contact density! Series 8007 provides you with screw actuating device offering positive lock against vibration plus easiest engagement and disengagement. 75, 100 or 130 contacts. Series 8008, without screw actuating device, available with 80, 95, 110, 125, 140 contacts. Both series offered with or without covers. The instant removal of contacts; various contact terminations; intermixing of various contact types within a connector; all molded body; and 36 different polarizing position possibilities are but a few more of its many features. Want more information? Or data relating to our Tube-Sockets / Shields and Varicon Connectors . . . the industry's most reliable lines for transistorization and printed circuitry! Drop us a line on your company letterhead; we'll rush Bulletins and Catalogs by return mail.



IF IT'S NEW... IF IT'S NEWS... IT'S FROM

ELCO CORPORATION

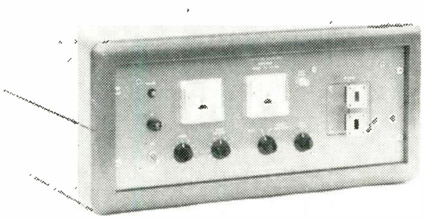
"M" St. below Erie Ave., Phila. 24, Pa., CU 9-5500

Elco-Pacific: 2200 Centinela Ave., West Los Angeles 64, Cal., GR 8-0671

New Products . . . Microwave

TW TUBE AMPLIFIER

The Model TA-49 PM permanent magnet focused traveling wave tube amplifier is a lightweight instrument for use in the frequency range 12.0 to 16.0 KMC. Power supply provides

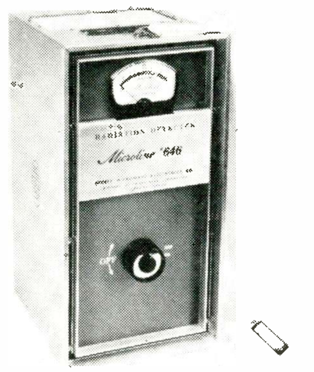


0.1% regulation, with max. ripple on the helix less than 10 mv. Other specs: Gain, 30 db; output power, 10 mw (Min); weight, 28 lbs.; hum, spurious modulation, 35 db; power supply, 115 volts ±10% 60 cycles. Designed for relay rack or cabinet mounting, it features front panel metering. Menlo Park Engineering, 711 Hamilton Avenue, Menlo Park, California.

Circle 235 on Inquiry Card

RADIATION DETECTOR

Microline 646 radiation detector provides a rapid simplified check of the power density of electro-magnetic energy in the microwave range. It can be used by medical personnel,

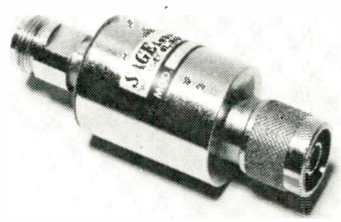


safety engineers, and radar engineers. Specs: Frequency ranges, 400 to 1600 MC—2700 to 3300 MC—5200 to 5900 MC—8500 to 9600 MC; detectable power density, min 1 mw/cm², max 20 mw/cm²; accuracy, −0 +2 db; power, 8 v mercury battery; size, 6½ x 8 x 13 in.; weight (approx), 8 lbs. Sperry Microwave Electronics Co. Div., Sperry Rand Corp., Clearwater Fla.

Circle 237 on Inquiry Card

COAXIAL ROTARY JOINT

SAGE 305 coaxial rotary joint employs a precious metal, completely contacting junction for excellent electrical properties with long life. The rotary joint covers the frequency range

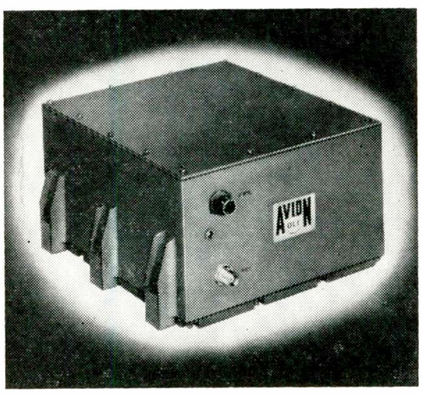


from dc to 12,400 MC. VSWR is less than 1.15 below 5000 MC and less than 1.25 from 5000 MC to 12,400 MC. It is designed for continuous duty at a speed of 500 RPM. WOW is negligible and insertion loss is less than 0.1 db. It is supplied with type "N" connectors but can be modified. Sage Laboratories, Inc., 3 Huron Drive, Natick, Mass.

Circle 238 on Inquiry Card

RADAR BEACON

Type 149 is a radar beacon designed as an airborne, pulse-type tracking aid for long-range missile or space application. The single housing includes a transistor power supply for developing regulated operating voltages from an external 24-28 vdc (nominal) power source. It operates in the C-Band or S-Band and responds to coded or uncoded pulse interroga-



tions from radars, such as those used in a radar-guided missile instrumentation system. Avion Div., ACF Industries, Inc., 11 Park Place, Paramus, N. J.

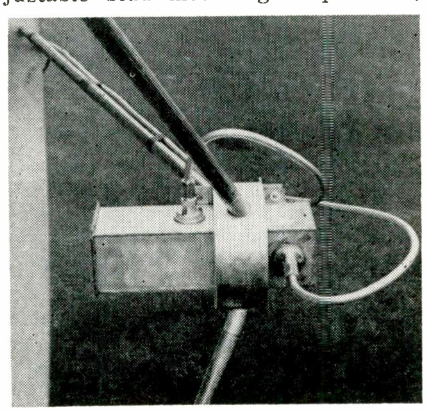
Circle 236 on Inquiry Card

! MORE !

The New Products mentioned here have been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred new product releases received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna.

DUAL POLARIZED ANTENNAS

Four dual polarized (or cross polarized) parabolic antennas cover 2 frequency ranges, 1700-1850 MC and 1850-1990 MC and are available in a 6 to 10 ft. parabolic reflector. The feed horn is supported by a tripod mount. The reflector is reinforced to withstand 100 mph wind loads with a 2-in. radial ice load. Four-point adjustable stud mounting is provided,



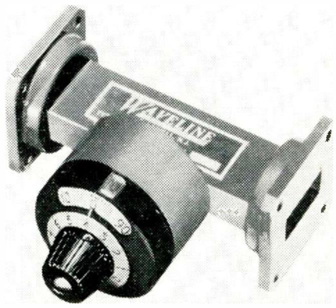
this can also be adapted for mounting on a 4 in. pipe. The entire assembly is made of corrosion resistant materials. Prodelin Inc., 307 Bergen Ave., Kearny, N. J.

Circle 239 on Inquiry Card

New Products

VARIABLE ATTENUATORS

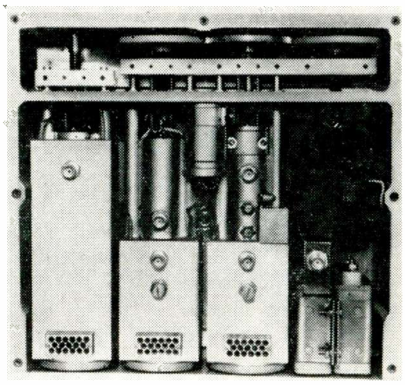
Precision variable attenuators, type No. 611 and 711, operate in the 8.20 to 18.0 KMC frequency range. Specs for type 611 are: wave-guide Type RG-52/U; O.D. size, 1 x ½; frequency range, 8.20 to 12.4 KMC; flange Type, UG-39/U; calibrated attenuation range, 30 db. Specs for Type 711 are: waveguide Type, RG-91/U; waveguide O.D. size, 0.702 x 0.391; frequency range, 12.4 to 18.0 KMC; flange type, UG-419/U; calibrated attenuation range, 30.0 db. Waveline, Inc., Caldwell, New Jersey.



Circle 240 on Inquiry Card

RADAR POWER SOURCE

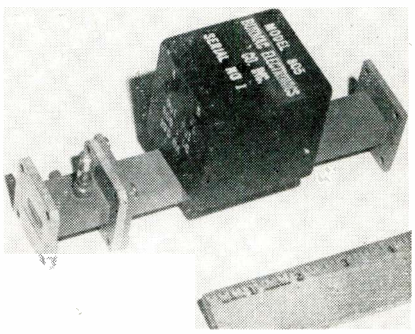
Exciter Driver provides a stable frequency power source in radar systems or as a Klystron driver source. It is for applications where 5 to 10 w. CW or pulsed r-f are required over S Band. Model 86 consists of an L Band cavity oscillator, cavity doubler to S Band and cavity r-f amplifier. The amplifier stage may be pulsed at any repetition rate. IFM is less than 150 cycles throughout the frequency range. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.



Circle 242 on Inquiry Card

POWER SUPPLY

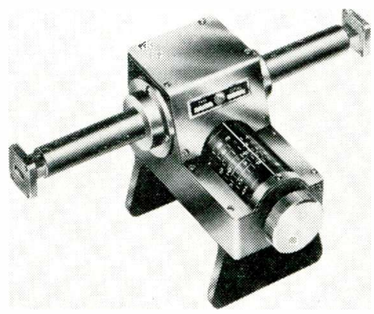
Series of "Mini-Keep" power supplies offer a packaged source of power for microwave T-R switch tubes. Designed for use in radar systems, laboratories and production test installations, they can be mounted to a chassis, bulkhead or wave-guide section adjacent to the T-R tube assembly. Output impedance permits use of any required series resistor called for under T-R tube specifications. Typical specs: output voltage of —1000 vdc, output current of 200μa and ripple of 5% peak to peak. The input is stated as 115 v, RMS at 60 or 400 CPS. Burmac Electronics Co., Inc., 142 S. Long Beach Rd., Rockeville Centre, N. Y.



Circle 241 on Inquiry Card

VARIABLE ATTENUATOR

Model S164A Direct Reading Precision Variable Attenuator operates over the 2.60 to 3.95 KMC range and uses the rotary vane principle. Attenuation is established by the angle of rotation of attenuating film in cylindrical waveguide. Readings are independent of freq and the film material. Components calibrated to 50 db and bilaterally matched. Max. VSWR is 1.15. Low reflection transitions to standard rectangular waveguide provided. Special tapers on low freq units provide min. insertion lengths. FXR, Inc., 26-12 Borough Place, Woodside 77, N. Y.

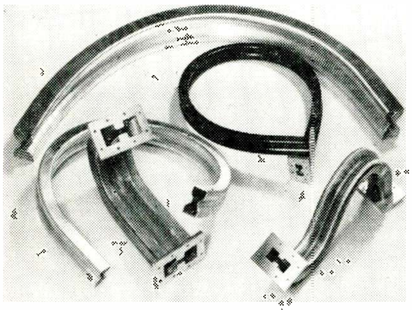


Circle 243 on Inquiry Card

New Products . . . Microwave

FLEXIBLE WAVEGUIDE

Flexible double ridged waveguide specs include: (D-19 size); Freq., 4.75 to 11 KMC; VSWR, 1.08 max. per end; Attenuation, 0.20 db/ft max.; min. bend radius, E bend 5 in., H bend, 10

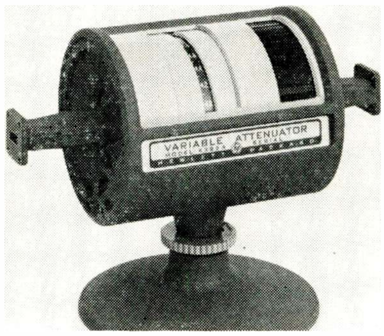


in.; twist, 45° per ft; jacket, neoprene type 502CS. (D-34 size) freq., 4.0 to 8.2 KMC; VSWR, 1.14 max.; attenuation, 0.10 db/ft; min. bend radius, E bend, 7 in., H bend, 14 in.; twist, 45°/ft; (size D-37) freq., 2.0 to 5.0 KMC; VSWR, 1.16 max.; attenuation, 0.08 db/ft; twist, 20°/ft. Ridged types are available. Microtech, Inc., 2975 State St., Hamden, Conn.

Circle 244 on Inquiry Card

WAVEGUIDE ATTENUATORS

Precision attenuators provide a reliable, true standard of attenuation for use as precision calibrators or for direct comparison measurements. No frequency correction is



required. Rectangular to circular transitions are provided so that the attenuators operate in standard rectangular waveguide systems. K and R band models available having either precision cover flanges or circular flanges; all other bands have precision cover flanges. Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle 246 on Inquiry Card

MULTIPLEX EQUIPMENT

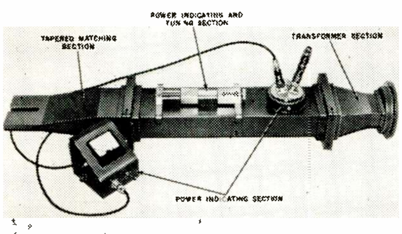
Transistorized for high speed, protective relaying over a microwave base band medium, the MC-22 multiplex equipment operates at 40-200 KC with 4 KC channel spacing. Up to 41 chan-

nels can be applied to a 6,000 MC base band channel without intervening equipment or using the voice channel capacity. It translates tripping info into a 1 KC frequency shift. This is reverted to a contact closure by the receiver at the remote station. Motorola Inc., Communications & Industrial Electronics Div., 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle 248 on Inquiry Card

WAVEGUIDE ASSEMBLIES

Waveguide assemblies, designed for use with Raytheon's PGM-100 and PGM-101 microwave power generators, complete a microwave power system for R & D laboratories working in fields of gas excitation relating to free radical production, photochemistry and spectroscopy. The waveguide assemblies include: a tapered matching section; a power indicating



and tuning section; transforming section; and a flexible waveguide section. Raytheon Co., Dept. 6978, 95 South Bedford St., Manchester, N. H.

Circle 245 on Inquiry Card

COAXIAL ATTENUATORS

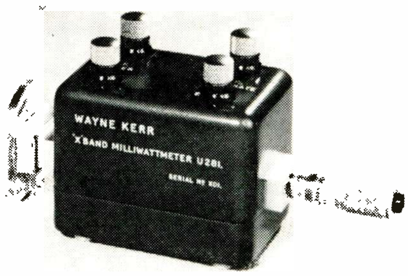
Fixed Coaxial Attenuators, 1 to 12.4 KMC, are available with Type SC connectors (male/female, double male or double female). Made with Weinschel Film Resistors for max. stability under pulse power, as well as humidity and temp cycling, specifications are: Frequency range, 1 to 12.4 KMC; attenuation range, 1 to 20 db; and impedance, 50 ohms. Model 663

—1 male, 1 female connector; Model 664—2 female connectors; Model 665 —2 male connectors. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

Circle 247 on Inquiry Card

MILLIWATTMETER

Resistive film bolometer wattmeter for measuring microwave power from 1 to 100 mw in the 12.0 to 18.0 KMC bands. Specs: Frequency, 12.0 to 18.0 KMC; input VSWR (at correct micrometer setting), not less than 1.1 over 50% of the band; not less than 1.25 at extremes; accuracy, ±3% if 5% loss is allowed for; sensitivity, approx 10 μv into open circuit per mw of r-f



power; waveguide, O.D. 0.702 in. x 0.391 inc., I.D. 0.622 x 0.311 in. coupling flange, plain square flange (similar to U 281) shown. Wayne Kerr Corp., 1633 Race St., Phila. 3, Pa.

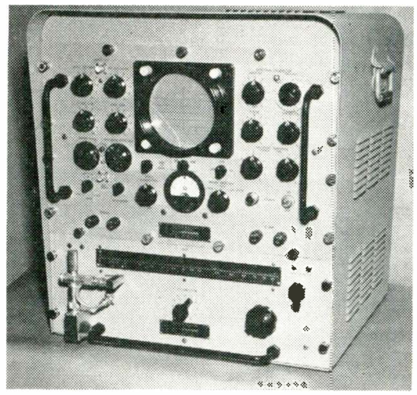
Circle 249 on Inquiry Card

Circle 61 on Inquiry Card

New Products

SPECTRUM ANALYZER

Spectrum Analyzer LA-20W, has an operating range of from 1,000 to 44,000 MC. Featured is wide-window frequency dispersion (adjustable from 500 KC to 70 MC), selection of square

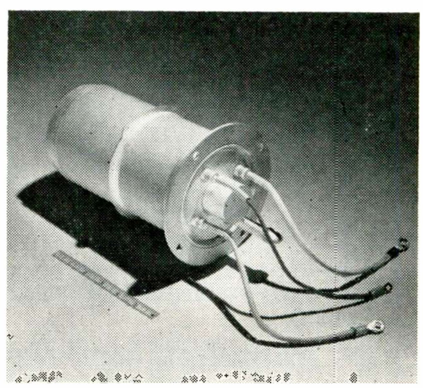


law, linear or logarithmic detection, ±35 MC spectrum marker, 10 KC or 50 KC resolution at 3 db points throughout the frequency range and regulated plate and filament supplies for optimum stability. Signal Amplitude is on the vertical axis; frequency is on the horizontal axis. Lavoie Laboratories, Inc., Morganville, New Jersey.

Circle 252 on Inquiry Card

HYDROGEN THYRATRON

Ceramic hydrogen thyratron, designed for high-power radar pulse modulators, features increased power handling capabilities and smaller size. The GL-7390 is 6 in. in dia. x 12½ in. long. Tube characteristics include:



peak anode voltage (forward and inverse) of 33 kv, peak anode current of 2,000 a. average anode current of 4 a., and an anode dissipation factor of 30 x 10^9. General Electric Co., Schenectady 5, N. Y.

Circle 253 on Inquiry Card

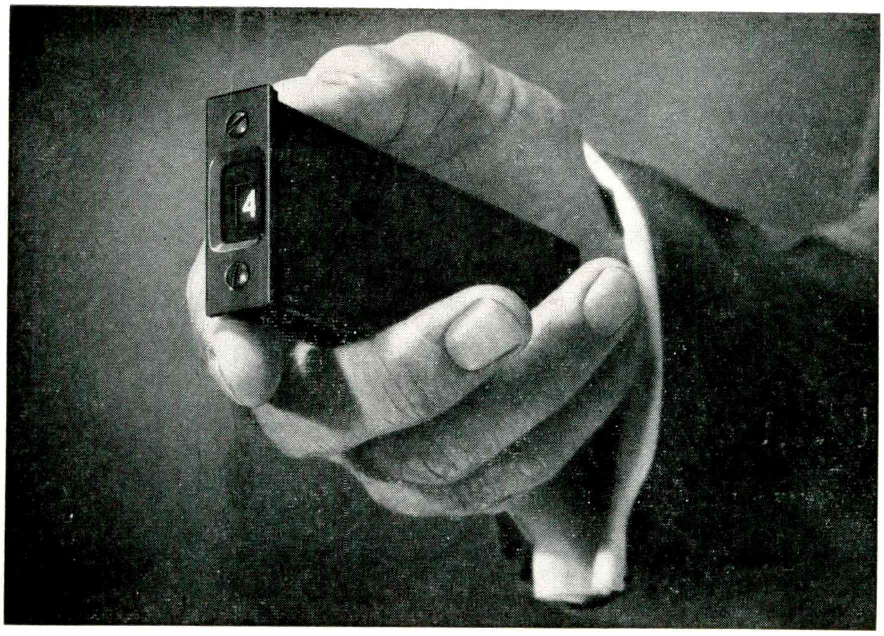
THE RELAY THAT FLIES *with* THE NEW NIKE

NIKE HERCULES, one of America's newest sentries of the sky, is faster and has a much greater range than the original version — Nike Ajax. Capable of carrying a nuclear warhead, NIKE HERCULES can blast an entire fleet of attacking aircraft.

Among the components selected to serve this prime defense weapon is the RX 1402-9, a special model of the WHEELOCK Series 121 tubular relay built to the customer's specification. The small size, handy shape and mounting arrangements, and wide ranges of coil resistance and sensitivity make the tubular a most attractive choice for many applications. Chances are you will find your requirements fulfilled by one of the many models available from the standard 500 milliwatt Series 120, the sensitive (85 milliwatt) Series 121 or the shorter Series 123. Technical literature on Wheelock's Tubular Relays available on request.

* 1¾" LONG, 15/32" O.D.

Wheelock SIGNALS INC.
LONG BRANCH, N. J.



New Products

POTENTIOMETERS

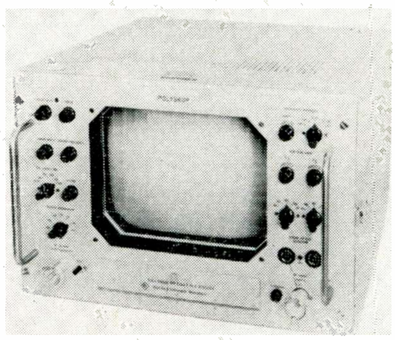
Potentiometers provide low noise, max. resolution from 0.015% to 0.059% and linearities from 0.08% to 0.2% (standard) or 0.03% to 0.15% (best). Max. resistance per 360°

ranges from 45 K ohms to 200 K ohms for the standard Type GC models. They withstand accelerations of over 40 G's and vibrations of over 1000 CPS and life expectancy is over 1 million cycles. Standard operating temp. range is —55° to +120°C. Other features: low torque (0.05 to 0.5 oz. in.), stability and a fungus resistant insulation capable of withstanding 250 v. nominal and 1500 v. breakdown. Noise level is 100 ohms at 4 RPM. Guidance Controls Corp., 110 Duffy Ave., Hicksville, L. I., N. Y.

Circle 254 on Inquiry Card

TEST INSTRUMENT

Electronic test instrument, Type SWOB, for 2 and 4-terminal network measurements, features 2-channel frequency-response display, 0.5 to 400 MC frequency range, and sweep width of ±0.2 to ±50 MC. Range of attenua-



tion measurement is 45 db. It uses low-capacitance diode probes or a coaxial 50-Q input with built-in detector. Rohde & Schwarz Sales Co., Inc., 111 Lexington Ave., Passaic, N. J.

Circle 255 on Inquiry Card

They got rid of the dobbin . . .

We got rid of the bobbin!

Why should precision wire wound resistors continue to be wound on bobbins and encapsulated in epoxy resin . . . when we know the life of the resistor is shortened and its stability lowered by the varying expansion rates of the wire, bobbin, and resin.

Let's face it: Bobbin's ready for the pasture! General Transistor has developed a precision wire wound **bobbinless** resistor that floats in a special viscous fluid. Result: a strain-free resistor with tolerances as low as 0.05% and Temperature Coefficients of Resistance as low as 2PPM/°C.

These facts alone are proof that it's time to learn more about GT Precision Wire Wound Bobbinless Resistors.

Get the full details! Write today for brochure GR-30.

GENERAL TRANSISTOR CORPORATION

91-27 138th Place • Jamaica 35, New York • Phone: HIckory 1-1000

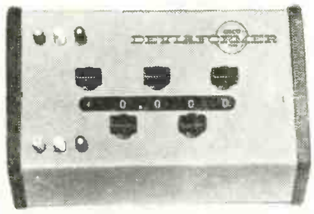
FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 6110 VENICE BLVD., LOS ANGELES, CALIF.

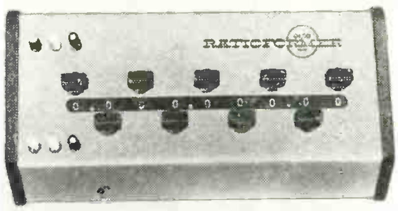
Circle 67 on Inquiry Card

New Products

TEST INSTRUMENT

The OECO Deviaformer brings laboratory test accuracy to the production line, transformers, synchros, resolvers, computers, and meters on a "go/no-go" basis. Accuracy level is



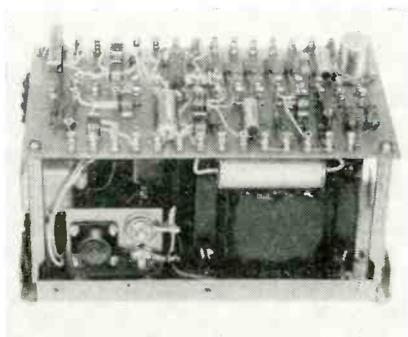


maintained to 0.001%. When used with a precision ac voltage divider, it gives a direct readout of % of deviation from specified voltage ratios. In-line digital readout is provided. High permeability internal shielding eliminates errors caused by pick-up of interfering magnetic induction. Osborne Electronic Corp., 712 S. E. Hawthorne Blvd., Portland, Ore.

Circle 256 on Inquiry Card

POWER SUPPLY

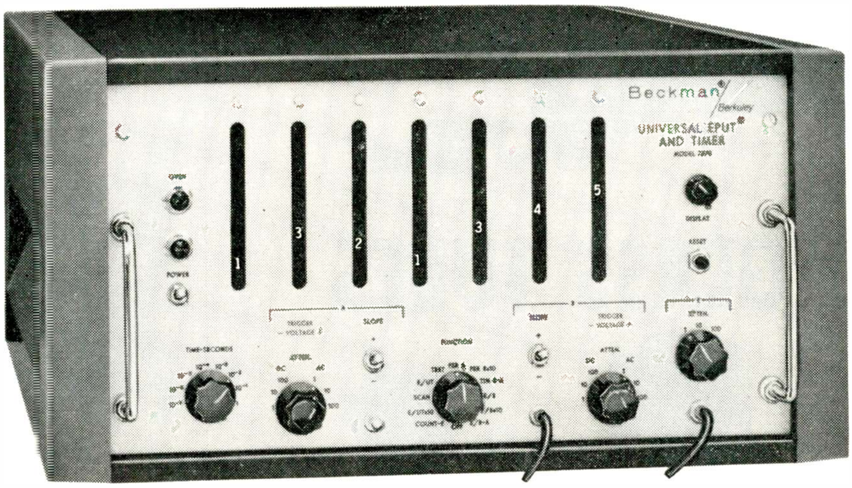
Ac to dc transistorized power supply, Model 62AR, has stability of ±0.1% regulation for 6 months. Featured: reliability of better than 0.95 for a period of 1 year at 8 hrs. per day, life expectancy 10 yrs., and an output impedance of less than 200 μohm at dc. Other characteristics: input, 115 vac, 60 or 400 CPS; output, 26 vdc @ 1 a. to 5 a.; load regulation, less than 1 mv, for load changes of 0



to full load; line regulation, less than 0.5 mv, for ±10% variations in line voltage or frequency; ripple, less than 1 mv RMS. The Daven Co., Livingston, N. J.

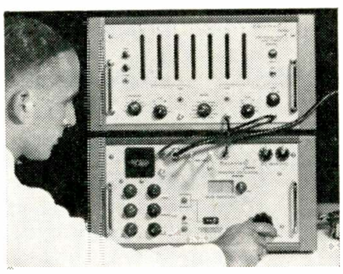
Circle 257 on Inquiry Card

10 Mc Counter displays microwave frequencies



to transfer oscillator

Coupled to a computing transfer oscillator, this counter will display the 13, 213.45Mc reading shown...one more instance of the unique utility of Model 7370.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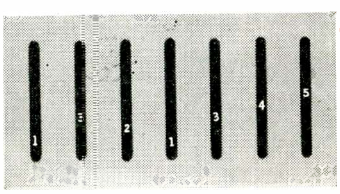

4

SPEEDY, PRECISE METHOD

1. Operator tunes transfer oscillator in the conventional way—finds two adjacent fundamentals having harmonics that zero-beat with the unknown frequency.
2. Reads harmonic number appearing on built-in automatic calculator.
3. Sets digital switches to harmonic number.
4. Reads microwave frequency as it appears on the face of the counter. The entire procedure takes less than one-fifth the time ordinarily required.

SPECIFICATIONS

Model 7370 used with transfer oscillator (Model 7580)

Frequency measuring range	dc to 15KMc
Types of signals accommodated	CW, AM, FM, pulsed r–f
Sensitivity	100 mv rms
Input impedance	50 ohms
Accuracy	up to ± 3p in 10^7
Fundamental range of trans. osc.	75 to 150 Mc & 7.5 to 15 Mc
Harmonics available	up to 100th
Stability of fundamental	.0001% per min

Model 7370 alone

Frequency counting range	dc to 10Mc
Sensitivity	selectable: 0.1v, 1v & 10v
Input impedance	10M ohms
Stability of time standard	3 parts in 10^7 per week
Additional functions	Measures period, phase & frequency ratio. Times interval between independent signals.

Prices

Model 7370 Universal EPUT® & Timer	$1975
Model 7580 Computing Transfer Oscillator	$1650

Write for detailed technical bulletins

Beckman® / *Berkeley Division*
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc.

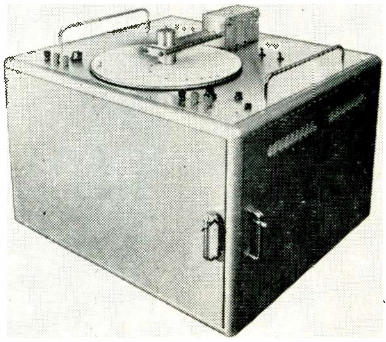
T22

Circle 70 on Inquiry Card

New Products

NYQUIST PLOTTER

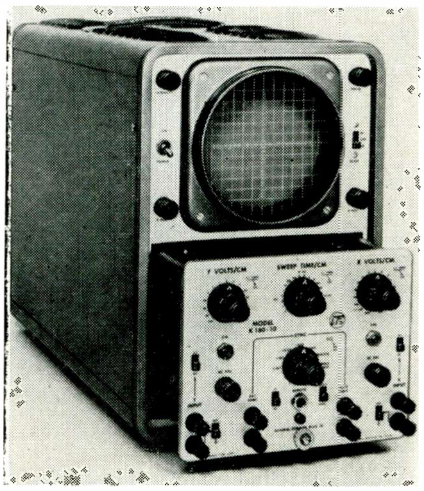
Series 100 Automatic Nyquist Diagram Plotter is a transfer function analyzer, including low frequency generator, phase detector and recorder. Nyquist diagrams are automatically plotted with an amplitude accuracy of 1% and a phase angle accuracy of 1°. Time required for a complete graph is 5 min., reduced to 90 sec. if the response below 1 cps is not required. Each graph is approx. 10 in. in dia., providing a permanent record of the system response. British Industries Corp., Special Instruments Div., 80 Shore Rd., Port Washington, N. Y.



Circle 258 on Inquiry Card

OSCILLOSCOPE

Model K-160 oscilloscope has all signal generating and processing circuitry — pre-amplification, switching, time-base generation, CR tube modulation, etc.—included in a single plug-in system. Several "plug-in" systems are available. The main frame indicator consists of a 5 in. single-gun CR tube, associated beam controls, identical X and Y main amplifiers, and a power supply. Electronic Tube Corp., 1200 E. Mermaid Lane, Phila. 18, Pa.



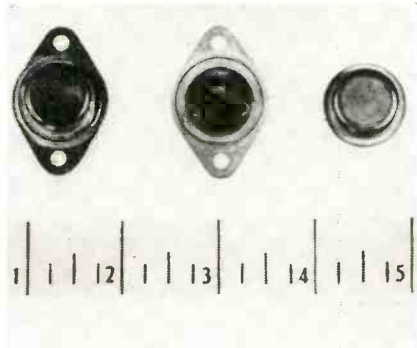
Circle 259 on Inquiry Card

Circle 72 on Inquiry Card

New Products

TRANSISTOR

Military-type 2N297A transistor is designed to meet MIL-T-19500/36A (SigC). The transistor can be used in military applications, high current switching, audio amplification, voltage



regulators, power supply circuits and power oscillator circuits. The new 2N297A transistor has a max. collector voltage rating of 60 v. and a max. collector current rating of 5 a. It will readily dissipate 35 w. at 25°C and 10 w. at 75°C. Bendix Aviation Corp., Red Bank Div., 201 Westwood Ave., Long Branch, N. J.

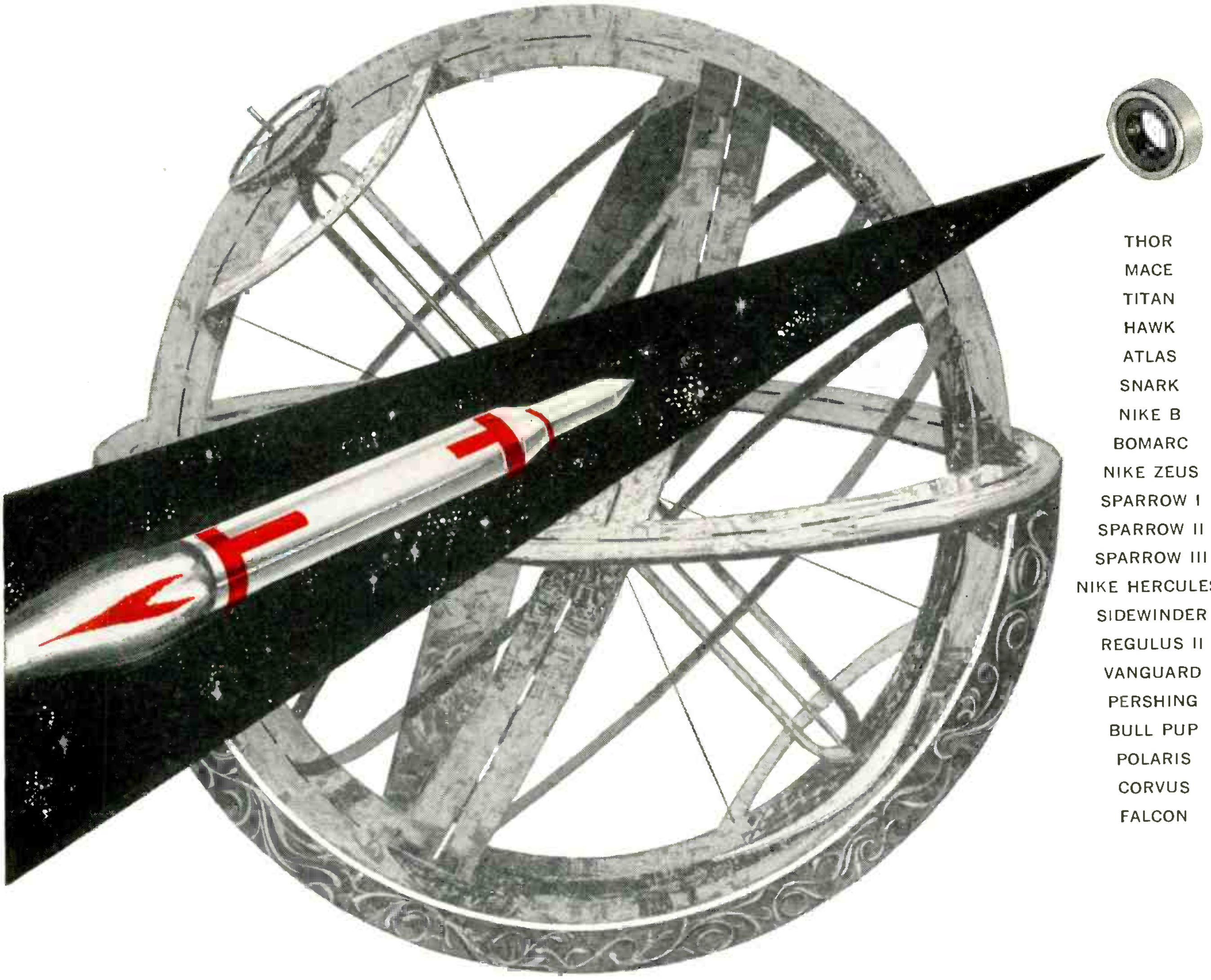
Circle 260 on Inquiry Card

SAWTOOTH GENERATOR

Model DY-2222 Sawtooth Generator meets the requirements for Serrodyne modulation of traveling-wave tube amplifiers and is designed as a building block element for doppler radar simulator applications. The sawtooth amplitude and sawtooth repetition rate are independent and separately adjustable. A 40-db step attenuator is provided, coupled with a concentric 5-db vernier ampli-

tude control. The max. output voltage level is 50 v. Front panel switch chooses + or — sawtooth slope at the output BNC connector. Dymec, Inc., 395 Page Mill Rd., Palo Alto, Calif.

Circle 261 on Inquiry Card



ND Adds New Dimensions To High Speed Gyro Rotor Bearings!

At speeds up to 24,000 RPM precision rotor bearings in inertial guidance and navigational systems are highly critical components. Early research and development in design and manufacturing at New Departure is solving the problem and thus winning vital roles for N.D. integral rotor bearings in missile projects. For example, "B" Series bearings with separable inner ring developed by N.D. are helping set performance records in such inertial guidance systems as the AChiever.

New Departure is also supplying high-precision rotor bearings for the inertial guidance system in Polaris. These bearings, through advanced manufacturing techniques, exacting inspections and controlled environmental tests, backed by 50 years of laboratory testing experience, give precision and uniformity far above the most precise industry standards. They promise new performance and *reliability* for the submarine-launched IRBM.

You can look to improved *performance* and *reliability* when you include an N.D. Miniature/Instrument Bearing *Specialist* in early design level discussions. Call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

Circle 74 on Inquiry Card

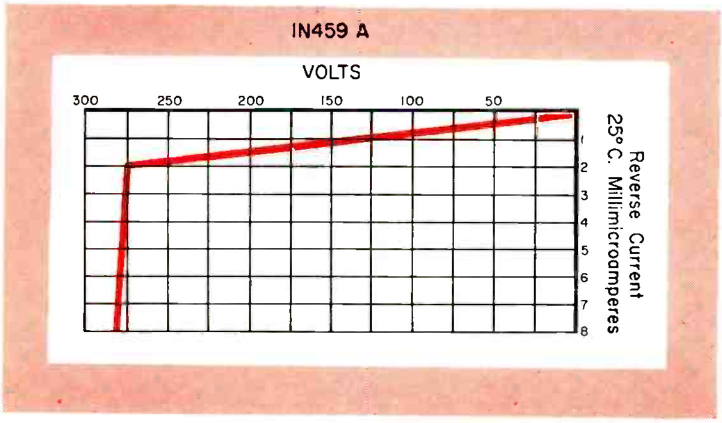
MORE DIODE per dollar

—from SYLVANIA

In Silicon Junction, Gold Bonded, and Germanium Point Contact types, Sylvania's complete mechanization assures EXTRA diode uniformity and quality control—at no extra cost.

Sylvania provides the design engineer with assurance of top-grade performance for its entire diode line. All Sylvania diodes in solder-sealed or all-glass packages are 100% tested for hermetic seals to assure maximum protection and reliability in any application—and particularly those where operating conditions are most severe.

Sylvania Silicon Junction Diodes are 100% tested on curve tracers for reverse characteristics—to eliminate such undesirable factors as soft breakdown, drift, flutter and creep.



Reverse characteristics of typical Sylvania Silicon Junction Diodes

A significant Sylvania EXTRA in automated diode quality control is the Sylvania-designed Digital Automatic Tester and Classifier. Here each unit is subjected to as many as 16 separate tests that can be programmed for an almost infinite variety of electrical characteristics. Accuracy of the automatic tester has proved to be better than 0.5 percent for every test.

In addition to 100% testing programs, all Sylvania diodes, through scientific sampling procedures, are thoroughly tested as follows:

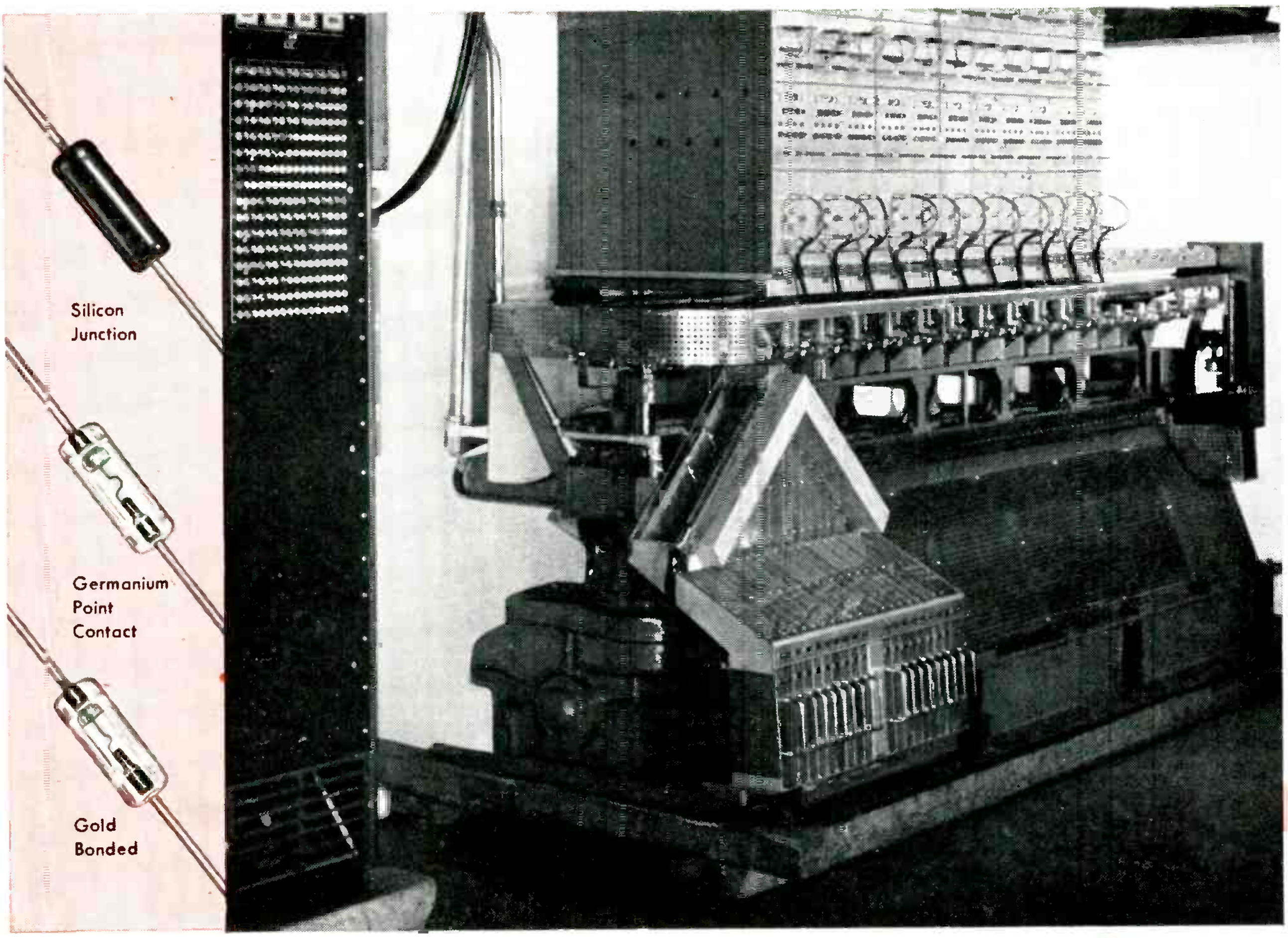
Extended Storage and Operating Life Tests—offer an extra safety factor, as they go beyond customer specifications.

Temperature Cycling Tests—ranging from −65° C to 200° C.

Lead Fatigue Tests—assurance of optimum mechanical stability.

Thermal Shock Tests—assure rugged seals.

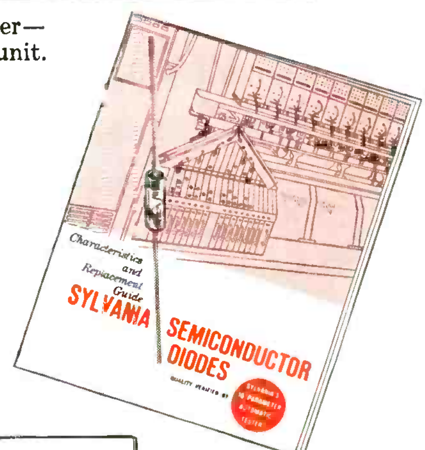
All of these mechanical and environmental tests are made in accordance with the most stringent specification procedures—military and non-military. In some cases, such as temperature cycling, the Sylvania limits exceed those of the specification.



Sylvania's Digital Automatic Tester and Classifier—performs up to 16 separate tests for each diode unit.

For the complete story on Sylvania Silicon Junction, Gold Bonded and Point Contact diodes, contact your Sylvania representative, or write the factory directly at the address below for a free copy of the new Sylvania 16-page diode booklet.

Write for your free copy of this new 16-page Sylvania Diode booklet.



POPULAR SYLVANIA MORE-DIODE-PER-DOLLAR TYPES

SILICON JUNCTION				POINT CONTACT		GOLD BONDED	
1N456,A	1N461,A	1N482,A,B	1N486,A,B,	1N126A	1N191	1N270	1N283
1N457,A	1N462,A	1N483,A,B	1N487,A	1N127A	1N192	1N276	D1165
1N458,A	1N463,A	1N484,A,B	1N488,A	1N128	1N198	1N279	D1248
1N459,A	1N464,A	1N485,A,B				1N281	

SYLVANIA

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

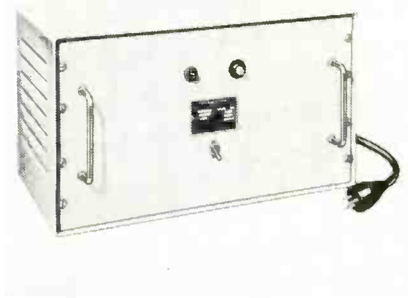
SYLVANIA ELECTRIC PRODUCTS INC.
Semiconductor Div.
100 Sylvan Road, Woburn, Mass.

Circle 76 on Inquiry Card

New Products

VOLTAGE REGULATORS

Automatic voltage regulators, IET Series, are for applications requiring instantaneous correction of ac line voltage fluctuations and the advantages of transistors: no filament



warm-up time, low power requirements, and low voltage operation. Recovery time is virtually instantaneous —in most instances 3 to 10 cycles. Series have an input range of 95 to 135 v. and an adjustable range of 110 to 120 v. The Superior Electric Co., Dept. IET, Bristol, Conn.

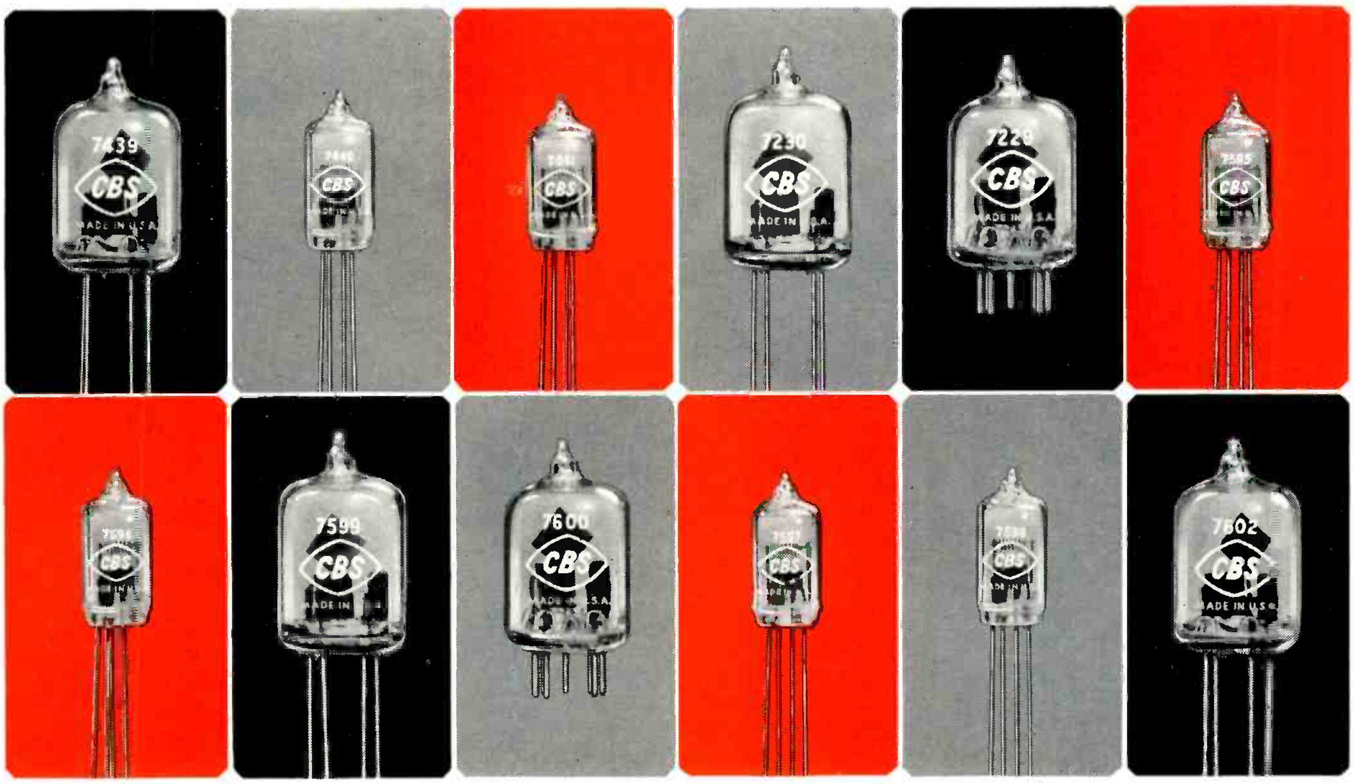
Circle 262 on Inquiry Card

TRANSDUCER PREAMPLIFIER

Preamplifier-monitor combination, Model PIG9X1, is designed to be fitted into a multi-channel tape recorder system. Each model has a preamplifier/vertical deflection amplifier with a sensitivity of 1 mv RMS per in. and a referenced 1 v. RMS recorder output. Bandwidth is 5 CPS to 30 KC. Input transformer is designed for 1 ohm line and may be used above ground. Transformer secondary is coupled to a balanced, stable preamplifier/verti-

cal deflection amplifier. For recorder use, a single ended output is 1 v. RMS when the scope shows a 1 in. signal. Waterman Products Co., Inc., 2445 Emerald St., Phila. 25, Pa.

Circle 263 on Inquiry Card



MORE NEW KRYTRONS

Advanced Electronic Devices for Triggers • Timers • Regulators • Pulsers • Etc.

This original, advanced and still growing family of CBS cold-cathode triggering, timing, regulating and pulsing devices now includes six subminiature and six miniature types. Designers are discovering virtually unlimited applications for these Krytrons. Efficient, accurate and dependable, they offer particular advantages in military and industrial equipment.

CBS Krytrons are as reliable and rugged as the most stable circuit elements. They provide conservative safety margins for extreme conditions of heat (+85°C), cold (−55°C), shock (2000-2800G), and vibration (10G at 0-5000 cycles). Their compact modern design fits neatly into potted and printed-circuit packages.

Check the features . . . the wide ranges of the major characteristics. Write for complete Technical Bulletin E-337A. Order from your local Manufacturers Warehousing Distributor, or from any CBS Electronics sales office.

MAJOR CHARACTERISTICS

Type	Hold-off Voltage (v)	Grid Firing Current (μamps)	Anode Delay (μsecs)	Anode Delay Variation (μsec)	Peak Anode Current (amps)	Test Specification
SUBMINIATURE						
7440	1500	20	4.0	0.4	100	Commercial
7441	1500	20	1.6	0.4	100	Reliable
7595	3000	8	1.0	0.15	400	Reliable
7596	5000	15	—	—	100	Commercial
7597	5000	15	1.0	0.15	100	Reliable
7598	4000	15	1.0	0.15	500	Commercial
MINIATURE						
7439	2000	40	4.0	0.4	500	Com., flying leads
7229	2000	40	4.0	0.4	500	Com., base pins
7230	3000	10	2.0	0.2	500	Rel., flying leads
7599	6000	7	1.5	0.2	500	Com., flying leads
7600	6000	7	1.5	0.2	500	Com., base pins
7602	6000	7	1.5	0.2	500	Rel., flying leads

Repetition rate is determined by allowable dissipation and by constants of gas fill.

FEATURES

- Very high hold-off voltages
- Low grid driving current
- Very high instantaneous pulse current
- Short anode delay time
- Negligible jitter
- Wide ambient temperature range
- Very rugged and reliable
- Compact and light
- Silent and cool
- Stable inert gas fill
- Instant-firing keep-alive
- Sure dark/cold starts

Reliable products through Advanced Engineering

CBS ELECTRONICS, DANVERS, MASSACHUSETTS
A Division of Columbia Broadcasting System, Inc.

New Products

VOLTMETER

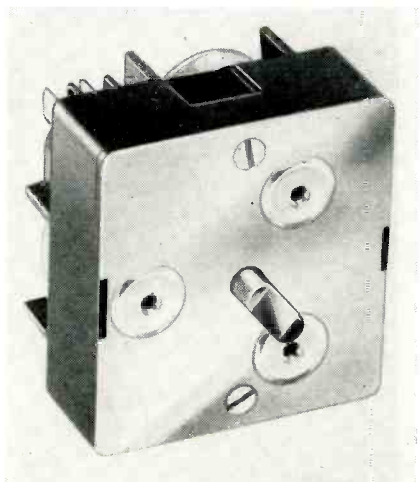
Model 2409, electronic voltmeter, measures either the true RMS, peak or average values of voltages over the frequency range from 2 to 200,000 CPS. An accuracy of 0.5 db is obtained

for true RMS indication of signals with crest factors up to 5 and over a 20 db dynamic range. It may serve as a calibrated decade amplifier with 60 db gain as well as a VTVM. B & K Instruments, Inc., 3044 W. 106 St., Cleveland 11, Ohio.

Circle 264 on Inquiry Card

INTERVAL TIMER

Interval timer, Series AT-31, is for use in the control of fans, heaters, battery chargers, photographic equipment, etc. Manually set to a selected interval, the switch opens, de-energizing the load and the timing motor. The switch is rated at 28 a. or 1 hp



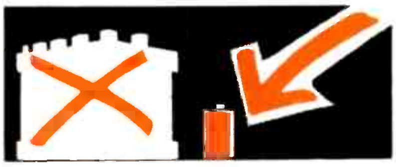
at 250 vac. It is available for 120 or 240 v. operation at 50 or 60 CPS with intervals of 1, 5, 15, 30, 60, 120 and 180 min. Hayden Div., General Time Corp., 245 E. Elm St., Torrington, Conn.

Circle 265 on Inquiry Card

Electron Tube News
—from SYLVANIA

New designs to meet new demands—everywhere in electronics

LOW HEATER POWER CATHODE-RAY TUBES...



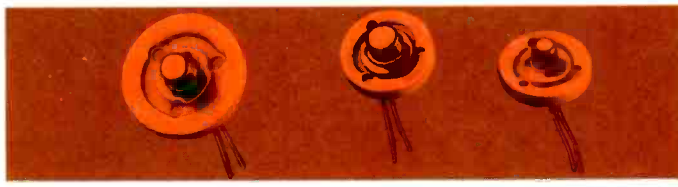
Low Heater Power CRT's use 1.5 v supply compared to 6.3 v for ordinary tubes

New 1.5 volt, 140 ma heater for CRT's under development at Sylvania will add new portability to oscilloscopes, radar and TV

Another revolutionary advance in cathode-ray tube design is now in final stages of experimental development at Sylvania's Industrial & Military Cathode-Ray Tube Department—Low heater power CRT's. The new 1.5 volt, 140 ma heater design requires less than 1/16 the power of ordinary CRT's—or less than ¼ watt compared to 4 watts. This not only means highly significant reductions in power supply requirements with the 210 mw heater but significant reductions in cooling requirements. As a result, new design approaches will be opened for portable oscilloscopes, portable radar, portable transistorized TV, missiles and any other application where minimum power supply weight and size are important considerations.

Your Sylvania equipment sales representative will be glad to discuss specific applications and sample availability with you.

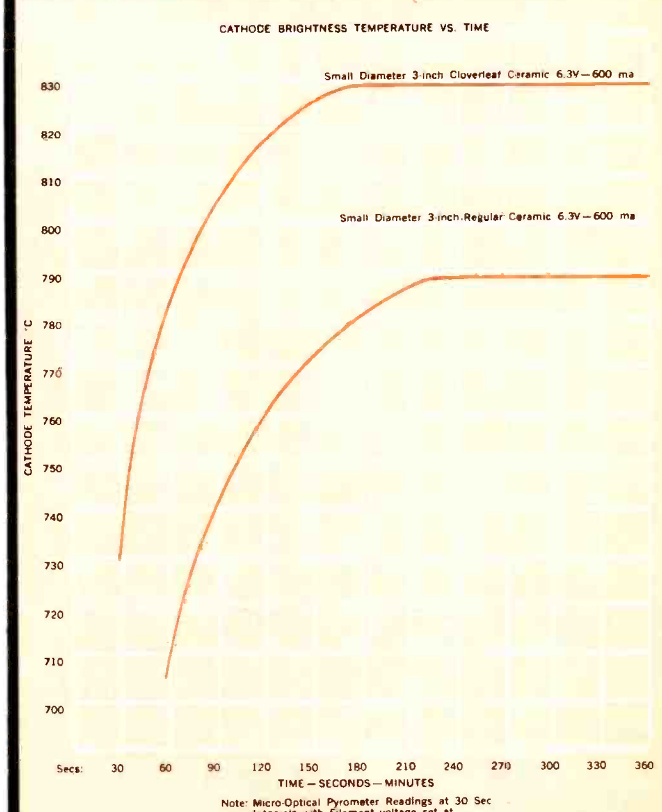
CLOVERLEAF CATHODE ASSEMBLY DESIGN...



"Cloverleaf" ceramic cathode assembly design, now available in all new Sylvania picture tubes, assures faster warm-up time throughout tube life

Already proved in hundreds of thousands of picture tubes is the Sylvania Cloverleaf cathode assembly. Its unique ceramic Cloverleaf configuration greatly reduces heat conduction losses and nearly doubles TV warm-up speed by reducing cathode-ceramic disc contact area. This not only increases assembly ruggedness but contributes to the overall efficiency of the tube.

Sylvania Cloverleaf is now available in all new TV picture tubes ranging from 110° 300 ma types to 72° 600 ma types as well as some industrial and military cathode-ray tubes. Contact your Sylvania representative for the full story on Sylvania Cloverleaf.



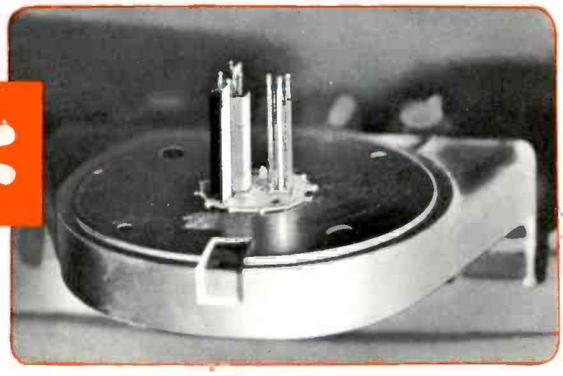
Faster picture tube warm-up time of the Sylvania Cloverleaf Cathode assembly shows up in this comparison of it with a conventional cathode assembly

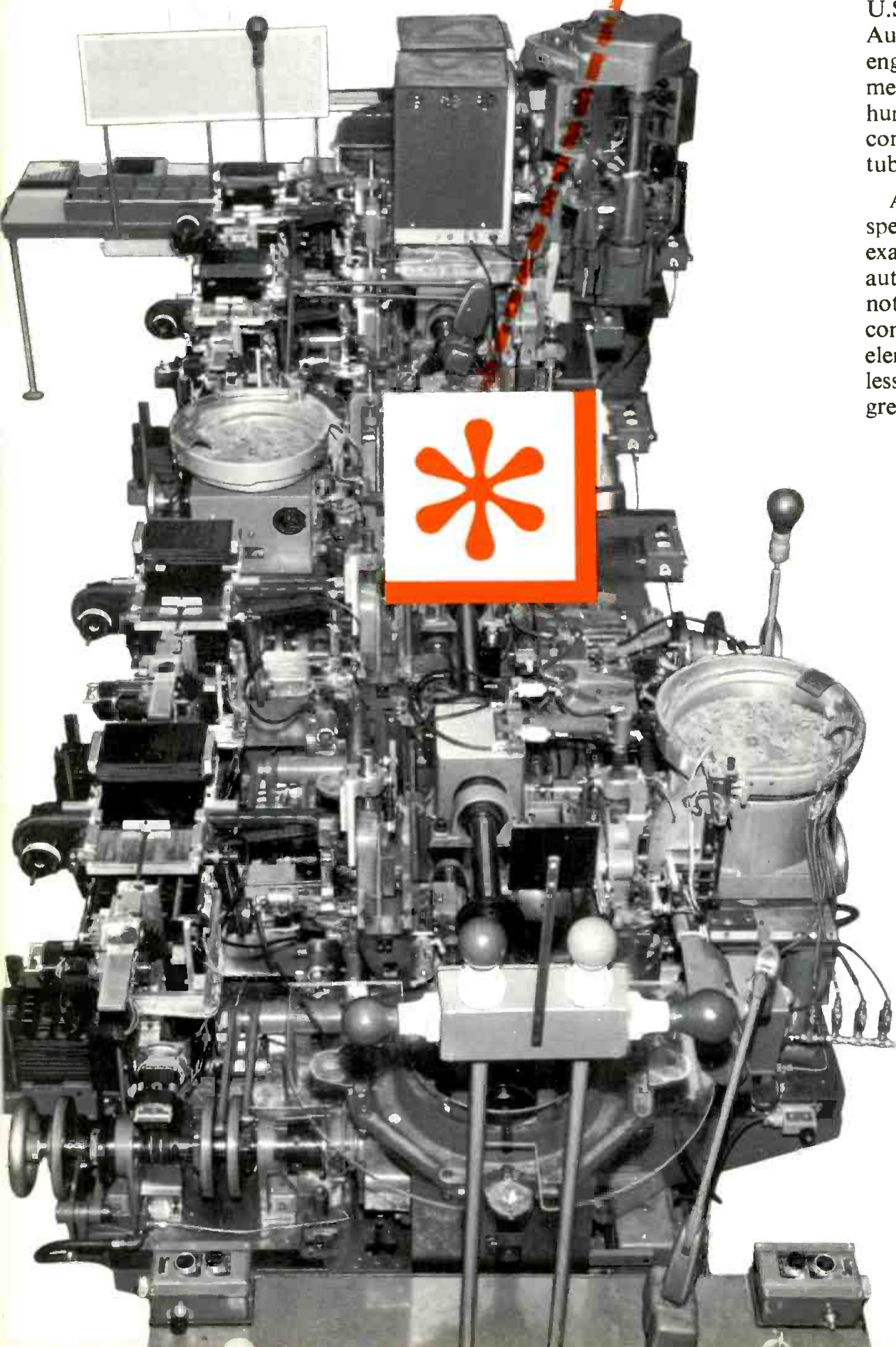
INDUSTRIAL & MILITARY CATHODE-RAY TUBES...

Today, Sylvania's Industrial and Military Cathode-Ray Tube department is producing over 150 tube types to meet the specialized needs of the growing industrial and military market. Here are the latest additions to this expanding line:

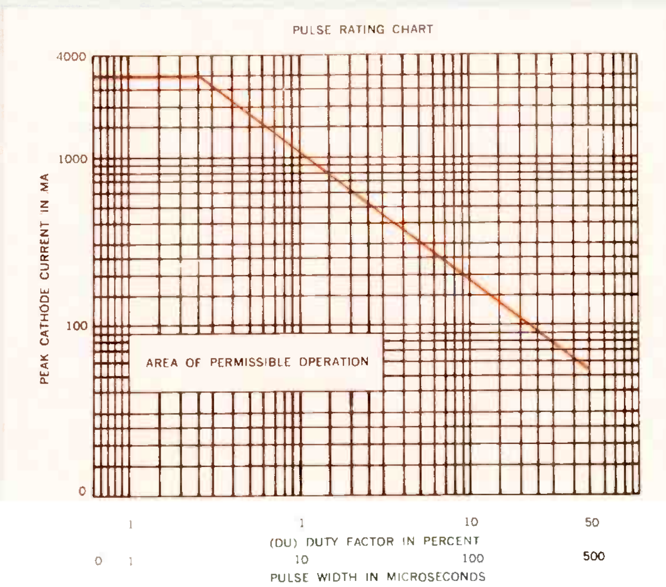
Type 4MP_series—This four-inch square face CRT is designed for use in oscilloscopes and other display devices where space considerations are important. It features electrostatic focus and deflection as well as post deflection acceleration. Its deflection plate leads are sealed through the neck . . . a design which assures low capacity and inductance.

Type 5BCP_series—This five-inch round oscilloscope tube is designed with a ⅞-inch neck diameter that can more effectively utilize low deflection power. It features magnetic focus and deflection.

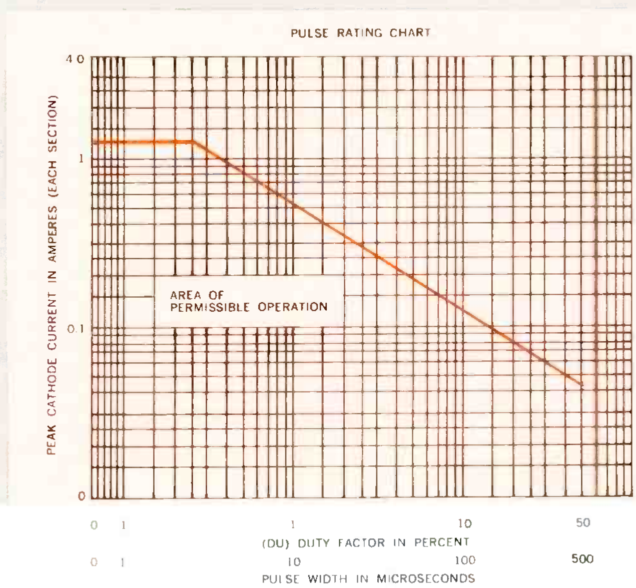




TYPE GB-7550



TYPE GB-7327



Pulse Rating Charts, exclusive with new Sylvania Pulse Types, show the high current capabilities of the new tubes

PULSE TUBES . . .

Sylvania develops industry's first subminiature Pulse Tubes specifically designed for pulse amplifier and BTO circuits

Now the design engineer can select subminiature tube types specifically designed for pulse applications. Sylvania is developing a line of pulse types rated to deliver high pulse current with reliability, compactness and accuracy. No longer is it necessary to use tubes designed for other purposes that are not rated to consistently meet pulse requirements. With the new Sylvania types, higher pulse current is assured and each is supplied with a pulse rating chart. This not only makes the design problem much simpler but means better end equipment performance.

Two new pulse types GB-7327 and GB-7550 are already in full production at Sylvania with more on the way:

TYPE GB-7327—This new subminiature (T-3 bulb) medium mu double triode is specifically designed and processed for pulse applications. It features low vibrational noise and excellent performance under rugged environmental conditions. It is a direct replacement for types 6111 and 6021 and with some modification can replace any double triode. The tube, as its GB prefix indicates, is specifically designed to meet commercial and industrial application requirements. In addition, it is the first tube made by Sylvania that employs both the AQL and new Sylvania ADL quality systems. This means extra assurance that every Sylvania pulse tube will meet customer specifications effectively.

TYPE GB-7550—This is Sylvania's newest pulse type, a subminiature (T-3 bulb) double triode with a higher cathode pulse current. It can easily replace types 6111 and 6021. With varying degrees of modification, it can be used in place of any double triode. It features a larger cathode for additional current capabilities and new grid radiators for more effective dissipation. It too is a Sylvania GB type made to meet the specific requirements of industrial and commercial applications. It also incorporates both the AQL and new Sylvania ADL quality standards.

Both new Sylvania pulse types, GB-7327 and GB-7550, may be used in pulse amplifier or BTO circuits. This opens applications in areas such as:

Aerial Navigation Equipment
(Pulse radar and missiles)

Sylvania is continuing to develop additional pulse tube types to meet increasing industry demand for accurate, dependable high-current pulses. Check with your Sylvania representative or contact the factory directly for latest information on Sylvania GB Pulse Tubes.

New Sylvania Pulse Types GB-7327 and GB-7550

Characteristics	GB-7327	GB-7550
DIRECT INTERELECTRODE CAPACITANCES (Unshielded)		
Grid to Plate	1.5 uuf	4.0 uuf
Input: g to (h+k)	1.9 uuf	4.0 uuf
Output: p to (h+k)		
Section No. 1	0.28 uuf	0.24 uuf
Section No. 2	0.32 uuf	0.28 uuf
Grid to Grid	0.011 uuf Max.	0.16 uuf Max.
Plate to Plate	0.50 uuf Max.	1.2 uuf Max.
RATINGS (Absolute Maximum Values)		
Heater Voltage 3	6.3±5% V	6.3±5% V
DC Plate Voltage	300 Vdc	300 Vdc
Instantaneous Forward Plate Voltage	400 V	400 V
Plate Dissipation (Each Plate)	0.95 W	2.0 W
Grid Dissipation (Each Plate)	0.2 W	3.6 W (Both Plates) 0.4 W (Each Grid)
CHARACTERISTICS RANGES (Each Section)		
Pulse Cathode Current: Ef=6.3 V; Eb=300 Vdc; Ec=−25 Vdc; egk=+50 v at tp=10 usec; prr=1000 pps; tr=0.8 usec Max.; tf=1.0 usec Max.	700 mA Min.	1400 ma Min. Ef=6.3 V; Eb=300 Vdc; Ec=−30 Vdc; Instantaneous Voltage Between Grid and Cathode (Smoothed Peak)=+40 v at tp=10 usec; prr=0.8 usec Max.; tf=1.0 usec Max.

Postage Will be Paid by Addressee

Nc Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 2833 Sec. 34.9 P.L.&R., Buffalo 9, N.Y.

SYLVANIA ELECTRIC PRODUCTS INC.

1100 Main St.

Buffalo 9, N. Y.

STRAP-FRAME CONSTRUCTION...

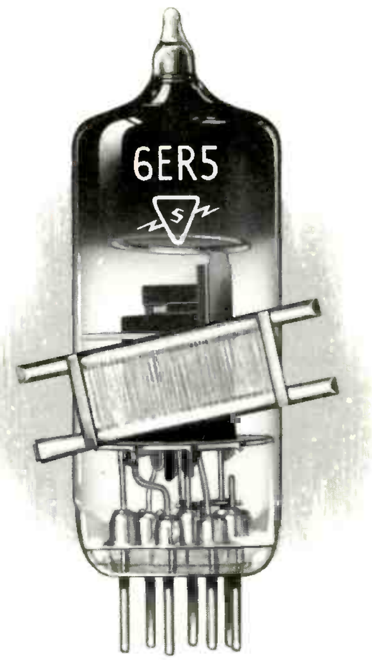
Sylvania introduces the strap-frame grid design in a new tetrode type 6ER5, designed as a VHF amplifier for TV tuners

Complementing the Framelok Grid design for power applications is the Sylvania strap-frame grid development for high frequency tuner type applications. First Sylvania tube incorporating strap-frame grid construction in a T-3 envelope is type 6ER5. It is a semi-remote cutoff tetrode designed as a VHF amplifier for TV tuners. It features high transconductance, high input impedance, low intermodulation distortion and dual cathode pins. Grid No. 2 functions as a shield to reduce grid to plate capacitance.

The strap frame, as its name implies, gives new extra support to grid side rods. Not only does this make a more rugged, accurately aligned grid possible, but since the grid laterals themselves do not support the rods, finer grid wire with greater TPI (turns per inch) can be used. The end result is higher gm, better dissipation and overall more efficient performance.

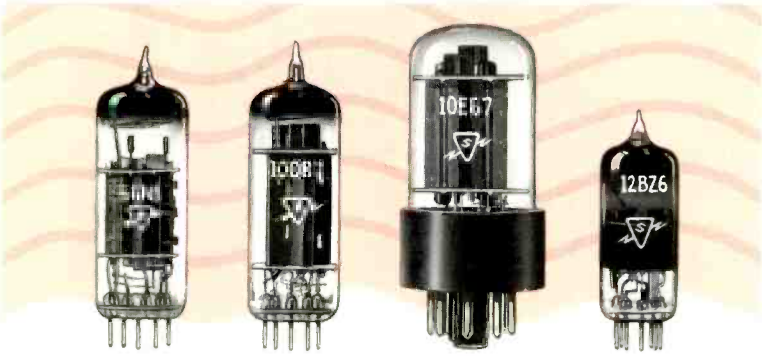
RATINGS (Design Center Values)

Supply Voltage	550 Volts
Plate Voltage	250 Volts Max.
Grid No. 2 Voltage	100 Volts
Plate Dissipation	2.2 Watts Max.
Grid No. 2 Dissipation	0.5 Watts
Cathode Current	20 Ma Max.
Negative Grid Voltage	50 Volts Max.
Grid Circuit Resistance Cathode Bias	1.0 Megohm Max.



Sylvania's new Strap-Frame high frequency tuner type, 6ER5. Strap-Frame grid construction permits use of finer grid wire for more TPI

VIDEO...



SYLVANIA GENERAL SYSTEM

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
P. O. Box 1190, Station "O," Montreal 9

Five new types from Sylvania for TV service

TYPES 6GN8 AND 8GN8—Both of these new types incorporate a high mu triode and a sharp cutoff pentode in one T 6½ envelope. The triode section is designed for voltage amplifier or sync separator service. The pentode section, designed for video amplifier service, features a controlled knee characteristic.

TYPE 10DR7—Double triode in a T 6½ envelope with a high mu section for vertical deflection oscillator use, and a low mu section for use as a vertical deflection amplifier.

TYPE 10EG7—T9 double triode for series string TV with a medium mu section designed for vertical deflection oscillator use and a low mu section for vertical deflection amplifier use.

TYPE 12BZ6—T 5½ semi-remote cutoff pentode for use as an automatic gain controlled amplifier.

Please send additional information on the items checked below:

Industrial & Military Cathode Ray Tubes
- ☐ Type 4MP—series
- ☐ Type 5BCP—series

New Sylvania Pulse Tubes:
- ☐ Type 7327
- ☐ Type 7550

New Strap-frame Grid Tube
- ☐ Type 6ER5

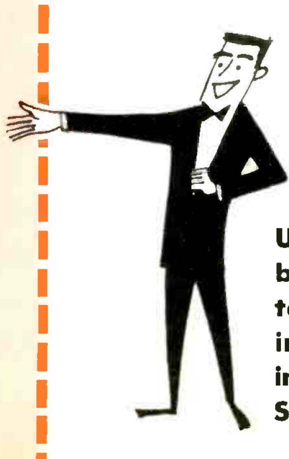
New entertainment receiving tubes
- ☐ Type 6GN8 ☐ Type 10EG7 ☐ Type 8GN8 ☐ Type 12BZ6
- ☐ Type 10DR7 ☐ Special tube designs for particular applications

Name____________________

Address____________________

Company____________________

Code 4Q59



Use this handy business reply card to request additional information on these important new Sylvania developments

ELECTRONIC INDUSTRIES'

1960 Summary of Microwave Electron Devices

(Part One of Two Parts)

Listing complete technical specifications on the commercially available microwave electron tubes, both foreign and domestic, and the newest family of microwave amplifying devices—the parametric amplifier.

Magnetrons

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwr. Out.
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y.										
5J26	OSC tunable	1.22-1.35	23.5, 2.2	28K	46		0.001	1	Co	600kw
5609	OSC fixed treq.	2.425-2.475	6.3, 3.8	1.47k	0.125	6mc	cw	cw	Co	115w
7090	OSC fixed freq.	2.425-2.475	5.3, 3.2	1.6k	0.2	5mc	cw	cw	Co	200w
7091	OSC fixed freq.	2.425-2.475	5,32	4.5k	0.75	4mc	cw	cw	Co	2.5kw
7292			Same as 7091 but liq. cool.							
5586	OSC tunable	2.7-2.9	16, 3	27,32k	70	15mc	0.005	1	Co	800kw
5657	OSC tunable	2.9-3.1	16, 3	27.5, 325k	70	15mc	0.005	1	Co	800kw
6589	OSC tunable	3.35-3.5	16, 3	26,30k	50	10mc	0.005	1	Wg	500kw
4J59	OSC fixed freq.	6.275 - 6.375	12.6, 3.5	16, 19k	30	15mc	0.001	1	Wg	210kw
4J58	OSC fixed freq.	6.375-6.475	12.6, 3.5	16, 19k	30	15mc	0.001	1	Wg	210kw
4J57	OSC fixed freq.	6.475-6.575	12.6, 3.5	16, 19k	30	15mc	0.001	1	Wg	210kw
2J51	OSC tunable	8.5-9.6	6.3, 1	14k	14	18mc	0.001	1	Wg	63kw
2J51A	OSC tunable Hi-Stab.	8.5-9.6	6.3, 1	14k	14	18mc	0.00033	2	Wg	60kw
DX125	OSC tunable freq.	8.5-9.6	20, 4	28, 34k	25	16mc	0.001	1	Wg	225kw
4J78	OSC fixed freq.	9.003-9.168	13.7, 3.5	20, 23k	27.5	15mc	0.001	1	Wg	225kw
55032	OSC fixed freq.	9.003-9.168	13.7, 3.5	20, 23k	27.5	17.5mc	0.001	1	Wg	225kw
55031	OSC fixed freq.	9.168-9.345	13.7, 3.5	20, 23k	27.5	17.5mc	0.001	1	Wg	225kw
JP9-7A	OSC fixed freq.	9.21-9.27	6.3, 0.6	5.5k	4.5	15mc	0.001	1	Wg	7kw
7028	OSC fixed freq.	9.345-9.475	6.3, 0.5	3.5k	2.5	14mc	0.0002	0.1	Wg	3kw
2J42	OSC fixed freq.	9.345-9.405	6.3, 0.6	5.5k	4.5	15mc	0.001	1	Wg	7kw
JP9-7D	OSC fixed freq.	9.345-9.405	6.3, 0.6	5.5k	5.5	15mc	0.0001	0.1	Wg	8kw
JP9-15	OSC fixed freq.	9.345-9.405	6.3, 0.6	6.5, 8k	6.5	18mc	0.001	2	Wg	19.5kw
725A	OSC fixed freq.	9.345-9.405	6.3, 1	12k	12	15mc	0.001	1	Wg	50kw
6972	OSC fixed freq.	9.345-9.405	10, 2.8	15k	15	15mc	0.0002	0.1	Wg	75kw
4J52A	OSC fixed freq.	9.375±25mc	12.6, 2.2	15k	15	15mc	0.001	5	Wg	80kw
4J50	OSC fixed freq.	9.345-9.405	13.7, 3.5	20, 23k	27.5	15mc	0.001	1	Wg	225kw
55030	OSC fixed freq.	9.345-9.405	13.7, 3.5	20, 23k	27.5	17.5mc	0.001	1	Wg	225kw
55029	OSC fixed freq.	9.405-9.505	13.7, 3.5	20, 23k	27.5	17.5mc	0.001	1	Wg	225kw
7093	OSC fixed freq.	34.512-35.208	4-4	13.5, 15k	15.5	40mc	0.0001	0.02	Wg	25kw
BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass.										
5780	tunable OSC	8.5-9.6	20, 4	30k	30					250kw
6551	fixed tuned OSC	23.7-24.2	5, 2.8	14k	15					40kw
BL212		5.4-5.9	5, 0.5	1300	0.8					100w
BL216		15.9-16.1	15, 3.7	20.5k	20					100w
BL208		16.-16.5		3500	1					500w
BL-218		51.5-55.5	6.3, 3	14k	7					5kw
BL-219		54.5-57.5	6.3, 3	15.5k	7					5kw
BL-220		56.5-60.	6.3, 3	14k	7					5kw
BL-223		5.4-5.9	5, 0.7	1900	1.1					400w
BL-226		9.4-9.5	5, 0.5	1300	0.90					90w

NATO SELECTS EIMAC KLYSTRONS TO POWER EUROPE'S LARGEST TROPO-SCATTER NETWORK

One and ten kilowatt amplifiers in NATO's continent-spanning tropo-scatter system will be Eimac Amplifier Klystrons. Since Eimac Klystrons first made large-scale tropospheric communications possible in 1954, they've become famous for reliability in all major tropo-scatter networks: Pole Vault, Dew Line, Texas Towers, White Alice, Florida-Cuba TV. Individual Eimac Klystrons have logged more than 35,000 hours continuous air time in tropo-scatter service.

Exclusive design features make Eimac Klystrons outstanding for tropo-scatter. Extra-wide frequency tuning is achieved with one set of tuning cavities. Inductive tuning achieves uniform bandwidth plus greater broadbanding by external cavity loading. Eimac's external cavity design lowers original cost, and replacement cost is lower since tuning circuitry is purchased just once.

One wide range load coupler covers the entire frequency range. Eimac's series connected body magnets permit use of one power supply, one control for body magnets.

Eimac Klystrons will be used in NATO installations. Proved Eimac reliability will aid in safeguarding the security of all free European nations.

EITEL-McCULLOUGH, INC.

Eimac® San Carlos • California

Magnetrons

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. (cont'd.)

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
BL-227		8.7-9.1	5, 0.5	1300	0.90					90w
BL-228		8.3-8.7	5, 0.5	1300	0.90					90w
BL-230		5.4-5.9	5.0, 0.7	2800	1.9					1kw
BL-231		5.3-6	5.0, 0.5	1400	1					200w
BL-242		5.4-5.9	5, 0.7	1900	1.1					400w
BL-243		5.4-5.9	5, 0.5	1400	1					200w

BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N.Y. (Representing General Electric Co., Ltd.)

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
CV76	air-cooled	2.95	5, 2.5	27k	35		.001	2		450kw
CV160	air-cooled	3	6, 1.25	22.5k	22.5	7	.001	1	Co	200kw
CV192	cond. cooled	3.288	6, 1.25	21.5k	23		.0008	1		225kw
CV1475/78	air-cooled	3.23	5, 2.6	26k	40		.001	0.5		450kw
CV1479/82	air-cooled	2.95	5, 2.5	27k	35		.001	2		450kw
CV1495/1500	air-cooled	3	6, 1.25	21.5k	22.5	7	.001	1	Co	200kw
MAG2[1,2]	air-cooled	9.35-9.5	3, 2.5	15kv	10	15	.00025	0.25	Wg	45kw
MAG3[1]	air-cooled, pkgd.	9.345-9.405	6.3, 0.55	6kv	7	15	.0001	0.1	Wg	14kw
MAG5	air-cooled	9.36-9.45	3, 2.3	17kv	12	15	.001	1	Wg	60kw
MAG7	pkgd., rugg.	9.2-10	2, 10	16kv	15	15	.001	1	Wg	80kw
MAG8(CV2380)	on B7G base	9.2-9.6	6.3, 0.2	0.95kv	0.025		.004	2		800mw
CV214	air-cooled	9.65-9.7	3, 2.5	15.5kv	10	15	.0005	1	Wg	47kw
CV370	air-cooled, pkgd.	9.21-9.27	6.3, 0.55	5.7kv	4.5	15	.001	1	Wg	7.7kw
CV2111/2114	air-cooled	9.59-9.89	6.3, 1.3	14.5kv	10	15	.0005	1	Wg	50kw
CV5031[1]	air-cooled	9.003-9.168	3, 3.5	13.5kv	12	12	.001	1	Wg	50kw

1. Position of first voltage standing wave min. and magnitude of V.S.W.R defined.
2. Can also be supplied to JAN 1A 2J42 specification.

CANADIAN MARCONI CO., 2442 Trenton Ave., Montreal 16, Quebec, Canada

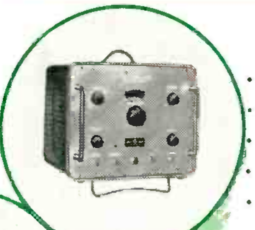
Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
7138 to 7143	plsd. OSC, int. mag.	9.05-9.55 (in 100mc steps)	6.3, 0.51	7.8k	8	15	.0025	2.5	Wg	18kw
7182	plsd. OSC	2.75-2.86	12, 14	33k	185	5	.0015	6	Wg	2.5megw
2J42	plsd. OSC, int. mag.	9.345-9.405	6.3,	6k	5.5	15	.0025	2	Wg	
2J424	plsd. OSC, int. mag.	9.345-9.405	6.3	6k	4.5	20	.002	2.5	Wg	
4J50	plsd. OSC, int. mag.	9.345-9.405		23k	3.75		.002	2.7	Wg	
4J50A	plsd. OSC, int. mag.	9.345-9.405				15			Wg	225kw
5J26	plsd. OSC, ext. mag.			34k			.0025			400kw
5586	plsd. OSC, tunable	2.7-2.9				15				
6027	plsd. OSC, int. mag.	9.345-9.405	6.3	8k	8	15	.0025	2.5		
6249A	plsd. OSC, int. mag.	8.5-9.6	10,	29k		15	.0013	2.8		200kw

ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
2J30-34	multi-res. 5 bands	2.7-2.9	6.3, 1.5	20k	30	15	.002	1	Co	300kw
2J42	multi-res., int. mag.	9.345-9.405	6.3, 0.5	5.5k	4.5	15	.0025	2	Wg	8kw
4J31-35	multi-res. 5 bands	2.7-2.9	16, 3.1	28k	70	15	.001	1	Co	1 megw
4J43-44	multi-res. 2 bands	2.965-3.019	16, 3.1	28k	70	15	.001	1	Co	900kw
4J50A	multi-res.	9.345-9.405	13.75, 3.25	22k	25	15	.001	1	Wg	225kw
4J52A	multi-res.	9.35-9.4	12.6, 2.2	15.5k	15	13	.001	1	Wg	80kw
4J53	multi-res.	2.793-2.813	16, 3.1	28k	70	15	.001	1	Co	1 megw
4J78	multi-res.	9.003-9.168	13.75, 3.5	21.5k	27.5	15	.002	1	Wg	250kw
714AV	multi-res.	3.28-3.32	6.3, 1.5	20k	20	15	.002	1	Co	180kw
5586	(tunable version of 4J31-35)									
5657	multi-res.	2.9-3.1	16, 3.1	30k	70	15	.001	1	Co	1 megw
6027	multi-res.	9.345-9.405	6.3, 0.5	6.9k	7	15	.0025	1	Wg	20kw
7182	multi-res.	2.750-2.86	12, 15	35k	157		.0015	5	Wg	2.5megw
M501, A, B	multi-res.	2.94-3.06	5, 2.6	27k	35		.001	2		500kw
M502A	multi-res.	9.325-9.425	12.6, 2.25	21k	22.5	15	.0005	1	Wg	180kw
M503A	multi-res., int. mag.	9.345-9.405	6.3, 0.5	5.5k	4.5	15	.0025	0.1	Wg	8kw
M504	multi-res.	9.325-9.425	5, 40	35k	50	15	.0006	0.6	Wg	750kw
M505	multi-res.	9.36-9.45	3, 3.5	11.1k	12	15	.001	1	Wg	45kw
M506A	multi-res.	9.36-9.46	3, 3.5	11.2k	12	15	.001	1	Wg	50kw
M507	multi-res.	3.23-3.38	5, 2.6	27k	40.		.001	0.5		425kw
M508	multi-res.	9.21-9.27	6.3, 0.5	5.5k	4.5	15	.0025	2	Wg	8kw
M509	multi-res.	8.77-8.83	6.3, 0.5	5.5	4.5		.0025	2	Wg	8kw
M513A	multi-res.	9.345-9.405	6.3, 0.5	7.5k	7.5		.0025	0.1	Wg	18kw
M519	multi-res.	3.45-3.614	5, 2.6	27k	40		.001	0.5		425kw
M521	multi-res.	9.6-9.7	3, 3.5	11.1k	12		.001	1	Wg	45kw
M523	multi-res.	9.58-9.705	13.75, 3.25	22k	25	15	.002	1	Wg	225kw
M525	multi-res.	2.75-2.855	8.5, 9	36k	70		.0012	1	Wg	1.15megw
M528	multi-res.	3-3.12	6, 1.25	22.5k	22.5		.001	0.5	Co	200kw
M529	multi-res.	8.83-8.995	13.75, 3.25	22k	25		.001	1	Wg	225kw
M535	multi-res.	9.5-9.6	6.3, 0.5	5.5k	4.5		.0025	0.1	Wg	7.2kw
M537	multi-res.	8.77-8.83	6.3, 0.5	5.5k	4.5		.0025	1	Wg	8kw
M538A	multi-res.	9.21-9.27	13.75, 3.25	22k	25		.001	1	Wg	225kw
M539	multi-res.	8.665-8.83	13.75, 3.25	22k	25		.001	1	Wg	225kw
M546	multi-res.	9.7-9.85	13.75, 3.25	22k	25		.001	1	Wg	225kw

FXR's wide selection of microwave test equipment and waveguide components cover the frequency spectrum from 350 megacycles to 220 kilomegacycles—from the giant size WR-2100 components to the 2 MM & 3 MM wavelength miniature instruments. High power pulse modulators and high-voltage power supplies are equally prominent in FXR's production line.

MICROWAVE INSTRUMENTATION



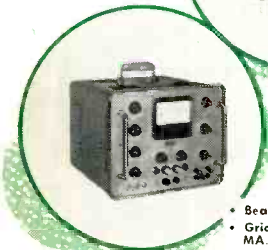
SIGNAL SOURCES

- Model L771B: 950 to 2000 MC/SEC.
- Model S771B: 1900 to 4000 MC/SEC.
- Model C772A: 3950 to 8200 MC/SEC.
- Model X772A: 7000 to 11,000 MC/SEC.
- Power Output: 10-100 MW CW, MAX. into matched load. Variable through level-set attenuator.
- Modulation: pulse, square wave both internal and external.

UNIVERSAL RATIOMETER

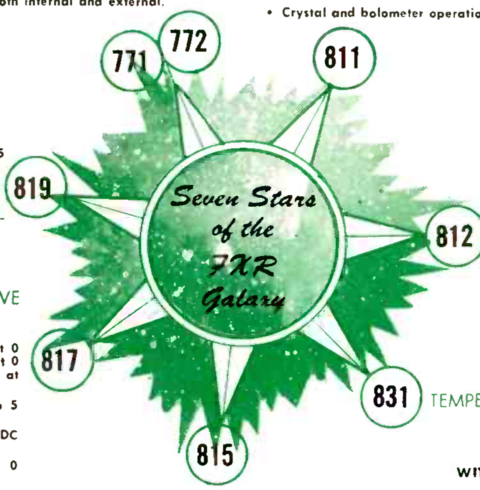
RATIO METER AND STANDING WAVE AMPLIFIER IN ONE COMPACT PACKAGE

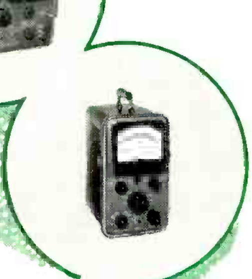
- Two-cycle Precision Logmeter: VSWR reflectometer readings of 1.02 to ∞ on only two scales.
- VSWR, DB and reflection coefficient scales eliminate conversion tables.
- Full 70 DB standing wave amplifier operation, expanded VSWR scales.
- Crystal and bolometer operation.



KLYSTRON POWER SUPPLY

- Beam: 300-1000 V at 85 MA.
- Grid: —300 to +150 V at 0 to 5 MA. Built-in limiting resistor.
- Reflector: 0-900 V at 10-20 μA.
- Regulation: 1%.
- Internal Modulation: pulse, sawtooth, square wave.





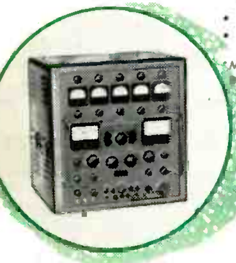
STANDING WAVE AMPLIFIER

- A 5-inch removable meter with 1% linearity provides high resolution and accuracy.
- A filter, tunable between 950 and 1050 CPS, aligns instrument with output frequency of signal source.
- Range: 70 DB in six decade steps. Normal and expanded scales for VSWR and DB.
- Gain automatically maintained when switching from normal to expanded scales.
- Detectors: crystal or bolometer.
- Full scale sensitivity, 0.1 μV: signal-to-noise ratio, 3:1.

UNIVERSAL MICROWAVE POWER SUPPLY

- Helix (beam): 0 to 1800 V at 0 to 100 MA; 1700 to 2500 V at 0 to 100 MA; 2500 to 3500 V at 250 W MAX.
- *Grid 1: 0-300 V DC at 0 to 5 MA.
- *Grid 2 (reflector): 0-1200 V DC at 0 to 1 MA.
- *Grid 3 (focusing electrode): 0 to 750 V DC at 0-1 MA.
- *Grid 4 (focusing electrode): 0 to 500 V DC at 0-1 MA.
- Collector: 0-300 V DC at 0-100 MA.
- Anode: 0-600 V DC at 0-0.60 MA.
- Filament: 0-15 V DC, 0-3 AMP at 20 W MAX.

**May be internally modulated: pulse, sawtooth, square wave.*



TEMPERATURE COMPENSATED POWER METER

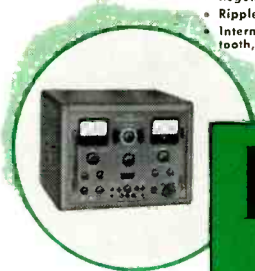
RANGE SWITCHING WITHOUT RECALIBRATION

- A hundred times more stable than comparable instruments—readings virtually drift-free.
- Six ranges—10 μW to 3 MW full scale.
- DC calibration at all levels.
- Self-balancing at 200 ohms.
- Maximum possible accumulative error $\pm$ 2%, exclusive of thermistor head.

FXR Series 218 Temperature Compensated Thermistor Head a required accessory.

UNIVERSAL KLYSTRON POWER SUPPLY

- Beam: 200 to 2000 V at 0 to 125 MA, 1800 to 3600 V, 250 W to 3600 V.
- Control Grid: Pos. 0 to 150 V, Neg. 0 to 300 V.
- Reflector: 0 to 1000 V.
- Regulation: 0.03%.
- Ripple: 3 MV, RMS, MAX.
- Internal Modulation: pulse, sawtooth, square wave.



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PRECISION MICROWAVE EQUIPMENT • HIGH-POWER MODULATORS • RADAR COMPONENTS • ELECTRONIC TEST EQUIPMENT

Circle 82 on Inquiry Card

Magnetrons

ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England (cont'd.)

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
M547	multi-res.	9.85-10	13.75, 3.25	22k	25		.001	1	Wg	225kw
M548	multi-res.	9.003-9.168	3, 3.5	13.5k	12		.001	1	Wg	50kw
M549	multi-res.	8.5-8.665	13.75, 3.25	22k	25		.001	1	Wg	225kw
M555	multi-res.	14-16.5	12.6, 2.25	16k	15		.001	1	Wg	65kw
M569	multi-res.	2.85-2.96	12, 15	40k	140	7	.0015	5	Wg	2.5megw
M570	multi-res.	2.95-3.06	12, 15	40k	149	7	.0015	5	Wg	2.5megw
M573	multi-res.	2.85-2.96	12, 15	38k	144		.0015	5	Wg	2.5megw
M574	multi-res.	2.95-3.06	12, 15	41k	132	7	.0015	5	Wg	2.5megw
M558										
M561										

GENERAL ELECTRIC COMPANY, Electronic Components Div., One River Road, Schenectady 5, N. Y.

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
GL-7389	volt. tun.	2.2-3.85	2.7, 3.2	2k	.030		cw		Co	2w
Z-5266	volt. tun.	2.35-3.6	2.6, 3	2k	.040		cw		Co	0.5mw
Z-5300	volt. tun.	2.7-3.85	2.7, 3.2	2k	.030		cw		Co	2w
Z-5321	volt. tun.	2.9-3.1	2.6, 3	2k	.040		cw		Co	10w
Z-5360	volt. tun.	2.8-3.5	2.6, 3	2k	.040		cw		Co	100mw

LITTON INDUSTRIES, Electron Tube Division, 960 Industrial Road, San Carlos, Calif.

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
L3204	rugged.	8.8±25mc					0.25			40w
L3105	rugged.	9.3±40mc					.027			100w
L3028c	pulse train	9.28-9.32					.027			120w
L3379	rugged.	8.8-9.5*					.003			1kw
L3058		9.33-9.35*					.003			1kw
L3358	rugged.	16-16.5*					.001			1kw
L3380	rugged.	8.8-9.5*					.002			2kw
L3359	rugged.	16-16.5*					.001			2kw
L3381	rugged.	8.8-9.5*					.001			3kw
L3382	rugged.	8.8-9.5*					.001			4kw
LT6233	beacon	9.28-9.345					.003			7kw
L3103	Hi-duty of LT6543	8.5-9.6*					.002			30kw
L3168	Hi-duty of LT4J52A	9.375±30mc					.002			30kw
L3306	Hi-duty of L-3083A	16-17*					.002			30kw
L3083A		16-17*					.001			60kw
LT6543A	for MTI-Systems	8.5-9.6*					.001			65kw
L3305	hydraul. tun.	8.6-9.5*					.001			65kw
LT6510	for MTI-Systems	9.375±30mc					.001			65kw
LT4J52A		9.375±30mc					.001			70kw
L3312		8.5-9.6*					.001			200kw
LT4J50A		9.375±30mc					.001			225kw

*Fixed frequency versions available throughout tunable range.

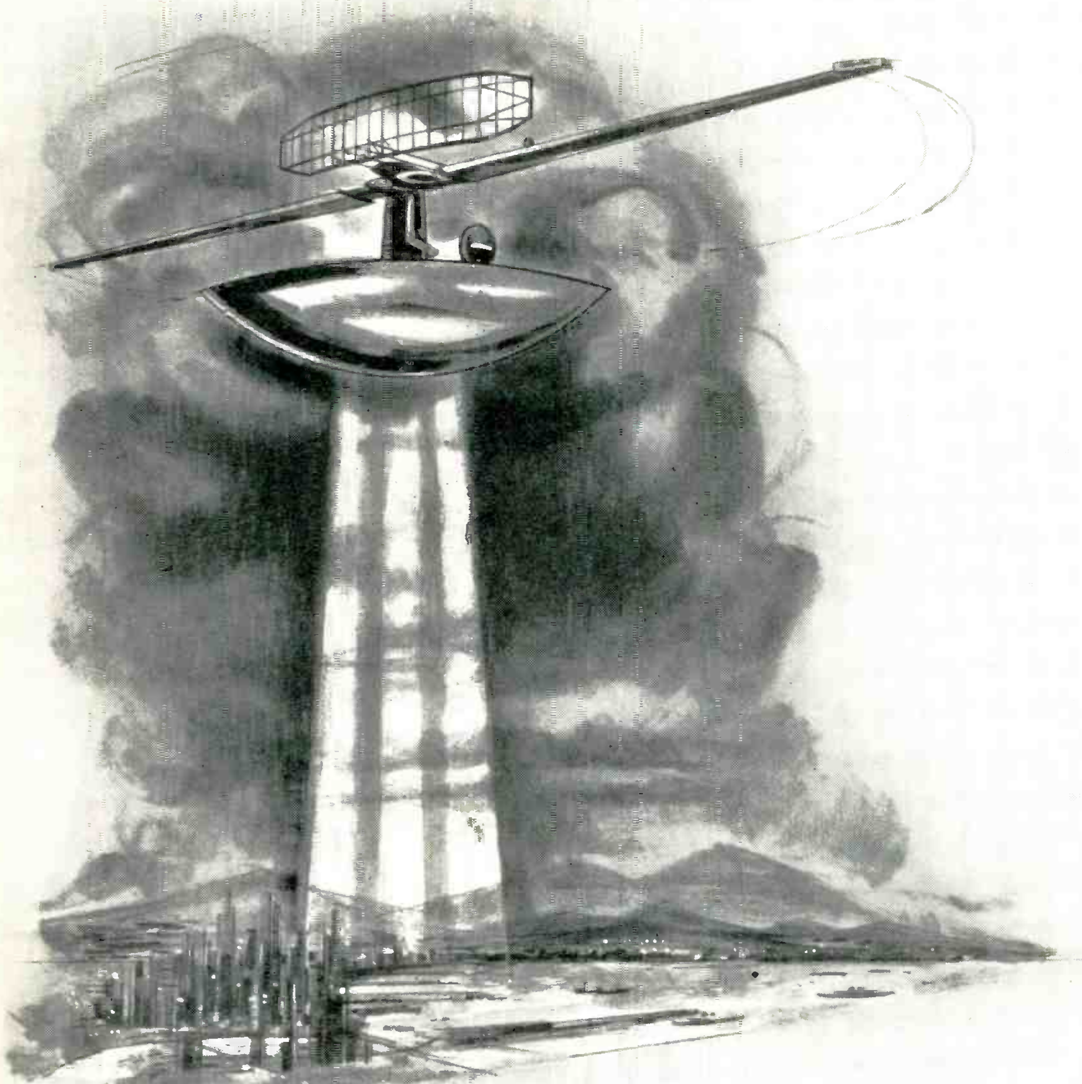
MICROWAVE ASSOCIATES, Burlington, Mass.

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
MA-221	fix. tun.	7.5-8.8	5, 0.4	400	0.015		1	cw		1w
		5	5, 0.4	515	0.15		0.1	1		10w
			5, 0.4	515	0.5		0.1	5		10w
			6.3, 0.45	530	0.35		.001	1		20w
MA-212	fix. tun.	8.8-10	5, 0.4	440	0.015		1	cw		1w
			5, 0.4	515	0.15		0.1	1		10w
			5, 0.4	515	0.15		0.1	5		10w
			6.3, 0.45	530	0.15		.001	1		10w
MA-217	mech. tun.	7.5-8.5	5, 0.4	440	0.015		1	cw		1w
			5, 0.4	525	0.15		0.1	1		5w
			5, 0.4	525	0.15		0.1	5		5w
			6.3, 0.45	550	0.35		.001	1		20w
MA-219	mech. tun.	8.5-9.6	5, 0.4	440	0.015		1	cw		1w
			5, 0.4	525	0.15		0.1	1		5w
			5, 0.4	525	0.15		0.1	5		5w
			6.3, 0.45	550	0.35		001	1		20w
MA-214	mech. tun.	9-10	5, 0.4	440	0.015		1	cw		1w
			5, 0.4	525	0.15		0.1	1		5w
			5, 0.4	525	0.15		0.1	5		5w
			6.3, 0.45	550	0.15		.001	1		10w
MA-208	mech. tun.	7.125-8.5	6.3, 0.6	900	0.2		0.02	0.5		20w
MA-205/7579	fix. tun.	8.8	6.3, 0.5	900	0.2		0.25	5		50w
MA-215	fix. tun.	8.8-9.6	6.3, 0.4	900	0.2		.001	1		100w
6229	mech. tun.	8.9-9.4	5, 0.4	4.5k	0.5		.005	0.25		500w
6230	mech. tun.	8.9-9.4	5, 0.4	4.5k	0.8		.003	1.0		1000w
2J42	fix. tun.	9.345-9.405	6.3, 0.5	5.7k	4.5		.002	1.0		8kw
MA-222	fix. tun.	9.345-9.405	6.3, 0.6	5.7k	4.5		.002	1.0		8kw
2J42H	fix. tun.	9.345-9.405	6.3, 0.5	5.7k	4.5		.002	1.0		8kw
6027 (2J42A)	fix. tun.	9.345-9.405	6.3, 0.5	7.4k	7.5		.001	1.0		20kw
MA-201	fix. tun.	9.345-9.405	6.3, 0.5	7.4k	7.5		.001	1.0		20kw
MA-209	mech. tun.	9.3-10.	6.3, 0.5	6k	4.5		.001	0.5		8kw
			6.3, 0.5	6k	4.5		.002	1		8kw

Magnetrons

MICROWAVE TUBES

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwt. Out.
MICROWAVE ASSOCIATES, Burlington, Mass. (cont'd.)										
MA-218	mech. tun.	9.3-10	6.3, 0.5	6k	4.5		.001	0.5		8kw
			6.3, 0.5	6k	4.5		.002	1		8kw
MA-226	fix. tun.	33-33.4	12.6, 2.5	13k	10		.0005	0.25		20kw
MA-225	mech. tun.	32.95-33.45	12.6, 2.5	13k	10		.0004	0.25		30kw
MA-224	fix. tun.	33-33.4	12.6, 2.5	13k	20		.00025	0.25		40kw
MA-227	fix. tun.	33-33.4	12.6, 2.5	13k	20		.00025	0.25		55kw
MA-206	fix. tun.	34.7-35	12.6, 2.5	13k	10		.0005	0.25		20kw
MA-210A	mech. tun.	34.2-34.7	12.6, 2.5	13k	10		.0005	0.25		30kw
MA-210B	mech. tun.	34.6-35.1	12.6, 2.5	13k	10		.0005	0.25		30kw
MA-210C	mech. tun.	35-35.5	12.6, 2.5	13k	10		.0005	0.25		30kw
MA-200	fix. tun.	34.7-35	12.6, 2.5	13k	20		.0005	0.25		40kw
5789	fix. tun.	34.5-35.2	6.3, 2	13k	20		.00025	0.25		40kw
MA-207A	fix. tun.	34.7-35	12.6, 2.5	13k	20		.0004	0.25		55kw
MICROWAVE ELECTRONIC TUBE CO., 76 Lafayette St., Salem, Mass.										
MCM-10	fix. tun.	5.5-5.6		7.5k	4		.0003	0.2		10kw
MCM-11	tun.	5.4-5.9		1.3k	0.8		.002	1		100w
MCM-12	tun.	5.4-5.9		2k	1.1		.002	1		400w
MCM-13	tun.	5.4-5.9		2.8k	1.9		.002	1		1kw
MCM-14	tun.	5.4-5.9		2.2k	1.2		.002	1		400w
MXM-10	fix. tun.	9.375±30mc		2.8k	1.5		.0004	0.25		800w
MXM-11	tun.	9-9.5			0.8		.002	1		100w
MXM-12	fix. tun.	9.375±30mc		3.7k	4.33		.0004	0.25		3.5kw
MXM-13	tun.	8.5-8.9		1.325k	0.9		.002	1		100w
MXM-14	tun.	8.9-9.6		1.225k	0.9		.002	1		100w
MULLARD OVERSEAS LIMITED, Mullard House, Torrington Place, London, W.C.1										
JN2-2.5A	fix. freq.	2.4	5, 32	4.7k	0.9		cw		Co	2.9w
JN2-2.5W	fix. freq.	2.4	5, 32	4.7k	0.9		cw		Co	2.9w
JN2-0.2	fix. freq.	2.4	5.3, 3.3	1.6k	0.22		cw		Co	290w
JP8-02	fix. freq.	8.8	6.3, 1.1	1k	0.12	15	4k		Wg	25w
JP9-01	fix. freq.	9.2;9.6	6.3, 1.1	920	.050	15	cw		Wg	10w
JP9-2.5	fix. freq.	9.3-9.5	6.3, 0.5	3.8k	3	18	10		Wg	3w
JP9-7	fix. freq.	9.3-9.4	6.3, 0.6	6k	5.5	15	25		Wg	7w
JP9-7A	fix. freq.	9.2-9.3	6.3, 0.6	6k	5.5	15	25		Wg	7w
JP9-7B	fix. freq.	9.5-9.6	6.3, 0.6	6k	5.5	15	25		Wg	7w
JP9-7D	fix. freq.	9.3-9.4	6.3, 0.6	6k	5.5	15	20		Wg	9w
JP9-15	fix. freq.	9.3-9.4	6.3, 0.6	8k	8	18	10		Wg	20w
JP9-50	fix. freq.	9.2-9.3	6.3, 2.1	12.8k	12	15	10		Wg	50w
JP9-75	fix. freq.	9.3-9.4	10, 2.85	16k	18	15	20		Wg	75w
JP9-80	fix. freq.	9.3-9.4	12.6, 2.1	15k	15	15	10		Wg	80w
JP9-80A	fix. freq.	9.2-9.3	12.6, 2.1	15k	15	15	10		Wg	80w
JP9-250	fix. freq.	9.3-9.4	13.75, 3.5	23k	27.5	15	20		Wg	250w
JP9-250A	fix. freq.	9-9.2	13.75, 3.5	23k	27.5	15	10		Wg	250w
JP16-40	fix. freq.	16-17	6.3, 2.2	12k	15	25	10		Wg	48w
JPT6-01	mech. tun.	5.8-7.3	6.3, 1.3	950	0.050	20	cw		Wg	10w
JPT8-01	mech. tun.	8.6-9.2	6.3, 1.1	920	0.050	20	cw		Wg	10w
JPT9-01	mech. tun.	9.1-9.6	6.3, 1.1	1.1k	0.060	20	cw		Wg	11w
JPT9-02	mech. tun.	9.1-9.6	6.3, 1.1	1.15k	0.12	20	500		Wg	25w
JPT9-60	mech. tun.	8.5-9.6	6.3, 1.1	16k	15.5	10	11		Wg	63w
RADIO CORPORATION OF AMERICA, Tube Division, Harrison, N.J.										
4J50	fixed freq., pulse OSC	9.375±30mc	13.75, 3.15	23k	27.5a					240kw
4J52	fixed freq., pulse OSC.	9.375±30mc	12.6, 2.1	15k	15a					80kw
6521	fixed freq., pulse OSC	5.4±20mc	10.0, 3.2	15k	13.5a					85kw
7008	tunable, pulse OSC	8.5-9.6					.001			230kw
7110	tunable, pulse OSC	8.5-9.6					.001			220kw
7112	tunable, pulse OSC	8.5-9.6					.001			220kw
7111	tunable, pulse OSC	8.5-9.6					.001			220kw
A-1127	tunable, pulse OSC	8.5-9.6					.001			280kw
6865-A	tunable, pulse OSC	8.75-9.6					.001			220kw
A1086-G	tunable, pulse OSC	8.75-9.6					.001			240kw
4011A	tunable, OSC	8.5-9.6	13.75, 3.15	22k	27.5		.001			250kw
RAYTHEON MANUFACTURING CO., Microwave & Power Tube Div., Waltham, Mass.										
QK172	OSC	9.33-9.42		30k			.001			440kw
QK264	OSC	1.25-1.35		75k	100a		.001			2megw
QK-313	OSC	5.4-5.8		27k	30a		.001			250kw
QK/324	OSC	15.8-16.1		30k	14a		.0028			70kw
QK-362A	OSC	9.3-9.5		2000	1.25a		.002			60w
QK-366	OSC	9.2-9.28		16k	14.5a		.001			75w
QK-367	OSC	9.01-9.07		16k	16a		.001			40kw
QK-389	OSC	23.8-24.2		16k	19a		.0007			50kw



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Each is a broad thinker, experienced at systems planning, hardware, analytical approaches. Aware of the increasing electronic content of systems, each knows that the minds which comprehend this content determine the future influence of systems upon civilization.

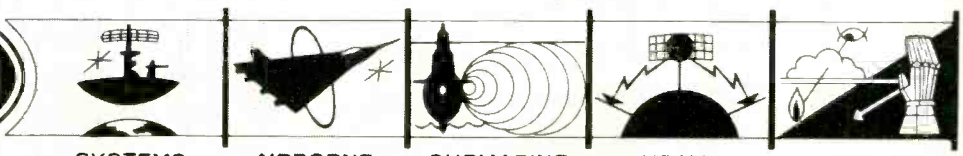
To these men, Raytheon's new SYSTEMS MANAGEMENT offers unparalleled professional satisfaction. They are invited to inquire of: Mr. Donald Sweet, Engineering & Executive Placement, Raytheon Company, 624R Worcester Road, Framingham, Mass. (suburban Boston).

SYSTEMS MANAGEMENT

GOVERNMENT EQUIPMENT DIVISION

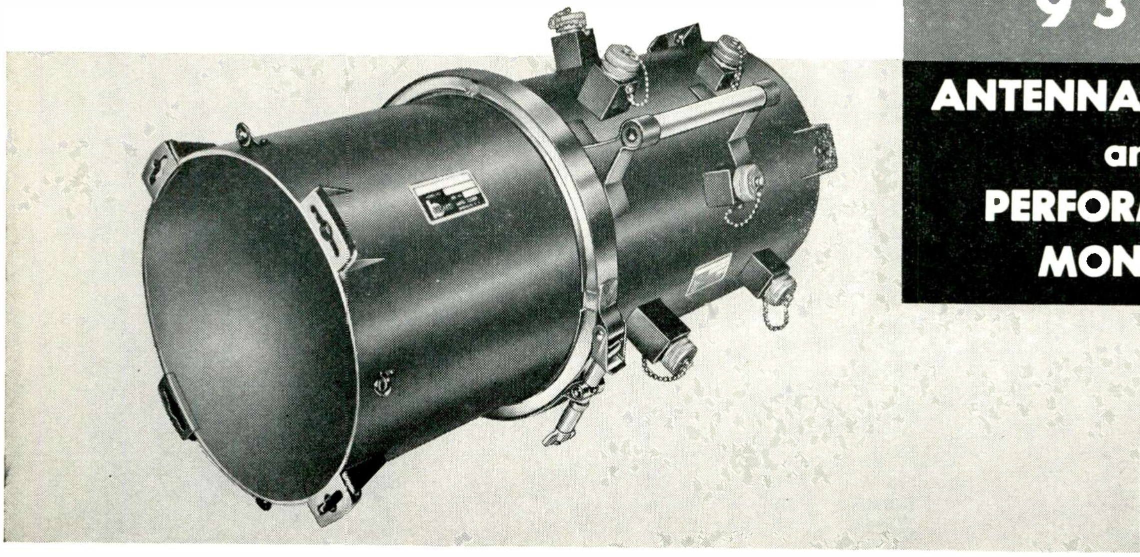
RAYTHEON

EXCELLENCE IN ELECTRONICS



SYSTEMS MANAGEMENT | AIRBORNE ELECTRONIC | SUBMARINE SIGNAL | HEAVY ELECTRONIC | SANTA BARBARA

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwr. Out.
RAYTHEON MANUFACTURING CO., Microwave & Power Tube Div., Waltham, Mass. (cont'd.)										
QK-390	OSC	2.42-2.47		6200	.375a		cw			800kw
QK-456	OSC	5.3-5.4		16k	20a		.001			75kw
QK-457	OSC	5.5-5.8		2000	1.0a		.002			200w
QK-470	OSC	1.2-1.3		75k	100a		.0012			2mw
QK-520	pulsed ampl.	1.22-1.35		40k	35a					800kw
QK-366A		9.245±40mc		15k	13.5		.001	0.5		100kw
QK-665	f. freq. OSC	1.25-1.285	15,150	72k	150		.0018	5		9.9kw
QK-666	f. freq. OSC	1.32-1.35	15,150	72k	150		.0018	5		9.9kw
QK-735	tun. OSC	5.4-5.9	5, 1	2.3k	1.5		.003	1		400w
RK4J30	f. freq. OSC	1.22-1.232	23,5, 2.2	30k	60		.002	4		600kw
RK5J26	tun. OSC	1.22-1.35	23.5, 2.2	31k	60		.002	4		400kw
RK6517	tun. OSC	1.25-1.35	2.5, 85	70k	60		.0013	3		1000kw
RK5609A	f. freq. OSC	2.425-2.475	6.3, 1.5	1.6k	0.15		cw			80w
RK4J61	tun. OSC	2.450-2.72	6.3, 1.5	1.5k	0.15		cs			50w
RK2J69	tun. OSC.	2.695-2.755	6.3, 1.5	20k	25		.001	1		150kw
RK4J62	tun. OSC	2.695-3.015	6.3, 3.5	1.5k	0.15		cw			50w
RK2J34	f. freq. OSC	2.7-2.74	6.3, 1.5	22k	30		.002	1		240kw
RK4J35	f. freq. OSC	2.7-2.74	16,3.1	30k	70		.001	1		800kw
RK5586	tun. OSC.	2.7-2.9	16, 3.1	32k	70		.001	1		700kw
RK6518	f. freq. OSC	2.7-3.01	13, 40	45k	92		.007	2		1500kw
RK2J33	f. freq. OSC	2.74-2.78	6.3, 1.5	22k	30		.002	1		240kw
RK4J34	f. freq. OSC.	2.74-2.78	16, 3.1	30K	70		.001	1		800kw
RK2J68	tun. OSC	2.745-2.805	6.3, 1.5	20k	25		.001	1		150kw
RK6410	f. freq. OSC	2.75-2.86	8.3, 85	76k	135		.001	2		4500kw
RK2J32	f. freq. OSC	2.78-2.82	6.3, 1.5	22k	30		.002	1		240kw
RK4J33	f. freq. OSC	2.78-2.82	16, 3.1	30k	70		.001	1		800kw
RK2J67	tun. OSC	2.795-2.855	6.3, 1.5	20k	25		.001	1		150kw
RK2J31	f. freq. OSC	2.82-2.86	6.3, 1.5	22k	30		.002	1		240kw
RK4J32	f. freq. OSC	2.82-2.86	16, 3.1	30k	70		.001	1		800kw
RK2J66	tun. OSC	2.845-2.905	6.3, 1.5	20k	25		.001	1		150kw
RK6406	f. freq. OSC	2.85-2.91	8.3, 85	56k	95		.0006	2		1750kw
RK2J30	f. freq. OSC	2.86-2.9	6.3, 1.5	22k	30		.002	1		240kw
RK4J31	f. freq. OSC	2.86-2. 9	16, 3.1	30k	70		.001	1		800kw
RK5657	tun. OSC	2.9-3.1	16, 3.1	32.5k	70		.001	1		700kw
RK2J29	f. freq. OSC	2.914-2.939	6.3,1.5	22k	30		.002	1		240kw
RK2J28	f. freq. OSC	2.939-2.965	6.3, 1.5	22k	30		.002	1		240kw
RK2J27	f. freq. OSC	2.965-2.992	6.3, 1.5	22k	30		.002			240kw
RK4J44	f. freq. OSC	2.965-2.992	16, 3.1	30k	70		.001			900kw
RK4J63	tun. OSC	2.985-3.335	6.3, 3.5	1.5k	0.15		cw			50w
RK4J43	f. freq. OSC	2.992-3.019	16, 3.1	30k	70		.001			900kw
RK2J26	f. freq. OSC	2.992-3.019	6.3, 1.5	22k	30		.002			240kw
RK2J25	f. freq. OSC	3.019-3.047	6.3, 1.5	22k	30		.002			240kw
RK2J70	f. freq. OSC	3.030-3.11	6.3, 1.25	7.5k	15		.002			20kw
RK2J24	f. freq. OSC	3.047-3.071	6.3, 1.5	22k	30		.002			240kw
RK2J23	f. freq. OSC.	3.071-3.1	6.3, 1.5	22k	30		.002			240kw
RK2571	f. freq. OSC.	3.19-3.101	6.3, 1.25	5.5k	8		.002			6kw
RK4J64	tun. OSC	3.305-3.675	6.3, 3.5	1.5k	0.15		cw			50w
RK4J41	f. freq. OSC	3.4-3.45	16, 3.1	30k	70		.001			700kw
RK6042	tun. OSC	3.43-3.57	8.3, 43	57k	55		.0016			700kw
RK6403	tun. OSC	3.43-3.57	8.3, 43	65k	90		.0014			2000kw
RK6695	tun. OSC	3.43-3.57	16, 3.1	33k	65		.001			600kw
RK4J40	f. freq. OSC	3.45-3.5	16, 3.1	30k	70		.001			700kw
RK4J39	f. freq. OSC	3.5-3.55	16, 3.1	30k	70		.001			700kw
RK4J38	f. freq. OSC	3.55-3.6	16, 3.1	30k	70		.001			700kw
RK4J37	f. freq. OSC	3.6-3.65	16, 3.1	30k	70		.001			700kw
RK4J36	f. freq. OSC	3.65-3.7	16, 3.1	30k	70		.001			700kw
RK6177	freq. mod. OSC	4.268-4.35	6.3, 0.6	350	.035		cw			11w
RK6344	tun. OSC	5.45-5.825	11, 11	24k	30		.001			175kw
RK6843	tun. OSC	5.45-5.825	9.5, 11	26k	30		.0012			250kw
RK4J59	f. freq. OSC	6.275-6.375	12.6, 3.75	25k	35		.001			180kw
RK4J58	f. freq. OSC	6.375-6.475	12.6, 3.75	25k	35		.001			180kw
RK4J57	f. freq. OSC	6.475-6.575	12.6, 3.75	25k	35		.001			180kw
RK2J51	tun. OSC	8.5-9.6	6.3, 1	16k	16		.0012			45kw
RK2J51A	tun. OSC	8.5-9.6	6.3, 1	15k	15.5		.0011			40kw
RK6249	tun. OSC	8.5-9.6	9, 14.4	32k	32		.0013			200kw
RK2J50	f. freq. OSC	8.75-8.9	6.3, 1	16k	16		.0012			40kw
RK2J49	f. freq. OSC	9-9.16	6.3, 1	16k	16		.0012			40kw
RK6229	tun. OSC	8.9-9.4	5,0.45	5k	1		.003			400w
RK6230	tun. OSC	8.9-9.4	5, 0.45	5k	1		.003			910w
RK2J36	f. freq. OSC	9.003-9.168	6.3, 1.3	13.5k	12		.002			14kw
RK2J56A	f. freq. OSC	9.215-9.275	6.3, 1	14k	13		.001			40kw
RK2J56	f. freq. OSC	9.215-9.275	6.3, 1	16k	16		.001			40kw
RK6002	f. freq. OSC	9.230-9404	4, 40	30k	40		.002			225kw
RK5982	f. freq. OSC	9.345-9.405	6.3, 2.9	16.5k	14.5		.001			75kw
RK2J55	f. freq. OSC	9.345-9.405	6.3, 1	16k	16		.001			40kw
RK2J424	f. freq. OSC	9.345-9.405	6.3, 0.5	6k	5.5		.0025			7kw
RK2J42	f. freq. OSC	9.345-9.405	6.3, 0.5	6k	5.5		.0025			7kw
RK7304	f. freq. OSC	9.345-9.405	6.3, 1	16k	16		.001			40kw



9322

ANTENNA COUPLER and PERFORMANCE MONITOR

MODEL NO. 9322

The Bogart Model 9322 Antenna Coupler and Performance Monitor is the outgrowth of a design program to develop a pre-flight check-out device utilizing lossy paint that could be used to **monitor an entire system, from magnetron through antenna.** Ordinarily, power and frequency checks are made looking **into** the antenna. Losses in the antenna itself are not checked.

The Bogart Applications Engineering Group developed a lossy paint which could be deposited on the inside of a radome type shield. The carbon-deposited horsehair materials now in use were found to be unsatisfactory for practical usage. They did not radiate heat, but fed heat back to the antenna, sometimes damaging the antenna itself; they were not suitable for outdoor use; they were suitable only for low-power usage; they were extremely frequency-sensitive; they had a limited life requiring frequent replacement and they were expensive. The Bogart LP* material has the heat conductivity of a metal, is exceptionally broadband, can be "weathered" indefinitely, will accept high power without deterioration, and is a comparatively inexpensive material.

The Model No. 9322 was designed for a specific radar installation. In this case, it was desired to measure the characteristics of a radar **through** the antenna, as well as to absorb the RF energy and prevent harmful radiation.

Coupling devices were designed by Bogart to permit measurements of the power out, frequency, spectrum analysis, and sweep rate, from the outside of the aircraft. The foregoing is a simple illustration of a single use of the Bogart Lossy Paint material.

The Bogart Applications Engineering Group would be pleased to discuss the uses of LP* material for your particular requirements. As examples of its current applications, this material has been used for various shapes of antenna couplers, lossy backplates on high power filters, and lossy transmission lines.

ANTENNA COUPLER APPLICATION

Frequency Range (Kmc/s)	Average Power Watts (CW)	VSWR††	Approx. Length (Inches)	Approx. Width (Inches)	Approx. Height (Inches)	Approx. Weight (Lbs.)
1.00 - 11.00	500	1.15	22-1/2	9-1/2	12	20

PERFORMANCE MONITOR USE

Frequency Range (Kmc/s)**		Coupling (db + 2.5)
1.00	1.50	40
1.50	2.40	40
2.40	3.60	40
3.60	7.30	40
7.00	8.80	40
8.70	10.50	40

(*) Lossy Paint

(††) The VSWR indicated is the difference seen by a circularly polarized antenna when "looking" into free space and into the Bogart Model No. 9322.

(**) Coupler Band Division

BOGART

BOGART MANUFACTURING CORPORATION

315 Seigel Street **Brooklyn 6, New York**

serving the electronics industry since 1942

design • development • production

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwr. Out.
RAYTHEON MANUFACTURING CO., Microwave & Power Tube Div., Waltham, Mass. (cont'd.)										
RK725A	f. freq. OSC	9.345-9.405	6.3, 1	16k	16		.001			40kw
RK6841	f. freq. OSC	16.41-16.625	4, 10.5	19k	16		.001			50kw
RK-7461	tun. OSC	9.3-9.5	5, 0.65	1.55k	0.95		.002	1		120Wkkb
2J-23	OSC	3-3.1		22k	30a		.002			240kw
2J-24	OSC	3.04-3.07								
2J-25	OSC	3.01-3.04								
2J-26	OSC	2.9-3.0								
2J-27	OSC	2.96-2.99								
2J-28	OSC	2.93-2.96		Same characteristics as above.						
2J-29	OSC	2.91-2.93								
2J-30	OSC	2.8-2.9								240kw
2J-31	OSC	2.82-2.86								
2J-32	OSC	2.7-2.8								
2J-33	OSC	2.74-2.87								
2J-34	OSC	2.7-2.74								
2J-36	OSC	9.0-9.1		14k	12a		.002			14kw
2J-42	OSC	9.3-9.4		5700	4.5a		.002			8kw
2J-50	OSC	8.7-8.9		16k	16a		.0012			40kw
2J-49	OSC	9.0-9.1								
2J-51	OSC	8.5-9.6		16k	16a		.0012			45kw
2J-55	OSC	9.3-9.4		16k	16a		.001			40kw
2J-56	OSC	9.21-9.27		16k	16a		.001			40kw
2J-66	OSC	2.8-2.9		20k	25a		.001			150kw
2J-67, 68	OSC	2.7-2.8								
4J35 to	OSC	2.7 to 2.9		30k	70a		.001			800kw
4J31		in 5 steps		Same characteristics as above.						
4J-41 to	OSC	3.4 to 3.7		30k	70a		.001			700kw
4J-36		in 6 steps		Same characteristics as above.						
4J-63	OSC	2.98-3.33		1500	.15a		cw			50w
4J-64	OSC	3.3-3.6		Same characteristics as above.						
2J-70	OSC	3.0-3.1		7500	15a		.002			20kw
2J71	OSC	3.1-3.2		5500	8a		.002			6kw
4J30	OSC	1.22-1.23		30k	60a		.002			600kw
2J69	OSC	2.6-2.7		20k	25a		.001			150kw
4J43	OSC	2.9-3		30k	70a		.001			900kw
4J44	OSC	2.96-2.99		Same characteristics as above.						
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		1500						50w
4J62	OSC	2.6-3.0								
5J26	OSC	1.2-1.3		31k	60a		.002			400kw
725A	OSC mil spec	9.3-9.4		16k	16a		.001			40kw
730A	OSC mil spec	9.3-9.4		16k	16a		.001			40kw
5982	OSC	9.3-9.4		17k	14.5a		.001			75kw
6002	OSC	9.2-9.4		30k	40a		.002			225kw
6177	OSC	4.2-4.3		350	.025a		cw		Co	1w
6229	OSC	8.9-9.4		5000	1.0a		.003			400w
6230	OSC	8.9-9.4		5000	1.0a		.003			910w
6249	OSC	8.5-9.6		29k	32a		.0013		Wg	200kw
6344	OSC	5.45-5.825		24k	30a		.001			175kw
6402	OSC	3.4-3.5		57K	55a		.0016			700kw
6406	OSC	2.8-2.9		56k	95a		.0006			1.75megw
6410	OSC	2.7-2.8		76k	135a		.001			1.5megw
6517	OSC	1.2-1.3		70k	60a		.0013			1megw
6518	OSC	2.7-3.0		45k	92a		.0007			1.5megw
6841	OSC	1.64-16.6		19k	16a		.001			50kw
6843	OSC	5.4-5.8		26k	30a		.0012			250kw
6586	OSC	2.7-2.9		30k	70a		.001		Co	800kw
5657	OSC	2.9-3.1		33k	70a		.001			700kw
5609A	OSC	2.42-2.47		1.6k	0.15a		.001			80w
6695	OSC	3.43-3.57		33k	65a		.001			650kw
6403	OSC	3.43-3.57		65k	90a		.001			2megw
ROGERS ELECTRIC TUBES & COMPONENTS, 116 Vanderhoof Ave., Toronto 17, Ont.										
7090	CW OSC	2.42-2.47								200w
7091	CW OSC	2.42-2.47								2kw
6972	OSC	9.3-9.4								65kw
7093	OSC	34.8-35.2								25kw
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.										
2J42	fix. freq.	9.375		5.7k	4.5		.002		Wg	8kw
2542H	hi. alt.	9.375								7kw
2J42B	rug.	9.375								7kw
6027	fix. freq.	9.375		7.4	7.5		.002		Wg	18kw

Magnetrons

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Anode V.	Anode A.	Pull. Fact. (mc/s)	Duty Cy.	Pulse Dur. (ms)	Type Out.	Pwr. Out.
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif. (cont'd.)										
6027H	fix. freq., rug.	9.375	6.3			15	.001			18kw
7098		9.3-9.5								60w
7503	7098 with TNC out.									60w
6874	tun.	9.0-9.6		23k	30		.001		Wg	180kw
7006	tun., hi RRV	9.0-9.6								190kw
M4163	tun.	8.5-9.6								180kw
M4164	tun., rug., hi RRV	8.5-9.6								200kw
M4193	tun., rug., hi RRV	8.5-9.6								200kw
M4154	fix. freq., rug.	24		15k	18		.00032			55kw
5789	fix. freq.	34.8		13k	20		.0006		Wg	40kw
M4155A	fix. freq., rug.	34.8								40kw
6799	fix. freq.	34.8		20k	40		.00035		Wg	100kw
6551	fix. freq.	23.8-24.27	6	16k	18	30	.0007	0.5		
WESTINGHOUSE, Electric Tube Division, P.O. Box 284, Elmira, N. Y.										
6249, A	OSC	8.5-9.6		29k	32a		.0013		Wg	200kw
6177	OSC	4.2-4.3		350	35ma		cw		Co	1w

Parametric Amplifiers

Type	Descr. App.	Freq. (mc)	Bandwidth	Gain (db)	Noise Fig. (db)	Pump Freq. (kmc)	Pump Power (mw)	Type Varact.	Input Z (ohms)	Output Z (ohms)
MICROWAVE ASSOCIATES, INC., Burlington, Mass.										
MA-1-150	negative res.	100-230	1% ctr.f.	20	2	4f	100	MA460A	50	50
MA-1-350	negative res.	220-400	1% ctr.f.	20	2	4f	100	MA460B	50	50
MA-1-450	negative res.	350-500	1% ctr.f.	20	2	4f	100	MA460C	50	50
MA-2-750	negative res.	700-1000	½% ctr.f.	10	2	8-12.5kmc	200	MA-421B		
MA-2-750A	negative res.	900-1000								
MA-2-1000	negative res.	950-1250								
MA-2-1000L	negative res.	1250-1350								
MOTOROLA, Solid State Electronics Dept., 3102 N. 56th Street, Scottsdale, Ariz.										
220-108	negative res.	170-250	1.2mc	16	1.5	1.1-1.7	0.5			

Description	Noise Figure	Bandwidth	Gain	Stability
ZENITH RADIO CORP., Chicago, Ill.				
Electron Beam Parametric Amplifier*	1db	40mc**	20-30db	with initial gain of 20db a 10% increase in pump power gives 1.2db increase in gain

*Available in a series of fixed-tuned units, from 400 to 900mc.
**Independent of gain.

Several organizations have mentioned manufacturing activity in parametric amplifiers, but at press time only three organizations (as listed above) have been able to report their products by type number and specification. Since this chart is published on an annual basis, it is recommended that readers requiring additional data contact our Reader Service Department for additional information on new suppliers, as they require it. (In these listings a parametric amplifier is considered to be the complete assembly, not the diode alone.)

TO BE CONTINUED • • •

The phenomenal number of new microwave tubes introduced during the past 12-month period makes it necessary to publish this year's "Summary of Microwave Electron Devices" in two parts. Part II, consisting of another nine pages of technical data which will appear in the December issue of EI, will contain technical specifications on klystrons, traveling wave tubes, backward wave tubes and planar triodes.

← Circle 86 on Inquiry Card

New Tech Data for Engineers

Hermetic Connectors

How to install hermetic connectors is described in a Technical Notes report, Tech. Notes P & PM #60-2 from The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif. Included is a step-by-step procedure for fusing hermetic connectors to plates, boxes or can—from pre-heating through the finish soldering—plus details on how to protect the connector during the fusion process.

Circle 191 on Inquiry Card

Semiconductor Directory

Edition #5 of the Allied Semiconductor Directory, is a comprehensive directory and pricing guide to transistors, diodes and rectifiers produced by 16 leading domestic manufacturers. Over 2100 types include the latest high speed switching, high current power, zener and diffused junction mesa types. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle 192 on Inquiry Card

Power Systems

Bulletin 17 from Bogue Electric Manufacturing Co., 52 Iowa Ave., Paterson 3, N. J., describes their line of continuous power systems. Featured are magnetic amplifier controlled power systems, a motor generator set, an automatic control unit, an engine driven generator, and standby batteries.

Circle 193 on Inquiry Card

Capacitors

A 6-page illustrated brochure from the Astron Sales Corp., E. Newark, N. J., contains catalog listings of their complete lines of capacitors for commercial use. Included are over 500 listings of Twist-Prong Electrolytics in single, dual, triple and quadruple styles. The listings show combinations in the smallest practical aluminum can sizes. Other commercial capacitors include molded tubular and metal and cardboard case electrolytics for various applications.

Circle 194 on Inquiry Card

Recorder

A 4-color brochure on the Ampex FR-600 Instrumentation Recorder, which offers a frequency response to 250 KC in Direct recording and to 20 KC in FM work, includes full specs and descriptions of accessories, optional equipment, and "human engineering" design are included. Ampex Instrumentation Corp., 934 Charter St., Redwood City, Calif.

Circle 195 on Inquiry Card

CR Tube Catalog

Technical information on over 75 types of standard (JEDEC registered) cathode-ray tubes is tabulated in a short-form catalog from the Electronic Tube Div., Allen B. Du Mont Labs., Inc., Clifton, N. J. It is divided into 5 parts and details physical and electrical parameters for CRT categories such as: electrostatic deflection and electrostatic focus, magnetic deflection and electrostatic focus, and magnetic deflection and magnetic focus.

Circle 196 on Inquiry Card

Switching Transistors

Bulletin E-353 from CBS Electronics, Information Services, 100 Endicott St., Danvers, Mass., describes a comprehensive line of npn transistors for high-speed switching and high frequency amplification. The line comprises 25 computer types suited for logic-circuit, core-driver, and other switching applications. Alpha-cutoff frequencies range from 1 to 17 MC and max. dissipations from 50 to 150 mw.

Circle 197 on Inquiry Card

Potting Compound

A silicone potting material that permits visual and instrument checking of individual parts within a potted assembly is described in a 4-page, illustrated brochure, 10-505, from Dow Corning Corp., Midland, Mich. In addition to tables of properties, the brochure includes a graph which shows the degree of stress exerted on parts by the material during and after curing.

Circle 198 on Inquiry Card

Autographic Plotters

Brochure, Bulletin PG-100, on their line of multi-channel autographic plotters from Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio, has application data and specs on standard, high speed, and extra high speed strain gage plotters; modulator plotter; segmental recorder and scanner plotter. "Visual data plotting" using the Co.'s plotters is also explained.

Circle 199 on Inquiry Card

Wide Band, I-F Amplifier

A 4-page color brochure on their line of wide band, i-f and transistorized amplifiers and pre-amplifiers from Instruments for Industry, Inc., Dept. RB, 101 New South Rd., Hicksville, L. I., N. Y., gives detailed specs and descriptions. Unit price and quantity discounts are also given.

Circle 200 on Inquiry Card

Code Bar Switches

A 4-page, 2-color bulletin CBS-1 describes features and specs of Code Bar Switches designed to meet recurring need for keyboard switches featuring direct binary-coded outputs. Cutaway drawing shows operating principle which achieves conversion from octal or decimal digit to corresponding binary code per digit without resorting to multiple-relay contact arrangements commonly employed for this purpose. Three models are described. Computer Control Co., Inc., Western Div., 2251 Barry Ave., Los Angeles 64, Calif.

Circle 201 on Inquiry Card

Electronic Galvanometer

Bulletin, No. 14-10, presents specs and a description of a multi-purpose electronic galvanometer. Outlined are operating characteristics and applications of Model 204A Electronic Galvanometer. A circuit diagram and description and tabulated spec are included. KIN TEL Div., Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego 12, Calif.

Circle 202 on Inquiry Card

Infrared Data

Infrared Technical Data, a series of data sheets, presents complete information about infrared photoconductors and instrumentation. They contain specs on infrared instrumentation—the ISL 501 Bias Supply; the ISL 403 Black Body with ISL 100 Temperature Controller; and the ISL 301 Infrared Detector Test Console. Infrared Industries, Inc., P. O. Box 42, Waltham 54, Mass.

Circle 203 on Inquiry Card

Soldering Problems

Preventing silver scavenging, effects of rate metals in soldering, choosing the right alloy when high creep strength is required, and other common soldering problems are described in a technical data sheet called "Tips on Soldering" from Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J. Included is a check list guide to solving soldering problems.

Circle 204 on Inquiry Card

Centrifugal Blowers

A 12-page catalog on centrifugal blowers illustrates typical single blower units. Featured are 54 flow charts, electrical specs and dimensions on the blowers which cover a range of frequencies from 60 CPS to 1000 CPS with free air ratings from 18 to 270 CFM. Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I., N. Y.

Circle 205 on Inquiry Card

Tubes are built for rugged service – at **SPERRY**

Hammer drop typifies tough environmental testing that assures dependability of Sperry TWT amplifiers.

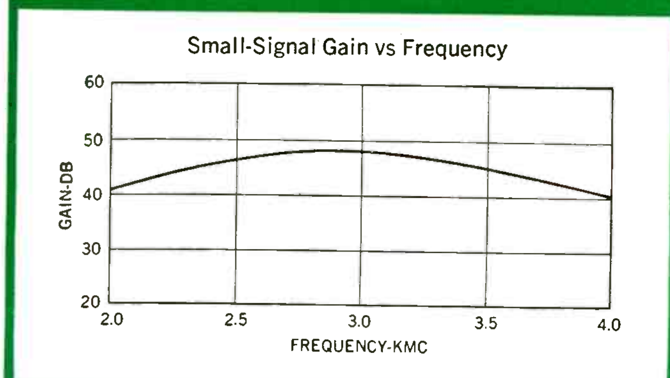
New high-power S-Band Traveling Wave Amplifier

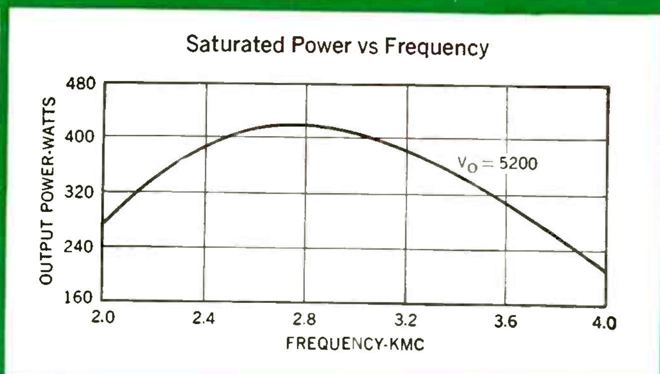
2.0-4.0 kmc with 300 watts nominal output power

STS-101

SPECIFICATIONS

Frequency Range	2.0-4.0 kmc
Small-Signal Gain	40 db
Output Power	300w (nom)
Saturated Gain	35 db
Beam Voltage	5.2-5.6 kv
Beam Current	380 ma
Heater Voltage	6.3 v
Heater Current	2.6 a
Helix Current (full)	8 ma





This new broadband, high gain cw traveling wave amplifier is the only tube in S-band – delivering 300 watts nominal – for service in microwave systems, high performance tracking radars, high frequency communications networks and other applications where high power and high gain in the 2.0 to 4.0 kmc frequency range are desirable. This tube features rugged, all metal-ceramic construction for high performance aircraft environments and is short-circuit stable.

The STS-101 may well be suited to projects or problems you are working with now. Write for data regarding your application.

SPERRY

ELECTRONIC TUBE DIVISION, *SPERRY GYROSCOPE COMPANY, GREAT NECK, NEW YORK, DIVISION OF SPERRY RAND CORPORATION*
Address all inquiries to Great Neck or Sperry offices in Brooklyn, Boston, Philadelphia, Los Angeles and Montreal. Export Dept., Great Neck, New York

New Tech Data for Engineers

Servomotors

Details of Beckman size 15 Servomotors are contained in a 16-page catalog from Helipot Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif. Electrical and mechanical specs, dimensional drawings, schematics and torque-speed curves are presented for advance design servomotors, servimotor-rate generators, inertia-damp and adjustable velocity-damp servomotors.

Circle 206 on Inquiry Card

Field Tapping Kit

A 4-page illustrated brochure, Form PTK-659, explains how to tap precision potentiometers in the field with the DeJur Field Tapping Kit. The tap setting procedure is outlined. Illustrations include a large view of the fixture. Installation of adjustable shorted areas (silver buss strips) are also described. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 207 on Inquiry Card

Brazing Alloys

Vacuum tube grade brazing alloys are the subject of 4-page Bulletin No. 25, from Handy & Harman, 82 Fulton St., New York 38, N. Y. It describes high-purity, low vapor pressure alloys which are required for klystron and magnetron tubes and complex electronic equipment for commercial and military use. Included is information on temp. and compositions of Vacuum Tube Grade brazing alloys, their brazing characteristics in a hydrogen atmosphere and their impurity limits. The melting and boiling points and vapor pressures of various metals are outlined on charts.

Circle 208 on Inquiry Card

Solderless Wiring

How to choose the best kind of terminal for a particular wiring application is featured in a brochure offered by ETC Inc., 990 E. 67th St., Cleveland 3, Ohio. A wide choice of basic types of electric terminals and connectors is shown, ranging from the "ring" and other standard tongue designs through multiple-wire connectors and quick-disconnects.

Circle 209 on Inquiry Card

High-Q Inductors

Two-sided catalog sheet describes a line of small, light-weight toroidal inductors which have exceptionally high Q values. Complete tech. specs, dimensional drawings and ordering instructions are included. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 210 on Inquiry Card

Semiconductor Directory

Semiconductor listing is designed to give the engineer and scientist a comprehensive, easy-to-use listing of the latest in germanium transistors, silicon transistors, diodes, and rectifiers. All major manufacturers and types are numerically listed complete with descriptions and applications. Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

Circle 211 on Inquiry Card

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna.

Digital Voltmeters

A 20-page, 2-color bulletin on NLS Series 30 digital voltmeters for measurement of ac and dc voltages and voltage ratios from Non-Linear Systems, Inc., Del Mar, Calif., includes a 2-page explanation of the instruments' transistorized "no-needlessnines" logic, a run-down on major features with illustrations, complete specs, operating information, a 3-page picture section on input and output accessories, conversions for ac measurements, and complete wiring diagrams for designing the instruments into data logging and measurements system.

Circle 212 on Inquiry Card

Data Processors

Data sheet from Systron Corp., 950 Galindo St., Concord, Calif., describes the series 160, Analog-Digital Data Processors. Included are specs, and basic operation details.

Circle 213 on Inquiry Card

Relays

New catalogs from HI-G, Inc., Bradley Field, Windsor Locks, Conn., describes in detail their complete line of hermetically sealed balanced rotary type relays.

Circle 214 on Inquiry Card

Computer

Catalog sheet, listing the 4 models of the series 2, microlog computer, from Ebex Technical Institute, Inc., Orem, Utah, includes a sheet on applications. The portable machine provides facilities for programming studies ranging from simple arithmetic through advanced calculus and differential equations. It may also be used by engineers for simulation of processes. It is designed primarily as a training instrument for students of analog computer applications and techniques.

Circle 215 on Inquiry Card

Plastic Shapes—Parts

A 4-page bulletin from National Vulcanized Fibre Co., 1059 Beech St., Wilmington 99, Del., describes the company's facilities for supplying extruded shapes or precision fabricated parts from nylon, "Delrin" (the new DuPont acetal resin), or "Penton" (Hercules Powder Co.'s chlorinated polyether resin). It includes a tabular comparison of the materials' properties. Table covers basic mechanical electrical, thermal, and miscellaneous properties.

Circle 216 on Inquiry Card

Wiring Harnesses

A 14-page booklet from Methods, Inc., 12 Bland Ave., Emerson, N. J., "Key Points in the Design, Manufacture & Use of Wiring Harnesses," contains practical hints for stripping, tinning, soldering, etc. of cable wires. Suggests procedures for facilitating in-the-instrument connecting operations and ways to plan, simplify and improve cable installations. Delineates ways for stepping up speed and accuracy of inspection. Line drawings illustrate techniques.

Circle 217 on Inquiry Card

Silicone Rubber Guide

Specs guide, CDS-188, an 8-page bulletin for users of silicone rubber lists a variety of standard industry and military specs which cover most application requirements. It summarizes current ASTM, AMS and military specs. General Electric, Silicone Products Dept., Waterford, N. Y.

Circle 218 on Inquiry Card

Silicon Power Rectifier

Data sheet on Style 20 Silicon Power Rectifiers, designed for operation at current levels from 1 to 15 a (single phase half wave average) presents description, data and specs for the new rectifiers. Syntron Co., 263 Lexington Ave., Homer City, Pa.

Circle 219 on Inquiry Card

1960 Directory of Microwave Manufacturers

(*Continued from page* 115)

Arrow Tool Co Inc
36 Mill St Wethersfield Conn
A R & T Electronics Inc
1101 McAlmont Little Rock Ark
Atlas Precision Products Co
3801 Castor Ave Phila 24 Penna
Austin Co Special Devices Div
76 9th Ave New York 11 N Y
Autonetics Div North American Aviation Inc
9150 E Imperial Hwy Downey Calif
Avco Mfg Corp Crosley Div
1329 Arlington St Cincinnati 25 Ohio
Avion Div ACF Industries Inc
11 Park Pl Paramus N J
Avionics Div-Bell Aircraft Corp
P O Box 1 Buffalo 5 N Y
Baird-Atomic Inc
33 University Rd Cambridge 38 Mass
Bart Mfg Corp
Manchester Pl Newark N J
Basic Controls Inc
11830 W Pico Los Angeles 64 Calif
Bendix Aviation Corp Bendix-Pacific Div
11600 Sherman Way N Hollywood Calif
Bendix Aviation Corp Bendix Radio Div
Baltimore 4 Md
Bendix Aviation Corp
1104 Fisher Bldg Detroit 2 Mich
Bendix Aviation Corp Eclipse Pioneer Div
Teterboro N J
Birdair Structures Inc
290 Larkin St Buffalo 10 N Y
Blaine Electronetics Inc
14657 Keswick St Van Nuys Calif
Blaw-Knox Co/Blaw-Knox Equip Div
Pittsburgh 38 Penna
Blonder-Tongue Labs
9 Alling St Newark 2 N J
Bogart Mfg Corp
315 Seigel St Brooklyn 6 N Y
Brach Mfg Corp Div Gen Bronze Corp
200 Central Ave Newark 3 N J
Breeze Corp
700 Liberty Ave Union N J
Brooks & Perkins Inc
1950 W Fort St Detroit 38 Mich
Brubaker Electronics Inc
3652 Eastham Dr Culver City Calif
Budd Stanley Co
43-01 22nd St Long Island City 1 N Y
Budelman Radio Corp
375 Fairfield Ave Stamford Conn
Canadian Aviation Electronics Ltd
6214 Cote de Liesse Rd St Laurent Que Canada
Canoga Corp of Calif Southern Div
77 Elgin Hwy Ft Walton Beach Fla
Canoga Div Underwood Corp
15330 Oxnard St Van Nuys Calif
Cascade Research Div Monogram Precision Industries Inc
5345 San Fernando Rd W Los Angeles Calif
Caswell Electronics Corp
414 Queens Lane San Jose 12 Calif
Centronix Inc
4000 N W 28th St Miami Fla
Chu Associates
P O Box 387 Whitcomb Ave Littleton Mass
Clear Beam Antenna Corp
21341 Roscoe Blvd Canoga Park Calif
Clegg Labs/Div Clegg Inc
Ridgedale Ave Morristown N J
Coaxial Connector Co Inc
37 N 2nd Ave Mt Vernon N Y
Collins Radio Co
855 35th St N E Cedar Rapids Iowa
Collins Radio Co
1930 Hiline Dr Dallas 7 Texas
Conrad & Moser
2 Borden Ave Long Island City 1 N Y
Consolidated Avionics Corp
800 Shames Dr Westbury N Y
Convair San Diego Div Gen Dynamics Corp
3165 Pacific Hwy San Diego Calif
Cook Electric Co
2700 N Southport Ave Chicago 11 Ill
Corbin Corp
5419 56th Pl Riverdale Md
Craig Systems Inc
90 Holten St Danvers Mass
Defiance Eng'g & Microwave Co
Beverly Airport Beverly Mass
DeMornay-Bonardi Corp
780 S Arroyo Pkwy Pasadena Calif
Designers for Industry
4241 Fulton Pkwy Cleveland 9 Ohio
Diamond Antenna & Microwave Corp
7 North Ave Wakefield Mass
Dittmore-Freimuth Corp
2517 E Norwich St Milwaukee 1 Wisc
Don-Lan Electronics Co
1101 Olympic Blvd Santa Monica Calif

Dorne & Margolin
29 New York Ave Westbury N Y
Douglas Microwave Co
252 E 3rd St Mt Vernon N Y
DuMont Labs Inc Allen B
750 Bloomfield Ave Clifton N J
Dwyer Eng'g Co
Pine St Ext Nashua N H
Dymec Inc
395 Page Mill Rd Palo Alto Calif
Dynamics Electronics Inc
87046 123rd St Richmond Hill N Y
Dynatronic Inc
717 W Amelia Ave Orlando Fla
Electronic Communications Inc
1501 72nd St St Petersburg Fla
Electronic Control Systems
2231 Barrington Ave Los Angeles 64 Calif
Electronic Specialty Co
5121 San Fernando Rd Los Angeles 39 Calif
Electron-Radar Products
4806 W Chicago Ave Chicago 51 Ill
Emerson Electric Mfg Co
8100 Florissant Ave St Louis 21 Mo
EMI Cosser Electronics
Woodside Dartmouth Nova Scotia
Eronca Corp
16 W 46th St New York 36 N Y
Farnsworth Electronics Co Div ITT
3702 E Pontiac St Ft Wayne Ind
Fecker Inc J W
6592 Hamilton Ave Pittsburgh 6 Penna
Federal Mfg & Eng'g Co
1055 Stewart Ave Garden City N Y
Federal Telecommunication Labs Div ITT
500 Washington Ave Nutley N J
Feedback Controls Inc
899 Main St Waltham 54 Mass
Fox Co Thomas J
95 Summit St Newark N J
FRX Inc
26-12 Borough Pl Woodside N Y
Gabriel Electronics Div Gabriel Co
135 Crescent Rd Needham Heights 94 Mass
Gar Precision Parts
36 Ludlow St Stamford Conn
G B Electronics Corp
Hook Creek Blvd Valley Stream N Y
General Communication Co
677 Beacon St Boston 15 Mass
General Electric Co Heavy Mil Electronics Equipment Div
Syracuse N Y
General Electric Co Light Mil Electronics Dept
Utica N Y
General Electric Co Communication Products Dept
Lynchburg Va
General Mills Inc Mechanical Div
1620 Central Ave Minneapolis 13 Minn
General Precision Labs Inc
180 N Vinede Ave Pasadena 8 Calif
General Precision Lab Inc
63 Bedford Rd Pleasantville N Y
Geotechnical Corp
3401 Shiloh Rd Garland Texas
Granger Associates
966 Commercial St Palo Alto Calif
Gulton Industries Inc
212 Durham Ave Metuchen N J
Haller Raymond & Brown
Science Park State College Penna
Hallicrafters Co
4401 W 5th Ave Chicago Ill
Hazeltine Electronics Div Hazeltine Corp
59-25 Little Neck Pkwy Little Neck 62 N Y
Hoffman Electronics Corp
3761 S Hill St Los Angeles 7 Calif
Houston Fearless Corp
11801 W Olympic Blvd Los Angeles 64 Calif
Hughes Aircraft Co—Ground Systems Div
P O Box 2097 Fullerton Calif
Hughes Aircraft Co El Segundo
Int'l A/P Sta P O Box 90426 Los Angeles Calif
Hughes Aircraft Co Electronic Mfg Div
Box 90426 Los Angeles 45 Calif
Hycon Mfg Co
1030 S Arroyo Pkwy Pasadena Calif
Itek Inc
1611 Trapelo Rd Waltham 54 Mass
ITT Labs Div ITT Corp
500 Washington Ave Nutley 10 N J
I-T-E Circuit Breaker Co
601 E Erie Ave Phila Penna
Jacobs Instrument Co
4718 Bethesda Ave Bethesda 14 Md
J-V-M Microwave Co
9300 W 47th St Brookfield Mass

Kaiser Aircraft & Electronics Div Kaiser Ind Corp
Toledo Electronics Plt P O Box 437 Toledo 1 Ohio
Kearfott Co Inc
14844 Oxnard St Van Nuys Calif
Kearfott Co Inc
1500 Main Ave Clifton N J
Kelsey-Hayes Co
3600 Military Ave Detroit 32 Mich
Kennedy & Co D S
155 King St Cohasset Mass
Laboratory for Electronics Inc
1079 Commonwealth Ave Boston 15 Mass
LaPoint Industries Inc
155 W Main St Rockville Conn
Lavoie Labs Inc
Matawan-Freehold Rd Morganville N J
Lewyt Mfg Corp
43-22 Queens St Long Island City 1 N Y
Lieco Inc
3610 Oceanside Rd Oceanside N Y
Lindly & Co
248 Herricks Rd Mineola N Y
Ling Electronics Inc
9937 Jefferson Blvd Culver City Calif
Ling Systems Inc
11949 Vose St N Hollywood Calif
Litton Industries of Md
4900 Calvert Rd College Park Md
Loral Electronics Corp
825 Bronx River Ave New York 72 N Y
McMillan Industrial Corp
Brownsville Ave Ipswich Mass
Madigan Corp
526 Mineola Ave Carle Place N Y
Magnavox Corp
2131 Bueter Rd Ft Wayne 1 Ind
Mark Products Co
6412 W Lincoln Ave Morton Grove Ill
Mathis Co G E
6100 S Oak Park Ave Chicago 38 Ill
Maxson Corp W L
460 W 34th St New York N Y
Melpar Inc
Sub Westinghouse Air Brake Co 3305 Arlington Blvd Falls Church Va
Meridian Metalcraft Inc
8739 S Millergrove Dr Whittier Calif
Metal Fabricators Corp
63 Pond St Waltham 54 Mass
Microtech Inc
2975 State St Hamden 17 Conn
Microwave Associates Inc
Burlington Mass
Microwave Eng'g Labs Inc
943 Industrial Ave Palo Alto Calif
Microwave Services Inc
Times Tower Bldg New York N Y
Milford Dept-Norden Div-United Aircraft
Milford Conn
Minn-Honeywell Regulator Co Ordnance Div
600 2nd St N Hopkins Minn
Minn-Honeywell Regulator Co Aeronautical Div
2600 Ridgway Ave Minneapolis 13 Minn
Minn-Honeywell Regulator Co/Mil Prod Co Aeronautical & Ordnance Div
2753 4th Ave S Minneapolis Minn
Miratel Inc
1080 Dionne St St Paul 13 Minn
Missileonics Inc
P O Box 716 Melbourne Fla
Motorola Communications & Electronics Inc
4500 W Augusta Blvd Chicago Ill
Narda Microwave Corp
118-160 Herricks Rd Mineola N Y
Northeast Electronics Corp
Airport Rd Concord N H
N R K Mfg & Eng'g Co
4601 W Addison St Chicago 41 Ill
Nuclear Products-Erco Div ACF Industries Inc
Riverdale Md
Packard Bell Electronics Corp
12333 W Olympic Blvd Los Angeles 64 Calif
Parker Metal Goods Co
85 Prospect St Worcester Mass
Patterson Moos Div Universal Winding Co
90-28 Van Wyck Expressway Jamaica N Y
Peebles & Co Ltd Bruce
East Pialon Edinburgh 5 Scotland
Philco Corp
Tioga & C Sts Phila 24 Penna
Philco Corp G & I Div
4700 Wissahickon Ave Phila 44 Penna
Polarad Electronics Corp
43-20 34th St Long Island City 1 N Y
Premier Instrument Corp
33 New Broad St Port Chester N Y
Prodelin Inc
305 Bergen Ave Kearney N J
Production Research Corp
Thornwood N Y
Pye Canada Ltd
82 Northline Rd Toronto 16 Ont Can
Pye Telecommunications Ltd
Newmarket Rd Cambridge Mass

(*Continued on page* 172)

3 *good ways to make dc measurements*

KEITHLEY ELECTROMETERS have up to 64 voltage, resistance and current ranges

1 Model 610A, 64 ranges

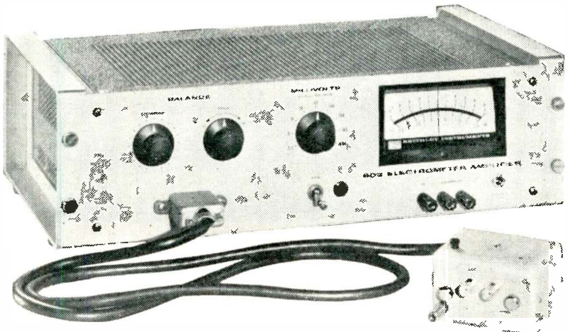
The line-operated 610A is a refinement of the popular 610, covering virtually every dc laboratory test. It measures nine voltage ranges from 0.01 to 100 volts full scale with 2% accuracy, current from three amperes to 1 x 10^{-13} ampere full scale, and resistance from 10 ohms to 10^{14} ohms full scale. The 610A also serves as a useful dc pre-amplifier with precise gains to 1000 and outputs for driving scopes and recorders. Input resistance is variable from one ohm to over 10^{14} ohms. The instrument checks its own resistance standards. Zero drift is within two millivolts per hour. **$480.00**

2 Model 600A, 54 ranges

This portable instrument is a battery-operated counterpart of the 610A. Its ranges cover 10 mv to 10 volts, 3 amperes to 10^{-13} ampere, and 10^{4} to 10^{13} ohms full scale. Like the 610A, it has selectable input resistance, a dc to 100 cps bandwidth, and output sufficient to drive recorders directly. Battery life is 500 hours; condition may be checked on the panel meter. **$380.00**

Three accessory probes and test shield are available to facilitate measurements and extend voltage ranges to 30 kv (Model 610A) or 10 kv (Model 600A).

3 Model 603, differential input



This instrument is a wide-band dc amplifier, with an extremely high input impedance, high voltage and current sensitivity, and a remote differential input. Its separate input head permits measurements up to 24 feet from the amplifier. The 603 has nine ranges from 2.5 to 1000 mv, with precise gains up to 4000, and a 10-volt output at 10 ma. Bandwidth is dc to 10 kc on the 2.5 mv range, rising to 30 kc on the 1000 mv range. **$650.00**

KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE • CLEVELAND 6, OHIO

1960 Directory of Microwave Manufacturers

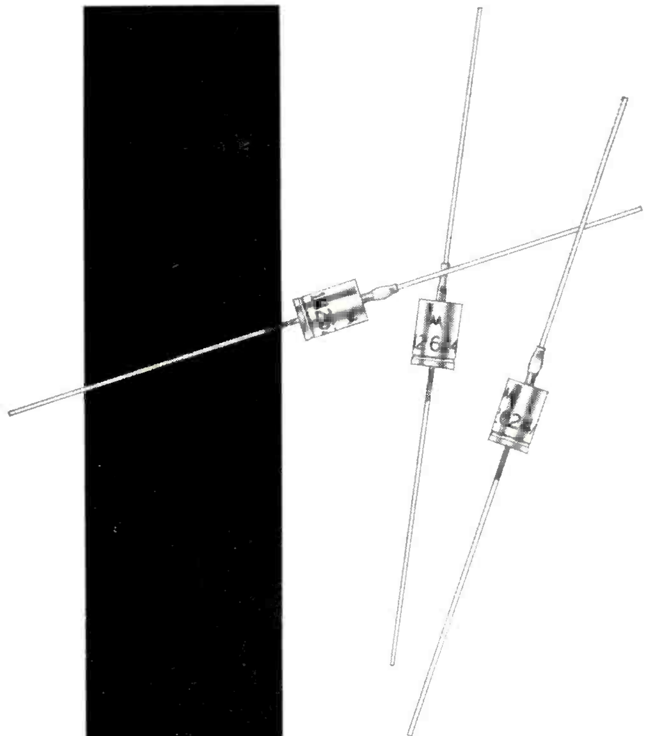
(*Continued from page* 170)

Q-Line Mfg Corp
1562 61st St Brooklyn N Y
Radiation Inc
P O Box 37 Melbourne Fla
Radiation Eng'g Labs
Main St Maynard Mass
Radio Activities Inc
119 Dawson Ave Boonton N J
Radio City Products Co
Centre & Glendale Sts Easton Penna
Radio Corp of America Commercial Electronic Products
Front & Cooper Sts Camden N J
Radio Eng'g Labs
29-01 Borden Ave Long Island City 1 N Y
Radioplane Div Northrop Aircraft Inc
800 Woodly Ave Van Nuys Calif
Radio Research Instrument Co
550 5th Ave New York N Y
Ramo-Wooldridge Corp Electronic Instrumentation Div
P O Box 8405 Denver 10 Colo
Raytheon Co Maynard Lab
Thompson St Maynard Mass
Raytheon Co
Commercial Equip Div 100 River St Waltham 54 Mass
Raytheon Co
100 River St Waltham 54 Mass
Rea Co J B Electronics Div
2202 Broadway Santa Monica Calif
Renfrew Electric Co Ltd
349 Carlaw Ave Toronto 9 Ont Can
Resdel Eng'g Corp
330 S Fair Oaks Ave Pasadena Calif
Sanders Associates
95 Canal St Nashua N H
Sarkes Tarzian Inc
East Hillside Dr Bloomington Ind
Scatter-Communications Inc
4923 St Elmo Ave Bethesda 14 Md
Scientific-Atlanta Inc
1262 Piedmont Rd NE Atlanta 6 Ga
Servomechanisms Inc
12500 Aviation Blvd Hawthorne Calif
Sierra Electronic Corp
3885 Bohannon Dr Menlo Park Calif
Sperry Gyroscope Co
Sunnyvale Dev Center 294 Commercial St Sunnyvale Calif
Sperry Microwave Electronics Co Div Sperry Rand
P O Box 1828 Clearwater Fla
Sperry Gyroscope Co
Air Arm Div Great Neck N Y
Sperry Gyroscope Co
Surface Armament Div Great Neck N Y
Sperry Gyroscope Co
Marine Div Roosevelt Field Mineola N Y
Sperry Gyroscope Co
Div Sperry Rand Corp Farragut Rd Bristol Tenn
Spincraft Inc
4122 W State St Milwaukee 8 Wis
Spinform Inc
65 Mechanic St Attleboro Mass
Stainless Inc
3rd St North Wales Penna
Stavid Eng'g Inc
U S Route 22 Plainfield N J
Stromberg-Carlson Div Gen Dynamics Corp
100 Carlson Rd Rochester 3 N Y
Summit Industries Inc
2104 W Rosecrans Gardena Calif
Sylvania Electric Products Co Electronic Systems Div
100 First Ave Waltham 54 Mass
Ta-Mar Inc
2339 Costner Ave Los Angeles 64 Calif
Technical Appliance Corp
1 Tace St Sherburne N Y
Technical Oil Tool Corp
1057 N LaBrea Los Angeles 38 Calif
Technicraft Labs Inc
Thomaston-Waterbury Rd Thomaston Conn
Telecomputing Corp
915 N Citrus Ave Los Angeles Calif
Telectro Industries Corp
35-18 37th St Long Island City 1 N Y
Telechrome Mfg Corp
28 Ranick Dr Amityville N Y
Tele-Dynamics Inc
5000 Parkside Ave Phila Penna

(*Continued on page* 174)

MOTOROLA
TEMPERATURE COMPENSATED
ZENER DIODES
TO .0005% / °C

NEW silicon diffused junction precision components for applications demanding extreme stability... reliability



ELECTRICAL CHARACTERISTICS, at 10.0 ma

Type Number	Voltage Range @ 10.0 ma (25°C Ambient) Volts	Voltage-Temperature Coefficient %/°C	Temperature Range °C
1N2620	8.9-9.7	.01	0 to +75
1N2620/A	8.9-9.7	.01	—55 to +100
1N2620/B	8.9-9.7	.01	—55 to +150
1N2621	8.9-9.7	.005	0 to +75
1N2621/A	8.9-9.7	.005	—55 to +100
1N2621/B	8.9-9.7	.005	—55 to +150
1N2622	8.9-9.7	.002	0 to +75
1N2622/A	8.9-9.7	.002	—55 to +100
1N2622/B	8.9-9.7	.002	—55 to +150
1N2623	8.9-9.7	.001	0 to +75
1N2623/A	8.9-9.7	.001	—55 to +100
1N2623/B	8.9-9.7	.001	—55 to +150
1N2624	8.9-9.7	.0005	0 to +75
1N2624/A	8.9-9.7	.0005	—55 to +100
1N2624/B	8.9-9.7	.0005	—55 to +150

• Maximum Dynamic Impedance: 15 ohms at 10 ma (all types)

Offering temperature coefficients as low as .0005% per °C and temperature ranges as wide as −55 to +150°C, these new Motorola devices provide an extremely stable 9.3 volt reference source. The new axial-lead, flangeless package (only .22" x .35") is ideal for automatic insertion in printed circuit boards and simplifies connections to terminal strips. Units meet or exceed mechanical and environmental requirements of MIL-S-19500 providing the same reliable operation as Motorola's standard zener diodes.

These new Motorola diodes are designed for such voltage reference applications as digital voltmeters, precision high-stability oscillators, frequency meters, analog to digital converters and precision DC power supplies. And, they are available, now, from your Motorola Semiconductor Distributor.

NEW MIL SPEC ZENERS ALSO AVAILABLE

Three new Motorola 10 watt zeners (1N1353-1N1358-1N1361), the first ever produced to military specifications, are now available. Contact your nearest regional office for complete information.

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MOTOROLA, INC., 5005 E. McDOWELL, PHOENIX, ARIZONA

Circle 114 on Inquiry Card

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Texas Instruments Inc
6000 Lemmon Ave Dallas 6 Texas
Tower Construction Co
2700 Hawkeye Dr Sioux City Iowa
Transco Products Inc
12210 Nebraska Ave Los Angeles 25 Calif
Tri-Ex Tower Corp
127 E Inyo St Tulare Calif
Underwood Corp-Canoga Div
150 Elgin Hwy Ft Walton Beach Fla
Uniwave Inc
109 Marine St Farmingdale N Y
Vectron Inc
1611 Trapelo Rd Waltham 54 Mass
Victor RF & Microwave Co
36 N Water St Wakefield Mass
Waveguide Inc
1769 Placentia Costa Mesa Calif
Westinghouse Electric Co Air Arm Div
P O Box 746 Friendship A/P Baltimore Md
Westinghouse Electric Co
P O Box 868 Pittsburgh Penna
Winder Aircraft Corp Fla
P O Box 8 Dunnellen Fla
Zenith Plastics Co
1600 W 135th St Gardena Calif

TEST EQUIPMENT

Admiral Corp
3800 W Cortland St Chicago 47 Ill
Aeronca Mfg Corp
Hilltop & Frederick Rds Baltimore 28 Md
Aerotronic Associates Inc
Box 419 Concord N H
Airborne Instruments Lab Div Cutler Hammer Inc
160 Old Country Rd Mineola N Y
Aircom Inc
354 Main St Winthrop Mass
Aircraft Armaments Inc
Cherry Tree Rd Box 126 Cockeysville Md
Aircraft Radio Corp
Boonton N J
Airtec Inc
130 E 1st Ave Roselle N J
Airtron Inc Div Litton Industries
200 Hanover Ave Morris Plains N J
Alford Mfg Co
299 Atlantic Ave Boston 10 Mass
Alfred Electronics
897 Commercial St Palo Alto Calif
Adler Electronics Inc
1 Lefevre Lane New Rochelle N Y
American Electronic Labs Inc
121 N 7th St Phila Penna
Amerac Inc
Dunham Rd Beverly Mass
Antenna & Radome Research Assoc
1 Bond St Westbury N Y
A R F Products Inc
P O Box 57 Ranton N M
Arma Div American Bosch Corp
Roosevelt Field Garden City N Y
Atlas Precision Products Co
3801 Castor Ave Phila 24 Penna
Audicon Corp
216 Lyon St Paterson 4 N J
Austin Co Special Devices Div
76 9th Ave New York 11 N Y
Avionics Ltd
P O Box 200 Niagara-On-Lake Ont Can
Baird-Atomic Inc
33 University Rd Cambridge 38 Mass
Beckman Instrument Inc Berkeley Div
2200 Wright Ave Richmond Calif
Bogart Mfg Corp
315 Seigel St Brooklyn 6 N Y
Boonton Radio Corp
Intervale Rd Boonton N J
Bosco Electronics Inc Don
56 Route 10 Hanover N J
Browning Labs Inc
100 Union Ave Laconia N H
Brubaker Electronics Inc
3652 Eastham Dr Culver City Calif
Bruno-New York Industries Corp
460 W 34th St New York 1 N Y
Bulova Watch Co Electronics Div
40-01 61st St Woodside 77 N Y
Burroughs Corp
6071 2nd Ave Detroit 32 Mich

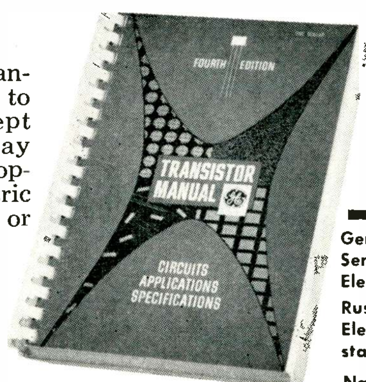
(Continued on page 178)

Test your Transistor I.Q. with this quick quiz:

1. What are the six main types of transistor computer logic?
2. What are the methods for servicing and aligning a transistor radio?
3. How is a transistor bias circuit designed taking into account variations of beta, I_{CO}, V_{BE} and temperature?
4. How are common base h parameters converted to common emitter h parameters?
5. What is the difference between an alloy diffused transistor and a drift transistor?
6. What circuit can be used for a 2 KW regulated power supply using silicon controlled rectifiers?
7. What circuit can be used for a transistor sawtooth generator with a 0.3% linearity?
8. Can a simple bass-boost circuit be designed to compensate for changes in output level of a phono preamplifier without lowering its sensitivity?
9. What are the major factors influencing transistor reliability?
10. What is the collector leakage current in a common emitter transistor when the base is reverse biased?

If you can't answer all of these questions, don't be discouraged. Help is at hand! Just get yourself a copy of the big new 4th Edition of General Electric's famous TRANSISTOR MANUAL. Its 227 fact-filled pages contain the answers to all these questions—and many, many more. There are 60 more pages, 7 more chapters and 23 additional circuits!

This is the one book in the transistor field you can't afford to be without—constantly kept up-to-date to help you stay abreast of the latest developments. Your General Electric Tube Distributor has them, or mail the coupon at right.



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Semiconductor Products Dept., Section S24119
Electronics Park, Syracuse, N. Y.

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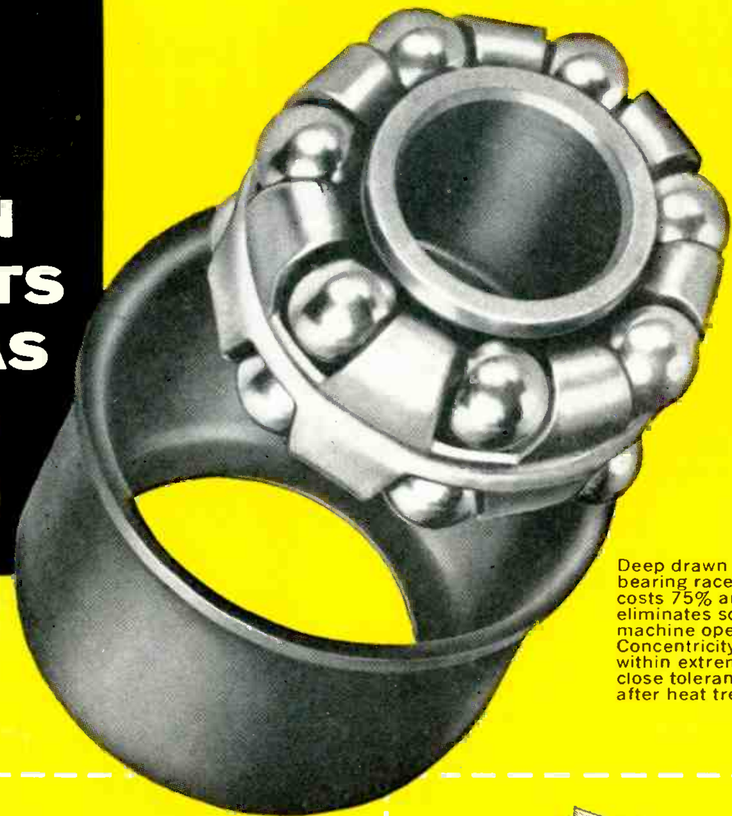

Deep drawn ball bearing race cuts costs 75% and eliminates screw machine operation. Concentricity held within extremely close tolerance even after heat treating.

Transistor dome has .018 weld flange made from .013 stock, without showing any indentation on reverse side.

Full stock thickness at top of draw on .018 brass case improved watch quality and saved assembly time.

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- **Increase production and speed assembly**
- **Eliminate screw machine costs**

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1960 Microwave Directory

(*Continued from page 174*)

Burroughs Corp Electronic Tube Div
Box 1226 Plainfield N J
Calif Technical Industries Div Textron Inc
1421 Old Country Rd Belmont 10 Calif
Canadian Marconi Co
2442 Trenton Ave Montreal 16 Ont Can
Canadian Research Institute
46 St George St Toronto 5 Ont Can
Canoga Corp of Calif Southern Div
77 Elgin Way Ft Walton Beach Fla
Caswell Electronics Corp
414 Queens Lane San Jose 12 Calif
Cawkell Electrical Eng'g A E
80 Shore Rd Port Washington N Y
Chemalloy Electronics Corp
Gillespie Airport Santee Calif
Clegg Labs/Div Clegg Inc
Ridgedale Ave Morristown N J
Clough-Brengle Co
6014 Broadway Chicago 40 Ill
Collins Radio Co
855 35th St N E Cedar Rapids Iowa
Collins Radio Co
1930 Hiline Dr Dallas 7 Texas
Consolidated Avionics Corp
800 Shames Dr Westbury N Y
Control Electronics Co Inc
10 Stepar Pl Huntington Sta N Y
Convair San Diego Div Gen Dynamics Corp
3165 Pacific Hwy San Diego Calif
Cook Electric Co
2700 N Southport Ave Chicago 11 Ill
Creative Electronics Corp
94 Lincoln Ave Stamford Conn
Cubic Corp
5575 Kearny Villa Rd San Diego 11 Calif
DeMornay-Bonardi Corp
780 S Arroyo Pkwy Pasadena Calif
Designers for Industry
4241 Fulton Pkwy Cleveland 9 Ohio
Diamond Antenna & Microwave Corp
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Douglas Microwave Co
252 E 3rd St Mt Vernon N Y
DuMont Labs Inc Allen B
750 Bloomfield Ave Clifton N J
Dymec Inc
395 Page Mill Rd Palo Alto Calif
Dynamics Electronics Inc
87046 123rd St Richmond Hill N Y
Elcor Inc
1225 W Broad St Falls Church Va
Electrical & Physical Instrument Corp
42-19 27th St Long Island City N Y
Electro Impulse Lab Inc
208 River St Red Bank N J
Elk Electronics Labs Inc
333 W 52nd St New York 19 N Y
Elsin Electronics Corp
Eileen Way Syosset N Y
EMI Cosser Electronics
Woodside Darthmouth Nova Scotia
Empire Devices Products Corp
37 Prospect St Amsterdam N Y
Farnsworth Electronics Co Div ITT
3702 E Pontiac St Ft Wayne Ind
Federal Mfg & Eng'g Co
1055 Stewart Ave Garden City N Y
Engineering Associates
434 Patterson Rd Dayton 9 Ohio
Foto Video Labs
36 Commerce Rd Cedar Grove N J
Frequency Standards Div
Harvard Industries Inc Box 504 Asbury Park N J
FXR Inc
26-12 Borough Pl Woodside N Y
Gates Electronic Co
1705 Taylor Ave New York N Y
General Communication Co
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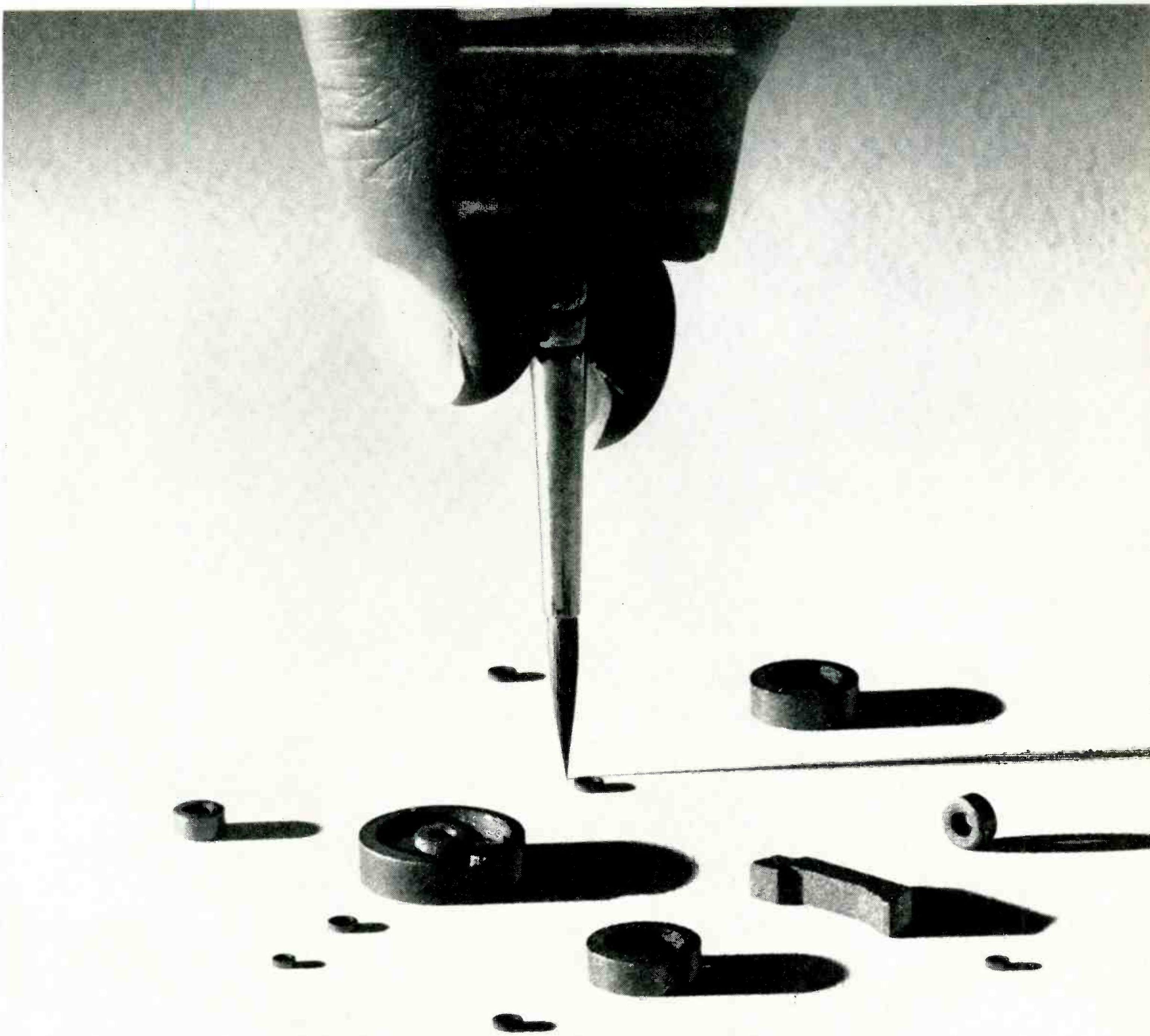
General Radio Co
West Concord Mass
Granger Associates
966 Commercial St Palo Alto Calif
Grem Eng'g Co
923 Longview Rd King of Prussia Pa
Hallicrafters Co
4401 W 5th Ave Chicago Ill
Hazeltine Electronics Div Hazeltine Corp
59-25 Little Neck Pkwy Little Neck 62 N Y
Hewlett-Packard Co
275 Page Mill Rd Palo Alto Calif
Hycon Mfg Co
1030 S Arroyo Pkwy Pasadena Calif
Itek Inc
1611 Trapelo Rd Waltham 54 Mass
Jacobs Instrument Co
4718 Bethesda Ave Bethesda 14 Md
J-V-M Microwave Co
9300 W 47th St Brookfield Mass
Kaiser Aircraft & Electronics Div Kaiser Ind
P O Box 1828 Oakland 4 Calif

(*Continued on page 180*)



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1960 Microwave Directory

(*Continued from page 178*)

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Kearfott Co Inc
14844 Oxnard St Van Nuys Calif
Kearfott Co Inc
1500 Main Ave Clifton N J
Kinevox-Hallen Div Electromation Co
1646 18th St Santa Monica Calif
Laboratory for Electronics Inc
1079 Commonwealth Ave Boston 15 Mass
Lambda Pacific Eng'g Corp
P O Box 70 Van Nuys Calif
Lavoie Labs Inc
Matawan-Freehold Rd Morganville N J
Leeds Co Inc Gerard G
12 Crampton Lane Great Neck N Y
Levinthal Electronic Products Inc
3180 Hanover St Palo Alto Calif
Lewyt Mfg Corp
43-22 Queens St Long Island City 1 N Y
Lieco Inc
3610 Oceanside Rd Oceanside N Y
Ling Systems Inc
11949 Vose St N Hollywood Calif
Lumatron Electronics Inc
68 Urban Ave Westbury N Y
Manson Laboratories Inc
375 Fairfield Ave Stamford Conn
Marconi Instruments Ltd
111 Cedar Lane Englewood N J
Maxson Corp W L
460 W 34th St New York 1 N Y
Meridian Metalcraft Inc
8739 S Millergrove Dr Whittier Calif
Mico Instrument Co
80 Trowbridge St Cambridge 38 Mass
Microwave Associates Inc
Burlington Mass
Miller Associates
P O Box 369 Lakeville Conn
Miratel Inc
1080 Dionne St St Paul 13 Minn
Mullard Equipment Ltd
Torrington Pl London WC 1 England
Narda Microwave Corp
118-160 Herricks Rd Mineola N Y
Omega Labs Inc
Haverhill St Rowley Mass
Panoramic Radio Products Inc
530 S Fulton Ave Mt Vernon N Y
Pitometer Log Corp
237 LaFayette St New York 12 N Y
Polarad Electronics Corp
43-20 34th St Long Island City 1 N Y
Polytechnic Research & Development Co
202 Tillary St Brooklyn 1 N Y
Precise Development Corp
2 Neil Ct Oceanside N Y
Press Wireless Labs Inc
25 Prospect Pl W Newton 65 Mass
Pye Canada Ltd
82 Northline Rd Toronto 16 Ont Can
Pye Telecommunications Ltd
Newmarket Rd Cambridge England
Radar Design Corp
P O Box 38 Pickard Dr Syracuse 1 N Y
Radar Measurements Corp
190 Duffy Ave Hicksville N Y
Radiation Inc
P O Box 37 Melbourne Fla
Radio City Products Co
Centre & Glendale Sts Eastern Penna
Radio Corp of America Commercial Electronic Products
Front & Cooper Sts Camden N J
Radioplane Div Northrop Aircraft Inc
800 Woodly Ave Van Nuys Calif
Raytheon Co Commercial Equip Div
100 River St Waltham 54 Mass
Raytheon Co
100 River St Waltham 54 Mass
Resdel Eng'g Corp
330 S Fair Oaks Ave Pasadena Calif
Scientific Atlanta Inc
1262 Piedmont Rd N E Atlanta 6 Ga
Sierra Electronic Corp
3885 Bohannon Dr Menlo Park Calif
Solartron Electronic Group Ltd
Queens Rd Thames Ditton Surrey England
Specialty Eng'g & Electronics Co
79 Clifton Pl Brooklyn 38 N Y
Spectralab Instrument Co
608 Fig Ave Monrovia Calif
Sperry Microwave Electronics Co Div Sperry Rand
P O Box 1828 Clearwater Fla
Sperry Gyroscope Co
Marine Div Roosevelt Field Mineola N Y
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Technical Oil Tool Corp
1057 N LaBrea Los Angeles 38 Calif
Technicraft Labs Inc
Thomaston-Waterbury Rd Thomaston Conn
Technitrol Eng'g Co
1952 E Allegheny Ave Phila 34 Penna
Tektronix Inc
P O Box 831 Portland 7 Ore
Telechrome Mfg Corp
28 Ranick Dr Amityville N Y
Telecomputing Corp
915 N Citrus Ave Los Angeles Calif
Telectro Industries Corp
35-18 37th St Long Island City 1 N Y
Telerad Mfg Corp
1440 Broadway New York 18 N Y
Tullamore Electronics Corp Sub Victoreen Instrument Co
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Uniwave Inc
109 Marine St Farmingdale N Y
Van Norman Industries Inc Electronics Div
186 Granite St Manchester N H
Varian Associates
Instrument Div 611 Hansen Way Palo Alto Calif
Vectron Inc
1611 Trapelo Rd Waltham 54 Mass
Victor RF & Microwave Co
36 W Water St Wakefield Mass
Wacline Inc
35 S St Clair St Dayton 2 Ohio
Waldorf Instruments Co
Div F C Huyck & Sons Park Ave Huntington Sta N Y
Waltham Electronics Corp
751 Main St Waltham Mass
Waveline Inc
P O Box 718 Caldwell N J
Wayne-Kerr Corp
2920 N 4th St Phila 33 Penna
Weinschel Eng'g
10503 Metropolitan Ave Kensington Md
Westinghouse Electric Co
P O Box 868 Pittsburgh Penna
Weymouth Instrument Co
1440 Commercial St E Weymouth 89 Mass

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160 Old Country Rd Mineola N Y
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Communication Products Div Box 110 Mineral Wells Texas
Alprodco Inc
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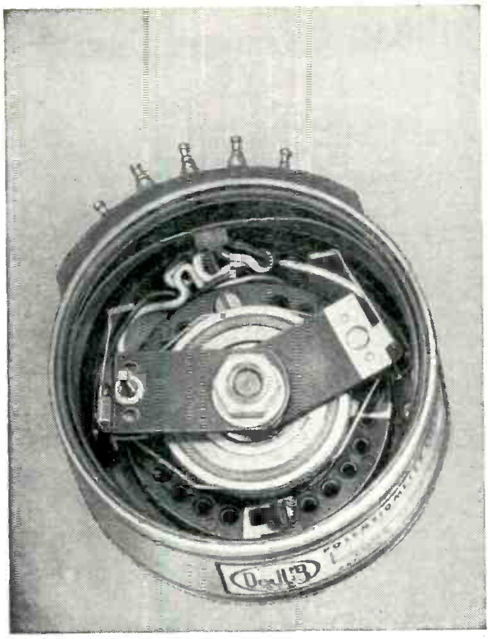
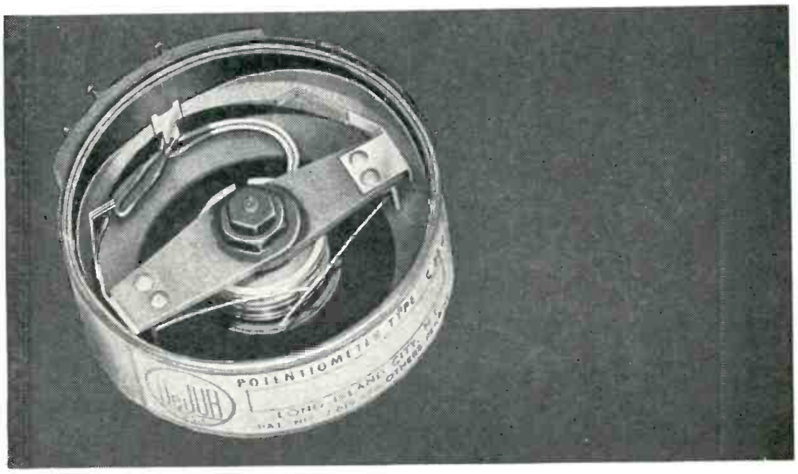
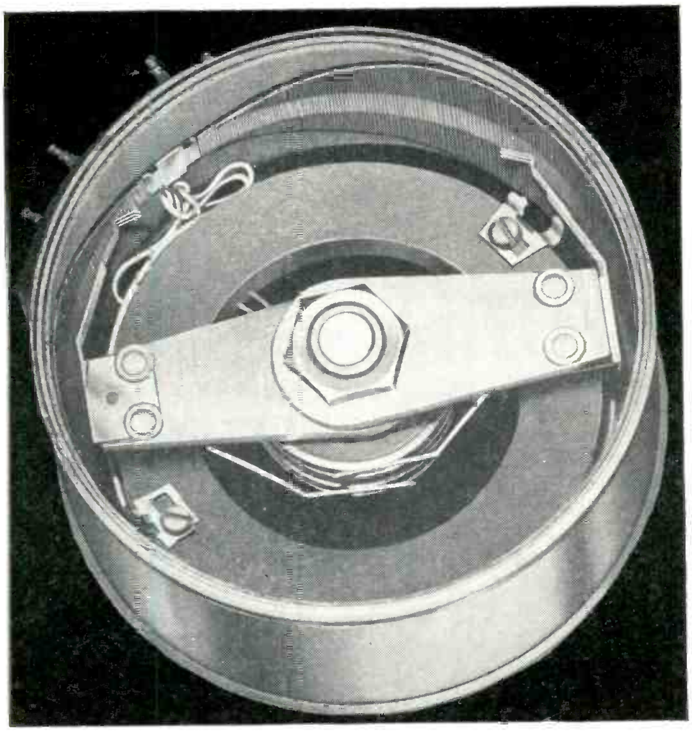
American Tower Co
RFD 2 Box 29 Shelby Ohio
Antlab Inc
6330 Proprietors Rd Worthington Ohio
APC Electronic Products Div
Box 110 Mineral Wells Texas
Bendix Aviation Corp Eclipse Pioneer Div
Teterboro N J
Blaine Electronics Inc
14757 Keswick St Van Nuys Calif
Dresser-Ideco Co
875 Michigan Ave Columbus 8 Ohio
E-Z-Way Towers Inc
5901 E Broadway Tampa 5 Fla
G B Electronics Corp Sub General Bronze Corp
711 Stewart Ave Garden City N Y
Hi-Lo Mfg Corp
1122 W Newport Ave Chicago 13 Ill
I-T-E Circuit Breaker Co
601 E Erie Ave Phila 34 Penna
Klein Iron & Steel Co
P O Box 1013-1225 35 Huger St Columbia S C
Magnesium Products of Milwaukee Inc
748 W Virginia St Milwaukee 4 Wis
MB Communications Co
4626 Walnut St Phila 39 Penna
Pioneer Industries Inc
2700 Hawkeye Dr Sioux City Iowa
Radio Corp of America Commercial Electronic Prod
Front & Cooper Sts Camden N J
Rohn Mfg Co
116 Limestone Belleview Peoria 5 Ill
Rostan Corp
5660 59th St Maspeth 78 N Y
Stainless Inc
3rd St North Wales Penna
Tele-Vue Towers Inc
701 49th St St Petersburg Fla
Telrex Labs
Asbury Park N J





NEW DeJUR SINE-COSINE POTENTIOMETERS

achieve exceptional functional conformity



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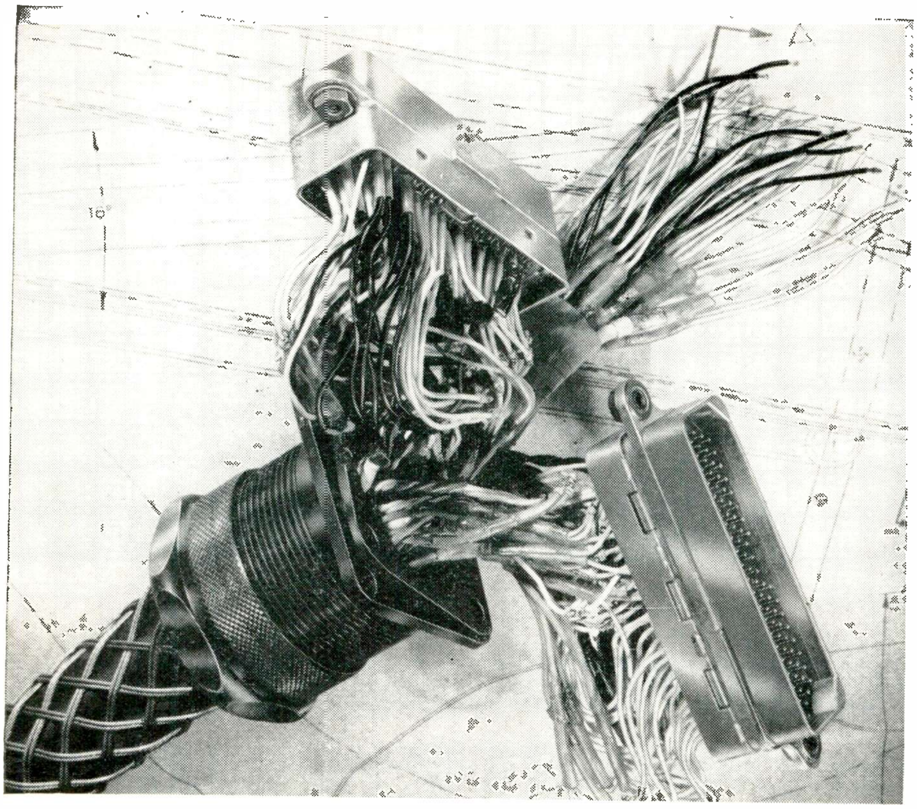

1960 Microwave Directory

Thomas Mold & Die Co
249 W Henry St Wooster Ohio
Tower Construction Co
2700 Hawkeye Dr Sioux City 2 Iowa
Tricraft Products Corp
1124 W Newport Ave Chicago 22 Ill
Tri-Ex Tower Corp
127 E Inyo St Tulare Calif
Tri-Ex Tower Corp
421 S Walnut St Ottawa Kan
Wind Turbine Co
E Market St & PRR West Chester Penna

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Admiral Corp
3800 W Cortland St Chicago 47 Ill
Advance Industries Inc
640 Memorial Dr Cambridge 39 Mass
Airborne Instruments Lab Div Cutler Hammer Inc
160 Old Country Rd Mineola N Y
Airtec Inc
130 E 1st Ave Roselle N J
Adler Electronics Inc
1 Lefevre Lane New Rochelle N Y
Alford Mfg Co
299 Atlantic Ave Boston 10 Mass
American Electronic Labs Inc
121 N 7th St Phila Penna
American Elite Inc
48-50 34th St Long Island City N Y
Avco Mfg Corp Crosley Div
1329 Arlington St Cincinnati 25 Ohio
Budelman Radio Corp
375 Fairfield Ave Stamford Conn
Centronix Inc
4000 N W 28th St Miami Fla
Collins Radio Co
1930 Hiline Dr Dallas 7 Texas
Corbin Corp
5419 56th Pl Riverdale Md
Designers for Industry
4241 Fulton Pkwy Cleveland 9 Ohio
Electronic Communications Inc
1501 72nd St St Petersburg Fla
Electronics Development Co
3743 Cahuenga Blvd N Hollywood Calif
Elk Electronics Labs Inc
333 W 52nd St New York 19 N Y
Engineering Associates
434 Patterson Rd Dayton 9 Ohio
General Communication Co
677 Beacon St Boston 15 Mass
General Electric Co Communication Products Dept
Lynchburg Va
Granger Associates
966 Commercial St Palo Alto Calif
Haller Raymond & Brown
Science Park State College Penna
Hallicrafters Co
4401 W 5th Ave Chicago Ill
Hazeltine Electronics Div Hazeltine Corp
59-25 Little Neck Pkwy Little Neck 62 N Y
Hoffman Electronics Corp
2761 S Hill St Los Angeles 7 Calif
Hughes Aircraft Co Electronic Mfg Div
Box 90426 Los Angeles 45 Calif
Johnson Co E F
206 2nd Ave S W Waseca Minn
Lenkurt Electric Co
1105 Old Country Rd San Carlos Calif
Lewyt Mfg Corp
43-22 Queens St Long Island City 1 N Y
Litton Industries of Md
4900 Calvert Rd College Park Md
Maxson Corp W L
460 W 34th St New York N Y
Packard Bell Electronics Corp
12333 W Olympic Corp 12333 W Olympic Blvd Los Angeles 64 Calif
Philco Corp
Tioga & C Sts Philadelphia 24 Penna
Philco Corp G & I Div
4700 Wissahickon Ave Phila 44 Penna
Polarad Electronics Corp
43-20 34th St Long Island City 1 N Y
Polytechnic Research & Development Co
202 Tillary St Brooklyn 1 N Y
Pratt Albert
114 W Lake View Ave Milwaukee 17 Wis
Pye Canada Ltd
82 Northline Rd Toronto 16 Ont Can
Pye Telecommunications Ltd
Newmarket Rd Cambridge England
Rauland Borg Corp
3535 W Addison St Chicago 18 Ill
Raytheon Co
100 River St Waltham 54 Mass
Resdel Eng'g Corp
330 S Fair Oaks Ave Pasadena Calif

(*Continued on page* 187)

Circle 99 on Inquiry Card

Circle 101 on Inquiry Card →

PULSE

GENERATION

Five plug-in pulse generators provide any code—1 to 5 pulses —with completely independent adjustment of width and delay for each pulse.

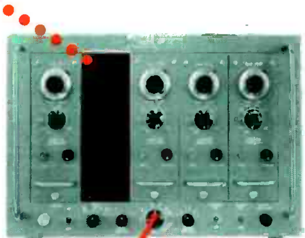
PULSE DELAY: variable 0 to 300 microseconds

PULSE WIDTH: variable 0.2 to 2 microseconds

PULSE TIME MODULATION: Sensitivity, 2 volts RMS per microsecond

CODED MULTIPULSE GENERATOR

Model MP-1A



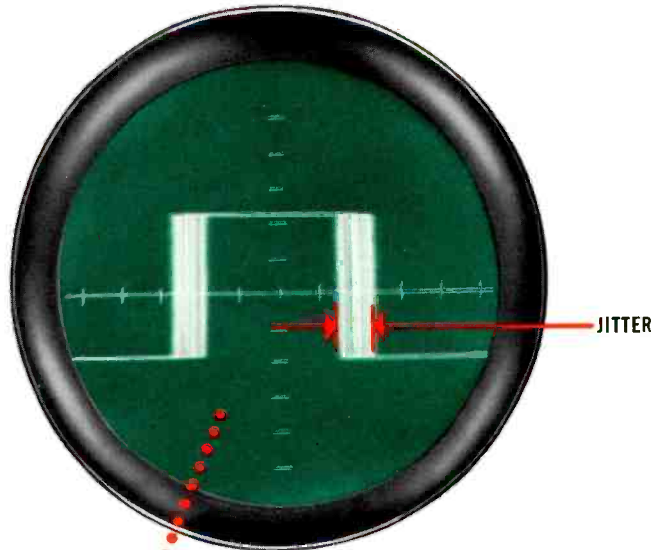
RISE AND DECAY TIME: 0.1 microsecond

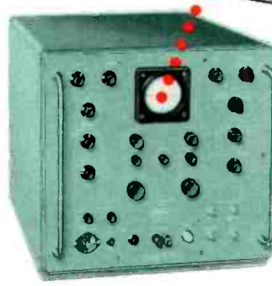
GROUP REPETITION RATE: 10 to 10,000 pps

Used to modulate r-f signal generators with coded pulse groups. Internal or external sync; square wave output, 10 to 10,000 pps. Pulses can be independently pulse-time modulated by external signal.

APPLICATIONS: Design and testing of missiles, radar, beacons, IFF, telemetry, etc.

TESTING



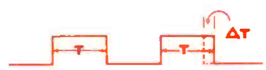


PULSE JITTER TESTER

Model PJ-1

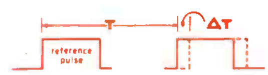
Displays the magnitude and waveform of pulse jitter (time deviation) in rate generators, pulse width modulators, encoding devices and precision time generators.

MEASURES:



PULSE WIDTH JITTER: Peak-to-peak time deviation (△T) at the half-amplitude points, between the leading and trailing edges of a recurrent pulse having a nominal width represented as "T" in the diagram at left.

ABSOLUTE JITTER: Time deviation (△T) at the half-amplitude points, from leading edge to leading edge of successive pulses (of duration "T" in the diagram) in a pulse train.



RELATIVE JITTER: Peak-to-peak time deviation (△T) at half-amplitude points of the leading edge of one pulse to the leading edge of a reference pulse. The time difference between the two is "T" in the diagram.

Repetition Rate Jitter: 5 millimicroseconds to 100 microseconds full scale. **Relative or Width Jitter:** 5, 10, 100 millimicroseconds.

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MAIL THIS CARD for complete specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

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Representatives in principal cities

POLARAD ELECTRONICS CORPORATION:

Please send me information and specifications on:

EI ☐ Model MP-1A Coded Multi-Pulse Generator

☐ Model PJ-1 Pulse Jitter Tester

E ☐ Model VS-2 Rapid-Scan Ratio-Scope (see reverse side of page)

MJ ☐ Model ESG Electronic Sweep Generator (see reverse side of page)

My application is: ____________________

Name ____________________

Title ____________ Dept. ____________

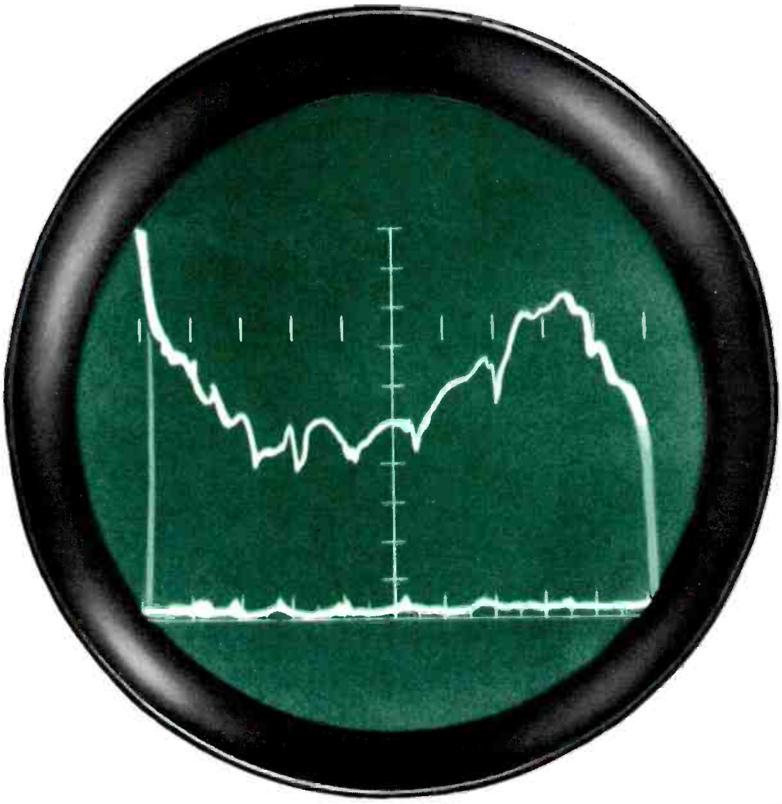
Company ____________________

Address ____________________

City ____________ Zone ____ State ____________

INSTANTANEOUS MICROWAVE ANALYSIS

SINGLE FREQUENCY OR OVER A FULL OCTAVE



Complete VSWR pattern of a microwave component over an entire frequency octave is displayed on a calibrated 7" CRT.

Saves Engineering Manhours

1,000 to 15,000 mc

ELECTRONIC SWEEP GENERATOR

Model ESG 1,000-15,000 mc

Sweep width continuously adjustable, single frequency to an entire octave.

RAPID SCAN RATIO-SCOPE

Model VS-2

Displays the ratio of two input signals; gives visual plot of VSWR as a function of frequency.

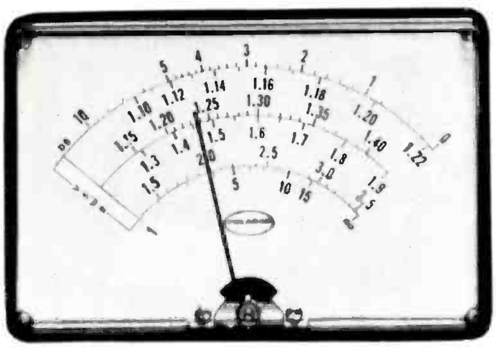
Measure and Analyze:

VSWR, transmission and reflection coefficients, gain and attenuation, image rejection, sensitivity, selectivity, bandwidth and filter characteristics, antenna patterns, etc.

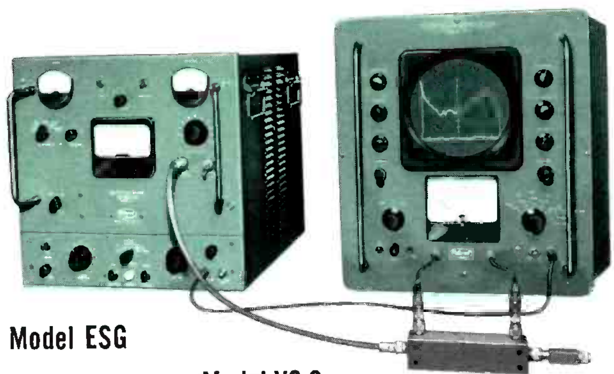
Microwave Components:

Radars, receivers, beacons, waveguides, antennas, pads, terminations, couplings and hybrid junctions, attenuators, crystal mounts, preselectors, amplifiers.

Instantaneous measurements at a single frequency or over an entire swept frequency range can be obtained with an Electronic Sweep Generator and a Rapid-Scan Ratio Scope



VSWR at any single frequency is indicated on the Ratio-Scope front panel meter.



Model ESG

Model VS-2

Typical set-up for measuring VSWR of a microwave component. Directional coupler outputs feed incident and reflected signals separately into the Ratio-Scope. Scope displays the pattern of the ratio between the two inputs over the entire frequency range swept.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 18, Long Island City 1, N.Y.

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Sarkes Tarzian Inc
East Hillside Dr Bloomington Ind
Scientific-Atlanta Inc
1262 Piedmont Rd NE Atlanta 6 Ga
Standard Electronics Div Radio Eng'g Labs
30th & Borden Sts Long Island City N Y
Stavid Eng'g Inc
U S Route 22 Plainfield N J
Stromberg-Carlson Div Gen Dynamics Corp
100 Carlson Rd Rochester 3 N Y
Sylvania Electric Products Co Electronic Systems Div
100 First Ave Waltham 54 Mass
Telectro Industries Corp
35-18 37th St Long Island City 1 N Y
Tele-Dynamics Inc
51st & Parkside Ave Phila Penna
Telerad Mfg Corp
1440 Broadway New York 18 N Y
Westinghouse Electric Co
P O Box 868 Pittsburgh Penna

TUBES & ELECTRON DEVICES

American Elite Inc
48-50 34th St Long Island City N Y
Amperex Electronic Corp
230 Duffy Ave Hicksville N Y
Applied Radiation Corp
2404 N Main St Walnut Creek Calif
Barry Electronics Corp
512 Broadway New York N Y
Bendix Aviation Corp
Red Bank Div Rt 35 Eatontown N J
Bomac Labs Inc
Salem Rd Beverly Mass
British Electronics Sales
Oakland Gardens Flushing 64 N Y
Canadian Marconi Co
2442 Trenton Ave Montreal 16 Ont Can
Cascade Research Corp
53 Victory Lane Los Gotos Calif
CBS-Electronics Corp Columbia Broadcasting System
100 Endicott St Danvers Mass
CBS-Electronics Corp
Kent & Warren Sts Newburyport Mass
Central Electronics Mfrs
2 Richwood Pl Denville N J
Continental Electric Co Taylor Tubes Inc
6 N Michigan Ave Chicago 2 Ill
Edgerton Germeshausen & Grier
160 Brookline Ave Boston 15 Mass
Eitel-McCullough Inc
301 Industrial Way San Carlos Calif
Electro-Mechanical Eng'g Co Inc
1516 S Long Beach Blvd Compton Calif
Electronic Enterprises Inc
65 7th Ave Newark N J
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Chelmsord Essex England
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Bethayres Penna
Geisler Labs
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Genalex Div British Industries Corp
80 Shore Rd Port Washington N Y
General Electric Co Power Tube Div
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General Electric Co of England Ltd
80 Shore Rd Port Washington N Y
Huggins Labs Inc
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Hughes Aircraft Co Hughes Products Group
Box 90427 Los Angeles 45 Calif
Int'l Electronics Corp
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MacKay Research Labs
R R 2 Box 401 McHenry Ill
Metropolitan Supply Co
1133 Broadway New York 10 N Y
Microwave Associates Inc
Burlington Mass
Microwave Electronics Corp
4061 Transport St Palo Alto Calif
Microwave Electronic Tube Co Inc
P O Box 272 Salem Mass
Mullard Equipment Ltd
Torrington Pl London WC 1 England
North American Philips Co Inc
100 E 42nd St New York 17 N Y
Nuclear Corp of America
2 Richwood Pl Denville N J
Polarad Electronics Corp
43-20 34th St Long Island City 1 N Y
Radio Corp of America Electron Tube Div
415 S 5th St Harrison N J
Raytheon Co Distributor Products Div
55 Chapel St Newton 58 Mass

(Continued on page 188)

1960 Microwave Directory

Raytheon Co Industrial Tube Div
55 Chapel St Newton 58 Mass
Raytheon Co
100 River St Waltham 54 Mass
Raytheon Co Microwave & Power Tube Div
Foundry Ave Waltham Mass
Resitron Labs Inc
2908 Nebraska Ave Santa Monica Calif
Sperry Gyroscope Co
Electronic Tube Div Great Neck N Y
State Labs Inc
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Box 277 Soquil Calif
Super Electronics Corp
53 Worth St New York 13 N Y
Sylvania Electric Products Inc
Special Tube Operations 500 Evelyn Ave Mt View Calif
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Emporium Penna
Sylvania Electric Products Co
E 3rd St Williamsport Penna
United Electronics Co
42 Spring St Newark N J
Vacuum Tube Products Div Hughes Aircraft Corp
2020 Short St Oceanside Calif
Varian Associates
611 Hansen Way Palo Alto Calif
Westinghouse Electric Corp
Box 284 Elmira N Y
Zenith Radio Corp
6001 Dickens Ave Chicago 39 Ill

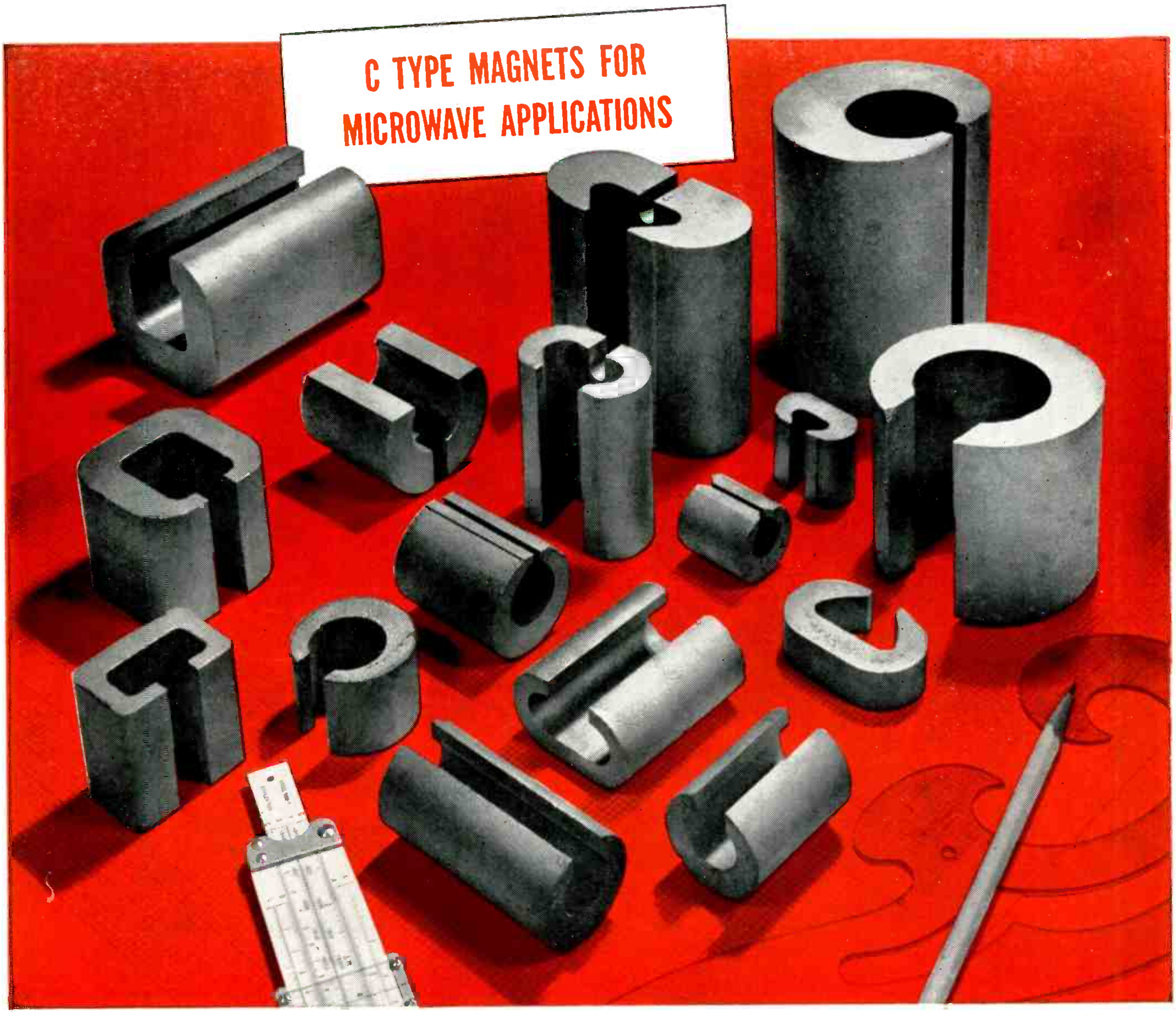
Test Relay Seals

Hermetically sealed relays are being tested automatically and nondestructively at Potter & Brumfield Div., American Machine & Foundry Co., Princeton, Indiana, with a non-toxic, inert, radioactive gas. The system, Radiflo, is built by American Electronics, Inc.

The relays are first exposed to the gas and then air washed to remove traces of the gas from the surface of the relay. A scintillation counter registers the radiation intensity indicating the number of atoms that have leaked into the hermetic seal.

CONTROLLED ATMOSPHERE

U. S. Relay-Electronics Div., A-S-R Products Corp., uses this manufacturing facility to prevent contaminants from entering their hermetically sealed relays. Provided with system of temp., humidity, and dust controls, it is designed so that air movement is always outward from the area. Pressure inside is always maintained higher than that outside. Pressure gauges and alarms are installed between each protected area, and the temp. and humidity are recorded on 24-hr. circular charts. Personnel wear lint-free Dacron uniforms.



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

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.*

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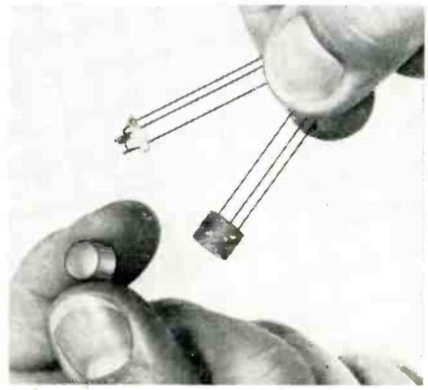
Find them FAST in the YELLOW PAGES

Circle 113 on Inquiry Card

New Products

GERMANIUM TRANSISTORS

Ten types of industrial pnp units for general purpose industrial applications such as medium frequency switching, servo amplifiers and other circuits requiring audio frequency op-

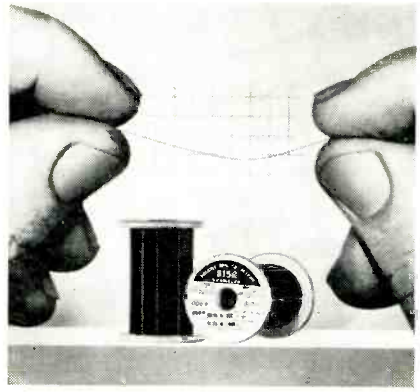


eration. All industrial types 2N1372 and 2N1381 feature 250 mw dissipation, 200 ma collector current and operation to 100°C. Types 2N1372 through 2N1379 dc betas range from 30 to 300 in closely controlled 3-to-1 beta spread categories. Available with collector-to-base voltage ratings of 12, 25, or 45 v. 6 new pnp entertainment types are also available. Texas Instruments Incorporated, P.O. Box 312, Dallas, Tex.

Circle 288 on Inquiry Card

RESISTOR MATERIAL

A low density resistor alloy has high electrical resistivity—815 ohms/-cmf at 20°C.—and a low temp. coefficient of resistance inherently controlled within limits at ±0.00001 ohm/ohm/°C. (±10ppm). Alloy 815-R is basically a modified iron-chromium-aluminum composition containing small percentages of several other



elements. Available in standard wire sizes ranging from 0.0031 in. (40 gauge) down to and including 0.0005 in. dia., bare or insulated. Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich.

Circle 289 on Inqiury Card

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 8

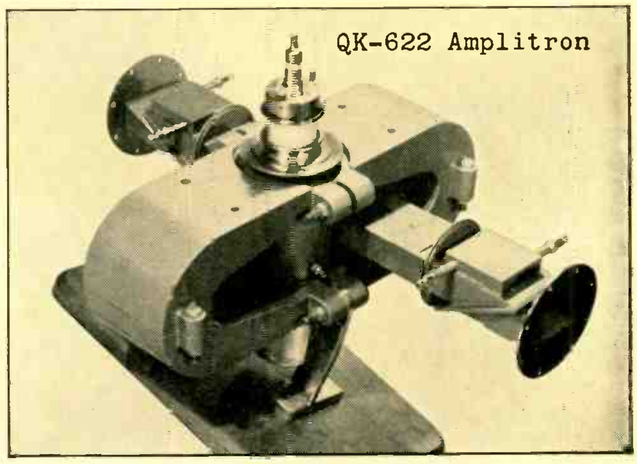
NEW RAYTHEON HEATERLESS AMPLITRONS EXCEED 1,000 HOURS AT RATED POWER OUTPUT

Two new 3-megawatt, S-band Amplitrons have demonstrated an operating life of more than 1,000 hours at rated power output. The QK-622 covers the 2,900 to 3,100 Mc band; the QK-783, the 2,700 to 2,900 Mc band. Both tubes supply full power with low phase pushing characteristics over their entire operating bands at efficiencies greater than 70%--making them unquestionably the most highly efficient microwave tubes thus far developed.

Tubes may be operated at reduced peak power levels to serve as driver stages. High efficiencies are retained at peak power of 600 Kw and gain of 10 db.

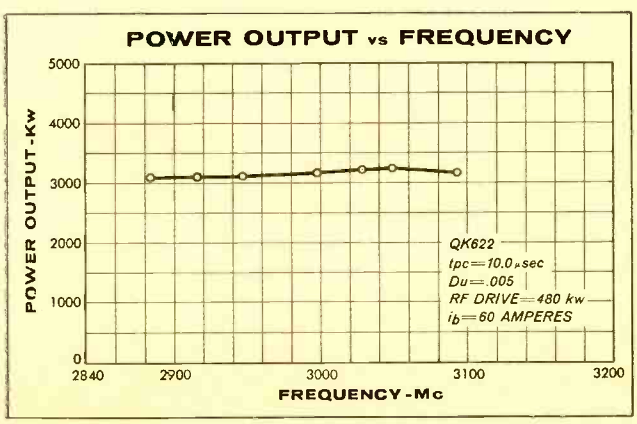
Exceptionally long tube life is made possible by the fact that no cathode warmup is required. Starting takes place whenever RF input is present prior to application of modulating pulse. Heater supplies may be omitted entirely from the equipment.

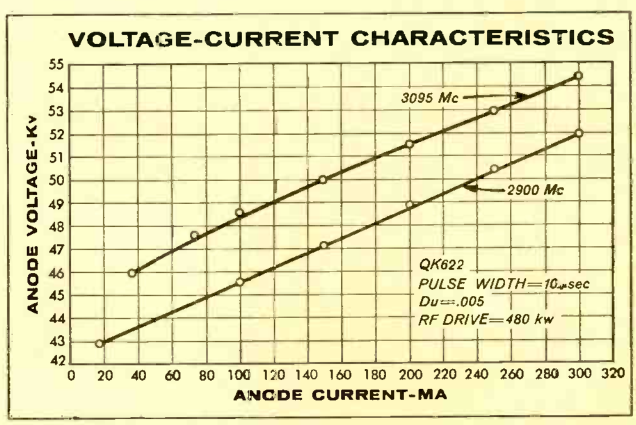
Applications include power-amplifier stages for long-range radars. The tube has been used successfully as an RF power source for linear accelerators.



Typical Operating Characteristics
(QK622 and QK783 Amplitrons)

Peak Power Output (min.)	3 Mw
Average Power Output	15 Kw
Pulse Duration	10 μ sec
Band Width	200 Mc
Duty Cycle	.005
Pulse Voltage	50-55 Kv
Peak Anode Current	65 amps
Efficiency	70%
RF Input	475 Kw
Weight (with permanent magnet)	125 lbs.





Excellence in Electronics

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts

RAYTHEON

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

Circle 84 on Inquiry Card

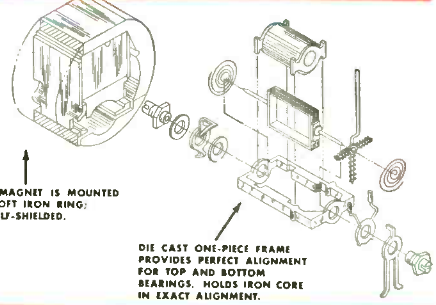
Quality... First to last

COMPLETE PANEL METER

BURTON BROWNE ADVERTISING

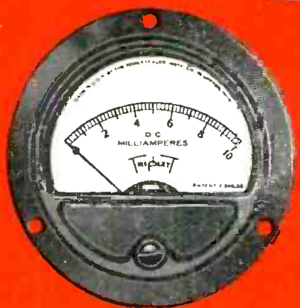
BAR-RING TYPE MOVEMENTS (Exclusively Triplett)

- Self Shielded
- Not affected by magnetic panels or substantially by stray magnetic fields.
- More Torque
- Lower Terminal Resistance
- Faster Response
- Exceedingly Rugged and Accurate
- All Case Sizes

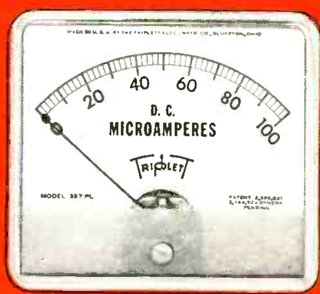


ALNICO MAGNET IS MOUNTED INSIDE SOFT IRON RING; FULLY SELF-SHIELDED.

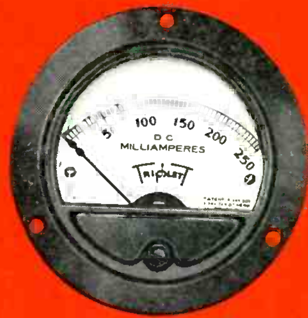
DIE CAST ONE-PIECE FRAME PROVIDES PERFECT ALIGNMENT FOR TOP AND BOTTOM BEARINGS. HOLDS IRON CORE IN EXACT ALIGNMENT.



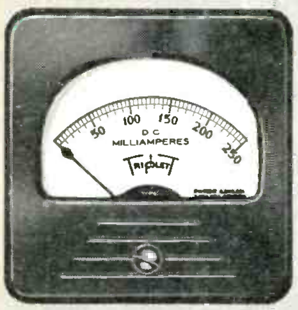
Round Flush Mounting (2½")
Model: DC 221-T, AC 231-S, RF 241-T



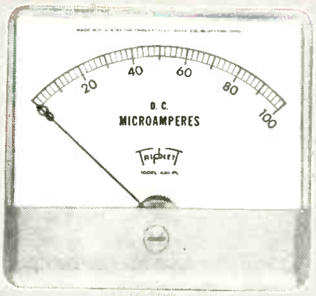
Rectangular Flush Mounting (3⅜")
Model: DC 327-PL, AC 337-PL, RF 347-PL



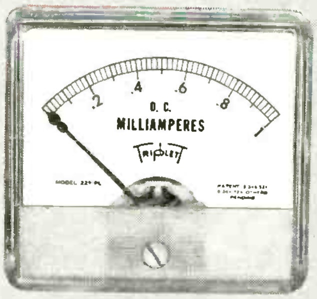
Round Flush Mounting (3½")
Model: DC 321-T, AC 331-S, RF 341-T, Dyn. 361



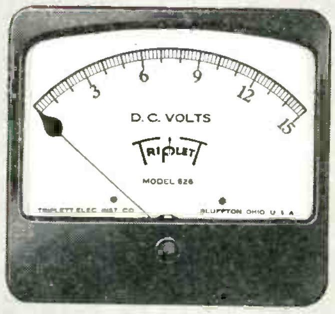
Rectangular Flush Mounting (2¾")
Model DC 227-T, AC 237-S, RF 247-T



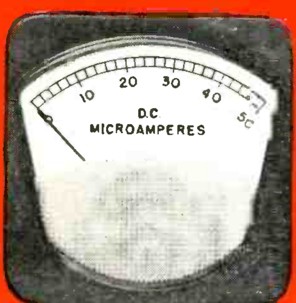
Rectangular Flush Mounting (4⅜")
Model: DC 420-PL, AC 430-PL, RF 440-PL



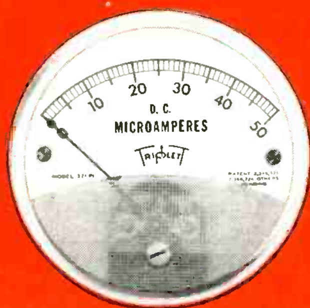
Rectangular Flush Mounting (2³⁄₃₂")
Model: DC 227-PL, AC 237-PL, RF 247-PL



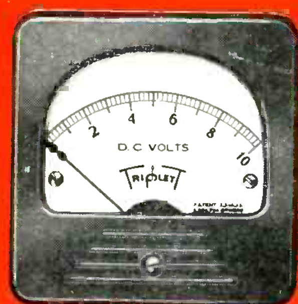
Rectangular Flush Mounting (6")
Model: DC 626, AC 636, RF 646



Ruggedized Instruments— 1½", 2½" and 3½"
In addition to the popular commercial line of panel instruments, Triplett supplies a complete line of ruggedized and sealed instruments designed to meet government specification MIL-A-10304A.

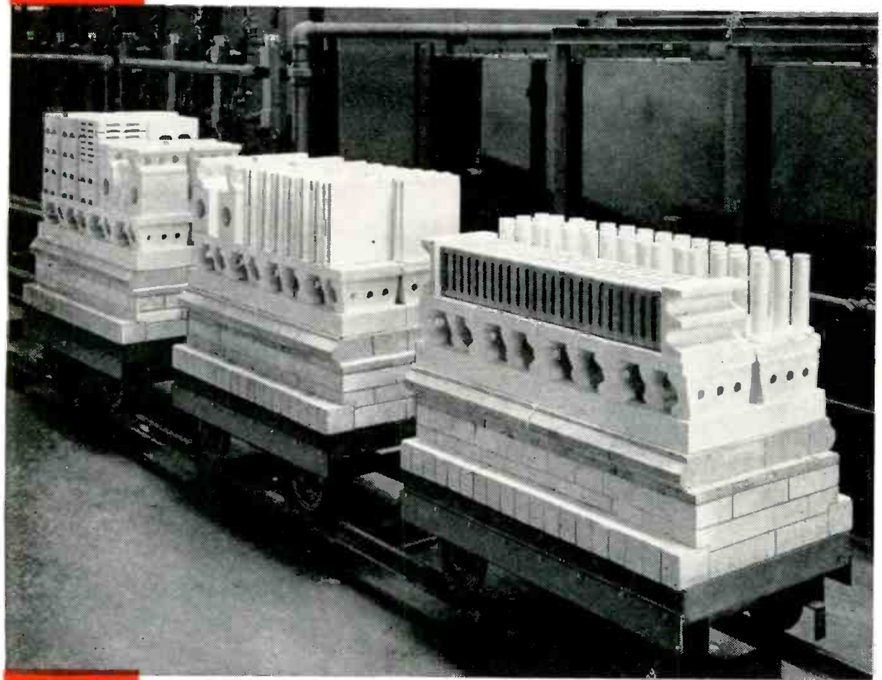


Round Flush Mounting (2¹³⁄₁₆")
Model: DC 221-PL, AC 231-PL, RF 241-PL



Rectangular Flush Mounting (3")
Model: DC 327-T, AC,337-S, RF 347-T, Dyn. 367-A

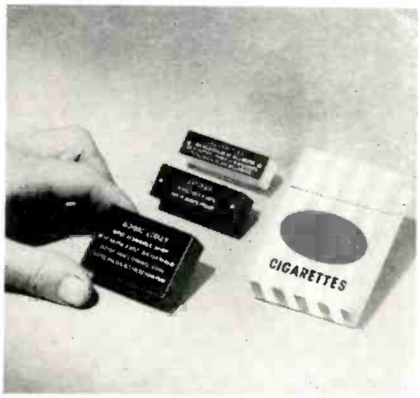
For complete details see your Electronic Parts Distributor, or write



New Products

DIGITAL DATA LOGGER

Digital data logger weight 2 oz., can continuously monitor up to 10 channels of information in a tactical telemetry system. The logger occupies 2½ cu. in. It can be used in air-to-air missiles to monitor various signals in guidance, control, fuzing, arming or other missile subsystems while the missile is being carried by the aircraft. Performance information on these signals is telemetered to the aircraft and an indication is given to the pilot should any signal go out of tolerance. Aeronca Manufacturing Corp., Middletown, Ohio.

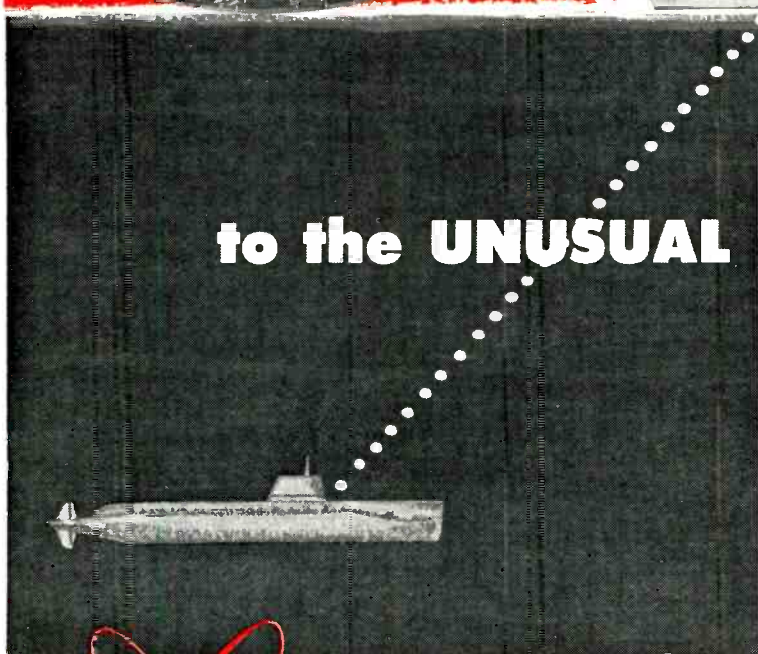


Circle 290 on Inquiry Card

BEAM POWER TUBE

Types 7270 and 7271 are high-perveance beam power tubes with high power gain. Alike except for heater ratings, they are for use in VHF power amplifiers, and as a-f power amplifiers and modulators. The 7270 has a 6.3 v., 3.1 a. heater; the 7271, a 13.5 v., 1.25 a. heater. Each has a max. plate-dissipation rating of 80 w. under ICAS conditions, and can be operated with a cw input of 315 w. up to 60 MC or with 235 w CW input at 175 MC. As linear r-f power amplifiers in SSB suppressed-carrier service, the tubes can provide a useful power output of about 135 w. Radio Corporation of America, Electron Tube Div., Harrison, New Jersey.

Circle 291 on Inquiry Card



DELAY LINES

by C-A-C

In the C-A-C line of quality toroidal components, the design and manufacture of delay lines has become a growing series of custom projects.

From simple types used in communication systems to complexities such as this design for use in sonar gear, C-A-C's design engineering in lumped constant delay lines plays a big part in developing *the component* to meet your tightest requirements.

Technical data sheets are available.

C-A-C®

COMMUNICATION ACCESSORIES CO.

Lee's Summit, Missouri • Phone Kansas City, Broadway 1-1700

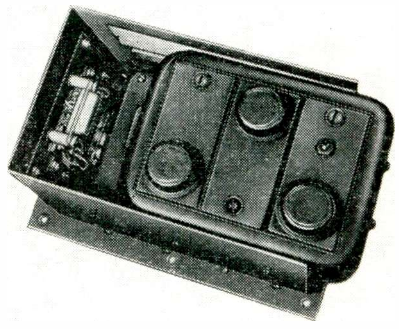
A Subsidiary of Collins Radio Company

C135

New Products

CONTROL SYSTEM

Modular control package contains no moving contacts or relays. Three input channels enable use in a control system having in input command, rate and feedback loops. Power amplifiers

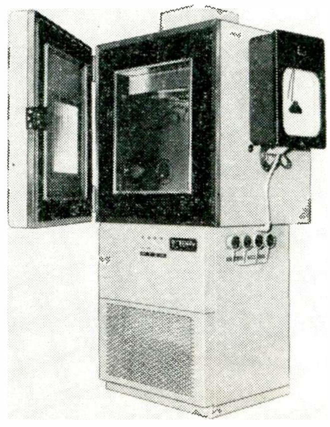


drive ac and dc servo motors ranging up to 200 w. Transistorized pre-amplifier weighs 0.64 lb., has a chassis operating temp. range of —55°C to +71°C. Gain for 1 input, 200 v/v; 2 inputs, 125 v/v; 3 inputs, 100 v/v. Power output approx. 50 mw. Power amplifier (same temp. range) gain is 11 v/v. Power output is 25 w. Airborne Accessories Corp., Hillside 5, N. J.

Circle 292 on Inquiry Card

TEST CHAMBER

Temperature environmental chamber is a 3-cubic ft., front opening upright chamber to which relatively humidity can be added. Standard features include: Temp. down to —40°, —100° or —120°F, and up to +240°F or +350°F; pull-down rate is 1 hr.



from amb. to —100°; heat-up is 70 min. from amb. to +350°; work space of 18 x 17 x 18 in.; temp. indicator controller; and a single electrical connection. Tenny Engineering Inc., Union, N. J.

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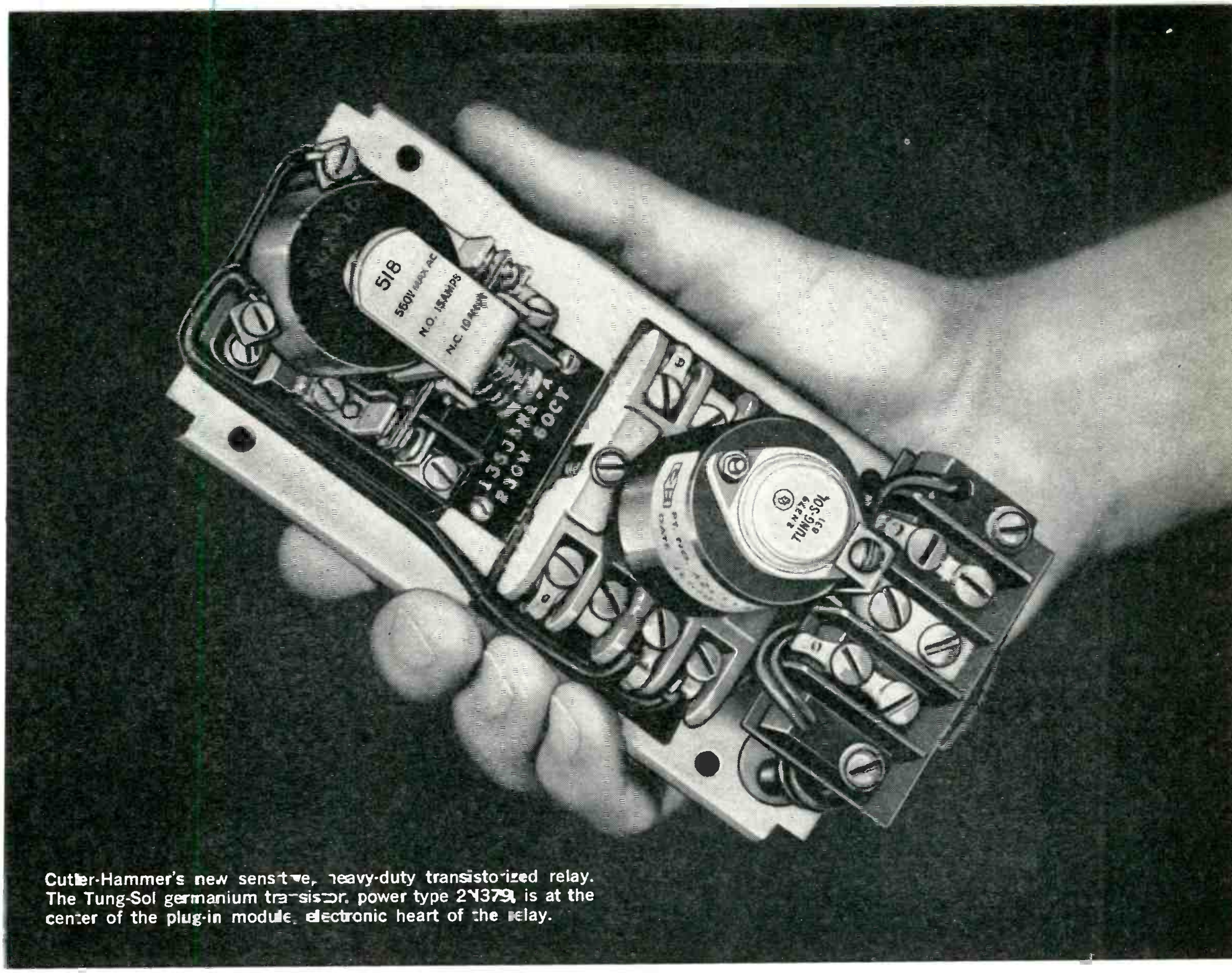

Cutler-Hammer's new sensitive, heavy-duty transistorized relay. The Tung-Sol germanium transistor, power type 2N379, is at the center of the plug-in module, electronic heart of the relay.

New versatile CUTLER-HAMMER CONTROL C-H relay relies on Tung-Sol semiconductor

Tung-Sol semiconductors furnish the combination of sensitivity and ruggedness needed for Cutler-Hammer's new transistorized relays. The Tung-Sol units react quickly and display unfaltering electrical stability. They resist shock and vibration, and stand up under the most severe industrial service.

The cold weld seal found in all Tung-Sol power and high power transistors —an exclusive development of Tung-Sol research — contributes heavily to the long-life reliability Cutler-Hammer values. Cold welding gives a true hermetic, copper-to-copper seal and eliminates heat damage, "splash" and heat-caused moisture. The special seal stays vacuum-tight, moisture-proof even through "breathing".

If you need the power-saving, space-saving features of semiconductors . . . if your circuit calls for tubes — you can be assured of premium performance when you specify Tung-Sol. Tung-Sol makes both to a single high quality standard. Our applications engineers, expert in both vacuum tube and semiconductor problems, can give you an impartial recommendation for the circuit complement that most efficiently answers your design needs. Tung-Sol Electric Inc., Newark 4, New Jersey.

TWX:NK193

ts TUNG-SOL®

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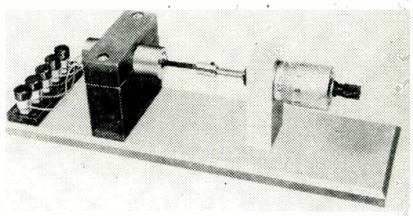
New Products

TEST STAND

Test stand, Model PMB-100-C is for precise measurements of LVDT response to linear core motion independently of installation. Base and micrometer mounting block are silver-



anodized aluminum. Mounting block and terminal strip are phenolic. There are 5 push-type binding posts mounted on the terminal strip for interconnecting the LVDT and the test circuitry. Schaevitz Engineering, Pennsauken, N. J.

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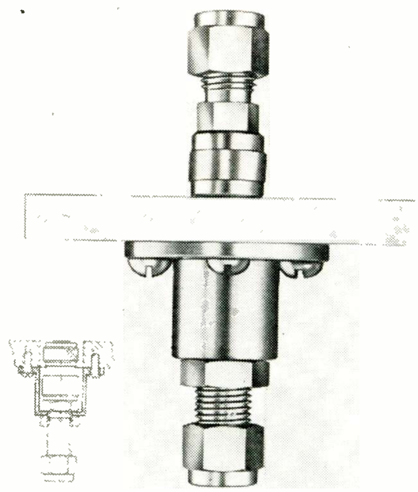
FITTING ADAPTERS

Adapter unit for flush rear-mounting of Swagelok Bulkhead Quick Connect Fittings on instrument panels permits a more uniform and attractive appearance on the front of the panel board since there will be no projecting parts of the quick-connect. Better housekeeping, and prevention of de-



facement of the panel board front also are advantages. These new Swagelok flush-mount flanges will fit ¼ and ⅜ in. Swagelok Bulkhead Quick Connect. Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio.

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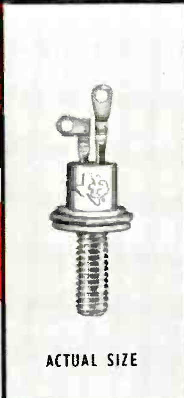
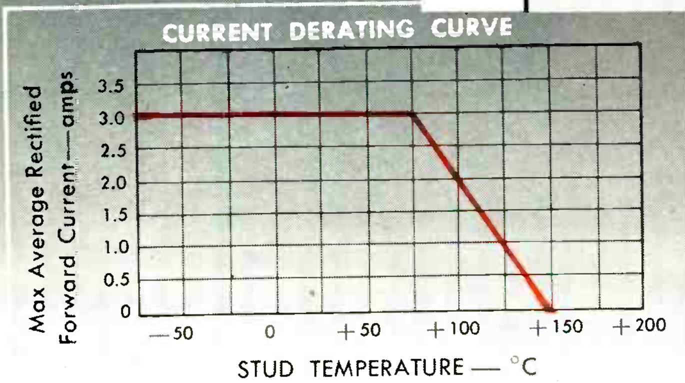
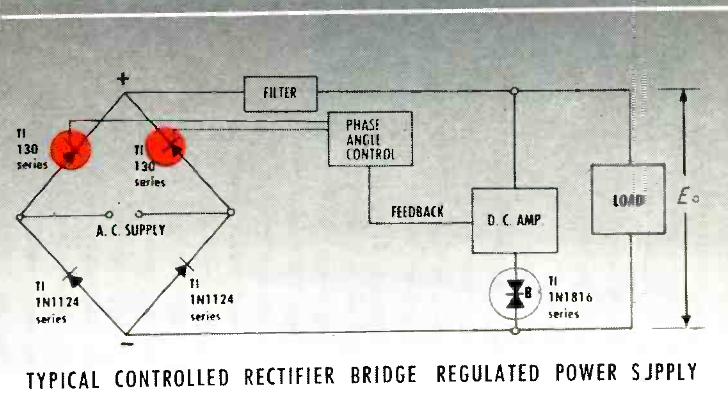
NOW FROM TI.. P N P N



DIFFUSED SILICON CONTROLLED RECTIFIERS





Switch 1-Ampere at 125°C Stud Temperature

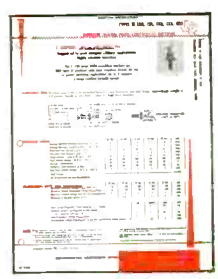
Now, the high current-high temperature capabilities and new small size of the TI 130-Series permits practical use of controlled rectifiers in such applications as relays and switches in regulated power supplies, light dimmers, servo-motor controls, reversing drives and surge voltage suppression devices.

The TI diffused silicon P-N-P-N controlled rectifier has a third lead which controls current flow. A low 5-ma current fires the device which requires only 0.6 microsecond turn-on time. You get guaranteed PIV and breakover voltage ranges from 50 to 400 volts and an average rectified forward current of 3 amperes at 75°C and *1 ampere at 125°C stud temperature.* Maximum operating temperature is 150°C!

You are assured of uniform reliability through *completely diffused silicon construction* which provides higher power dissipation and high sensitivity.

Contact your local TI representative for immediate delivery of TI P-N-P-N controlled rectifiers in production quantities!

Write for data folder containing complete parameters on Types TI 130, 131, 132, 133, 134 Diffused Silicon P-N-P-N Controlled Rectifiers.



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Tele-Tech's
ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • NOVEMBER 1959

SYSTEMS—WISE . . .

▶ **Closed circuit color TV unit at the U. S. Exhibition in Moscow was made available for on-the-spot purchase by the Soviet Union, through special export authorization, by action of Secretary of Commerce Frederick H. Mueller.**

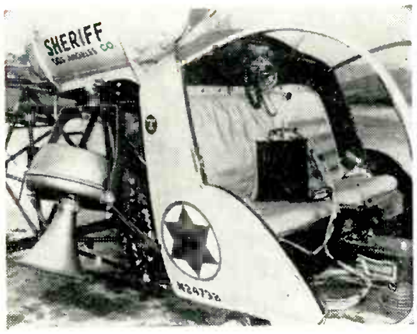
▶ Harold E. Fellows, president of the National Association of Broadcasters, says that the Federal Communications Commission must be given authority to regulate community antenna TV systems if local, live TV service is to continue to develop in smaller cities and towns. He also said that, in licensing CATV's the Commission should consider "the effect on its allocations structure and the overall public interest." CATV, he explained, "takes the heart of the market" and "deters construction of local, live broadcasting stations . . . ."

USAF COMMUNICATION CHIEFS

Discussing respective responsibilities in USAF's communication system —the world's largest—are, from left, Brig. Gen. H. E. Neal (GEEIA), Maj. Gen. C. Mitchell (ROAMA), Mr. Chas. Gordon, Maj. Gen. H. W. Grant, Dir. of Communication & Electronics, USAF, and Brig. Gen. D. P. Graul (RADC). Conversation occurred at the 5th Annual Communications Symposium, Utica, N. Y. Mr. Gordon was Chairman.

▶ Rules for Amateur, Citizens, and Disaster Services, in the new loose-leaf form, will soon be available from the Government Printing Office. Part 12, Rules covering Amateur Radio Service; Part 19, Rules covering Citizens Radio Services; and Part 20, Rules covering Disaster Communications Service, are included. Amendments for an indefinite period, costs $1.25 (domestic mailing) and $1.75 (foreign mailing).

▶ **A golden Smokey Bear statuette was awarded to the National Association of Broadcasters in recognition of outstanding public services in the field of forest fire prevention. The State Foresters Association and the Forest Service, with The Advertising Council, sponsor the Smokey Bear Forest Fire Prevention Program.**



STRONG TALK

Mounted on pilot's seat is a Bogen BT-400 amplifier which carries the human voice to an effective range of one mile or more. The 14 lb. amplifier works with equal ease from the ground, in land vehicles, in aircraft, or on ships.

▶ More efficient operation of a natural gas liquids cracking furnace is expected through use of a Recomp general purpose digital computer now being installed at a Phillips Chemical Company plant here. Recomp is a product of Autonetics, a division of North American Aviation, Inc., Downey, California, and it is tied in with a Phillips developed data scanning and conversion system.

▶ **Radio amateurs around the world have been asked by the National Academy of Sciences to record as many transmissions of the new U. S.-IGY satellite, 1959 ETA (Vanguard III), as they can.**

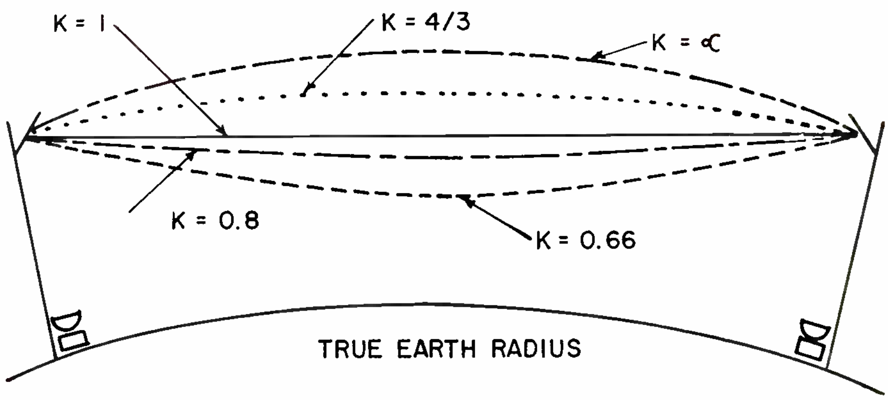
▶ The chairman of the 1959-60 AM Radio Committee of the National Association of Broadcasters is C. L. (Chet) Thomas, vice president and general manager, KXOK, St. Louis, Mo.

▶ **Six film production and distribution firms, associate members of the National Association of Broadcasters, have formed a liaison group to exchange ideas with the NAB Film Committee on common problems involving TV films. The six firms: CBS Films, Inc.; Independent Television Corp.; MGM-TV, Div. of Loew's, Inc.; Screen Gems, Inc.; California National Productions; and Ziv Television Programs, Inc.; were chosen in a poll conducted by mail among all film producers and distributors which are NAB associate members. The NAB Film Committee members are TV broadcasters whose stations are in NAB membership.**

INCREASED COVERAGE

Part of a 30-mile moving operation for Channel 11 at Green Bay, Wisc., was the erection of this 80-foot General Electric helical antenna on a 960-foot tower. The new facility serves 1½ - million viewers.

Fig. 1: Various refraction paths are shown with respect to true earth.



By JOSEPH J. SEDIK
Systems & Equipment Div.
Raytheon Co.
100 River St.
Waltham 54, Mass.

For Microwave Systems....

Determining

Strong reflections of the microwave signal can completely cancel the signals of the receiving antenna. By calculation of the reflection points for various tower heights and locations, the least harmful reflection point can generally be located.

UNDER normal atmospheric conditions the pressure, temperature, and humidity of the air decrease with height, resulting in a dielectric constant which decreases with height. The index of refraction, a quantity proportional to the square root of the dielectric constant, is normally used in calculating radio refraction in the troposphere. With so-called "standard atmosphere" refraction, the line of microwave propagation bends slightly downward and approximates a huge arc with a radius four times the earth's radius.

Refraction

The radio systems engineer normally uses a series of profile sheets to account for refraction in plotting path clearances. These profile charts use a conventional representation of refraction by assuming the radio rays to travel in straight lines while distorting the earth's surface to that of a sphere with a radius K times the true earth's radius, thus maintaining an accurate relationship between the line of propagation and the earth's surface along the path. This K used for radio profile charts is derived from the formula:

$$K = \frac{1}{1 - \frac{r_e}{\rho}}$$

where ρ = radius of curve of propagated energy and r_e = 3960 miles, true earth radius. Different charts present various refraction conditions; and these sheets are available for 4/3, true, and 2/3 earth's radius conditions.

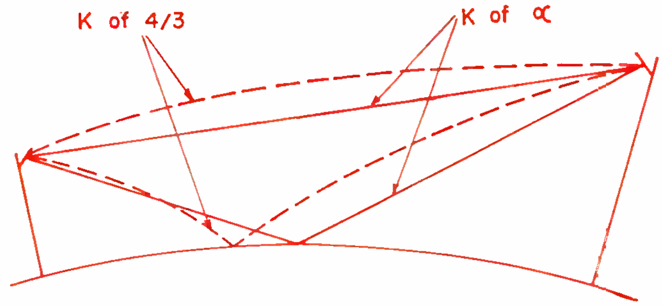
Figure 1 illustrates various values of "K" represented by different refractive conditions. We approximate normal Temperate Zone refraction by selecting a K of 4/3. This earth's radius factor is increased to indicate greater than normal bending and decreased to represent less than normal bending. A K of less than one indicates a downward bowing, the reverse of normal refraction. This latter condition is often termed "inverse bending."

Path Reflection

On most microwave links the received signal is composed of a direct space ray and an earth reflected ray. These two signals may either add to or subtract from each other, dependent upon their phase relationship at the receiving antenna. The field tests conducted by the Bell Telephone Laboratories and the American Telephone and Telegraph Company for their transcontinental radio-relay systems have indicated an average overland path reflection coefficient of 0.3. This represents a possible signal variation of 5 db due to changes of reflection phase. Thus, the reflection phenomena for overland paths, while they should be considered, will not cause deep cancellation fading.

However, if the microwave path spans an efficient reflecting surface such as a body of water or salt flats, the reflection coefficient may approach unity and cause heavy cancellation and reinforcement. The addition of the direct and reflected rays forms a vertical lobe structure in which the received signal strength varies with the height of the receiving antenna. Fig. 2 outlines a typical lobe structure pattern for a 20 mile, 7000 MC microwave link. Reflection coefficients of 0.3 and unity have been

Fig. 3: As K increases the reflection point will move closer to the center of the path.

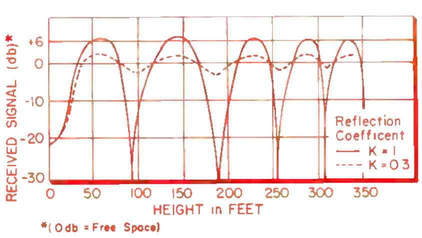


Path Reflection Points

assumed to illustrate typical overland and overwater paths.

The maximal and minimal are created by the vector addition of the direct and the reflected rays. Since the reflected signal undergoes a 180° phase shift at the reflection point, the first maximum occurs when the physical path difference between the direct and reflected ray is ½ wavelength. The first minimum occurs when the physical path difference is one wavelength (the electrical difference being $^3/_2$ wavelengths, ½ wavelength due to reflection phase shift and 1 wavelength of geometrical difference). The succeeding maximal and minimal are multiples of half wavelengths. As shown in Fig. 2, the magnitude of the maximal and minimal with relation to the free space value is dependent upon the value of the reflection coefficient.

Fig. 2: The magnitude of the maximal and minimal with relation to the free space value is dependent on the value of the reflection coefficient.



Overwater Paths

In the microwave systems engineer's analysis of overwater path profiles, it is desirable to ascertain the area of reflection causing this vertical lobe structure. It may then be possible to shift tower heights to relocate the reflection point onto a peninsula or group of islands. This rough surface will generally have a lower reflection coefficient and thus eliminate the complete cancellations and reinforcements.

If both the receiving and transmitting antennas are of equal height with respect to the reflecting surface, the reflection point lies in the geometric center of the path. However, for most cases, the reflection point will lie somewhere between the station with the lower antenna elevation and the middle of the path. For a condition of propagation in which the K is constant over the length of the path, it is possible to find the point of reflection by either a graphical solution or a plot of the cubic equation. A cubic equation chart for the solution of reflection points (K of 4/3) is given in Fig. 5 and a derivation of this formula is also provided in Section (A) of the Appendix.

Actually, the refractive characteristics of the atmosphere are constantly in motion due to continual changes of humidity, temperature and pressure. This means that the line of propagation between the two antennas is constantly varying. If the refraction becomes less than normal, the beam will follow a path closer to the earth's surface; if the refraction becomes greater than normal, the beam will follow a path farther from the earth's surface. Typical changes of this type were illustrated in Fig. 1.

It may be recognized that the specific point of reflection will move back and forth with the changes in the path of refraction. If we start at a condition of normal propagation ($K = 4/3$), as K increases the reflection point will move toward the center of the path; while if K decreases, the reflection point will move away from the center of the path toward the lower tower. This is illustrated in Fig. 3.

Under meteorological conditions, which occur quite regularly in many parts of the world, the variation of the refractive index with height may depart markedly from the standard condition. Several articles have reported field tests in which the normal range of K varied from 0.8 to 5. In a few instances the authors have measured K's as high as infinity or as low as 0.5.

(*Continued on page 208*)

CUES for Broadcasters

Reducing the Number of Preamps

F. J. HOLIK, Dir. of Eng'g. WMEX, Boston, Mass.

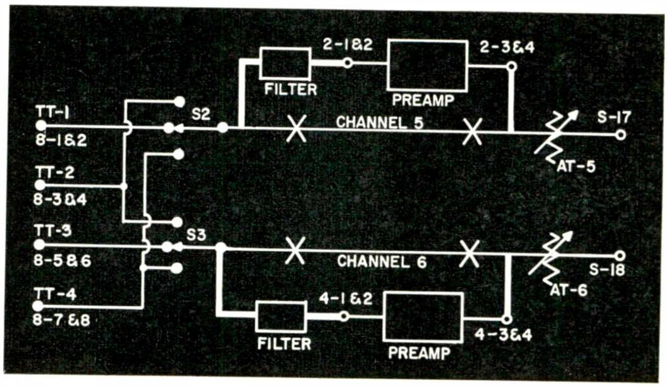
I have seen several studio installations using the Gatesway studio console. In some instances where only two turntables are employed, in order to save a preamp, the turntables were fed into a couple of the microphone channels.

In other cases the turntables are fed into the regular turntable channels (channels five and six) using two external preamps.

In the most common cases, where there are only two microphones and four turntables required, the turntables are usually fed into channels four and five, leaving two of the microphone preamps unused. This arrangement requires four preamps and four equalizers. This is actually the way the Gatesway was designed to be used.

It occurred to the writer that by connecting the two unused preamps and two equalizers between the "criss-cross" switches (designated S2 and S3 in the schematic) and channel five and six attenuators (AT5 and AT6). The four external preamps used, as well as two of the equalizers could be saved.

This arrangement is operating with gratifying results. The accompanying schematic shows internal changes required.



The wire is broken where indicated by the crosses. Heavy lines indicate added wiring.

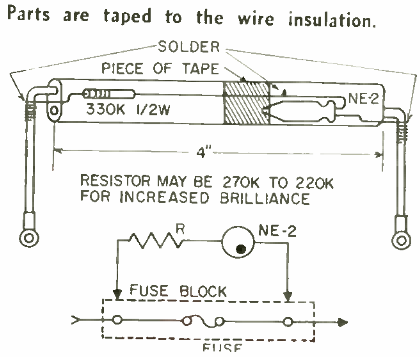
Blown Fuse Indicator

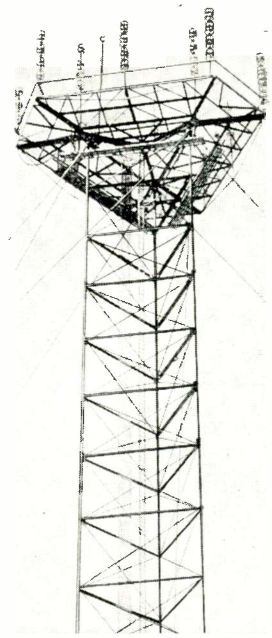
WILLIAM R. SHOOTS, Ch. Eng. KHBM, Monticello, Ark.

Electrical storms are commonplace in our area. Their nuisance value is, that, too often lightning will excite our half mile long 2400v feeder causing any one (or two) of our five 230v fuses to open up. As our DJs are college students, resulting in a moderate amount of turnover of operating personnel, excessive air time is lost in their not knowing which fuse (if it is a fuse) to change while waiting for the engineer to arrive from five to ten minutes away. The problem was solved by installing neon indicators across the cartridge fuses, which are the two 100 Amp. jobs in the main box, the two 30 Amp. line units in the transmitter (a BC-1F), and a 30 Amp. fuse in the primary circuit of the H.V. plate transformer (an "added" feature).

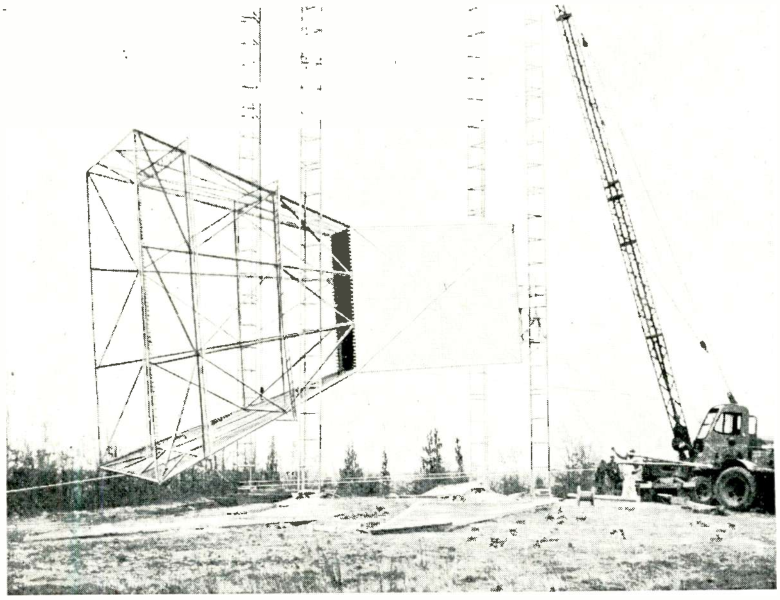
Plastic covered, underground type 12/2 feeder was used (although Romex would be satisfactory) as a pig-tail support. The assemblies are, of course, connected across the fuse blocks. The interlocks would have to be cheated to be able to see the plate fuse indicator glow (with door open). But if the other indicators are out, and there is no high voltage when in "operate," one may assume the plate fuse is open.

Parts are taped to the wire insulation.

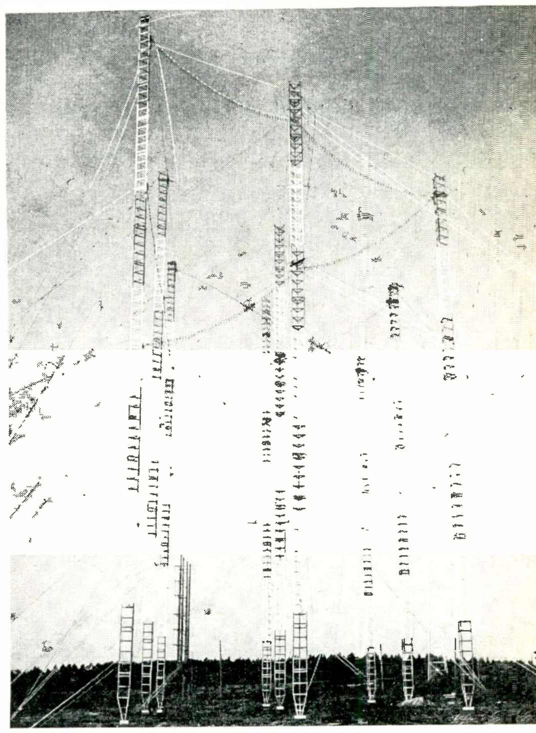




Special-design tower supporting Air Force antennas for test purposes.



Horn-type receiving antenna and support towers for signal amplification.



Towers supporting large curtain type antenna for scatter communication.

STAINLESS TOWER DESIGNS OFFER UNUSUAL VERSATILITY FOR SPECIAL APPLICATIONS

"Custom" design utilizing Stainless stock tower sections is the answer to many special tower requirements. Standard stock tower sections may be modified and adapted to special specifications at minimum cost.

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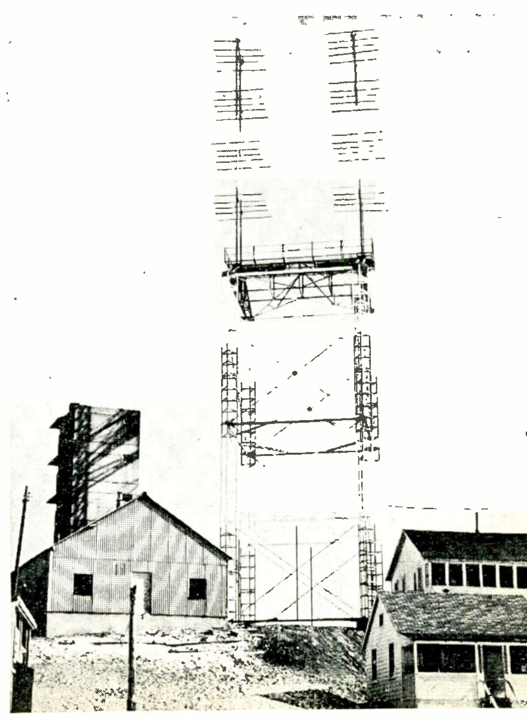
Let Stainless' Design Staff advise and assist you with your structural problems.



Special design self-supporting test structure having very rigid deflection and ice load specification.

STAINLESS, INC.
NORTH WALES • PENNSYLVANIA

Circle 115 on Inquiry Card

Reflection Points

Continued from page 205)

These abnormal atmospheric conditions can occur frequently enough on overwater paths to necessitate a prediction of the variation of the reflection point.

Point of Reflection Charts

To account for these variations, it was necessary to construct a chart which would quickly indicate the complete range of variation of the reflection point with changes in atmospheric conditions. This chart is illustrated in Fig. 8.

APPENDIX

(A) Derivation of Reflection Point on a Microwave Path (*K* of 4/3)

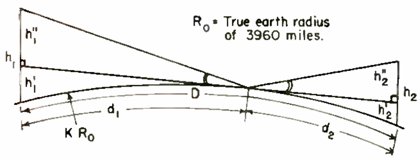


Figure 4

Let the arc and the chord be equal. Then

(1) $\frac{h_1''}{h_2'} = \frac{d_1}{d_2}$ from equality of angle of incidence and reflection

thus

(2) $\frac{h_1 - h_1'}{h_2 - h_2'} = \frac{d_1}{d_2}$

but

$h_1' = \frac{d_1^2}{2KR_o}$ $h_2' = \frac{d_2^2}{2KR_o}$ (from standard equation for horizon drop)

Thus we have

(3) $\frac{2KR_o h_1 - d_1^2}{2KR_o h_2 - d_2^2} = \frac{d_1}{d_2}$

Now $d_1 + d_2 = D$

Furthermore let

$n = \frac{d}{D}$ $X = \frac{h_1}{D^2}$ $Y = \frac{h_2}{D^2}$

Substitution in (3) gives

(4) $$\frac{2KR_o D^2 X - n^2 D^2}{2KR_o D^2 Y - (1-n)^2 D^2} = \frac{nD}{(1-n)D}$$

Cancelling D^2 and D we have

(5) $$\frac{2KR_o X - n^2}{2KR_o Y - (1-n)^2} = \frac{n}{1-n}$$

Solving for Y in terms of X gives

(6) $$Y = \frac{1-n}{n}X + \frac{2n^2 - 3n + 1}{2KR_o}$$

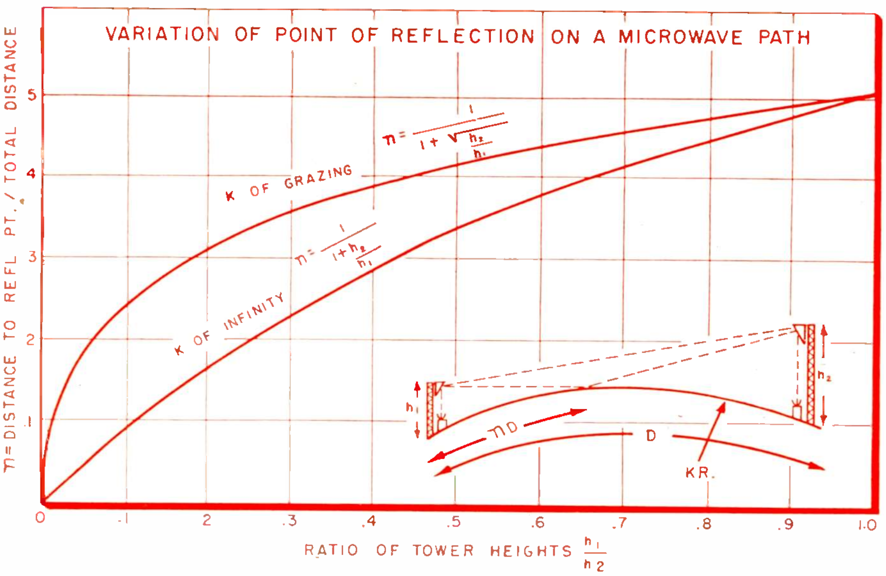
This is an equation of the straight line.

By letting n take on various values from 0 to 0.5 we may plot a family of straight lines. By computing X and Y for our given conditions we can locate a point and determine the n value associated with it. The nD gives the location of the reflection point. (When h_1 and h_2 are in feet, and D is in miles, then $2R_o$ is equal to 1.50.)

(B) Derivation of Range of Reflection Point

There are two limits in the location of the point of reflection. One may be defined by a K of infinity, which is the maximum practical bending we may expect (possibly obtained by waves trapped in a duct adjacent to the earth's surface); the second is the lower limit of K which will allow direct communication (often termed a grazing path).

Fig. 5: The solution for locating the reflection points are illustrated graphically.



K of Infinity

For a K of infinity, we may assume straight line propagation on a flat earth (caused by an infinite earth's radius).

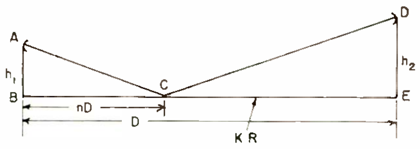


Figure 6

This case is illustrated below:

Since angles ABC and DEC are right angles, and angle ACB equals angle DCE (angle of incidence equals angle of reflection), triangle ACB is similar to triangle CDE.

From inspection

$$\frac{nD}{D} = \frac{BC}{BC + CE} = n$$

Therefore

$$n = \frac{h_1}{h' + h_2} = \frac{1}{1 + \frac{h_2}{h_1}} \qquad (1a)$$

K of Grazing

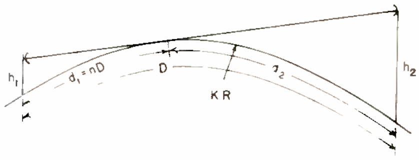


Figure 7

We may see from the above figure that, at a grazing condition, the height of each transmitter will just equal the protrusion of the earth to the radio horizon.

Thus at grazing:

$$h_1 = \frac{2/3\, d_1^2}{K} \text{ and } h_2 = \frac{2/3\, d_2^2}{K} \qquad (2a)$$

$$\frac{h_2}{h_1} = \left(\frac{d_2}{d_1}\right)^2$$

Therefore:

$$\frac{d_2}{d_1} = \sqrt{h_2/h_1}$$

Since:

$$d_1 + d_2 = D \text{ and } d_1 + \frac{d_2}{d_1} d_1 = D$$

Then

$$d_1\left(1 + \frac{d_2}{d_1}\right) = D$$

$$\text{and } d_1 = D\frac{1}{1 + d_2/d_1}$$

Since

$$d_1 = D\frac{1}{1 + \sqrt{h_2/h_1}} \text{ and } d_1 = Dn$$

Then

$$n = \frac{1}{1 + \sqrt{h_2/h_1}} \qquad (3a)$$

Data for Variation of Reflection Point Chart

h_1/h_2	n for K of ∞	n for K of Grazing	$\sqrt{h_1/h_2}$
0	0	0	0
.1	.091	.241	.3182
.2	.167	.3095	.447
.3	.2305	.354	.547
.4	.2855	.387	.632
.5	.333	.414	.707
.6	.375	.436	.774
.7	.412	.456	.837
.8	.444	.472	.894
.9	.473	.487	.948
1.0	.5	.5	1.0

Anyone for Hyphens?

In case anyone has a use for a load of hyphens, The Electric Autolite Company, Toledo, O., has an oversupply on hand, and its employees are adding to the surplus everyday through honest error.

R. H. Davies, President of The Electric Autolite Co. is presented the first hyphen dropped from corporate name. New symbol is also shown.

You see, Auto-Lite last month became Autolite. Company officials eliminated the (-) because it separated two words, thus inferring that Autolite made autos and light bulbs. It makes neither . . . but it does make over 400 other items for cars, trucks, tractors, planes and boats, and it is now moving strongly into electronics.

Though the name change is rather simple it is creating a major dilemma to the thousands of employees who write, type or print the name each day. Sheer habit keeps the (-) in and the (-) should be out. See the problem?

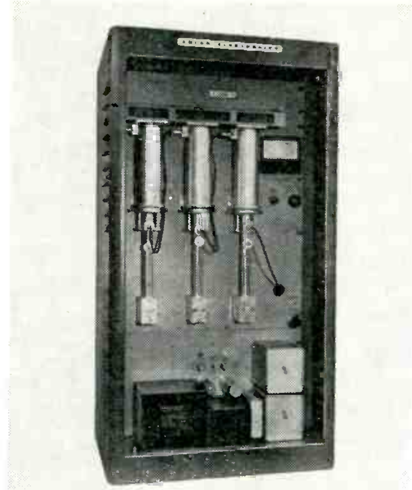
Air Flow System

Tinsley Labs., Inc., has been awarded a contract by Lockheed Aircraft Corp. for a Schlieren air flow visualization system for Lockheed's supersonic wind tunnel near Saugus, Calif. The installation will be mobile, mounted on tracks and designed to roll in the direction of the tunnel. It will perform with several cameras simultaneously.

New Products

TV REPEATER

The RT-3, 2 KMC Heterodyne Repeater for TV microwave system feature: Heterodyne techniques for reliability and economy; no demodulation for no appreciable picture and

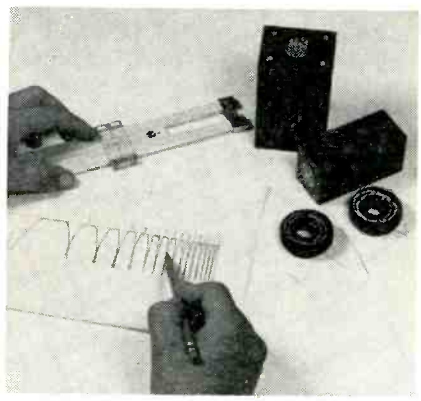


sound degradation through a multi-hop system; crystal-controlled frequency stability of 0.002%; superior propagation characteristics in 2 KMC range; handles color; unattended operation; uses low cost tubes; and built-in metering. Adler Electronics Inc., 1 Le Fevre Lane, New Rochelle, N. Y.

Circle 271 on Inquiry Card

FILTER

A series of comb filters offers 75% utilization of the available passband, increasing channel utilization by 25%. Units available include: 16-parallel element filters for operation in the audio range of 100-3000 CPS; the units can be adapted for any frequency range, including microwave. Designed for the audio range of 100-3000 CPS, they have a 180 CPS interval between



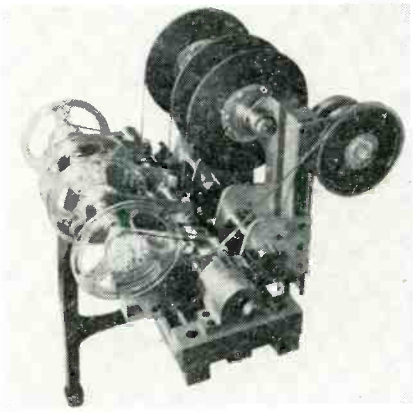
each of the center frequencies—the center frequency for the first filter element starting at 200 CPS. Rixon Electronics, Inc., 2414 Reedie Dr., Silver Spring, Md.

Circle 272 on Inquiry Card

New Products

DUPLICATOR

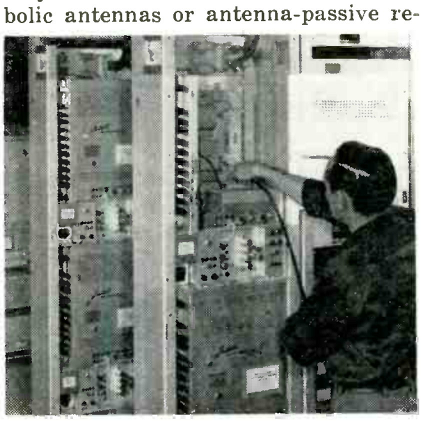
Tape duplicator produces 150 copies in an 8-hr. day. Using the common, horizontal mandrel principle, it makes 3 high-speed duplicate copies simultaneously. The standard unit can be loaded with up to 3600 ft. of tape. Any RETMA standard reels can be used on the takeup side. Operating at 30 ips, Model 10 can duplicate a 1200-ft. tape in 7½ min. Frequency response is 50 to 10,000 CPS with a signal to noise ratio within 2db of a magnetic tape recording system's theoretical limit. Magnetic Recording Industries, 126 Fifth Ave., New York, N. Y.



Circle 273 on Inquiry Card

TRANSMITTER/RECEIVER

Type 74A microwave equipment provides broad-band radio transmission facilities in the 6000 MC region. Basic transmitter/receiver accepts up to 240 voice channels from telephone carrier equipment. Provision is made for simultaneous operation of up to 4 transmitters and receivers over a single antenna. Antenna systems may include either elevated parabolic antennas or antenna-passive reflector combinations. A system (up to 3 operating r-f channels with one standby on a common antenna) can accommodate as many as 720 voice channels. Lenkurt Electric Co., Inc., San Carlos, Calif.

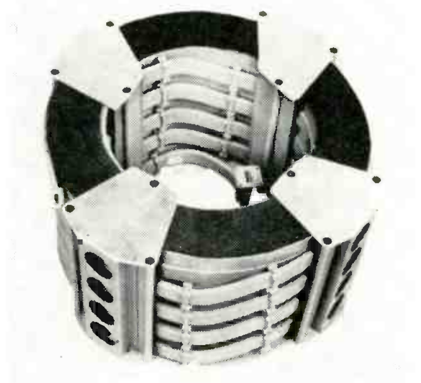


Circle 274 on Inquiry Card

New Products

DELAY LINES

Cylindrical assemblies of Spiral Waveguide Delay Lines feature input VSWR measurements less than 1.20 at any X-band frequency. Insertion loss is less than 0.1 db/ft of length.

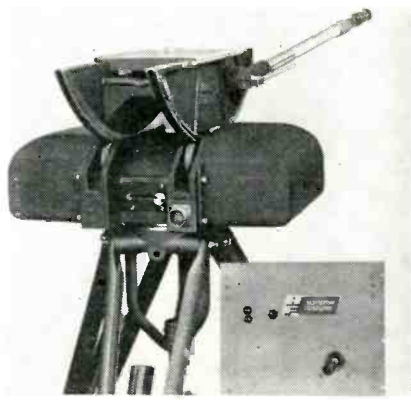


It is constructed from 1.000 in. x 0.300 in. O.D. aluminum waveguide with grazed flanges. Power handling capabilities are near the theoretical maximum for the uncoiled waveguide. A typical 1000 ft assembly occupies a dia. of 2 ft. and is 15 in. high. Turbo Machine Company, Lansdale, Penna.

Circle 275 on Inquiry Card

TV CAMERA CRADLE HEAD

Remote Control Cradle Head is powered by 2 motors which tilt the camera 30° up and 38° down and rotate 370°. They are housed in soundproof housings for silent operation. Manual operation is also possible. Movement is controlled by a "joy stick." Both actions can be performed simultaneously. Speed is governed by distance joy stick is moved from vertical. Head will accommodate monochrome TV studio cameras and Vidi-



con color cameras and mounts on standard tripods, pedestals, dollies or hi-hats. Houston Fearless Corp., 11813 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 276 on Inquiry Card

AUTOLITE® OFFERS ONE-STOP SERVICE WITH THE COMPLETE LEAD WIRE LINE

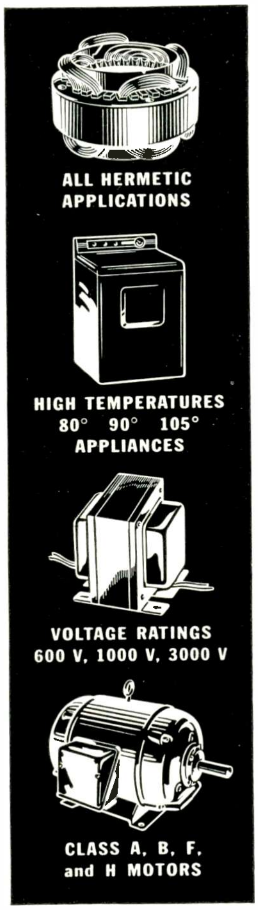
SILICONE RUBBER

Silicones operate successfully where natural rubber and plastics break down. Available in many formulations and sizes.

PVC FILMS

(polyvinyl chloride)

Uniform quality plastic insulation for temperatures from —65° C to 105°C. Offered in many formulations.



ACRYLIC TAPES

Autolite acrylic-coated glass tape insulation offers added protection under severe conditions. Unaffected by common refrigerants and most solvents.

TEFLON* FILMS

For continuous operation from –65°C to 200°C. Available extruded or taped in a choice of colors.

**DuPont registered trademark*

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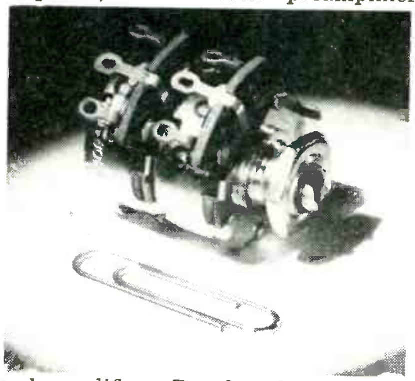
Circle 120 on Inquiry Card

New Products

STEREO BALANCE CONTROLS

Type AD47 dual controls are tandem-mounted pairs of the Series 47, 15/16 in. dia. ½ w carbon controls for insertion on the input side of an amplifier, or between preamplifier



and amplifier. Panel and rear units have the same resistance value and taper. Balance is achieved by increasing the resistance of one unit while decreasing the other, in exact proportion, at the turn of a knob. Also may be used for volume control tracking in dual-channel sound systems with complete isolation between the 2 sound channels. Clarostat Mfg. Co., Inc., Dover, New Hampshire.

Circle 277 on Inquiry Card

SHARP-CUTOFF TETRODE

High-frequency, sharp-cutoff tetrode tube, Type 6EV5, is for use as the r-f amplifier in VHF TV tuners. High transconductance and high input impedance at 200 MC make it suited for

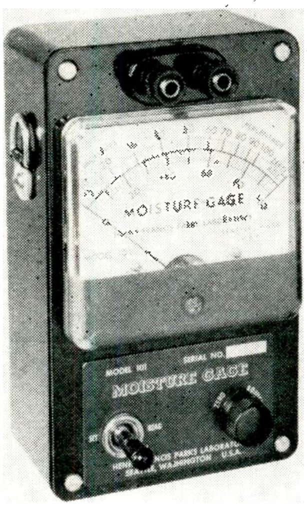
use in i-f amplifiers and other VHF applications. The 6EV5 has a noise figure 1.3 db below that of the 6CY5. Under typical operating conditions—plate voltage of 250 vdc and screen voltage of 80 vdc—the new tube has the high transconductance value of 8800 μmhos for a plate current of 11.5 ma and a screen current of 0.9 ma. Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.

Circle 278 on Inquiry Card

New Products

MOISTURE GAGE

Model 101 moisture gage is a direct-reading, moisture percentage meter for granular materials. Featured are: printed circuit wiring; accuracy of ±2% at 70°F. amb., for dc resistance

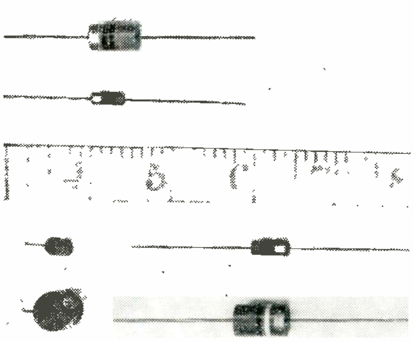


ranges between 0 and 85,000 ohms and for which it has been calibrated; long battery life (max. drain is 100 millionths of an amp.) and portability. Henry Francis Parks Laboratory, P. O. Box 1665, Lake City Station, Seattle 55, Wash.

Circle 279 on Inquiry Card

CHOKE COILS

Miniature series of molded choke coils, the "Ring Ding," exhibits high Q, and very low distributed capacity. Current ratings are approx. 100-150 ma., and Standard series values are available up to 10,000 μh. Each coil



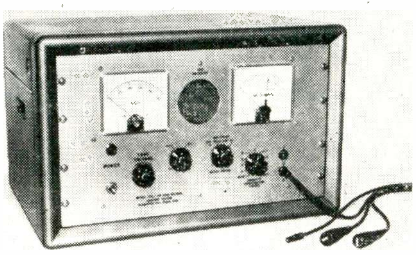
is hermetically sealed through molded incapsulation. No ferrite materials are used, thus assuring greater stability at max. operating temp. of 125°C. Delevan Electronics Corp., 77 Olean Rd., E. Aurora, N. Y.

Circle 280 on Inquiry Card

New Products

INSULATION TESTER

The Model 103/105 tester is a universal multi-range instrument for laboratory analysis and production checking of insulation characteristics under either ac or dc test conditions. Ac tests provide data for a complete analysis of the insulation—total leakage, resistive leakage, ac resistance, power factor, inherent capacity, and breakdown strength. When used for dc testing, insulation resistance in megohms may be checked at any test voltage within the range of the instrument. Slaughter Co., Piqua, Ohio.

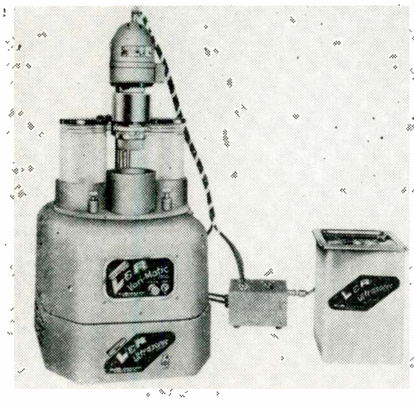


Circle 281 on Inquiry Card

New Products

ULTRASONIC CLEANER

Vari-Matic, an ultrasonic cleaning unit, cleans, rinses and dries pellets, wafers and headers automatically with no manual handling. Featured are: precise control of the timing



cycles; full-time activation of the cleaning solution and both rinses; automatic cut-off when removed from solution; all necessary spin-off and drying; safe low frequency range; 110 v. ac. L & R Manufacturing Co., 577 Elm St., Kearny (Arlington), N. J.

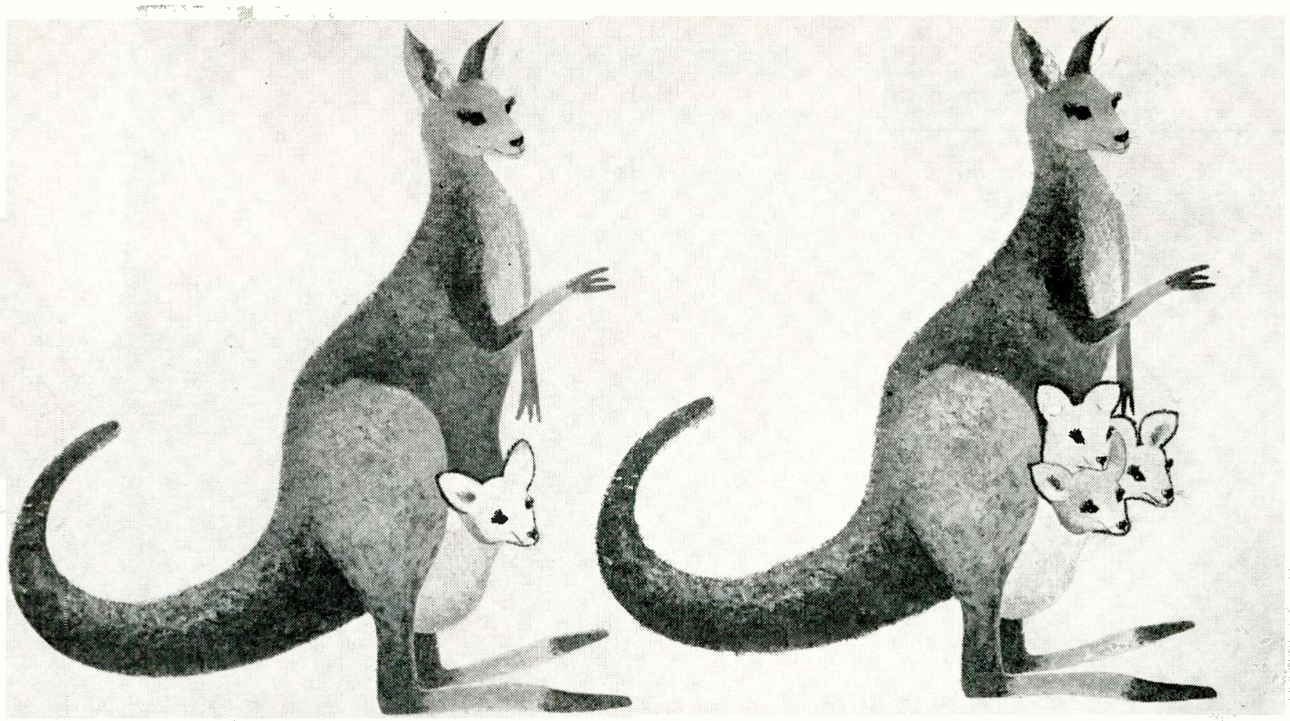
Circle 297 on Inquiry Card

SILICON RECTIFIERS

Series of plug-in silicon rectifiers are designed to match the electrical ratings of many standard vacuum tube rectifiers. Seven types cover current ratings from 85 to 600 ma and

PIV ratings from 1500 to 2800 volts. Within this series are exact electrical and base connection equivalents for such tube types as the 6X4, 12X4, 5AW4, 5U4, 5R4, 6AX5, 6X5, 0Z4, 5X4, 5Z3, 80, 82, 83, 84/6Z4, as well as many other standard tubes. International Rectifier Corporation, 1521 E. Grand Avenue, El Segundo, California.

Circle 296 on Inquiry Card



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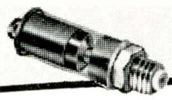

actual size

MAX-C*

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Now you can have *triple* the range previously attainable in a miniature trimmer capacitor — at *no* sacrifice in volume — with new MAX-C Sealcaps.

Imagine the possibilities in your circuitry!

This new series incorporates revolutionary new advances in trimmer production which combines the advantages of a thin dielectric gap with the structural strength and ruggedness of a heavy wall glass tube. The result is a broad capacitance tuning range at a *300 per cent* saving in volume over other presently available piston trimmer caps.

Also, MAX-C Sealcaps feature a new sealed interior construction that locks out all atmospheric effects, locks in stable performance under critical extremes of altitude, vibration, shock, temperature and other rigorous environmental conditions.

These new trimmers along with the complete JFD line of miniature and subminiature trimmers, and LC tuners offer you new dimensions in design. For complete data, write today for bulletin #221.

MINIATURE PANEL MOUNT MAX-C SEALCAP SERIES

Model	Min.	Max. (pf)	DISTANCE BEYOND PANEL	MAXIMUM DIAMETER
MC601	1.0	14.0	29/64"	5/16"
MC603	1.0	28.0	11/16"	5/16"
MC604	1.0	42.0	29/32"	5/16"
MC606	1.0	60.0	1 5/32"	5/16"
MC609	1.0	90.0	1 3/4"	5/16"

Also available in printed circuit lug and lead, and 4 wire lead type.

JFD

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ELECTRONICS CORPORATION

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CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

22 Acoustica Associates, Inc. — Ultrasonic cleaning equipment
37 Advance Relays, Elgin National Watch Co.—Relays
104 Aerovox Corporation—Tubular capacitor
324 Airtec, Inc.
138 Allegheny Electronic Chemicals Co.—Silicon crystal slices
153 Allen Bradley Co.—Resistors
142 Allied Radio—Electronic supply guide
69 American Electrical Heater Co.—Soldering iron
49 American Time Products, Inc. — Frequency standards
46 AMP Incorporated — Rack and panel connectors
308 Amperex Electronic Corp.—Frame grid tubes
145 Amperite Co., Inc.—Thermostatic delay relays and ballast regulators
144 Anderson Controls, Inc.—Solenoids
100 Andrew Corporation — Parabolic antennas
35 Armco Steel Corporation — Electrical steels and magnetic alloys
113 Arnold Engineering Company, The — ALNICO C-type magnets
63 Astron Corporation—Subminiature electrolytic capacitors
322 Avion Division ACF Industries, Inc.—S-band microwave components
126 Avion Division ACF Industries, Inc.—C-band microwave components
336 Bead Chain Mfg. Co., The—Bead chain drives, terminals & contacts
70 Beckman/Berkeley Division—Microwave frequency counter
42 Belden Manufacturing Co. — Wires, cables, cords
325 Biwax Corp.—Potting compounds

85 Bogart Manufacturing Corp.—Antenna coupler, performance monitor
64 Borg Equip. Div., Amphenol-Borg Electronics Corp.—Frequency standards
15 Bourns, Inc.—Trimming potentiometers, quality control
121 Bruno-New York Industries Corp. — "Pig-tailoring" machine
52 Brush Instruments Div. of Clevite Corp. —Direct writing recording systems
55 Burnell & Co., Inc.—Telemetering band pass filter
31 Bussman Mfg. Div., McGraw-Edison Co. —Fuses and fuseholders
105 Cannon Electric Co.—Plugs
89 Cascade Research Div.—Microwave ferrite components
78 CBS Electronics—Electron tubes
53 Cinch Manufacturing Company—Printed circuit connector
20 Circo Ultrasonic Corp. — Ultrasonic cleaning units
25 Cleveland Container Co., The—Phenolic tubing
50 Clevite Transistor Products Div. of Clevite Corp.—Silicon junction diodes
56 Clifton Precision Products Co., Inc.—Rotary components
9 Collins Radio Company—Microwave and carrier systems
109 Communication Accessories Co. — Delay lines
16 Conrac, Inc.—TV monitors
306 Cratex Manufacturing Co., Inc.—Tool & die makers kit
17 Curtiss-Wright Corp. — Digital motors, delay lines & time delay relays
303 Custom Components, Inc.—Ferrites
160 Dakota Engineering Co., Inc. — Cable clamps and straps

136 Davies Molding Company, Harry—Standard plastic parts
98 DeJUR - Amsco Corporation, Electronic Sales Division—sine-cosine potentiometers
48 Dale Products, Inc.—Precision resistors
130 Delco Radio Division of General Motors —Power transistors
334 Dimco-Gray Company — Snapslide fasteners
81 Eitel-McCullough, Inc. — Amplifier klystrons
315 Elastic Stop Nut Corporation of America, AGA Division—Time delay relays
58 Elco Corporation — Positive lock connector
120 Electric Autolite Co., The — Wire & Cable
51 Electro Engineering Works—High power transformers
329 Electro-Impulse Labs., Inc.—
322 Electronic Instruments Co. EICO—Electronics catalog
108 Engineered Ceramics Manufacturing Company—Ceramic materials
77 ESI—Voltage dividers
24 Fairchild Semiconductor Corporation—Silicon mesa transistors
151 Film Capacitors, Inc.—Precision capacitors
36 Formica Corporation, subsidiary of American Cyanamid—Laminated plastic fabricated parts
326 Freed Transformer Co., Inc.—Miniature pulse transformers
32 Fusite Corporation, The—Glass-to-steel Hermetic terminal
82 FXR, Inc.—Microwave test equipment and waveguide components
335 Gamewell Company, The — Multi-turn potentiometer
12 GB Electronics Corporation Subsidiary of General Bronze Corp. — Antenna systems
159 General Electric, Defense Electronics Div.—Ceramics & ferrites
90 General Electric, Semiconductor Products Dept.—Transistor manual
57 General Instrument Corporation, Semiconductor Division—High power silicon rectifiers
119 General Products Corporation—Military terminal boards
67 General Transistor Corporation — Precision wirewound resistors
68 Gertsch Products, Inc.—Ratio bridge
140 Graphic Systems—Visual control board
62 Gulton Industries, Inc. — Rechargeable sealed nickel cadmium button cell battery
2 G-V Controls Inc.—Thermal timing relays
21 Hi-Q Division, Aerovox Corporation—Ceramic power and transmitting capacitors
137 Hoffman & Co., Inc., H. L. (E.M.I.)—Oscilloscopes
332 Houston Fearless Corp.—Pedestals, tripod and dolly
310 Howard Industries, Inc. — Fractional H.P. gear motor
4 Hughes Aircraft Company, Hughes Products—Memory-type oscilloscope
5 Hughes Aircraft Company, Hughes Products—Direct-view storage tubes
6 Hughes Aircraft Company, Hughes Products—Specialized cathod ray tubes
8 Hughes Aircraft Company, Semiconductor Division—Silicon PNP fused alloy transistor
29 Indiana Steel Products Company, The—Permanent magnets
328 Industrial Electronic Engineers, Inc.—Rear-projection type digital display
127 ITT Industrial Products Division—Advanced ohmmeter
45 Industro Transistor Corporation—Alloy junction germanium transistors
91 Institute of Radio Engineers, The—Bio-Medical Electronics issue
79 International Electronic Research Corporation — Heat - dissipating electron tube shields
112 Jeffers Electronics Division, Speer Carbon Company—Fixed composition capacitors
128 JFD Electronics Corporation—Miniature trimmer capacitor
327 Johnson Co., E. F.—Miniature capacitors
309 Jones Division, Howard B., Cinch Mfg. Co.—Shielded type plugs & sockets
47 Jones Electronics Co., Inc., M.C., Subsidiary of Bendix Aviation Corp.—RF test equipment
318 Kay Electric Company—Attenuators
95 Kearfott Company, Inc., Microwave Division—Ferrite circulators

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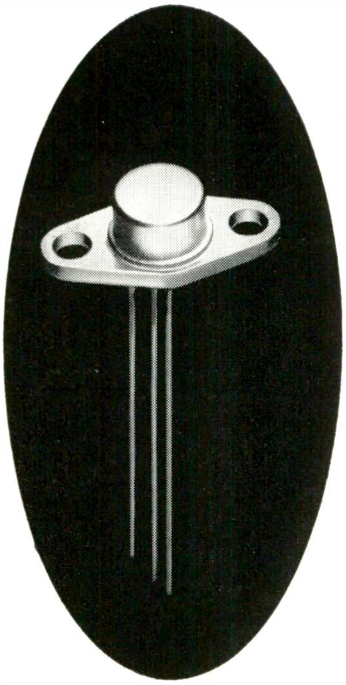

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ANTENNAS, PROPAGATION

Propagation Constant Determination in a Long Conductor, S. P. Belousov and V. G. Yampol'skii. "Radiotek," v. 14, No. 7 (1959). 5 pp. Current distribution in a conductor parallel to a boundary of two media has been dealt with by many authors and approximate formulas for the propagation constant obtained. More accurate formulas unsuitable for engineering purposes were later developed. This article suggests an approximate simple method of calculation based on the accurate formula and involving integration by means of consecutive approximations. For ease of calculations the approximation coefficients are given in the form of graphs. (U.S.S.R.)

Antenna Array with Rotating Polarization, A. L. Drabkin. "Radiotek," v. 14, No. 8 (1959). 5 pp. The author describes a slightly directional antenna with a rotating polarization which he designed. The array consists of horizontal and vertical dipoles with currents which bear certain phase relations to each other. The antenna field strength has in all directions a rotating polarization which approaches a circular form. The radiation pattern in any plane passing through the array axis has a cardioidal shape which provides an almost semi-spherical scanning field. (U.S.S.R.)

Dipole Radiations Over a Flat Homogeneous Ground, L. S. Tartakovskii. "Radiotek." v. 14, No. 8, (1959). 6 pp. This is a continuation of the article which appeared in "Radiotek," v. 13, No. 4 (1958). The author derives and analyzes general formulas for the field strength produced by vertical and horizontal magnetic ground level dipoles placed over a flat homogeneous ground. The field strength formulas for ground level dipoles are transformed to those for raised dipoles. (U.S.S.R.)

Application of Kotel'nikov's Theorem in the Theory of Antennas, V. P. Peresada. "Radiotek." v. 14, No. 8, (1959). 4 pp. The modern aperture method of calculating antenna radiation patterns leads to their representation by two conjugate Fourier functions similar to a pulse spectrum and its form. This provides the possibility of calculating the full radiating power of the antenna by integrating the Umov-Pointing vector along the aperture surface or along a sphere surface of an infinite radius. An expression is obtained, however, which provides the possibility of evaluating the radiation pattern by means of Kotel'nikov's theorem without the complicated and difficult integration. (U.S.S.R.)

The Height-Gain-Function of Band-IV Receiving Aerials Using Horizontal Polarization, Von Paul Thiessen. "Rundfunk." Aug. 1959. 7 pp. For the purpose of adapting field-strength measurements with low receiving aerials (for instance 3 m) to the standard height of 10 m as usually used for planning and coverage purposes a height-gain-function is required. As yet little is known concerning the variation of this height-gain-function and how it is dependent from the terrain. On the basis of measurements made on flat, hilly and mountainous terrain, it has been possible to establish a connection which makes it possible to indicate a simple relationship between the type of terrain and the height-gain-function. (Germany.)

Some Investigations on Long-Wave Propagation, S. N. Mitra. "J. ITE." June 1959. 15 pp. The paper describes some experimental observations on the propagation of long waves (164 kc./s.) from Radio Tashkent (42°N., 69°E.) to Delhi (28°35'N., 77°5'E.) over a distance of 1650 km. The amplitude of the received wave is continuously recorded at Delhi. The recordings show well defined sudden increases in amplitude (and gradual fall) coincident with solar flares. The data from 9th August to 16th December 1958 have been analyzed and 144 instances of sudden increase observed during the period. (India, in English.)

Ionospheric Irregularities and Propagation at Frequencies Above the 'Classical' M.U.F., A. K. Saha. "J. ITE." June 1959. 4 pp. Sweep frequency pulse measurements, carried out elsewhere, have shown that the maximum usable frequency via the Fl and Fa layers may be extended by an anomalous mode of propagation. The extension may be 10-15 per cent above the value calculated from classical theory and is observed only during daytime. It is absent at night. The phenomenon has been ascribed by some authors to scattering by irregularities present in the reflecting layers. (India, in English.)

Propagation of Long-Distance H.F. Signals, Kenichi Miya and Masahi Kawai. "E. & R. Eng." July 1959. 9 pp. Characteristics of high-frequency signals propagated between the United Kingdom and Japan are described. It has been observed that, in winter and when the frequency in use is above the classical maximum usable frequency, signals of considerable intensity can be received along paths which deviate widely from the great-circle path while, at the same time, pulse signals are too weak to be received. On the other hand (especially in seasons other than winter), both pulse and continuous signals are received at good strength from directions close to the great-circle path during periods when the signal frequency exceeds the classical m.u.f. (England.)

CIRCUITS

Stability of Double Tuned Circuit Amplifiers with Feedback through the Control Grid to Plate Capacity, A. M. Shenderovich. "Radiotek." v. 14, No. 7, (1959). 2 pp. Formulas derived for stable single tuned circuit amplifiers are applicable to double tuned circuit ampli-

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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 Electric 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 Electrotechniczne

USSR

Avto. i Tel Avtomatika i Telemakhanika
Radio. Radio
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Rad. i Elek. Radiotekhnika i Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR.

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fiers only if the circuits are critically coupled. An amplifier stage with two overcoupled tuned circuits provides a higher stable gain than with one tuned circuit. This advantage decreases with the number of stages. With one stage it is equal to 3.5 (U.S.S.R.)

Design of a Cathode-Coupled Triode dc Paraphase Stage, A. M. Imas. "Radiotek." v. 14, No. 7, (1959). 6 pp. A method of designing a paraphase stage based on calculation and tests is described. The order and method of selecting components and design formulas are given. (U.S.S.R.)

A Filter with Mutual Inductance, V. N. Bogomolov. "Radiotek." v. 14, No. 7, (1959). 2 pp. A parallel tuned LC filter in the form of a potentiometer supplied with an addition winding providing mutual inductance, increases the Q of the circuit sufficiently to make this filter preferable to an RC filter even at frequencies as low as a few tens of cycles per second. (U.S.S.R.)

A Generalized Method of Designing a Band-Pass Amplifier with Unequal Tuned-Circuit Parameters, G. A. Shevtsov and I. M. Simontov. "Radiotek." v. 14, No. 8, (1959). 3 pp. Amplifiers with two tuned coupled circuits are of interest when the frequency characteristics of the circuits are symmetrical. This occurs if their tuned frequencies or Qs are equal. It is shown in this article that contrary to previous notions it is possible to obtain parameters of these circuits by means of simple calculations when above conditions are not fulfilled. It is also shown that the formulas and graphs given in the article do not apply if the Q of one of the circuits tends to infinity, when unstable conditions of operation occur. (U.S.S.R.)

Design of a Low Frequency Tuned Amplifier with a Twin-T Feedback Network, S. V. Svechnikov and A. I. Petrenko. "Radiotek." v. 14, No. 8, (1959). 8 pp. The article provides methods of designing a highly selective low-frequency amplifier with a twin-T feedback circuit. A general case of a terminated twin-T circuit is considered when its input and output impedances are determined by the terminating impedances of the amplifier stages. Conditions for a symmetrical frequency characteristic with a maximum selectivity are obtained. Above method permits one to design with sufficient precision low frequency tuned amplifiers with a given Q and a given attenuation at frequencies outside resonance. The theoretical investigations were confirmed by experiments. (U.S.S.R.)

Stabilization of a Frequency-Band Oscillator by Means of a Time Delay Line, N. N. Nesvit. "Radiotek." v. 14, No. 8, (1959). 5 pp. This circuit dispenses with a stable reference oscillator. A series of voltages are produced with zero values at regular frequency intervals which depend on the time-delay line only. Thus with very stable time-delay lines using vitreosil elements or coaxial cable stubs in the SHF range it is possible to produce a series of reference frequencies at convenient intervals in the required range. (U.S.S.R.)

Temperature Effect on the Power Characteristics of a Transistor Oscillator, S. M. Gerasimov. "Radiotek." v. 14, No. 7, (1959). 7 pp. At high frequency oscillations the temperature remains practically constant throughout the cycle and is determined by the thermal balance. In time the latter changes with ambient temperature and conditions of operation, this changes the junction temperature and in turn the conditions of operation. On the basis of a family of static characteristics at a constant p-n junction temperature it is possible to design the required automatic stabilizing circuit. Tests were made with alloyed-junction transistors, but it was found that the conclusion also apply to diffused-junction transistors. (U.S.S.R.)

Peculiarities of Transients in Tuned Circuits when the Phase of Oscillations or the Circuit Parameters are Keyed, A. S. Vinitskii and P. I. Ebdokimov. "Radiotek." v. 14, No. 7, (1959). 10 pp. In previous papers transients due to phase keying were only briefly analyzed and those due to keying circuit parameters were not examined at all. Theoretical analysis showed that in phase keying the transient amplitude has a smooth dip in it which increased with the phase difference and the transient phase, expressed in terms of frequency, jumps up and then decreases exponentially. When the circuit inductance is keyed both the transient amplitude and frequency pass through a maximum and minimum at large changes of inductance. For smaller changes the amplitude rises and falls smoothly and the frequency jumps up and then decreases approximately exponentially. Thus for small changes in phase or circuit parameters, transients due to keying are similar in character. The analysis was confirmed experimentally. (U.S.S.R.)

Control of Induction Motor Speed Corresponding to Valve-Contact Cascade Circuit, I. B. Semjonov, V. Z. Yarina. "Avto. i Tel." Aug. 1959. 8 pp. The paper deals with using the valve-contact cascade circuit to control the speed of the induction motor with phase rotor. The main ratios and the comparison with the circuit of the mercury rectifier valve cascade are given. The crystal diode together with the serial synchronous operating contact is shown to be a controlled valve from the viewpoint of its operation. (US.S.R.)

Generalization of the Method of Shaping Filter on Nonstationary Random Processes, A. M. Batkov. "Avto. i Tel." Aug. 1959. 14 pp. There are considered main properties both of the impulsive transient responses of the general type variable linear systems and of the correlation functions of the output random processes with the white noise at the input. The problem of determining the characteristics of the shaping filter for this class of nonstationary processes is solved. There is suggested the way of using the characteristics determined while simulating the problems of analysis of the dynamic accuracy of the system. (U.S.S.R.)

A Bootstrap Integrator, F. K. Altenhein. "rt." July 1959. 6 pp. Amplifiers are used in electronic analogue computers and kindred calculating devices for establishing exact mathematical relationships. Whereas Miller arrangements (e.g. the Miller Integrator) require high degrel dc amplifiers, the Bootstrap instruments (e.g. the Bootstrap Integrator) are based upon amplifiers having a gain approximately equal to unity. A new amplifier for Bootstrap Integrators is distinguished by its superior linearity. (Germany.)

Oscillators and their Conditions of Oscillation, W. Herzog. "Nach. Z." Aug. 1959. 10 pp. High-Q oscillator circuits with balanced and unbalanced quadripoles are described in which the amplitude conditions are independent from the quadripole determining the frequency. The Q value is calculated. An example of a design is given. (Germany.)

Application of Boolean Algebra to the Design of Switching Circuits, A. K. Choudhury. "J. ITE." June 1959. 6 pp. Application of Boolean algebra to the logical design of switching circuits is discussed. It is pointed out that for the design of a circuit requiring the minimum number of elements the Boolean function must be minimized by either an algebraic or a graphical method. A graphical method developed at the Institute of Mathematical Machines, Czechoslovakia, for minimizing a Boolean function is described. (India in English.)

The Design of Thyratron Stabilized DC Supplies, B. G. Higdon & M. E. Bond. "El. Eng." Aug. 1959. 5 pp. For stabilized h.t. supplies at currents greater than about 0.5 adc the grid controlled gas-filled rectifier is, in general, preferable to the series vacuum valve types of stabilizer. In this article the design of the thyratron type stabilizer and a more complex unit incorporating an amplifier in the feedback loop are discussed and performance details are given. (England.)

Concertina Phase-Splitter—1. "E. & R. Eng." July 1959. 4 pp. The Concertina phase-splitter has been widely used for 25 years or so for feeding push-pull amplifiers from unbalanced sources. It also has application in phase-shifting circuits. (England.)

A Voltage Operated Logarithmic Amplifier, R. F. Mathams. "El. Eng." Aug. 1959. 3 pp. A circuit is described which accepts an input from a voltage source and produces an output proportional to the logarithm of the input voltage over a range of inputs from 0.1 v. to 100 v. or more. The input voltage is chopped by a vibrating relay and differentiated. The time taken for the resulting exponential pulses to decay to a reference voltage is proportional to the logarithm of the input voltage. (England.)

The Theory of Broadband Coupled Circuits, W. Dougharty. "El. Eng." Aug. 1959. 7 pp. This article gives the exact transfer admittance formulae for various types of parallel-tuned coupled circuits. No approximations are made and there is no limitation as to bandwidth. From these formulae are derived expressions for such characteristics as the peak separation, peak-to-valley ratio, etc., which are sufficiently accurate for bandwidths approaching the value of the center frequency. Formulae for the phase response are also given for various types of coupling. (England.)

A Multi-Range, Low Frequency Band-Pass Filter, J. B. Bratt. "El. Eng." Aug. 1959. 5 pp. The band-pass filter described was developed as part of an amplitude control circuit used with apparatus designed for research in the field of unsteady aerodynamics. A frequency range from 16 c/s to 175 c/s is covered in 9 bands, the ratio of the upper to the lower frequency of each pass-band being 1:38. The basis of the filter circuit is the frequency selective R-C valve amplifier modified to give zero output at frequencies of O and ∞. With such amplifiers in cascade the response in the pass-band is flat within $\pm 0.5\%$, and attenuation of the 3rd harmonic of the lower frequency limit is 33 times. The use of a special feedback network in the amplifiers enables a change of pass-band to be made by switching two capacitors in each network. (England.)

COMMUNICATIONS

Analysis of a Generating Tube Effect on a Telegraph Signal Spectrum, B. A. Kravchenko. "Radiotek." v. 14, No. 7, (1959). 4 pp. Theoretical analysis showed that the anode circuit spectrum of a telegraph impulse leading edge depends on the grid bias and the trailing edge suffers no distortion. All spectral functions decrease inversely proportionately to the square of the frequency. Above conclusions may help to reduce telegraph transmitter interference with nearby receiving devices. (U.S.S R.)

Effect of the Antenna and Mixer Temperature on the Microwave Receiver Noise, I. V. Shavlovskii. "Radiotek." v. 14, No. 7, (1959). 7 pp. In designing microwave receivers the antenna and mixer were assumed to be at room temperature. In fact at high altitudes and rapid motion their temperature can differ from the above considerably. Since the sensitivity of microwave receivers is determined to a great extent by the noise and the latter depends mainly on temperature, relations between the effective temperature of the antenna and mixer and the noise factor and gain were derived. Since the modern crystal detectors are approaching their theoretical limit of sensitivity, cooling appears to be the only way of increasing their effective sensitivity. (U.S.S.R.)

Experimental Investigation of Methods for Separating Laguerre Functions, A. G. Leont'ev. "Radiotek." v. 14, No. 8, (1959). 4 pp. An experimental equipment for producing, transmitting and identifying Laguerre function is described. This equipment may serve as a prototype of a communication system with a

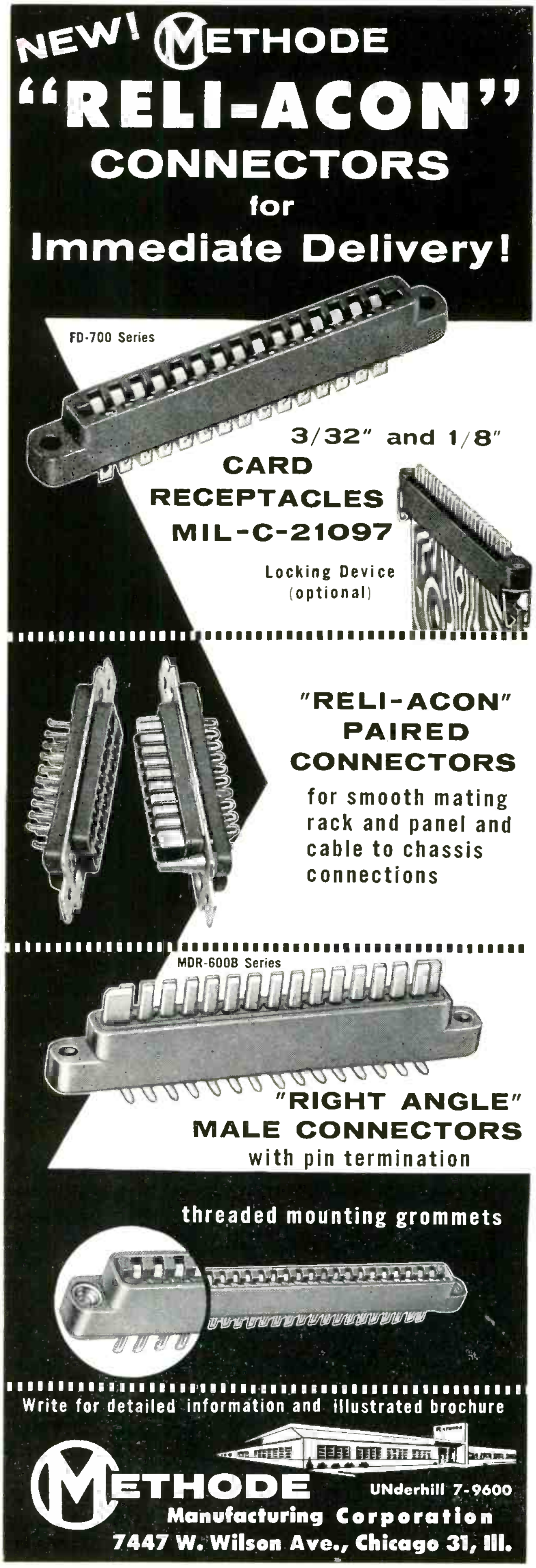
Sources

Laguerre function carrier. Two systems of separation are critically examined, one based on the orthogonality of the function and the other on the use of Duhamel's integral which relates the filter output with its input by means of the filter response to a unit pulse. (U.S.S.R.)

Controlled Current Static Telemetering System, M. Duma, V. Roisman. "Avto. i Tel." Aug. 1959. 3 pp. There is described the controlled current telemetering system worked out in Electrotechnical Scientific Institute of RPR. The system operation is based on properties of the amplifier with negative feedback. The operation of the system and its separate units is analyzed and the data of the system test are given. (U.S.S.R.)

Meeting Concerning Problems of Stereophony, held at the Institute for Rundfunktechnik at Hamburg on 8th and 9th April, 1959. "Rundfunk." Aug. 1959. 13 pp. The abridged versions of the papers give a general picture of the basic principles related to stereophonic listening and of the present situation in that field. Beginning with a summary of the problems of stereophy if used in broadcasting and a report on the demonstrations made during the meeting, the fundamental ideas of stereophonic listening are discussed and a summary is given of stereophonic and pseudo-stereophonic systems. (Germany.)

Stereophonic Broadcasting Using Pulse-Amplitude-Modulation, Von H. F. Mayer & F. Bath. "Rundfunk." Aug. 1959. 6 pp. For transmission of the two stereo signals of a stereophonic radio broadcast, a time multiplex method operating with pulse amplitude modulation is proposed. The transmitting principle is described. The questions of compatibility, transmitter excitation, baseband width and radio band width, signal-to-noise ratio for single-channel and stereo reception, and synchronization are discussed. An account is given of



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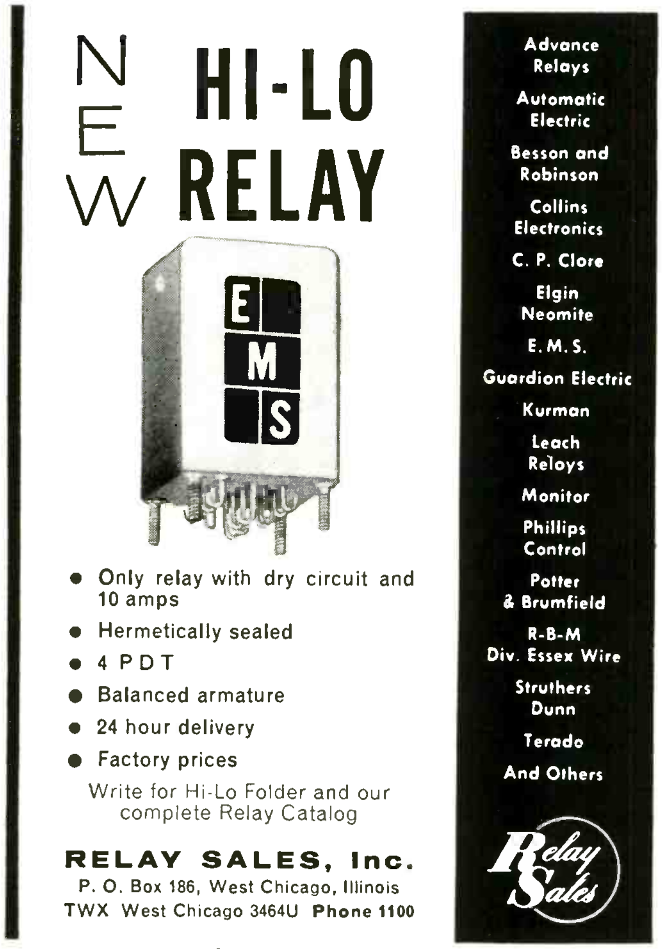

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the results obtained in trial workouts. (Germany.)

The Diurnal Variations of the Back-Scatter Fieldstrength of Telegraph Signals, B. Beckmann and K. Vogt. "Nach. Z." Aug. 1959. 2 pp. An example of the diurnal variations of the back-scatter fieldstrength is given in the paper with the aid of stills from a film. From this, conclusions can be drawn relating to the prevailing propagation conditions. (Germany.)

Transmission of Speech with the Aid of an Ear Microphone, J. Naujoks. "Nach. Z." Aug. 1959. 3 pp. The effectiveness of an ear microphone for the transmission of speech has been published in the literature. When a microphone is applied to the external auditory canal the character of the speech is changed in comparison with the reception of sound from the air. The transmission properties of the path from the organ of speech to the auditory canal is measured with various transducers at various sounds. (Germany.)

Echo-Distortion in Frequency-Modulation, R. G. Medhurst. "E. R. Eng." July 1959. The level of intermodulation distortion generated in an fm, fdm trunk radio system by a small echo depends on the echo amplitude and delay, on the phase relation between the wanted carrier and the echo carrier, and on the parameters of the modulation; i.e., the maximum and minimum modulating frequencies, the RMS deviation and the base-band spectral distribution. Numerical evaluation for the important case of top channel distortion has been carried out on a Hollerith Hec. 2M digital computer, the results being presented as general curves covering a wide range of parameter values. (England.)

A Six-Channel High-Frequency Telemetry System, T. C. R. S. Fowler. "J. BIRE." Aug. 1959. 15 pp. A frequency-multiplex fm-am system is described which provides six continuous channels via which waveforms with frequency

Sources

components in the approximate band 10 c/s to 10 kc/s may be simultaneously telemetered; extension of the frequency coverage to include the band 0-10 c/s is achieved by the use of commutated reference levels. A radio frequency in the 465 Mc/s band and sub-carrier frequencies between 250 and 500 kc/s are used. A short historical introduction is followed by descriptions of the system and of units of the flight and ground equipment, and details of operational results. Future uses of the system are discussed and methods of increasing the useful range are suggested. (England.)

A Domestic FM Receiver Using Diffused Base Mesa Transistors, M. Applebaum & E. Midgley. "El. Eng." Aug. 1959. This article discusses briefly the characteristics of the diffused base mesa transistor and describes its use in the r-f and i-f stages of a domestic FM receiver. Performance details for the complete receiver are given. (England.)

A Comparison of Telemetry Systems, A. Cowie. "J. BIRE." Aug. 1959. 2 pp. The factors influencing the choice of modulation system to be employed are reviewed. The transmission of information channels is discussed with reference to time division and frequency division multiplex systems. (England.)

COMPONENTS

Temperature Compensation of Transistor Kipp-Relay, E. I. Model and A. G. Aleksenko. "Radiotek." v. 14, No. 7, (1959). 8 pp. Compensation of the Kipp-relay time delay temperature intability is analyzed. Above compensation is possible because left and right hand triodes of the relay have an opposite effect on time delay. Temperature compensation avoids the tedious temperature adjustment of the device. A practical example of circuit temperature compensation is given. Experimental results are cited and the selection of elements and conditions of operation of a Kipp-relay suggested. (U.S.S.R.)

Equivalent Dynamic Parameters of Thermal Resistors, A. A. L'vovich. "Radiotek." v. 14, No. 8, (1959). 8 pp. By transforming the heat balance equation of the thermal resistor, its equivalent representation is found which corresponds to small changes in currents and voltages at high and audio frequencies. This equivalent circuit can be used in deriving an "abridged" differential equation for analyzing transient processes in circuits using thermal resistors. The equivalent circuit proposed supersedes the existing equivalent circuits. Experimental data was in good agreement with calculations of transients obtained by this method in oscillator and amplifier circuits which used thermal resistances. (U.S.S.R.)

A Method of Demagnetizing the Core of a Pulse Transformer, P. Kh. Bal'yan, V. I. Laletin and I. V. Trofimov. "Radiotek." v. 14, No. 8, (1959). 3 pp. The proposed method of demagnetization avoids the separation of circuits into operating and demagnetizing and uses for demagnetizing the entire winding of the transformer, which reduces to the minimum the demagnetizing current. A specification of a miniature transformer suitable for 50 msec pulse operation is appended (U.S.S.R.)

Photo-Resistors Made of Compressed and Sintered Cadmium Suphide, N. A. de Gier, W. van Gool and J. G. van Santen. "Phil. Tech." No. 10, Vol. 20. 11 pp. Cadmium sulphide photo-resistors, highly sensitive to light, can now be manufactured on an industrial scale. The basic material is very pure powdered CdS: to this, certain substances containing copper and gallium are added, the mixture being subjected to a heat treatment. The result is a course powder, in which the additives are now uniformly distributed; this is compressed into plates of the desired shape.

Sources

Lattice defects arising during the pressing process (and which reduce the photosensitivity of the substance) are largely removed or modified in a second heat treatment, which causes the grains to cohere. (Netherlands, in English.)

COMPUTERS

Composing Music with Electronic Computers, P. G. Neumann and H. Schappert. "Nach. Z." Aug. 1959. 5 pp. The multi-purpose application of electronic computers has aroused the interest in the simulation of the human processes of thinking by means of such devices. The possibilities of composing music with the aid of electronic computers is investigated in this paper. The computer makes use of random numbers and "rule of composition" stored in the computer. The rules can be given in an explicit form by a program or in an implicit form by composition patterns. The methods are explained with the aid of two concrete examples. (Germany.)

Simulation of Non-Linear Effect by Analogue Computer, H. B. Mohanti. "J. ITE." June 1959. 6 pp. This paper will be confined to electronic differential analyzer and the type used in 'EASE Analog Computer' manufactured by Berkeley Div. of Beckman Instruments, Inc., U. S. A. Variplotter 205K manufactured by Electronic Associates Inc., U. S. A., has been used to plot variable dc voltages. (India, in English.)

CONTROLS

Transients in Automatic Frequency Control Systems Which Use Ferrites as Control Ele-

Sources

ments, V. I. Kaganov. "Radiotek." v. 14, No. 8, (1959). 8 pp. Phase difficulties and slow response in the case of a reactance tube and mechanical devices repectively preclude their use in the microwave range for automatic frequency control. Ferrites whose permeability can be easily controlled within narrow limits without affecting the Q of the tuned circuit were found to be more suitable for this purpose. Transient conditions in AFC circuits using ferrites are analyzed in this article. The nonlinear differential equation describing the process is solved by means of Chaplygin's method, which provides a measure of the errors of approximation. Calculations made by means of the formulas thus obtained are in good agreement with experimental data. (U.S.S.R.)

Automatic Correction of Compensation Devices in Feedforward Systems, S. A. Doganovsky. "Avto. i Tel." Aug. 1959. 10 pp. There is considered application of the automatic optimizer to correct the compensation devices in the feedforward systems. The optimizer circuit is described and examples of its application are given. (U.S.S.R.)

Equation and Some Properties of Root Locus of Automatic Control Systems, N. N. Michaelov. "Avto. i Tel." Aug 1959 8 pp General case of the root locus equation of the automatic control systems and the root locus properties yielded by the said equation are considered. (U.S.S.R.)

Noise Stability of Magnetic Tape Program-Control Continuous Systems, V. N. Shadrin. "Avto. i Tel." Aug. 1959. 6 pp The paper deals with potential noise stability of the magnetic tape program-control multichannel systems with phase modulation The problem is solved for the systems with soft fluctuation interference caused by magnetic tape noise. There are derived expressions for interference intensity at the ideal receiver output for the cases of space, frequency and time channel division. (U.S.S.R.)

Automatic Control of Position of Division Bound of Two Media by Means of Ultrashort Waves, V. B. Bradky. "Avto. i Tel." Aug. 1959. 4 pp The method of automatic control of liquid level based on wave reflection is used to control the position of the division bound of two media The method is shown to permit the control without considerable measurement error when the dielectric constant of one of the media widely change. (U.S.S.R.)

On Designing Control Circuit for Pure Time Delay Systems, E. I. Itskovich. "Avto. i Tel." Aug. 1959. 9 pp The paper deals with designing control circuits for time delay systems with random disturbance The design of circuits according to desirable quality requirements is well-grounded. It is based on studying properties of the correlation function of the controlled value. The described method is used to design a control circuit for an output value of the process of cement burning in the rotary kiln. (U.S.S.R.)

The Stability of Control System of a Special Kind, J. Tchauner. "rt." July 1959. 2 pp. A control system the regulating unit of which has itself a definite undamped frequency and where the signal transmission is continuous is frequently unstable. The present investigation, however, proves that the same system will become perfectly stable if the signal transmission is made intermittent It is thus demonstrated that intermittent signal transmission (impulse regulation), under certain conditions, is a suitable means for improving the stability of a control system. (Germany.)

The Stability of Control Systems with "Square Law" PI-Controllers, R. Herschel. "rt." July 1959. 7 pp. Control systems are studied consisting of controlled plants of the n^{th} order with inherent regulation and PI-controllers. The proportion of the P-action to the I-action of these controllers is determined by the square of the deviation from the desired value. It is found that the performance of control systems of the second and third order can be improved

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Sources

within certain ranges of the controller parameters. (Germany.)

GENERAL

Calculations of Dynamic Frequency Characteristics of Linear Passive Systems, L. G. Sodin. "Radiotek." v. 14, No. 7, (1959). 9 pp. A general formula covering static and dynamic characteristics is first derived for single tuned circuits. Transient effects are considered. The conclusions are extended to any filter systems. Dynamic frequency and time characteristic formulas for three types of filters are given. It is shown that a frequency characteristic of any complex filter system can be represented as a sum of single tuned circuit characteristics. A worked example of deriving a dynamic frequency characteristic for a band-pass filter is given in an appendix. (U.S.S.R.)

Effect of Nonstationary Fluctuations on Linear Systems, Yu. I. Samoilenko. "Radiotek." v. 14, No. 7, (1959). 2 pp. Usually in finding the effect of these fluctuations the Einstein-Fokker equation is integrated. In applying the results it is often sufficient to obtain the relation to time of the basic ditribution parameters, which greatly simplifies the problem. In this article the basic distribution parameters of the linear system movement fluctuations with one degree of freedom when acted upon by a nonstationary stochastic force are found directly. (U.S.S.R.)

Control of the First-Order Delay System with the Help of Nonlinear Compensation Floating Controller, S. V. Emeljanov. "Avto. i Tel." Aug. 1959. 11 pp. There is considered a possibility of stabilizing and improving the quality of the dynamic delay systems described by the second-order differential equations with the help of the nonlinear converter which changes the system structure during the transient process depending on the sign and the ratio of two coordinates—the controlled parameter and its derivative. (U.S.S.R.)

Steady Process in Simplest Discrete Optimalizing System with Random Disturbances, A. A. Feldbaum. "Avto. i Tel." Aug. 1959. 15 pp. The investigation of the processes in the discrete optimalizing systems with random disturbances leads to the analysis of Markov equivalent circuits. On the basis of this investigation the steady error and the step in the optimum value of the simplest system are determined. Some generalizations of the problem are given. (U.S.S.R.)

On Optimum Transient Process in System with Restricted Third Derivative, A. A. Pavlov. "Avto. i Tel." Aug. 1959. 17 pp. Optimum transient process in the system restricted third derivative of the control value is analyzed. For step disturbances there is determined the optimum transient process and suggested the possible way to synthesize the optimum control element of the system. (U.S.S.R.)

On Approximate Synthesis of Optimum Linear Detecting Systems, Yu P. Leonov. "Avto. i Tel." Aug. 1959. 10 pp. The paper deals with the approximate solution of the integral equation for the weighing function of the optimum system. (U.S.S.R.)

Open and Closed Loop Controls for Diesel-Electric Locomotives, Part I, N. N. Costake. "rt." July 1959. 6 pp. Owing to the competition of hydraulic transmission it is necessary to exploit to the fullest extent the advantages of electric transmissions, particularly the greater elasticity and adaptability of the drive. This can be achieved on the one hand by improving the electrical equipment including the safety devices, and on the other hand by employing simpler yet more comprehensive control systems. Modern systems prove that this is well possible. The latest trends are the use of recently developed components (amplidynes and transductors), simplification of regulation, infinite-step output control, automatic

Sources

field weakening and control of starting acceleration. (Germany.)

Excitation of the Ear by Continuous Noise and by Short Pulses, R. Oelinger. "Nach. Z." Aug. 1959. 9 pp. The excitation of the organ of Corti by continuous noise is measured by means of a covering method. The investigations include noise of wide frequency-group bands as well as uniformly exciting noise and bands of uniformly exciting noise. The method for measuring the excitation by continuous noise is modified so that this can be used for the calculation of the equivalent continuous excitation of the organ of Corti by short pulses. The equivalent continuous excitation for separate pressure pulses is investigated. (Germany.)

Electronic Magnetizing and Demagnetizing, D. Hadfield, et al. "E. & R. Eng." July 1959. 4 pp. (England.)

INDUSTRIAL ELECTRONICS

A Neglected Possibility of Preventing Flash-Back in Power Rectifier Circuits, E. P. Khmel'-nitskii. "Radiotek." v. 14, No. 7, (1959). 7 pp. Various direct methods of preventing flash-back in high-tension gas-filled power rectifiers are not very effective and the use of capacitors and series resistors is limited in scope. In powerful industrial rectifiers choke coils are successfully used to prevent flash-back. This article describes a method of using chokes in high-tension rectifiers for radio transmitters in order to decrease the probability of a flash-back. Design equations are derived and a sample calculation made. (U.S.S.R.)

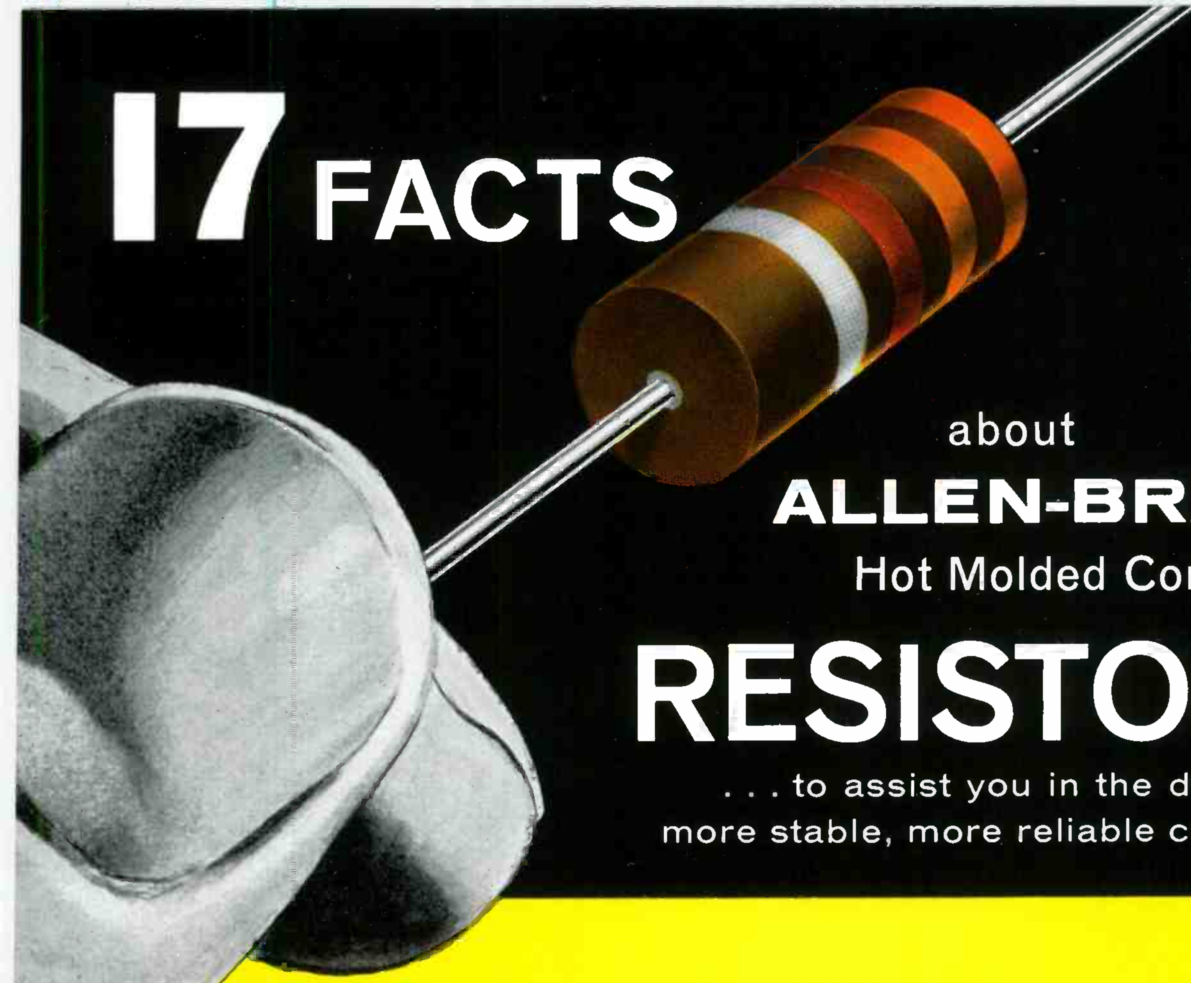
MATERIALS

The Effect of Mica Thickness on its Specific Volume Resistance, B. N. Tardov. "Radiotek." v. 14, No. 8, (1959). 1 p. On the basis of extensive tests of mica plates obtained from different parts of the USSR an empirical relation is established between the thickness of the plate and the specific volume resistance of mica. The effect of thickness on the specific resistance could be explained by the dielectric polarization back emf, which is lower in thicker plates. (U.S.S.R.)

Phosphors for Cathode-Ray Tubes in Industrial and Low Scanning Speed Display Systems, M. D. Dudley. "J. BIRE." Aug. 1959. 5 pp. Cathode-ray tube displays for industrial television, radar and facsimile systems need phosphors having a very wide range of color, texture and persistence. The characteristics of these phosphors are discussed, with particular emphasis upon those for use in high-resolution and low scanning speed displays. A recently developed combination of phosphors enables images to be stored for several minutes before presentation by controlling the persistence with infra-red radiation. (England.)

MEASURE & TESTING

Measurement of the Ionospheric Absorption on 2.5 MC./S. at Ahmedabad, J. S. Shirke. "J. ITE." June 1959. 6 pp. Measurements of ionospheric absorption were carried out at Ahmedabad (latitude 23°0'N., longitude 72°6' E.) on 2.5 ms./s., using vertical pulsed transmission during the period August 1957 to July 1958. The strength of the transmitted signal was kept constant and the intensities of the vertically reflected pulses were cut down by



17 FACTS

about

ALLEN-BRADLEY
Hot Molded Composition

RESISTORS

. . . to assist you in the design of more stable, more reliable circuits

Circuit reliability is determined by the quality of the components and the understanding with which they are applied. A-B hot molded resistors are universally recognized for their quality and reliability. Here are 17 facts that will assist you with your design and development work.

1 Resistance changes due to humidity are temporary, but Allen-Bradley resistors can be returned to their original value by proper conditioning or "loading."

2 Resistance changes due to increase in moisture content are always positive.

3 Resistance change due to humidity varies with the resistance value and is less in the lower values.

4 Resistance change which has occurred due to humidity may be returned to the original value by conditioning the resistor at 100°C for 48 hours.

5 Resistors operating at 1/10 rated wattage load are hardly—if at all—affected by humidity.

6 Hermetically sealed resistors do not change because of humidity.

7 Resistance change due to "load life" is permanent and ultimately negative.

8 Resistance change due to "load life" can be minimized—on the order of 1% to 2% in many thousands of hours of service by derating the resistor approximately 50%.

9 This same result can be attained by limiting the maximum operating surface temperature of the resistor under load to 100°C.

10 Resistance change due to soldering is positive; but if the resistor is dry, it will return to its original value in a matter of hours.

11 The temperature characteristic of the Allen-Bradley resistor is positive above and below room temperatures between +10°C and +80°C ambient.

12 The temperature characteristic of the Allen-Bradley resistor is negligible from +10°C to +80°C ambient.

13 The voltage characteristic of the Allen-Bradley resistor is negative. It is less at elevated temperatures than at room ambient (+10°C to +80°C).

14 The voltage characteristic is less in low-value resistors than in high-value units—it is linear.

15 The voltage characteristic and the temperature characteristic tend to cancel one another in an Allen-Bradley resistor under average operating conditions where both voltage and temperature are present.

16 The "heat sink" to which a resistor is connected affects its rating. Resistors operated in parallel should be derated unless an adequate "heat sink" is provided.

17 The quality and reliability of Allen-Bradley resistors are exactly the same regardless of the "tolerances" for which the resistor is listed.

5-59-E

ALLEN-BRADLEY | *Quality* Electronic Components

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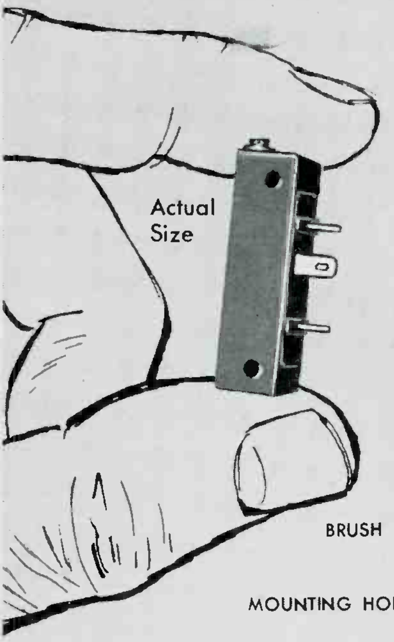
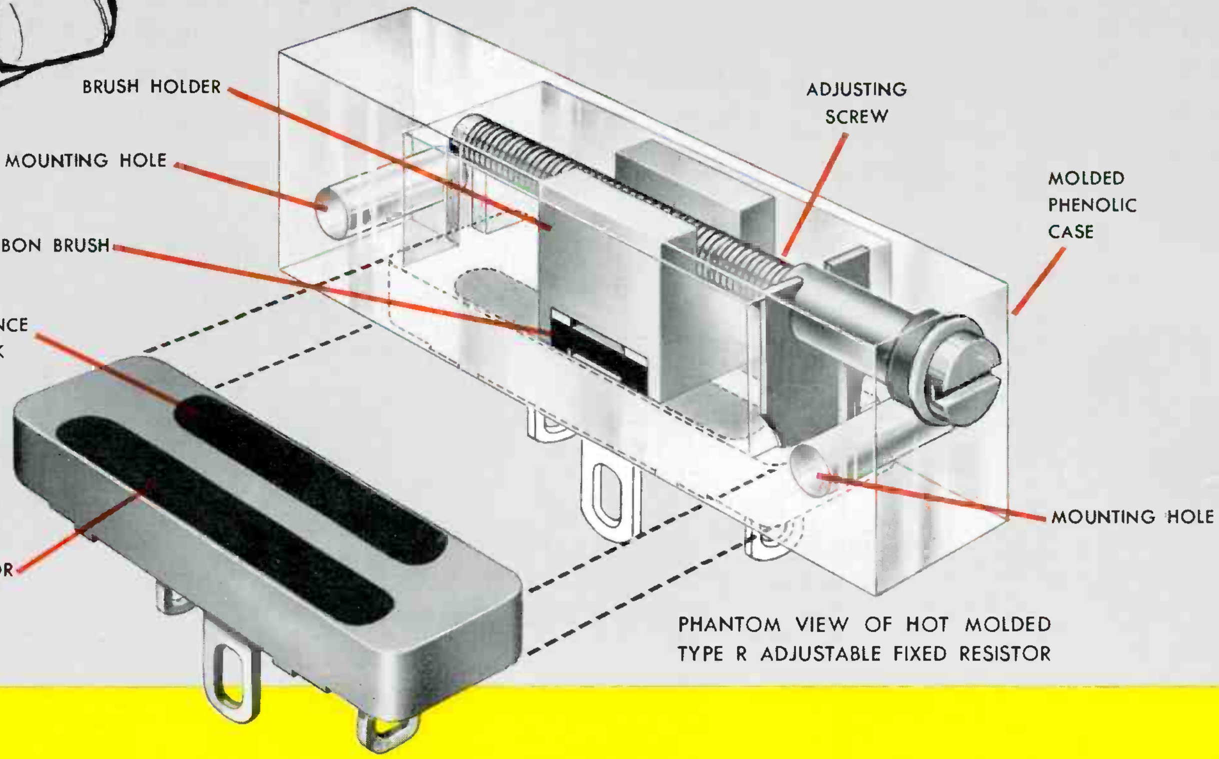
NEW ALLEN-BRADLEY

Adjustable Fixed Resistor





PHANTOM VIEW OF HOT MOLDED TYPE R ADJUSTABLE FIXED RESISTOR

Exclusive hot molded dual track resistance element and carbon brush give unmatched reliability and long life

SPECIFICATIONS

Power Rating: ¼ watt at 70°C ambient

Voltage Rating: 350 volts maximum

Temperature Range: −55°C to 120°C

Resistance Range: total resistance values from 100 ohms to 2.5 megohms ±10% or ±20%

Adjustment: approximately 25 turns

Dimensions: approximately 1¼" x 21/64" x ¼"

Terminals: lug and pin type terminals on 0.1" grid system and are gold plated for ease of soldering.

Here's a new, compact, adjustable fixed resistor—the Type R—with Allen-Bradley's exclusive hot molded resistance element. It's the same type resistance element used in the popular Type J and Type G units . . . which have proved unequaled for reliability and long life. Operation is exceptionally smooth—no abrupt resistance changes occur with adjustment. The molded case of the Type R adjustable fixed resistor is watertight and dust-tight. The mounting for the moving element is self-locking to assure stable setting—and the entire unit can be "potted" after adjusting. The adjustment screw has a "free wheeling" clutch to prevent damage.

Send for complete information on this latest addition to the Allen-Bradley line of *quality* potentiometers.

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QUALITY

ELECTRONIC COMPONENTS

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the use of a passive attenuator so as to give a constant intensity of signal on the oscilloscope screen of the receiving circuit. (India, in English.)

Investigation on Programme Meters, S. N. Salgarkar and N. K. D. Choudhury. "J. ITE." June 1959. 6 pp. The pressing necessity for metering programmes for transmission on networks and circuits with maximum equipment utility and without undue distortion brought into vogue many types of volume indicators. After initial multiplicity of instruments, two standard instruments were evolved, namely Peak meter, a peak reading instrument and VU meter which is classified under 'R.M.S. type of instruments.' (India, in English.)

RADAR, NAVIGATION

Evaluation of the Radar Reception Methods by Means of the Theory of Information, F. P. Tarasenko. "Radiotek." v. 14, No. 7, (1959). 8 pp. The advantage of the information theory criteria as compared with criteria based on the signal to noise ratio is stressed. The technique of the information theory methods of evaluating radar reception is described, including methods involving immediate signal transformation and signal storage. The signal carrying capacity of immediate transformation methods based on amplitude or phase sensitive detection or both are calculated. It is shown that the greatest amount of information is provided by the signal storage method based on consecutive statistical analysis. (U.S.S.R.)

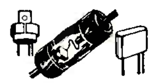
Follow-up Drive with Gyrocopes on Oscillating Foundation, S. G. Kolesnichenko. "Avto. i Tel." Aug. 1959. 8 pp. A device (finder) on oscillating foundation with power gyroscope drive is investigated. It automatically follows

Sources

up a celestial body and measures the absolute angular speed of its line of hearing. The false constant component of the angular speed is found. (U.S.S.R.)

Automatic Recording of Luminous Intensity Diagrams, W. Bahler. "Phil. Tech." No. 10, Vol. 20. 3 pp. Short description of an instrument that automatically records contours of constant luminous intensity (isocandela curves) from a light source; it traces these on a grid, the coordinates of which may be the azimuth and elevation of the direction of measurement. The instrument can trace closed loops, so that it is suitable for measurements on beamed light sources. The recorder portion of the instrument can also be used for the tracing of other kinds of "iso" curves. (Netherlands, in English.)

An Electronic Clock Coder for Coded Radio Beacons, J. W. Nichols, et al. "El. Eng." Aug. 1959. 9 pp. A crystal controlled clock and electronic coder is described which is capable of originating the coded signal for marine radio beacons in conformity with the requirements of the Paris International Agreement, and also of regulating the time of transmission to a high degree of accuracy. Facilities have been provided for remote or manual control together with a fault warning system designed to monitor the timing and coding of the equipment. (England.)



SEMICONDUCTORS

Some Problems in the Design of Transistor Amplifiers, K. P. P. Nambiar. "J. ITE." June 1959. 11 pp. In this article, basic forms of ac equivalent circuits of transistors are first discussed followed by techniques of direct current biasing. On the basis of these, design problems of audio frequency and intermediate frequency (h-f) amplifiers are discussed; the effect of parameter variations particularly at i-f frequencies, methods of minimizing the detrimental effects due to these variations and application of automatic gain control in transistor circuits are also dealt with. (India in English).

Transistor Current Gain, R. W. Smith, et al. "E & R. Eng." July 1959. 4 pp. Apparatus used for a twin-channel comparator method of measuring complex values of current-gain at frequencies between 1 and 210 Mc/s, and for a single-channel null method at frequencies up to 25 Mc/s are described. Results obtained by both methods in the overlap frequency range are shown, and the effects of stray capacitance on the measurements are illustrated. (England)

Transistor Blocking Oscillator for Use in Digital Systems, Agnes A. Kaposi. "El Eng." Aug. 1959. 5 pp. A saturable transformer is used in a blocking oscillator circuit. It is shown that the pulse length is independent of the transistor parameters of the temperature and of load current. Practical circuits have been made giving pulse lengths from 1.5 μsec upwards. The circuit is particularly suitable for driving magnetic core counters. (England)

An Electrical Analogue for Heat Flow Problems in Semiconductors, N. L. Potter. "El. Eng." Aug. 1959. 4 pp. In semiconductor protection problems it was found necessary to be able to estimate the temperature of the semiconductor junction. This article shows the similarity between heat flow and current flow in a resistance capacitance network and hence the theory leading to the construction of an analogue for the study of junction temperature. A typical analogue is shown with oscillograph displays obtained from it. Other uses of the analogue are suggested and the possibility of three dimensional work is discussed. (England)

TELEVISION

Optimum Operating Conditions for Asymmetrical Picture Signal Transmission. V. G. Alek-

FILTERS FOR ALL APPLICATIONS FROM STOCK

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327 SPECS.

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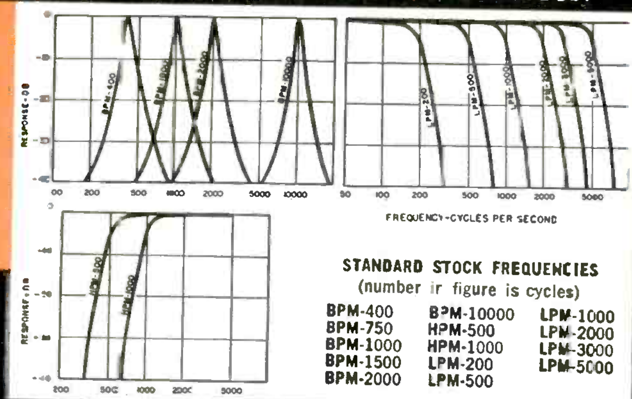
MINIFILTERS

New Minifilters provide almost the same characteristics (with attenuation only slightly less) as the industry's standard interstage and line filters immediately below.

BPM band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db ±3% from center frequency, then 35 db per octave.

HPM high pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at .67 cut-off frequency, 40 db at .6 cutoff frequency. Input and output 10K.

LPM low pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at 1.5 cut-off frequency, 40 db at 1.65 cutoff frequency. Input and output 10K.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BPM-400	BPM-10000	LPM-1000
BPM-750	HPM-500	LPM-2000
BPM-1000	HPM-1000	LPM-3000
BPM-1500	LPM-200	LPM-5000
BPM-2000	LPM-500	

BPM case (MIL AF) ¾ x ¾ x 1⅝" Weight....1 oz.

HPM and LPM case (MIL AG) 1 x 1 x 1⅝" Weight....2¼ oz.

INTERSTAGE & LINE

These six basic types cover most popular filter applications and frequencies.

BMI band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

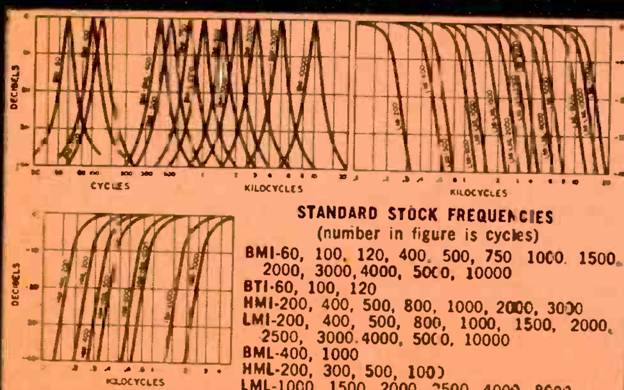
HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

LMI low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

HML high pass filters are same as HMI but 500/600 ohms in and out.

LML low pass filters are same as LMI but 500/600 ohms in and out.

BML band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BMI-60, 100, 120, 400, 500, 750, 1000, 1500, 2000, 3000, 4000, 5000, 10000
BTI-60, 100, 120
HMI-200, 400, 500, 800, 1000, 2000, 3000
LMI-200, 400, 500, 800, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 10000
BML-400, 1000
HML-200, 300, 500, 1000
LML-1000, 1500, 2000, 2500, 4000, 8000, 10000, 12000

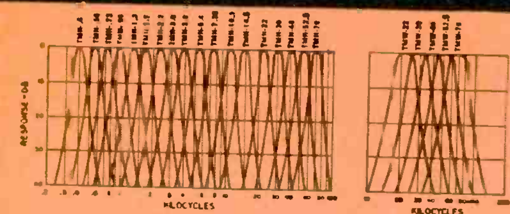
Base .... 1³⁄₁₆ x 1⁵⁄₁₆"
Height, BMI, LMI, BML ...... 1⅝"
Height, HMI, HML, LML ...... 2½"
Weight .... 6 oz. and 8 oz.

TELEMETERING BAND PASS

UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

TMN units are within 3 db at ± 7.5% of center frequency . . . down more than 18 db at ± 25% . . . more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at ± 15% of center frequency . . . down more than 20 db at ± 50% . . . more than 40 db beyond 2.5 and .4 center frequency.



STANDARD STOCK FREQUENCIES
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TMN-.4	TMN-1.7	TMN-5.4	TMN-30	TMW-22
TMN-.56	TMN-2.3	TMN-7.35	TMN-40	TMW-30
TMN-.73	TMN-3.0	TMN-10.5	TMN-52.5	TMW-40
TMN-.96	TMN-3.9	TMN-14.5	TMN-70	TMW-52.5
TMN-1.3		TMN-22		TMW-70

TMN-2.3 thru TMW-70 ²³⁄₃₂ x ²³⁄₃₂ x 1⅝" Weight....1.2 oz.

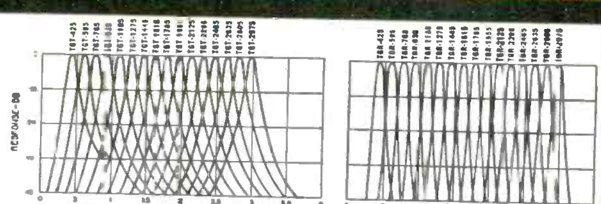
TMN-.4 thru TMN-1.7 1⁵⁄₁₆ x 1½ x 2" Weight....3.5 oz

TELEGRAPH TONE CHANNEL

These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

TGT transmitting filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 16 db at ± 170 cycles . . . down more than 7.5 db at adjacent channel cross-over.

TGR receiving filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 30 db at ± 170 cycles . . . down more than 15 db at adjacent channel cross-over.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

TRANSMITTING		RECEIVING	
TGT-425	TGT-1785	TGR-425	TGR-1785
TGT-595	TGT-1955	TGR-595	TGR-1955
TGT-765	TGT-2125	TGR-765	TGR-2125
TGT-935	TGT-2295	TGR-935	TGR-2295
TGT-1105	TGT-2465	TGR-1105	TGR-2465
TGT-1275	TGT-2635	TGR-1275	TGR-2635
TGT-1445	TGT-2805	TGR-1445	TGR-2805
TGT-1615	TGT-2975	TGR-1615	TGR-2975

TGT CASE 1½ x 1½ x 2½" Weight....8 oz.

TGR CASE 1½ x 1½ x 4¼" Weight....15 oz.

And Special Units to Your Specifications

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PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

Sources

seeva. "Radiotek" v. 14, No. 8, (1959), 3 pp. Amplitude-frequency modulation with rectilinear discriminators provides by simpler means the same resolution as modern amplitude modulation with skew-symmetrical filters. Amplitude-frequency modulation with piecewise linear discriminators is the nearest approach to the optimum conditions of operation for asymmetrical signal transmission, when one sideband is partially suppressed, and provides a better resolution without deteriorating the transmission of edges. The theoretical investigations were confirmed experimentally. (U.S.S.R.)

Television Receiver Production in the U.S.S.R., A. Y. Bratebart. "J. BIRE." Aug. 1959. 3 pp. Information concerning the circuits and engineering features of television receivers being produced in the Soviet Union is given. The prospects for future receiver production development are also discussed. (England)

Some Aspects of Television Transmission over Long Distance Cable Links, H. Mumford. "J. BIRE." Aug. 1959. 11 pp. An outline of the basic properties of 0.375 in. diameter coaxial cable and the combined or alternative multichannel telephony/television systems based on it is given. Most of the required transmission limits for such systems have now been agreed internationally and a "hypothetical reference circuit" evolved for which such limits can be stated. Although limits have tended to be agreed by national experiments on the various television systems, two basic subjective laws, the Weber-Fechner law and Ricco's law, on which limits must ultimately be based, are illustrated and discussed. (England)

TUBES

Transmitting valves for Use in Industry, E. G. Dorgelo. "Phil. Tech." No. 10, Vol. 20. 6 pp. To meet the demand for industrial transmitting valves (for high-frequency heating, ultrasonic generators, etc.) the following triodes have been developed: TB4/1500 and TB 5/2500 for 50 Mc/s max., and TB 6/14 and TB 12/38 for 30 Mc/s max. These valves are designed for generators delivering from 1 to 30 kw. Distinguishing features of the valves are a strong cathode of thoriated tungsten, a grid of low-emitting K material, an anode of high heat capacity, an optimum amplification factor μ (giving a variation of no more than $\pm 10\%$ in the delivered power for a load variation of 1:3) and robust construction. (Netherlands, in English)

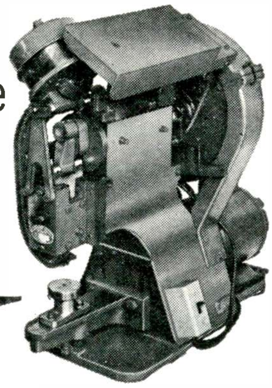
Distant-focus X-ray Tubes, A.H.G. Kuntke. "Phil. Tech." No. 10, Vol. 20. 8 pp. In normal X-ray tubes the electrons are focused with a two-electrode system. It is shown that this is still possible where the electron trajectories are very long, e.g. up to 600 or 800 mm as in rod-anode tubes. For this purpose a wide and deep "cathode cup" is placed in front of the filament, itself mounted in a slot in the cathode, i.e. a virtual "image" produced by the slot-filament electron-optical system and having a fairly uniform electron distribution. (Netherlands, in English)

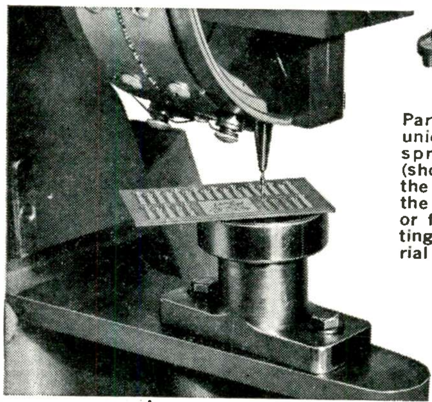
A Proposed Ferrite-Tuned Magnetron, Amarjit Singh. "J. ITE." March 1959. 5 pps. General considerations are given for tuning a magnetron by suitably placing a ferrite material in the resonator and varying its effective permeability by means of biasing magnetic field. It is shown that an inverted interdigital magnetron with a coaxial line coupled to the region enclosed by the fingers is well suited for this purpose. The ferrite can be placed near the shorted end of the line and can be biased by a radial field. The ferrite material thus located can be kept out of the main magnetic field of the magnetron; so that the interference of one with the other is avoided. (India, in English.)

* * *

PLANNING FUNNEL TYPE EYELETS FOR PRINTED CIRCUIT BOARDS?

this Edward Segal automatic machine feeds, inserts and flares with utmost reliability!





Part of the secret's in Segal's unique anvil tool holder and spring loaded work table (shown at left) which allow the eyelet to pass through the assembly before staking or flaring. Avoids loose settings, compensates for material variations, too.

There's a Segal machine for every eyeleting application. Tell us about yours and we'll gladly look into it without obligation. And write today for new bulletin EI-11

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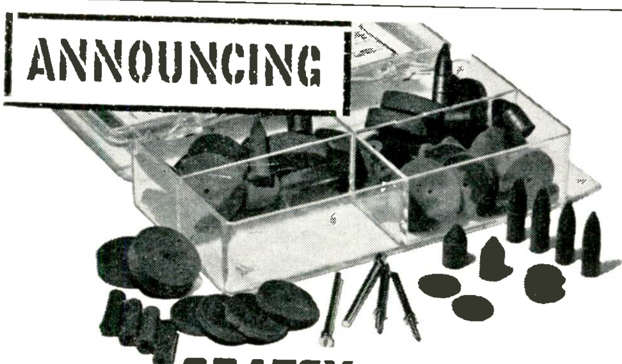

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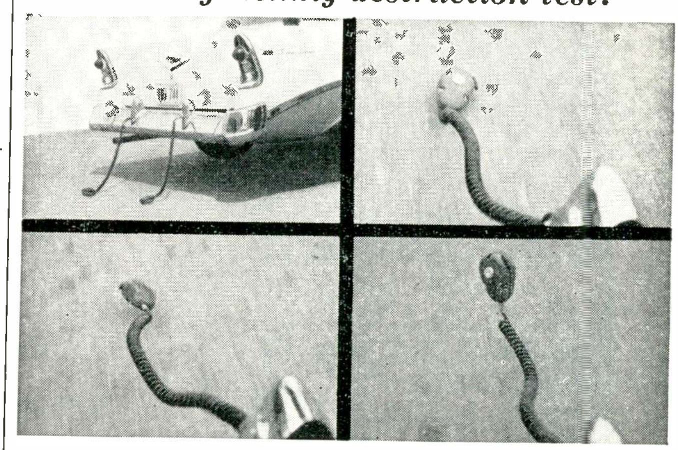
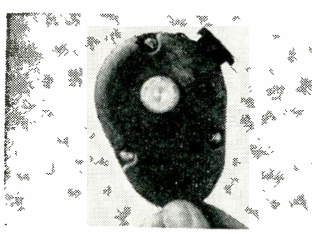
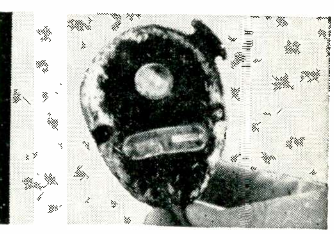
proves its incredible durability in this gruelling destruction test!



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.

Available only to Manufacturers of Communications Equipment.
(Can be furnished with "Controlled Magnetic" or carbon cartridge.)

SHURE BROTHERS, INCORPORATED
222 Hartrey Avenue, Evanston, Illinois, Dept. 33-K
HIGHEST QUALITY MICROPHONES—FIXED-STATION AND MOBILE

Circle 307 on Inquiry Card

Contamination

(*Continued from page* 110)

b. *Sonic energy* agitation in chlorinated solvent removed 89.1% of contamination.

c. *Mechanical* agitation in water based detergent solution removed 91.3% of residual flux.

d. *Sonic energy agitation* in water based detergent solution removed 97.8%.

5. Further radiological and chemical studies determined that the 2.2% of contaminating flux (remaining after optimum cleaning with sonic energy agitation in water based detergent solution) consisted of:

a. Infinitesimal particles driven into the surface of the board at the time of contact with the hot solder.

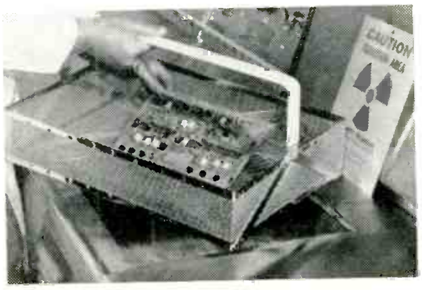
b. Minute nuclei of flux occluded within the solder.

c. Quantities so minute and so dispersed as to substantially lessen or completely eliminate the incidence of functional failure due to short circuiting.

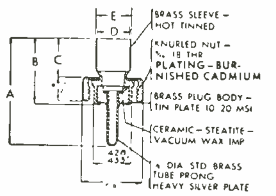
The important finding in this study was the verification that "clean is not always clean." The printed circuit boards which had given trouble in the field previously had been considered "clean." Thorough but conventional cleaning methods, plus close visual inspection, had ostensibly precluded the possibility of contamination.

However, the thin film of flux which remained on the boards after conventional cleaning proved to be the cause of functional failure, and only the use of radiological identification and evaluation, combined with the cleaning efficiency of sonic energy, made possible the substantial contribution to performance reliability.

Board is cleaned by sonic energy, using water based detergent solution. This process proved most effective in removing trouble-causing flux contamination.



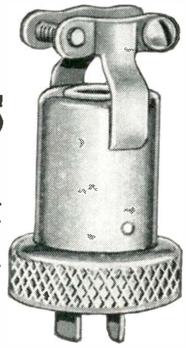
Ideal for
ANTENNA CONNECTIONS
PHOTO-CELL WORK
MICROPHONE CONNECTIONS



SUPPLIED IN 1 & 2 CONTACT TYPES

JONES
SHIELDED TYPE
PLUGS & SOCKETS


P-101-1/4


P-202-CCT

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS

For qquality construction thru-out, and fine finish, see diagram above.

101 Series furnished with 1/4", .290", 5/16", 3/8", or 1/2" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation; sockets bakelite. Assembly meets Navy specifications.

202 Series Phosphor bronze knife-switch type socket contacts engage both sides of flat plug contacts—double contact area. Plugs and sockets have molded bakelite insulation.

For full details and engineering data ask for Jones Catalog No. 22

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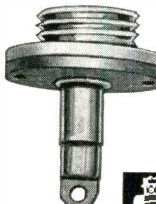
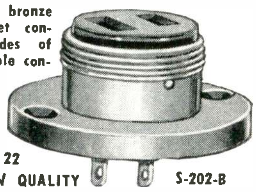

S-101


S-202-B

HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
CHICAGO 24, ILLINOIS
DIVISION OF UNITED-CARR FASTENER CORP.

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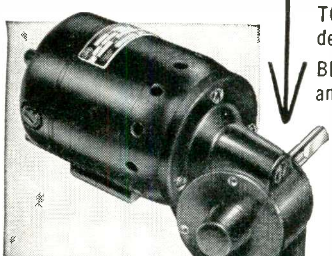
this Howard fractional H. P. gear motor can be used for

RATIOS FROM 10:1 to 60:1

MODEL 2900: 2 Pole—4 Pole Induction with A26 Gear Unit
DIAMETER 3 5/16"
LENGTH 7 5/64" to 8 11/64"
HORSE POWER: 1/70 to 1/15 depending on length of stacking.
TORQUE OUTPUT. Up to 60 in lbs depending on ratio.
BEARINGS: Permanently lubricated and sealed ball bearings



Check your specifications with Howard. Write for complete details and prices on these and other Howard gear motors and reduction units.

BOTH universal and induction applications

MODEL 29-500: Universal AC/DC or Shunt with A26 Gear Unit
DIAMETER: 3 5/16"
LENGTH: 7 13/64" to 7 3/64"
HORSE POWER: 1/70 to 1/4 depending on length of stacking.
TORQUE OUTPUT: Up to 60 in. lbs. depending on ratio.
BEARINGS: Permanently lubricated and sealed ball bearings.

POWERED BY **HOWARD**

HOWARD INDUSTRIES, INC.
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NEW FROM NARDA

Model 10001
$4700.

High Power

MICROWAVE MODULATOR

accepts over 40 magnetrons!

Here's the first of a series of new products from Narda's recently-established High Power Electronics Division! A high power Microwave Modulator that permits installation inside the unit of any of more than 40 magnetrons! Complete, compact and self-contained, it accepts magnetrons covering 3,200 mc to 35,000 mc, with peak outputs from 6 KW to 120 KW. Model 10001 features a completely interlocked circuit, with all high voltage leads and connections internal, for maximum safety; solid state high voltage bridge rectifiers for longer life and reduced heat output (prolonging life of other components, too); and built-in meters and viewing connectors for all principal parameters.

Other features are shown below. For complete specs and a list of at least 40 magnetrons suitable for use with the 10001, write Narda's High Power Electronics Division (HPED) at Dept. EI-7.

SPECIFICATIONS

High voltage supply: Continuously variable from 0 to 4 KV at 100 ma; **Pulse power:** 18 KV at 20 amps max.; **Magnetron filament supply:** Cont. variable from 0 to 13 volts at 3 A; **Rep. rate generator range:** Cont. variable from 180 to 3000 pps; **Pulse width:** 1 microsecond at 70% points, rise time 0.15 microseconds, max. slope 5% (other pulse widths available); **Size:** 38" h, 22" w, 18" d. **Weight:** 150 lbs.

Complete 1959 catalog available on request.

the narda microwave corporation
HIGH POWER ELECTRONICS DIVISION
118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

Circle 311 on Inquiry Card

Radio Fall Meeting Technical Papers

(Continued from page 87)

The Nuvistor Triode as an RF Amplifier in TV Receivers, Louis Barr, Radio Corporation of America

2:00 P.M. Transistorized TV Tuner Session

(Arranged by the IRE Professional Group on Electron Devices)

C. D. Simmons, Presiding

Design Notes on a Transistorized VHF TV Tuner, Victor Mukai, General Instrument Corp.

Transistorized TV and FM Tuners, Karl Whittig, Standard Coil Products Co. Inc.

Mesa Transistors for TV Tuners, H. F. Cooke and R. R. Webster, Texas Instruments, Inc.

Panel Discussion on Transistorized TV tuners including authors of above paper and the Session Chairman

6:15 P.M. Cocktail Party, East Room**

Courtesy of Radio Corporotion of America

** Admission only by specified portion of Fall Meeting Dinner Ticket.

6:45 P.M. Radio Fall Meeting Dinner, Ballroom

Toastmaster: D. R. Hull, President, Electronic Industries Association

Speaker: Frank W. Mansfield, Sylvanio Electric Products Inc., "The Soviet Union, It's People and It's Economy"

WEDNESDAY, NOVEMBER 11, 1959
EAST ROOM

9:30 A.M. Transistorized TV Session

(Arranged by the IRE Professional Group on Broadcast and Television Receivers)

R. R. Thalner, Presiding

Lineorization of a Transistorized Vertical Deflection System, R. B. Ashley, General Electric Company

A transistorized Sound Section for TV Receivers, L. J. Mattingly, Motorola, Inc.

Transistorized Bottery Operated Portable TV Receiver, A. R. Curll, Philco Corporation

Tronsistorized TV IF Amplifier, J. G. Humphrey, Generol Electric Compony

The Video Processing Circuits of an all Transistor TV Receiver, C. D. Simmons & C. R. Gray, Philco Corporotion

1:30 P.M. Transistorized Receiver Session

(Arranged by the IRE Professional Group on Broaccast ond Television Receivers)

Hugh Lowry, Presiding

Integrated AM/FM Transistorized Portable Receiver, H. van Abbe, Amperex Electronics Corporation

A Transistorized AM/FM Receiver Using Drift Tronsistors, R. A. Santilli and H. Thanos, Radio Corporation of Americo

Replacing Conventional Tuning with Semiconductor Capacitor Tuning in Auto Radios, J. Hammerslag, Hughes Products, Inc.

Solar Power Supplies for Transistorized Radios, J. Kalmon, Hoffman Electronics Corporation

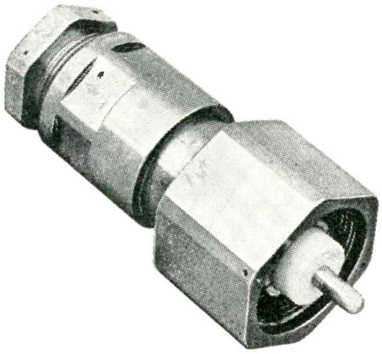
Transistorized Automobile Radios Employing Drift Transistors, R. A. Sontilli and C. Fronk Wheatly, Rodio Corporation of America

4:30 P.M. Adjournment

HI-POWER • HI-FREQUENCY TRANSMISSION LINE SYSTEMS

CABLE Connector

FOR RG-117/U CABLE



The Tamar USAF approved Captive Pin Connector embodies a captivated center conductor and dimensionally stable Teflon dielectric. Can be supplied in assemblies guaranteed to your specs., 100% tested for power and VSWR.

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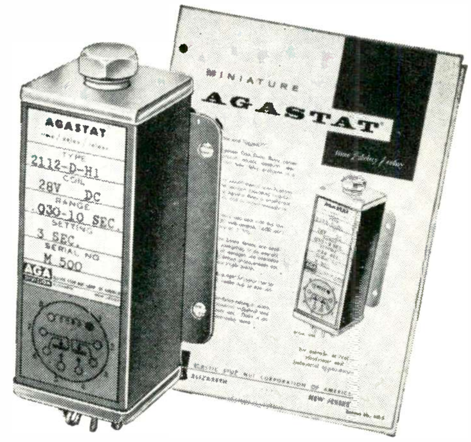

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This free folder contains complete specs on 24 models of the miniature AGASTAT Time Delay Relay for missile, aircraft, computer, electronic and industrial applications. They're small as 1-13/16" x 4-7/16" x 1½", with adjustable timing ranges starting at .030 and as high as 120 seconds.

The folder gives operating and environmental specs, coil data, contact capacities, dimensions, diagrams of contact and wiring arrangements. *Write:* Dept. A-33-1132.

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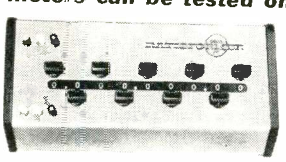
End Calculation and Transcribing Errors

- 0.001% Ratio Accuracy at a 1000:1 step down; this is terminal linearity of 1 part in 10 million.
- Resolution: 1 part in 100 million of input—300 million discrete steps above and below unity.
- Ratios of 3-to-1 step up to 10^{-8} step down.
- Direct, in-line readout of numbers on sloping panel.

Transformers, synchros, resolvers, computers, and meters can be tested on a simple "go/no-go" basis.



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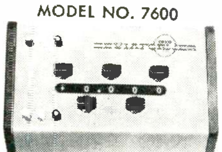
Ruggedly built. High input, low output impedance, extremely low phase shift make the OECO Ratioformer a versatile and adaptable instrument.



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Write for descriptive folder.

OSBORNE electronic sales corp.

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13105 S. Crenshaw, Hawthorne, California

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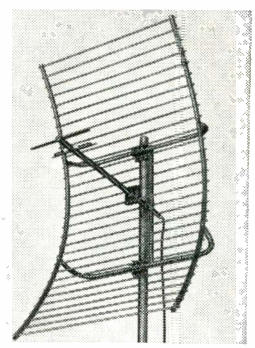
SCALA Paraflector

Equals a Dish for 350-1,000 mc



PARAFLECTOR* performance equals that of a parabolic dish of the same aperture. Yet the Paraflector costs less, weighs only 25 pounds, and is easier to assemble and install. Basically a parabolic section in one plane, the rugged Paraflector withstands 100-mile winds with a ¼-inch radial ice load. Driver is focused at the point source.

Applications—telemetering, point-to-point communications, off-the-air UHF/TV pick-up, TV translator/transmitter antenna.

Specifications: Gain, exceeds 15 db at 450 mc over half-wave dipole. Gain increases at higher frequencies, exceeds 17.5 db at 950 mc Horizontal beam width, 30 degrees to half power point. Vertical beam 22 degrees. Available with terminations of 72 ohms or 52 ohms. Aperture, 36" x 67".

Write for complete catalog on Scala corner reflectors, UHF-VHF yagis, paraflectors, ground plane and heated ground plane antennas. Please address Dept. EI-11.

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Circle 317 on Inquiry Card

B-58 Bombers Tested By Mobile Computer

A computer on wheels has been developed by Bendix to check out B-58 bombers on the flight line.

The computer-tester, first of its kind ever developed for any supersonic aircraft, can be rolled alongside the "Hustler" bomber and in approximately 90 minutes make 750 tests (one test every 7 secs) of the 1300-MPH-plus bomber's electronic "brain" and power control system.

Previously, it required two days merely to make spot checks of the B-58 control system.

Impossible for man to fly without its "power thinking" system, the Hustler now has a tactical ground support unit that can, to a large degree, "fly the plane on the ground." With the new check-out equipment the Hustler need not take off without absolute assurance that its complex control system is in working order.

The computer-tester, now being evaluated at the Ft. Worth plant of Convair, can be operated by two men who could be trained for their jobs in about 2 hrs. With the 750 tests programmed on a control tape, the test routine becomes largely a push-button operation.

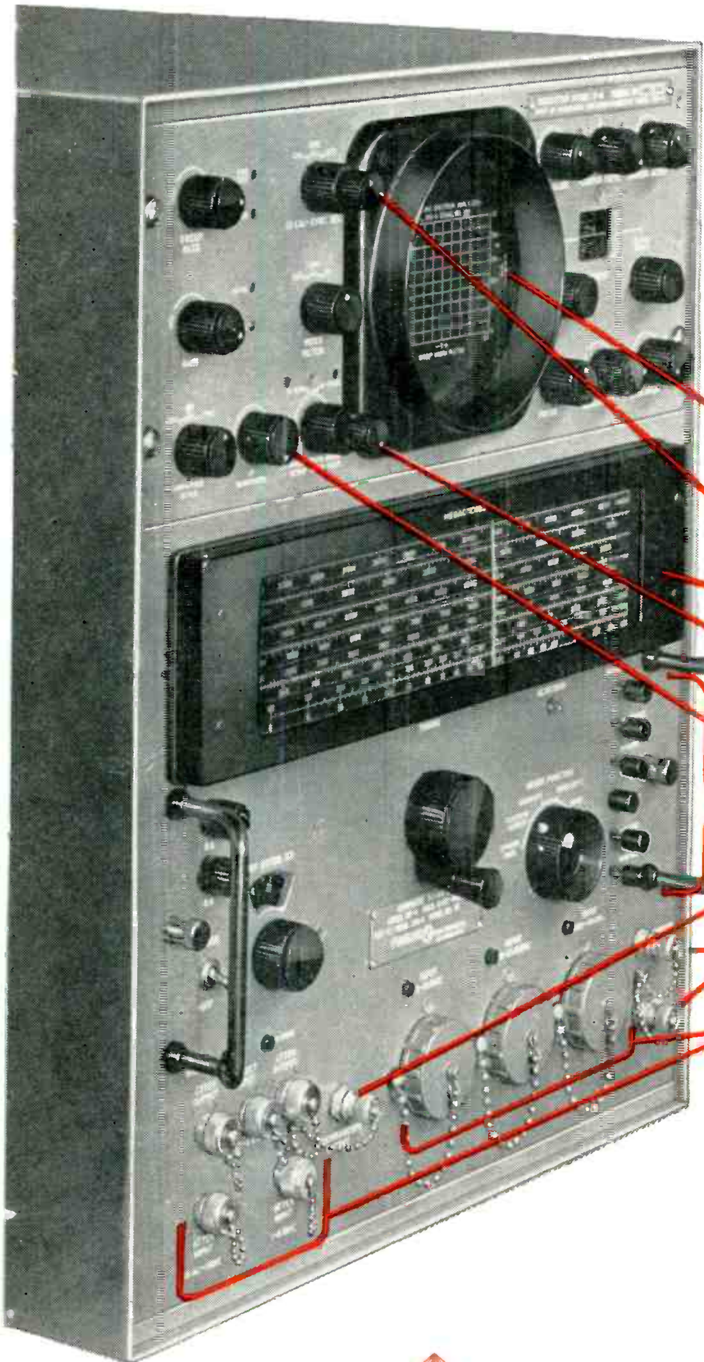
One member of the two-man test team is seated in the cockpit of the supersonic aircraft. On a small portable "cockpit subcontroller" he receives tape controlled instructions to throw switches, read instruments and move controls required to satisfy certain tests.

A special device, called the "surface motion transducer," is used during the test routine to measure actual control-surface (rudder and elevon) position during static and dynamic tests of the "Hustler." Under one set of flight conditions, for example, only eight-tenths of one degree of control-surface movement maneuvers the plane. Yet the same control surfaces need to move 20 degrees under extreme opposite conditions of speed and "air environment."

Memorial Park

Members of Varian Associates, Palo Alto, Calif., are seeking to purchase land which will be known as Castle Rock Memorial Park in honor of the recently deceased Russell Varian. Information requests and contributions are to be directed to Conservation & Memorial Fund, Sierra Club, 1050 Mills Building, San Francisco, Calif.

more exclusive advantages for applications demanding extreme sensitivity, stability, versatility



PANORAMIC'S SPA-4 SPECTRUM ANALYZER

10 mc to 44,000 mc

CHECK THESE IMPORTANT FEATURES:

THREE PRECISELY CALIBRATED AMPLITUDE SCALES — 40 db log, 20 db linear, 10 db power — for simultaneous measurement of signals having large or small amplitude differences and for reliable power point measurements. Front panel control selects scale.

CAL—SYNC SELECTOR simplifies sweep rate settings from 1 cps-60 cps to any submultiple of power line frequency.

ONE TUNING HEAD — 10 mc to 44,000 mc. Direct reading frequency scale with ±1% accuracy.

TWO INDEPENDENT FREQUENCY DISPERSION RANGES: Continuously adjustable; 0-70 mc for wide band investigations. 0-5 mc for extremely stable narrow band analysis. **Negligible Internal Frequency Modulation** permits extremely narrow band analysis free of FM problems.

VARIABLE I.F. BANDWIDTH 1 KC TO 80 KC for analysis of wide or narrow pulsed r.f. signals.

PUSH-BUTTON FREQUENCY RANGE SELECTOR. Automatically couples proper mixer and oscillator of desired band, illuminates applicable input connector and slide rule dial calibrations.

SYNCHROSCOPE OUTPUT WITH 40 DB GAIN for observations of input signal envelopes.

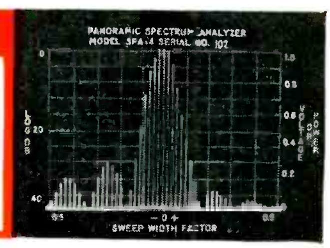
ACCURATE MEASUREMENT OF SMALL FREQUENCY DIFFERENCES. A self-contained marker oscillator, modulated by a calibrated external generator, provides accurate differential marker pips as close as 10 kc.

WAVEGUIDE INPUT CONNECTORS for 10.88 kmc to 44 kmc and type N connectors from 10 mc to 10.88 kmc.

PANORAMIC'S SPA-4 PROVIDES EXCEPTIONAL USABLE SENSITIVITY

	BAND	RF SENSITIVITY*
1-	10 — 420 MC	—95 to —105 dbm
2-	350 — 1000 MC	—90 to —100 dbm
3-	910 — 2200 MC	—90 to —100 dbm
4-	1980 — 4500 MC	—80 to —95 dbm
5-	4.5 — 10.88 KMC	—80 to —95 dbm
6-	10.88— 18.0 KMC	—70 to —90 dbm
7-	19.0 — 26.4 KMC	—60 to —85 dbm
8-	26.4 — 44.0 KMC	—55 to —85 dbm

*measured when signal and noise equal 2x noise



Analysis of pulsed signal on Model SPA-4 Sweep rate here was synchronized with PRF to show the individual spikes.

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Panoramic RADIO PRODUCTS, INC.

Tremendous flexibility and many unique advances of Panoramic's compact SPA-4 make it unsurpassed for visually analyzing FM, AM and pulsed signal systems; instabilities of oscillators; noise spectra; detection of parasitics; studies of harmonic outputs; radar systems and other signal sources.

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Circle 320 on Inquiry Card

Earth Image

(*Continued from page 107*)

000 miles above the earth—crossing Mexico.

The two-pound camera device, which took the picture, was made by Space Technology Labs., Inc. of Inglewood, Calif. They were the major industry contractor involved in the satellite experiment conducted by the National Aeronautics and Space Administration in cooperation with the U. S. Air Force Ballistic Missile Div. (ARDC).

While the earth was in the camera's field of view, the relative positions of the earth, sun and satellite allowed only a crescent of the sunlit earth to be seen. The southernmost portion of the crescent pictured (Fig. 2.) was not obtained because the transmitter was turned off. At the time of transmission the central part of the Pacific was lighted, while the North American continent was dark and Asia land masses were over the satellite's horizon.

In the image, scientists can discern cloud banks in the large white areas at the upper and lower parts of the crescent. The white area near the horizon in the equatorial region is believed to be sunlight reflected from the atmosphere or ocean.

Now for the technical details of transmission. The STL open-lens camera consists of two parts: a tube containing a mirror which receives and focuses light and dark impressions, and an electronic counter which computes and records these impressions before they are converted into radio signals. The payload is spinning about 2.5 times per second to give it stability. This provides the scanning movement. Once per revolution the camera unit records the impression it picks up, light or dark, in the form of a coded electrical impulse. This impulse can be reduced to a single dot. A row of dots form a line and eventually the lines form an image.

The signal from the camera is fed through a video amplifier. The video bandwidth of the image system is extremely narrow, 1.5 CPS. Compare this with the 4 MC. bandwidth used for commercial TV, which shows a complete picture in 1/30 of a second, whereas it requires 40 minutes to transmit one image from Explorer VI. Next the signal, governed by a clock, goes into one of two scalers, each having 64 elements and controlled by electronic gating. The image signals are fed to the FM telemetering transmitter and appear at the receiver on the earth as pulses of various heights, mixed-in with the other telemetered information from the satellite.

Explorer VI carries three transmitters, designed to operate on 378 MC, 108.09 MC and 108.06 MC. The latter has stopped transmitting. This might be due to the fact that one of the "paddle-wheels" is not properly extended. The image transmission took place on 108.09 MC by means of a transmitter rated at 60 milliwatts output—distance covered, 17,000 miles!

Videotape

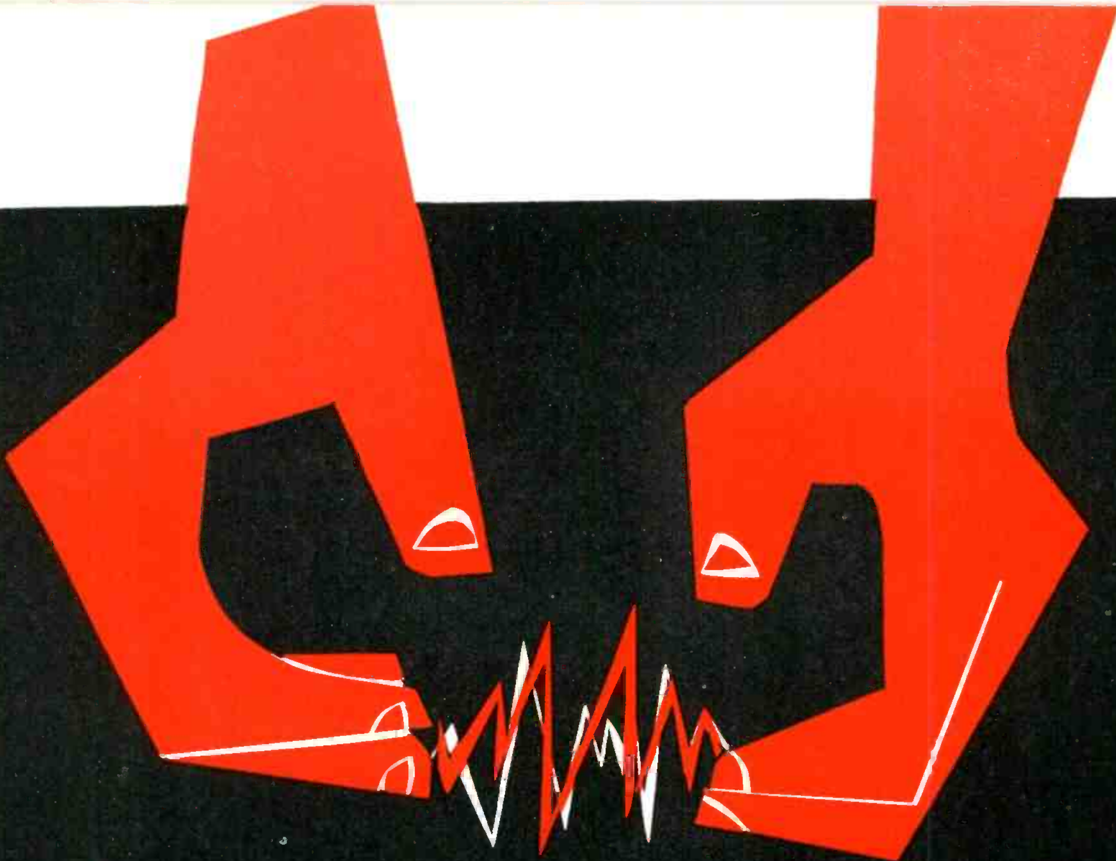
(*Continued from page* 93)

and one console. The entire system requires less than 100 sq. ft. of floor space. Within this space there is a complete recording and reproduction system. With 12½ in. reels, the machine provides up to 64 minutes of recording time.

Tape motion and modes of operation are controlled at the right-hand control panel on the console, or at a remote control unit. Correct operation of the system may be readily checked with indicators located on the control panel.

Placing Signals on Tape

The converted radar signal modulates a high-frequency carrier. This frequency-modulated signal is amplified and then impressed on the video heads. A modulator circuit is in operation during the record mode. A demodulator circuit is in operation during the reproduce mode. This modulator/demodulator circuitry serves the dual purpose of producing the frequency modulated signal during the recording process, and of recovering the original video signal by demodulation during the reproduction process.



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**

Advertisements Urge Boost for Engineers

Engineers Joint Council, 29 West 39th St., N. Y., N. Y., is sponsoring a series of advertisements in the trade magazines of the newspaper profession aimed at creating a better understanding of engineers and engineering by news writers and editors. EJC finds that the engineer's contribution to many projects is often neglected or minimized while the lion's share of credit goes to the scientists.

One of the ads urges editors and newspaper and TV writers to find out more about engineering "jargon," the obscure phrases that often occur in descriptions of engineering jobs.

Help for Inventors

A new pamphlet, available from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. ($0.15) is designed to guide inventors in deciding whether to apply for patents, in obtaining patent protection, and promoting their inventions.

The pamphlet suggests to the inventor: the consideration of the practicality of the invention; the importance of witnesses, records and diligence; making a search; studying patents found in the search, preparing the patent application and Patent Office prosecution. A second section comments briefly on the marketing and developing of the invention.

Other information: the meaning of "Patent Pending," when to apply for a patent, who may obtain a patent, ownership and sale of patents, duration of a patent, patent searching, plants and design patents, technical knowledge available from patents, infringement of other patents, etc.

← Circle 503 on "Opportunities" Inquiry Card

50th GRADUATE

George H. Mettler, (right) President, MB Electronics, presents diploma to Jack A. Ling, the 50th engineer to graduate from MB Electronics' special series of 10-day seminars on complex motion vibration testing. Ling is a reliability engineer at Sperry Utah Engineering Laboratory, Salt Lake City.

Engineering Careers Open With the FCC

The Federal Communications Commission is looking for more radio engineers. Opportunities are open to college seniors and graduates in engineering; also persons with some experience in electronics in general.

Starting salary is $4,490 to $4,940 a year for the GS-5 grade and $5,430 to $5,880 a year in the GS-7 grade. Those who feel they can qualify for higher grades should write for Announcement 112-B, Executive Secretary, Board of U. S. Civil Service Examiners, Federal Communications Commission, Washington 25, D. C.

Engineering positions are open in Washington and at various FCC field offices located throughout the U. S. including Alaska, Hawaii, and Puerto Rico. The FCC has 31 field offices and 18 monitoring stations in addition to broadcast, common carrier, safety and special and other operating units in its Washington office.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 221.

South Touted as Prime Industrial Location

"Facts and Figures about Atlanta," a 42-page, pocket-sized booklet published by the Industrial Bureau, Atlanta Chamber of Commerce, Atlanta 3, Georgia, is crammed full of information and statistics aimed at attracting industry to locate in the growing Southern market.

Some data supplied: auto registration figures, communications facilities, schools, information on local government, transportation data, annual rainfall and water supply, utilities, medical facilities, etc.

Operation Square Peg

The Air Force (probably with tongue in cheek) has named its new personnel system for Research and Development job-man matching, "Operation Square Peg."

The project is aimed at developing and implementing a new, highly mechanized system of job-man matching. The system will employ a procedure for matching of job profiles (job specifications) against the personnel profiles of research and development officers. Such a matching procedure will be mechanized within the limits of the statistical reporting system; but in addition, available personnel records will be utilized to a considerable extent.

Engineers and scientists have long protested the malassignments and malutilization of technical people by the armed services. The Air Force, while not claiming perfection, believes they are coming as close as possible to an optimum use of engineers and scientists in the Research and Development Command.

The sustenance for a R & D organization is new business—new projects. How does the company maintain the sharpness of thought and creativity of ideas? This is a key problem to the managers of such a firm. Several solutions are offered.

Education for R&D

By E. B. GILROY
Employee Relations Manager
Space Technology Laboratories, Inc.
P. O. Box 95001, Los Angeles 45, Calif.

THE life-blood of a company working specifically on R & D projects is knowledge or more to the point, the quest for knowledge. This type company is geared to solving technical problems. One method suggested to increase the knowledge for projects is to establish a program of education for the scientist and engineers working on them.

A general concept of training and education is that it essentially is learning. Learning is a continuous process, particularly in a R & D organization, where new solutions are ever-sought to old and new problems. Most thoughtful students of education and training advise that these activities should be planned, systematized, and formalized for efficient and accurate learning. Further, that a program for education and training should adapt itself to the individual—or at least lend itself to the needs of the individual.

Training

Inherent in an R & D company is the emphasis on the individual. While the lonely scientist plodding across unknown horizons of physical phenomena may be gone, there is evidence that the scientist can individually see his efforts come to fruition. Certainly more so than the clerk or mechanic in the mass production industries. Thus, a program should reflect this individuality.

In addition, the training and education programs should fulfill the needs for advanced learning. Technology and its present rapid rate of change require continuous learning.

Companies find their engineers and scientists patterned by degrees as follows:

Doctorate	14%
Masters	33%
Bachelors	50%
No Degree	3%

Note the emphasis on the advanced degrees. Almost half the technical population holds two or more degrees.

Engineers and Training

The core of education and training in the R & D company truly must be different. They are the programs established to constantly provide the company with the ever-curious, ever-thoughtful, and ever-creative engineer and scientist. Most education and training have as objectives reduction of waste, improvement of methods, reduction of learning time, or a combination of these objectives. The objectives of education and training in an R & D company for its scientists and engineers is knowledge.

The spark of creativity, the solution for problems, the theories for evaluation and study come from strange sources in varying shapes. Some may be the result of timeless observations. Others may be the result of insight or accident. Yet behind every solution is knowledge. Knowledge turned to good avail at a time of need.

A Philosophy

The key to the successful educational program should be based on a philosophy oriented to the individual scientist and engineer which provides not only opportunity but encouragement and incentive; and that knowledge in itself is good.

Quite naturally, this establishes a broad base for educational efforts. When you consider the extremely varied personal, educational, and professional backgrounds of most engineers and scientists, it would appear the broad approach to continuing education is only an extension of their total previous learning experience.

Four types of educational programs are appropriate for an R & D company. They are: "On-Site," "On-Campus," Conferences and Home Study. More types might be considered but these appear to be the main ones.

"On-Site"

"On-Site" training and education lends itself to a number of possibilities. These possibilities are visiting lecturers, symposiums, and special classes.

The visiting lecturer series can be offered on a continuing basis. This offers a large number of topics over an extended period. Such a series is bound to attract one or all of a company's engineers with its varied technical topics.

The symposiums probably should be limited. Here depth of study about one subject is the prime objective. The planning, programming and carrying through for a successful symposium naturally limits the number which can be undertaken.

The selection of special classes presents several problems. One is appeal. Another is instruction. Another is equipment, since advanced study could involve laboratory work. Of course, a language course or a short and intensive course on a new piece of equipment or component is fairly easy to schedule and teach. The student group can come from varying areas within the company, yet have sufficient interest to join together for the duration of the course. The advanced engineering course, provided the instructor and facilities can accommodate the subject matter, may also be successful.

"On-Campus"

"On-Campus" education is superior to the "On-Site" method with the possible exception of an industrial application. Knowledge and education are the products of the university, The research and development organization generally is only a poor competitor.

Yet, there are problems in utilizing the resources of a university. The obvious ones are time and effort. In some cases, it may be advantageous for men to attend school full time and work part time, with the major share of expense being borne by the company. In other cases, the natural course would be for the men to attend evening classes or to attend a very limited number of hours during the work day.

It would seem that the built-in desires of the individual engineer and scientist should key the company share of the individual's educational expense. If an individual decided to sacrifice a portion of his salary to attend school full time for an advanced degree, a wise investment for his company would be to share the expense for the additional education.

The part-time student problem is not as great. Laboratory projects permit some flexibility for scheduling work when a day-time class is particularly attractive to a scientist. Thus, attendance may be possible at a campus not too distant from the work site and the project not lose ground.

The evening student, from the standpoint of work schedule, is the least of problems. And it is in the evening that many engineers, particularly the younger ones, can enhance their knowledge and continue their education. Perhaps the bulk of formal study of a company's engineers will be conducted during the evening.

Conferences

While a conference or a convention may not be considered as "On-Campus" they definitely are "Off-Site." This type of education can be used to acquaint engineers with recent developments in a given discipline, or a segment of a discipline. In addition, the conference or convention generally permits observation of new components, equipment and techniques. For a brief and intensive exposure to a limited subject, the conference lends itself very well.

Home Study

One other educational technique remains. This is the home study method. It should be remembered that the motivation to learn has been satisfied for years by correspondence schools. Indeed, the most prominent of our contemporary correspondence schools could, and oft-times does, point with pride at the number and eminence of some of its alumni.

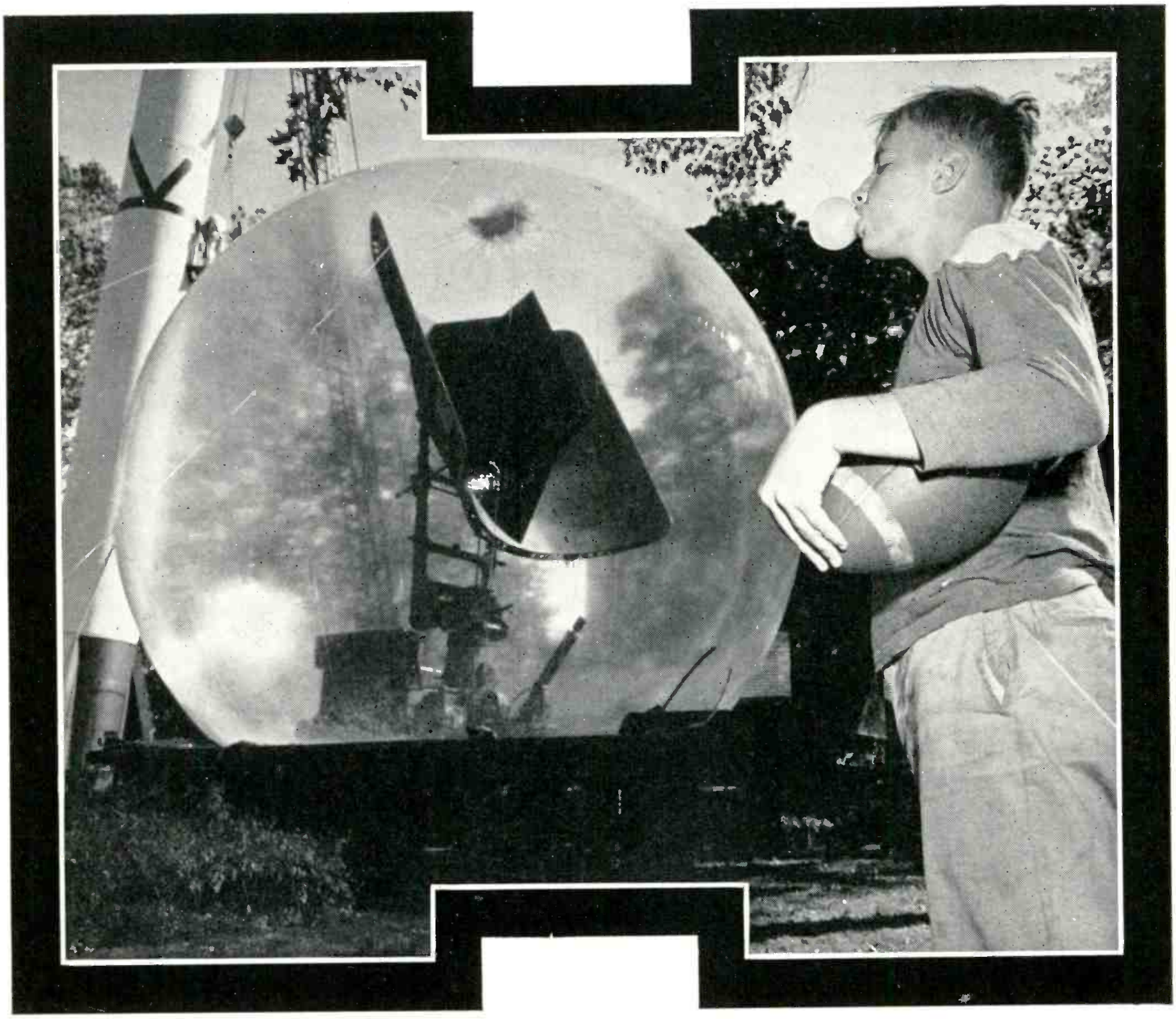
The general nature of most home study courses precludes the avid interest of the graduate engineer. But such study should not be discouraged. Indeed, the better the technician and junior engineer can perform his work, the stronger the company.

One further thought about home study. The group which will primarily be interested in home study will be the least able financially to undertake such work solely on their own. A R & D company may want to recognize this possibility by providing a slightly higher reimbursement than for other courses of study:

It seems appropriate to close with a thought which must underlie the entire educational effort. Training and education will succeed whether it be by methods, such as classes, or conferences when the company atmosphere encourages and recognizes technical and professional growth. The words and the actions of those who manage the business are the finest of all incentives.

★ ★ ★

A new dimension in



bubble blowing

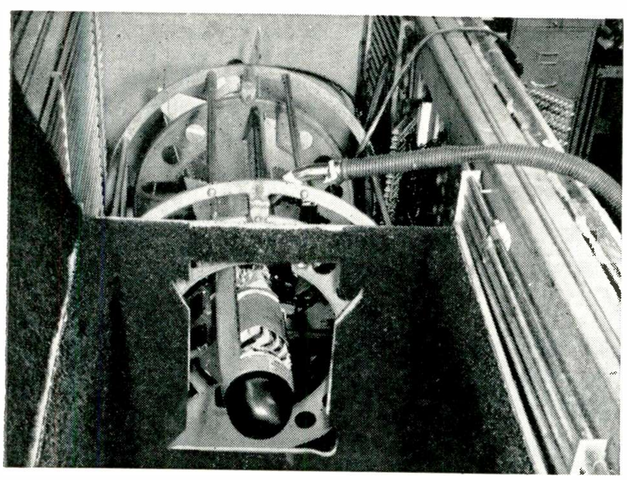
This plastic bubble protects the antenna of a radically new aerial three-dimensional radar defense system.

Sensitive to the inadequacies of conventional radar systems, engineers at Hughes in Fullerton devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This advanced technique allows simultaneous detection of range, bearing and altitude...with a single antenna.

Hughes engineers combined this radar antenna with "vest-pocket sized" data processors to co-ordinate antiaircraft missile firing. These unique data processing systems provide:

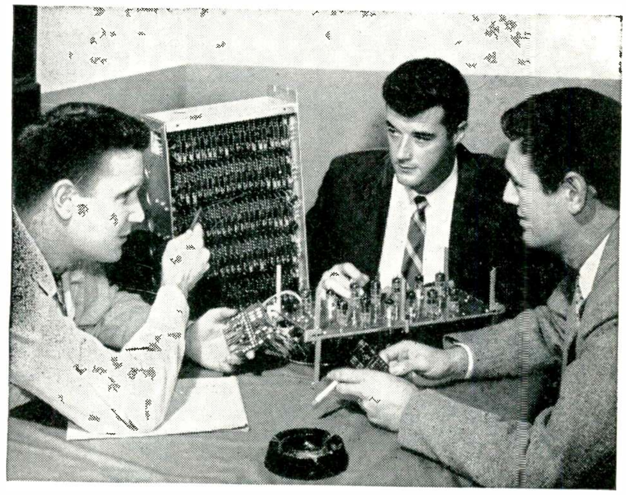
1. Speed—Complex electronic missile firing data was designed to travel through the system in milliseconds, assuring "up-to-date" pinpoint positioning of hostile aircraft.
2. Mobility—Hughes engineers "ruggedized" and miniaturized the system so that it could be mounted into standard army trucks which could be deployed to meet almost any combat problem—even in rugged terrain.
3. Reliability — By using digital data transmission techniques, Hughes engineers have greatly reduced any possibility of error.

Result: the most advanced electronics defense system in operation!



Falcon air-to-air guided missiles, shown in an environmental strato chamber are being developed and manufactured by Hughes engineers in Tucson, Arizona.

Reliability of the advanced Hughes systems can be insured only with the equally advanced test equipment designed by Hughes El Segundo engineers.



Other Hughes projects provide similarly stimulating outlets for creative talents. Current areas of Research and Development include advanced airborne electronics systems, advanced data processing systems, electronic display systems, molecular electronics, space vehicles, nuclear electronics, electroluminescence, ballistic missiles...and many more. Hughes Products, the commercial activity of Hughes, has assignments open for imaginative engineers to perform research in semiconductor materials and electron tubes.

Whatever your field of interest, you'll find Hughes diversity of advanced projects makes Hughes an ideal place for you to grow...both professionally and personally.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Infrared	Thin Films
Plasma Physics	Microwave Tubes
Digital Computers	Circuit Design & Evaluation
Field Engineering	Systems Design & Analysis
Quartz Crystal Filters	Logical Design
Communications	Semiconductor Circuit Des.

Write in confidence to Mr. Mike Welds
Hughes General Offices, Bldg. 6-C11, Culver City, Calif.

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Tucson, Arizona

First V-E Conference Was Lively Affair

The EIA-sponsored Value Engineering Conference held in Phila., Oct. 6-7, highlighted the techniques, current achievements, and goals of Value Engineering. This relatively new discipline aims at the scientific analysis and solution of cost problems in manufactured products.

Attendance was well over the 300 originally expected. Representation was about evenly divided between Armed Service (mostly Army & Navy) and Industry groups. Mechanical and Electrical engineering specialties were also about evenly represented. Many companies, faced with implementing VE provisions in military contracts, sent people to find out how to get a VE program started.

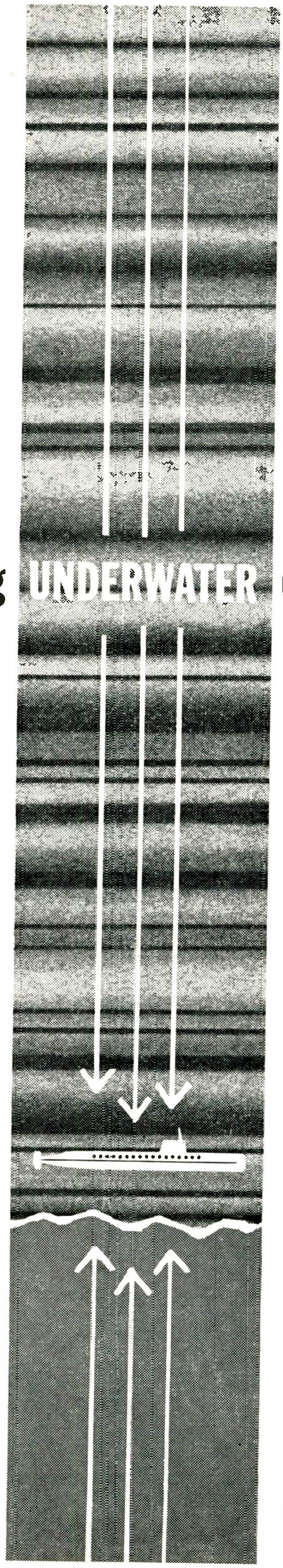
The technical sessions, covering both military and industrial aspects of VE, sparked some lively discussion periods. Spirited (but friendly and humorous) exchanges frequently broke out between the mechanical and electrical engineers over which group was doing the most work in the field. Questions most frequently asked dealt with the problems of organizing and installing value engineering programs—the value of the programs was seldom questioned since the cost cutting illustrations used in the talks were rather spectacular.

Typical questions were: What is the make-up of a typical VE group? What level of responsibility should the group have and who should get the "credit" for engineering changes? Where in the research-design-development-production process does value engineering produce the best results.

Of particular interest were the incentives to industry (especially to those companies having military contracts) to develop VE programs. Some Army & Navy contracts are already providing this incentive by sharing the profit derived from VE in varying proportion with the companies.

Some topics covered: simplification of design; realistic applications of tolerance; proper selection of material; proper application of processes; utilization of standard parts; and utilization of specialists' services and products.

The proceedings of the conference are available (approx. $6.00) from: Engineering Publishers, P. O. Box 2, Elizabeth, N. J.



EEs MEs AEs Physicists — Immediate openings at various levels:

Systems Development
EEs, MEs or AEs with 5 yrs development of automatic controls for weapons.

Systems Evaluation
EEs with 5 to 8 yrs electronics experience in weapons systems; supervisory experience.

Fire Control Engineering
EEs with 2 to 8 yrs fire control systems, circuits or component design.

Inertial Equipment Design
EE, ME or Physicist with 8 to 10 yrs in design and development of inertial components.

Underwater Equipment Design
EEs or Physicists with 2 to 4 yrs in electronics, design or testing underwater equipment (torpedoes).

Electronic Circuit Development
EEs with 2 to 10 yrs in circuit design preferably solid state.

Contract Administration
EEs, MEs or BBAs with 2 to 5 yrs in military contracts.

Computer Development
EEs with 2 to 7 yrs in digital or analog circuit development, test and evaluation.

Quality Control Engineering
EEs, MEs or Physicists with 2 to 7 yrs in fire control or radar, strong QC interest.

Product Design
EEs, MEs with 6 to 10 yrs in electronic package design, printed wiring boards and heat transfer.

Computer Programming
Physicist or Mathematician with 3 yrs in digital computers.

Sales Engineering
EEs, MEs with 3 to 7 yrs in defense electronic products preferably underwater ordnance or inertial equipment.

Technical Publications
EEs or Physicists with 1 to 6 yrs in engineering writing, military electronics.

engineers

Developing UNDERWATER Ordnance Systems to Meet the NEW Threats of Submarine Warfare

. . . one stimulus to creative engineering at General Electric's Ordnance Department

One of the fastest growing threats to our nation's safety is the mounting offensive power of the submarine, in terms of missile launching capabilities, increased speed, greater cruising depths.

To meet this Under Sea Warfare threat with Anti-Submarine Warfare capabilities, General Electric's Ordnance Department is active in a number of areas.

An example of Ordnance's ASW work is the new submarine killer, the Torpedo MK44, which is capable of *attaining the speeds and depths associated with nuclear powered submarines.*

Designed, developed, and manufactured by the General Electric Ordnance Department, this versatile acoustic homing torpedo can be surface launched or air-dropped in the vicinity of its submerged target. Once in the water, the electric-powered torpedo begins a search for the target in a programmed pattern, its acoustic system listening for the tell-tale sound of the submarine. The target detected, the MK44 homes in for the kill.

Other unclassified ASW projects include mines, their mobile countermeasures, etc.

GE-Ordnance Dept. also deeply engaged in missile programs — They include:

- Missile Inertial Guidance Systems and Components
- Missile Fire Control Systems and Components
- Missile Handling and Launching Equipment
- Missile Guidance Trackers • Missile Directors

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ORDNANCE DEPARTMENT
OF THE DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

100 PLASTICS AVENUE, PITTSFIELD, MASSACHUSETTS

Circle 505 on "Opportunities" Inquiry Card

News of Reps

Vernon E. Hopler has joined the sales staff of N.L.R. Assoc., Manufacturers' Rep, West Orange, N. J., as a Sales Engineer covering Metropolitan New York and Long Island.

Appointment of **Costello & Co.**, Los Angeles, as West Coast technical rep for the Kollmorgen Optical Corp. has been announced.

Seatronics, Inc., the Components Div., Forland-Drake Corp. has been appointed sales rep by Ohio Semiconductors, Inc., in Washington, Oregon, Idaho and Vancouver, B. C., Canada.

The Kittleson Co., West Coast manufacturers' rep firm, has appointed **Bill Anderson** to a Staff Engineer position in their Los Angeles office. He was formerly with Chrysler Corp's Missile Operations Div. and with Douglas Aircraft.

W. Anderson

M. A. Stolaroff

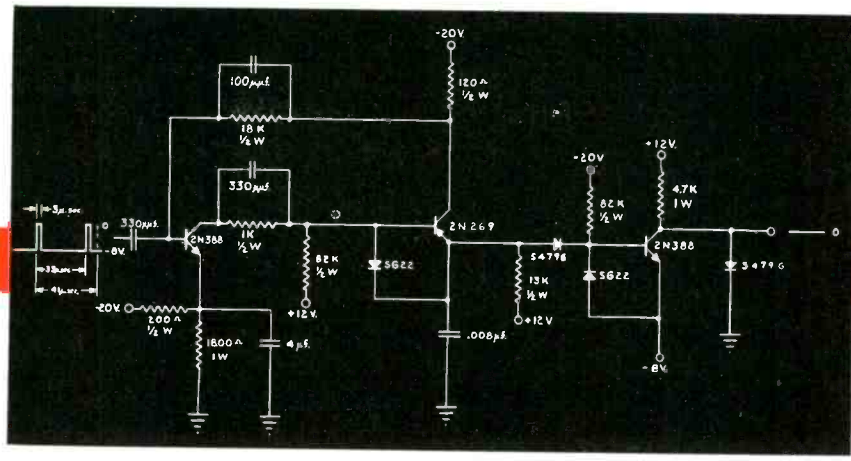
M. A. Stolaroff Co., Los Angeles, Calif. is now rep in Southern California and Arizona for The Daven Co.

Deveer Sales Engineering Co., Needham, Mass. is now industrial sales rep for the six New England States, excluding Fairfield County, Conn., for Power Sources, Inc.

Wallace-Gluck Co., Dallas, Tex., has been appointed Texas sales rep for Perkin Engineering Corp., Electronic Div. Territory includes Louisiana, Arkansas, Oklahoma, and all of Texas except El Paso.

Grace Electronic Chemicals, Inc., has appointed **Earl S. Chafin & Assoc.**, Los Angeles, as technical sales rep in California and Arizona.

Nuclear Electronics Corp., has appointed **Lin Assoc.**, Brighton, Mass., as manufacturers sales rep for New England.



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The National Cash Register Company—a leader in the application of automation to business machines—has organized its Research and Development Division to provide ideal working environments for technically trained men and women of the highest calibre. Projects in progress are of an exciting, stimulating nature . . . for instance, considerable work is being done on Encapsulation and thin film memory and switching components. Your training and experience may qualify *you* for a position in one of these areas:

DATA PROCESSING RESEARCH AND DEVELOPMENT

Computer Theory
Computer Component Development
Machine Organization Studies
High-Speed Non-Mechanical Printing and Multi-Copy Methods
Direct Character Recognition
Systems Design

ELECTRONIC ENGINEERING DEVELOPMENT

High-Speed Switching Circuit Techniques
Random Access Memory Systems
Circuit and Logical Design
Advanced Storage Concepts Utilizing Electron Beams
Microminiaturization of Components and Circuitry

SOLID STATE PHYSICS

Electrodeposited Magnetic Films
Vacuum Deposited Thin Magnetic Films
Ferrites and Ferromagnetics
Electroluminescence-Photoconductor Investigations
Advanced Magnetic Tape Studies

CHEMISTRY

Plastics and Polymers
Encapsulation *(A process for producing microscopic capsules containing liquids or reactive solids)*
Photochromic Materials *(Studies of National-developed compounds which are photosensitive to specific wave lengths of light, for application to memory, printing and photocopy devices)*
Magnetic Coatings

NATIONAL'S NEW RESEARCH AND DEVELOPMENT Center is located in Dayton, Ohio, one of the midwest's most progressive cities.

FOR COMPLETE INFORMATION, simply send your resume to Mr. T. F. Wade, Technical Placement, F-1, The National Cash Register Company, Dayton 9, Ohio. All correspondence will be kept strictly confidential.

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Circle 507 on "Opportunities" Inquiry Card

News of Reps

Associated Industries, Seattle, Wash., has been appointed rep for Rogers Corp. in Oregon and Washington and at the Boeing Co., Wichita, Kans.

McCarthy Assoc. Inc., Pasadena, Calif. has been appointed engineering rep for Cubic Corp. The firm will represent Cubic in Southern California and Arizona.

Packard Assoc. have been appointed by Atohm Electronics, factory rep in Oklahoma, Arkansas, and Louisiana.

Chicago Telephone Supply Corp. has appointed **Koehler-Pasmore Co.,** Detroit, Mich. and **Hollingsworth & Still,** Atlanta, Ga., as reps in those areas.

Frank C. Minch & Associates, Dayton, Ohio, and **Radionics, Ltd.,** Montreal, Canada, have been appointed sales reps for CBS Laboratories, division of Columbia Broadcasting System, Inc.

General Transistor International Corp., Jamaica, N. Y., has been appointed export distributor for Columbus Electronics Rectifiers, Columbus Electronics Corp.

Rivett Inc. has appointed **Ray Bobbs Air-Draulics, Inc.,** Portland, Ore. as rep in Oregon and Washington.

The Grip Nut Co. has appointed **James McGraw,** St. Louis, as sales rep in Kansas, Missouri, Western Tennessee and lower Illinois.

E. F. Sullivan is now sales rep for Stromberg-Carlson's Telecommunication Div. in Ohio and West Virginia.

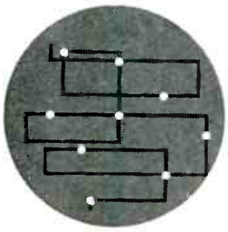
Atlas EE Corp. has appointed **Charles Kemp** of Kemp Engineering, Dallas, Tex., as their rep for Tex.

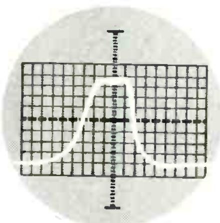
Frank Tylinski, Queens, N. Y. has been appointed New York sales rep for Ohio Semiconductors, Inc.

Grant D. Whipple has been named New York Area rep for Autonetics, Div. of North American Aviation, Inc.

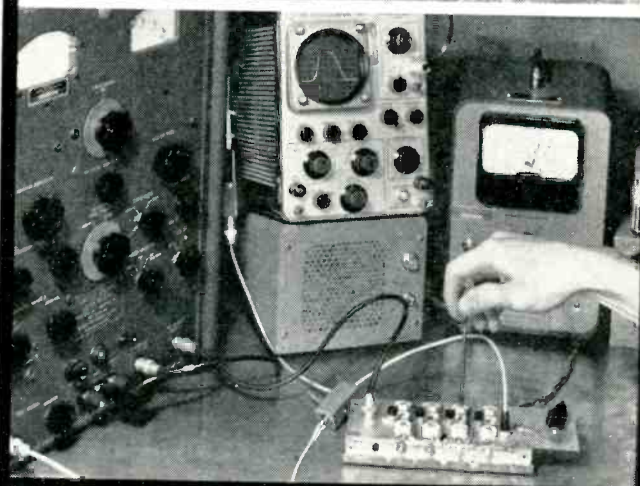
Arthur Cohen is now sales rep in Florida for McIntosh Laboratory, Inc.

CAREER OPPORTUNITIES AT TI





CIRCUIT DEVELOPMENT ENGINEER



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C. A. Besio, Dept. 201-EI

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INCORPORATED
SEMICONDUCTOR – COMPONENTS DIVISION
POST OFFICE BOX 312 • DALLAS, TEXAS

For immediate Eastern appointment, contact
H. C. Laur
Dept. 201-E-EI
1141 E. Jersey St.
Elizabeth, N. J.

Circle 509 on "Opportunities" Inquiry Card

News of Reps

Three new reps have been appointed by Teletronics Laboratory, Inc., a subsidiary of Crosby-Teletronics Corp. They are: **John B. Lightstone**, Syracuse, N. Y., Upper New York State, north of and including Delaware, Greene and Columbia counties; **Electro-Mec Associates**, Warren, Mich., and **J. K. Dooley Co.**, Seattle, Wash., in Washington and Oregon.

Fred F. Barlett & Co., Wayne, Pa., has been appointed field rep in the Mid-Atlantic area for Eitel-McCullough, Inc.

James R. Bunn, Staff Engineer in the Neely Enterprises, Albuquerque office, has been promoted to Field Engineer.

Elliott-Sarles Co., Westlake, Ohio, is now sales rep in Ohio, Michigan and Western Pennsylvania for Systems Div., Beckman Instruments, Inc.

Bishop Mfg. Corp. appointed **Hugo Sales Co., Inc.**, Minneapolis, Minn., as sales rep in Minnesota, North Dakota and South Dakota.

J. D. Robertson, Inc., Atlanta, has been appointed rep for F. J. Stokes Corp., in North and South Carolina, Georgia, Florida, Tennessee, and Alabama.

Robert O. Whitesell and Assoc., Indianapolis, has been appointed sales rep by Ohio Semiconductors, Inc., to cover Indiana, Ohio, Kentucky, West Virginia and Eastern Pennsylvania.

Harry L. Harkness has joined the Burt C. Porter Co., Seattle, rep, as inside salesman. He was formerly with the Industrial Engineering Sect., Boeing Airplane Co.

Perkin Engineering Corp., Electronics Div. appointed **E. G. Holmes Assoc.**, Atlanta, Ga. as southern sales rep. Territory is Tennessee, North and South Carolina, Georgia, Alabama and Mississippi.

Chris Hrushowy is now sales and service rep for TelePrompTer of Canada, Ltd., div. of S. W. Caldwell Ltd.

Books

Elementary Decision Theory

By Herman Chernoff and Lincoln E. Moses. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 364 pages. Price $7.50.

This book introduces statistics as the science of decision making under uncertainty. This approach furnished a direct and elementary method of exhibiting the fundamental aspects of statistical problems.

Special features of the work are the employment of simple non-technical examples to suggest fundamental principles, requirement of only an understanding of high school mathematics, and the inclusion of exercises that are not difficult, yet involve enough use of the imagination to prepare the reader to accept and retain important material.

It also provides well motivated use of interesting elementary mathematical ideas by repeated application to statistical problems, and contains special chapters on utility theory and model building.

Digital Computer Primer

By E. M. McCormick. Published 1959 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 205 pages. Price $7.50.

This book provides a concise explanation of the fundamentals of modern digital computers. How they work, what they can do, and their important mathematical, engineering, electronic, and accounting aspects are described in non-specialists language.

Following a review of basic units, essential characteristics, terminology, and sequence operations, the book gives a detailed coverage of coding; number systems; the logic of computers; and the control, arithmetic, storage, and input-output units. Instructions, programming, and methods of checking accuracy are also carefully treated.

The chapter on computer logic takes an intuitive, non-mathematical approach. As simple examples, the book describes the logical organization of a tick-tack-toe playing machine and other game-playing devices. The appendix presents material on the value of representing logical operations by means of Boolean algebra and basic manipulations possible.

Basic Data of Plasma Physics

By Sanborn C. Brown. Published 1959 by The Technology Press, Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 336 pages. Price $6.50.

This volume presents the fundamental data for plasma physics which will be necessary for an understanding of any work in gas discharges, plasma physics, the plasma in controlled thermonuclear devices, upper atmospheric research, including satellites, insofar as ionizations are im-

Books

portant. The whole emphasis of the book is on the fundamental processes with the necessary data and background information given in the form of graphs and tables. Devices are discussed only as illustrations of the fundamental physics of the motion of charged particles.

Finite Mathematical Structures

By John J. Kemeny, Hazleton Mirkil, J. Laurie Snell, and Gerald L. Thompson. Published 1959 by Prentice-Hall, Inc., 70 Fifth Ave., New York 11. 487 pages. Price $7.95.

This new book provides unique coverage of the most recent development in the field of modern mathematics.

Emphasizing the applications of mathematical principles to the physical scientist, the book offers unusual but appropriate ways to apply basic mathematical principles. Typical of these is Markov chain theory applied to electric circuits.

Within a solid framework of topics related to and reinforcing each other, new connections are developed between logic, probability, and algebra. Fresh in approach and challenging in presentation, this book clearly presents: careful and detailed presentations are the elementary ideas of real vector spaces; probability theory firmly based on logic and set theory; sharp distinctions between affine and Euclidean concepts; and, emphasis on the finite case allowing for the avoidance of cumbersome mathematical machinery.

A Table of the Incomplete Elliptic Integral of the Third Kind

By R. G. Selfridge and J. E. Maxfield. Published 1959 by Dover Publications Inc., 180 Varick St., New York 14. 832 pages. Price $7.50.

This work contains the first complete 6-place table of values of incomplete integrals of the third kind. The table was prepared under the auspices of the Research Dept. of the U. S. Naval Ordnance Test Station. It was calculated in response to the need for such a table in the solution of specific problems after a search of the literature had disclosed that no complete set of values of these integrals were available. Calculations were made on an IBM type 704 calculator and thoroughly verified both by an echo-checking procedure and by means of a check integral at the completion of each value of a.

Frequency Response for Process Control

Edited by William I. Caldwell, Geraldine A. Coon, and Leslie M. Zoss. Published 1959 by McGraw Hill Book Co., Inc., 330 W. 42nd St., New York 36. 400 pages. Price $11.50.

The fundamental methods of frequency response in their application to the analysis, testing, and design of process control systems are clearly presented in this newly published book. It explains the analysis of complete systems by means of highly effective techniques, and gives typical solutions to many practical problems.

In the section of the book devoted to theory, careful treatment is given to the distance-velocity lag, linear lag, and stability considerations. Methods of analysis are presented with emphasis on the damped response method. The coverage of controller responses includes control charts for a variety of responses. Results are shown for variation of process and controller parameters. Closed-loop responses are explained, and disturbances are discussed with regard to their magnitude and location in the control loop.

Package Design Engineering

By Kenneth Brown. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 263 pages. Price $8.50.

The material presented in this book was originally prepared for a course in "industrial package design" which was offered at the University of California and Los Angeles by the author. The first 8 chapters cover the basic fundamentals of static and dynamic mechanics, strength of materials, and stress analysis that are required by the packaging engineer to provide him with the necessary background for solving the structural and dynamic packaging problems.

The next 4 chapters are devoted to the design characteristics of the tension spring, rubber shear mount, solid cushioning, and canvas straps suspension systems. Another 4 chapters are devoted to the peculiarities of corrugated, sheathed crate, plywood and metal shipping containers. The final 3 chapters illustrate the engineering fundamentals of design application of dehumidification and pressurization, giberation, and package test instrumentation.

Microwave Measurements for the Technician

By Ralph W. Ritchie. Published 1959 by Wm. C. Brown Co., 135 S. Locust St., Dubuque, Iowa. 167 pages. Price $3.50.

The purpose of this manual is to provide a background of the basic microwave measurements. It is designed for use at the college or technical school level. A technician, in order to be capable at a microwave test bench, does not have to have the background in electromagnetic theory and mathematics required for the courses in microwave which are given as part of engineering training.

It will be noted in some of the explanations of microwave components, reactances and impedances are used instead of the admittance-susceptance concept which is usually applied to this work.

Books

Books Received

Low Frequency Amplifiers

Edited by A. Shure, PhD. Published 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 88 pages, paper bound. Price $1.80.

Principles of Transistor Circuits

By S. W. Amos. Published 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 176 pages, paper bound. Price $3.90.

Scientific Russian

By George E. Condoyannis. Published 1959 by John F. Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 225 pages, paper bound. Price $3.50.

Handbook of Electronic Control Circuits

By John Markus. Published 1959 by McGraw-Hill Book Co., Inc., 331 W. 42nd St., New York 6. 350 pages. Price $8.50.

1959 Registry of Public Safety Radio Systems

Published 1959 by Communication Engineering Book Co., Monterey, Mass. 176 pages, paper bound. Price $4.00.

Electronic Components Handbook

Published 1959 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 6. 192 pages. Price $10.00.

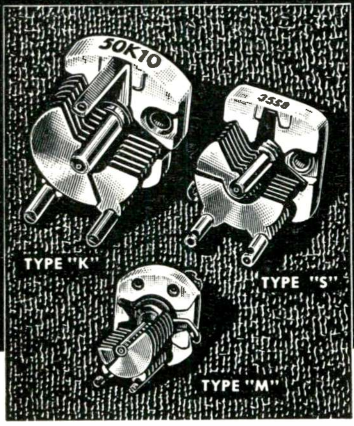
Space Medicine Electronics

Published 1959 by The Franklin Institute, Phila. 3, Pa. Price $4.00.

ELECTRONIC INDUSTRIES Advertisers—November 1959

JOHNSON MINIATURE CAPACITORS

Compact Design! Rugged Construction!



Save valuable space in RF equipment...

Johnson miniature and sub-miniature air variable capacitors are available in a wide range of sizes, types, and capacities—perfect for use in compact RF applications. The 3 types described below have soldered plate construction, oversize bearing, and heavily anchored stator supports to provide extreme rigidity. Inductance path to both stator supports is extremely low with bridge-type stator terminal. Large compression rotor contact provides steady torque—rotor stays "put" where set. Rotor contact and all other metal parts are nickel-plated—steatite insulator is DC-200 treated.

SUB-MINIATURES—In addition to the miniature air variables described below, the new Johnson Type "T" and "U" sub-miniature capacitors are also available in production quantities. Write for our new components catalog 978 listing complete specifications.

TYPE "M"—Peak voltage 1250 volts on .017" plate spacing; 850 volts on .013" spaced units. Shaft slotted for fast screwdriver adjustment—mounting bushing threaded with flats to prevent turning—mounting nut furnished. Available in production quantities with the following features: locking bearings; 180° stop; various shaft extensions; high torque; silver or other platings. Single section, butterfly, and differential types available.

TYPE "S"—Midway in physical size between the Type "M" and "K" capacitors, the Type "S" has a plate spacing of .013" with a peak voltage rating of 850 volts. Other spacings, single hole mounting types, straight shaft, screwdriver shaft, or locking type screwdriver shaft available on special order in production quantities.

TYPE "K"—Widely used for many military and commercial applications, the Type "K" has a peak voltage rating of 1000 volts with a plate spacing of .015". Unit is available in production quantities to meet MIL-C-92A specifications—other capacities and variations for specialized military and commercial applications are also available in production quantities.

New Catalog

For detailed specifications, including engineering drawings, on Johnson miniature and sub-miniature capacitors, as well as other Johnson electronic components, write for your free copy of our new components catalog No. 978.

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Advertisers Index —continued

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FEATURES
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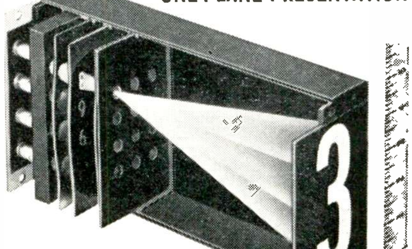

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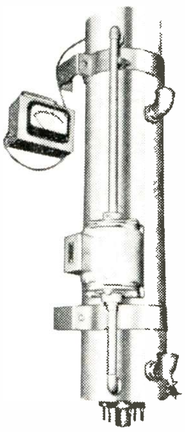
NEW! HI-POWER COAXIAL

CALORIMETRIC POWER METER

DIRECT READING—5 to 50 KW
DC—1000 MC • VSWR less than 1.3



These power meters are greatly simplified Calorimeters which use water to carry the heat away, for economy of space and cost.
The instrument is fully self-contained, portable, water cooled and requires only connection to the power line and water supply. It does not use any flow meters, thermometers or any other controls. There is only the "ON" and "OFF" switch for the operator to use on the front panel, when a measurement is to be made. A sensitive thermopile and microammeter measure the power dissipated in the R.F. load. The microammeter is calibrated in watts, is direct reading and can be remotely located.
The radio frequency load has a low VSWR between DC to 1000 MC. This feature makes it possible to calibrate this instrument at 60 cps against an accurate laboratory type wattmeter, and then use it at any frequency up to 1000 MC. Thus an accuracy of 5% can be easily accomplished. This recalibration is necessary only when measurements are made at extreme temperatures or when wear is suspected.
This calorimeter is particularly recommended for field service where a rugged and yet accurate Power Meter is required for use by unskilled personnel.

Model	Power Rating	Connector	Max. VSWR	Water Supply	Price
CX-5	5 KW	1-5/8"	1.3	1.5 G.P.M.	$1050.00
CX-10	10 KW	3-1/8"	1.3	3 G.P.M	1250.00
CX-20	20 KW	3-1/8"	1.3	6 G.P.M.	2250.00
CX-50	50 KW	6-1/8"	1.3	15 G.P.M.	4500.00

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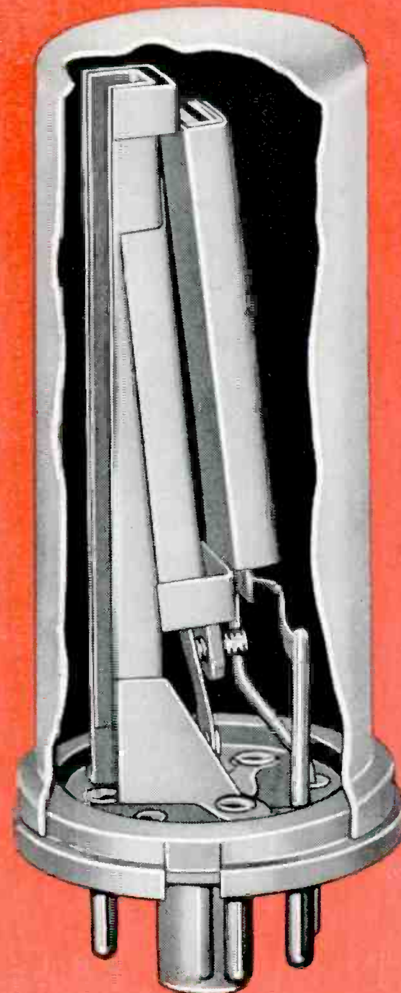
Dependability and long life previously available only in high-cost relays...

G-V RED/LINE

low-cost thermal timing relays



The sound design, sturdy construction and reliable operation long associated with G-V Hermetically Sealed Thermal Relays is available in a low-cost form, fully qualified for industrial control . . . light and inexpensive enough for electronic and communications circuits. Delays of 2 seconds to 3 minutes • Energizing voltages - 6.3 to 230 AC or DC.

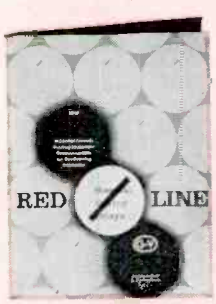
- **RUGGED STAINLESS STEEL MECHANISM**
  Relay mechanism is of stainless steel, differential expansion type, used in all G-V Thermal Relays. All parts are welded into a single integral structure.
- **SHATTERPROOF—NO GLASS**
  No glass is used in mechanism, encasing shell, or base. This avoids the danger of cracking or breakage in handling and use.
- **STEEL ENCASED HEATERS**
  Heating elements are conservatively designed, wound with Ni-chrome wire on mica and encased in stainless steel, insuring long heater life even when energized continuously.
- **DUST TIGHT ENCLOSURE**
  A dust tight metal shell completely enclosing the relay mechanism and contacts, crimped tightly to the base, provides complete protection for the structure.
- **TAMPER PROOF**
  Time delay intervals are preset at the factory. Thus changes of delay interval in the field which might damage associated equipment are avoided.
- **DIRECTLY INTERCHANGEABLE**
  Directly interchangeable with all other octal-size relays.

AVAILABLE FROM STOCK

For rapid delivery, Red Line Relays are manufactured and stocked in both normally open and normally closed types, in the standard heater voltages and delay intervals listed. Relays for other voltages and delay intervals can be provided on special order.

63 v.	26.5 v.	115 v.	230 v.
2 sec.	2 sec.	2 sec	—
5 sec.	5 sec.	5 sec.	—
10 sec.	10 sec.	10 sec	10 sec
20 sec.	20 sec.	20 sec	20 sec
30 sec.	30 sec.	30 sec	30 sec
45 sec.	45 sec.	45 sec.	45 sec.
60 sec.	60 sec.	60 sec.	60 sec.
90 sec.	90 sec.	90 sec.	90 sec.
120 sec.	120 sec.	120 sec.	120 sec.
180 sec.	180 sec.	180 sec.	180 sec.

U. S. PAT. 2,700,084
OTHER U. S. & FOREIGN PATENTS PENDING



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G-V CONTROLS INC.
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Another RCA Contribution to Microwave Electronics

Economies in equipment size, weight, and power consumption begin with...

RCA PPM TRAVELING-WAVE TUBES *for* X-Band *operation*

RCA Dev. Type 1140 PPM Traveling-Wave Tube—cut away to show self-contained periodic permanent magnets

RCA TRAVELING-WAVE TUBES FOR X-BAND OPERATION

RCA Type No.	Frequency (MC)	Typical Performance		Duty Factor	Focusing Method	Approx. Size	
		Power Output	Low-level Gain (db)			Weight (lb.)	Length (in.)
A-1140	8000-12000	10 mw	40	CW	PPM	5½	14
A-1133	8000-12000	1 w	35	CW	PPM	6	15
A-1181	7500-11200	50 peak watts	35	0.05	PPM	6	14

RCA Microwave-Tube Engineers invite inquiries for customized versions

RCA's continuing program to provide designers with a comprehensive and reliable line of traveling-wave tubes is exemplified by three new PPM focused X-band TWT's.

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For traveling-wave tubes in any application in the L, S, C, and X bands, call the RCA Field Office nearest you. Your RCA Field Representative will be happy to give you detailed information on RCA commercial and developmental types—or customized versions—for your specific system needs.

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