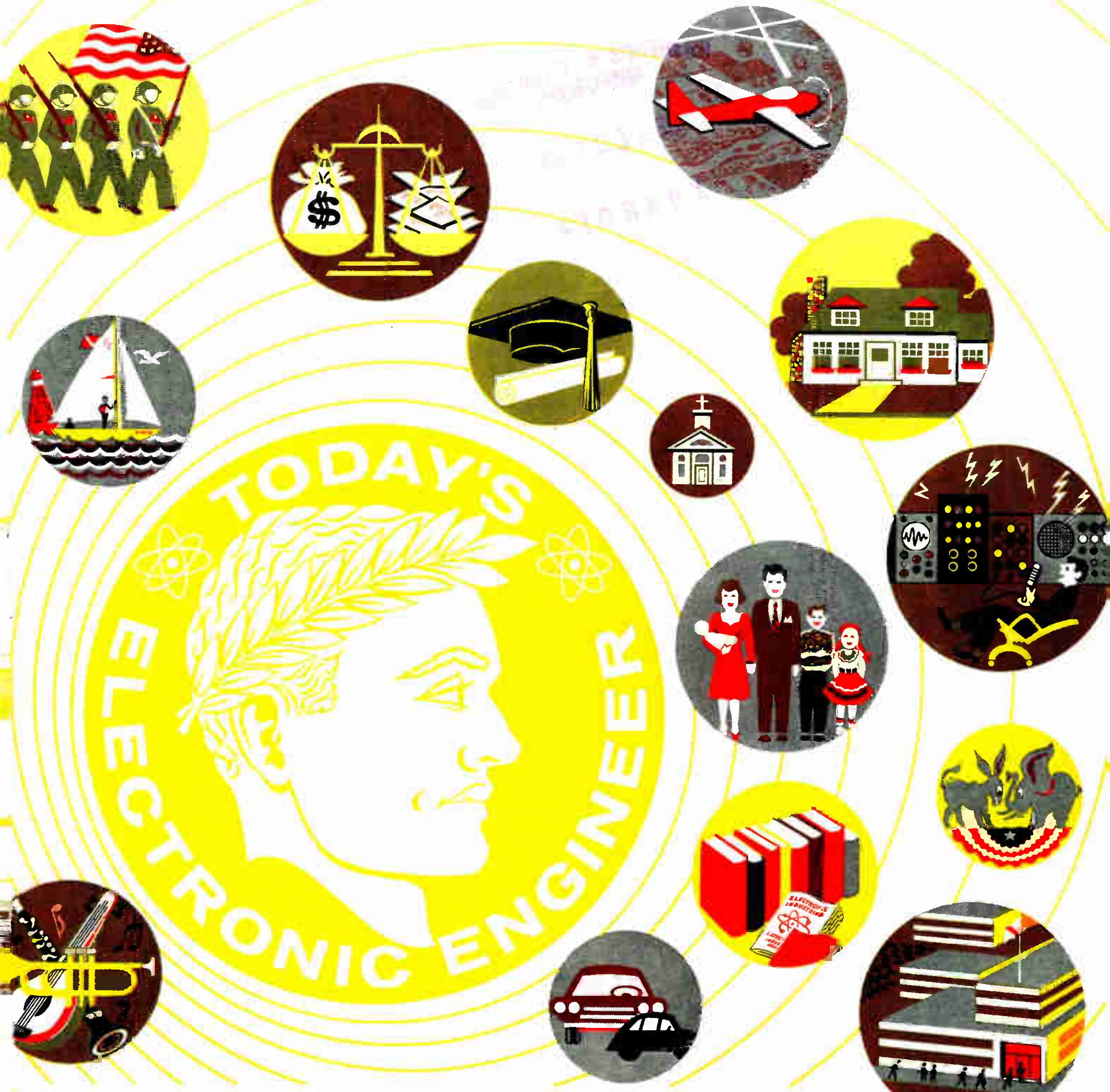
# ELECTRONIC INDUSTRIES




*More Than 50,000 Will Attend The*
47th Annual IRE National Convention, March 23-26 ...... See page 108

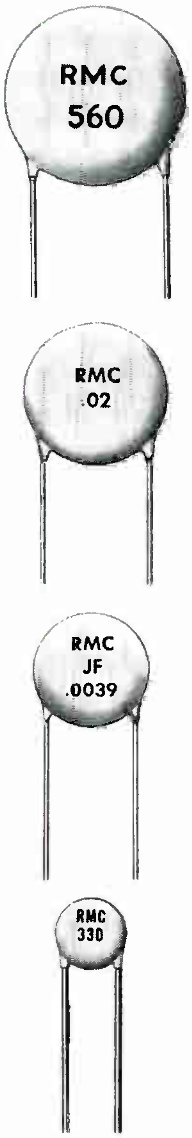
*For An Exclusive Comprehensive Analysis Of*
His Work, Family, Hobbies, Pay, Possessions, etc. ....... See page 251

March • 1959
A Chilton Publication

RMC

# High Performance Ceramic Capacitors

# DISCAPS




## TYPE C

Type C DISCAPS meet or exceed the specifications RS-198 of the E.I.A. Small size and lower self-inductance make them ideal for many applications. Rated at 1000 working volts, Type C DISCAPS have a higher safety factor than other standard ceramic or mica capacitors.

*Also available in Fin-Lock leads.*

## TYPE B

These DISCAPS are designed for by-passing, coupling or filtering applications and meet all specifications of the E.I.A. for type Z5U capacitors. Rated at 1000 V.D.C.W., Type B DISCAPS are available in capacities from .00015 to .04 M.F.D.

*Also available in Fin-Lock leads.*

## TYPE JF

Type JF DISCAPS have a frequency stability characteristic superior to similar types. These capacitors extend the available capacity range of the E.I.A. Z5F type between +10° and +85° C and meet Y5S specifications between —30° and +85° C.

*Also available in Fin-Lock leads.*

## TYPE JL

For exceptional stability over an extended temperature range, Type JF DISCAPS should be specified. They provide a minimum capacity change as temperature varies between —55° and +110° C. Standard working voltage is 1000 V.D.C.

*Also available in Fin-Lock leads.*

**See Booth 2216 at IRE Show**

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, page 123

# ELECTRONIC INDUSTRIES

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

## Surprised and Pleased

It's nearly time again for ELECTRONIC INDUSTRIES most outstanding annual event. The 47th National IRE Convention takes place at the New York Coliseum and the Waldorf-Astoria Hotel, March 23-26. Traditionally, we devote a considerable portion of each year's March issue to a review of the technical sessions and to the exhibits planned for this event. This year the convention report starts on page 108.

More than a decade of experience in reporting this occasion served to provide us with very reliable tools for estimating each year's editorial requirements . . . at least so we thought. We were very much surprised at the business reports for this year, however. An unexpected increase in volume makes this year's issue some 66 pages larger than last year. This in turn has enabled us to add quite a number of timely editorial pages in this issue. For this we are more than pleased. . . . We now have an opportunity to provide even more in the way of editorial features that we hope will benefit you, our reader. All in all, this "IRE" issue of ELECTRONIC INDUSTRIES is the largest one ever produced since the publication was founded in 1942 as ELECTRONIC INDUSTRIES! From all of us, thanks again for this wonderful vote of confidence.

## Todays' Engineer

In the December 1958 editorial "Today's Electronic Engineer" we summarized the results of a survey that ELECTRONIC INDUSTRIES conducted during the fourth quarter. This was a mail survey to EI readers to determine more of the personal characteristics of today's engineer. In the conclusion it was mentioned that the questionnaire data had been transcribed onto IBM cards. These IBM cards, properly manipulated, can be made to reveal most interesting and significant data. We have performed such a breakdown by age groups and by the regions where engineers are located. Our 11-page report begins on page 251. We hope you find this to be as interesting and as informative as we have!

## Problem Clinic

Some of you have noticed our new editorial monthly feature "Problem Clinic." But for those who haven't, we should like to call your especial attention to it. In the past many readers have written to us about particularly vexing technical problems that have confronted them. Our readers service department and our editorial staff has been able to provide solutions to a great many of these. Some of them, however, seem to have no known answers.

The purpose of the "Problem Clinic" is to take such problems to as many professional engineers as possible. It is our hope that at least one of our readers has previously solved this or a similar problem. Or perhaps one of our readers will be able to suggest a solution to this unknown.

At any rate, so far "Problem Clinic" has averaged six suggested solutions per problem and the number of "new" problems coming in has about doubled. As another EI reader service, we'd be glad to assist you with any technical problems you may have!

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# ELECTRONIC INDUSTRIES

Vol. 18, No. 3 — March, 1959

## MONTHLY NEWS ROUND-UP



## NEW PRODUCTS & TECH DATA



## DEPARTMENTS



BPA NBP

# Highlights

## Of This Issue

### "Today's Electronic Engineer" — page 251

Some six months ago EI set out to learn just as much as possible about the average electronic engineer. Thousands of questionnaires went out to engineers in all parts of the country. The whole range of engineers was included: jr. engineers, project engineers, senior engineers, vice-presidents for engineering. And the questions we asked were searchingly personal, such as:

- What is your income today?
- What was your income 5 years ago?
- How much life insurance do you have?
- How much is your house worth?
- What is the worth of your liquid assets?
- How many firms have you worked for?
- Does your firm have a pension plan?
- How many cars do you own?
- What are your future plans?
- How many children do you have?

Amazingly enough, more than half of the engineers that we questionnaired sent in their answers. Here is a summary of what they reported.

### Industry's First Transistor Interchangeability Chart! — page 143

"Interchangeability" has been looked to for many years in the transistor industry but until now only scattered attempts have been made on the part of individual manufacturers to make interchangeability information available to engineers. Here for the first time is comprehensive all-industry cross-referencing of transistors and their nearest equivalents. All the major transistor manufacturers have cooperated with EI in this project. It is the first time that such unanimous cooperation has been obtained. The information includes not only data on interchangeability but also dimension drawings as well, so that both electrical and physical interchangeability can be checked.

### Ionospheric Interference — page 77

Where directional antennas are pointed skyward two main sources of interference are encountered that are propagated by the ionosphere. First is where static interference and man-made signals enter the radar beam; and second, where transmitted power is scattered back along the path. These difficulties can be minimized through proper design.

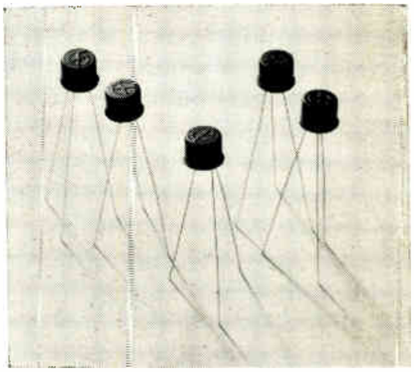
### Other Communications Media! — page 79

Radio communications has distinct disadvantages, to the military's thinking. Frequency space is limited, it is easily jammed, and much too unreliable. To overcome these drawbacks the USAF is investigating the properties of low frequency radio, sound, light, heat and nuclear radiation as means of communication.

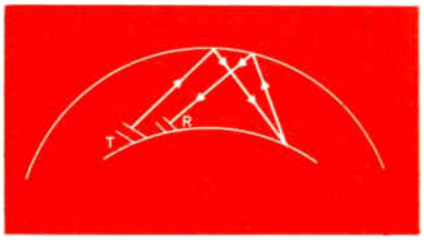
### 1959 National IRE Convention! — page 108

"Space" will be the featured theme of this year's IRE Show meeting at the New York Coliseum, March 23-26. Highlight will be a panel discussion by 10 distinguished authorities on the various aspects of space travel and communication. Over 850 exhibitors will be displaying products for the expected 55,000 engineers and show visitors.

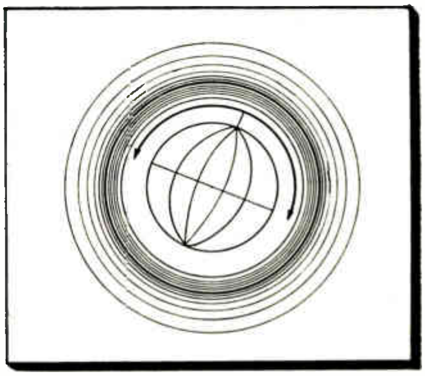

Today's Electronic Engineer



Transistor Interchangeability Chart




Ionospheric Interference



Other Communications Media

1959 National IRE Convention

# RADARSCOPE

**READ-OUT LAMP**

**This 14-segment electroluminescent readout lamp — termed an Alpha lamp by Westinghouse — can display all letters of the alphabet, numerals 0 through 9 and symbols. Characters are formed by applying 240-volt or 460-volt ac signal to the proper terminals.**

**SMALL ELECTRONIC FIRMS** are showing an increasing tendency to form cooperative pools to strengthen their position in bidding for government contracts. The Small Business Administration is lending its assistance in the formation of these pools and formally approves the pools' proposed operations. Five pools have now been set up. The latest, Electrodyne Industries came into existence last month. It was formed by 4 Long Island firms, Holden-Massey Corp., Republic Electronic Industries Corp., Microtran Co., Inc., and Paromal Products Inc. The pool will seek government contracts for radio transmitting and receiving and radio navigation equipment, radar and radiac equipment, guided missile assembly and instrumentation.

**"NUCLEAR POWER** is not the panacea for the world's future energy needs," says W. Kenneth Davis, former Director of Reactor Developments of the USAEC. He says, "At most we can anticipate only about 25% of our total energy requirements coming from nuclear power even after it is fully developed and economically competitive." This is still quite a substantial contribution, for the consumption is expected to just about quadruple by 2000 A.D. "Methods of storing thermo or electrical energy for use in mobile applications and many specialized uses should be developed and will become of increasing importance in future decades," he says.

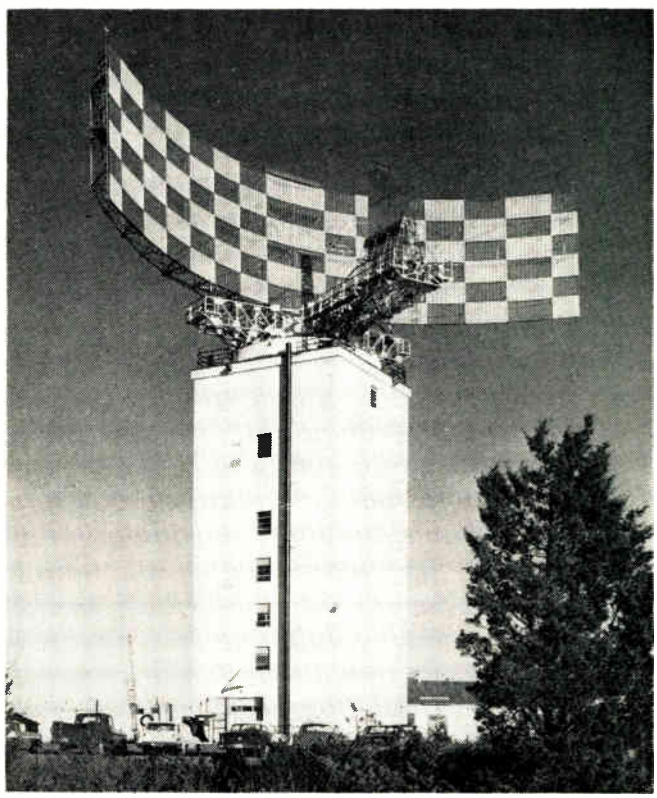
**CLOSED CIRCUIT COLOR TV** has important implications for department store use. With wide screen projectors, such as the newly introduced CIBA "Eidophor" units, the stores have an important tool for window displays and store front merchandising.

**VACUUM TUBE PROSPECTS** continue to look up, despite the various obituaries being written for the industry. Sales volume last year reached about $800 million despite the first half recession. A total of $866 million for 1959 is now estimated by at least one major manufacturer.

**"TIME REVERSAL TECHNIQUES"** are based on a theory that signals transmitted over long distances, if reversed in their direction of flow midway between the transmitter and receiver, will retain their fidelity over the entire transmission route. Case Institute of Technology last month was issued a contract from Rome ADC to investigate whether this theory has applications to the transmission of digital data. The research will be carried on over a transmission line 700 miles long. Among the applications foreseen is the transmission of digital information to a satellite for rebroadcast back to earth.

**EXPERIMENTAL SEARCH RADAR**

**Lincoln Lab of M.I.T. has just completed construction of this new high-power experimental search radar on Boston Hill in North Andover, Mass. Though it weighs more than 50 tons, it can be rotated at 5 rpm in winds of 60 mph and still maintain accuracy of less than 0.1°.**



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

**COST-PLUS POLICY** of the government is getting some second thoughts. Pentagon purchasing agents, in certain cases are offering extra profits to defense contractors for contributions toward improved performance, earlier delivery, or lower cost. They figure that each extra dollar profit is more than offset by the savings in other costs. The Defense Dept. is caught in a pinch, between the demands for economy on one side and the skyrocketing costs of modern weapons system on the other. Somehow new methods must be derived to cut costs, or provide improved performance for the same costs. The logical party to make these improvements is the contractor. The only thing needed is incentive, and the most logical incentive is added profits.

**AN EXPECTED BOOM** in FM car radios could give a shot in the arm to FM station operation. Certain advertisers have found that for certain products and services, FM is already more economical in cost per thousand than AM radios. FM is acquiring a reputation for audiences of "taste and discrimination," which is attractive to certain advertisers.

**THE RECESSION** had little effect on the semiconductor business last year. Sales of transistors, rectifiers, and diodes reached a new record high of $195 million, an increase of 35% over 1957. Industry spokesmen are estimating a further growth of 30% in 1959 and a gross business in excess of $250 million. H. B. Fancher, General Manager of GE's Semiconductor Products Dept. sees the largest growth in the rectifier area. "Sales of semiconductor rectifiers," he says, "can be expected to increase by 50% from the 1958 level of 33 million, to around $50 million." However he estimates that the largest dollar increase will be in transistors, which will be twice as large as that for rectifiers.

## ENGINEERING

**IF SPACE ENGINEERING** is to acquire the momentum typical of American competitive industry, something will have to be done about the patent situation. So long as the Government retains the controls in the Space Acts, there is hardly sufficient incentive for the bulk of the industry to get excited over the space age possibilities. It is easy to demand relaxation of the Government's control, but obviously the requirement of military security must also be recognized. Just how much relaxation can be reasonably expected was discussed last month by 130 members of the National Association of Manufacturers' Patents Committee in a meeting in Washington. Sitting in on the discussions for the Government was Commissioner of Patents, Robert C. Watson. A long range plan is now being drafted.

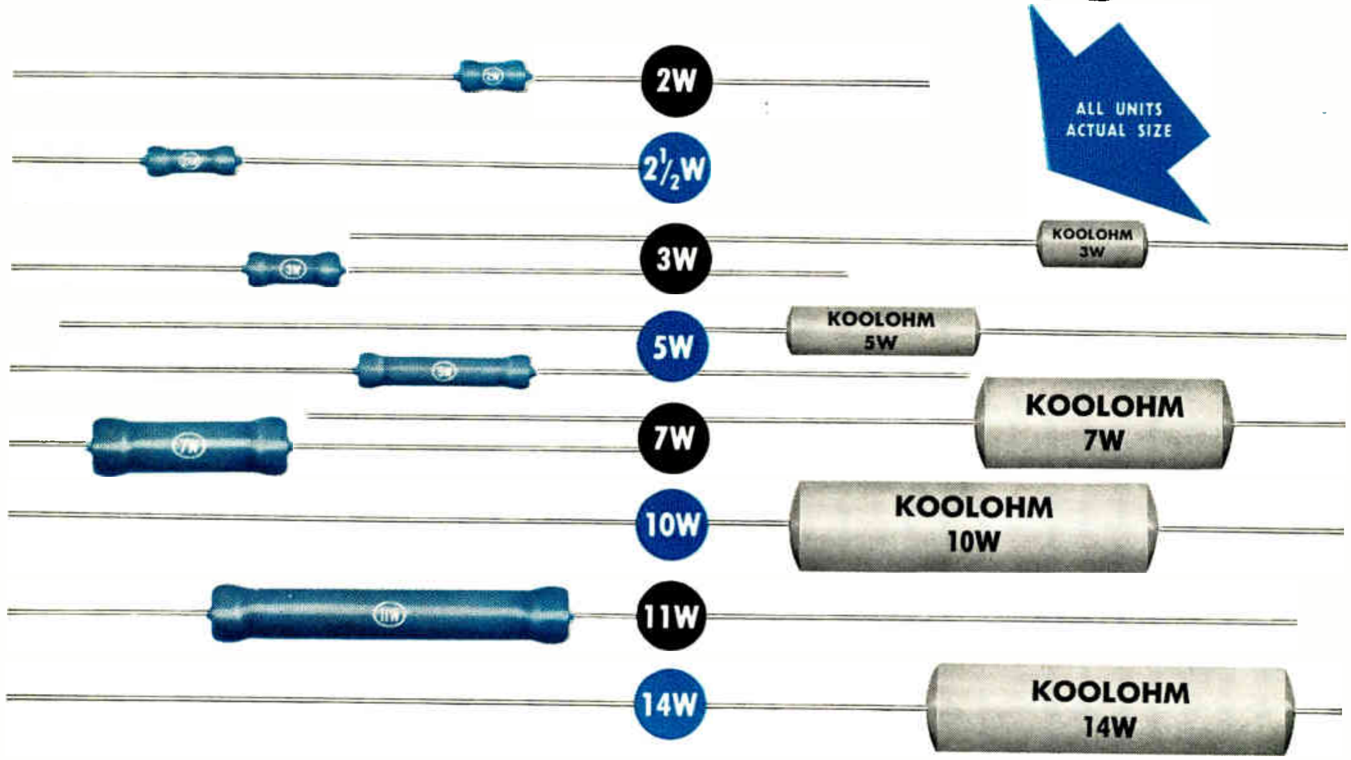
## PRODUCTION

**PRE-PRODUCTION COSTS** have been significantly reduced at Westinghouse's Air Arm Div. in Baltimore through a system they tab MMI (Mechanized Manufacturing Information). The new system, designed around semi-automatic and automatic business machines, significantly compresses the time involved in getting new military developments from drawings into actual weapons systems. Company spokesmen estimate, "The new technique will save approximately a half a million dollars in the Air Arm Division's measurable 'paper work' processing costs by 1962." Under MMI, the basic information is placed on perforated paper tape immediately after engineering drawings and specifications are issued. From this point on, data needed by each of the many departments involved in the manufacturing process are issued simultaneously on either tape or punched cards so that purchasing can begin to acquire materials while manufacturing is preparing to process the materials when they arrive. A time study showed that where 4 to 10 weeks were required under the old system, MMI has reduced the work to from 2 to 5 weeks. Westinghouse spokesmen feel that the new system will have far reaching effects throughout the entire defense products industry.

## MISSILE RESEARCH

New hypervelocity instrumentation for missile and space vehicle research has been developed by Avco Research and Advanced Development Div. This shadowgraph system employs a catadioptric light screen that detects the presence of a projectile breaking the beam.

# SPRAGUE® RELIABILITY
## in these two dependable wirewound resistors




MINIATURE
## Blue Jacket®
VITREOUS-ENAMEL POWER RESISTORS

Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

A look at the small *actual sizes* illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, **write for Engineering Bulletin 7410.**

**TAB-TYPE BLUE JACKETS:** For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. **For complete data, send for Engineering Bulletin 7400A.**

NEW SMALLER SIZE
## KOOLOHM®
INSULATED-SHELL POWER RESISTORS

New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—*aged-on-load* to stabilize resistance value.

*You can depend upon them to carry maximum rated load for any given physical size.*

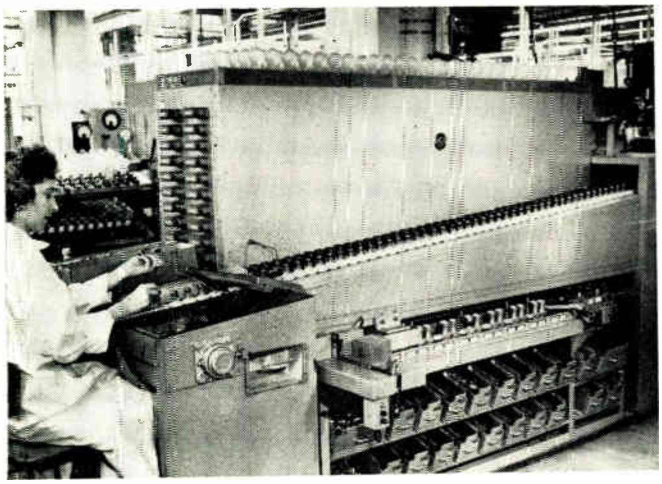
**Send for Engineering Bulletin 7300 for complete technical data.**

**SPRAGUE ELECTRIC COMPANY**
233 MARSHALL STREET • NORTH ADAMS, MASS.

**SPRAGUE®**
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS
INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

# As We Go To Press . . .



**TUBE CHECKER DELUXE**

Up to 2,500 electron tubes per hour are checked by this new testing machine at RCA Electron Tube Div., Harrison, N. J.

## Gravity Measurements Can Be Made From Air

A major technological breakthrough in geophysics by taking the first successful measurements of gravity from an aircraft was announced by the Air Research and Development Command.

The flight tests signify a giant step forward in gaining basic knowledge of our planet, said Dr. Lloyd Thompson of the Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass. "This opens a whole new field of geodetic, gravity and geophysical applications," he said.

Previously, it had been thought impossible to measure gravity from the air. Scientists charting the earth's gravity field were restricted to tedious, time-consuming measurements on land or sea involving many variable factors.

Airborne gravity measurements will give rapid answers to many geodetic survey questions. For example, map-makers will be able to precisely locate islands, measure exact distances between continents and accurately plot the entire world. Also, the exact center of the earth can be located.

## Call For WESCON Papers

Engineers who wish to present papers at the 1959 WESCON should send 100-200 word abstracts, with complete texts or detailed summaries, to Dr. K. R. Spangenberg, WESCON, 60 W. 41st Avenue, San Mateo, Calif.

## Political Pressure Kills Booster Ruling

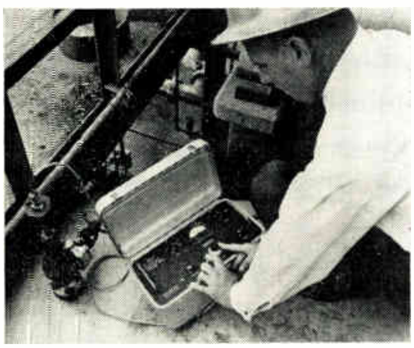
The FCC's plans to kill off operation of illegal TV booster stations by March 30 have foundered under a barrage of complaints from Congress.

An FCC letter of Dec. 31 stated that all VHF boosters—channel repeaters or VHF-VHF translators—must convert to UHF translator systems by the March date. Approximately 1,500 stations would be affected.

With the long-delayed ruling finally announced Congress suddenly erupted with a flurry of bills to legalize booster operation. Faced with mounting opposition the FCC hurriedly reconsidered, voted to give operators 6 months, rather than 90 days, to suspend booster operation.

The commission announced that it needs to "give further study to the legal and technical aspects of the situation."

**CORROSION MEASUREMENTS**



Differences of as little as 1-millionth of an inch in the internal corrosion in a pipe or tank are detected by this new measuring instrument by Crest Instr. Co. div. of Magna Products Co.

## Missiles Guided By Photos of Terrain

By combining radar and aerial mapping the Air Force has come up with an electronic guidance system that controls not only the direction of an aircraft's flight but also its altitude.

The system can be programmed to ascend over mountain peaks or to skim at low levels over coastal plains.

The ATRAN guidance system, developed by Goodyear Aircraft Corp. for the Mace weapon system, gets no direction after the launching. The aircraft is controlled through comparison of the radar image returned from the ground with actual aerial photos. For use with the equipment the aerial photos are translated into synthetic film.

Since topographical maps exist for most of the world, the film can be quickly made for any desired course, enabling a missile or an airplane to be electronically guided almost anywhere.

## Electronic Support Systems to Rome AMA

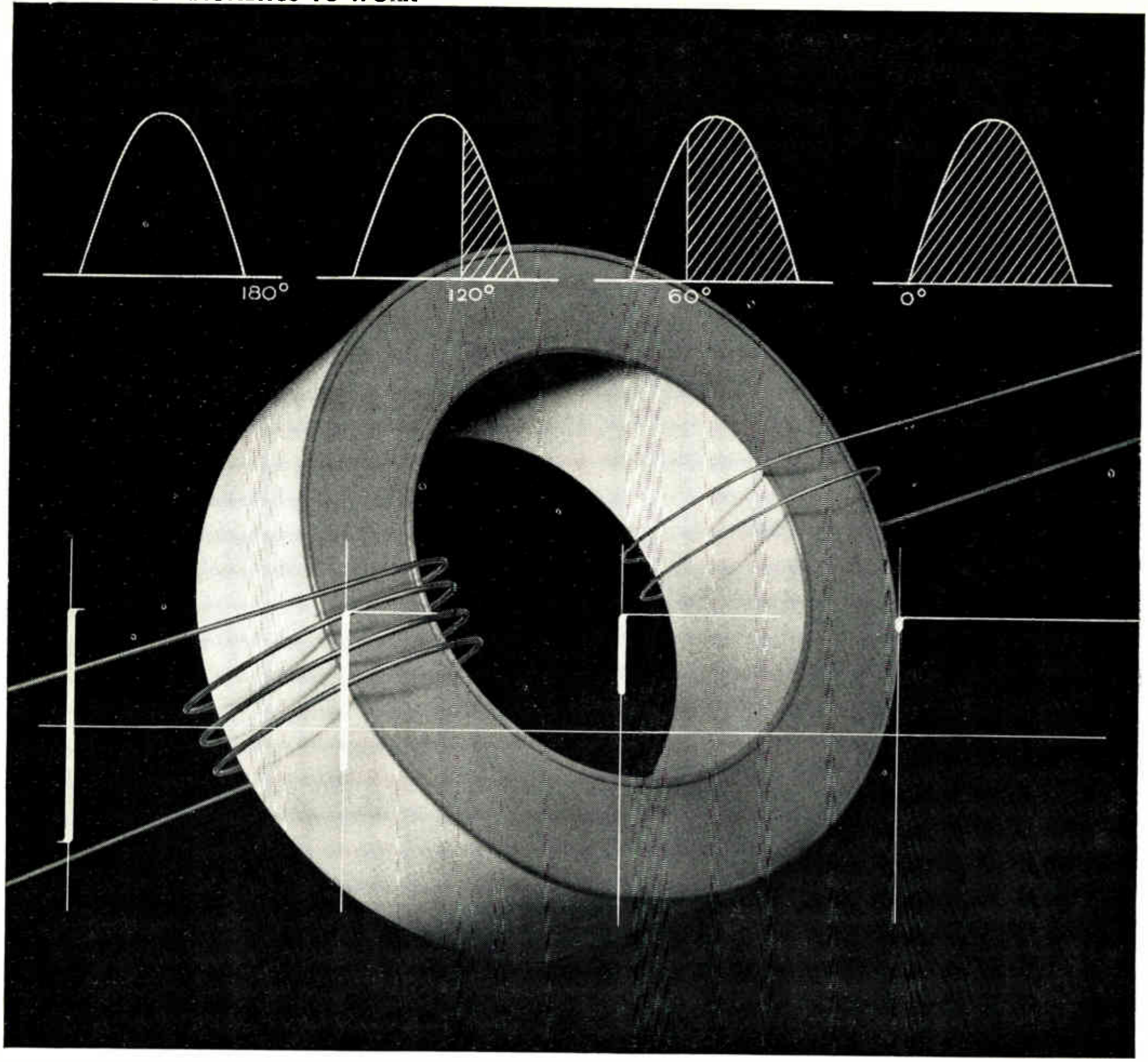
The Air Materiel Command is tightening up the management of Electronic Support Systems. The first move as made last month in setting up a new unit, Detachment 1. Rome Air Materiel Area, located at Wright-Patterson AFB.

The Support Systems are used in gathering intelligence data, in air defense and strategic bombing, controlling air traffic and in long-range weather forecasting.

Rome AMA now becomes responsible for procurement and production for a number of Support systems necessary for communication and control networks, and for air defense.

AMC is also establishing a new office to handle liaison with the far-flung radar picket lines, BMEWS, DEW Line, SAGE and White Alice, and the Air Defense Systems Integration Division (ADSID). The new office comes under the Directorate of Procurement and Production.

More News on Page 9




# Want a billion-position switch?

## Magnetic amplifier manufacturers turn to Orthonol® tape cores for precise proportioning control or switching action

Orthonol is a switching material that can be turned all the way on—or part way on—with vast precision.

The rectangular B-H loop of the 50% nickel, grain-oriented alloy provides an amplifier output which is linear and directly proportional to control (reset) current. This response is so linear that the amplifier acts as a valve with an infinite (at least a billion) number of steps from full off to full on.

Full off and full on can be achieved with snap action, because the horizontal saturation characteristic of the B-H curve means a very low saturated impedance. Thus, when the amplifier is on, it is *on;* when it is off, it is *off*. On-to-off impedance ratios of at least 1000 to 1 provide complete assurance of this absolute characteristic.

Should your manufacturing facilities prevent the use of Orthonol in tape wound core form, you can still take advantage of this excellent material in laminations. An Orthonol laminated core has characteristics almost identical to those in toroidal form.

Like all Magnetics, Inc. products, Orthonol tape wound cores and laminations are Performance-Guaranteed. Full details await your inquiry. *Magnetics, Inc., Dept. EI-60, Butler, Pennsylvania.*

**MAGNETICS inc.**

***Visit our Booth 2533 at the IRE Show***

# Coming Events

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

**Mar. 1-3:** Southeastern Regional Conference, Nat'l Assoc. of Music Merchants; Dinkler-Plaza Hotel, Atlanta, Ga.
**Mar. 2-4:** Electronics Conference, American Management Assoc.; Statler Hilton Hotel, New York, N. Y.
**Mar. 2-6:** Western Joint Computer Conf., IRE, AIEE, ACM, Fairmount Hotel, San Francisco, Calif.
**Mar. 5-6:** Flight Propulsion Meeting, IAS; Hotel Carter, Cleveland, Ohio.
**Mar. 5-7:** Western Age Conference, Domestic Trade Dept., Los Angeles Chamber of Commerce; Los Angeles, Calif.
**Mar. 6-7:** Meeting, American Physical Society; Univ. of Texas, Austin, Tex.
**Mar. 8-11:** Gas Turbine Power Conf. and Exhibit, ASME; Netherlands-Hilton Hotel, Cincinnati, Ohio.
**Mar. 8-12:** Aviation Conference, ASME; Statler Hilton Hotel, Los Angeles, Calif.
**Mar. 10:** Annual Meeting & Election of Officers, Assoc. of Electronic Parts & Equipment Mfgs. Assoc.; Como Inn, Chicago, Ill.
**Mar. 10-12:** Electrical Mfg's Exposition; Franklin County Veteran's Memorial Bldg., Columbus, Ohio.
**Mar. 11-12:** Iron & Steel Instrumentation Conference, ISA; Pick-Roosevelt Hotel, Pittsburgh, Pa.
**Mar. 12:** Symp. on Microwave Techniques for Computing Systems, ONR, Information Systems Branch; Dept. of Interior Auditorium, Washington, D. C.
**Mar. 15-18:** 37th Annual Convention & Broadcast Engineering Conf., National Assoc. of Broadcasters; Chicago, Ill.
**Mar. 16-20:** 11th Western Metal Exposition and Conference, American Society for Metals; Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.
**Mar. 17:** Annual Meeting, Broadcast Pioneers; Conrad Hilton Hotel, Chicago, Ill.
**Mar. 17-21:** 8th Electrical Engineer's Exhibition; Earls Court, London, Eng.
**Mar. 18-20:** Conference, EIA; Statler Hotel, Washington, D. C.
**Mar. 22-24:** Northwestern Regional Conf., National Assoc. of Music Merchants; Hotel Multnemah, Portland, Oregon.
**Mar. 22-25:** Numerical Control of Machines in Production Processes, Engineering Depts. of UCLA and Purdue Universities; Campus, UCLA, Los Angeles, Calif.
**Mar. 23-25:** Meeting, American Rocket Society; Daytona Beach, Florida.
**Mar. 23-26** National Convention and Radio Engineering Show, IRE; Waldorf-Astoria Hotel and the Coliseum, New York City.
**Mar. 24-25:** Meeting, Institute for Printed Circuits; New York, N. Y.
**Mar. 26:** 15th Annual Quality Control Clinic, Rochester Society for Quality Control; University of Rochester, Rochester, N. Y.
**Mar. 30-31:** Meeting, American Physical Society; Hotel Somerset, Cambridge, Mass.
**Mar. 30-April 1:** Chicago Electrical Industry Show; Hotel Sherman, Chicago, Ill.
**Mar. 31-April 2:** 21st American Power Conf., Ill. Inst. of Tech.; Sherman Hotel, Chicago, Ill.
**Mar. 31-April 2:** 9th Intn'l Symp. on Millimeter Waves, Polytechnic Inst. of Brooklyn, IRE, Dept. of Defense Research Agencies; Auditorium of the Engineering Societies Bldg., Polytechnic Institute of Brooklyn.
**Mar. 31-April 3:** National Aeronautic Meeting, SAE; Hotel Commodore, New York, N. Y.
**Apr. 1-30:** 9th Plenary (CCIR) International Radio Conf., CCIR; Biltmore Hotel, Los Angeles, Calif.
**Apr. 2-3:** Conference on Silicon Carbide, Air Force Cambridge Research Center, Boston, Mass.
**Apr. 2-3** Conf. on Electrical Applications in the Textile Industry, AIEE; Heart of Atlanta Motel, Atlanta, Ga.
**Apr. 2-3:** Tech. Conf. on Physical Metallurgy of Stress Corrosion Fracture, AIME, Mellon Institute, Pittsburgh, Penna.
**Apr. 2-4:** Meeting, AIP, Optical Society of America; Hotel New Yorker, New York, N. Y.

**Abbreviations:**

ACM: Association for Computing Machinery
AFOSR: Air Force Office of Scientific Research
AIEE: American Inst. of Electrical Engrs.
AIME: American Institute of Mining & Metallurgical Engineers
ASME: American Society for Mechanical Engineers
ASTM: American Society for Testing Material
CCIR: International Radio Consultative Committee
EIA: Electronic Industries Assoc.
IAS: Institute of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
ONR: Office of Naval Research
SAE: Society of Aeronautical Engineers
SMPTE: Society of Motion Picture & TV Engineers
SPI: Society of Plastics Industry
WCEMA: West Coast Electronic Manufacturers Assoc.

## As We Go To Press . . .

### *Employment to Rise in '59—Boom in '60*

"Help wanted" advertising, a reflection of the country's economic trend, is increasing after declining for 23 months. A gradual increase will continue through 1959 but surge upward during 1960. These are some of the conclusions reached by a survey conducted by "Help Wanted Trend" (January 1959), a monthly report published by B. K. Davis & Bro., 1616 Walnut St., Phila., Pa.

The survey showed that the recent recession hit bottom in March. The cities hardest hit were Detroit, Cleveland, and Pittsburgh, which depend on heavy industry.

The report predicted that consumer spending will go up in 1959. Government spending will increase —despite the President's plea for economy. Employment will go up, but so will unemployment, and college recruiting will boom again this year.

### *Engineering Writing*

The IRE Professional Group on Engineering Writing and Speech will present a program of five technical papers at the coming IRE Show and Convention.

The program will be presented on Monday, March 23, at 2:30-5:00 P.M. in the Jade Room, Waldorf-Astoria.

### SOME HIGHLIGHTS OF 1959

**Mar. 23-26:** National Convention, IRE; Waldorf Astoria (Hdqts), New York Coliseum (Radio Engr'g Show), New York, N. Y.
**April 5-10:** 5th Nuclear Congress, Institute of Aeronautical Sciences, Coordinated by EJC, ISA, ASME, IRE; Municipal Auditorium. Cleveland, Ohio.
**May 6-8:** Electronic Components Conference, WCEMA, IRE, EIA, AIEE; Benjamin Franklin Hotel, Phila., Pa.
**May 18-20:** Electronic Parts Distributors Show, Assoc. of Electronic Parts & Equipment Mfg., Inc.; Conrad Hilton Hotel, Chicago, Ill.
**Aug. 18-21:** WESCON, West Coast Electronic Mfgs. Assoc. & 7th Region IRE; San Francisco, Calif.
**Oct. 12-14:** Nat'l Electronics Conf., IRE, AIEE, EIA, SMPTE; Hotel Sherman, Chicago, Ill.
**Nov. 9-11:** Radio Fall Meeting. IRE EIA; Syracuse, N. Y.
**Nov. 30-Dec. 1:** Eastern Joint Computer Conf., IRE (PGEC), AIEE, ACM; Hotel Statler, Boston, Mass.

# ELECTRONIC SHORTS

▶ Dept. of the Army has awarded four contracts in excess of $5-million for the development and production of three additional MOBIDIC computers and for programming assistance. MOBIDIC is the high-speed, van-mounted digital computer being developed for the Army by Sylvania Electric Products, Inc., under contract with the Army Signal Corps. The awards announced today bring to a total of four the number of MOBIDIC computers ordered by the Army.

▶ The largest closed-circuit TV network in history was employed by International Business Machines Corporation for a coast-to-coast sales meeting. The one-hour telecast, produced and networked by TNT (Theatre Network Television, Inc.), covered 157 locations in 147 cities. This is the largest number of cities ever linked in any closed-circuit telecast of any kind. The largest previous business meeting ever held was also an IBM sales meeting which embraced 80 cities on September 2, 1958. The IBM telecast reached all IBM salesmen and customer engineers in the United States.

▶ Radar advisory service to civil air carrier jet aircraft has been extended to the three transcontinental jet routes linking Los Angeles and San Francisco with New York. This joint service of the Federal Aviation Agency and the U. S. Air Force Air Defense Command, is also provided to civil jets operating from New York over the Northeastern portion of the country and from New York to Miami, Florida, at altitudes from 24,000 feet to 35,000 feet inclusive. The radar advisory services is designed to inform pilots of civil jet transports operating en route with information on other traffic as observed on radar in their area.

▶ Successful test firing of a revolutionary new low-cost meteorological rocket that can be launched by a 2-man crew has been accomplished. The rocket eventually will be made of finely spun glass fibers so that it may be fired by meteorological personnel over populated areas and exploded to fragments after it has gathered needed data. Named ARCAS (All-purpose Rocket for Collecting Atmospheric Soundings) the rocket was made for the Office of Naval Research by the Atlantic Research Corporation of Alexandria, Virginia. In the most impressive of 4 rounds fired, ARCAS reached 174,000 feet with a payload of instrumentation. A new type launcher of ingenious design makes it possible to fire the ARCAS with a crew of only two men.

▶ A new development in electron tube manufacture that promises to greatly improve performance of electronic equipment, has been accomplished by Sylvania Electric Products, Inc. Known as "Sarong," the skin-tight film coating is wrapped around the tube cathode. In conventional tube manufacture, the cathode coating is sprayed on in liquid form. More stable tube characteristics and longer tube-life are anticipated. First application will be in the field of TV tuners.

▶ A new micromodule concept can reduce many military electronic items to at least one-tenth—and in some cases to as much as one-thousandth—their present bulk. Experimental circuits, including entire assemblies of transistors, wiring and other elements, have been compressed by Radio Corp. of America into micromodules no bigger than a cough drop. A single unit, or module, can be built to function as an amplifier, oscillator, filter and the like, in aggregate, to meet specified needs in electronic circuit design. RCA is now at work on a 2-year, $5-million contract with the U. S. Army Signal Corps for development of the micromodule concept to the point where ground tactical, fixed plant, and airborne systems can be sharply reduced in bulk and weight.

▶ The first photographs of a conventional radar display have been made at an altitude of 100,000 ft from a balloon-lofted instrumented radar gondola. Using an unmanned 2-million cu. ft. free balloon, the task was accomplished through a joint effort by Goodyear Aircraft Corp. and the Winzen Research Corp. of Minneapolis, Minn. for the USAF. The present contract calls for three such flights. The unusual pictures, showing an aerial radar view in plan position form rather than the view as seen in conventional photographs, will extend man's limited knowledge of radar characteristics at stratospheric altitudes.

## As We Go To Press . . .

### Electronic Firms, Govt. 1-2 in Campus Recruiting

The California Institute of Technology recently released its annual report on "Placement Activities: 1957-1958." It contains many facts of interest, but the following merit special mention:

For the first time in five years there was a decrease in the number of organizations represented on the campus for the purpose of interviewing students. From 183 in 1956-57, the number dropped to 158. The number of interviews declined from 2667 to 2592. Electronics - computing companies had the largest representation; government agencies were second.

The percentage of Bachelors planning to do graduate work continued to increase. It was 64%, as compared with 60% in 1957, 58% in 1956, 47% in 1955.

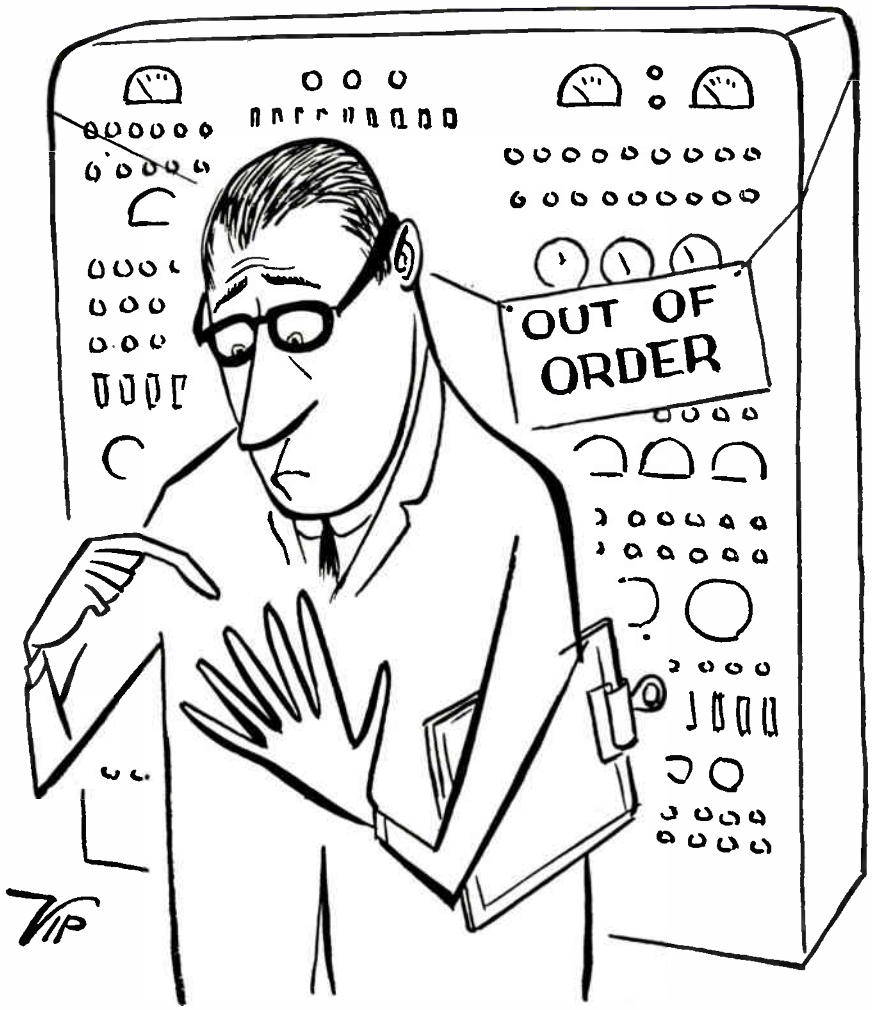
One hundred per cent of the engineering graduates received and accepted job offers. Salary offers for this group ranged from $575 to $1,050, with a median of $750. The median for Ph.D.s was only $700, but the range was from $350 to $1,-292. The median for Bachelors of Science in fields other than engineering was $490, for Masters of Science, $615. Offers in each category except the Ph.D. were substantially higher than in 1957.

The head of a private employment agency foresees no increase in the demand for college graduates without experience "until after the first of the year—if then.

### Urge More R&D Contracts For Smaller Companies

The Small Business Administration, Lafayette Bldg., Washington, D. C., is distributing a new directory of 1,400 companies interested in Research and Development contracts. In issuing the directory, the Small Business Administration urged procuring agencies and major contractors doing R & D work to consider the potential of smaller businesses. Receiving the directory are Government agencies, some major prime contractors, Government R & D centers, and other agencies.

More News on Page 26




## Digital Computer Techniques—*State of the Art*

*Failure of computers* has been known to force scientists back to more primitive forms of calculation. (Note the extra digit which comes in handy when numerical concepts need to be "carried".) However, at Hughes, we have developed and are producing components which insure you against breakdown even under the most severe operational conditions. Our most powerful ally is an almost unreasonable passion for quality control.

On the following three pages you'll find specific examples of Hughes *reliable* components—Parametric Amplifier Diodes, TONOTRON* Storage Tubes, and MEMO-SCOPE® Oscilloscopes.

In addition to these, other Hughes Products devices which offer you this "built-in" reliability include: Precision Crystal Filters for selective tuning...Rotary Switches...Thermal Relays... MEMOTRON® and TYPOTRON® Storage Tubes... Microwave tubes...Diodes, Transistors and Rectifiers with uniform performance...and Industrial Systems which automate a complete and integrated line of machine tools.

*Trademark of H.A.C.

*I. R. E. SHOW: See the Hughes Exhibits Number 2801-2807.*

*Creating a new world with ELECTRONICS*

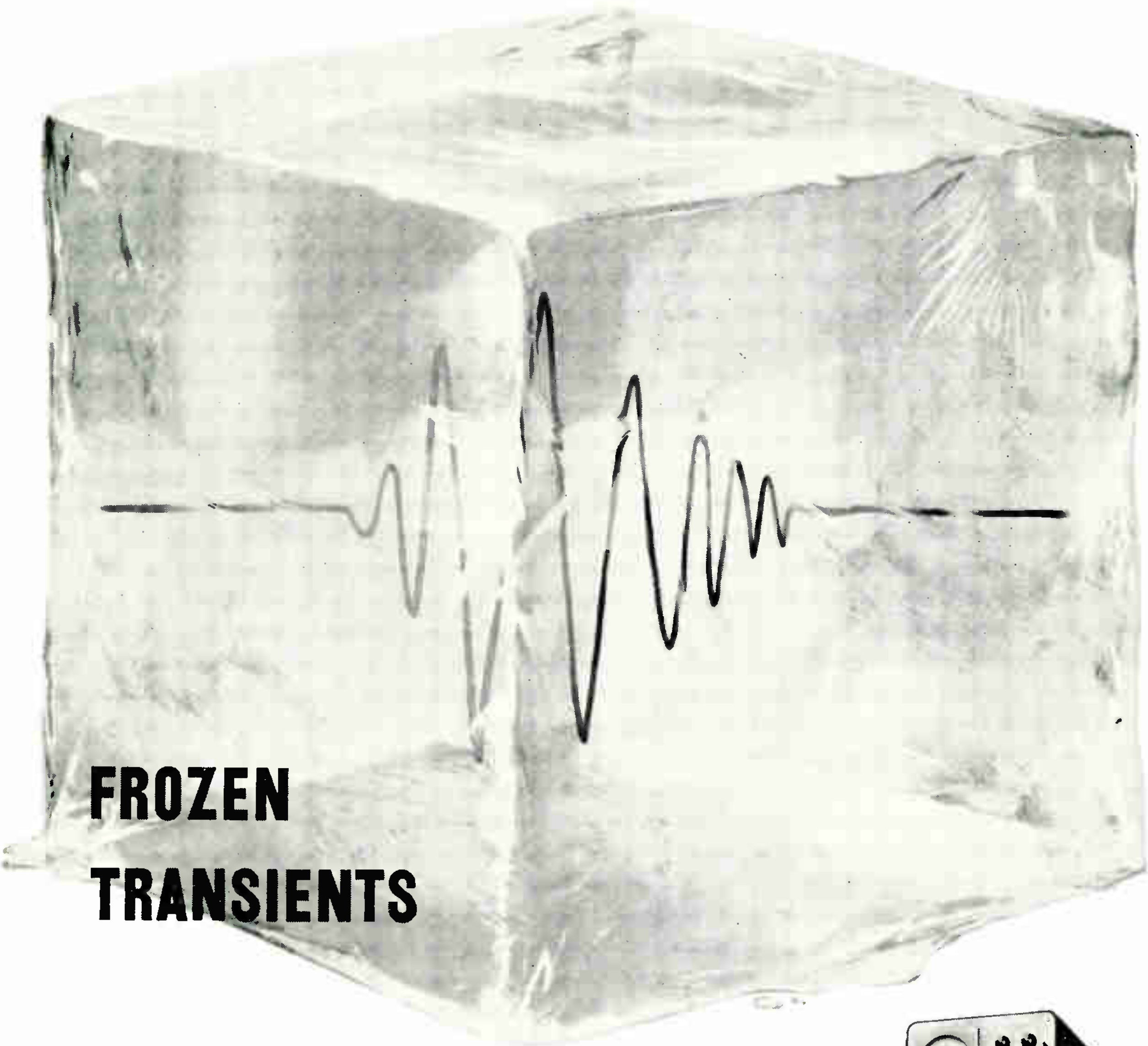
**HUGHES PRODUCTS**



SEMICONDUCTOR DEVICES · STORAGE AND MICROWAVE TUBES · CRYSTAL FILTERS · OSCILLOSCOPES · RELAYS · SWITCHES · INDUSTRIAL CONTROL SYSTEMS

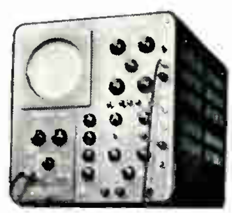


Circle 7 on Inquiry Card, page 123



# FROZEN TRANSIENTS

## with the Hughes MEMO-SCOPE® Oscilloscope



Trial and error methods necessary to capture elusive transients on conventional scopes waste time, film, and precious research dollars. Never again need this happen. With the Hughes MEMO-SCOPE® oscilloscope you may instantly "freeze" wave forms with brilliant clarity for careful study, comparison and analysis.

The Hughes MEMO-SCOPE® oscilloscope retains these frozen transients until intentionally erased. Selected transient information may be triggered externally or internally. Successive wave forms may be written above, below or directly over the original information.

SWEEP SPEED FOR STORAGE: 10 microseconds to 10 seconds per division (0.33").

FREQUENCY RESPONSE: DC to 250 KC down 3 db.

SENSITIVITY: 10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.

APPLICATIONS: Trouble shooting data reduction equipment . . . switch and relay contact study . . . ballistics and explosives research . . . ultrasonic flaw detection . . . physical testing — shock — stress — strain.

*A Hughes representative will gladly demonstrate the MEMO-SCOPE® oscilloscope in your company. Simply address your request to: Hughes Products, Marketing Dept.—MEMO-SCOPE® International Airport Station, Los Angeles 45, California*

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 Circle 10 on Inquiry Card, page 123 

*AN IMPORTANT NEW PRODUCT ANNOUNCEMENT FROM HUGHES!*

# PARAMETRIC AMPLIFIER DIODES

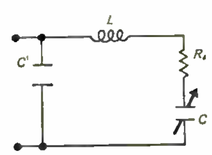
*FOR LOW-NOISE MICROWAVE AMPLIFIERS*

Now Hughes Products brings you high performance parametric amplifier diodes at a price in the same range as good microwave mixer crystals. These Hughes diodes have been designed to solve your problems associated with low-noise parametric amplifiers, modulators, frequency converters, harmonic generators, electronic tuners, switches, etc., at microwave as well as at lower frequencies.

Used in a 3000 Mc high gain parametric amplifier with both signal and idler channels as inputs, these diodes have produced at room temperature in the laboratory a noise temperature of 100°K above absolute zero. Noise temperatures of 50°K above absolute zero were obtained when diode was cooled by liquid nitrogen.

The Hughes Parametric Amplifier Diodes are available in two rugged, hermetically sealed versions. One has a miniaturized glass package (type HPA 2800); the other has been adapted to a conventional microwave package (type HPA 2810). Both are hermetically sealed in glass and have the same cutoff frequency.

**TECHNICAL SPECIFICATIONS AND DATA:**

| Package (actual size) | C' | C @ zero bias (nominal) | cutoff frequency* (nominal) | L (nominal) | $V_S$** Min. | $V_S$** Nom. | Equivalent Circuit |
|---|---|---|---|---|---|---|---|
| HPA 2800  | 0.1μμf | 2.5μμf | 70KMC | 4mμh @ 1KMC | 5V | 7V |   |
| HPA 2810  | 0.2μμf | | | | | | |

*At breakdown voltage **Breakdown voltage (10μA point)

CAPACITANCE vs. BIAS VOLTAGE

| Reverse Bias Voltage | Capacitance C |
|---|---|
| 0 V | 2.5 μμf |
| 3 V | 0.76 μμf |
| 7 V | 0.60 μμf |

*Address inquiries to:*
***Hughes Products, Semiconductor Marketing Dept.,***
***P. O. Box 278, Newport Beach, California.***

Creating a new world with ELECTRONICS

**HUGHES PRODUCTS**



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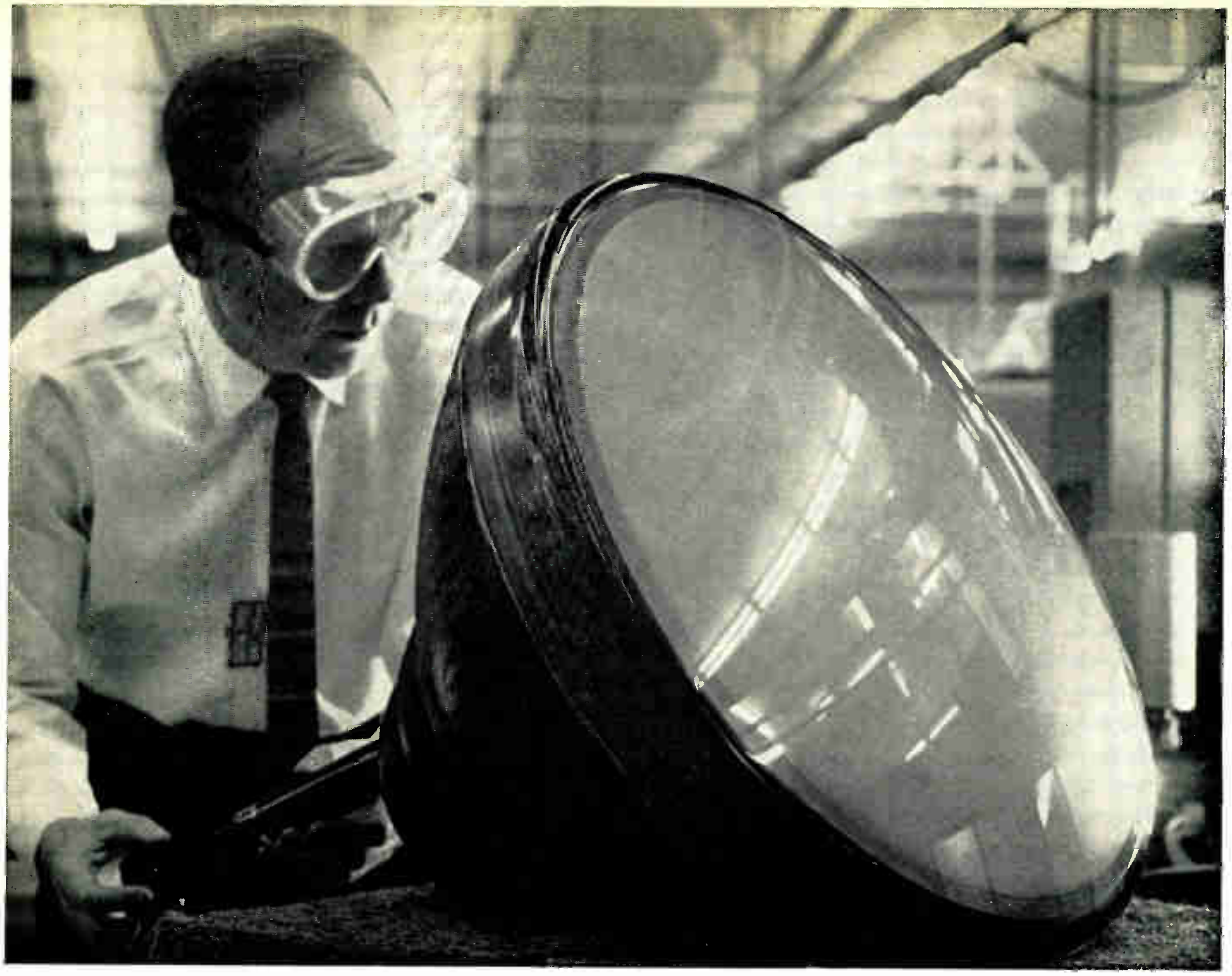
Circle 8 on Inquiry Card, page 123



# THE FIRST 21" STORAGE TUBE

***High light output! Controlled Persistence! Full gray scale!***

The Hughes 21″ TONOTRON* tube offers you a new level of sophistication in displays for: Air traffic control, Combat situation plotting, Radars, Large-scale read-out, Medical diagnosis, Industrial television, and Slow-scan displays.

This new TONOTRON tube provides high light output, integration abilities, full gray scale, controllable persistence, and a very large display area—all in one envelope!

Hughes also announces a 21″ character-writing TYPOTRON® storage tube, which gives you the *added* capability of high-speed digital character display. The 21″ TYPOTRON tube is ideally suited for any of your digital read-out requirements. In addition, this unique TYPOTRON tube offers you either character read-out or spot writing modes—or a combination of both capabilities.

Both the 21″ TONOTRON Tube and the 21″ TYPOTRON tube are now available for delivery. For additional information please write: Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, California.

*See the new Hughes 21" TONOTRON tube in action at the I.R.E. show (Booths 2801-2807)*

*Creating a new world with ELECTRONICS*

**HUGHES PRODUCTS**

*Trademark of Hughes Aircraft Co.



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# Electronic Industries International

**Canada**—E.M.I., Electrical & Musical Industries Ltd., has increased its investment in A. C. Cossor (Canada) Ltd., and obtains a controlling interest in the firm. The new name of A. C. Cossor Ltd. will be E.M.I.—Cossor Electronics Ltd.

**United Kingdom**—Philco Corp. has reached a licensing agreement with Thorn Electrical Industries, Ltd., London, whereby Thorn will acquire two Philco British subsidiaries to manufacture and sell the American firm's television receivers, radios, and high-fidelity phonographs. Thorn has acquired all the issued capital stock of Philco (Overseas) Ltd., and Philco (Great Britain), Ltd. Both concerns will be operated as units of Thorn. Thorn will manufacture and sell Philco-trademarked equipment in the United Kingdom and make export models of some Philco equipment for Philco International Corp's overseas distribution outside the U. K.

**Colombia**—International Petroleum Co., Ltd., subsidiary of Standard Oil Co. (New Jersey), will install a Bendix G-15 general-purpose computer in its Bogota plant. The computer will handle survey data reduction in the petroleum engineering field and data processing of company payrolls.

**Territory of Hawaii**—A $400,000 observatory is to be built on Ewa Beach about two miles west of the entrance to Pearl Harbor, Honolulu. Designated The Honolulu Magnetic and Seismological Observatory, it will serve as a center for magnetic observations, needed for accurate compass calibration, and as the heart of the seismic sea warning system in the Pacific. The observatory should be ready for use by December 1959.

**USSR** — The U. S. Government, American Industry, and other private groups will collaborate on an "American Exhibition" in Moscow for 6 weeks beginning around July 4, 1959. The USSR will stage a similar exhibition in the Coliseum in New York City around June 28. The American exhibit will feature American education, science and research, and art. President Eisenhower has authorized the use of $3,300,000 in Mutual Security Funds in addition to $300,000 available from a U. S. appropriation for an exhibit which did not take place last year. While there will be industrial displays, it will not be a trade fair.

**Liberia**—Liberia is getting $3,000,000 from the U. S.'s Development Loan Fund to improve their telecommunications facilities. The loan covers telephone, telegraph, teletype and other services between Monrovia and county and provincial centers.

**Switzerland**—Controls Company of America has formed a new subsidiary, Controls A.G., in Zug, Switzerland, under Mr. Remy Ludwig. The new company becomes the center of foreign operations for Controls Company, which also operates a manufacturing plant in Nijmegen, Holland.

**Export Controls**—Eighty five commodities, removed earlier from individual export requirements, now require individual export licenses for shipment to Poland. At the same time, thirty commodities have been removed from the list, including certain capacitors, resistors and magnetic and electrostatic separators.

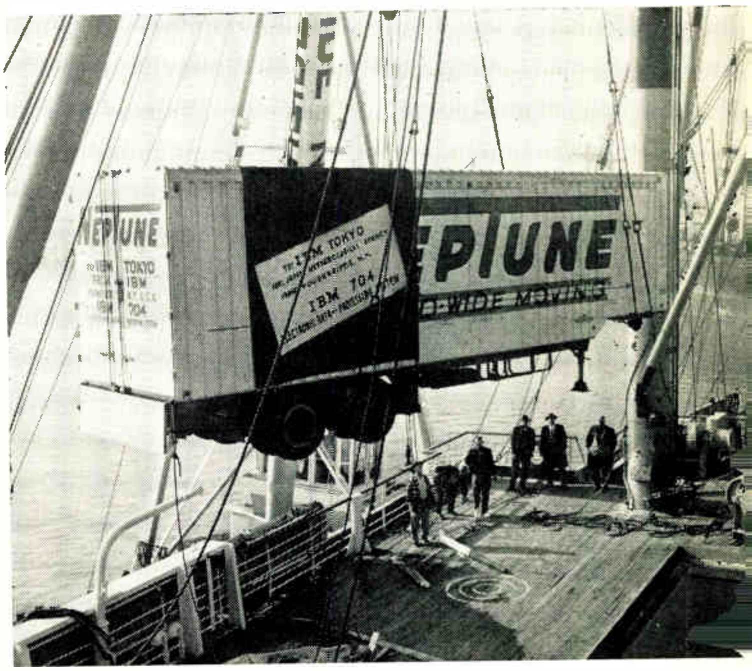
**West Germany**—General Controls Co. has set up a new subsidiary, General Controls, G.m.b.H, in Dusseldorf. Helmut Kiepe, West German industrialist, is General Manager and holds minority interest. The subsidiary will be the sales and distribution center for Continental Europe for the parent company. Limited manufacturing of some General Controls products will begin late this year.

**Norway**—Marconi VHF multichannel terminals and repeaters have been ordered by the Norwegian PTT to extend their coastal radio telecommunications network. Terminal stations have been planned for Hammerfest, Honningsvag, Berlevag and Vardo, with repeaters at Gamvik and Makkaur. The total distance covered by the route is about 200 miles.

**Israel** — Snyder Mfg. Co., Phila. manufacturer of auto radios and TV antennas, plans to purchase more of its electronic components from plants in Israel during the coming year. The company has been purchasing electronic components from European and Far East manufacturers for the past 10 years.

**Japan**—An IBM 704 is being installed at the Japanese Meteorological Agency in Tokyo, to be used for daily weather predictions, especially the prediction of the course and speed of typhoons. There will be a mutual exchange program of information with the U. S. Weather Bureau in Washington to conduct weather studies for the entire northern hemisphere. Information will also be fed to the system from ships at sea and from U. S. Air Force weather stations. The Japanese Meteorological Agency, a branch of the Japanese Government, ordered the machine from International Business Machines Co. of Japan, Ltd. *(See photo below.)*

IBM 704 data processing system, destined for the Japanese Weather Bureau in Tokyo, is loaded aboard ship in San Francisco. It is the first of its size delivered to the Asia Pacific area. The weight of the loaded van—45,000 lbs. —made a thorough inspection of the highway route from Yokohama to Tokyo for height and bridge load clearances necessary.




MORE INTERNATIONAL NEWS ON PAGE 26

# BROAD-BAND TRAVELING-WAVE TUBES OF GENERAL LABORATORY ANTICIPATE NEEDS OF ECM AND

Designers of electronic countermeasure and pulsed radar systems are continually making important progress toward equipments with greater flexibility, increased range, improved accuracy and reliability.

Development of low- and medium-power traveling-wave tube amplifiers for these equipments is a major effort at the General Electric Power Tube Department's Microwave Laboratory, Palo Alto, California.

These amplifiers provide wide, instantaneous bandwidths (typical range, 2 to 1) through the use of slow-wave structures having unique helix designs. Active programs include tubes with CW power levels up to 100 watts and above, and pulsed power outputs of several kilowatts. Gains from 25 to 35 db are typical.

The use of permanent magnets and full metal-ceramic construction allows the design of compact, lightweight tubes, able to withstand severe environments found in aircraft and missile applications.

Traveling-wave tube pioneering is only one of the broad range of activities at the General Electric Microwave Laboratory. Active developments in other fields are listed at the right.

All developmental work is done with an eye to practical, economical manufacture —thus minimizing the time lapse between prototype development and quantity production—and to the realistic tube needs of future microwave equipment. Technical inquiries pertaining to advanced tube development invited. *Power Tube Dept., General Electric Co., Schenectady, N.Y.*

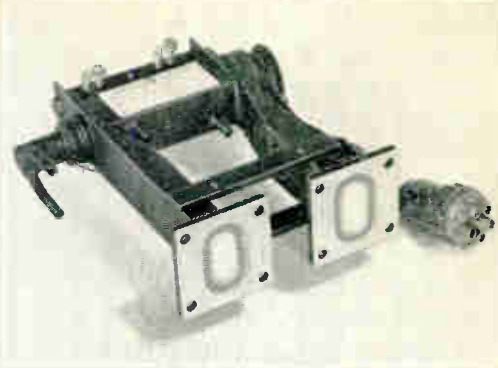
Professional opportunities available for electron tube production, engineering and scientific personnel. Inquiries are invited.


The General Electric Power Tube Microwave Laboratory is located at Stanford Industrial Park, Palo Alto, California where it was one of the Park's pioneer installations. Its scientists and engineers have the advantage of technical exchange with the faculty and research staff of Stanford University, as well as extensive opportunities for graduate training. Constant technical liaison is also maintained with General Electric's own Research and General Engineering Laboratories, Schenectady, New York.

# ELECTRIC MICROWAVE PULSED RADAR SYSTEMS

The extensive program of the General Electric Microwave Laboratory on advanced microwave components and techniques includes the following:

- CW Klystron Amplifiers
- Super-Power Klystrons
- Voltage-Tunable Oscillators
- High-Power Duplexers
- Microwave Filters
- Pulse Klystron Power Amplifiers
- High-Power Pulsed TWT Amplifiers
- Low- and Medium-Power CW TWT Amplifiers
- Low-Noise, Broad-Band TWT Amplifiers
- Frequency Multiplier TWT Amplifiers



One of several unclassified designs in advanced development, this 100-watt CW tube features a multiple helix structure, involving four parallel beams for higher power output over a wider bandwidth. Frequency range is 7.5 to 11.3 kmc, with 25 db gain minimum.

Palo Alto engineers responsible for design of low- and medium-power traveling-wave amplifiers discuss tube features for possible use in a final product design. (L. to R.) J. L. Putz (project engineer), G. Van Hoven, L. E. Didier and R. H. Winkler. Parallel groups of engineers are doing similar work on advanced design low-noise and high-power traveling-wave amplifiers.

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**

9545-8481-18

*From Transistor Center, U.S.A. ...*

# PHILCO®

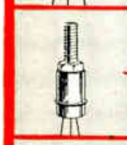
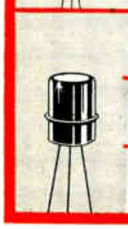
# announces a new family of LOW COST Medium Power Alloy Junction Transistors

Introducing a completely new family of PNP germanium transistors, especially designed to meet rigid military and industrial specifications . . . at lowest possible prices.

These transistors are available in production quantities, for use in teletypewriters, control amplifiers, ignition systems, mobile radios and desk calculators (2N1124); servo amplifiers, voltage regulators and pulse amplifiers (2N1125, 2N1126, 2N1127); medium power audio and switching applications (2N1128, 2N1129, 2N1130).

Also available in quantities 1-99 from your local Philco Industrial Semiconductor Distributor.

**Make Philco your prime source of information for all transistor applications. Write to Lonsdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. EI 359.**

| | TYPE | $V_{CB}$ Max. (Volts) | $V_{CES}$ Max. (Volts) | Peak $I_C$ (Amps) | P Max. (Watts) | $F_{\alpha b}$ (MC) | Beta | Applications | PRICE |
|---|---|---|---|---|---|---|---|---|---|
|  | **2N1124** | 40 | 35 | 0.5 | 0.3 | 0.4 Min | $h_{fe}$ 40 Min | For high voltage general purpose use in amplifier and switching. Small signal beta controlled. | $ 1.30 |
| | **2N1125** | 40 | 40 | 0.5 | 0.3 | 1.0 Min | $\bar{h}_{fe}$ 50-150 @ 0.5 amp | For high voltage, higher frequency industrial amplifier and switching systems. Large signal beta controlled. | $1.90 |
|  | **2N1126** | 40 | 35 | 0.5 | 1.0 | 0.4 Min | $h_{fe}$ 40 Min | 1 watt version of 2N1124 for servo amplifiers and relay actuators. Small signal beta controlled. | $1.80 |
| | **2N1127** | 40 | 40 | 0.5 | 1.0 | 1.0 Min | $h_{FE}$ 50-150 @ 0.5 amp | 1 watt version of 2N1125 for servo amplifiers and control systems. DC beta controlled. | $2.40 |
|  | **2N1128** | 25 | 18 | 0.5 | 0.15 | 1.0 | $h_{fe}$ 70-150 | For low distortion, high level driver and output application. Small signal beta controlled. | $ .95 |
| | **2N1129** | 25 | 25 | 0.5 | 0.15 | 0.75 | $h_{FE}$ 100-200 @ 0.1 amp | For high gain general purpose amplifier and switching. Typical DC beta 165. | $1.10 |
| | **2N1130** | 30 | | 0.5 | 0.15 | 0.75 | $h_{FE}$ 50-165 @ 0.1 amp | For higher voltage, higher level amplifier and switching applications. Typical DC beta 125. | $ .95 |

**Available in Production Quantities—Also Available from Local Distributors**

**PHILCO CORPORATION**

**LANSDALE TUBE COMPANY DIVISION**

**LANSDALE, PENNSYLVANIA**

**See us at the I.R.E. Show, Booths 1302-08**

Circle 12 on Inquiry Card, page 123

# JAPANESE ELECTRONICS PRODUCTION

## 1956, 1957 and nine months 1958

**An increasing amount of interest is being shown in foreign production and exports. Japan is one of the countries that is creating this interest. The figures for Japanese production are tabulated below.**

| | Thousand Units | | | Value | | |
|---|---|---|---|---|---|---|
| | 1956 | 1957 | Jan.–Sept. 1958 | 1956 | 1957 | Jan.–Sept. 1958 |
| Consumer electronic products | ...... | ...... | ...... | 40,370.0 (112.1) | 61,519.3 (170.9) | 63,505.2 (176.4) |
| Radio receivers | 3,060.3 | 3,684.9 | 3,357.1 | 19,958.8 | 25,977.6 | 23,384.8 |
| Television receivers | 312.1 | 605.3 | 745.5 | 18,126.5 | 31,257.9 | 35,851.5 |
| Television receiver kits | n.a. | 7.5 | 9.2 | n.a. | 271.6 | 311.9 |
| Phonographs | 56.2 | 59.6 | 38.1 | 540.2 | 778.3 | 465.2 |
| Record players | 158.8 | 312.2 | 273.0 | 841.3 | 1,535.3 | 1,409.5 |
| Recorders | 21.1 | 49.4 | 66.7 | 903.2 | 1,408.9 | 1,783.0 |
| Other | ...... | ...... | ...... | n.a. | 289.7 | 299.3 |
| Commercial, industrial, and military electronic equipment | ...... | ...... | ...... | 20,050.5 (55.7) | 27,845.8 (77.4) | 21,979.7 (61.1) |
| Radio broadcast equipment | ...... | ...... | ...... | 375.7 | 167.2 | 123.0 |
| Television broadcast equipment | ...... | ...... | ...... | 683.1 | 1,090.8 | 2,099.4 |
| Industrial television equipment | ...... | ...... | ...... | n.a. | 36.9 | 74.9 |
| Radio & microwave communications equipment: | | | | | | |
| Fixed: | | | | | | |
| Single channel communications equipment: | | | | | | |
| Long, medium & shortwave transmitting equipment | 0.1 | 0.2 | 0.4 | 75.8 | 97.3 | 90.1 |
| Long, medium & shortwave receiving equipment | 0.1 | 0.2 | 0.1 | 32.8 | 70.2 | 47.7 |
| H-F transmitting equipment | 0.2 | 0.1 | 0.1 | 459.6 | 503.3 | 267.4 |
| H-F receiving equipment | 0.3 | 0.1 | 0.7 | 96.0 | 73.3 | 206.0 |
| VHF transmitting & receiving equipment | 1.2 | 1.9 | 1.6 | 623.0 | 547.2 | 404.8 |
| Microwave transmitting & receiving equipment | ...... | 0.3 | 0.3 | 2.0 | 84.3 | 93.6 |
| Accessories | ...... | ...... | ...... | 126.4 | 221.9 | 178.6 |
| Multi-channel communications equipment: | | | | | | |
| VHF transmitting & receiving equipment | .1 | .1 | .1 | 197.5 | 230.9 | 161.7 |
| Microwave transmitting & receiving equipment | .2 | .4 | .4 | 646.0 | 1,937.0 | 1,150.6 |
| Accessories | ...... | ...... | ...... | 207.6 | 477.3 | 372.9 |
| Mobile radio equipment: | | | | | | |
| Land | 2.8 | 3.2 | 4.2 | 1,176.7 | 1,016.9 | 1,380.4 |
| Marine | 2.6 | 3.1 | 1.9 | 1,730.1 | 2,124.6 | 1,286.6 |
| Airborne | .1 | .2 | .2 | 104.2 | 140.8 | 207.1 |
| Portable | 3.1 | 1.8 | 1.9 | 335.0 | 326.7 | 297.8 |
| Electronic detection & navigation equipment: | | | | | | |
| Sonar | ...... | ...... | ...... | 454.3 | 509.0 | 237.7 |
| Loran | ...... | ...... | ...... | 127.4 | 775.4 | 275.7 |
| Direction finder | ...... | ...... | ...... | 466.1 | 673.4 | 530.2 |
| Radio beacon | ...... | ...... | ...... | 28.6 | 40.4 | 41.8 |
| Radar | ...... | ...... | ...... | 591.2 | 808.4 | 627.1 |
| Other | ...... | ...... | ...... | 441.0 | 339.5 | 485.3 |
| Ultrasonic equipment | ...... | ...... | ...... | 110.7 | 175.9 | 103.7 |
| H-F heating equipment | ...... | ...... | ...... | 113.5 | 399.0 | 310.0 |
| Other | ...... | ...... | ...... | 10,846.2 | 14,978.2 | 10,925.6 |
| Electron tubes | ...... | ...... | ...... | 18,803.7 (52.2) | 25,018.6 (69.5) | 18,684.2 (51.9) |
| Semiconductors | | | | n.a. | 3,852.6 (10.7) | 5,814.5 (16.2) |
| Diodes | n.a. | 3,862.8 | 6,381.6 | n.a. | 592.4 | 657.6 |
| Transistors | n.a. | 5,746.0 | 15,823.4 | n.a. | 3,203.9 | 5,064.0 |
| Photo-transistors | n.a. | 2.4 | 9.8 | n.a. | 5.1 | 13.7 |
| Thermistors | n.a. | 178.5 | 842.1 | n.a. | 51.2 | 79.2 |
| Electronic components | ...... | ...... | ...... | 9,586.4 (26.6) | 12,143.8 (33.7) | 9,851.5 (27.4) |
| Capacitors | 138,533.6 | 232,398.0 | 201,814.0 | 3,948.5 | 5,094.6 | 4,161.4 |
| Resistors | 120,398.5 | 210,988.0 | 184,300.0 | 1,646.5 | 2,255.0 | 1,919.3 |
| Transformers | 7,740.8 | 8,293.8 | 7,790.2 | 2,400.7 | 2,727.0 | 2,068.2 |
| Speakers | 2,322.8 | 2,969.5 | 2,801.5 | 1,590.7 | 2,067.2 | 1,702.6 |
| TOTAL | ...... | ...... | ...... | 88,810.6 (246.7) | 130,380.1 (362.2) | 119,835.1 (332.9) |

NOTE: U. S. dollar equivalent converted from yen at the rate of 360 yen = $1.00
Value in million yen; figures in parentheses, U. S. dollar equivalents in millions

—*Compiled from data submitted by the U. S. Embassy, Tokyo. Electronics Div., BDSA, U. S. Department of Commerce*

**This month's government Contract Awards will be found on page 30**

# SINGLE-GUN

# COLOR TUBE RETROFITS!

We've been hearing comments that have the ring of praise about them. They have been comments on the simplicity of our Lawrence-type color display tube, 5CGP29. We build other color and monochrome cathode ray tubes, *e.g.*, for applications requiring high definition of a hush-hush nature, or for fine character writing and many other applications. But let us discourse on the 5CGP29.

First of all it adapts to a great many equipments now limited by monochrome. It adapts with the same yoke you are now using and without the need to build a six-foot voltage-control console. The 5CGP29 does not have fussy requirements.

Post-Deflection Focusing is incorporated in the design. The electron beam paths are directed through an array of grid wires to an aluminum-backed phosphor screen on the face of the tube. Switching voltages on adjacent grid wires change the impact point of the focused beam. None of this is particularly critical in operation. And the operating voltages are such as not to produce what the low-temperature lab men call "thermal chaos."

There is very likely nothing more dramatic in the world of electronics than the face of a 5CGP29 discriminating between different classes of information in extra dimensions with bold colors. Military people appreciate it when, again with different colors, the 5CGP29 promptly discriminates in radar between hazardous and non-hazardous objects, or between friendly and unfriendly targets, for example.

A number of commercially available phosphors, with differing responsive qualities, afford wide variations in persistence and colors. There are dozens of uses for the tube in science, industry, and the military service. Let us tell you about them. Electronic Display Laboratory, Litton Industries Electron Tube Division, Office E10, 960 Industrial Road, San Carlos, Calif.

**See us at IRE Show, March 23-26, Booths 1610-16, 1709-15**

## LITTON INDUSTRIES Electron Tube Division

MAGNETRONS • GAS DISCHARGE TUBES • CARCINOTRONS • TRAVELING WAVE TUBES
KLYSTRONS • BACKWARD WAVE OSCILLATORS • NOISE SOURCES • DISPLAY TUBES

# CAPABILITY THAT CAN CHANGE YOUR PLANNING

# Electronic Industries' News Briefs

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

## EAST

**ROME CABLE CORP. AND ALUMINUM CO. OF AMERICA** have announced plans to affiliate. Alcoa will acquire all the properties of Rome Cable for 355,226 shares of Alcoa common stock. The agreement is subject to approval of Rome shareholders who will meet on March 25th.

**MICROTRAN CO., INC.**, Valley Stream, N. Y., has announced completion of a 5000 sq. ft. addition to their present transformer manufacturing facilities. This represents a 50% increase in plant facilities.

**SERVO CORP. OF AMERICA, L. I., N. Y.**, has received a production contract totaling $481,400 for computers for airborne dead reckoning tracers. Contract was awarded by U. S. Navy's Aviation Supply Office.

**EASTERN PRECISION RESISTOR CORP.** has announced that it is now operating the delay line and pulse transformer business for the Electronic Circuits Corp. E.C.C. was acquired from Epsco, Inc., Boston, Mass., and Digitronics Corp., Westbury, L. I.

**ALLEN B. DU MONT LABORATORIES, INC.**, Clifton, N. J., has received a $1.3 million sub-contract to produce 22 universal missile test sets for the Navy's Sparrow III program. The award was made by Raytheon Mfg. Co., prime contractor for the missile system. Units will be produced at their West Coast plant.

**AVION DIV., ACF INDUSTRIES, INC.**, has received a series of contracts totaling $200,000 for production of radar beacons for the U. S. Air Force Titan Intercontinental ballistic missile nose cone. They were awarded by Avco Mfg. Co.

**KAHLE ENGINEERING CO.** has completed a move to new and enlarged plant quarters. The new plant is located at 3322 Hudson Ave., Union City, N. J.

**PHILIPS ELECTRONICS INSTRUMENTS DIV.**, Mt. Vernon, N. Y., has just announced the completion of a new Norelco portable X-ray spectrograph. It was developed specifically for use in the field and around industrial plants.

**RAYTHEON MFG. CO.** has signed an agreement for the purchase of approximately 130 acres of land on Routes 2 and 128 in Lexington, Mass., for an executive-research park. The first building plan will be an executive office building. It will become headquarters for the electronics firm when completed.

**FXR, INC.**, announced a production schedule that enables them to make immediate deliveries of the recently introduced Model B811A Universal Ratiometer. The instrument houses, in one package, a VSWR amplifier and a ratiometer for reflectometer measurements.

**SYLVANIA ELECTRIC PRODUCTS, INC.**, has opened a new 30,000 sq. ft. building which houses their Electronic Systems Division headquarters and fabrication facility. The building is located near their Waltham Laboratories.

**SPRAGUE ELECTRIC CO.**, North Adams, Mass., has purchased the magnetic component and filter product lines of the Hycor Div. of the International Resistance Co. of Philadelphia. Sprague will take over the manufacture of the various Hycor product lines except for precision resistors which are not involved in the sale.

**WESTINGHOUSE ELECTRIC CORP.** has announced the development of a digitally programmed analog computer. It is a hybrid of two basic computing techniques, digital and analog.

**RADIO CORP. OF AMERICA** has announced the development of electroluminescent panels that emit a soft glow of light in any one of six specific colors instead of the single green color heretofore achieved. The panels have possible uses in many fields.

**BENDIX AVIATION CORP.**, Red Bank Div., has announced the production of a new germanium driver transistor series that can be used in audio amplifiers, audio oscillators, Class A and Class B amplifiers, power switches, servo controls, relay drivers and motor controls. They are designated 2N1008-A-B.

**IT&T'S INTELEX SYSTEMS, INC.**, will build and equip the nation's first fully mechanized mail processing plant and post office at Providence, R. I. It will be leased to the Post Office Dept. for 20 years. Estimated construction cost is $20 million.

## MID-WEST

**MONSANTO CHEMICAL CO.**, St. Louis, Mo., has developed a new modifier for epoxy resins. It is trademarked Mod-Epox and is said to improve the bonding strength of simple epoxy adhesives as much as 40 to 80%.

**DALE PRODUCTS INC.**, Columbus, Nebr., has announced their affiliation with International Standard Electrical Corp. to handle their overseas business. They will offer broader international representation of Dale Products' components.

**ROHN MFG. CO.**, Peoria, Ill., has increased their hot-dipped galvanizing facilities by 600% with a new modern galvanizing plant.

**EMERSON ELECTRIC MFG. CO.** of St. Louis, and **LITTON INDUSTRIES, INC.**, of Beverly Hills, Calif., have announced the formation of an industrial team to complete the development of a counterbattery radar and computer system. The team is participating in a competition for a counterbattery system now under consideration for inclusion in Army equipment requirements.

**SAVAGE INDUSTRIES, INC.**, Phoenix, Ariz., has announced that it will cease operations of its subsidiary, Savage Instrument Co. Telemetering operations of the instrument firm will be moved to Wiley Electronics in Phoenix.

**TEXAS INSTRUMENTS INCORPORATED** has started construction on a 192,000 sq. ft. addition to the present 310,000 sq. ft. Semiconductor-Components Div. plant. Completion is expected in about 12 months.

**BURROUGHS CORP.**, Detroit, Mich., will shortly start construction of a new $2 million engineering and administration building at its Tireman Ave. military electronic computer plant.

**MOTOROLA INC.**, Chicago, Ill., has announced the addition of a complete line of car radio antennas to their list of consumer products. They have models to fit and complement almost every foreign and domestic car, truck, boat or tractor.

**THE VICTOREEN INSTRUMENT CO.** has established a new Industrial Automation Div. Division will handle the fields of radioactive isotopes application to automatic process control, non-destructive testing, gamma irradiation and polymerization with nuclear devices.

## WEST

**GLOBAL VAN LINES, INC.**, worldwide moving firm with headquarters in San Gabriel, Calif., has placed in service the first of a fleet of vans which have been designed specifically for the movement of electronic equipment. The first manufacturer to take advantage of this new service was the Burroughs Corp., Electrodata Div. at Pasadena, Calif.

**HOFFMAN ELECTRONICS CORP.** have established their Science Center in Santa Barbara, Calif., pending construction of a permanent facility.

**UNGER ELECTRIC TOOLS, INC.**, Los Angeles, Calif., has just celebrated the production of their 10 millionth soldering iron.

**LING ELECTRONICS INC.** has completed an agreement for the acquisition of Altec Companies, Inc., stock. The proposed acquisition is to be effected through a share for share exchange of common stock.

**HUGHES AIRCRAFT CO.** has purchased the assets of Vacuum Tube Products Co., Inc., of Oceanside, Calif. The latter company will continue to market and produce its lines of vacuum tubes, precision electronic welding equipment, diodes, gauges, controls and timers in existing plants under the same management.

**SERVOMECHANISMS, INC.**, Hawthorne, Calif., has received contracts from The Martin Co. in the amount of $656,859. This raises the total amount of True Airspeed Computer orders to over $1.6 million. Two other orders presently on the books are from Lockheed Aircraft and Douglas Aircraft.

**FISHER BERKELEY CORP.**, Emeryville, Calif., says they are now the largest intercom manufacturer in the west as a result of their recent purchase of Bennett Laboratories, Inc., of Redwood City, Calif. The two companies will remain separate entities, but overall management will come entirely from Fisher Berkeley personnel.

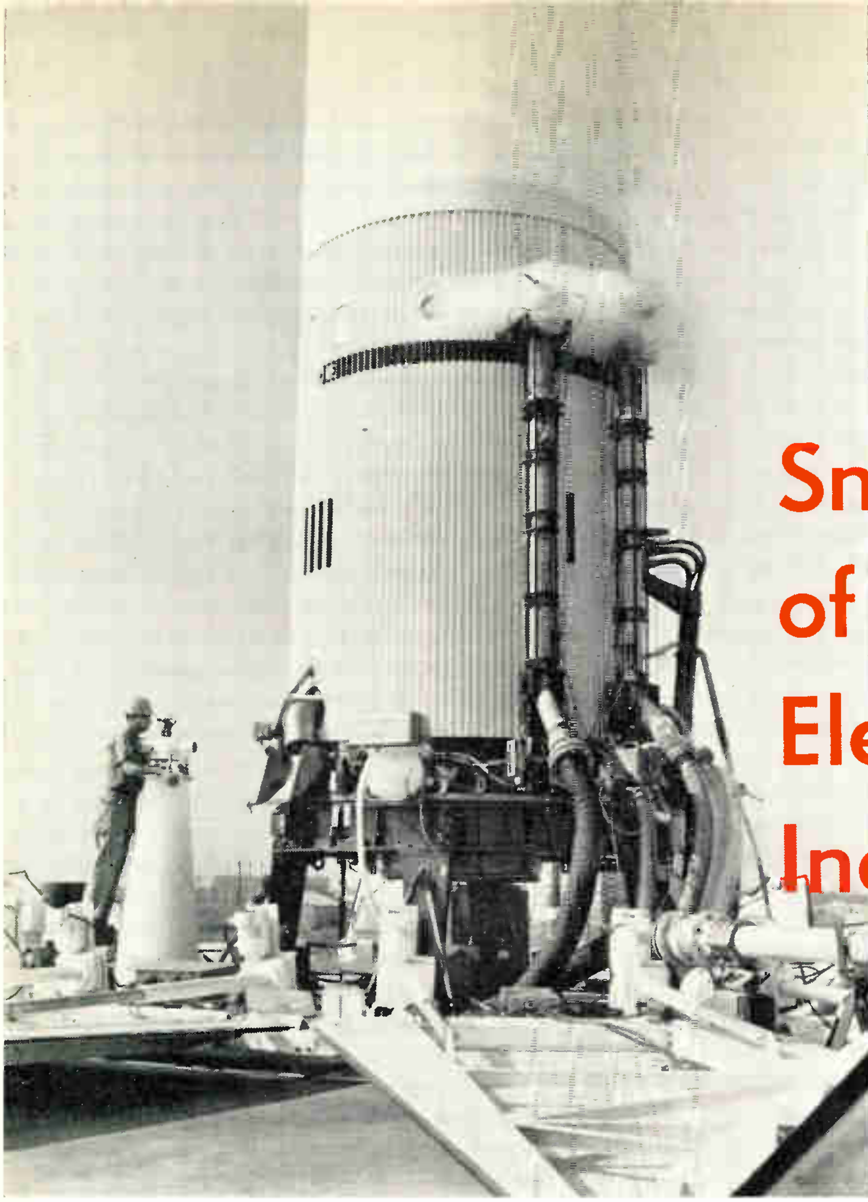
**CONVAIR DIV. OF GENERAL DYNAMICS CORP.** has just received a $31,400,000 contract from the U. S. Navy for production of an advanced version of Terrier guided missiles. The new missile will incorporate improved guidance features and substantial improvements in coverage over the present Terrier. It is intended for the same surface-to-air use as the now-operational version.

**UNITED STATES CHEMICAL MILLING CORP.**, producer of chemically milled products for the aircraft and missile industries, has announced the formation of an Electronics Div. The Manhattan Beach, Calif., firm has complete manufacturing facilities for the design and production of all types of printed circuit boards and chemically blanked parts.

**PACKARD-BELL ELECTRONICS CORP.**, Los Angeles, Calif., has been awarded two contracts totaling approximately $5 million for the production of advanced electronics equipment for the U. S. Navy. The prime contract with the Navy Bureau of Aeronautics calls for additional mission and traffic control equipment for Douglas A4D "Skyhawks" and Chance Vought F8U "Crusaders."

**CONSOLIDATED ELECTRODYNAMICS CORP.**, Pasadena, Calif., Board of Directors approved a plan to incorporate the company's Systems Div. and to operate it as a wholly owned subsidiary of the parent corporation. The new company will be called the Consolidated Systems Corp.

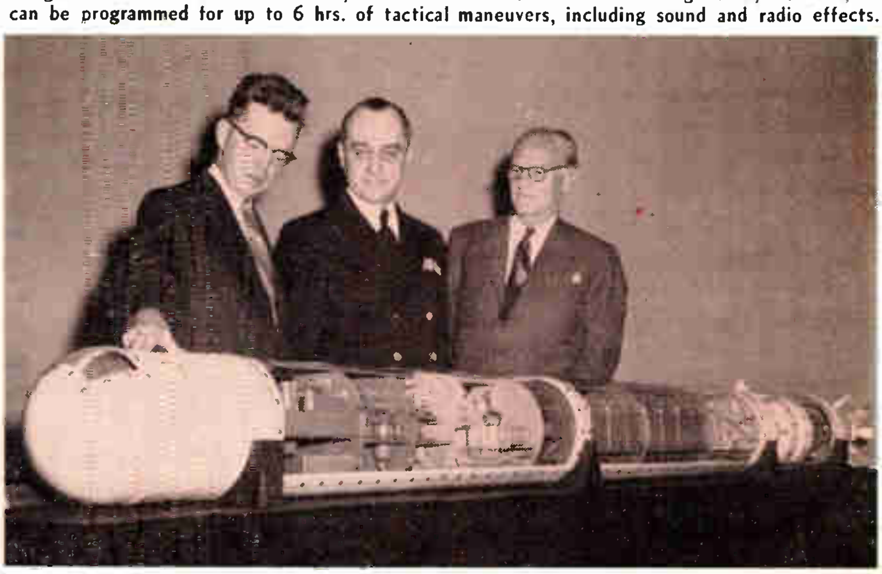
# Snapshots . . . of the Electronic Industries

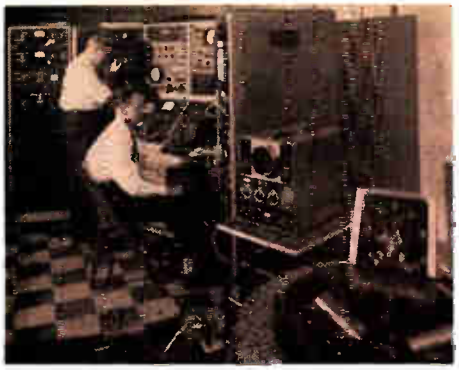


**"STRAIGHTEN UP 'N' FLY RIGHT"**
Azimuth heading of the Jupiter guidance system is monitored right up to blast-off. Perkin-Elmer short range theodolites, planted next to missile, correct any deviations.

**LARGEST SAPPHIRE LENS**
Synthetic sapphire lens, reportedly the largest in the world, is part of highly advanced infra-red optical system produced by Spectron, dept. of the Transducer Div., Consolidated Electrodynamics Corp.

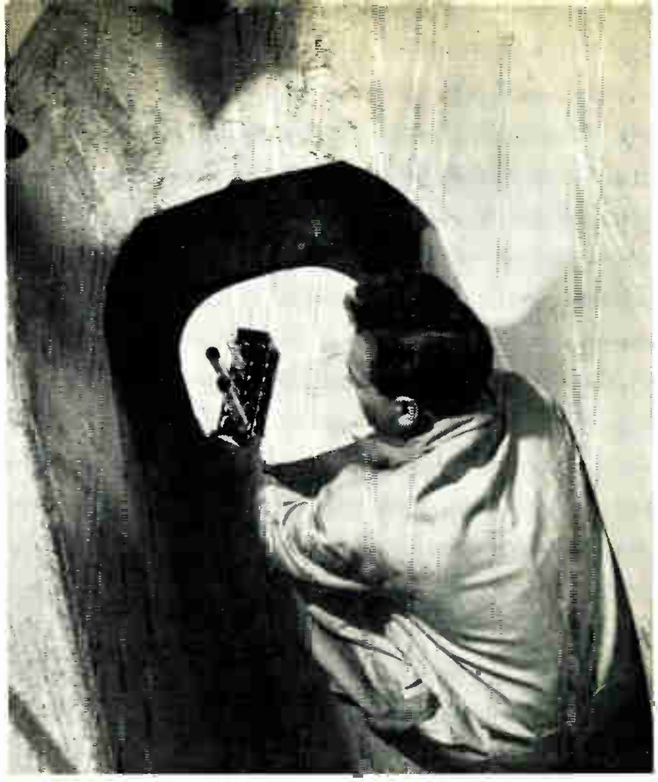
**SUBMARINE SIMULATOR**
Adm. C. Wheakley and Clevite's T. E. Lynch (l) and A. L. W. Williams discuss the intelligence mechanism of the Navy's new submarine simulator. Designed by Clevite, it can be programmed for up to 6 hrs. of tactical maneuvers, including sound and radio effects.





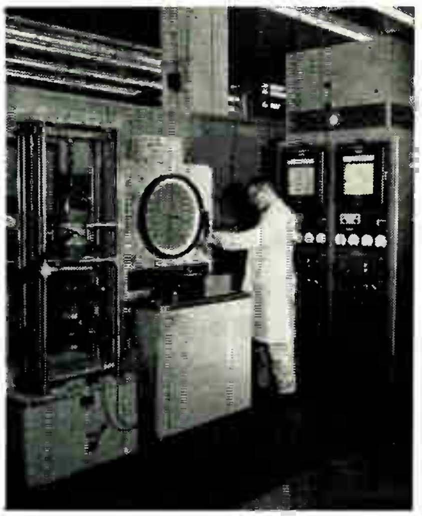
**VIBRATION TESTS**

Random noise pulses feed the shaker table at right to check a typical component utilized in space vehicles. DuMont 411 scope shows noise signal at USARDL, Ft. Monmouth.



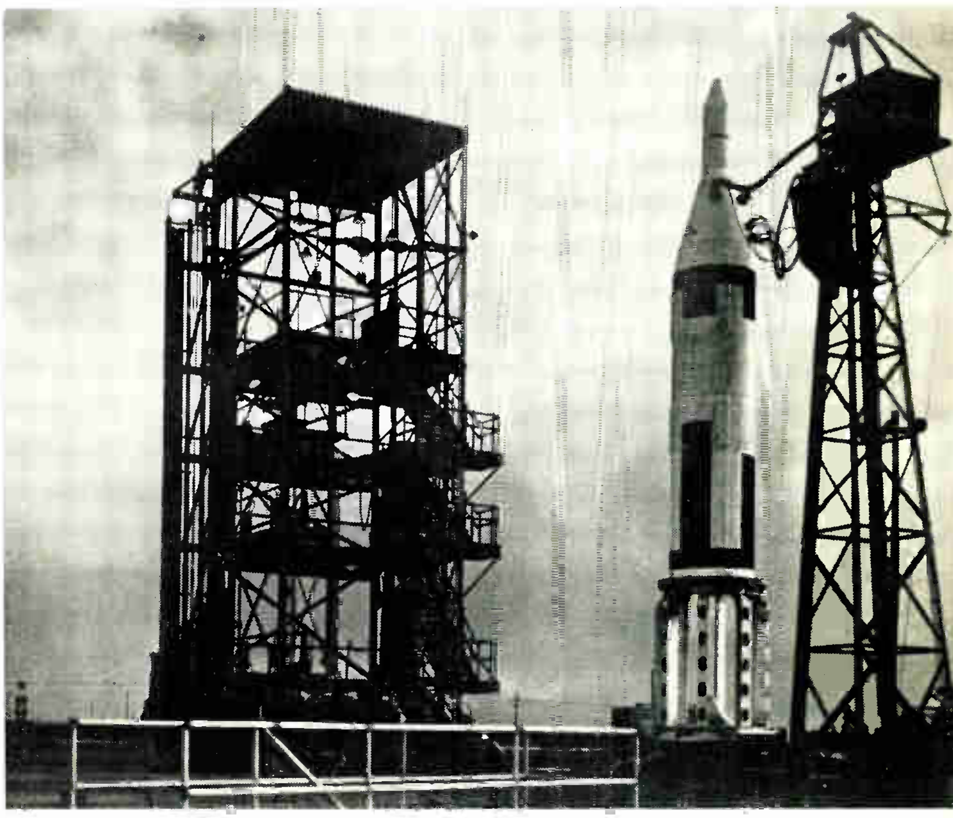
**IRRADIATED PLASTICS**

From the "pit" (right) at Radiation Applications Inc. a test run of plastics is removed which contains important new properties induced by radiation grafting. The cobalt-60 source is housed in 3½ ton lead shield with 4-ft. thick walls of concrete.



**HIGH-SPEED HEAT**

The simulated temperatures of high-speed flight are produced by this quick-heat source at Boeing Airplane Co. Ignitron units at right provide close control of heat level.

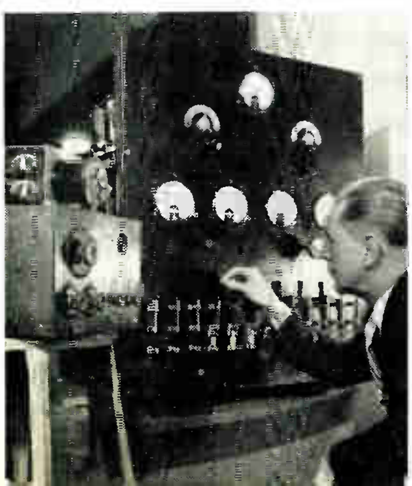


**NAVY'S PRIDE—POLARIS!**

First photos of the Polaris AX-1 test vehicle (above), placed on its launcher prior to test firing at the Atlantic Missile Range, Cape Canaveral, Fla. The solid-propellant missile, developed by Lockheed's Missile Systems Div., has a range of 1,500 miles.

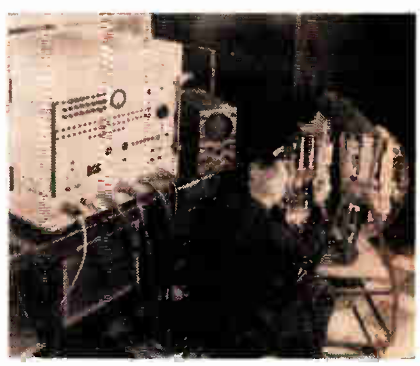
**OLD-TIMER!**

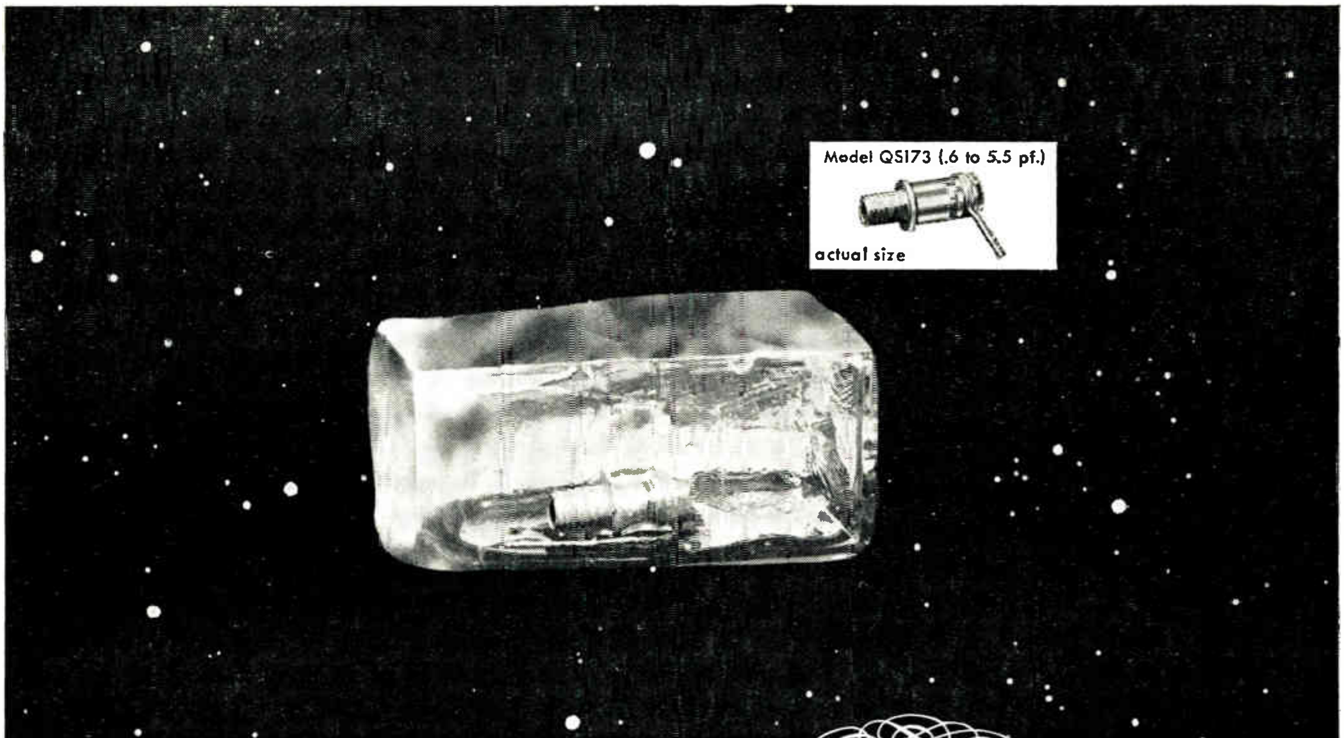
KDKA chief engineer Ted Kenney (below) demonstrates replica of KDKA's original control board used to transmit results of the Harding-Cox election in 1920. Board is being delivered to Smithsonian Inst., Wash., D. C.



**AUTOMATIC TESTING**

For testing a missile target seeker (right), Westinghouse has developed a series of test stands such as this. The operator checks the data and a photo of the computer output as presented on the oscilloscope.






Patent Pending

# NEW FROM JFD Electronics

## COMPLETELY SEALED
# MINIATURE QUARTZ SEALCAPS

Moving upstairs? Then you'll welcome the new JFD precision Miniature Quartz Sealcaps that seal out moisture, seal in reliability and accuracy, regardless of atmosphere.

These new JFD variable trimmer piston capacitors combine the unique characteristics of Sealcap construction and miniature quartz capacitor design. Each is filled with dry nitrogen under pressure and then sealed to maintain the compression, prevent corona and voltage breakdown at high altitude. Linear tuning with fine resolution is assured permanently, without breaking of seal.

Sealcap design also blocks the formation of moisture inside the unit, increases insulation resistance and dielectric strength. The use of quartz dielectric results in high Q, ultra low loss high frequency operation, greater stability, and approximately zero temperature coefficient.

JFD Standard Sealcaps are available unpotted or encapsulated in epoxy resin for higher dielectric strength. Our engineering staff will welcome the opportunity to relate the advantages of Sealcaps to your specific application. In the meantime, why not write for Bulletin No. 215? Also available in glass dielectric, Bulletin No. 207A.

### FEATURES

1. Sealed interior construction locks out all atmospheric effects.
2. High Q.
3. Anti-backlash design assures excellent tuning resolution — no capacitance reversal while tuning.
4. Extreme stability at high and low temperatures.
5. Ultra linear tuning for accurate alignment.
6. Low temperature coefficient of capacitance.
7. Low-loss low inductance coaxial tuning for high frequency use.
8. Special alloy plating protects metal parts against corrosion.
9. Fused Quartz dielectric with excellent electrical properties offers no derating at 150° Centigrade.
10. Rugged construction for shock and vibration resistance.
11. Miniaturized construction supplies maximum capacity in minimum space.
12. Positive mechanical stops at both ends of adjustment.
13. Available in panel and printed circuit type mountings — unpotted or encapsulated for complete imperviousness to humidity and moisture.

Pioneers in electronics since 1929

PHONE DEWEY 1-1000

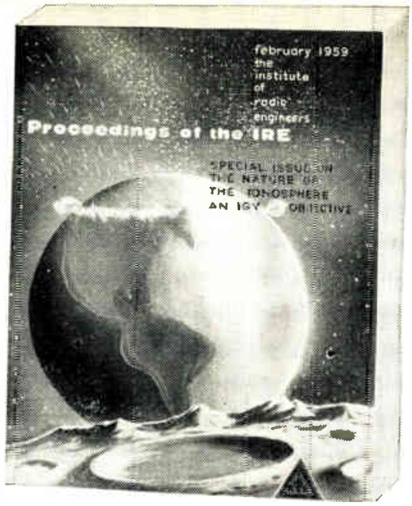
## JFD ELECTRONICS CORPORATION

1462 62nd Street, Brooklyn, New York

JFD Canada Ltd.
51 McCormack St.
Toronto, Ontario, Canada

JFD International
15 Moore Street
New York, New York

Ranges from .6 to 1.8 pf. to .8 to 16 pf. in 12 standard models.




# KNOW YOUR NEW WORLD *by reserving your copy*

*of* ***THE NATURE OF THE IONOSPHERE—AN IGY OBJECTIVE,*** *special February issue of* ***PROCEEDINGS OF THE IRE.*** *On these pages you will find a distillation of 18 months of an intensive international effort. Set against a background of earlier work, here is a new compendium of engineering knowledge edited to your special interests. Here is your new frontier.*

## PARTIAL CONTENTS OF IONOSPHERE—IGY ISSUE

**"The Earth and its Environment"** by S. Chapman, U of Colorado

**"The Constitution and Composition of the Upper Atmosphere"** by M. Nicolet, Radio and Meteorology Institute, Belgium

**"The Normal F-Region of the Ionosphere"** by D. F. Martyn, Radio Research Labs. CSIRO, Australia

**"The Normal E-Region of the Ionosphere"** by E. V. Appleton, U of Edinburgh, Scotland

**"The D-Region of the Undisturbed Ionosphere"** by J. J. Gibbons & A. H. Waynick, Penn State U

**"The Distribution of Electrons in the Ionosphere"** by J. O. Thomas, U of Cambridge, England

**"Motions in the Ionosphere"** by C. O. Hines, Defense Research Board, Canada

**"Meteors in the Ionosphere"** by L. A. Manning & V. R. Eshleman, Stanford U

**"Atmospheric Whistlers"** by R. A. Helliwell, Stanford U & M. G. Morgan, Dartmouth U

**"Radiation and Particle Precipitation upon the Earth from Solar Flares"** by L. G. B. Biermann & R. Lust, Max Planck Institute for Physics and Astrophysics, Germany

**"The Very-Low-Frequency Emmissions Generated In The Earth's Atmosphere"** by R. M. Gallet, National Bureau of Standards

**"The F-Region During Magnetic Storms"** by K. Maeda, Kyoto U & T. Sato, Shiga U, Japan

**"Aurora Phenomena"** by E. N. Parker, U of Chicago

**"Rocket Observations of the Ionosphere"** by H. Friedman, U. S. Naval Research Lab.

**"Earth Satellite Observations of the Ionosphere"** by W. W. Berning, Aberdeen Proving Grounds

**"Exploration of the Upper Atmosphere with the help of the 3rd Soviet Sputnik"** by V. I. Krassovsky, Institute for Atmospheric Physics, Moscow

REMEMBERS THE MAN

IRE

## THE INSTITUTE OF RADIO ENGINEERS

1 East 79th St., New York 21, N. Y.

△ Enclosed is $3.00

△ Enclosed is company purchase order for the February 1959 issue on I.G.Y. and Ionosphere.

Send this special issue of THE NATURE OF THE IONOSPHERE—AN IGY OBJECTIVE to:

NAME__________

COMPANY__________

ADDRESS__________

CITY & STATE__________

All IRE members will receive this February issue as usual.

Extra copies to members, $1.25 each (only one to a member)

 Circle 15 on Inquiry Card, page 123 

## ELECTRONIC INDUSTRIES International

(*Continued from page* 15)

Ireland—Operations have begun at the first industrial plant erected in the free zone of Shannon Free Airport. The U. S. owned Coin-Operated Amusement Machines Co. (COAMCO) is using the facility for the assembly and shipment of electronically-operated amusement machines. Future plans call for complete manufacturing in Ireland. The development inducement program offers grants of up to $140,000 for construction, 25 year exemption from income taxation, and customs-free use of the airport's facilities.

Canada—Hughes Aircraft Co. has named R-O-R Assoc., Ltd., Toronto, Ontario as distributor of their commercial products in Canada. The firm will distribute the complete line of Hughes semiconductors, cathode ray storage tubes, microwave tubes, and test instrumentation.

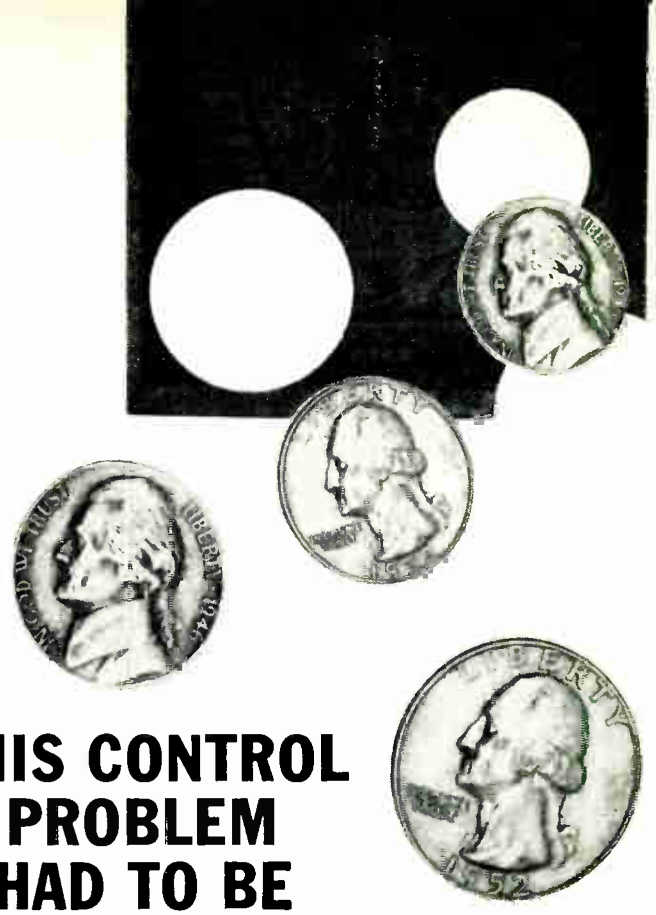
United Kingdom—Professor E. E. Zepler, Ph.D., Chair of Electronics at the University of Southampton, has been elected the 15th President of the British Institution of Radio Engineers.

Japan—Japanese electronic production continued to increase in 1958. Production for the first 9 months of 1958 was 24% above the same period in 1957. Japanese exports are also showing rapid gains. Exports for the same period amounted to $26,000,000—about $8,000,000 more than in 1957. The above figures were compiled from reports prepared by the American Embassy in Tokyo.

Transatlantic TV — Tropospheric scatter now makes transatlantic TV technically possible—but over $50,000,000 would be needed to build from 6 to 10 North Atlantic relay stations. Ed Dykes, Assistant Director of Page Communications Engineers, Inc. lists these developments which make such transmission possible: bigger antennas, accurate prediction of fades, power requirement reduction, bandwidth reduction, easier tests, and the "Mavar" amplifier, a device which cuts noise amplification.

United Kingdom—Three special-design radar projectors, which minimize "radar blindness" through a rapid photographic process which projects the picture on a large screen have been bought from England. The annoying flicker found on the ordinary radar screen can cause " radar blindness" after prolonged watching by otherwise healthy and efficient personel.

A HOFFMAN SEMICONDUCTOR APPLICATION CASE HISTORY



# THIS CONTROL PROBLEM HAD TO BE SOLVED

r new semiconductor application ideas,
sit Booths 3242-3243 at the I.R.E. Show

# FOR AUTOMATIC DOLLAR BILL CHANGERS

## *Hoffman Silicon Solar Cells were the solution*

A.B.T.'s (division of Atwood Vacuum Machine Co., Rockford, Illinois) intricate control problem in their unique "bill changer" required Hoffman Silicon Solar Cells, of exacting quality, to automatically register the authenticity of a dollar bill, in this innovation in automatic vending.

You, too, may have a control problem requiring immediate and accurate registering—instantaneous response (20 microseconds)—long life (10,000 years*)—high light conversion efficiency (up to 10%)—wide spectral response range (4,000-11,500 angstroms)—extended operating temperature range (—65°C to +175°C).

Hoffman Silicon Solar Cells, born from the same family as those which are still powering the U. S. Navy's Vanguard satellite's radio transmitter, can be the answer to your control problem. For details consult the Hoffman Solar Cell applications specialist in your area or write to Department SS.

*If you need a job in electronics done quicker and better, contact*

**Hoffman Electronics CORPORATION**
**SEMICONDUCTOR DIVISION**
930 PITNER AVENUE EVANSTON, ILLINOIS

r R.C.A. Laboratories, Princeton, New Jersey,
ort No. 212-PH-55-91 [1114], April 15, 1957)

Circle 17 on Inquiry Card, page 123

# FREQUENCY STANDARDS

### 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

*3⅛" high
400 - 1000 cy.

### 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.)

### 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

*3½" high
400 to 500 cy.
optional

### 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 — NEW
TYPE 2007-6
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**

### FREQUENCY STANDARD
TYPE 2121A

*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.

### ACCESSORY UNITS
for TYPE 2001-2

- L—For low frequencies multi-vibrator type, 40-200 cy.
- D—For low frequencies counter type, 40-200 cy.
- H—For high freqs, up to 20 KC.
- M—Power Amplifier, 2W output.
- P—Power supply.

*This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.*

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

# *American Time Products, Inc.*

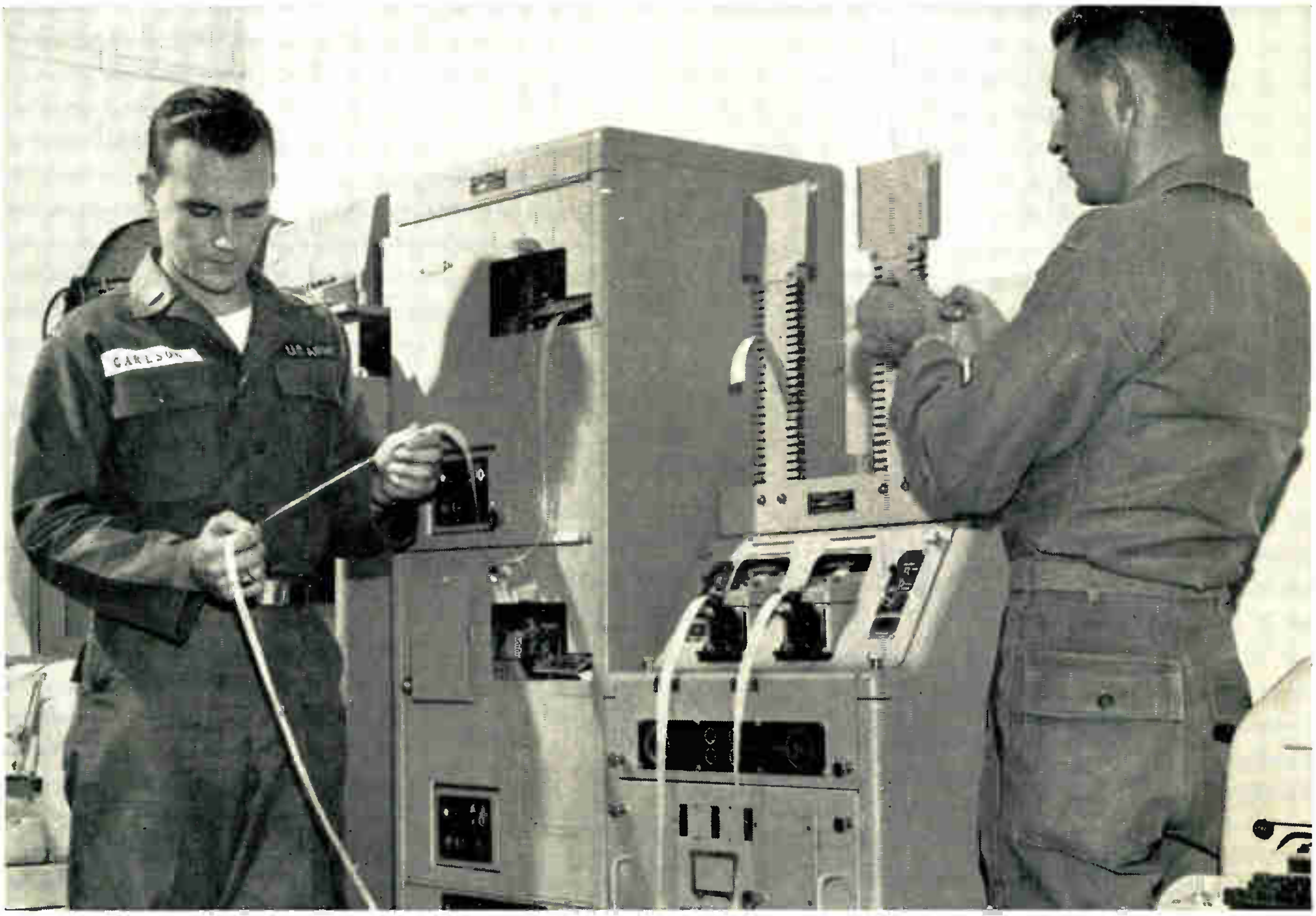
Watch Master Timing Systems

**Telephone: PLaza 7-1430**

**580 Fifth Ave., New York 36, N. Y.**

# TOP LEVEL TALK

## *relayed on teleprinted tape*




**At U.S. Army field communications centers, Kleinschmidt torn tape relay units send, receive, retransmit messages to widely-dispersed commands**

"Getting the word" from top command to outlying units in the field can create a communications traffic jam. This compact relay unit solves the problem. It quickly, accurately, automatically numbers and *prints* each message as it simultaneously *relays* another message to one or 100 receivers in the communications network! Developed in cooperation with the U. S. Army Signal Corps, the unit's applications include telemetering, integrated data processing, torn tape communication. In recognition of Kleinschmidt's high standards of performance, equipment produced for the U. S. Army is manufactured under the Reduced Inspection Quality Assurance Plan.

# KLEINSCHMIDT

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

Pioneer in teleprinted communications systems and equipment since 1911



Circle 19 on Inquiry Card, page 123

## GOVERNMENT ELECTRONIC CONTRACT AWARDS

*This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in January, 1959.*

| | |
|---|---|
| Adapter, tube socket | 85,383 |
| Analyzer, amplitude distribution | 31,050 |
| Antennas & accessories | 1,678,775 |
| Battery, dry | 2,063,295 |
| Beacon, radio | 990,000 |
| Cable assemblies | 40,480 |
| Component, electronic | 866,880 |
| Computers | 95,061 |
| Converter, kinetape | 553,558 |
| Converter, telephone signal | 59,553 |
| Dome, sonar | 797,880 |
| Handset | 102,912 |
| Headset | 338,838 |
| Kit, modification | 124,872 |
| Meter | 64,264 |
| Microphone | 39,604 |
| Potentiometer | 25,725 |
| Radar sets & accessories | 13,692,924 |
| Radio set | 1,254,693 |
| Radiosonde | 92,346 |
| Receiver/transmitter | 150,000 |
| Receiver/transmitter, telemetric data | 513,935 |
| Recorder/reproducer | 451,341 |
| Recorder, telemetric data | 1,221,486 |
| Relay, armature | 74,947 |
| Relay assemblies | 26,123 |
| Relay, solenoid | 27,918 |
| Research & Development | 637,982 |
| Resistor | 46,435 |
| Signal Generator | 187,308 |
| SSB equipment | 1,530,132 |
| Switchboard equipment | 28,036 |
| Switch, rotary | 44,070 |
| Synchros | 865,055 |
| Teleprinter | 406,097 |
| Teletypewriter | 1,780,791 |
| Television facilities | 55,964 |
| Terminal, telephone | 1,207,912 |
| Test set, radar | 31,891 |
| Test equipment | 102,458 |
| Transformer | 201,178 |
| Transmitter, countermeasures | 409,743 |
| Transmitter | 2,031,990 |
| Tube, Cathode ray | 62,386 |
| Tube, electron | 3,120,695 |
| Tube, magnetron | 93,815 |
| Waveguide assemblies | 61,336 |

## *Fellowships Awarded*

Nine Hughes Aircraft Co. scientists and engineers: Dale B. Donalson, Edward H. Erath, Robert Lull Forward, Robert W. Hougardy, Maier Margolis, James E. Mercereau, Louis A. Rondinelli, Frank L. Vernon, Jr., and James K. Yakura have been awarded Hughes Staff Doctoral Fellowships, according to Dr. Andrew V. Haeff, company vice-president.

The fellowships provide a minimum of $1500 a year plus cost of tuition, fees and textbooks. Winners will hold their regular full-time jobs at Hughes during the summer and those attending nearby universities will work one day a week during the academic year.

**More News on Page 68**

# ALL-PURPOSE DIGITAL VOLT-OHM METER

**Examine these outstanding features.**

**RAPID, ERROR-FREE READINGS BECAUSE**

Type of measurement indicated.

Polarity automatically displayed.

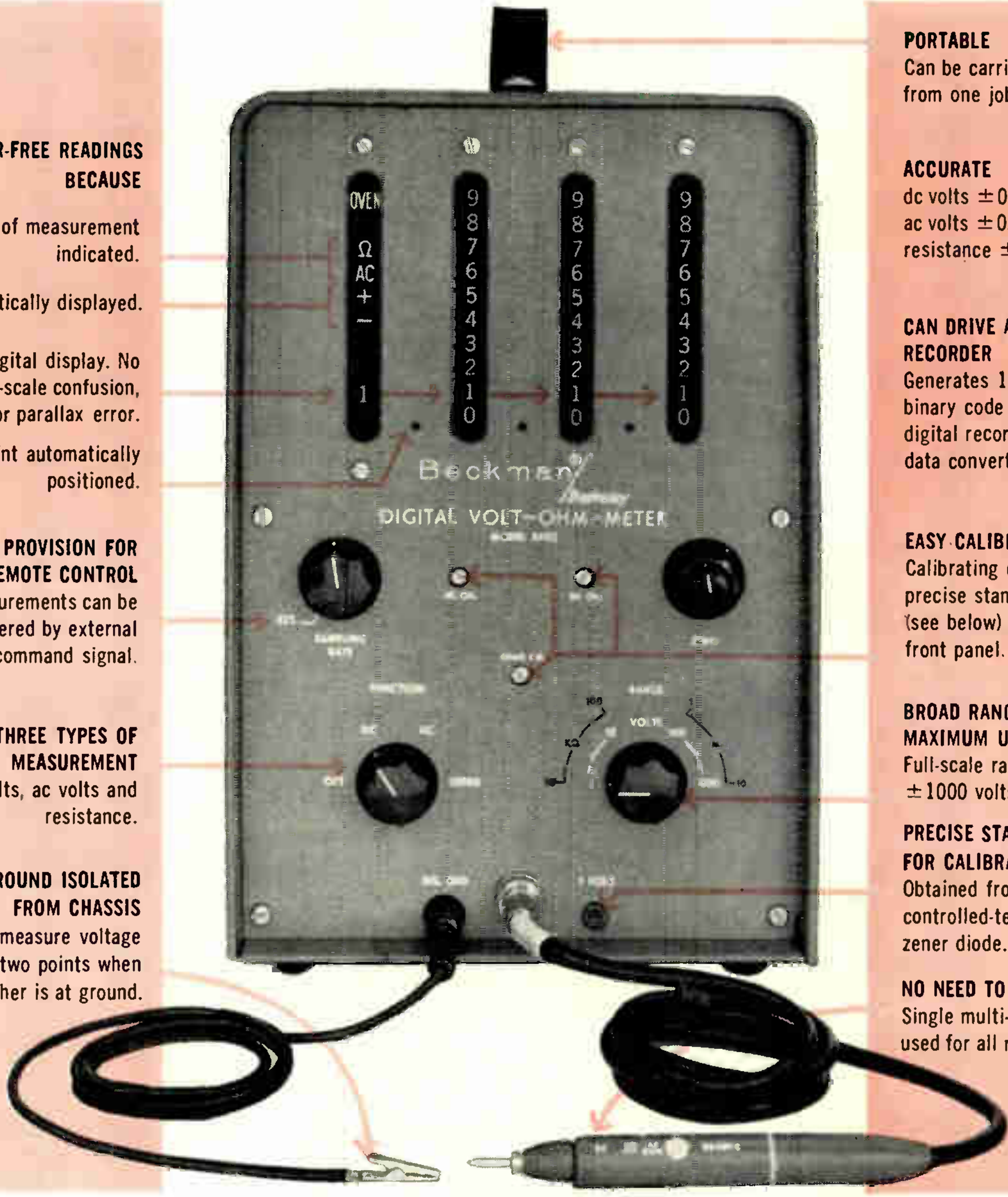
Digital display. No multi-scale confusion, interpolation or parallax error.

Decimal point automatically positioned.

**PROVISION FOR REMOTE CONTROL**
Measurements can be triggered by external command signal.

**THREE TYPES OF MEASUREMENT**
dc volts, ac volts and resistance.

**SIGNAL GROUND ISOLATED FROM CHASSIS**
You can measure voltage between two points when neither is at ground.




**PORTABLE**
Can be carried easily from one job to another.

**ACCURATE**
dc volts ±0.2%
ac volts ±0.5%
resistance ±1.0%

**CAN DRIVE A RECORDER**
Generates 1-2-2-4 binary code for digital recorder, data converter, etc.

**EASY CALIBRATION**
Calibrating controls and precise standard voltage (see below) available on front panel.

**BROAD RANGE INSURES MAXIMUM UTILITY.**
Full-scale ranges of ±1 to ±1000 volts, 10k to 10M ohms.

**PRECISE STANDARD VOLTAGE FOR CALIBRATION**
Obtained from an internal controlled-temperature zener diode.

**NO NEED TO CHANGE PROBES**
Single multi-purpose probe used for all measurements.

160

As the picture reveals, BECKMAN/Berkeley's Model 5350 is the most useful, most versatile digital instrument of its kind. It offers operating flexibility and features not found in digital voltmeters costing three times as much. The Model 5350 makes it feasible to replace multi-purpose analog equipment with a more accurate, rapid and foolproof means of making the vast majority of everyday voltage and resistance readings.

Three digits present all readings within the nominal full scale range (000 to 999), a fourth digit permits off-scale readings up to 150% of full scale. All electronic construction eliminates troublesome stepping switches and permits an instantaneous display of readings at rates up to 10 per second.

Priced at only $845.00.

**Beckman®** / *Berkeley Division*

*2200 Wright Avenue, Richmond 3, California*

*a division of Beckman Instruments, Inc.*

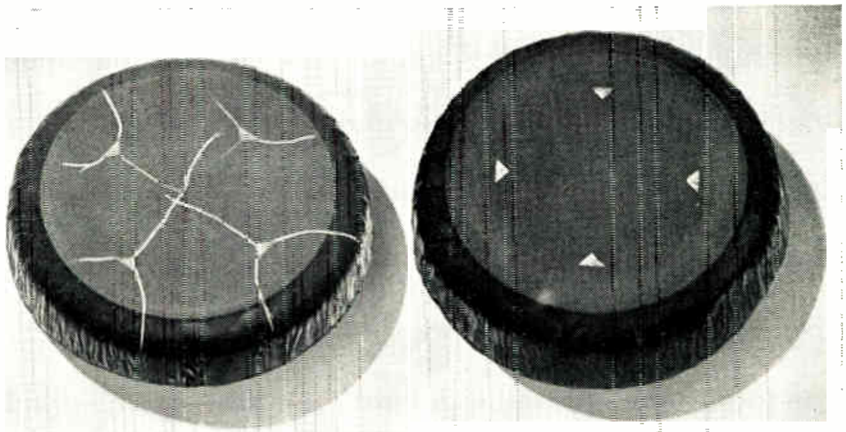


Circle 21 on Inquiry Card, page 123

*Proved in production:* **"SCOTCHCAST"** REG. U.S. PAT. OFF. BRAND *Flexible Resins have*

# Superior Crack Resistance

**Laboratory tests and production results prove "SCOTCHCAST" Flexible Resins (1) superior in resisting cracking from thermal or mechanical shocks; (2) offer important advantages for impregnation, embedding, and encapsulating motors, coils, transformers, resistors, capacitors, and other electrical and electronic components.**



WHY A FLEXIBLE RESIN? This unretouched photo shows what happened when two "shock resistant" resins—both passing Thermal Shock Tests of MIL-I-16923C Type C—were cast about a metal insert to more closely reproduce stresses in service. The permanently flexible "SCOTCHCAST" No. 241, on the right, withstood 10 cycles (130° to -55° C.) and absorbed all stresses without cracking. The resin on the left cracked during the first cycle. Shrinkage stresses during cooling exceeded the strength of the resin. Write for paper describing these tests in detail.

With "SCOTCHCAST" Brand Flexible Epoxy Resins, you can be sure of shock resistance properties that surpass any required to satisfy the most rigid military specifications*; can reduce the expenses normally entailed in screening and testing resins for prototypes. "SCOTCHCAST" Flexible Resins can also cut your production costs by reducing rejections because of insulation cracking. And, of course, "SCOTCHCAST" Flexible Resins give you the added assurance of customer satisfaction because the units you supply can withstand stresses of the most severe environmental conditions.

**A paper describing specially developed thermal shock tests of greater severity than those called for by the MIL-I-16923C Shock Test, is available upon request. Contains complete information to duplicate tests in your own laboratory. Free upon request to 3M Co. at the address below.*

## *When to use* FLEXIBLE RESINS

"SCOTCHCAST" Flexible Resins were developed by 3M to meet the need for crack resistance under stresses of mechanical and thermal shock. In addition, the stress-relieving properties of these resins reduce to a minimum the effect of resin shrinkage on the magnetic properties of core materials. Similarly, fine wire breakage is completely eliminated.

"SCOTCHCAST" Brand Flexible Resins are true flexible resins—made permanently flexible by modifying the molecular structure of the resin itself. This gives them the permanent ability to withstand shrinkage stresses during cooling when cured, and environmental stresses of mechanical shock and rapid severe temperature changes.

"SCOTCHCAST" is a registered trademark for the electrical insulating resins of 3M Co., St. Paul 6, Minn. Export: 99 Park Ave., New York 16. Canada: London, Ontario.

## *Ready-to-use* "SCOTCHCAST"

As with all "SCOTCHCAST" Brand Resins, you get these crack-resistant resins in ready-to-use production-proven formulations: "SCOTCHCAST" Nos. 235 and 241 for the ultimate in impregnating and casting ability; and "SCOTCHCAST" No. 253 for smooth, uniform dipcoating results. All three have 2 to 4 day pot life at room temperature, yet can be cured in 2 hours at 250° F. All are supplied as pre-formulated, pre-measured resin-and-hardener systems, complete, ready to use in simple mixing ratios such as one-to-one and two-to-one to eliminate the need for special mixing and dispensing equipment and highly trained scientific personnel on the production line.

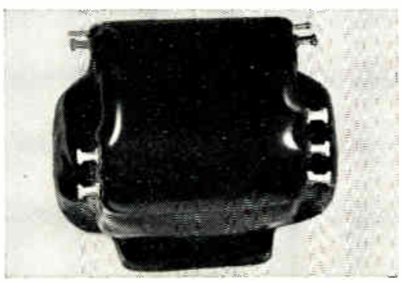
### FREE TECHNICAL ASSISTANCE

3M's trained field engineers supported by 3M's research organization are fully qualified to assist or advise you in designing or modifying units for resin encapsulation; can help you select the correct "SCOTCHCAST" formulation for any application. Technical service is provided without cost or obligation. Write: 3M Co., 900 Bush Ave., St. Paul 6, Minn., Dept. TP-39.

### "SCOTCHCAST" No. 253 . . . the flexible resin for *dipping!*

This transformer meets MIL-T-27A Grade 5 requirements. It was impregnated using "SCOTCHCAST" No. 241, and then dip-coated with "SCOTCHCAST" Resin No. 253. There is no limit to the sizes and shapes of properly designed components that can be dip encapsulated with No. 253.

A newly revised booklet covering impregnating and encapsulating transformers to meet MIL-T-27A specifications is now available. Covers all six grades and gives four proven processes. Free . . . write for it.



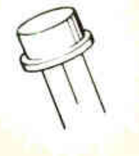
REG. U.S. PAT. OFF.
**SCOTCHCAST**
BRAND
**INSULATING RESINS**

**MINNESOTA MINING AND MANUFACTURING COMPANY**
**. . . WHERE RESEARCH IS THE KEY TO TOMORROW**
3M COMPANY


Circle 326 on Inquiry Card, page 123
Circle No. 22 on Inquiry Card, page 123 →

# NEW!

## Very High Frequency Silicon Power Transistors



*Triple-diffused npn mesa structure*

Six new types, three oscillator transistors and three amplifier transistors, are currently available in limited quantities for evaluation orders.

- Power capabilities at 70 megacycles of ¼, ½, and ¾ watts output.
- High voltage capability permitting operation at collector voltages up to 100 volts DC.
- Collector power dissipation rating of 2¼ watts at 50°C case temperature.
- Typical amplifier gain of 10 db at 70 mc.

Specification sheets, curves, and additional information are available on written request. Address your inquiries to Department T-10.

*Please Note:*

All specifications and information contained herein are current as of February 25, 1959. This advertisement has been inserted in the March issue of Electronic Industries to speed the communication of PSI product information to the specifying engineer. Similar product advertisements, compiled from latest PSI specifications, will appear regularly in this and other leading electronic publications.

PSI

## Silicon General Purpose Diodes

ACTUAL SIZE

| EIA TYPE NUMBER | Minimum Saturation Voltage @ 100 µa @ 25°C (volts) | Minimum Forward Current @ +1.0 VDC @ 25°C (mA) | Maximum Inverse Current at Maximum DC Operating Voltage (µa @ volts) @ 25°C | @ 150°C | Maximum Average Rectified Current (mA) @ 25°C | @ 150°C |
|---|---|---|---|---|---|---|
| 1N456 | 30 | 40 | .025 @ 25 | 5 @ 25 | 90 | |
| 1N456A | 30 | 100 | .025 @ 25 | 5 @ 25 | 200 | 70 |
| *1N457 | 70 | 20 | .025 @ 60 | 5 @ 60 | 75 | |
| 1N457A | 70 | 100 | .025 @ 60 | 5 @ 60 | 200 | 70 |
| *1N458 | 150 | 7 | .025 @ 125 | 5 @ 125 | 55 | |
| 1N458A | 150 | 100 | .025 @ 125 | 5 @ 125 | 200 | 70 |
| *1N459 | 200 | 3 | .025 @ 175 | 5 @ 175 | 40 | |
| 1N459A | 200 | 100 | .025 @ 175 | 5 @ 175 | 200 | 70 |
| 1N461 | 30 | 15 | 5 @ 25 | 30 @ 25 | 60 | |
| 1N461A | 30 | 100 | 5 @ 25 | 30 @ 75 | 200 | 70 |
| 1N462 | 70 | 5 | 5 @ 60 | 30 @ 60 | 50 | |
| 1N462A | 70 | 100 | 5 @ 60 | 30 @ 60 | 200 | 70 |
| 1N463 | 200 | 1 | 5 @ 175 | 30 @ 175 | 30 | |
| 1N463A | 200 | 100 | 5 @ 175 | 30 @ 175 | 200 | 70 |
| 1N464 | 150 | 3 | 5 @ 125 | 30 @ 125 | 40 | |
| 1N464A | 150 | 100 | 5 @ 125 | 30 @ 125 | 200 | 70 |

*JAN Types

OTHER ABSOLUTE MAXIMUM RATINGS: Power Dissipation 0.5 Watts @ 25°C. Power Dissipation 0.25 Watts @ 150°C. 1 Second Surge Current 1.5 Amperes 25°C. Storage and Operating Temperature Range −80°C to 200°C.

## Silicon High Conductance Diodes

ACTUAL SIZE

| PSI or EIA TYPE NUMBER | Minimum Saturation Voltage @ 100 µa @ 25°C (volts) | Maximum Forward Voltage DC @ 25°C volts @ 100 mA | @ 200 mA | Maximum Inverse Current at Maximum DC Operating Voltage µa @ volts @ 25°C | @ 150°C | Maximum Average Rectified Current mA @ 25°C | @ 150°C |
|---|---|---|---|---|---|---|---|
| 1N482 | 40 | 1.1 | | .250 @ −30v | 30 | 125 | 50 |
| 1N482A | 40 | 1.0 | | .025 @ −30v | 15 | 200 | 70 |
| 1N482B | 40 | 1.0 | | .025 @ −30v | 5 | 200 | 70 |
| PS603 | 40 | | 1.0 | .250 @ −30v | 30 | 200 | 100 |
| PS604 | 40 | | 1.0 | .025 @ −30v | 15 | 200 | 100 |
| PS605 | 40 | | 1.0 | .025 @ −30v | 5 | 200 | 100 |
| 1N483 | 80 | 1.1 | | .250 @ −60v | 30 | 125 | 50 |
| 1N483A | 80 | 1.0 | | .025 @ −60v | 15 | 200 | 70 |
| 1N483B | 80 | 1.0 | | .025 @ −60v | 5 | 200 | 70 |
| PS609 | 80 | | 1.0 | .250 @ −60v | 30 | 200 | 100 |
| PS610 | 80 | | 1.0 | .025 @ −60v | 15 | 200 | 100 |
| PS611 | 80 | | 1.0 | .025 @ −60v | 5 | 200 | 100 |
| 1N484 | 150 | 1.1 | | .250 @ −125v | 30 | 125 | 50 |
| 1N484A | 150 | 1.0 | | .025 @ −125v | 15 | 200 | 70 |
| 1N484B | 150 | 1.0 | | .025 @ −125v | 5 | 200 | 70 |
| PS615 | 150 | | 1.0 | .250 @ −125v | 30 | 200 | 100 |
| PS616 | 150 | | 1.0 | .025 @ −125v | 15 | 200 | 100 |
| PS617 | 150 | | 1.0 | .025 @ −125v | 5 | 200 | 100 |
| 1N485 | 200 | 1.1 | | .250 @ −175v | 30 | 125 | 50 |
| 1N485A | 200 | 1.0 | | .025 @ −175v | 15 | 200 | 70 |
| 1N485B | 200 | 1.0 | | .025 @ −175v | 5 | 200 | 70 |
| PS621 | 200 | | 1.0 | .250 @ −175v | 30 | 200 | 100 |
| PS622 | 200 | | 1.0 | .025 @ −175v | 15 | 200 | 100 |
| PS623 | 200 | | 1.0 | .025 @ −175v | 5 | 200 | 100 |
| 1N486 | 250 | 1.1 | | .250 @ −225v | 50 | 125 | 50 |
| 1N486A | 250 | 1.0 | | .050 @ −225v | 25 | 200 | 70 |
| 1N486B | 250 | 1.0 | | .050 @ −225v | 10 | 200 | 70 |
| PS627 | 250 | | 1.0 | .250 @ −225v | 50 | 200 | 100 |
| PS628 | 250 | | 1.0 | .050 @ −225v | 25 | 200 | 100 |
| PS629 | 250 | | 1.0 | .050 @ −225v | 10 | 200 | 100 |
| 1N487 | 330 | 1.1 | | .250 @ −300v | 50 | 125 | 50 |
| 1N487A | 330 | 1.0 | | .100 @ −300v | 25 | 200 | 70 |
| PS632 | 330 | | 1.0 | .250 @ −300v | 50 | 200 | 100 |
| PS633 | 330 | | 1.0 | .100 @ −300v | 25 | 200 | 100 |
| 1N488 | 420 | 1.1 | | .250 @ −380v | 50 | 125 | 50 |
| 1N488A | 420 | 1.0 | | .100 @ −380v | 25 | 200 | 70 |
| PS636 | 420 | | 1.0 | .250 @ −380v | 50 | 200 | 100 |
| PS637 | 420 | | 1.0 | .100 @ −380v | 25 | 200 | 100 |

OTHER ABSOLUTE MAXIMUM RATINGS: Maximum Power Dissipation 0.5 Watts @ 25°C. Maximum Power Dissipation 0.25 Watts @ 150°C. Maximum 1 Second Surge Current 1.5 Amperes @ 25°C. Storage and Operating Temperature Range −80 to 200°C.

## Silicon Subminiature Rectifiers

ACTUAL SIZE

MEDIUM POWER TYPES

| EIA TYPE NUMBER | MAXIMUM RATINGS: Peak Inv. Voltage (v) | Maximum Avg. Rectified Current (mA) @ 25°C | @ 150°C | ELECTRICAL CHARACTERISTICS: Minimum Saturation Voltage @ 100°C | Maximum Reverse Current @ PIV µA @ 25°C | @ 100°C | Max. Avg. Voltage Drop @ Io 400 mA @ 25°C (v) |
|---|---|---|---|---|---|---|---|
| 1N645 | 225 | 400 | 150 | 275 | 0.2 | 15 | 1.0 |
| 1N646 | 300 | 400 | 150 | 360 | 0.2 | 15 | 1.0 |
| 1N647 | 400 | 400 | 150 | 480 | 0.2 | 20 | 1.0 |
| 1N648 | 500 | 400 | 150 | 600 | 0.2 | 20 | 1.0 |
| 1N649 | 600 | 400 | 150 | 720 | 0.2 | 25 | 1.0 |

400 MILLIAMPERE PSI TYPES

400 mA @ 25°C, 150 mA @ 150°C

| PSI TYPE NUMBER | MAXIMUM RATINGS @ 100°C: Peak Recurr. Inverse Voltage volts | Maximum RMS Input Voltage volts[1] | Maximum Average Rectified Current[1] mA @ 150°C | ELECTRICAL CHARACTERISTICS: DC Forward Voltage @ Specified Current @ 25°C volts @ mA | Maximum Average Inverse Current[2] @ 100°C µa |
|---|---|---|---|---|---|
| PS 405 | 50 | 35 | 150 | 1.5 @ 500 | 500 |
| PS 410 | 100 | 70 | 150 | 1.5 @ 500 | 500 |
| PS 415 | 150 | 105 | 150 | 1.5 @ 500 | 500 |
| PS 420 | 200 | 140 | 150 | 1.5 @ 500 | 500 |
| PS 425 | 250 | 175 | 150 | 1.5 @ 500 | 500 |
| PS 430 | 300 | 210 | 150 | 1.5 @ 500 | 500 |
| PS 435 | 350 | 245 | 150 | 1.5 @ 500 | 500 |
| PS 440 | 400 | 280 | 150 | 1.5 @ 500 | 500 |
| PS 450 | 500 | 350 | 125 | 1.5 @ 500 | 500 |
| PS 460 | 600 | 420 | 125 | 1.5 @ 500 | 500 |

250 MILLIAMPERE PSI TYPES

250 mA @ 25°C, 140 mA @ 100°C

| PSI TYPE NUMBER | Peak Recurr. Inverse Voltage volts | Maximum RMS Input Voltage volts | Maximum Average Rectified Current mA | DC Forward Voltage @ Specified Current volts @ mA | Maximum Average Inverse Current µa |
|---|---|---|---|---|---|
| PS 005 | 50 | 35 | 140 | 1 @ 100 | 100 |
| PS 010 | 100 | 70 | 140 | 1 @ 100 | 100 |
| PS 015 | 150 | 105 | 140 | 1 @ 100 | 100 |
| PS 020 | 200 | 140 | 140 | 1 @ 100 | 100 |
| PS 025 | 250 | 175 | 140 | 1 @ 100 | 100 |
| PS 030 | 300 | 210 | 140 | 1 @ 100 | 100 |
| PS 035 | 350 | 245 | 140 | 1 @ 100 | 100 |
| PS 040 | 400 | 280 | 140 | 1 @ 100 | 100 |
| PS 050 | 500 | 350 | 140 | 1 @ 100 | 100 |
| PS 060 | 600 | 420 | 140 | 1 @ 100 | 100 |

1. Resistive or inductive load.
2. Averaged over one cycle for half wave resistive or choke input circuit with rectifier operating at full rated current and maximum RMS input.

Storage and Operating Temperature Range −65°C to 200°C.

PSI 1959 IRE SHOW BOOTHS 2529-2531

*Pacific Semiconductors, Inc.*

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

## Silicon Miniature Rectifiers

ACTUAL SIZE

500 MILLIAMPERE TYPES — 500 mA @ 25°C, 200 mA @ 150°C

| PSI TYPE NUMBER | MAXIMUM RATINGS @ 150°C: Peak Recurr. Inverse Voltage volts | Maximum RMS Input Voltage[1] volts | Maximum Average Rectified Current[1] mA | ELECTRICAL CHARACTERISTICS: DC Forward Voltage @ Specified Current @ 25°C volts @ mA | Maximum Average Inverse Current[2] @ 150°C µa |
|---|---|---|---|---|---|
| PS 105 | 50 | 35 | 200 | 1.5 @ 500 | 500 |
| PS 110 | 100 | 70 | 200 | 1.5 @ 500 | 500 |
| PS 115 | 150 | 105 | 200 | 1.5 @ 500 | 500 |
| PS 120 | 200 | 140 | 200 | 1.5 @ 500 | 500 |
| PS 125 | 250 | 175 | 200 | 1.5 @ 500 | 500 |
| PS 130 | 300 | 210 | 200 | 1.5 @ 500 | 500 |
| PS 135 | 350 | 245 | 200 | 1.5 @ 500 | 500 |
| PS 140 | 400 | 280 | 200 | 1.5 @ 500 | 500 |
| PS 150 | 500 | 350 | 150 | 1.5 @ 500 | 500 |
| PS 160 | 600 | 420 | 150 | 1.5 @ 500 | 500 |

1. Resistive or inductive load.
2. Averaged over one cycle for half wave resistive or choke input circuit with rectifier operating at full rated current and maximum RMS input.

Storage and Operating Temperature Range −65°C to 200°C.

## Silicon HighVoltage Rectifiers

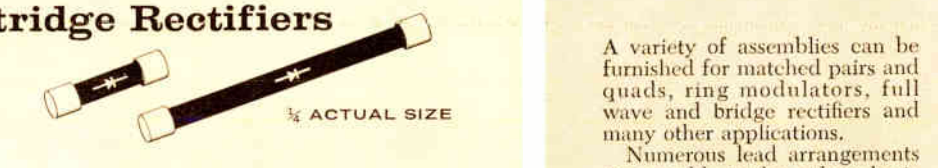
⅔ ACTUAL SIZE

| EIA TYPE NUMBER | Peak Inverse Voltage @ 25 & 100°C volts | Continuous DC Voltage @ 25 & 100°C volts | Average Rectified Current mA @ 25°C | @ 100°C | RMS Input Voltage @ 25 & 100°C volts | Max. DC Fwd. Voltage Drop @ 100MA DC 25°C |
|---|---|---|---|---|---|---|
| 1N1730 | 1000 | 1000 | 200 | 100 | 700 | 5 |
| 1N1731 | 1500 | 1500 | 200 | 100 | 1050 | 5 |
| 1N1732 | 2000 | 2000 | 200 | 100 | 1400 | 9 |
| 1N1733 | 3000 | 3000 | 150 | 75 | 2100 | 12 |
| 1N1734 | 5000 | 5000 | 100 | 50 | 3500 | 18 |

Maximum DC Reverse Current @ Rated PIV 25°C 10µA 100°C 100µA
Maximum Surge Current 8msec @ 25 & 100°C 2.5 Amps

Dimensions: Length 1N1730 and 1N1731 .50″ 1N1732 1N1733 and 1N1734 1.0″; Diameter .375″ 1N1734 .50; Leads .030 diam 1½″ long on all units

## Silicon Very High Voltage Cartridge Rectifiers



¼ ACTUAL SIZE

| EIA Type | Length Inches | Absolute Max. Rtgs. H W Res. Load at 75°C Ambient: Peak Inverse Voltage Volts | Max. Rectified DC Output Current MA | Electrical Characteristics at 25°C Ambient: Forward DC Volt Drop at Rated DC Current Volts | Reverse DC Current at Rated PIV MA |
|---|---|---|---|---|---|
| 1N1139 | 4 3/16 | 3600 | 65 | 27.0 | .025 |
| 1N1140 | 2 1/2 | 3600 | 65 | 18.0 | .025 |
| 1N1141 | 4 3/16 | 4800 | 60 | 36.0 | .025 |
| 1N1142 | 2 1/2 | 4800 | 50 | 24.0 | .025 |
| 1N1143 | 4 3/16 | 6000 | 55 | 45.0 | .025 |
| 1N1143A | 4 3/16 | 6000 | 65 | 30.0 | .025 |
| 1N1144 | 6 1/16 | 7200 | 50 | 54.0 | .025 |
| 1N1145 | 4 3/16 | 7200 | 60 | 36.0 | .025 |
| 1N1146 | 6 1/16 | 8000 | 45 | 60.0 | .025 |
| 1N1147 | 6 1/16 | 12000 | 45 | 60.0 | .025 |
| 1N1148 | 6 1/16 | 14000 | 50 | 52.0 | .025 |
| 1N1149 | 6 1/16 | 16000 | 45 | 60.0 | .025 |

Storage and Operating Temperature Range −55°C to 150°C

## Varicap® Voltage-Variable Capacitor

ACTUAL SIZE

| Varicap Type | Capacitance @ 4VDC µµf | Approx. Range µµf* | Quality Factor Q @ 50 mc: Minimum @ 4VDC | Typical @ 4VDC | Typical @ MWV | Maximum Working Voltage (MWV) Volts D.C. |
|---|---|---|---|---|---|---|
| MODULATION, AFC AND OTHER APPLICATIONS | | | | | | |
| V-7 | 7 | 3.0-18 | 13 | 18 | 43 | 25 |
| V-10 | 10 | 4.3-26 | 13 | 18 | 43 | 25 |
| V-12 | 12 | 5.2-31 | 13 | 18 | 43 | 25 |
| V-15 | 15 | 6.5-39 | 13 | 18 | 43 | 25 |
| V-20 | 20 | 10-50 | 7.0 | 18.7 | 40.2 | 20 |
| V-27 | 27 | 14-70 | 7.0 | 15.7 | 33.8 | 20 |
| V-33 | 33 | 17-85 | 7.0 | 14.6 | 31.4 | 20 |
| V-39 | 39 | 20-100 | 7.0 | 15.1 | 32.4 | 20 |
| V-47 | 47 | 24-120 | 7.0 | 15.4 | 32.4 | 20 |
| V-56 | 56 | 37-145 | 7.0 | 11.5 | 24.8 | 15 |
| V-68 | 68 | 39-175 | 9.0 | 11.0 | 25.8 | 15 |
| V-82 | 82 | 47-210 | 9.0 | 13.0 | 23.9 | 15 |
| V-100 | 100 | 57-260 | 8.0 | 11.0 | 20.2 | 15 |
| HIGH VOLTAGE TYPES, TUNING AND OTHER APPLICATIONS | | | | | | |
| V-7E | 7 | 1.5-18.0 | 3.0 | 4.5 | 22.5 | 100 |
| V-10E | 10 | 2.2-26.0 | 3.5 | 5.5 | 27.5 | 100 |
| V-12E | 12 | 2.7-31.0 | 4.0 | 6.5 | 32.5 | 100 |
| V-15E | 15 | 3.3-39.0 | 4.5 | 7.5 | 37.5 | 100 |
| V-20E | 20 | 5.0-50.0 | 7.0 | 18.7 | 78.5 | 70 |
| V-27E | 27 | 7.0-70.0 | 7.0 | 15.7 | 63.5 | 65 |
| V-33E | 33 | 9.0-85.0 | 7.0 | 14.6 | 56.5 | 60 |
| V-39E | 39 | 11.0-100.0 | 7.0 | 15.1 | 55.8 | 55 |
| V-47E | 47 | 14.0-120.0 | 7.0 | 15.4 | 53.8 | 50 |
| V-56E | 56 | 20.0-145.0 | 7.0 | 13.5 | 41.8 | 40 |

*C range specified from 0.1 volts to maximum working voltage.

"VARICAP" is the registered trade mark of silicon voltage variable capacitors manufactured by Pacific Semiconductors, Inc.

## Non-Linear Resistors

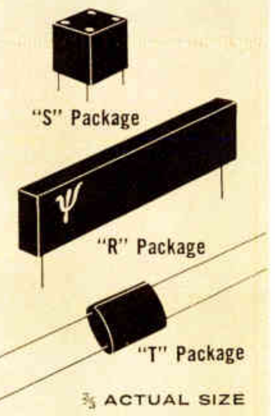
ACTUAL SIZE

| PSI Type | E @ 1mA volts | I @ 1VDC min mA | Max Dyn Res @ 1mA ohm | I @ 25°C µA Max. |
|---|---|---|---|---|
| PS594 | 0.62 ± 10% | 100 | 60 | 1.0 @ −5v |
| PS594G | 0.62 ± 5% | 100 | 60 | 1.0 @ −5v |
| PS595 | 0.62 ± 10% | 250 | 60 | 5.0 @ −5v |
| PS595G | 0.62 ± 5% | 250 | 60 | 5.0 @ −5v |

## Standard Encapsulations

A variety of assemblies can be furnished for matched pairs and quads, ring modulators, full wave and bridge rectifiers and many other applications.

Numerous lead arrangements are possible in these three basic configurations. Up to four diodes or rectifiers can be encapsulated in the "S" or "T" packages. Up to 12 units can be contained in the "R" package. The number of units contained determines its maximum length.




⅔ ACTUAL SIZE

Leads .020″ diameter,
1″ minimum length.
Spaced on .1″ grid centers.

DIMENSIONS

| | "R" Package | "S" Package | "T" Package |
|---|---|---|---|
| Length | .375″ to 1.75″ | .45″ | .50″ |
| Width | .25″ | .39″ | — |
| Height | .50″ | .40″ | — |
| Diameter | — | — | .375″ |

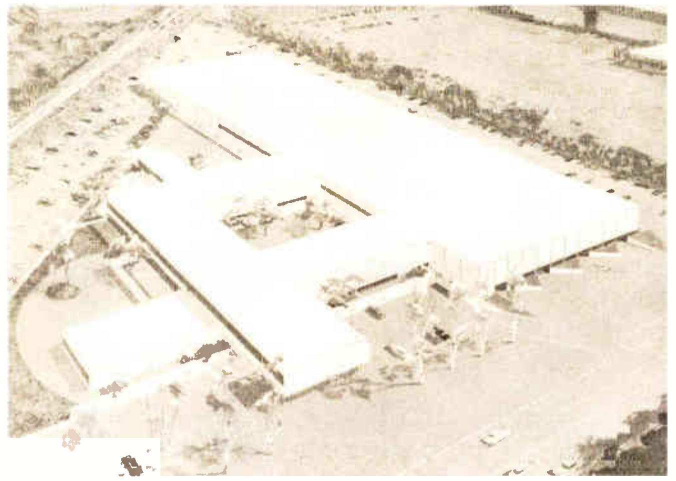
*Unusual Opportunities in Semiconductor Electronics*

Rapidly expanding programs in Very High Frequency and Very High Power silicon transistors, silicon microdiodes, voltage-variable capacitors and other advanced diode types have created a number of exceptional technical staff opportunities at Pacific Semiconductors, Inc.

**ELECTRICAL ENGINEERS** . . . diode and transistor applications and test equipment development.

**PHYSICISTS** . . . product research including development of transistors, diodes, and other semiconductor components.

**PHYSICAL SCIENTISTS** . . . challenging research programs in crystal growth and perfection studies employing the latest infrared and etch pit techniques . . . solid state diffusion techniques and the study of surface phenomena.



Some of these positions encompass full supervisory responsibility. All offer an opportunity for growth and individual recognition that is unique in the semiconductor field.

If you are interested in associating yourself and your future with a dynamic, growing company such as Pacific Semiconductors, Inc., you should investigate these opportunities at once.

For specific information in your particular field, write to Technical Staff Placement, Pacific Semiconductors, Inc., 10451 W. Jefferson Blvd., Culver City, California.

# NEW!

## Eight new EIA types Fast Recovery Silicon Diffusion Computer Diodes

ACTUAL SIZE

| Type Number | Min. Sat. Voltage @ 100 μa (v) | Min. Fwd. Current @ +1.0v | Maximum Reverse Current (mA) 25°C | 100°C | Reverse Recovery Characteristics Reverse Res. (ohms) | Max. Recov. Time (μs) |
|---|---|---|---|---|---|---|
| 1N789 | 30 | 10 | 1 (20v) | 30 (20v) | 200K | 0.5 |
| 1N791 | 30 | 50 | 5 (20v) | 30 (20v) | 200K | 0.5 |
| 1N792 | 30 | 100 | 5 (20v) | 30 (20v) | 100K | 0.5 |
| 1N793 | 60 | 10 | 1 (50v) | 30 (50v) | 200K | 0.5 |
| 1N795 | 60 | 50 | 5 (50v) | 30 (50v) | 200K | 0.5 |
| 1N801 | 150 | 10 | 1 (125v) | 30 (125v) | 200K | 0.5 |
| 1N802 | 150 | 50 | 5 (125v) | 50 (125v) | 200K | 0.5 |
| 1N804 | 200 | 50 | 10 (175v) | 50 (175v) | 200K | 0.5 |

## ...added to the broadest line of Fast Recovery Silicon Computer Diodes in the industry!

MILITARY TYPES

| Type Number | Min. Sat. Voltage @ 100 μa (v) | Min. Fwd. Current @ +1.0 v | Maximum Reverse Current (μa) 25°C | 100°C | Reverse Recovery Characteristics Reverse Res. (ohms) | Max. Recov. Time (μs) |
|---|---|---|---|---|---|---|
| •1N643 | 200 | 10 | .025 (10v) | 5 (10v) | 200K | 0.3 |
| •1N662 | 100 | 10 | 1 (100v)<br>1 (10v) | 15 (100v)<br>20 (10v) | 100K | 0.5 |
| §1N663 | 100 | 100 | 20 (50v)<br>5 (75v) | 100 (50v)<br>50 (75v) | 200K | 0.5 |

•Mil-E-1/1171 (SigC). #Mil-E-1/1139 (SigC). §Mil-E-1/1140 (SigC).

HIGH CONDUCTANCE TYPES

| | | | | | | |
|---|---|---|---|---|---|---|
| PS700 | 30 | 100 | 5 (20) | 25 (20) | 100K | 1.0 |
| PS701 | 60 | 50 | 5 (45v) | 50 (45v) | 100K | 0.5 |
| PS702 | 100 | 75 | 20 (75v) | 50 (75v) | 200K | 1.0 |
| PS703 | 100 | 50 | 5 (75v) | 50 (75v) | 100K | 0.5 |
| PS704 | 150 | 50 | 5 (75v) | 50 (75v) | 100K | 0.5 |
| PS705 | 200 | 50 | 5 (75v) | 50 (75v) | 100K | 0.5 |

MEDIUM CONDUCTANCE TYPES

| | | | | | | |
|---|---|---|---|---|---|---|
| PS720 | 30 | 3 | 5 (20v) | 25 (20v) | 100K | 0.5 |
| PS721 | 60 | 5 | 5 (45v) | 50 (45v) | 100K | 0.3 |
| PS722 | 100 | 5 | 5 (75v) | 50 (75v) | 100K | 0.3 |
| PS723 | 200 | 3 | 20 (175v) | 100 (175v) | 100K | 0.3 |
| PS724 | 150 | 4 | 20 (125v) | 100 (125v) | 100K | 0.3 |

LOW CONDUCTANCE TYPES

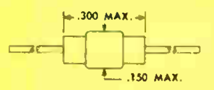
| | | | | | | |
|---|---|---|---|---|---|---|
| 1N625 | 30 | 4 @ 1.5v | 1 (20v) | 30 (20v) | 400K | 1μsec |
| 1N626 | 50 | 4 @ 1.5v | 1 (35v) | 30 (35v) | 400K | 1μsec |
| 1N627 | 100 | 4 @ 1.5v | 1 (75v) | 30 (75v) | 400K | 1μsec |
| 1N628 | 150 | 4 @ 1.5v | 1 (125v) | 30 (125v) | 400K | 1μsec |
| 1N629 | 200 | 4 @ 1.5v | 1 (175v) | 30 (175v) | 400K | 1μsec |

*Switch to Silicon!*

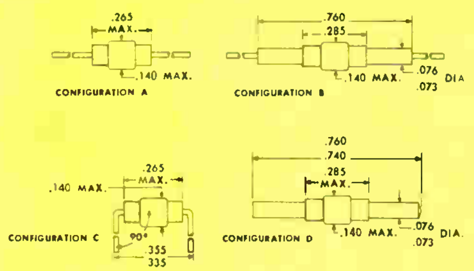
## Standard Packaging... Immediate Delivery

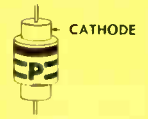
"Off-the-shelf" delivery is available from the leading distributor in all major electronic centers.

Call your nearest PSI sales office for delivery and price quotations on production quantities.




Normally supplied in the MIL Specification dimensions shown above. On special request dimensions shown below can be supplied.




## Physical Characteristics

**HERMETICALLY SEALED** — Glass-to-metal fused and metal-to-metal welded seals.

**TERMINALS** — Tinned copper leads .020 inches diameter. Lead length 1¼ inch minimum.

**MARKING** — Wide color band indicates cathode end. (Wide band indicates positive bias on Vari-caps.) Type number designated by color bands reading from cathode.

**ALL DIMENSIONS SHOWN IN INCHES** — Patented under one or more of the following United States Patents: No. 2815474, No. 2827403. Other patents pending.


PSI Pacific Semiconductors, Inc.
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TExas 0-4881, TExas 0-6113 • TWX: CULVER CITY CAL 7135

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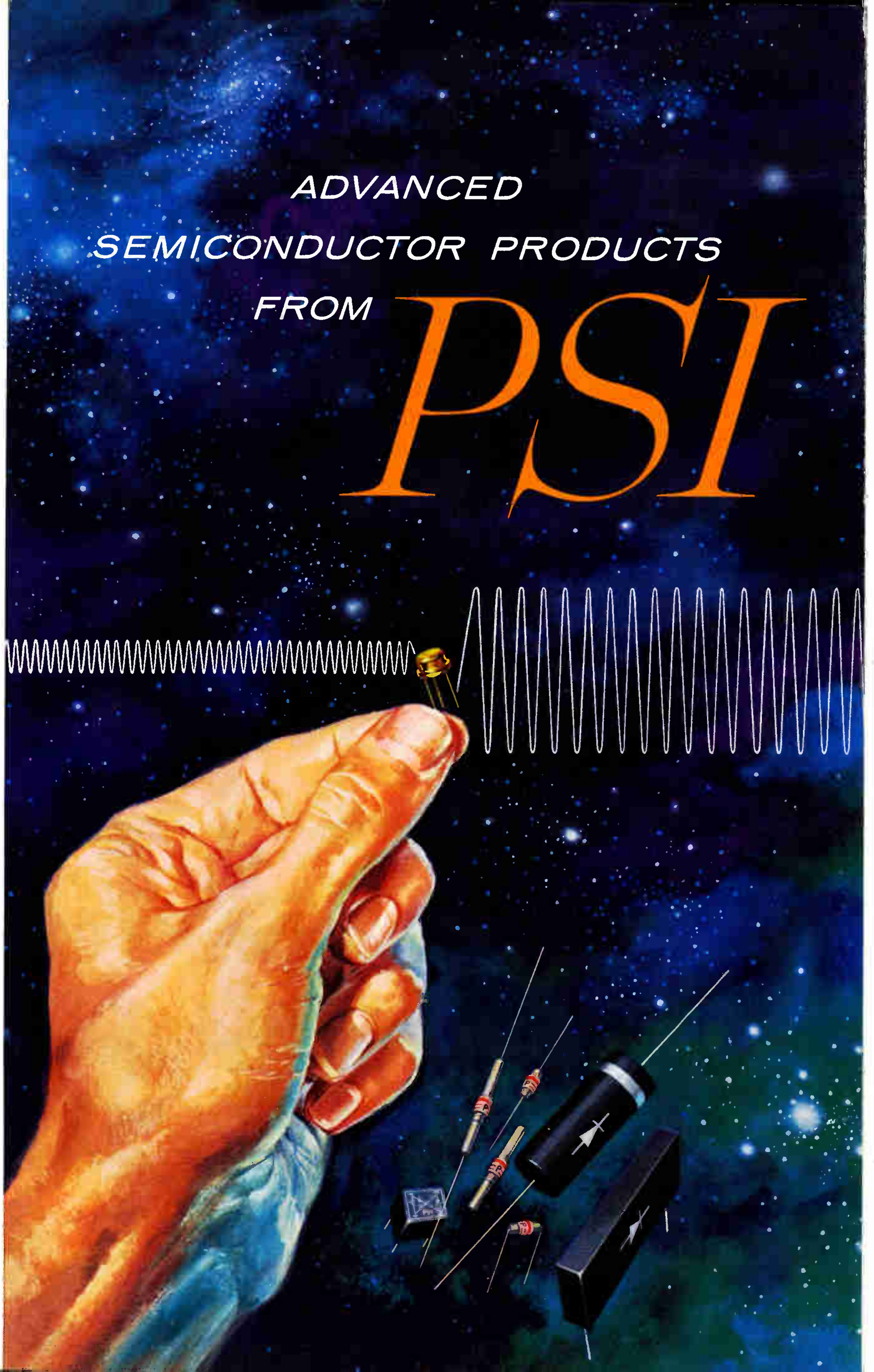



# NEW!

## Zener Diodes 500 mW Power Dissipation

ACTUAL SIZE

LOW VOLTAGE GROUP

| PSI Type Number | Elect. Equiv. | Zener Voltage @ 5 mA @ 25°C $E_z$ Min. (v) | $E_z$ Max. (v) | Maximum Dynamic Resistance (ohms) 1 | Maximum Inverse Current $I_b$ @ 25°C (μA) | $I_b$ @ 100°C (μA) | At Inverse Voltage (v) |
|---|---|---|---|---|---|---|---|
| PS6465 | 1N465 | 2.0 | 3.2 | 60 | 75 | 100 | 1 |
| PS6466 | 1N466 | 3.0 | 3.9 | 55 | 50 | 100 | 1 |
| PS6467 | 1N467 | 3.7 | 4.5 | 45 | 5 | 100 | 1 |
| PS6468 | 1N468 | 4.3 | 5.4 | 35 | 5 | 100 | 1.5 |
| PS6469 | 1N469 | 5.2 | 6.4 | 20 | 5 | 100 | 1.5 |
| PS6470 | 1N470 | 6.2 | 8.0 | 10 | 5 | 50 | 3.5 |

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed.

MEDIUM VOLTAGE GROUP

| PSI Type Number | Elect. Equiv. | Zener Voltage @ 200 μA @ 25°C $E_z$ Min. (v) | $E_z$ Max. (v) | Maximum Inverse Current $I_b$ @ 25°C (μA) | $I_b$ @ 100°C (μA) | At Inverse Voltage (v) |
|---|---|---|---|---|---|---|
| PS6313 | 1N1313 | 7.5 | 10 | .5 | 5 | 6.8 |
| PS6314 | 1N1314 | 9 | 12 | .5 | 5 | 8.2 |
| PS6315 | 1N1315 | 11 | 14.5 | .5 | 5 | 10.0 |
| PS6316 | 1N1316 | 13.5 | 18 | .5 | 5 | 12.0 |
| PS6317 | 1N1317 | 17 | 21 | .5 | 5 | 15.0 |
| PS6318 | 1N1318 | 20 | 27 | .1 | 10 | 18.0 |

HIGH VOLTAGE GROUP

| PSI Type Number | Elect. Equiv. | Zener Voltage @ 200 μA @ 25°C $E_z$ Min. (v) | $E_z$ Max. (v) | Maximum Inverse Current $I_b$ @ 25°C (μA) | $I_b$ @ 100°C (μA) | At Inverse Voltage (v) |
|---|---|---|---|---|---|---|
| PS6319 | 1N1319 | 25 | 32 | .1 | 10 | 22 |
| PS6320 | 1N1320 | 30 | 39 | .1 | 10 | 27 |
| PS6321 | 1N1321 | 37 | 45 | .1 | 10 | 33 |
| PS6322 | 1N1322 | 43 | 54 | .1 | 10 | 39 |
| PS6323 | 1N1323 | 52 | 64 | .1 | 10 | 47 |
| PS6324 | 1N1324 | 62 | 80 | 1.0 | 50 | 56 |
| PS6325 | 1N1325 | 75 | 100 | 1.0 | 50 | 68 |
| PS6326 | 1N1326 | 90 | 120 | 1.0 | 50 | 82 |
| PS6327 | 1N1327 | 110 | 145 | 1.0 | 50 | 100 |

MAXIMUM Power Dissipation 500 mW @ 25°C.
Operating Range −65°C to 200°C.

# Tele-Tips

**THE U. S. RADAR SCREEN** showed some embarrassing holes in the middle of the Cuban trouble. Two Cuban air force officers landed their B-26's at Daytona Beach, Florida without being detected.

**ELECTRONIC MUSIC** got a grant of $175,000 from the Rockefeller Foundation. Columbia and Princeton Universities shared jointly in the award which covers a five-year period. It provides for acquisition and design of electronic equipment and its maintenance, and technical assistance to composers.

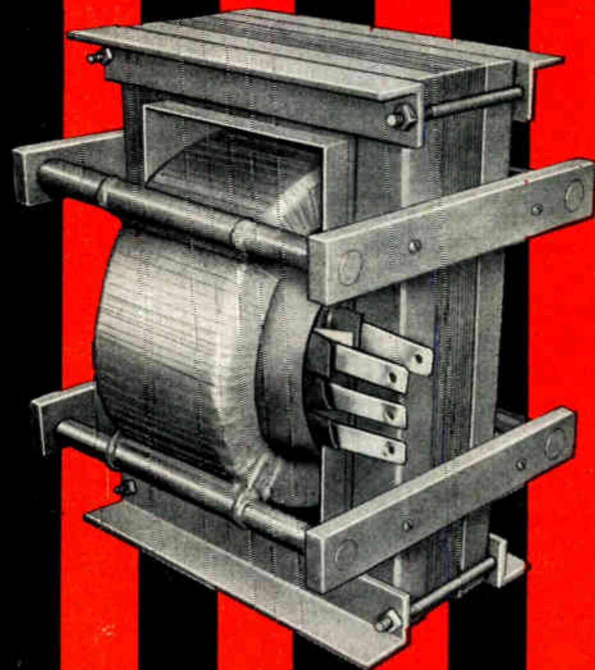
**DEFINITIONS** of the international yard and the international pound have been agreed on by the six principal English-speaking countries. The yard is set at 0.9144 metre, and the pound equal to 0.45359237 kilogram.

**RADAR SPACE** observatory containing a nuclear power source to supply electrical energy is proposed by three Univ. of Michigan researchers to determine where on the moon the first landing should be made to avoid sinking in the globe's dust-like surface.

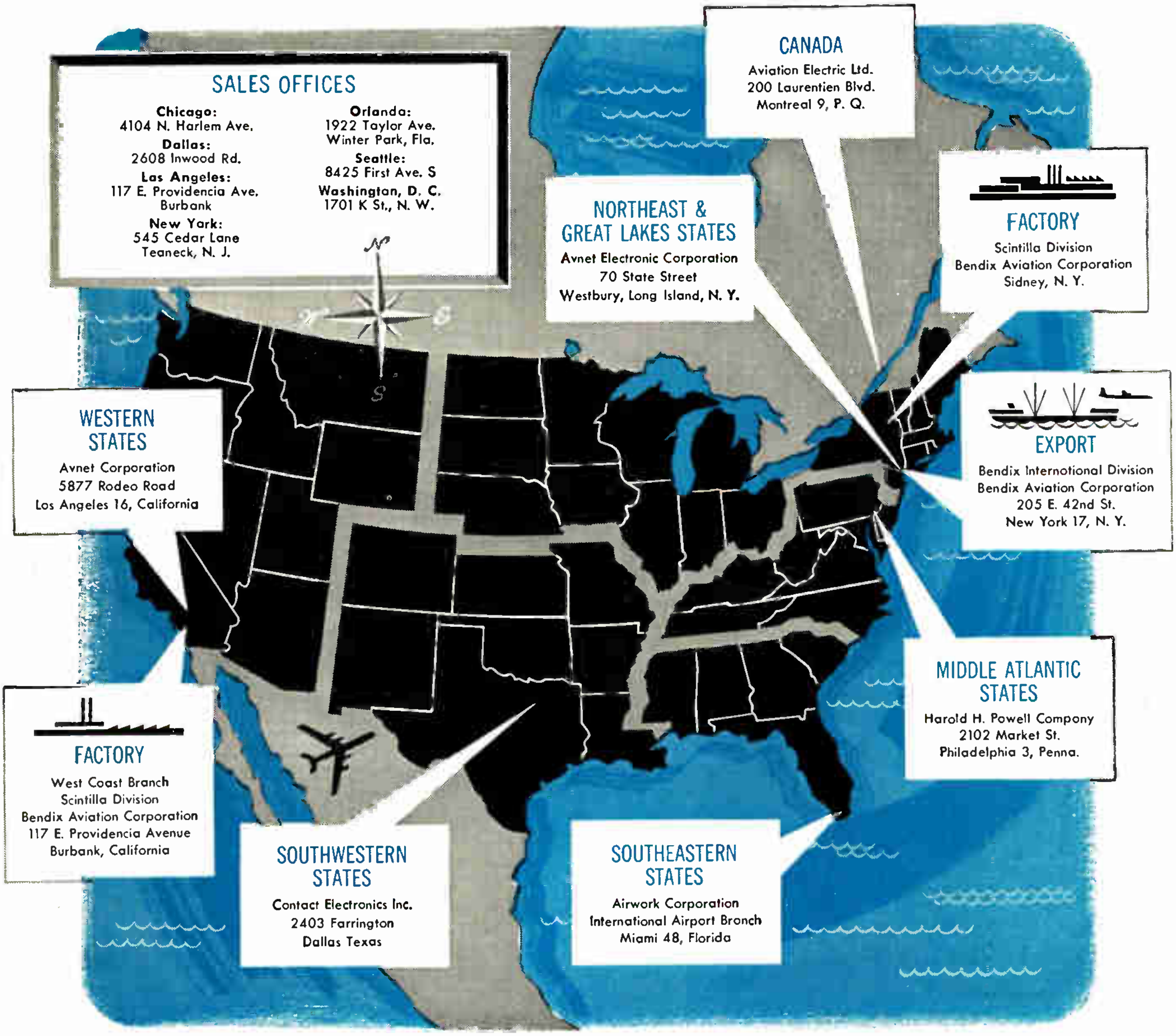
**"SOS"** signals off the California coast were traced to two teenagers and their surplus "Gibson Girl" transmitters. The boys didn't realize that the sets automatically transmitted d i s t r e s s calls when they tinkered with them.

**JAMMING SPACE** communications would be one way of restricting the Russians' effectiveness in space warfare, says Dr. Simon Ramo. Speaking at the Institute of the Aeronautical Sciences he made the point that the only way to beat the Russians in a space war would be actually to have more satellites in the sky than they do. With more satellites we could jam the Reds' communications network, and immobilize their operations.

(*Continued on page* 46)



# NEW DISTRIBUTION NETWORK MAKES IMMEDIATELY AVAILABLE ALL THE IMPORTANT ADVANTAGES OF BENDIX CONNECTORS




Large inventories of Bendix® Electrical Connectors are now strategically located to assure you rapid delivery, regardless of your requirements or your location.

Each distribution center is factory-approved and inspected, and is stocked with connectors and components in an exceptionally wide range of types and sizes. Assembly and quality control facilities are maintained in complete accordance with factory standards and recommendations. Their staffs are adequate to assure not only immediate service but also reliable, efficient shipment of your order.

This expanded distribution system, combined with our greatly enlarged factory production facilities, makes available to all users the important advancements in engineering and design for which Bendix Electrical Connectors are favorably known.

We suggest you check the map now for the source nearest you.

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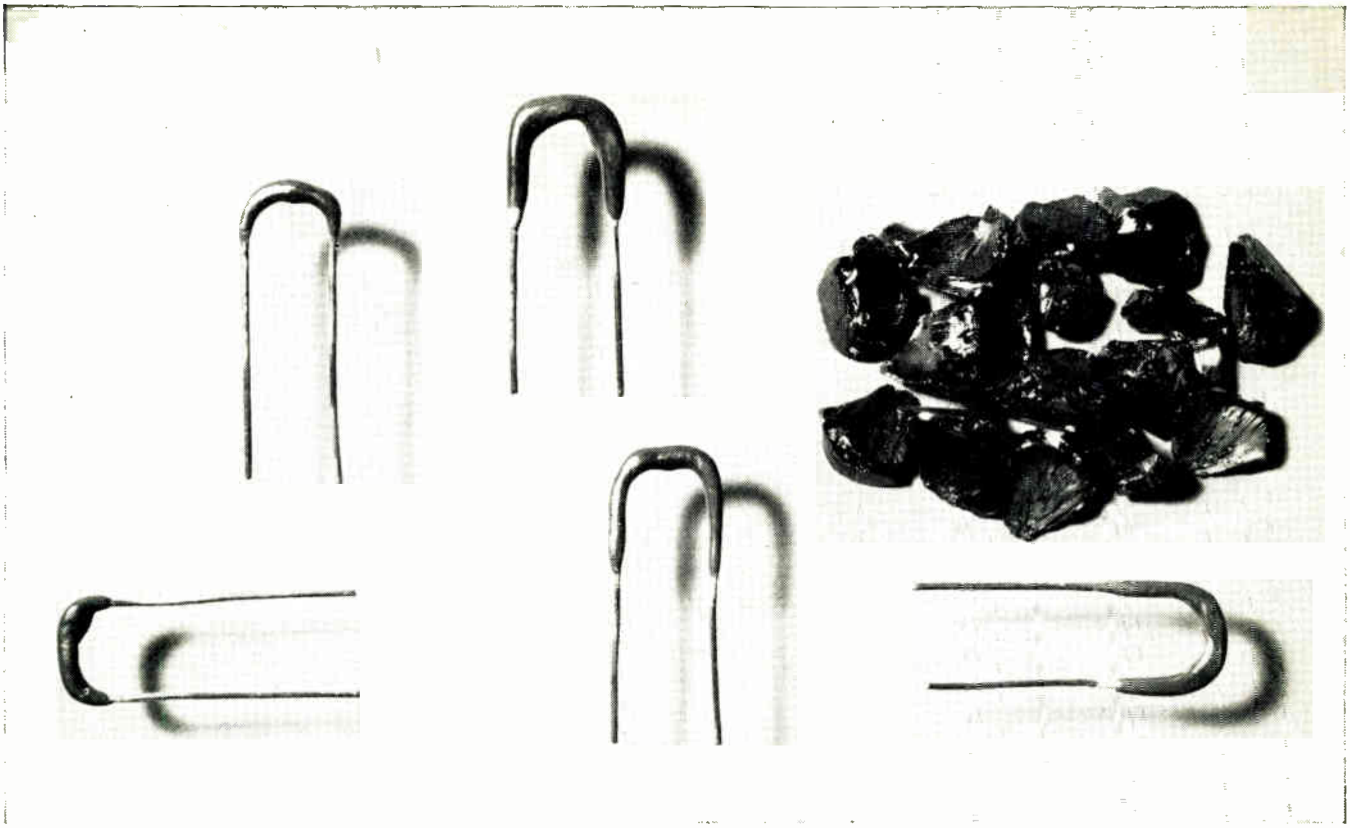

Now Available from B&A®

# HIGH-PURITY LOW-MELTING GLASS

*For Coating Electronic Devices*

Here's good news for every producer of electronic devices. Low-melting glasses—a new research development reported before the Electrochemical Society by S. S. Flaschen and A. D. Pearson of Bell Telephone Laboratories* — may represent a major breakthrough in low cost and highly efficient protective coating of semiconductors, capacitors, diodes and other types of electronic devices.

These new, high-purity, low-melting glasses promise an ideal coating for protecting germanium and silicon transistors and diodes from atmospheric oxidation, contamination and humidity. Coating may be accomplished by simply dipping the devices in a fluid bath of the glass, withdrawing and cooling; by vapor deposition; or through the use of a pre-form (compressed powder).

**Research quantities now available from B&A!**

We can now supply low-melting glasses to meet the needs of your development engineers. Write us today for further information or technical assistance.

**SEE IT DEMONSTRATED**

Booth 4331

Radio Engineering Show, I. R. E.

March 23-26

New York Coliseum

*Abstract No. 116, Journal of The Electrochemical Society, August, 1958.

**BAKER & ADAMSON®**
"Electronic Grade"
Chemicals

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**GENERAL CHEMICAL DIVISION**
40 Rector Street, New York 6, N. Y.



Circle 25 on Inquiry Card, page 123

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

*Radio Receptor* *silicon diodes*

# IN ANY COMBINATION OF CHARACTERISTICS

*high speed • high conductance • high temperature*
*high voltage • high back resistance*

General Instrument semiconductor engineering has made possible these Radio Receptor diodes with a range of characteristics never before available to the industry.

The types listed here are just a small sampling of the complete line which can be supplied in volume quantities for prompt delivery. Write today for full information.

**Including the industry's most versatile diode with uniform excellence in all parameters** **1N658**

| GENERAL PURPOSE TYPES | | FAST RECOVERY TYPES | HIGH CONDUCTANCE TYPES | |
|---|---|---|---|---|
| 1N456 | 1N461 | 1N625 | 1N482 | 1N484A |
| 1N457* | 1N462 | 1N626 | 1N482A | 1N484B |
| 1N458* | 1N463 | 1N627 | 1N482B | 1N485 |
| 1N459* | 1N464 | 1N628 | 1N483 | 1N485A |
| | | 1N629 | 1N483A | 1N485B |
| | | | 1N483B | 1N486 |
| | | | 1N484 | 1N486A |

* JAN Types

PLUS a large group of special DR numbers developed by General Instrument Corporation with characteristics that far exceed any of the standard types listed above!

*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 Diego: Shanks & Wright Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capitol Electronics

**See us in March at the IRE Show in New York—Booths 2211-2217**



Circle 27 on Inquiry Card, page 123

# Tele-Tips

(*Continued from page* 41)

**FLYING SAUCER** sightings hit a new low during the last half of 1958. A slim total of two were reported.

**SOLDERING TIPS** take on new life through a plating process by Hexagon Electric Co. The plating immunizes the shank of the tip from solder, to prevent adhering of solder except on the working surface.

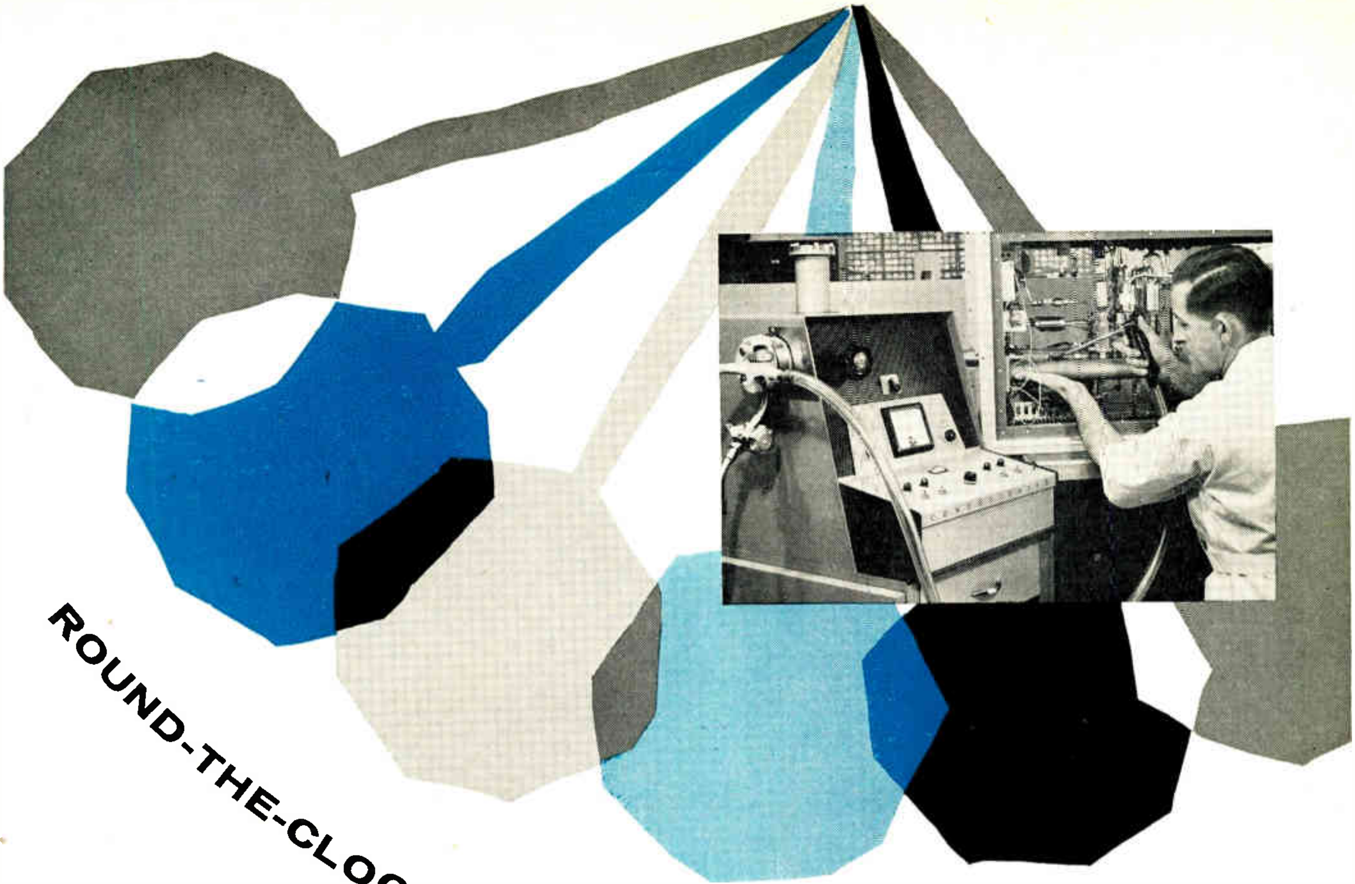
**FCC FIELD ENGINEERS** ran into their usual quota of odd-ball interference cases during the past year.

One particularly queer case involved a California family that went on vacation, leaving their AM receiver turned on. Possibly out of loneliness, it began to retransmit the programs of a local broadcast station, in a way that played havoc with reception by radiotelephone stations up to 33 miles away. A new tube and flick of the "off" switch cleared up the trouble.

Hoax signals being transmitted on a space satellite frequency were confusing scientists here and elsewhere. By working night and day, FCC field engineers traced the transmitter to a spot deep in a national forest. The three operators were arrested and fined. The six FCC engineers got citations and cash awards.

Another problem is the "salty" language used by the boat skippers. Fines up to $500 have been levied for off-color remarks transmitted on marine radiotelephones.

Alaskan stations heard the plaintive distress call, "My engine has conked out. I have landed but can't walk out. Send a 'copter to pick me up." A coordinated air search fanned out over the area, searched vainly for a downed aircraft. Finally, a 12-year old boy confessed that, while "playing jet pilot" in an unattended private plan, he had used the transmitter.



# ROUND-THE-CLOCK LEAK TESTING ... *with unsurpassed reliability*

Newest version of Consolidated's low-cost leak detector contains an integral cold trap and design changes which greatly extend analyzer life and provide optimum performance during weeks of continuous leak testing. On the quality-control line of Wiancko Engineering Co.—in constant operation up to 24 hours a day—CEC's 24-210A keeps the leak checkout of explosion-proof systems abreast of a crash-basis production schedule.

As the ideal leak detector for aircraft, missile, and armed-services suppliers, this helium-sensitive mass spectrometer accurately locates leaks of 1 x $10^{-9}$ atm cc/sec of air on both vacuum and pressure systems. Mobile operation in the shop is afforded by a wheeled workstand—specially designed for convenience.

Constructed for years of economical performance, the 24-210A features a stainless steel manifold system, standard 110 volt/60 cycle line power for operation, and a large-volume cold trap which needs refilling only once an eight-hour shift.

The instrument is designed for maximum operator efficiency in mass-production testing...offering the highest performance per dollar invested. Contact your nearest CEC Field Office for information, or write for Bulletin CEC 1830-X35.

*Analytical & Control Instrument Division* CEC

**CONSOLIDATED ELECTRODYNAMICS** *300 N. Sierra Madre Villa, Pasadena, Calif.*

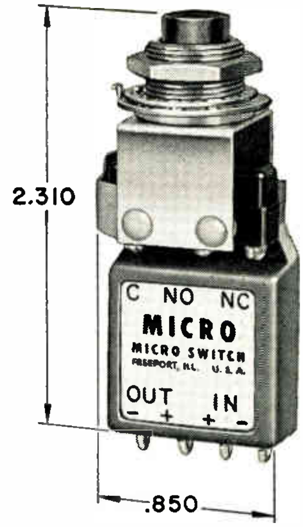
FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

**AUXILIARY TEST STATIONS...** PSM 102 & 202 may be used with all CEC Leak Detectors for hooding, probing, and inside-out leak testing techniques. PSM 102 is a semi-automatic or manual unit with one or two bell jars. PSM 202 is fully automatic. Write for Bulletin CEC 4-62.

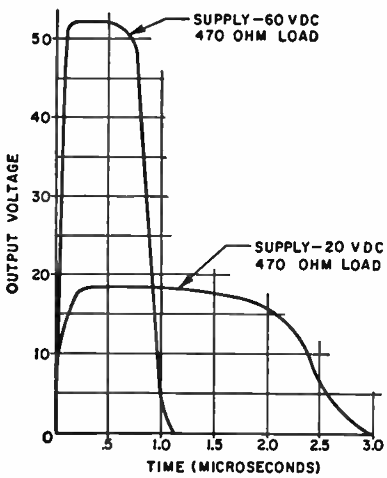


Circle 29 on Inquiry Card, page 123

"1PB600" Series pushbutton switch, one of many in the "One-Shot" line.




# New "One-Shot" switches produce one square wave pulse per operation




**These are typical output curves for the "1PB600" Series "One-Shot" switch, illustrated above.**

This new series of snap-action switches incorporates a special circuit which produces a single square wave pulse regardless of the speed of switch operation. Variations can be furnished with pulse widths from 0.1 to 10.0 microseconds. The basic "One-Shot" circuit can be provided with a variety of switch types. No standby power is required. The circuit is potted for physical and environmental protection.

These "One-Shot" assemblies provide a pre-engineered, compact package to accomplish a shaped wave output, thus eliminating costly, time-consuming custom development of circuits.

"One-Shot" switches are available for operation in temperatures from −65° to +185° F.

Applications include computer and radar consoles, keyboards, electronic test equipment, fusing, arming and firing circuits, checking ring counters, setting and resetting flip-flops, and reflected pulse systems. Ask for data sheet 150.

Engineering assistance on switch application is available from the MICRO SWITCH branch office near you. Consult the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILL.

A division of Honeywell

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**MICRO SWITCH PRECISION SWITCHES**

# Have 310 • Will Travel... Light!



Hand size, but with the features of a full-size V-O-M.

20,000 ohms per volt DC; 5,000 AC.

EXCLUSIVE SELECTOR SWITCH speeds circuit and range settings. The first miniature V-O-M with this exclusive feature for quick, fool-proof selection of all ranges.

SELF-SHIELDED Bar-Ring Instrument; permits checking in Strong Magnetic Fields.

Fitting interchangeable test prod tip into top of tester makes it the common probe, thereby freeing one hand.

Unbreakable plastic meter window.

BANANA-TYPE JACKS—positive connection and long life.


Actual Size
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Net

Carrying Case
$3.20


MODEL 100

The most comprehensive test set in the Triplett line is Model 100 V-O-M Clamp-On-Ammeter Kit, now available at distributors. The world's most versatile instrument—a complete accurate V-O-M plus a clamp-on-ammeter with which you can take measurements without stripping the wires. Handsome, triple-purpose carton holds and displays all the components: Model 310 miniaturized V-O-M, Model 10 Clamp-On-Ammeter, Model 101 Line Separator, No. 311 extension leads and a Leather Carrying-Case, which neatly accommodates all the components. Model 101 literally makes it possible to separate the two sides of the line when using Model 10. Extension leads permit use of Model 10 at a distance from the V-O-M. Complete Model 100 is only $59.50.

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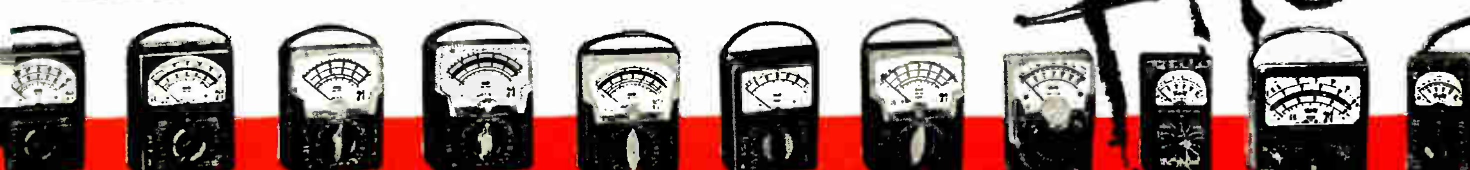


630 | 630-A | 630-PL | 630-APL | 630-NA | 630-T | 631 | 310 | 666-HH | 625-NA | 666-R

# Books

### *Nonlinear Problems in Random Theory*

*By Norbert Wiener. Published 1958 by The Technology Press, Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 4th Ave., New York 16. Price $4.50.*

Based on a series of 15 lectures given by Dr. Wiener at M.I.T. this book is a comprehensive study of nonlinear problems in random theory.

The role of nonlinear processes in physics, mathematics, electrical engineering, physiology, and communications theory is examined. How random processes—in space as well as in time—enter into the study of statistical mechanisms, opening new opportunities for research in gas and plasma theory is demonstrated.

The book will be of interest to electrical engineers working in communication theory, students of nonlinear electrical networks, those interested in the stability of electrical generating systems and students of all branches of statistical mechanics.

### *The Atom and the Energy Revolution*

*By Norman Lansdell. Published 1958 by Philosophical Library, Inc., 15 East 40th St., New York 16. Price $6.00.*

This illustrated book relates atomic energy to the political, social, economic and scientific issues of the day. It considers the effect of atomic energy on the balance of world trade and on the relation of industry to the state. The problem of national sovereignty vs. radiation hazards is treated in detail.

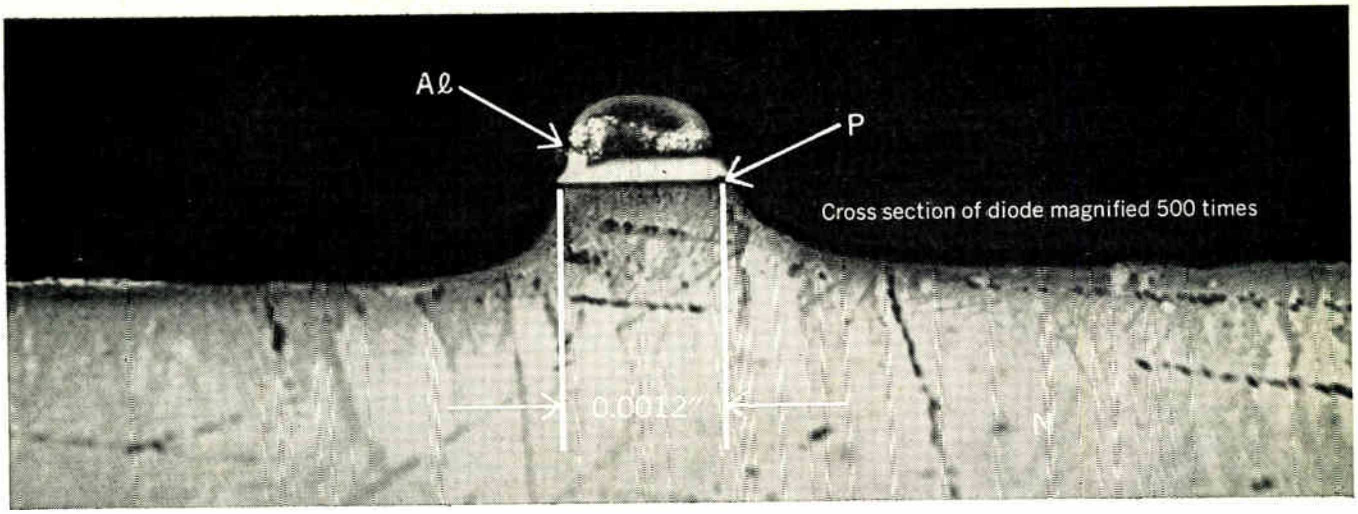
Among the subjects covered are, world energy sources and demand, possible new sources of energy, atomic energy and its exploitation, political and commercial organizations for atomic energy development, and radiation risks and insurance against them.

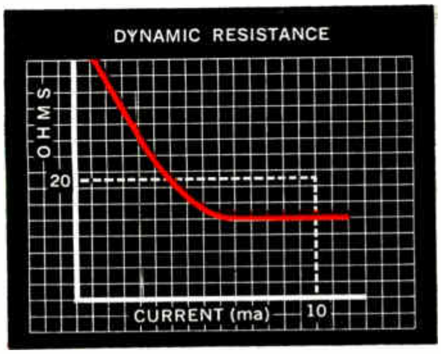
### *Dictionary of Astronomy and Astronautics*

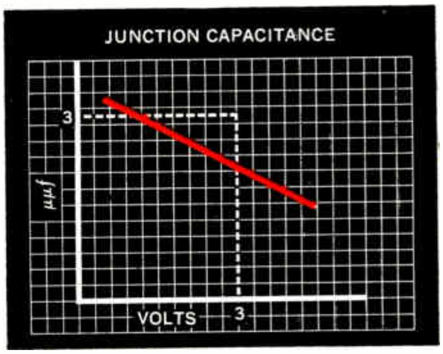
*By Armand Spitz and Frank Gaynor. Published 1959 by Philosophical Library, Inc., 15 East 40th St., New York 16. Price $6.00.*

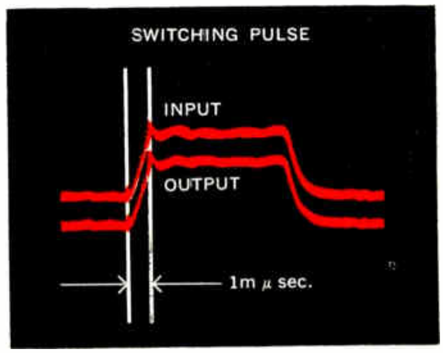
A handy reference for the new space age, this book contains concise definitions of over 2,200 terms and concepts related to astronomy and astronautics. It is published as a dictionary type reference book and does not attempt a textbook coverage; however, it offers answers in ready form to those who do not have a complete technical library at their fingertips.

(*Continued on page* 52)




**SPECIFICATIONS**

| Breakdown Voltage @ 1 ma (volts) | | Dynamic Resistance @ 10 ma (ohms) | | Reverse Current @ −3v (μa) | | Reverse Current @ BV −½v (μa) | | Junction Capacitance @ −3v (μμf) | |
|---|---|---|---|---|---|---|---|---|---|
| Min | Max | Typ | Max | Typ | Max | Typ | Max | Typ | Max |
| 6.0 | 7.5 | 8 | 20 | 0.005 | 0.10 | 0.5 | 5.0 | 1.8 | 3.0 |

Maximum Power Dissipation 250 mw    Maximum Operating Temperature 150°C

# NEW "AVALANCHE" DIODE SWITCHES IN LESS THAN 0.15 MILLIMICROSECOND

## Low Capacitance—Low Dynamic Resistance

Fastest switching device known to science is a new Sperry Semiconductor diode, developed in collaboration with the Univac Division. Observations indicate this diode turns on a current pulse in less than 0.15 millimicrosecond. While calculations indicate even faster response is possible, measurement is limited by the rise time of present-day pulse generators.

Full significance of this Sperry achievement in the art of solid state switching is still to be explored. Immediate applications seen for the design engineer include advanced computers capable of processing data in three days that today takes a year . . . experimental UHF, TV and microwave circuitry . . . navigation and guidance systems for missiles and space vehicles. Prime feature of this device is that its low dynamic resistance and capacitance do not limit its switching time.

The device, packaged as a subminiature glass diode, is designed to operate around the breakdown voltage of an alloyed P-N junction utilizing the avalanche breakdown effect for switching. The P-N junction is formed by alloying a microscopically small (.0015" diameter) aluminum dot onto an N type silicon wafer. This aluminum dot is biased negatively with respect to the silicon wafer near the breakdown voltage. A sudden increase or pulse on this negative voltage causes a current to flow by an "avalanche" mechanism in which one electron will cause many, many more electrons and holes to flow.

Designed for volume production, this new diode is available in limited numbers for experimental use. Write for more information.

*Visit our booth 1410-1416, 1959 Radio Engineering Show, March 23-26.*

SPERRY

**SPERRY SEMICONDUCTOR DIVISION,** *SPERRY RAND CORPORATION, SOUTH NORWALK, CONNECTICUT*

*Address all inquiries: Marketing Department, Great Neck, N. Y., or Sperry Gyroscope offices in Brooklyn, Chicago, Cleveland, Seattle, San Francisco, Los Angeles, New Orleans, Boston, Baltimore, Philadelphia.*

 Circle 31 on Inquiry Card, page 123 

# Books

(*Continued from page* 50)

### *Reflex Klystrons*

*By J. J. Hamilton. Published 1959 by The Macmillan Co., 60 Fifth Ave., New York 11. 260 pages. Price $9.00.*

This book, a survey work, provides a simple, concise — but thorough — treatment of the reflex klystron. It is written primarily for those just entering the microwave oscillator field, but it should be of interest and value to all microwave engineers.

It opens with an historical background, then gives operating principles, theoretical aspects, and a description of cavity resonators and output systems with definitions, measurements and circuits. The theory of an idealized reflex oscillator is presented along with the effects of deviations from the ideal case and the extent of validity of the simple theory applied to the practical case. It discusses load effects and engineering aspects. Chapters are devoted to representative and unconventional reflex klystrons. The final section discusses future trends and new microwave devices and lists the principal symbols used.

### *The Practical Dictionary of Electricity and Electronics*

*By R. L. Oldfield. Published 1959 by American Technical Society, 848 East 58th St., Chicago 37. Price $5.95.*

A basic vocabulary of modern electricity and electronics, this book contains the terms most often used in theory and practice. Drawings and pictures are used wherever they help in visualizing the action or term being defined.

A handbook section has tables, symbol charts (illustrated) and formulas most often used by engineers and scientists. A "memory refresher" technique is used for classifying types of equipment or components under general headings. Cross referenced terms are indicated in boldface type.

### *Guide to the Literature of Mathematics and Physics Including Related Works on Engineering Science*

*By Nathan Grier Parke III. Published 1958 by Dover Publication, Inc., 920 Broadway, New York 10. Price $2.49.*

This book was written to meet the needs of scientists and engineers for a classified guide to mathematical and physical literature. The first section of the book offers suggestions for those unfamiliar with library techniques.

(*Continued on page* 54)

Circle 35 on Inquiry Card, page 123

# Books

(*Continued from page* 52)

The bibliographical part of the guide contains about 2300 entries under some 150 subject headings. Under each heading is a paragraph or two delineating the subject, suggesting related headings, and in some cases singling out titles that will prove useful as a point of departure.

### *Guided Missile Engineering*

*Edited by Allen E. Puckett and Simon Ramo. Published 1959 by McGraw Hill Book Co., Inc., 330 West 42nd St., New York 36. Price $10.00.*

Guided missile engineering requires the simultaneous and compatible solution of problems in aerodynamics, structures, propulsion, electronics, instrumentation and other related fields. Thus the modern engineer needs to know not only the problems in his own specialized field, but to some degree the problems in all other areas relating to the over-all performance of the device.

This book, written by 18 missile engineering experts, gives important principles and engineering techniques of the various sciences that make up the field. With it the engineer can gain a clear understanding of the relation between his field and guided missile engineering as a whole.

## Books Received

### *Research Highlights of the National Bureau of Standards Annual Report, Fiscal Year 1958*

*Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 45 cents.*

### *Tube & Semiconductor Selection Guide—1958-59 2nd Edition*

*Compiled by Th. J. Kroes. Published 1958 by the Tech. & Scient. Lit. Dept., N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland. 158 pages. Price $1.50.*

### *Guide to Mobile Radio*

*By Leo G. Sands. Published 1958 by Gernsback Library, Inc., 154 West 14th St., New York 11. 160 pages. Price $2.85.*

### *Transistors Theory and Practice 2nd Edition*

*By Rufus P. Turner. Published 1958 by Gernsback Library, Inc., 154 West 14th St., New York 11. 160 pages. Price $2.95.*

### *A-C Circuit Analysis*

*By A. Schure. Published 1959 by John F. Rider, Inc., 116 West 14th St., New York 11. 104 pages. Price $1.80.*

Circle 37 on Inquiry Card, page 123

# DUST FREE

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### Now commercially available

Shielding, Inc. manufactures dust free enclosures for use in sub-assembly rooms, laboratories and prototype departments, high precision and military equipment production areas, and all applications which require a high degree of freedom from contamination.

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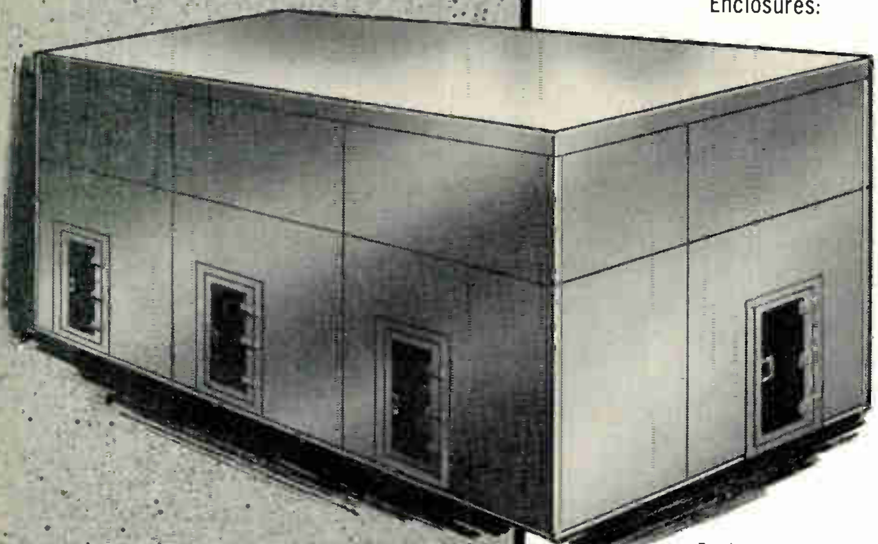

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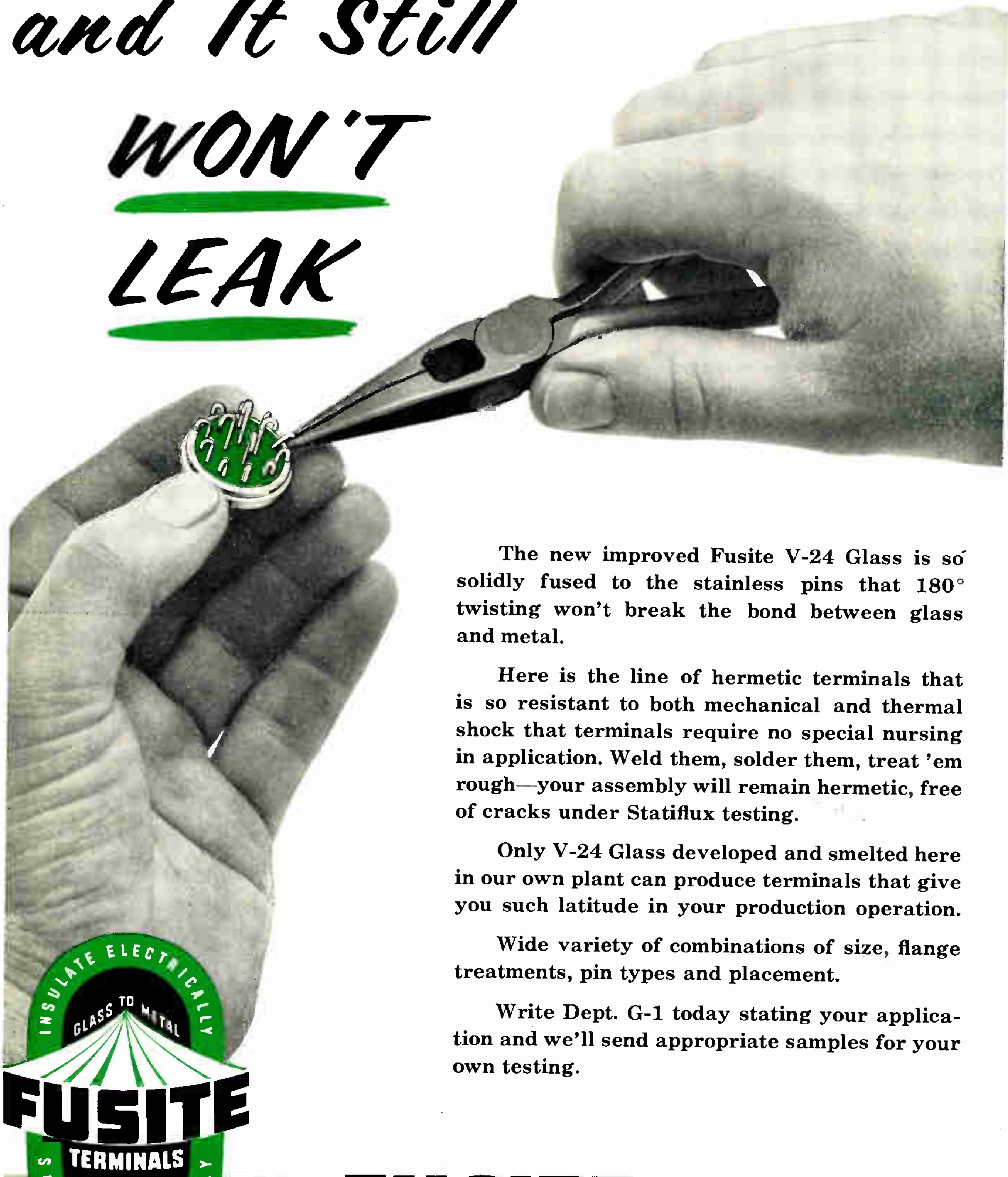
Circle 39 on Inquiry Card, page 123

# Twist It 'til It Snaps and It Still WON'T LEAK



The new improved Fusite V-24 Glass is so solidly fused to the stainless pins that 180° twisting won't break the bond between glass and metal.

Here is the line of hermetic terminals that is so resistant to both mechanical and thermal shock that terminals require no special nursing in application. Weld them, solder them, treat 'em rough—your assembly will remain hermetic, free of cracks under Statiflux testing.

Only V-24 Glass developed and smelted here in our own plant can produce terminals that give you such latitude in your production operation.

Wide variety of combinations of size, flange treatments, pin types and placement.

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

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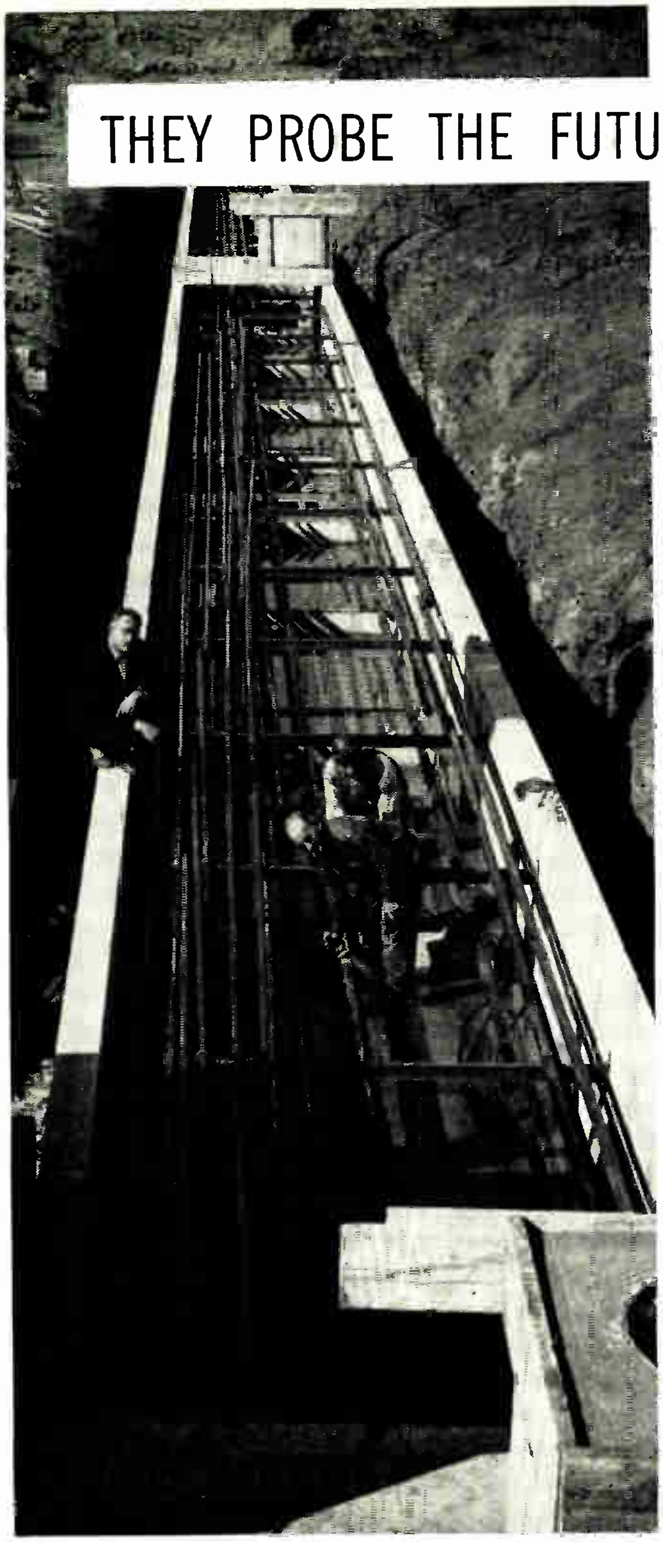
# THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

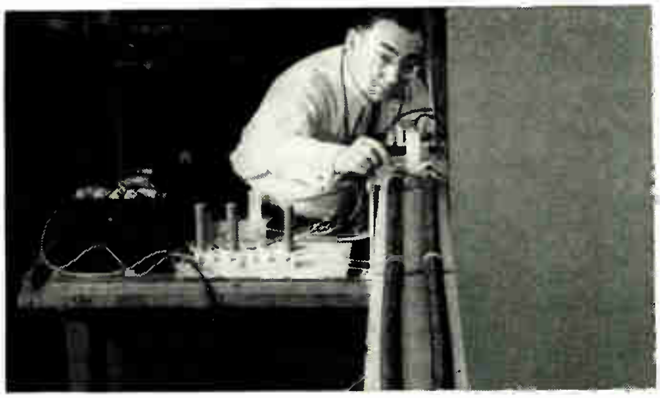


"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.



Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.

Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

**BELL TELEPHONE LABORATORIES**

WORLD CENTER OF COMMUNICATIONS
RESEARCH AND DEVELOPMENT

# Letters

## to the Editor

### "Perforated Pages"

"If possible, have each feature article so printed that it can be removed and filed separately from any other feature articles . . . "

Samuel A. Welk
Engr.
Carrier Development Dept.
Lenkurt Electric Co., Inc.
San Carlos, Calif.

---

"I am sure that there are many engineers like myself who "clip" and "abstract" your very fine magazine, after it has been read by all the regular people on the circulation list.

Can you possibly move the informative articles to the "left hand" side of the page, as shown on the attached sample. This would simplify clipping the pages a great deal since a very sharp razor blade is now required to do this, at the binding margin."

John E. Troutman,
Section Head, Liaison
Electronics Systems,
Stromberg-Carlson Co.
1400 N. Goodman St.,
Rochester 3, N. Y.

---

"I have a suggestion on your format. A wider binding-edge margin would permit page-clipping and notebook filing without loss of information from punch holes . . . "

Loren A. Long,
Engr.
Electronics Div.,
Iron Fireman Co.
Portland, Ore.

---

"Print on one side of page only, with advertising on opposite side so references may be clipped and mounted . . . "

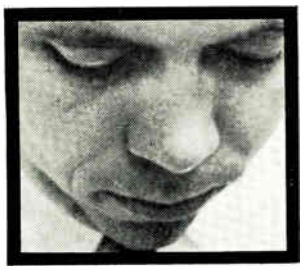
Rolland B. Arndt,
Staff. Engr.
Remington-Rand Univac Div.,
Sperry Rand Corp.
St. Paul 16, Minn.

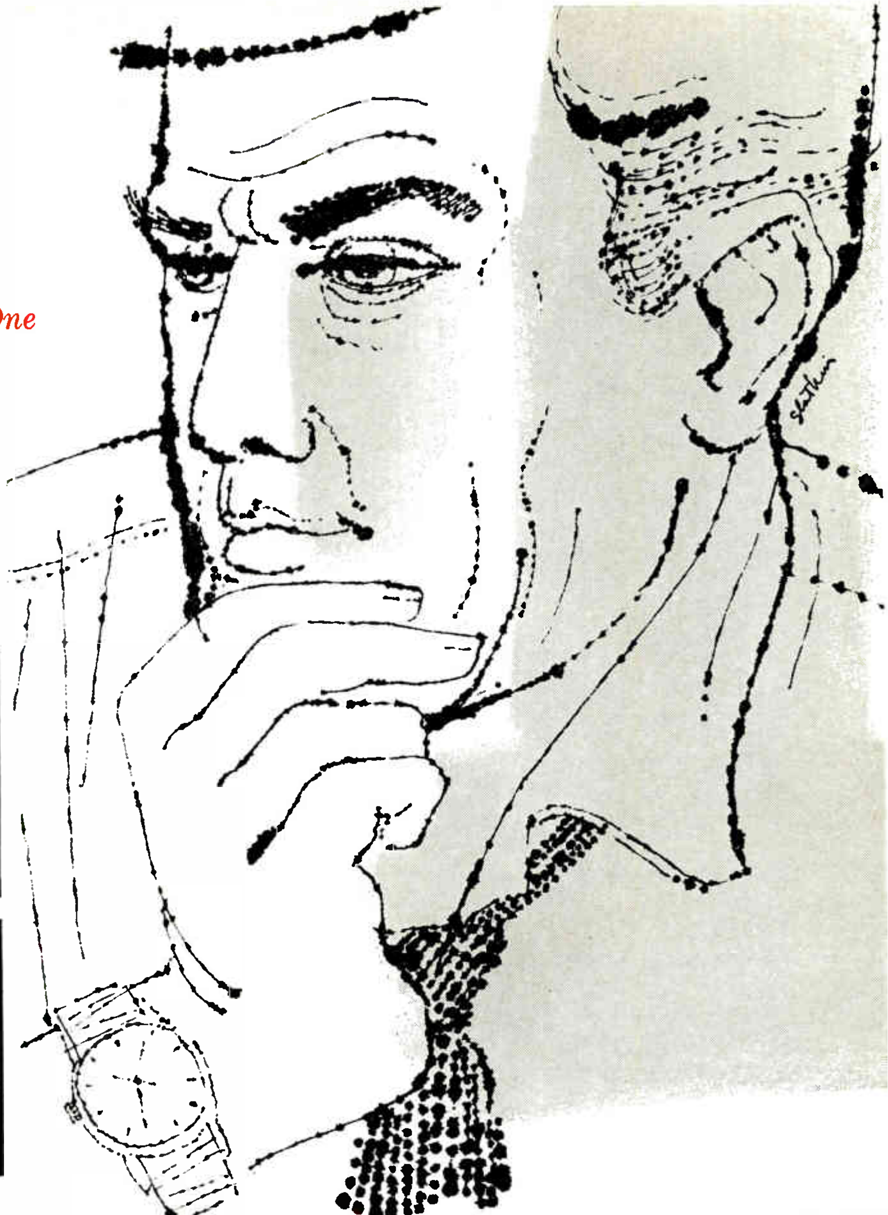
---

*Ed. These letters are typical of the many that we have received on this subject. And that is why last month we started perforating the pages of EI's editorial section, where the main articles are found. Now these pages can be easily detached and filed away for future reference, just as you, our readers, requested. We think that this is a big step forward in technical journalism. We hope you will agree.*

*As to the second point—separating articles so they can be removed individually—this is rather difficult to arrange at times. The only promise we can make is that—we'll try.*

*Inside ESC: Number One*





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But there is more to ESC leadership. Its production and quality control facilities are unequalled in the field. ESC submits complete and definitive laboratory reports with all custom-built prototypes which include submitted electrical requirements, photo-oscillograms, the test equipment used, and an evaluation of the electrical characteristics of the prototype.

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Circle 43 on Inquiry Card, page 123

# NEW KLYSTRON POWER SUPPLY

## Features Wide Voltage Range, Hi-Power Capacity and Small, Compact Construction


**SPECIFICATIONS**

| | BEAM | REFLECTOR | GRID |
|---|---|---|---|
| Voltage Range | −200 to −4000 V | 0 to 1000 v | 0 to +150 v 0 to −300 v |
| Regulation | 0.01% | 0.01% | 0.01% |
| Max. Ripple | 3 mv | 3 mv | 5 mv |
| Current | 0 to 150 ma (360 w max) | — | 5 ma (max) |

Power Requirements: 105-125 v, 50/60 cps (also available for 230 volt operation) Dimensions: 11½" W x 20" H x 17½" D Weight: 110 pounds

This new *Microline*® Universal Klystron Power Supply Model 62A1 is a good example of many superior engineering developments coming from the modern Clearwater plant of Sperry Microwave Electronics Company.

Using conservatively-rated components, the Model 62A1 provides a voltage range from 200 to 4,000 volts — meets the needs of nearly every klystron available today, as well as several small cw magnetrons. Internal modulator supplies sawtooth, square wave or sine wave modulation . . . external modulation from either a high or low level outside source is committed through the use of an internal amplifier.

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SPERRY

**SPERRY MICROWAVE ELECTRONICS COMPANY,** *CLEARWATER, FLORIDA · DIVISION OF SPERRY RAND CORPORATION*

*Address all inquiries to Clearwater, Florida, or Sperry Gyroscope offices in Great Neck · Cleveland · New Orleans · Los Angeles · San Francisco · Seattle*



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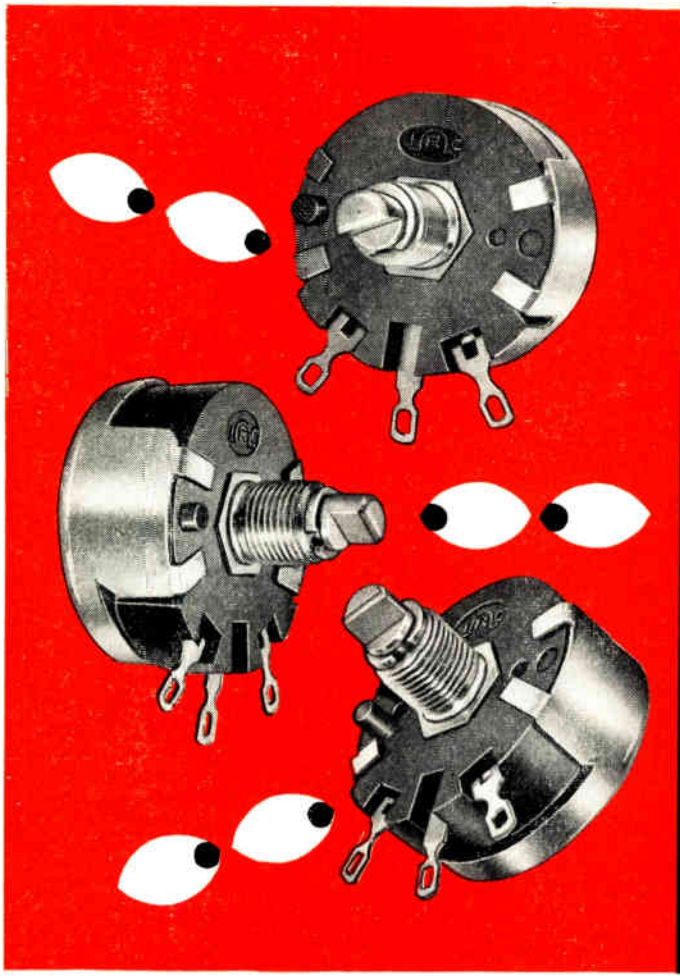

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IRC Type 2W

# 2 WATT RHEOSTAT POTENTIOMETERS

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IRC 2W's are designed with a one-piece nickel silver center terminal and collector ring. Resistance wire is wound by specially designed IRC machines and bonded to the core by a special coating to prevent wire shifting even under most unfavorable conditions.

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IRC 2W's are available with most any shaft and bushing style, including a "shaft locking" type bushing. For your further convenience there is a wide selection of standard and special locating lugs.

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### LOOK AT THEIR CHARACTERISTICS

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### LOOK AT THEIR APPLICABILITY

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for complete details of construction and specifications; derating, taper and resolution charts. Write for it today.

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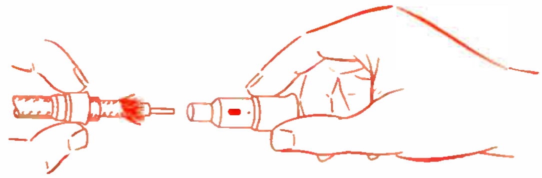
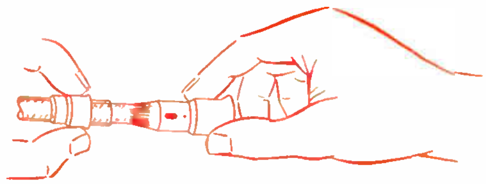


# COAXIAL



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Circle 47 on Inquiry Card, page 123

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A system with *complete* files, *complete* data and *complete* processing . . . to handle all operations.

It's a proven fact . . . that of the total work necessary to put a missile into the air, a staggering 90% is primarily logistical and involves the control of many individual maintenance parts. This figure becomes compounded as the number of inactive, but ready-to-fire missiles increases . . . and keeping track of their individual needs becomes a herculean task.

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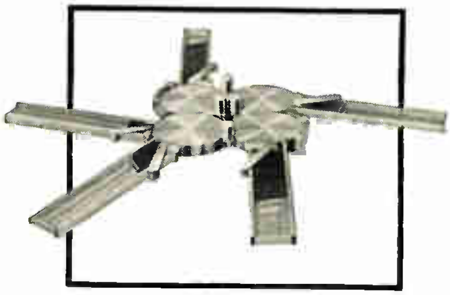

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# ONLY BOURNS TRIMPOT® GIVES YOU ALL THESE OUTSTANDING FEATURES

**SPRING** — Carriage spring provides positive no-slip performance during rotation plus a reliable idling feature at mechanical limits of travel.

**LEAD SCREW** — Stainless steel lead screw for low noise, high performance during rotation.

**O-RING** — Silicon rubber O-Ring seals potentiometer against humidity. Prevents flash-over to shaft head for high voltage operation.

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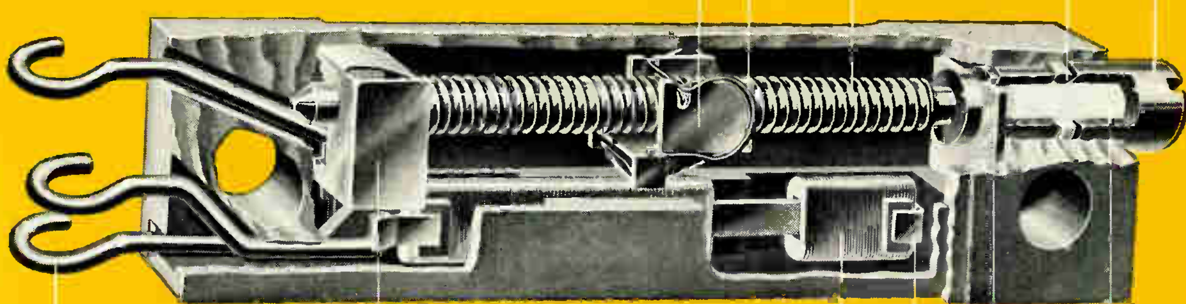

**SOLDER TERMINALS** — Tinned terminals are compact, yet large enough for easy soldering. Teflon-insulated leads and printed circuit pins are also available.

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**SHAFT INSULATOR** — High-dielectric-strength, ceramic insulator isolates shaft head from internal circuits.

*This cutaway of Model 224 is typical of the design of all Bourns potentiometers though some features vary from model to model.*


ACTUAL SIZE
Most models available with insulated stranded leads, solder lugs or printed circuit pins in resistances from 10Ω to 1 Meg.

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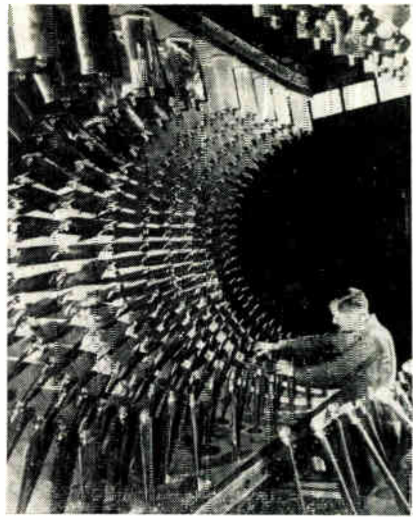
Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration



Circle 49 on Inquiry Card, page 123

WINDTUNNEL BOOSTER



Auxiliary compressor designed by Westinghouse for the 16 ft. transonic wind tunnel at NASA, Langley Field, Va. will remove dead air around tunnel at 1,000,000 ft 3 min.

## Night Photos Taken With Infrared Device

Objects or scenes can be photographed in total darkness using a new research tool, the Thermograph, developed by the Barnes Engineering Co., Stamford, Conn. for the U. S. Army Engineer Research and Development Labs., Fort Belvoir, Va.

Infrared radiation is collected by an optical scanning system and focused onto a detector which produces a voltage output. The difference between the signal and a reference signal is amplified and then modulates the light output of a glow tube. The glow tube forms a thermal image on a photographic film.

The Thermograph will be used in developing the basic characteristics for the design of therml imaging devices for night reconnaissance, terrain mapping and target location. It has already found some commercial application such as detecting "hot spots" in inaccessible equipment areas.

## One Billion Dollars For Space Conquest

The basic formula for the conquest of space—money, organization and research—is now available to the United States, according to Maj. Gen. J. F. Phillips (USAF-Ret.), Secretary of the Guided Missile Committee, Aircraft Industries Association.

The National Aeronautics and Space Administration, an extension of the National Advisory Committee for Aeronautics, the Advanced Projects Research Agency within the Department of Defense and the research facilities of the military services are mentioned as major coordinating space agencies.

A billion dollars is available for new hardware and basic research. A solid foundation of programs has already been established in such widely separated areas as: housing humans in space capsules, super radio antenna for maintaining space vehicle communications and a 1,000,000 pound thrust rocket for lunar probes.

---

## *IRE Awards for '59*

The Board of Directors of I.R.E. has announced that the 1959 W.R.G. Baker Award will be given to Richard D. Thornton, Assistant Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. for his paper entitled "Active RC Networks" which appeared in the September 1957 issue of "IRE Transactions On Circuit Theory."

Franklin H. Blecher of Bell Telephone Labs., Murray Hill, N. J. is the recipient of the 1958 Browder J. Thompson Memorial Prize Award for his paper entitled "Design Principles for Single Loop Transistor Feedback Amplifiers." Mr. Blecher's paper, like Mr. Thornton's also appeared in the September 1957 issue of IRE Transactions On Circuit Theory.

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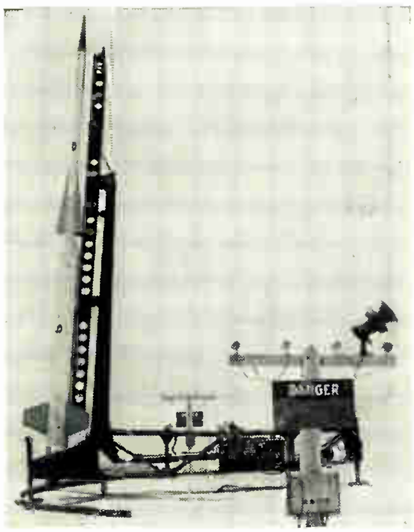
### HIGH FLYER

**NIKE-ASP research rockets built by Cooper Development Corp. are gathering data on radiation at altitudes as high as 150 miles up.**









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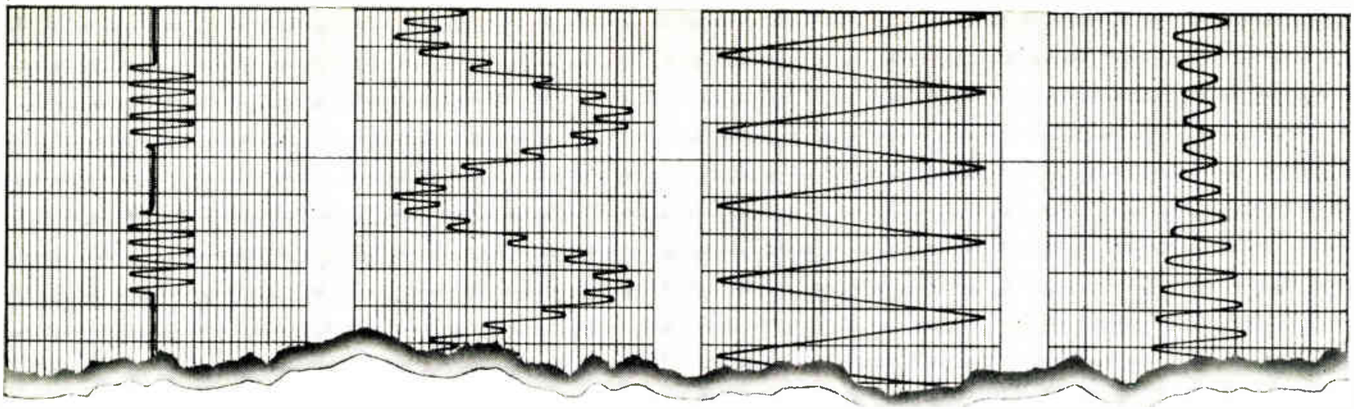

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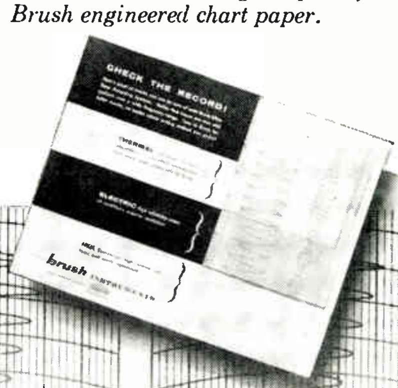


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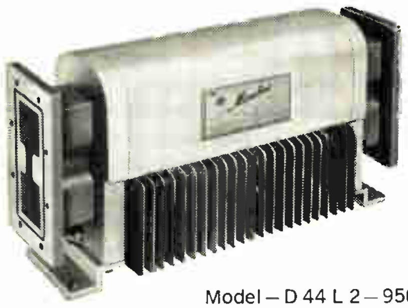
## GENERAL PURPOSE BROADBAND

Model 44 L 2 – 1000-2000 mc
44 S 2 – 2000-4000 mc
44 C 2 – 4000-7000 mc
44 X 2 – 7000-11,000 mc

Insertion loss (max) 1 db, isolation 10–20 db,
Power average 10 w, Peak 10 kw

### HIGH POWER VERSION FOR COUNTERMEASURES APPLICATIONS



Model – D 44 L 2 – 950-2350 mc
D 44 S 2 – 2000-4000 mc
D 44 S 22 – 2000-4000 mc
D 44 C 22 – 4000-7000 mc
D 44 X 22 – 7000-11,000 mc

Power average – 400 w
Peak – 10 kw
Insertion loss (max) – 1.0 db
Isolation (min) – 10 db

### NARROW BAND— IMPROVED CHARACTERISTICS FOR RADAR

Model – 44 L 1 – 1250-1350 mc
44 S 1 – 2700-3100 mc
44 C 1 – 5200-5900 mc
Insertion loss (max) – 0.6 db
Isolation (min) – 12 db
Power average – 10 w

The isolators shown here are typical of the wide variety of new ferrite and solid state devices developed and manufactured by Sperry Microwave Electronics Company. All of these components represent the latest technical advances—all are the result of more than six years of intensive research devoted to this highly-specialized field.

For additional information, write to Sperry Microwave Electronics Company, Clearwater, Florida.

*Visit our booth 1410-1416, 1959 Radio Engineering Show, March 23-26.*

SPERRY

**SPERRY MICROWAVE ELECTRONICS COMPANY,** *CLEARWATER, FLORIDA · DIVISION OF SPERRY RAND CORPORATION*

*Address all inquiries to Clearwater, Florida, or Sperry Gyroscope offices in New York · Cleveland · New Orleans · Los Angeles · San Francisco · Seattle*


Circle 53 on Inquiry Card, page 123

# Personals

**Richard D. Fullerton** is now Chief Engineer, Systems Div., at Pacific Automation Products, Inc. He was formerly with the Radio Corp. of America, Missile and Surface Radar Dept. as Systems Project Engineer Leader.

**Dr. Sherrerd B. Welles** is now Senior Engineering Specialist for Sylvania Electronics Systems, a division of Sylvania Electric Products Inc. He will be responsible for improving and maintaining the interchange of technical information.

**Walter Bein,** Chief Engineer for Burnell & Co. has been elected an Officer of the company and to the post of Director of Engineering with broad research and development responsibilities.

W. Bein

C. H. Single

**Charles H. Single** is now Computer Engineering Manager at the Berkeley Div. of Beckman Instruments. He was formerly Chief Project Engineer.

**Dr. C. E. Oelker** has been appointed Director of Engineering for the Cincinnati Div. of Bendix Aviation Corp. He was formerly Manager of missile systems for the Crosley Div. of the Avco Mfg. Corp.

**Edward Hoffart** has been appointed an Executive Staff Engineer for Hoffman Laboratories Div., Hoffman Electronics Corp. He was previously Chief Engineer, Topp Industries, Inc.

**Walter W. Mieher** has been appointed Engineering Manager of Sperry Gyroscope Co.'s countermeasures Div. Until his promotion, he had been serving as Chief Engineer of Sperry's Air Armament Div.

**Kenneth A. Simons** has been appointed Chief Engineer at Jerrold Electronics Corp., Philadelphia. He will head the research and development program.

**Gail B. Rathbun** has been named Engineering Manager for electrical products at Westinghouse Electric Corp.'s Sunnyvale, California Div.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Circle 55 on Inquiry Card, page 123 →

# Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASS., Vol. 1, No. 3

## NEW AMPLITRON* BOOSTS L-BAND RADAR OUTPUTS TO MORE THAN 5,000 KW

### Extends range to radius of 250 miles at 80,000 feet

Now being incorporated in L-band ARSR systems for the C.A.A., Raytheon's new broad-band QK-653 pulsed-type Amplitron transmits ten times more power than maximum power levels of original RF drivers, increasing the detection range of these systems more than 60%.

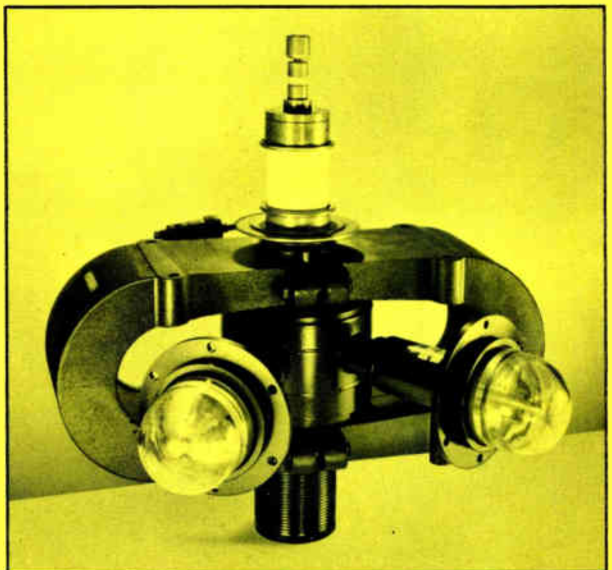
The Amplitron is a highly efficient (50% to 70%) liquid-cooled, integral-magnet microwave tube.

When used with Raytheon's new high-gain 40-ft. antenna, the QK-653 triples the detection range and the warning time of standard long-range search radars.

Non-reentrant RF circuit permits control of oscillation by frequency of RF input over the entire band, 1,280 to 1,350 Mc, at optimum gain and efficiency, without mechanical or electrical tuning. Changes in anode current or voltage have little effect on total phase shift. The Amplitron exhibits excellent reproduction of input spectrum even under high-ripple pulse conditions.

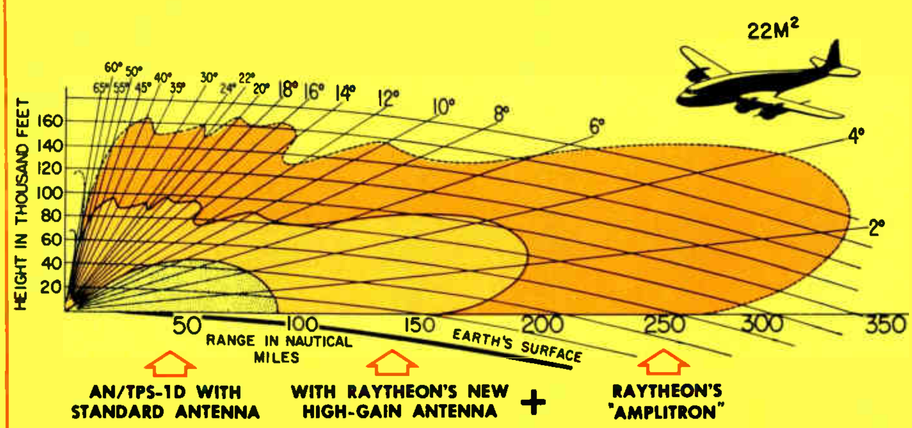
The exceptional phase stability of the QK-653 is particularly advantageous in MTI radar applications.

* Raytheon Trade Mark

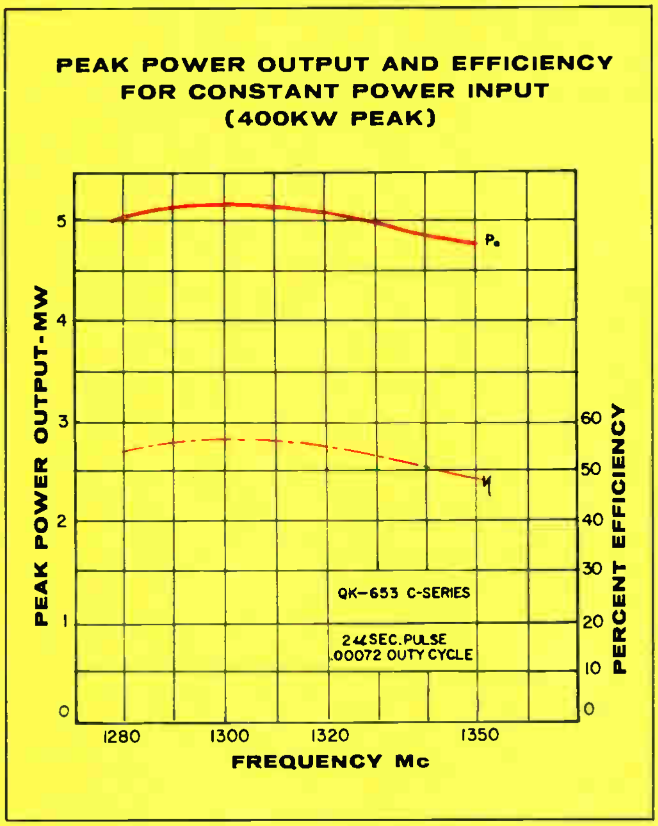


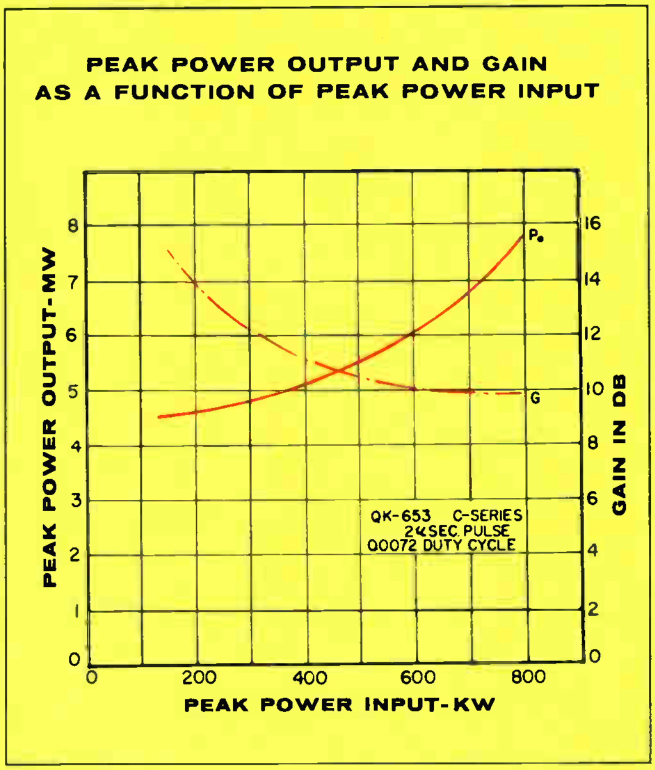
Typical Operating Characteristics

| | |
|---|---|
| Anode Voltage | 94 KV |
| Anode Current | 78 amps |
| Peak Power Output | 4 MW |
| Average Power Output | 2,880 W |
| Efficiency | 55% |
| Gain | 10 db |
| Operating Band | 1,280-1,350 Mc |
| Peak Power Input | 400 KW |

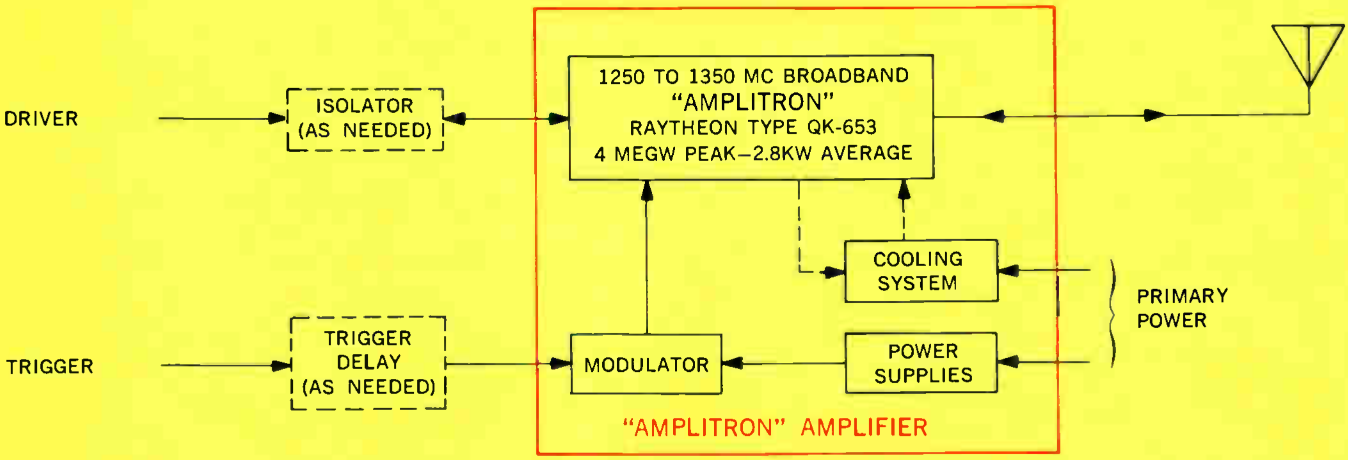



300% increase in coverage and warning time of type AN/TPS-1D radar results when Raytheon's new QK-653 Amplitron and 40-ft. high-gain antenna are added to the system. With other radars of more limited range, improvement factor may be even greater.




Block Diagram of Typical Amplitron Installation




You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Massachusetts

*Skyward facing directional antennas are easy prey for ionospheric reflection interference. How to determine the possibilities of subjection to this source is this article's objective.*

# Interference from the

**By MARTIN L. SHAPIRO**
*Research Engineer*
*Boston Engineering Office*
*Boeing Airplane Co.*
*Lexington Mass.*

GROUND to air communications systems, radars or other radio links with directional antennas that point skyward are subject to two main sources of interference propagated via the ionosphere.

In the first case, static interference and man-made signals may be reflected from the ionosphere and enter the beam of the radar receiving antenna, Fig. 1.

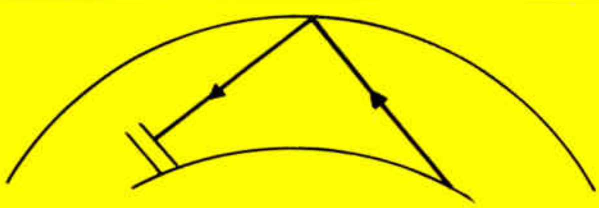
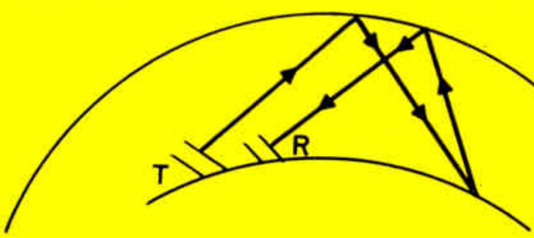


Fig. 1: Static interference and man-made signals, reflecting from the ionosphere, may enter the beam of a radar receiving antenna.

Fig. 2: Transmitted power can be scattered back to the receiver.




In the other case, transmitted power can be scattered back along the path transmitter—ionosphere—ground—ionosphere—receiver, as show in Fig. 2.

In either case interference is only possible when the ionosphere reflects the "operating frequency" ($f_c$) at an angle of incidence $\phi$, Fig. 3.

### *Theory*

Consider the passage of a plane electromagnetic wave across the boundary of two media of refractive indices $n$ and $n'$, Fig. 4. Snell's law states that $n \sin \phi = \sin \phi'$. For the ionosphere

$$n' = \sqrt{1 - [Ne^2 / (m\, \epsilon_o\, \omega^2)]} \qquad (1)$$

Where $N$ = number of electrons per cubic meter

$e$ = electronic charge

$m$ = mass of electron

$\epsilon_o$ = permittivity of free space

$\omega = 2\pi \times$ the frequency of the electromagnetic wave

Critical reflection exists when $\angle \phi = 90°$ or $\sin \phi = n'$.

In this case

$$\sin \phi = \sqrt{1 - [Ne^2 / (m\, \epsilon_o\, \omega^2)]} \qquad (2)$$

$$\omega^2 = Ne^2 / (m\, \epsilon_o \cos^2 \phi) \qquad (3)$$

Hence

$$f_c' = (1 / \cos \phi) \sqrt{Ne^2 / (4\pi^2\, m\, \epsilon_o)} \qquad (4)$$

where $f_c'$ is the critical frequency for forward reflections at an angle of incidence, $\phi$.

**Table 1**

**MAIN LOBE FREQUENCY**

| $\alpha$ | $h$ | $f_o$ | Layer |
|---|---|---|---|
| 40° | 50 km | 19.5 MC | |
| 40 | 100 | 19.7 | E and $E_s$ |
| 40 | 200 | 19.9 | $F_2$ |
| 40 | 300 | 20.2 | |

# Ionosphere

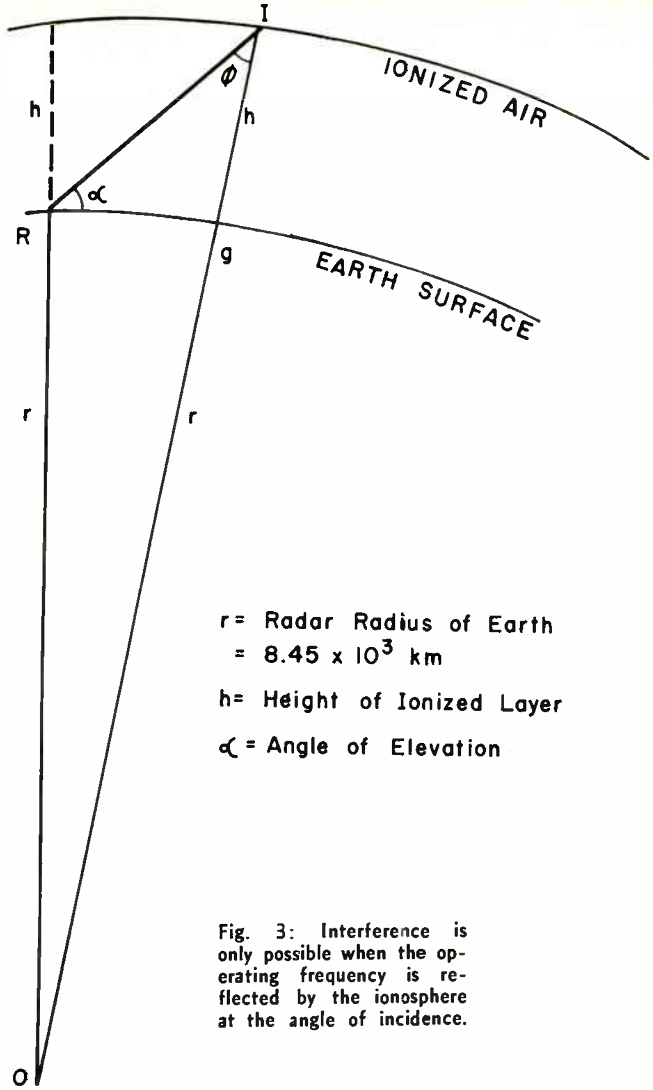



Fig. 3: Interference is only possible when the operating frequency is reflected by the ionosphere at the angle of incidence.

Now reflections at vertical incidence occur at a critical frequency of $f_o$ which is given by making $\phi = 0°$ in Eq. (4),

$$f_o = \sqrt{[Ne^2 / (4\pi^2 m \epsilon_o)]}. \quad (5)$$

Hence, substituting in Eq. (4), we may relate the critical frequency $f_c'$ at oblique incidence to the critical frequency at vertical incidence by the expression

$$f_o = f_c' \cos\phi. \quad (6)$$

The angle $\phi$ is shown in triangle RIO, Fig. 3, where O is the center of the earth and R is the radar site. From triangle RIO

$$r / \sin\phi = (r + h) / [\sin(90 + \alpha)] \quad (7)$$

$$\sin\phi = (r \cos\alpha) / (r + h) \quad (8)$$

and from Eq. (6)

$$f_o = f_c' \sqrt{1 - [(r \cos\alpha) / (r + h)]^2} \quad (9)$$

Thus when the vertical sounding of the ionosphere shows that $f_o$ is greater than the value given by Eq. (9), oblique reflection will occur at a frequency $f_c'$ and transmission angle $\alpha$. Conversely we may assume that no interference from ionospheric reflection will occur when $f_o$ is below this value.

### *Example*

Assume: (1) a desired operating frequency, $f_c$, of 30 MC,

(2) a beam elevation of 40°,

(3) the operating site to be Washington, D. C., and

(4) the equipment will operate during sun-spot maxima.

Using these assumptions in Eq. (9), the computed vertical critical frequency $f_o$ indicates that oblique reflections are possible. Table 1 shows values obtained for heights from 50 to 300 km. Under these conditions, $f_o$ does not vary appreciably with the height of the ionized layer, and therefore it is necessary to

**Table 2**

**VERTICAL CRITICAL FREQUENCY**

**$F_2$ Layer Over Washington, D. C. – National Bureau of Standards**

| Frequency MC | Dec. '46 | Jan. '47 | Feb. '47 | Mar. '47 | Apr. '47 | May '47 | June '47 | July '47 | Aug. '47 | Sept. '47 | Oct. '47 | Nov. '47 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hours Per Month | | | | | | | | | | | |
| 15 – 15.9 | — | — | — | — | — | — | — | — | — | — | 1 | — |
| 4 – 14.9 | — | 1 | 5 | 1 | — | — | — | — | — | — | 3 | 29 |
| 3 – 13.9 | 6 | 15 | 61 | 37 | 4 | — | — | — | — | — | 61 | 120 |
| 12 – 12.9 | 57 | 76 | 133 | 106 | 41 | — | — | — | — | 36 | 116 | 73 |
| 11 – 11.9 | 108 | 94 | 46 | 56 | 83 | 14 | — | — | — | 55 | 42 | 28 |
| 10 – 10.9 | 51 | 47 | 14 | 30 | 80 | 47 | 3 | 1 | 11 | 87 | 34 | 25 |

# Ionospheric Interference

### *(Concluded)*

consider only the layer with highest electron density, irrespective of its height in the ionosphere.

National Bureau of Standards measurements of vertical critical frequencies centered at Washington, D. C., were used as a basis for the data collected here.

On all occasions during the day the highest electron densities occurred in $F_2$ region. Table 2 shows the number of hours per month in which the vertical critical frequency of the $F_2$ region was greater than 10 MC. The year 1947 has been chosen as it corresponds to the maximum of the sunspot cycle. The records of 1952 (not shown) were also examined. These records correspond to the minimum of the sunspot cycle and show that the critical frequencies of the $F_2$ layer were much less than in 1947.

It can be seen that $f_o$ is never greater than 20 MC and hence no reflections are expected in the main beam from the $F_2$ layer.

During the night the highest electron densities occurred in the E region, but on no occasion were the critical frequencies as great as the $F_2$ values given in Table 2.

### *Side Lobes*

From Eq. (9) the vertical critical frequency for oblique reflections at an angle of elevation may be computed. These values are given for $\alpha$ between 0° and 40° in Table 3.

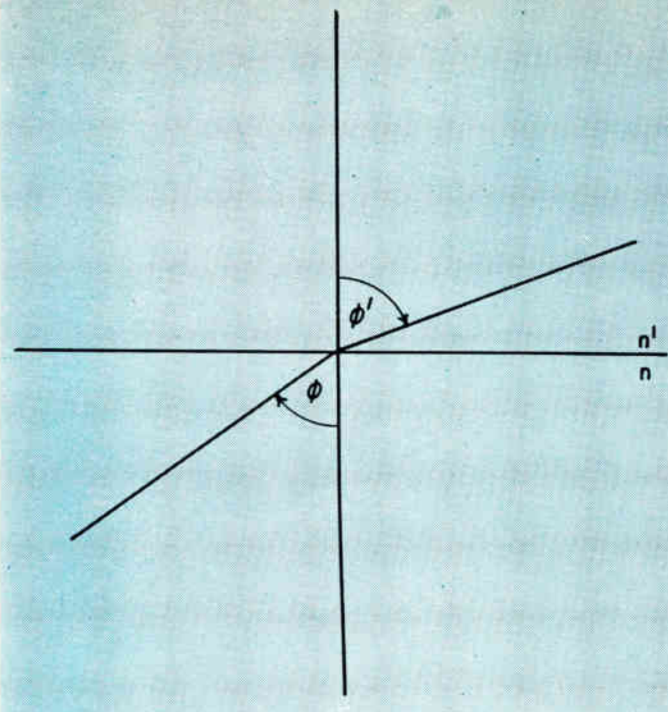



Fig. 4: Refraction from one medium to another.

**Table 3**

**SIDE LOBE ANGLE**

| $\alpha$ | $\phi$ | $f_o$ |
|---|---|---|
| 0° | 78° | 6.72 MC |
| 5 | 76 | 6.9 |
| 10 | 74 | 8.5 |
| 15 | 71 | 9.95 |
| 20 | 67 | 12 |
| 25 | 62 | 14 |
| 30 | 58 | 16 |
| 35 | 53 | 18 |
| 40 | 48 | 19.9 |



In the preceding example no interference will be obtained in the main lobe by reflection from the ionospheric layers. However, since it is difficult to design an antenna with no side lobes, it is necessary to examine the chart to avoid side lobes where they will degrade the system operation.

### *Sample Calculation*

$$f_o = f_c' \sqrt{1 - [(r \cos \alpha) / (r + h)]^2} \qquad (9)$$

$$= 30 \text{ MC} \sqrt{1 - \left(\frac{8.45 \times 10^3 \text{ km} \cos 25^\circ}{8.45 \times 10^3 \text{ km} + 200 \text{ km}}\right)^2}$$

$$= 30 \times 10^6 \sqrt{1 - \left(\frac{8.45 \times 10^6 \times 0.906}{8.45 \times 10^6 + 200 \times 10^3}\right)^2}$$

$$= 30 \times 10^6 \sqrt{1 - (7.66 / 8.65)^2}$$

$$= 30 \times 10^6 \sqrt{1 - (0.855)^2}$$

$$= 30 \times 10^6 \sqrt{1 - 0.784}$$

$$= 30 \times 10^6 \sqrt{0.216}$$

$$= 30 \times 10^6 \times 0.465$$

$$= 14.0 \text{ MC}$$


### *Acknowledgment*

The author wishes to acknowledge that this article has been prepared from information derived from research conducted while a member of the Scientific Staff of Harvard College Observatory, working under the direction of Dr. Gerald S. Hawkins and Prof. Fred L. Whipple. In effect, this article is a general case of a specific problem faced by the Harvard Radio Meteor Project and debated by Dr. Gerald S. Hawkins (Radio Astronomer) and Mr. Martin L. Shapiro (Radio Engineer) in their paper, "Oblique Reflections at 32.8 MC."


**References**


1. Lovell, Clegg, *Radio Astronomy.*
2. Pawsey, Bracewell, *Radio Astronomy.*
3. Hawkins, Dr. Gerald S. and Shapiro, Martin L., "Oblique Reflection at 32.8 MC."
4. Revised edition of the Final Summary Report of The Harvard Radio Meteor Project, Sept. 14, 1956, by Prof. Fred L. Whipple, Dr. Gerald S. Hawkins—Contract AF 19 (122)—458 Subcontract 57.

By **JOSEPH L. RYERSON**

*Chief, Advanced Development Lab.*
*Directorate of Communications*
*Rome Air Development Center*
*Griffiss AFB, New York*

# Exploiting Other Communications Media

*Extensive development of radio communications has overcrowded existing facilities. A solution to relieve this situation, through the use of light, heat, gamma rays and other media is proposed.*

In spite of the extensive development of radio communications over the past 50 years many problems have arisen due to the great number of users. In particular, the USAF faces an unsatisfactory communication situation for these reasons:

a. Huge volumes of information must be transmitted over channels which are unreliable because of the natural properties of the transmission media used.

b. "Subscribers" must communicate with each other without delay.

c. No single type of communication circuit is satisfactory for the entire globe.

USAF's communication problems are further aggravated by the limited radio spectrum and the common use of the spectrum. Other factors involved in communication problems are cross talk, enemy jamming, and enemy eavesdropping.

This article examines means of communication other than conventional radio frequencies and shows what may be expected. It outlines the necessary research to give us the capability we require. Some of these means offer truly exciting possibilities for solving the most severe problems which face the Air Force in its global mission.

We will consider low frequency radio, sound, light, heat and nuclear radiation for communications. Possible frequency ranges

(*Continued on following page*)

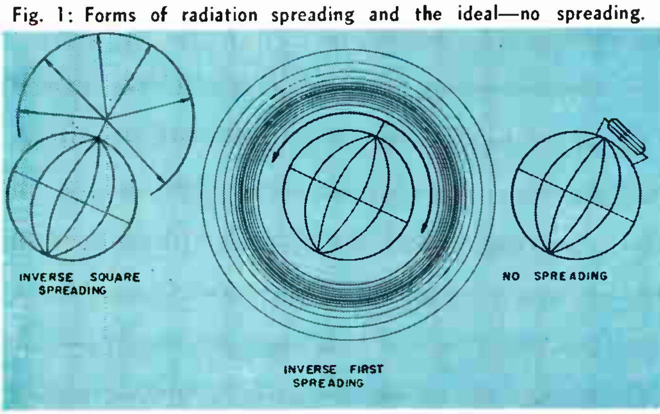



Fig. 1: Forms of radiation spreading and the ideal—no spreading.

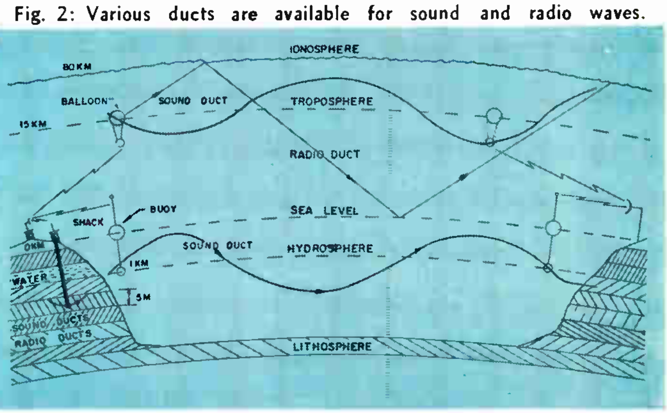



Fig. 2: Various ducts are available for sound and radio waves.

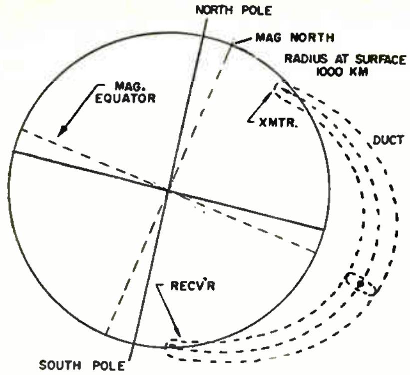



Fig. 3: Radio waves at 10 KC are conducted in this rare duct of about 2000 km dia.

**TABLE 1**

**POSSIBLE FREQUENCY RANGES AND MEDIA OF PROPAGATION**

| Type of Energy | Propagation Medium | Frequency or Wavelength Range |
|---|---|---|
| Audible sound | atmosphere, sea water, rock strata, underground water | 16 cycles per second to 10 kilocycles |
| Ultrasonics | atmosphere, sea water, rock strata, underground water | 10 kilocycles to 100 kilocycles |
| Very low frequency radio | atmosphere, outer ionosphere, rock strata | 1 kilocycle to 100 kilocycles |
| Present radio | atmosphere, lower ionosphere, surface of earth | 100 kilocycles to 1000 megacycles |
| Microwave | —— | 1000 megacycles to 1000 kilomegacycles |
| Infra red | —— | 100 kilomegacycles to 0.7 microns |
| Visible light | atmosphere | 0.7 to 0.4 microns |
| Ultraviolet | —— | 0.4 to $3 \times 10^{-4}$ microns |
| X-rays, gamma rays | —— | $3 \times 10^{-4}$ and lower (microns) |
| Electrons, protons, etc. | outer space | High energy particles |

# Communications Media *(Continued)*

and media of propagation are as shown in Table I.

### *Energy Transmission*

The range of energy transmission is limited by the nature of the medium of progagation and the equipment. Signals are lost in a medium by:

a. Spreading
   (1) inverse square law
   (2) inverse first law
b. Absorption—attenuation per unit range
c. Noise.

Forms of spreading, Fig. 1, follow the inverse square range law (spherical divergence) and the inverse first law (circular divergence). Fig. 1 also shows the ideal case in which all energy passes between two points without spreading.

Nature has provided a number of media in which propagation occurs by the inverse first power of range. This comes about when the material composing the earth and its atmosphere occurs as spherical shells. Transmission through these natural ducts is very desirable because of the great ranges which may be obtained with low-powered transmitters. Fig. 2 illustrates a number of ducts for sound and radio.

The sound duct in the troposphere at 15 km and in the sea at a depth of 1 km are caused by bending of the waves rather than reflection. At the center of each duct the waves move more slowly than those that deviate from the center. Consequently, a received signal spreads out over a longer time period than is required to transmit it. This reduces the speed with which messages may be sent to about one every ten seconds.

Radio waves are ducted within the troposphere by reflection from both the ionosphere and the earth's surface. It is possible to conduct sound and radio waves through appropriate rock strata by reflection from their boundaries and it is also possible to conduct sound along underground water. Ducting by reflection from well-defined boundaries causes messages to arrive over individual paths which means that the same message may be received more than once. This does not limit the message rate to the extent that it is limited by ducting due to bending. VHF radio waves may also be conducted along atmospheric refraction minima which are known to exist in the vicinity of the trade winds.

A rare form of duct in which spreading of power does not occur is shown in Fig. 3. Radio waves of a frequency of 10 KC are conducted along the earth's magnetic field in a tube about 2000 km in diameter. The receiving point is in the same relation to the earth's south pole as the transmitting point is to the north pole.

Absorption of energy by the transmission medium results in a loss which increases exponentially with range in all media and propagation modes. In general, the attenuation per unit range for all forms of propagation is a first or square law function of frequency. The attenuators per unit range for most of the radio spectrum is so low that its increase with frequency has only a negligible effect. For sound this is not true.

Received signals are often obscured by the presence of undesired signals in the medium. These signals result from both natural and man-made phenomena. For radio, natural noise is caused by lightning and the sun. For sound, natural noise is caused by animal life, winds, thunder, water waves, rain, and so forth. In general, the medium noise level rises as the frequency is reduced. It falls off at very low frequencies due to the absence of natural sources near zero frequency.

### *Generation, Radiation, and Reception*

The range over which any signal may be transmitted depends on these equipment parameters:

a. Transmitted power

(1) generated power
(2) antenna gain
(3) efficiency

b. Received power
(1) sensitivity
(2) antenna gain
(3) efficiency.

The ability to transmit over long ranges is related to power of the transmitter, the gain of the antennas, and the efficiency for a specified receiver.

The sensitivity of the receiver is the minimum power which may be identified as the signal. Sensitivity is limited both by noise present in the medium and noise generated in the equipment. Receiver noise results from thermal vibration of atoms and emission of electrons due to thermal or other causes. Since noise occurs over a wide band of frequencies, it may be reduced by reducing the number of frequencies to which the receiver is sensitive. This group of frequencies, called the bandwidth of the receiver, is directly proportional to the noise power received.

The gain of the receiving antenna has the effect of multiplying the amount of power received in a specific direction. If an antenna receives power equally in any direction, it has a gain of one. If an omnidirectional antenna receives a signal of one millionth of a watt, an antenna gain of 1000 would cause the receiver to receive one-thousandth of a watt. If received power is converted to heat in the antenna, only a fraction of the power received will be delivered. This fraction is called its efficiency.

Fig. 4 shows a functional diagram of a general transmitting and receiving system. The delivered power is intensified by the antenna gain and transmitted through the medium. In the medium, power is absorbed and spread so that only a fraction of it is delivered to the receiver. The receiving antenna intensifies both the signal and medium noise and delivers it to the receiver. The receiver introduces additional noise and the recovered signal is mixed with both forms of noise.

## *Propagation Losses*

The Appendix contains an analysis of all propagation losses and equipment limitations of proposed methods of communications except for deep rock sound and radio, and upper atmospheric sound, which are not included because of lack of sufficient data. Curves of relative system sensitivity vs. range in kilometers are shown in Fig. 5. These curves are plotted for inverse square law spreading. The two horizontal parallel lines show the effect of the improvement of the present state-of-the-art sensitivities by a factor of 1000. From this curve it can be seen that improvements of less than five km result for sound in air, supersonic sound in sea, and gamma rays. Low frequency radio and low frequency sea sound show an improvement of 5000 km, while ultraviolet, infra-red and 5 KC sea sound show improvement in the order of 50 km.

Fig. 6 illustrates the effect of ducting of very low frequency radio and sound in air. It can be seen that 5 KC sea sound is improved by 80 km, low frequency sea sound is improved by 100,000 km and very low frequency radio by 72,000 km. These improvements are rather startling, but

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### TABLE 2

**COMPARATIVE SUMMARY TABLE**

| Form of Energy | Medium of Propagation | Frequency or Wave Length | Radiation Efficiency % | Range Inverse Square-Kilometers | Range Inverse First-Kilometers | No. Teletype Channels 60 WPM |
|---|---|---|---|---|---|---|
| Audible Sound | Sea depth 1 km | 200 cps | 20 | 350 | 8,000 | 1 |
| | | 5 kc | 50 | 30 | 45 | 25 |
| Audible Sound | Upper air<br>Rock strata | 200 cps to 10 kc | Further exploration required | | | |
| VLF Radio | Air | 5 kc | 0.5 | 680 | 4,500 | 42 |
| | | 30 kc | 30 | 1,200 | 10,000 | 132 |
| VLF Radio | Outer ionosphere | 5 kc to 35 kc | 1.0 | 1000 to 15,000 | | 63 |
| Radio Frequencies | Rock Strata | 5 kc to 1 mc | Further exploration required | | | |
| Ultraviolet | Lower atmosphere | 0.2 to 0.35 microns | 25 | 100 | | 25,000 |

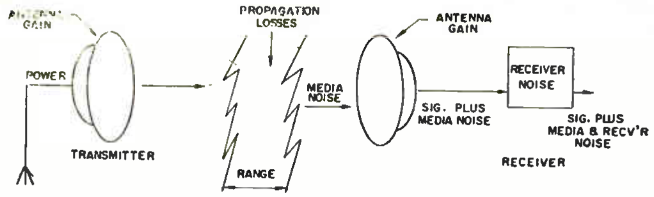


**Fig. 4 (above): In the transmission medium, power is absorbed and spread so that only a fraction of it is delivered to the receiver.**

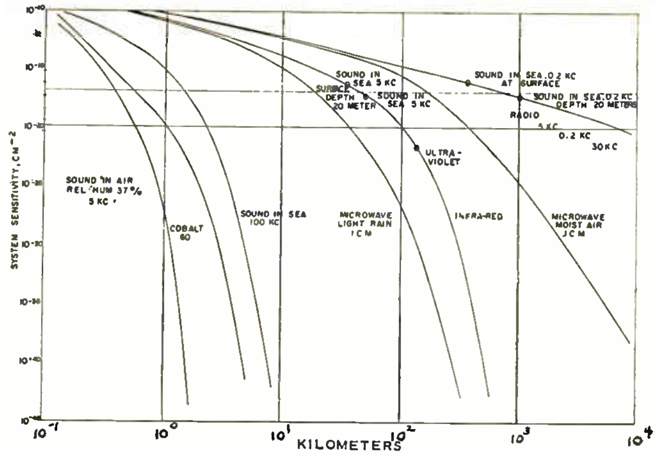


**Fig. 5 (right): The relationship of system sensitivities to the range measured in kilometers, for spherically divergent propagation.**

# Communications Media *(Continued)*

you should bear in mind that the curves are based on average power. The improvement figure of 1000 is also high, but it is used only for comparison.

The long range potential of low frequency sound in sea and very low frequency radio is attractive. However, use of this type of propagation involves the areas of inefficient radiation from small antennas, and transmission of small amounts of information per unit time.

To transmit low frequency sound or radio, the dimensions of an antenna should be comparable to the wave length but this is not possible because wave lengths of many kilometers are used for radio and wavelengths of many meters are used for sound. When high power is fed into a relatively small sound transducer, the resulting high pressures exceed the static pressure of the medium and cause elastic breakdown. High voltage required for small radio antennas causes dielectric breakdown (arcing) in air.

It is possible to use small transmitting antennas if they are surrounded by a small wavelength medium. If the outer surface of the medium is arranged so that excessive reflection of radiation does not occur, transmission of power can be achieved with smaller structures. Experiments with powdered iron have confirmed this concept in radio transmission.

### *Ferromagnetics*

Wavelengths of radio waves that measure 10 to 100 KC are reduced by a factor of over 1000 in ferromagnetic materials. Fig. 7 shows a proposed antenna of this type compared with a conventional antenna.

Analysis shows that greater bandwidth can be achieved with the proposed ferromagnetic antenna than with a conventional antenna with a resulting increase in the rate of information transmission. As an example, when conventional antennas are used, teletype pulses may be generated at the rate of about 40 per second at 30 KC which is equivalent to 120 five-letter words per minute. A standard teletype can deliver 60 words per minute over this frequency band. If a ferromagnetic antenna is used, the rate would be 2000 words per minute.

A method for improving the information rate of a narrow band system is given in the Appendix. It is shown that very small variations in the power level of a pulse may be detected in a narrow band system. For example, if the level of a pulse is allowed to vary from 1 watt to 26 watts, each pulse level may be used to represent one letter of the alphabet. This means that one pulse becomes the equivalent of the five teletype pulses presently required to represent one letter. However, more sophisticated methods are possible, such as phase instead of amplitude coding.

### *Findings*

Examining the results we see that audible sound in the sea, rock strata and upper atmosphere, very low frequency radio in the atmosphere, rock strata and outer ionosphere, and ultraviolent in the lower atmosphere appear to be most

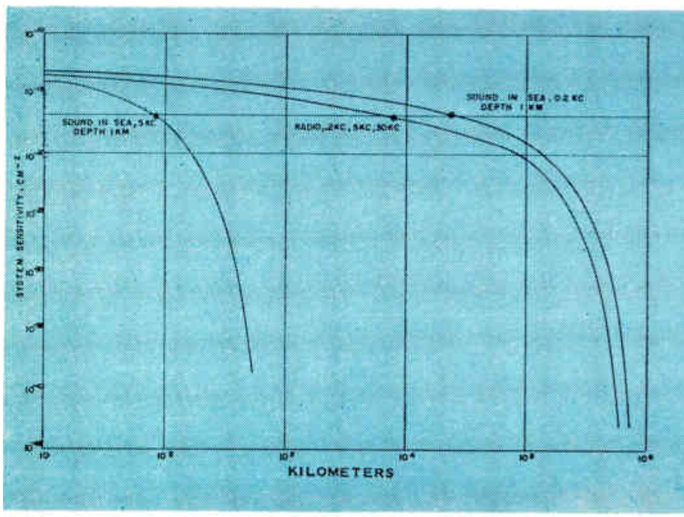


**Fig. 6: System-Range relationship for circularly divergent propagation.**

promising types of propagation. However, before actual utilization of these may be accomplished, further experimental data must be obtained since many of the calculations were based on meager data or theoretical extrapolations.

In the case of audible sound, samples of deep rock strata must be obtained to determine its absorption characteristics. Efficient transmitters and receivers must be embedded in the strata of deep wells to determine the actual ranges of propagation. Further data must also be obtained on the propaganda of sound in ducts in the upper atmosphere.

To effectively use the range potentialities of very low frequency radio, smaller, more efficient antennas must be perfected. A thorough study must be made of the concept of using media such as ferrites for construction of these antennas. In addition, the electrical characteristics of deep rock strata must be obtained to carefully evaluate this medium.

Although ultraviolet radiation may only be used for line of sight transmission because of the lack of ducts, it has a great deal of promise due to low background signal. High intensity sources of ultraviolet and suitable modulating equipment should be developed.

The comparative summary in Table II shows those areas which have promise. The method of computing information rate as teletype channels is given in the Appendix. Ranges are based on a power of 5 kw for each type of transmission.

An extremely serious disadvantage of these modes of communication (except ultraviolet) is the excessively narrow bandwidth of the channels. Very low frequency radio has this limitation only because of the inherent properties of present antennas. The intermediate matching media technique suggested in this article could improve very low frequency radio. Low frequency sound in sea has nonlinear effects in the duct as well as other reverberation sources which also limit the information capacity.

Based on a paper presented at the IRE National Convention, March 1958, New York, N. Y.

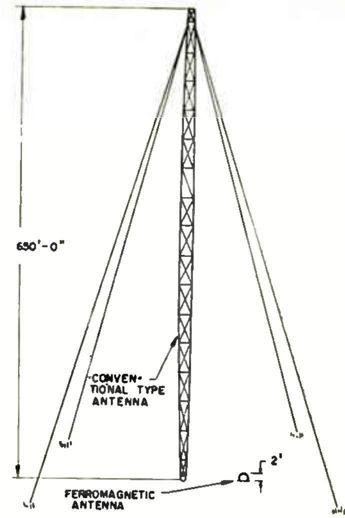


Fig. 7: A comparison of the ferromagnetic antenna with the conventional type.

Because of space limitations, detailed analyses and calculations have been placed in an Appendix. A copy of this appendix may be obtained by writing on company letterhead to

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## The Military Is Looking For . . .

The Government carries on a comprehensive research and development program that continually seeks to improve the quality of American arms and equipment. But despite this activity the Government must continually look to private industry for new developments, ideas, or techniques. One of the principal ways of making their interests known to industry is through the National Inventors Council which each year publishes, "Inventions Wanted by the Armed Forces."

The following are some of the highlights among the electronic and electrical requirements that the Government is looking to private industry to provide.

**Acoustic Transducer** — A sharply unidirectional device of small size compared to wavelength for sound detection on signals as low as 5 cps.

**Power Rectifiers**—to work in an ambient of —20° to 500°C.

**Transistors** — to operate efficiently (greater than 50%) as oscillators and amplifiers at UHF, and at temperatures over 150°C.

**Resistors** — in the 1 to 100 megohm range with positive temp. coefficients, preferably as high as 1,000 ppm°C. Power rating at least ¼-watt, and no larger than ½-watt commercial composition resistors.

**High Angle Direction Finding Techniques**—to handle steeply downcoming sky wave signals in the frequency range 1-12 MC. Instrumental bearing accuracy is of the order of 2 degrees standard deviation on signals with a minimum field strength of 20 mv/meter.

**Infrared Transmitting Materials**—Development of infrared transmitting materials having the following properties: 75% transmission from 0.8 to 8 micron wavelength in 1 cm. thickness. (2) Melting or softening point above 500°C. (3) Capable of standing thermal shock of 100°C/sec. (4) Resistance to abrasion and solution by atmospheric fluids.

**Television System**—of improved resolution which will permit optical tracking of guided missiles. Quality of the images should approach that of a photograph.

**Video Compression**—A method of bandwidth compression of 3.5 MC signals down to the order of 1 MC for transmission, and to recreate the original bandwidth signals after transmission.

# Increasing the Input Impedance

## In Transistor Amplifiers

***Transistor amplifiers can exchange voltage gain for input impedance by using negative feedback. In addition, voltage gain can be made more independent of transistor by the same circuitry.***

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A TRANSISTOR amplifier is usually considered to have relatively low input impedance, high output impedance, and high voltage gain. Since the maximum available power gain of the device is limited, voltage gain must be decreased if it is desired to have high input impedance and low output impedance. By employing negative feedback, voltage gain can be "exchanged" for input impedance. In addition to increasing the input impedance, negative feedback can be used to make the voltage gain more independent of transistor parameters.

This article describes a transistor amplifier having an input impedance of 8 megohms, a voltage gain of 40 db, and an output impedance of 600 ohms. The gain is stable to ±0.10 db over the temperature range of —55°C to +125°C, and to within ±1 db over the frequency range of 6 cps to 300 KC. The input impedance is greater than 1 megohm between the frequencies of 25 cps and 350 KC, and greater than 8 megohm between the frequencies of 400 cps and 30 KC.

The type 2N338 transistors used will give reliable performance at temperatures in excess of 150°C, but other components used in this amplifier limited the maximum safe temperature to 125°C.

### *Simplified Circuit*

Fig. 1 shows the simplified circuit of the amplifier. It consists of a common-collector stage followed by three common-emitter stages. High input impedance and gain stability are achieved by overall negative feedback provided by resistor $R_{F4}$. Resistors $R_{B1}$, $R_{C1}$, and $R_{C2}$ represent the effective impedances of the networks necessary to establish the proper operating bias conditions for the amplifier. Resistors $R_{F1}$, $R_{F2}$, and $R_{F3}$ are individual stage feedback resistors.

This simplified circuit is valid for mid-frequency range where the reactances of bypass and coupling capacitors may be neglected. The small arrows indicate the phase relationship of the signal voltage at various points in the circuit.

Note that in this circuit, the

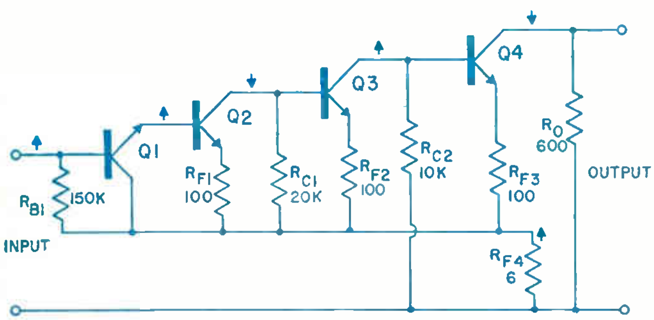


Fig. 1: Simplified circuit of the high input impedance amplifier has common-emitter collector stage followed by 3 common-emitter stages.

voltage drop across $R_{F4}$ is in phase with the input voltage. The ac current through $R_{F4}$ is approximately equal to the product of the input current and the current gain of the individual amplifier stages. Thus, the effective value of $R_{F4}$ referred to the input terminals is approximately $(A_1\ A_2\ A_3\ A_4)\ R_{F4}$, where $A_1$, $A_2$, $A_3$, and $A_4$ are the current gains of the individual stages.

If the amplifier current gain is $10^6$ and the value of $R_F$ is 6 ohms, then the equivalent value of $R_{F4}$ referred to the input terminals is 6 megohms. The approximate input impedance may be expressed as:

$$Z_{in} = |A|\ R_{F4} + Z_1 \qquad (1)$$

where, A = current gain of the amplifier, $R_{F4}$ = feedback resistor, and $Z_1$ = input impedance of the amplifiers without feedback.

The voltage gain may be expressed as:

$$\frac{V_0}{V_{in}} = - \frac{A\ R}{|A|\ R_{F4} + Z_1} \qquad (2)$$

and if

$$|A|\ R_{F4} >> Z_1 \qquad (3)$$

this reduces to:

$$\frac{V_0}{V_{in}} = - \frac{R}{R_{F4}} \qquad (4)$$

The negative sign merely indicates that the output voltage is 180° out of phase with respect to the input voltage.

### *Circuit Description*

The complete amplifier circuit is shown in Fig. 2. The four stages are direct-coupled. Adequate stability of bias conditions is provided by means of the large emitter resistors R4, R9 and R14, which are bypassed for signal frequencies. Bias voltage for the first stage is developed across the 9-volt "Zener" diode, D1.

The collector Q1 is coupled to the feedback resistor $R_{F4}$ by C2 and D1. If this collector was bypassed to ground, the input impedance would be shunted by the $h_{ob}$ of this unit. Table 1 gives the approximate dc bias conditions of the four transistors.

The output impedance is set by the value of R12 which is 600 ohms. The input impedance is approximately equal to the product of the amplifier current gain and the feedback resistor R13. Since the current gain is a function of transistor parameters, the input impedance can be expected to be a function of ambient temperature. Fig. 3 is a plot of the input impedance at 1 KC vs. the ambient temperature.

The voltage gain is largely determined by the ratio of the output resistor R12 to the feedback resistor R13 and is almost independent of transistor parameters. It, therefore, should not be sensitive to ambient temperature variations. This is confirmed by Fig. 4, which is a plot of the voltage-gain vs. ambient-temperature.

The noise level of the amplifier will be a function of the input termination. Equivalent input noise will range from about 24 μvolts with the input shorted up to about 540 μvolts with the input open. Fig. 5 is a plot of equivalent input-noise vs. input termination for the amplifier using typical transistors.

Careful consideration should be

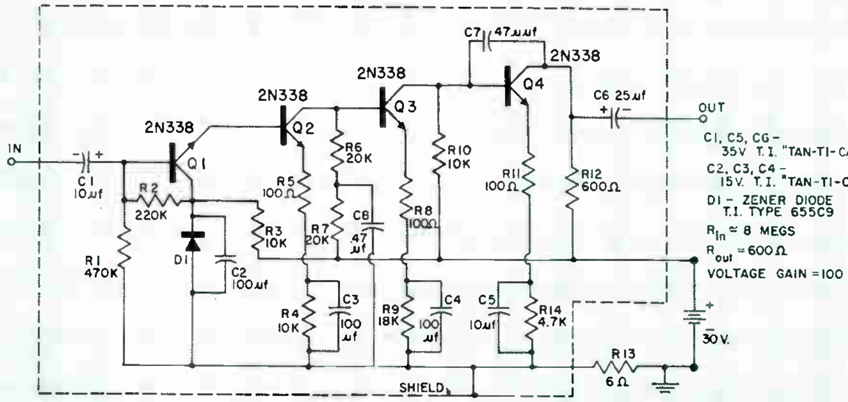


Fig. 2 (above): The complete amplifier circuit. Input impedance approximates product of amplifier current gain and feedback resistor, R13.

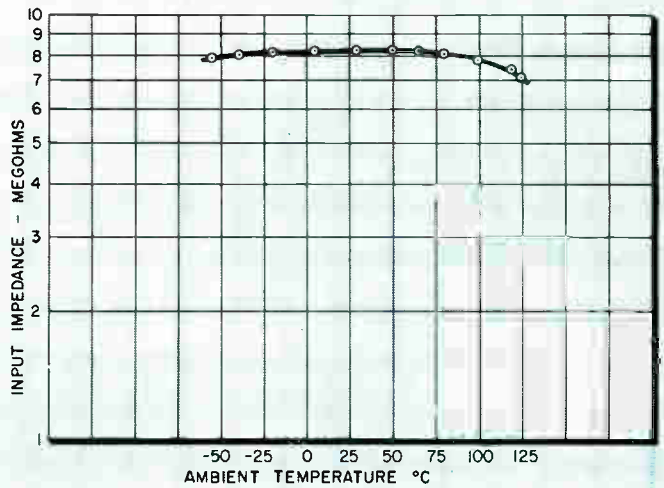


Fig. 3 (right): Relationship of input impedance, measured at 1 KC, to the ambient temperature.

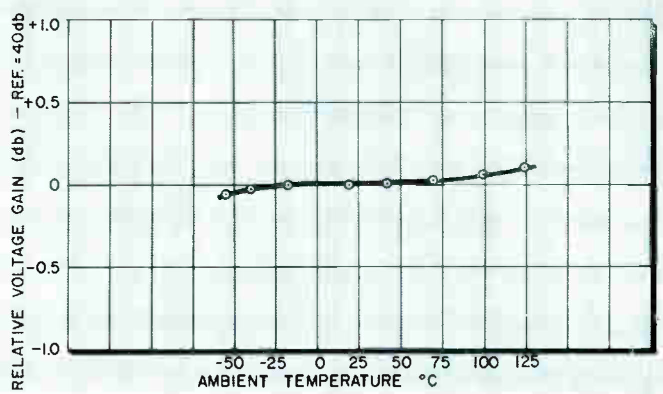


Fig. 4 (right): Voltage gain is almost independent of ambient temperature.

**TABLE 1**

| Transistor | $V_{ce}$ | $I_E$ |
|---|---|---|
| $Q_1$ | 3 v. | 0.010 ma |
| $Q_2$ | 6 | 0.50 |
| $Q_3$ | 13 | 0.59 |
| $Q_4$ | 6 | 4.8 |

given to the layout of the amplifier. particularly with respect to stray capacity to ground. In the breadboard model constructed for test purposes, all components were mounted on a 2 in. x 4 in. sheet of aluminum, which was insulated from the main chassis and electrically connected to the ungrounded side of feedback resistor R13. This greatly improved the high frequency characteristics of the amplifier by reducing the effect of stray capacity between components and ground. Fig. 6 shows the voltage-gain and input-impedance vs. frequency characteristics of the amplifier.

This amplifier was designed and built to demonstrate a technique for obtaining high input impedance in a transistor amplifier. Calculations indicate that, with careful construction, performance can be predicted with a fair degree of accuracy. Silicon transistor type 2N338 was chosen because of its high value of $h_{fe}$, high $\alpha$ cutoff frequency, and good high-temperature performance.

Of course, the principles involved are not limited to silicon transistors. They can be used just as effectively for germanium transistors. In fact, the circuit shown in Fig. 2 can be used with germanium transistor type 2N366 if the voltage reference diode D1 is changed from type TI 655C9 to type TI 653C6. For germanium units, however, the maximum ambient temperature should be reduced from +125°C to +80°C.

### *Acknowledgment*

Credit goes to Mr. Lee L. Evans for helpful suggestions in arriving at the final design of this amplifier and for making measurements to obtain performance characteristics.

Because of space limitations, detailed analyses and calculations have been placed in an Appendix. A copy of this appendix may be obtained by writing on company letterhead to

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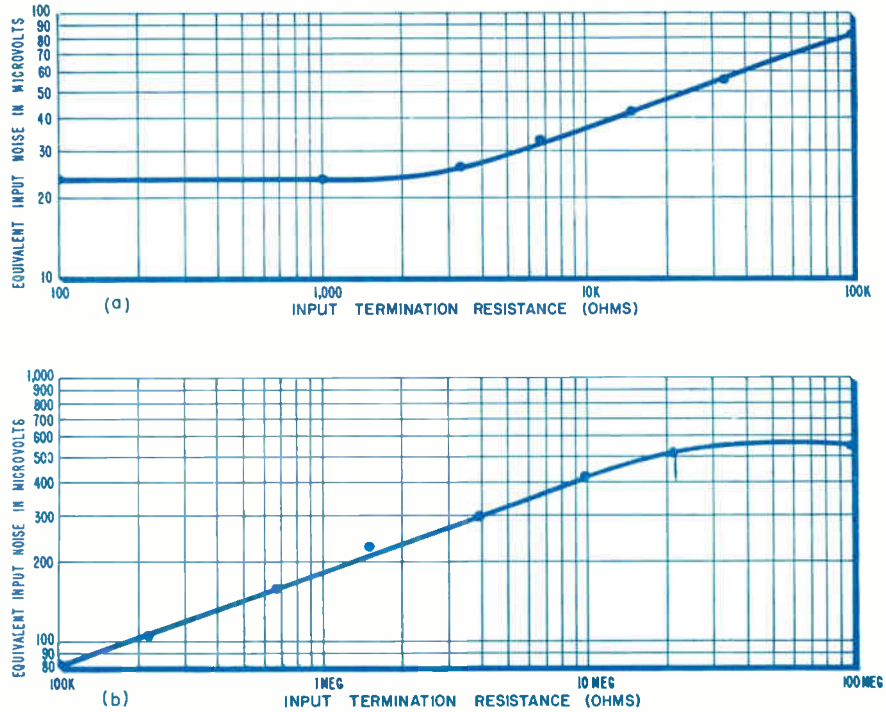
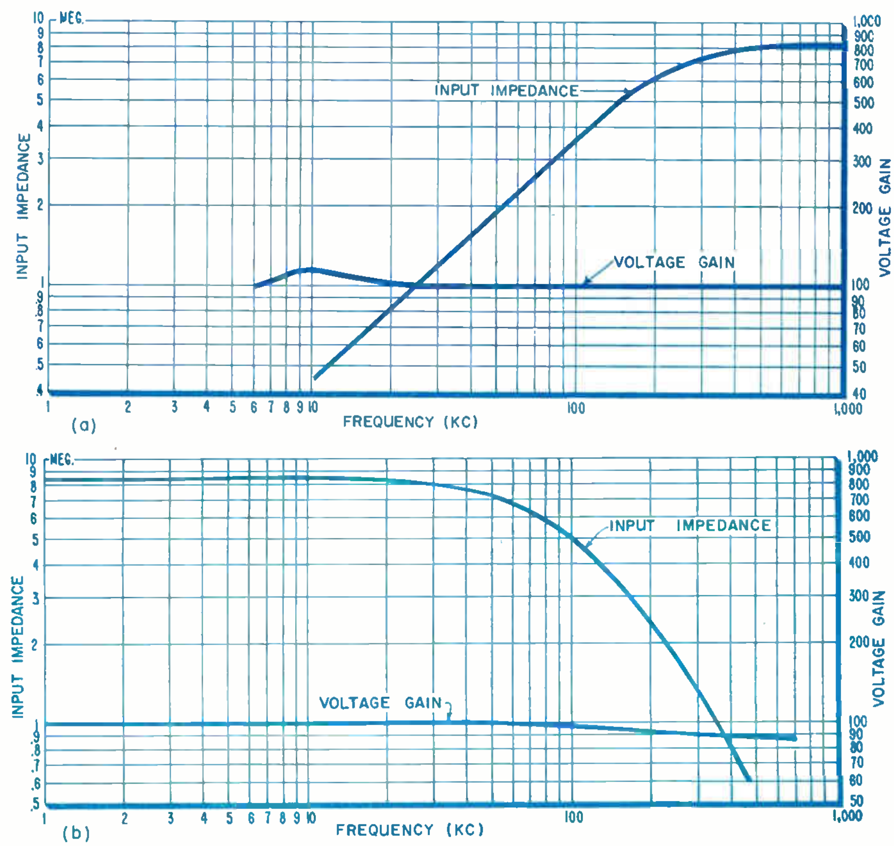



Fig. 5 (above): Noise level of the amplifier is a function of the input termination.

Fig. 6 (below): Relationship of the input impedance and voltage gain to the frequency.



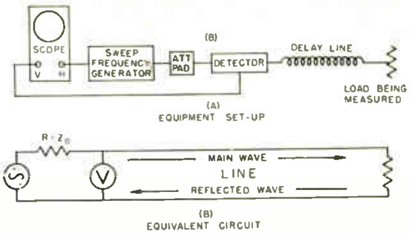



Fig. 1: This is the basic test set-up for making wide-band impedance measurements.

# How to Measure Wide Band Impedance

*The sweep frequency, delay line method of testing is not new. First used to align TV broadcast antennas, it has since found widespread use in that industry. Basic principles and some techniques that allow an increase in measurement accuracy are discussed.*

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THE basic equipment test set-up for wide-band impedance measurements is shown in Fig. 1 (A). An attenuator pad is generally connected between the sweep and the detector to isolate the generator from the varying impedance. It also ensures that the detector is fed from a well-matched source.

The detector is needed when the sweep covers a frequency range above the upper response limit of the scope. The high-frequency voltage is rectified, and the detected output, a slowly-varying voltage representing the envelope of the high-frequency input, is applied to the oscilloscope.

The equivalent circuit is shown in Fig. 1 (B). A voltmeter (the detector and scope) measures the voltage at the junction between a matched source and a transmission line with a load on its far end. The voltage at this junction may be considered as being due to the sum of two waves: the *main wave* energy which comes out of the sweep and goes down the line and the *reflected wave*, energy which has travelled down the line, is reflected from the load, and comes back up the line.

### *Terminated Line*

With a well-designed sweep, the main-wave is made approximately constant with frequency. When the

Fig. 2: A typical scope pattern when the delay line is terminated in a resistance equal to its characteristic impedance.


Fig. 3: With a generator sweeping from 0 to 50 MC, this is the pattern for an open circuit delay line ½ wavelength long.

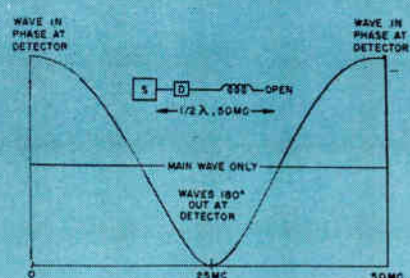
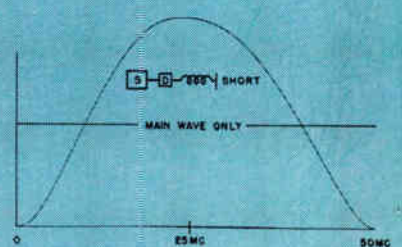



Fig. 4: When end of the line is short circuited, phase of the reflected wave is reversed producing zero voltage at short.



# Impedance Measurement

*(Continued)*

delay line is terminated in a resistance equal to its characteristic impedance, there is no reflected wave. The scope then shows a constant voltage.

Fig. 2 illustrates a typical pattern. On the forward trace the output stays constant as the frequency changes across the sweep band. The reverse trace is "blanked"; the sweep output being keyed to zero to provide a reference line showing where zero output is.

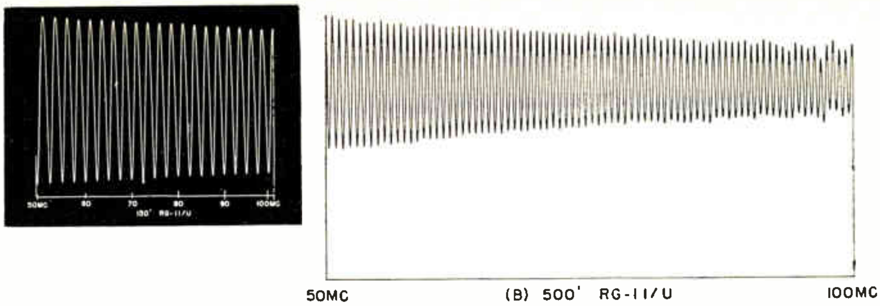



Fig. 7: (A) Ripple pattern from 150 ft. of RG11/U cable, shorted at the far end. Notice that the pattern is about the same as that for 66 ft. piece of RG59/U, in Fig. 6(B). The attenuation of RG11/U is about one-half that of RG59/U for a given length; so doubling the length just about cancels the attenuation improvement due to the larger cable. (B) shows the pattern from about 50 ft. of RG11/U showing the great reduction in ripple height at this length.

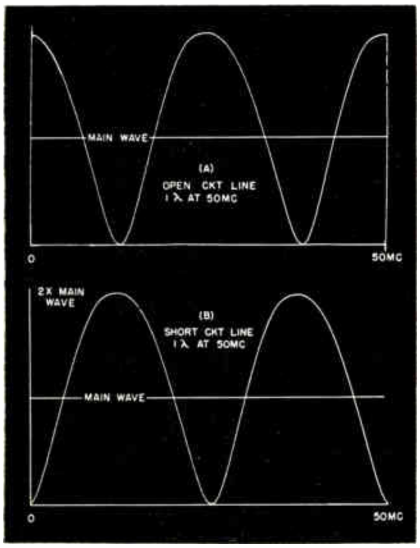



Fig. 5: Effect of doubling the line length is evident. Open circuit delay line pattern is shown in (A); short circuit in (B).

## *Open Circuit Line*

When nothing is connected to the end of the line, this "open circuit" cannot dissipate. All the energy striking it is then reflected. When the line loss is small, the reflected wave at the detector has essentially the same amplitude as the main wave. The total voltage there depends only on their phase relation. When they are in phase, they add to produce a voltage twice the "main wave only" condition. When they are 180° out of phase, they cancel to produce zero output.

Fig. 3 illustrates the pattern with a generator sweeping 0 to 50 MC, and an open-circuited delay line ½ wavelength long at 50 MC. The reflected wave *at the open circuit* is in phase, at all frequencies, with the main wave. Near zero frequency the effective length of the line is zero. The two waves are then in phase and add at the detector, producing a maximum. At 25 MC, the line is ¼ wavelength long. The main wave shifts 90° in phase as it travels down the line to the end. The reflected wave shifts another 90° on its way back. The two components are then 180° out of phase at the detector, giving a minimum at that frequency. At 50 MC, the reflected wave has travelled a full wavelength (½ wave down, ½ wave back) by the time it gets back to the detector so the components add to a maximum.

## *Short Circuit Line*

Fig. 4 illustrates the pattern obtained by connecting a short circuit across the end of the line. This reverses the phase of the reflected wave so that the two components are 180° out at the short, and produce zero voltage there. At the detector, this produces a minimum at zero frequency (effective line length 0), a maximum at 25 MC, (reflected wave shifted 180° having travelled ½ wavelength extra), and a minimum again at 50 MC.

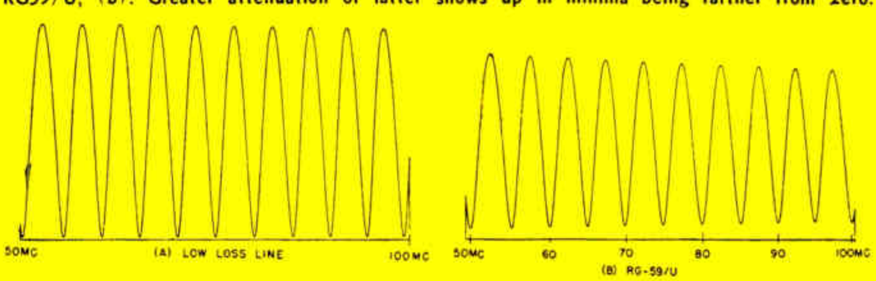
## *Longer Delay Lines*

Fig. 5 shows the effect of doubling the length of the line, keeping the sweep-width the same. With an open-circuit (A) there are maxima at 0 frequency (0 line length), 25 MC. (½ wavelength) and 50 MC (1 wavelength) and minima when the line length is ¼ and ¾ wavelength. A short-circuit termination gives the reverse pattern (B).

It is apparent that increasing the length of the delay line increases the number of ripples occurring in a given sweep-width. Specifically, the frequency change from one maximum (or minimum) to the next is equal to the frequency at which the line is one-half wavelength long. For a spacing of $f$ MC between peaks, the line length in feet is 492 $d/f$ where $d$ is the delay factor, the ratio of the speed with which a wave travels in the particular type cable, to the speed in air. The symbol $d$ equals 0.67 for solid polyethylene insulated cables, and approximately 0.8 for polyfoam or other dielectrics with a high proportion of air insulation.

Since more ripples depict more clearly what happens in a given frequency band, in this respect, longer lines are preferred over shorter ones. One factor that limits

Fig. 6: Ripple pattern for high-grade delay line (A) compared with that for a cheaper cable, RG59/U, (B). Greater attenuation of latter shows up in minima being farther from zero.



the length that may be effectively used is the line attenuation. As the length is increased, more and more energy is lost in the line, so the reflected signal, as it shows up back at the detector, gets increasingly weaker. Fig. 6 (A) shows the ripple pattern resulting with a short-circuit termination, a sweep from 50 to 100 MC., and a high-grade delay line for 5 MC. between peaks.

The delay factor for this cable was 0.8, so its length, by the formula, would be (492 × 0.8)/5 or 79 ft. Due to the greater length of this line, and the higher frequencies involved there is appreciable loss in the line. Although the reflected wave at the shorted end is equal to the main wave (reflection —100%), the main wave is stronger at the detector than it is at the far end. This is due to attenuation as it travels down the line. The reflected wave is weaker at the detector than it is at the load, due to attenuation as it travels up the line from the load. This shows up on the ripple pattern in the fact that the minima do not quite go to zero, since the weakened reflected wave does not quite cancel the main wave.

Fig. 6 (B) shows the effect of using a cheaper cable (RG59/U) with higher loss. This line was cut for the same electrical length, but because its delay factor is 0.67, its physical length was shorter, 66 ft. Its greater attenuation shows up in the fact that the minima are still farther from zero. Notice that this effect is more pronounced at the high frequency end of the sweep, where the line loss is higher.

### *Various Resistive Terminations*

The wave reflected from a purely resistive termination is in phase with the main wave at the load for resistance values higher than $Z_0$, or 180° out of phase for values lower than $Z_0$, and the amplitude of the reflection increases as the reresistance differs from $Z_0$.

Fig. 8 (A) shows superimposed the ripple patterns obtained with a low-loss 20 MC delay line, a sweep from 50 to 100 MC, and the indicated terminations. Note that all the patterns have minima at the same frequency as that with a shorted end.

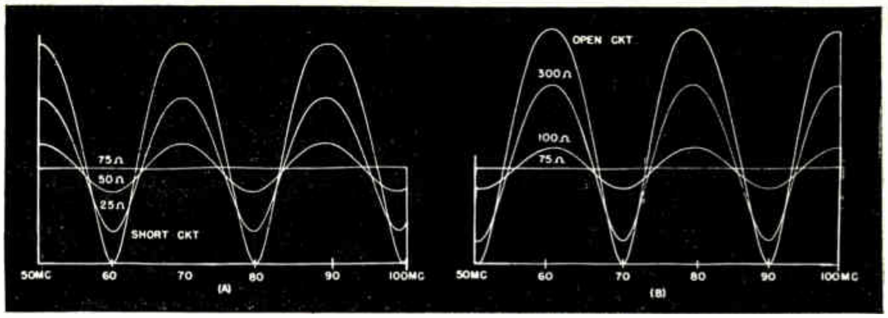
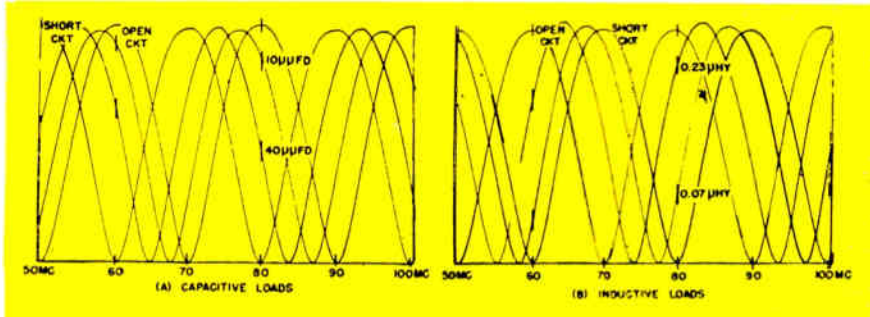



**Fig. 8 (above): Patterns from several resistive terminations: when they are (A) lower than the characteristic impedance; (B) higher than characteristic impedance.**

**Fig. 9 (below): A capacitive termination (A) has minima higher in frequency than those due to a short; inductive termination (B) minima are above those from an open circuit.**




*The impedance of a load giving a minimum at the same frequency as a short circuit is resistive and lower in resistance than $Z_0$.*

Fig. 8 (B) shows the patterns from several resistive terminations higher than $Z_0$. They all have maxima at the "short-minimum" frequencies.

*The impedance of a load giving a maximum at the same frequency as a short-circuit minimum is resistive and higher in resistance than $Z_0$.*

### *Purely Reactive Terminations*

A pure reactance does not dissipate energy. so the wave is reflected from a purely reactive termination at full amplitude. Its phase is shifted depending on the magnitude of the reactance relative to $Z_0$. Thus the ripple pattern obtained with purely reactive terminations has the same amplitude as with an open or short circuit, but the minima and maxima are shifted in frequency. Fig. 9 (A) shows the patterns obtained with two sizes of capacities compared with open and short circuit patterns.

The ripple pattern resulting from a capacitive termination has mini-

**Fig. 10: (A) The pattern for a series RC termination is compared with those for matched and short circuit terminations (B).**

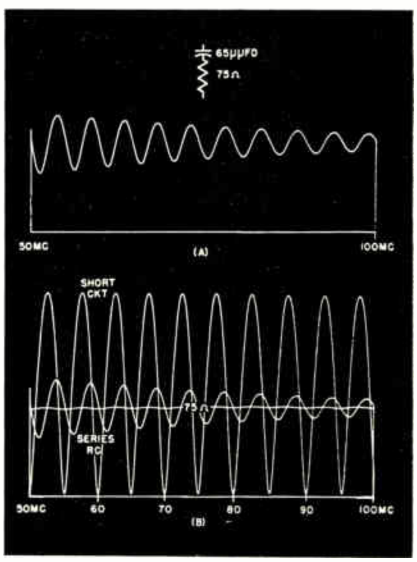
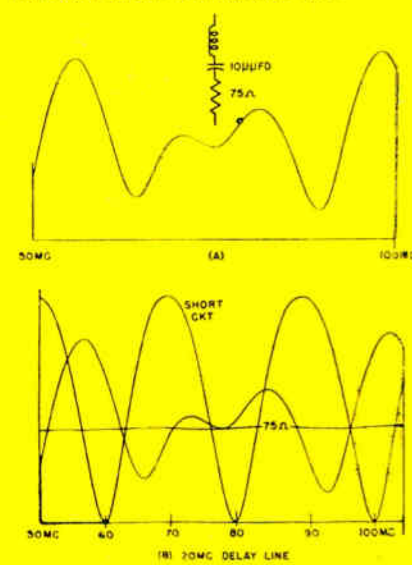



**Fig. 11: A series resonant circuit termination pattern (A) is compared with matched and short circuit terminations (B).**



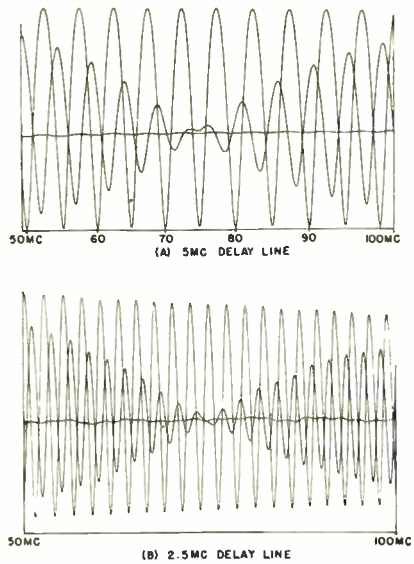



**Fig. 12: Same conditions as Fig. 11(B) but with (A) 5 MC and (B) 2.5 MC delay lines.**

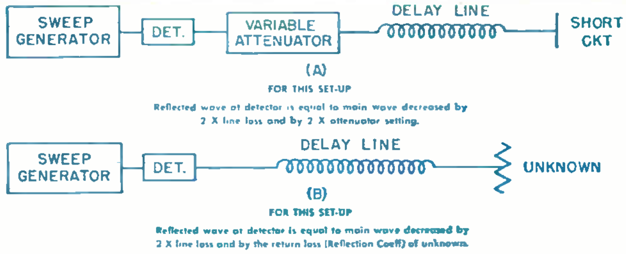
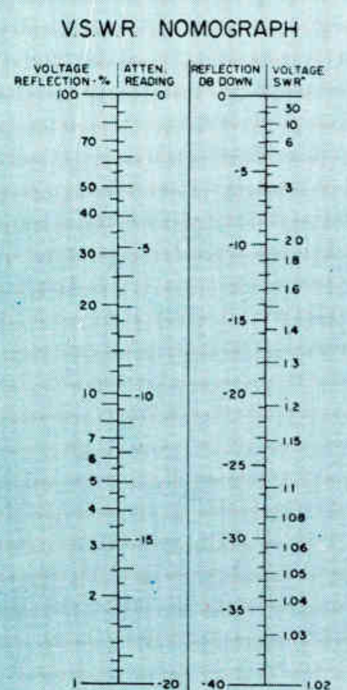



**Fig. 14: If attenuator (A) is set for same ripple height as from unknown (B), return loss of the unknown equals twice the attenuator settingindb.**

# Impedance Measurement

*(Continued)*

**Fig. 13: The degree of mismatch can be conveniently related with this nomogram.**




NOTE

$$SWR = \frac{E\ MAX}{E\ MIN.}$$

AND $$\%\ REFLECTION = \frac{(SWR)-1}{(SWR)+1} \times 100$$

ma falling higher in frequency than those due to a short circuit, and lower than those due to an open circuit. This may be stated another way:

If we mark the frequencies of short circuit minima (see marks on Fig. 9A) the marks will fall on down slopes with a capacitive load.

Fig. 9 (B) compares the ripple patterns for two sizes of purely inductive terminations with those from an open and a short circuit.

The ripple pattern from an inductive termination has minima falling above those from an open circuit, and below those from a short circuit. If we mark the frequencies of short circuit minima, the marks fall on up-slopes for inductive terminations.

### *Complex Terminations*

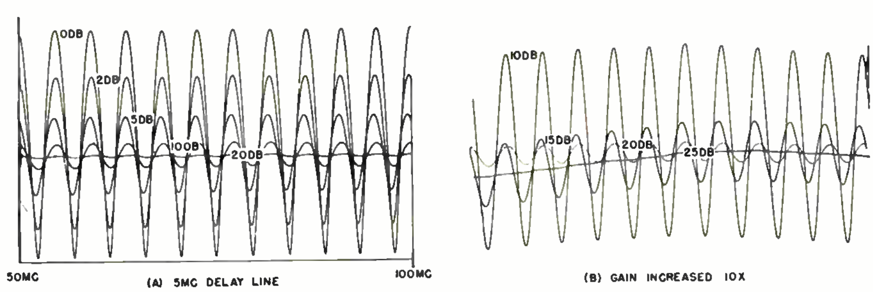
When a termination has both dissipation (resistance) and reactance the reflected wave is reduced in amplitude, and shifted in phase relative to the main wave. Correspondingly, the ripple pattern has a lower amplitude, and minima shifted in position compared with a short or open circuit.

Fig. 10 (A) illustrates the ripple pattern obtained with a low-loss 5 MC delay line and a series RC termination. At higher frequencies, where the reactance is lower, the termination approaches a matched condition, and the ripple has lower amplitude. The nature of the termination can be seen more clearly if the ripple pattern is compared with that obtained with a short circuit, and that obtained with a matching resistance. Fig. 10 (B) shows the three patterns superimposed. By observing the fact that down-slopes occur at shorted-minimum frequencies, and the ripple gets smaller at high frequencies, we could conclude that the load had the characteristics of a series RC circuit.

Fig. 11 (A) shows the ripple pattern with a 20 MC line and a series resonant circuit. Fig. 11 (B) shows the same pattern superimposed on a short circuit pattern and one from a matched resistor. By observing that its impedance is capacitive below the resonant frequency (down-slope at short-circuit minimum frequencies), matched at resonance (low ripple amplitude near 75 MC), and inductive above resonance (up-slope at shorted-minimum) we could deduce that it was a series RLC circuit with $R$ equal to $Z_0$.

Fig. 12 (A) and (B) show the ripple patterns obtained under the

**Fig. 15: Patterns obtained with the attenuator connected at the detector end of the line.**



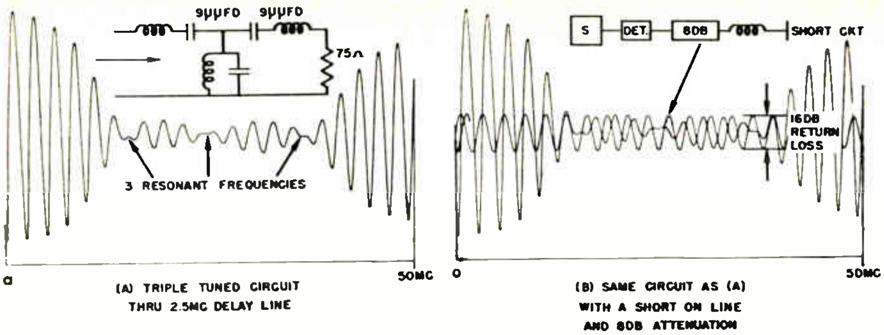



Fig 16: To determine the return loss: pattern for triple tuned bandpass filter connected to end of line (A) is superimposed on pattern of a shorted line with 8 db attenuation (B).

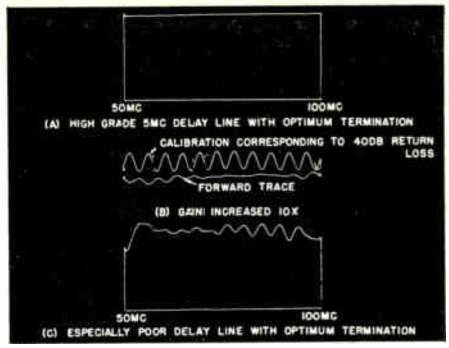



Fig. 17: These traces show the extremes that may be encountered in cable reflections.

same conditions as Fig. 11 (B) but with 5 MC and 2.5 MC delay lines respectively. They show how increased length in the delay line depicts the impedance characteristic in more detail.

### *Determining Reflection Coefficient and VSWR*

There is a temptation, in using the delay-line technique, to assume that the VSWR of the load is found by taking the ratio of minimum to maximum of the ripple pattern displayed on the scope. Two factors, the loss of the delay line and the non-linearity of the detector, make this procedure quite inaccurate. A more accurate procedure that eliminates the effect of the line loss and minimizes detector non-linearity is to compare the amplitude of the ripple pattern from the unknown with that from a short- or open-circuit.

Let $A$ be the peak-to-peak amplitude of the ripple pattern obtained at the frequency of interest with the line shorted. Let $B$ be the peak-to-peak amplitude of the ripple pattern from the unknown at this frequency.

Then the reflection coefficient of the unknown (ratio of main wave to reflected wave): $K = B/A$.

*% reflection* = 100K.

The *Return Loss* (reflection coefficient as a db ratio) is 20 $\log_{10} 1/K$.

The VSWR (ratio of max. voltage at load to min. voltage) is $(1+K)/(1-K)$. These various ways of expressing the degree of mismatch are conveniently related by the nomogram shown in Fig.13.

A more accurate, and generally more convenient way of determining the reflection coefficient of a load is to compare the height of its ripple pattern with the height of the pattern obtained with a short at the far end of the line, and a variable attenuator inserted between the line and the detector.

Fig. 14 illustrates the calibration set-up. By putting the attenuator at the detector end of the line the ripple height is determined

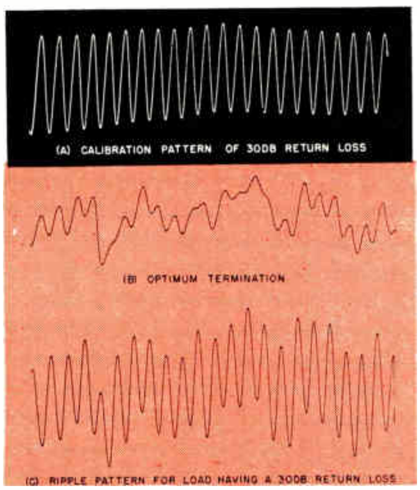



Fig. 18: Accurate measurements are made difficult by irregularities in delay line.

primarily by its attenuation, and its impedance match is less important than if it were connected at the load end of the delay line.

Fig. 15 illustrates the ripple patterns obtained at various settings of an attenuator connected in this way. Note that the ripple height with 5 db set on the attenuator, is what would be seen from a load having a return loss of twice this many db, e. g., 10 db. Fig. 15 (B) was made by increasing the vertical gain 10X compared with (a). Note that the ripple corresponding to a return loss of 40 db (VSWR 1.02) is readily seen. Also, note the irregularities in the way these traces match up. These are due to very small errors in the impedance match and delay of the attenuator used.

Fig. 16 illustrates how the technique is used in determining return loss. A triple-tuned band-pass filter was connected to the end of a 2.5 MC delay line, giving the ripple pattern of Fig. 16 (A). Note the three frequencies of best match. To determine the maximum reflection within the pass band, the ripple from a shorted line through a variable attenuator was set to the same height as the maximum ripple in the pass band. The attenuator read 8 db, indicating a maximum return loss for this filter of 16 db. The two patterns are shown superimposed in Fig. 16 (B).

### *Irregularities in Delay Lines*

With reasonable sweep output level and scope gain, we see ripples corresponding to 40 or even 50 db return loss. It is not generally possible to make measurements with this much accuracy. The limiting factor is not gain, but the uniformity of the delay line.

Many commercial coaxial cables have a degree of nonuniformity that results in appreciable reflections from within the cable, even when terminated with the best possible load. A poor cable may have reflections with a return loss of as little as 20 db. Most cables run at or above 30 db, and only an exceptionally uniform cable has internal reflections more than 40 db down.

To illustrate the extremes that may be encountered several traces were made. Fig. 17 (A) shows the ripple pattern of a 5 MC delay line

# Impedance Measurement
*(Concluded)*

of exceptional uniformity terminated in a load that closely matches its impedance. It was possible to see variations in the pattern only by increasing the vertical gain 10X (Fig. 17B). Comparing the ripple pattern with the calibration pattern corresponding to 40 db return loss, it can be seen that the combined return loss of cable and termination is decidedly better than 40 db over the whole frequency range of the sweep. For contrast, Fig. 17 (C) shows the trace with a very poor piece of cable. Even with the best termination possible, its variation is more than 10X greater than the other cable (compare with 17A).

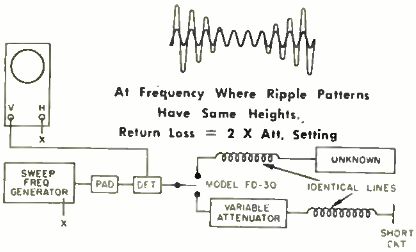



**Fig. 19: A coaxial switch will give the same convenience of simultaneous presentation for the calibration of delay lines.**

Fig. 18 is an illustration of the way in which irregularities in the delay line can make accurate measurement difficult. (A) shows the ripple pattern amplitude under a calibration condition corresponding to 30 db return loss (high vertical gain was used). (B) shows the pattern with termination adjusted for minimum ripple. This line, a 150 ft. length of RG11/U, has internal reflections a little more than 30 db down. (C) shows the pattern resulting when a load having a return loss of 30 db was connected to the end of this line.

The line irregularities prevent accurate display of the load characteristics. A further hazard is that the internal reflections probably indicate a considerable variation in characteristic impedance of one section of the cable as compared with another. Thus, the impedance which will match the far end depends on just where the cable is cut.

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### *Comparison Technique*

The patterns illustrating this article were recorded with a Moseley X-Y recorder, using a Jerrold Model 707 Precision Sweep Generator, which has sweep speeds adaptable to use either with a recorder or a normal oscilloscope. Where patterns are shown superimposed, they were made by simply changing the load connections without touching the sweep settings and recording the second trace on top of the first. This is, of course, not possible with a scope, but the same convenience of simultaneous presentation for calibration can be obtained by using a Jerrold Model FD-30 Coaxial Switch.

For Delay Line work, it is connected as shown in Fig. 19, superimposing a calibration pattern from a second delay line on the pattern of the load being adjusted or measured.

# PROBLEM CLINIC
## Lightweight Magnetic Tape Recorder

A GOVERNMENT agency is interested in small lightweight magnetic-tape recording equipment for use in self-powered, free-running ship and submarine models.

Final detailed specifications for this equipment have not yet been established, since the design of the associated instrumentation system may depend somewhat on the type, capacity, and performance characteristics of the tape recorder which is obtainable. Tentative requirements for such a recorder are as follows:

Size: Limited by internal dimensions of model, approximately 6 x 10 x 14 inches or more in length.

Type of recording: Parallel binary digital, 10 bits, 1 sign, 1 parity, 1 sprocket, and 1 spare; serial digital; FM; or FM/FM. Type of recording will be selected based on considerations of accuracy, size, power consumption, cost, and availability. Multi-track digital recording is preferable, but other types may be dictated for other reasons. Overall accuracy must be at least 2%, with higher accuracy being expected for digital recording.

Number of tracks: 2 to 14, depending on mode of recording used.

Tape width: Standard width desirable, but special widths permissible.

Running time: 4 mins. minimum (duration of one test run); longer desirable.

Tape speeds: Speed and speed regulation consistent with the mode of recording.

Playback: Playback of data into shore-based recording equipment without removal from the model; capable of being rewound and readied for subsequent test by remote command.

Power supply: Operable from 400 cps 1-phase ac, or 24-28 v dc, or other.

Record amplifiers: Input from transducers ± 5 volts range, high impedance. May be packaged separately from transport if required to meet size limitation (or may not be supplied).

Temperature: + 5° to + 50° C (operating).

Pressure: Up to 35 psia (operating).

Humidity: Up to 100% relative; must be waterproof or adaptable to "canning" for use in flooded models.

# #47 Locating the Operating Point of a Triode

By M. MARTIN
and A. E. RICHMOND
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IN designing electronic equipment we often have to locate the operating point of a triode when $E_{bb}$, $R_L$, and $R_k$ are given. The following rapid method of locating the operating point will be explained using the circuit of Fig. 1 as an example.

1. On the family of tube $I_b$-$E_b$ curves, plot a load line (line *A* of Fig. 2), in the usual manner, taking the load resistance as the sum of $R_L$ and $R_k$. Neglect $R_k$ if $R_L$ is many times greater than $R_k$.

2. Select one of the $I_b$-$E_b$ curves corresponding to some given grid voltage $E_c$. (In Fig. 2 we have chosen the curve corresponding to $E_c = -6$ volts.) Calculate the plate current that must flow to produce the selected grid-cathode-bias voltage drop $E_c$ across $R_k$. Plot a point on the selected curve corresponding to this value of current (point *B* in Fig. 2).

3. Repeat Step 2 using a different curve corresponding to a new grid voltage $E_c$. (In Fig. 2 we have chosen the curve corresponding to $E_c = -4$ volts.) Plot a point on this second curve corresponding to the new current that must flow to produce the new voltage drop $E_c$ across $R_k$ (point *C* in Fig. 2).

4. Connect the points found in Steps 2 and 3 with a straight line. The intersection of this line (extended if necessary) with the load line is the operating point (point *D* in Fig. 2).

* * *

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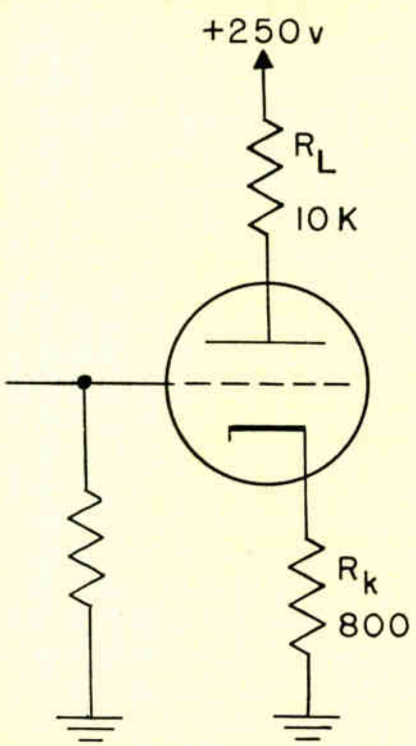



Fig. 1. Triode circuit used to illustrate method of locating operating point.

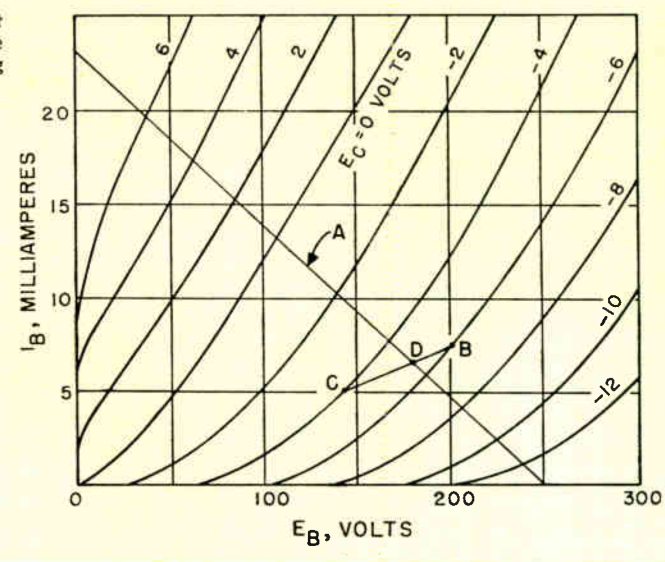



Fig. 2. Operating point is intersection *D* of load line *A* with line connecting two points defining two selected grid-cathode drops across $R_k$ and the corresponding plate currents (points *B* and *C*).

**By Dr. LEANG P. YEH***
*Aero Science Laboratory*
*General Electric Co.*
*3750 "D" St., Phila., Pa.*

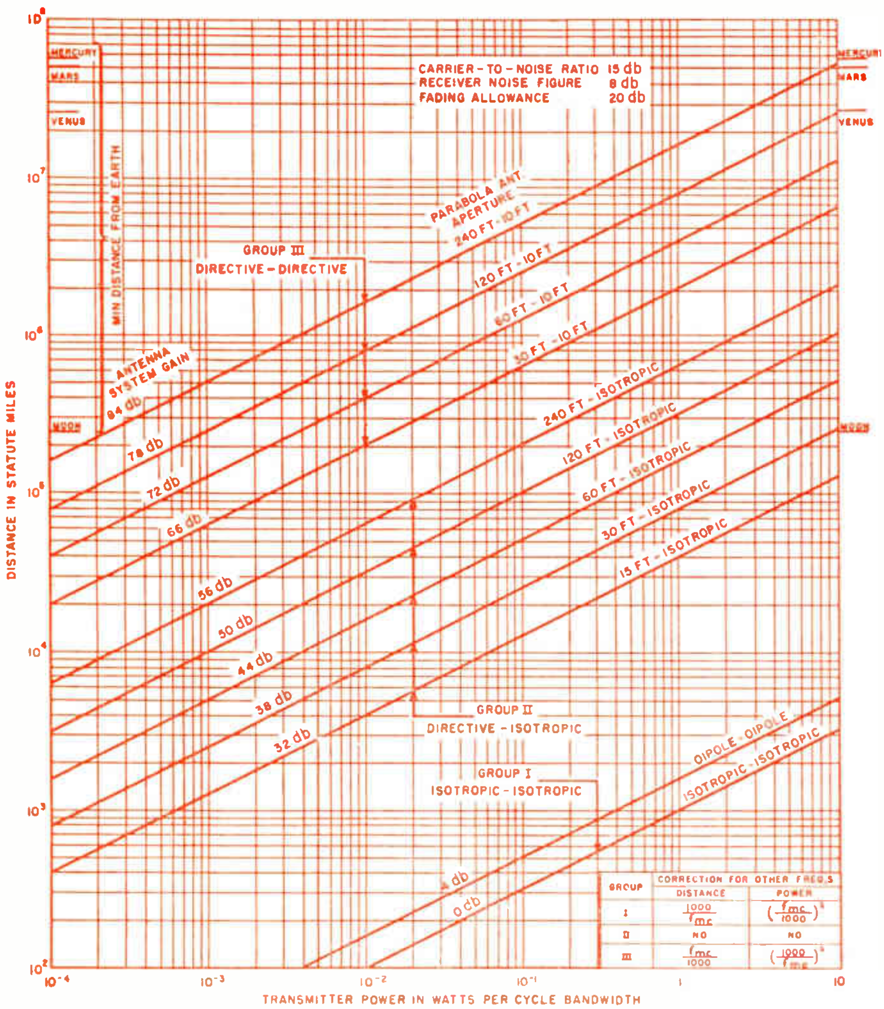
*System Designing . . .*

# Communicating in Space

*This young and controversial art is discussed from the overall and performance points of view. Known techniques and experimental data are analyzed, in hopes that a more realistic approach to the problem can be made.*

**Part Two of Two Parts**

Fig. 5: The ranges for feasible direct communication systems at 1000 megacycles.




In the present study, a fading margin of 20 db will be allowed in all cases. For space-to-space communication, this margin may be too severe but for either space-to-earth or earth-to-space communications, this margin may not be enough. Fading may be reduced by circularly polarized antenna systems or diversity techniques.

### *System Design Chart*

A 1000 MC system design chart with transmitter power required per cycle bandwidth vs. distance, based on the following assumptions is shown in Fig. 5.

(a) A carrier-to-noise ratio of 15 db is considered usable.
(b) A fading margin of 20 db is allowed.
(c) Parabolic antennas are assumed.
(d) Three groups of systems are used—Isotropic-Isotropic, Directive-Isotropic and Directive-Directive.
(e) 240 ft is considered the largest feasible antenna on earth and 10 ft in space vehicles.

*DR. LEANG P. YEH was a Fellow Engineer, Westinghouse Electric Corp., Baltimore, Md., when this article was prepared.

For other frequencies, a correction factor as shown in Table 4 may be used subject to an error of ±3 db within 100-10000 MC range because the frequency effects of both receiver noise figure and line losses are neglected.

### *Ranges of Feasible Systems*

With the present state of the art, the ranges of feasible direct communications, with a carrier-to-noise power ratio of 15 db and fading allowance of 20 db, may be read from Fig. 5. The results are summarized in Table 5.

It seems that long range space-to-space communication is a much harder nut to crack than either space-to-earth or earth-to-space communications. The development of omnidirectional high gain antenna for space vehicles seems to be one of the most urgent requirements.

### *Moon Relays*

There are two types of moon relays: (1) using the moon as a passive reflector. (2) using the moon as an active repeater station.

From the radio transmission point of view the active relay is easier because a lot of hardware can be put on the moon; but the problem is "how to get there and set up the equipment."

The passive relay is feasible for stations on earth at present if not too high a signal-to-noise ratio can be tolerated.

A sample calculation for a practical system is shown in Table 6.

If usable carrier-to-noise ratio (C/N) is taken as

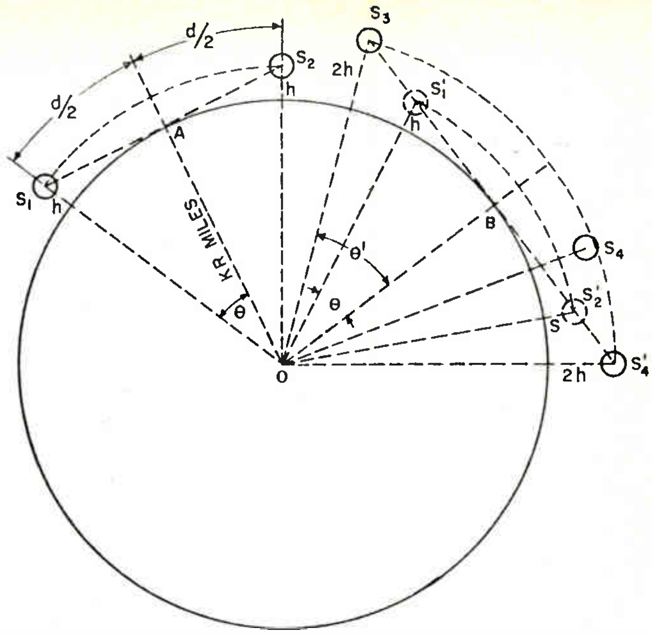



Fig. 6: Satellite communication geometry with the earth as a relay station.

R = TRUE EARTH RADIUS ≐ 4000 MILES
K = EFFECTIVE EARTH RADIUS FACTOR

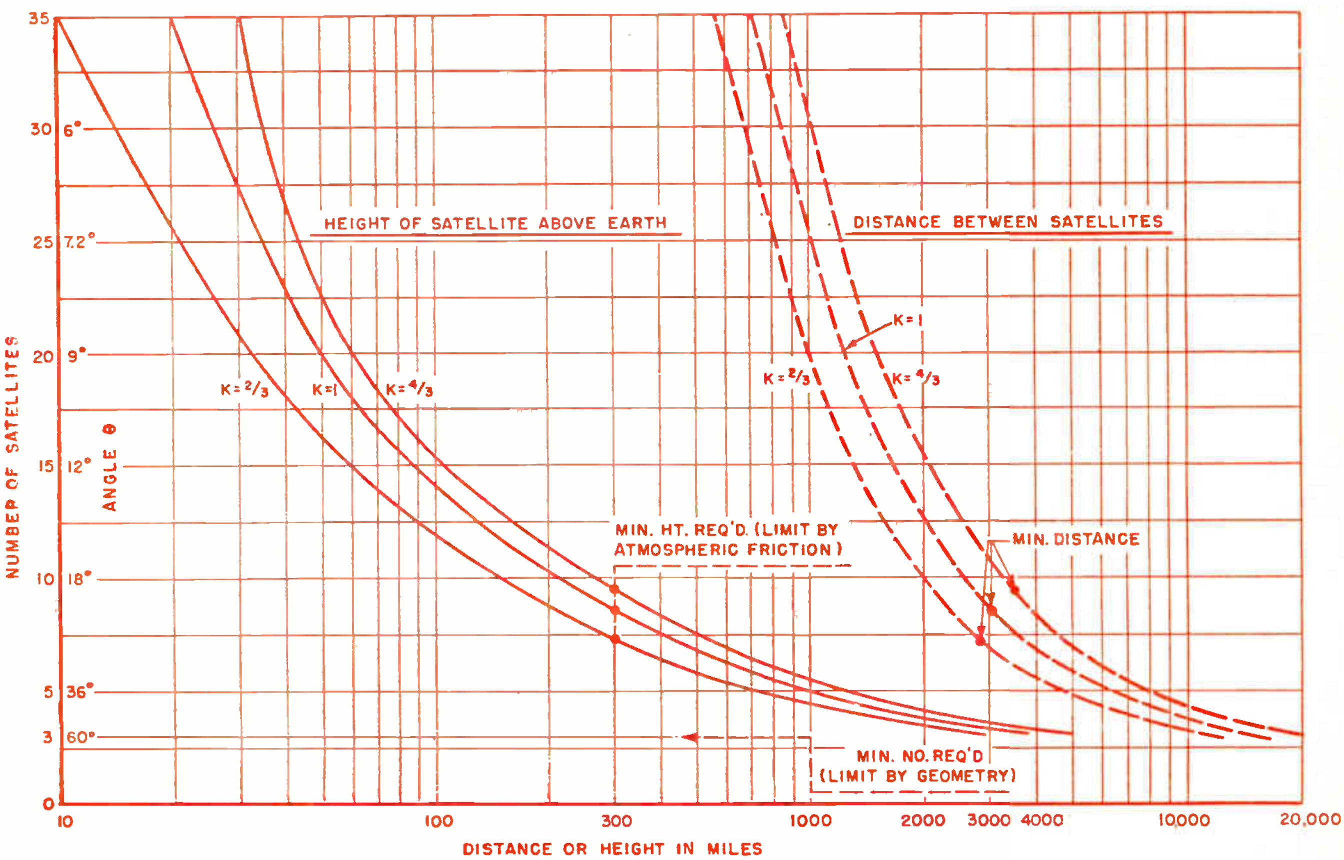
$$h = \frac{KR}{\cos\theta} - KR \quad (1)$$

$$d = \frac{2\pi(KR + h)}{n} \quad (2)$$

$$\theta = \frac{360^\circ}{2n} = \frac{\pi}{n} \text{ RAD.} \quad (3)$$



Fig. 7: Note that the min. number of satellites is set by the geometry; the min. height by atmospheric drag and satellite size and mass.



### Table 5

FEASIBLE DIRECT COMMUNICATION RANGES

| | Space-to-space | Space-to-earth or earth-to-space |
|---|---|---|
| Transmitter Power | 10 w | 10 w |
| Frequency | 100 MC | 300 MC |
| Space Antenna | Isotropic | Isotropic |
| Earth Antenna | — | 240 ft. |
| Fading margin | 20 db | 20 db |
| C/N power ratio | 15 db | 15 db |
| Range—1 cps B.W. | $3 \times 10^4$ mi. | $2 \times 10^6$ mi. |
| Range—10 cps B.W. | $10^4$ | $7 \times 10^5$ |
| Range—100 cps B.W. | $3 \times 10^3$ | $2 \times 10^5$ |
| Range—1 KC B.W. | $10^3$ | $7 \times 10^4$ |
| Range—10 KC B.W. | $3 \times 10^2$ | $2 \times 10^4$ |
| Range—100 KC B.W. | $10^2$ | $7 \times 10^3$ |
| Range—1 MC B.W. | $3 \times 10$ | $2 \times 10^3$ |
| Remarks | freq. cor. = 1000/100 = 10 | No freq. cor. |

Range $\propto 1/(\text{Bandwidth})^{1/2}$

### Table 6

PRACTICAL MOON-RELAY SYSTEM

| | |
|---|---|
| Frequency | 2000 MC |
| Transmitter Power | 10 kw CW (40 dbw) |
| Antenna size | 60 ft. parabolic |
| Antenna beamwidth | 0.6° |
| Antenna gain (two-way) | 100 db |
| Circuit loss (Isotropic antennas) | −276 db |
| Line losses | − 4 db |
| Received power | −140 dbw |
| Noise figure | 9 db |
| KT | −204 dbw |
| 3 kw bandwidth | 35 db |
| Noise power | −160 dbw |
| Median C/N ratio | 20 db |

### Table 7

SATELLITE COMMUNICATION SYSTEM PERFORMANCE

| Parameters | n = 3<br>h = 5000 mi. |
|---|---|
| Transmitter power | 10 w |
| Frequency | 100 MC |
| Antenna | Isotropic |
| Path distance K = 4/3 | 20,000 mi. |
| Antenna System gain | 0 db |
| Free space loss | 163 db |
| Line loss | 1 db |
| Fading margin | 20 db |
| Received power | −174 db |
| Receiver noise fig. | 7 db |
| KT | −204 dbw |
| Noise power per cycle | −197 dbw |
| C/N—1 cps B.W. | 23 db |
| C/N—10 cps B.W. | 13 db |
| C/N—100 cps B.W. | 3 db |

15 db, there is only a 5 db fading margin. The system will, therefore, work on slightly more than 50% of the time. To have a higher reliability, circular polarization and diversity system may have to be used.

Utilization of the moon as passive reflector for space-moon-space, space-moon-earth and earth-moon-space communications is rather remote because the limitation of the space transmitting system except when the space vehicles are not far away from the moon.

#### *Satellite Communication and Relays*

Satellite-to-satellite communications could only be made under certain limitations. Fig. 6 shows the geometry for line-of-sight transmissions between satellite at grazing incidence.

The curves in Fig. 7 are obtained from this geometry. It can be seen that the minimum number of satellites required is set by the geometry, and the minimum height by atmospheric drag and satellite's size and mass. The drag will take energy out of the orbit and cause the satellite to spiral to earth. To be useful for communication purposes, the satellite must remain in orbit for fairly long times, if not permanently. A method of calculating elliptical orbital lifetimes has been suggested.[13]

System performance for n = 3 (minimum number of satellites at grazing incidence) is tabulated in Table 7.

It seems that only narrow band operation is possible with satellite-to-satellite communications using 3 satellites. One solution is to increase substantially the number of satellites.

The range of satellite-to-satellite communication may be extended by using the earth station as a repeater. On the other hand, the range of earth-to-earth communication may be extended by using the satellite as a repeater. Satellite relays like moon relays, may also be divided into two types: Passive and Active.

To use the earth as a relay station, the satellites must be placed in orbits higher than the height required for line-of-sight communications at grazing incidence. This can be explained by referring to Fig. 6. Ground station located at A can see the two satellites simultaneously at one instant only. As soon as the satellites move away from the positions ($S^1$ and $S^2$) as shown. A can see only one satellite. Therefore, relay is impossible.

Suppose the satellites are placed in orbits 2h miles (twice as much as the height required for satellite-to-satellite line-of-sight communications at grazing incidence). Then a ground station at B can see both satellites at a distance corresponding to 2 $(\theta'-\theta)$ and the number of ground stations required will be equal to $\frac{2\pi}{2(\theta'-\theta)}$ or $\frac{\pi}{(\theta'-\theta)}$. Number of ground stations vs. number of satellites at various satellite heights are plotted in Fig. 8.

As an example, let the number, n, of satellites in orbit be 15. For satellite height equal to 4h (h may be read from Fig. 7, in this case h = 85 miles) or 340 miles, the number $n_g$ of ground stations required is equal to n or 15, to relay the communication from one satellite to the other.

The use of a passive reflector on earth as satellite-earth-satellite relay is impractical because of the size of the reflector required. Only active relay seems usable. A feasible active relay system is shown in Table 8.

### *Active Relay System*

In this system, it is assumed that a 10 w transmitter is used in the satellite. The earth station transmitter is thus limited also to 10 w, if two-way transmission is required. For one-way transmission, this limitation will be removed. The range, then, will depend on the parameters of the earth station. No example is given for one-way system but the same method as shown in Table 8 can be used for design.

The range of satellite-to-satellite communications can be extended many times as much by relay through an earth repeater station. This, however, requires the moving of two parabolic antennas 240 ft. in diameter to track the satellites at a velocity, say, of 20,000 mph. Such undertaking may not be easy, if not impossible.

An alternative is to have the earth antenna fixed. The information from one satellite first passing through the earth antenna is stored and later relayed to the next satellite passing through the same antenna. In this case, only one earth antenna is required. However, it must have a wider beamwidth so that there is enough time for an appropriate amount of information to be stored and become useful. This will reduce the gain of the earth antenna and thus the range extended.

In earth-satellite-earth relays, an active repeater in the satellite is also possible. However, the repeater must provide a large amout of gain. Since such provision is very unlikely at least at the present moment, the range extended by a satellite repeater may not be very much.

For passive relays, the factor of $A_b/4$ may be used to compare moon relay with satellite relay. Table 9 shows a comparison of the two.

A sphere with a diameter of approximately 200 in. (17 ft.) at 300 mile height is required to have the same effect as a reflecting body as the moon at 24 x $10^4$ miles away. To put a number of 17 ft. spheres in orbit is possible in the not too distant future.

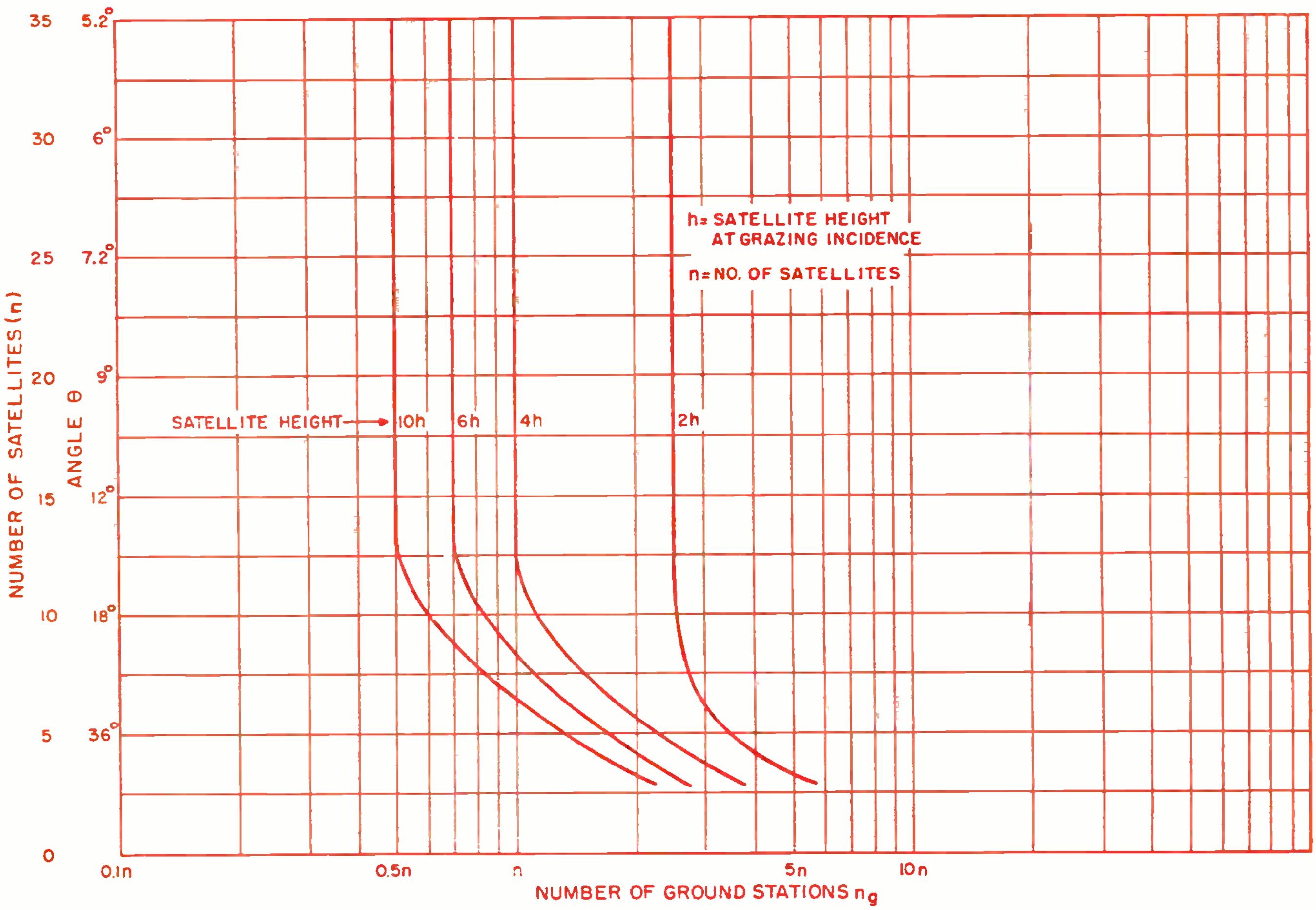
The angle subtended by the satellite of 100 in. diameter is, however, extremely small, in the order of $10^{-3}$ degree. Unless its orbit can be pre-calculated to a fair accuracy, radio tracking will not be easy. Fortunately, from the experience gained in the observation of the Russian and American satellites, determination of a satellite's orbit is no longer considered as a serious problem.

Another interesting parameter in satellite relays is the slant range, which is the maximum distance between the earth station and the satellite. Fig. 9 gives the slant range for various satellite heights.

### *Other Considerations*

The Carrier-to-Noise Power Ratio previously dis-

**Fig. 8: The relationship of the number of ground stations to the number of satellites, orbitting at different heights, for relay purposes.**



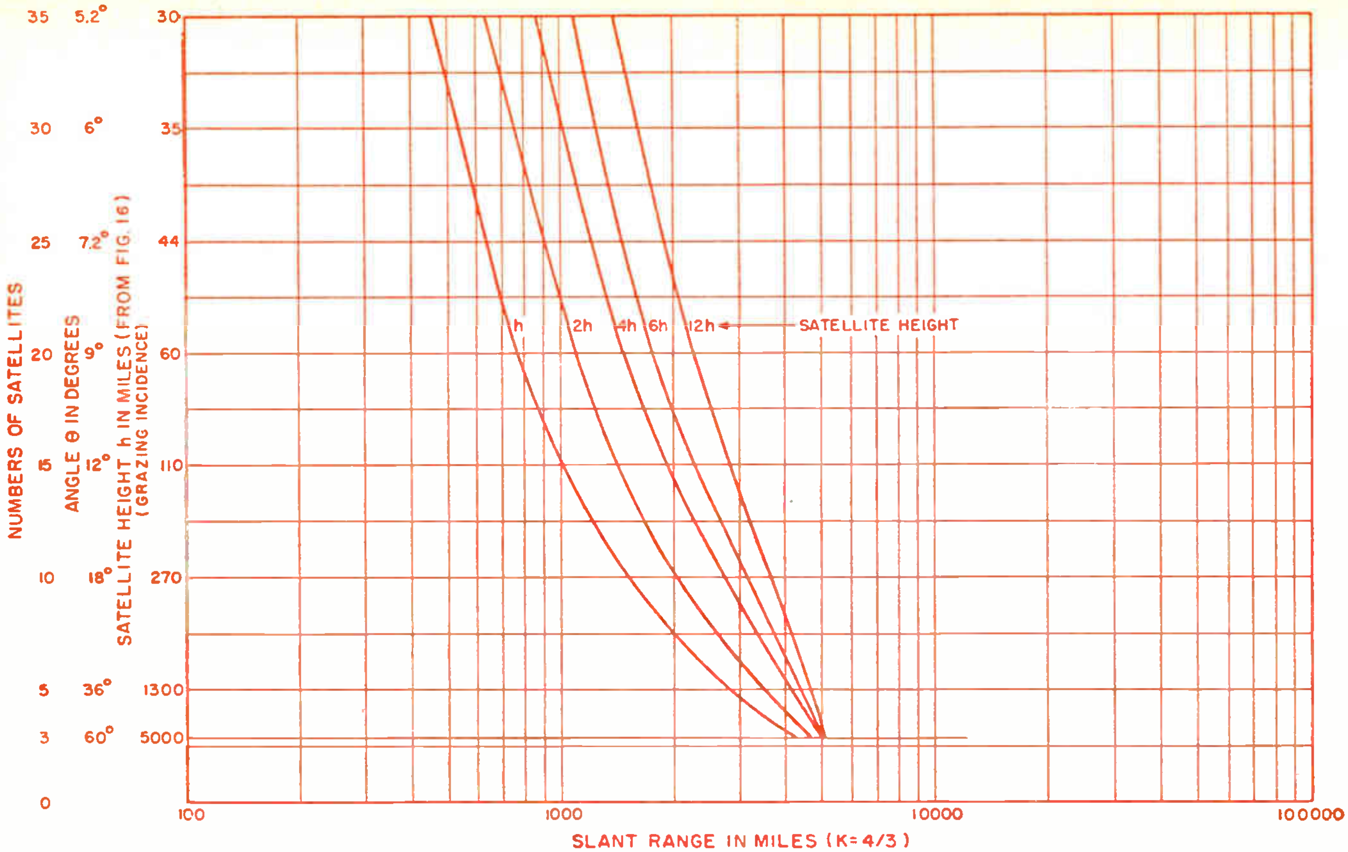



Fig. 9: The maximum slant range for various satellite heights.

# Space Communications

*(Continued)*

cussed sets the limit of the reliability of the system. The actual performance is, however, specified as the post detection or baseband signal-to-noise power ratio per channel at the receiver output. Typical value is 40 db or 50 db FIA Weighting, corresponding to 37 db or 47 db flat weighting.

In dealing with radio transmission through Space, long range is of primary interest. The received signal is, therefore, usually weak. Therefore, a minimum usable signal-to-thermal noise power ratio per channel other than the conventional and more realistic to radio transmission in space must be established. It is suggested that a minimum of 25 db signal-to-noise power ratio per channel for 0 dbm test tone is considered usable for space communication.

There are definite relations between the carrier-to-noise power ratio (C/N) and the channel signal-to-noise power ratio $S_0/N_0$. These relations, however. depend on the modulation and multiplexing techniques.

Various combinations of mulitplexing and modulating techniques in various degrees (single, double, triple, etc.) of modulation could make up a large variety of systems. Much has been written about such combinations and their advantages and disadvantages [14-16]. However, regarding the final modulation (modulation of the radio carrier) emphasis has been put on either AM or FM and very little is said about SSB.

Although there is the obvious difficulty of dealing circuit-wise with single sideband and its pulse demodulation problem in the application of time division multiplex to modulate the radio carrier, the use of SSB as the final modulation (modulation of the radio carrier) in frequency division multiplex seems to have some advantages over either AM or FM, such as smaller i-f bandwidth and no threshold effect.

Another interesting subject is the antenna system. It is not intended here to cover this topic in detail. Only a brief outline will be given. Antenna systems in space communications may be divided into two main categories.

(a) Those installed in the space vehicles and (b) Those used on the earth. Important, factors to be considered in both categories are gain, polarization and physical characteristics.

The antenna systems in the space vehicles may be developed from the known techniques such as turnstile, dipoles and slot antennas that had been used in rockets, missiles and satellites. However, due to much longer path distances being involved, the antennas must have large gains. At the same time it should not have too high a directivity for easier tracking. Furthermore, the physical dimensions must be small due to the limited size of the vehicle. Large gain, omnidirectivity, and small sizes are contradicting requirements in conventional types of antenna systems. Therefore, new techniques and radical designs are required.

On earth, the antenna systems are not as restricted as those in the space vehicle. In radio astronomy, dipole arrays and rhombic antennas have been used for

VHF frequencies and parabolic antennas (up to 250 ft. diameter) for UHF frequencies. In missile tracking, Helical arrays have been used because of its circularly polarized characteristics. This characteristic is very useful because of the fading of the signal. All these kinds of antenna systems could be very well adopted for space communications except, perhaps, a much higher degree of maneuverability is required because of the high speed of space vehicles. This requirement is very tough for large antennas such as 250 ft. parabola. Furthermore, a beamwidth of not less than 2-5° is preferred at present to ease up the tracking problem. This would limit the gain considerably. Again intensive research and development are required.

* * *

This article is based on a paper presented at the 4th National Aero-Com Symposium, Oct. 1958, Utica, N. Y.

## Table 9

### SATELLITE vs. MOON RELAY

| | Distance d in miles | Radius R | $A_b/d^4 = \pi R^2/d^4$ | Value Relative to moon |
|---|---|---|---|---|
| Moon | 24 x $10^4$ | $10^3$ mi. | $10^{-15}$ mi.$^{-2}$ | 1 (0 db) |
| Satellite | 300 | 10 in. | $10^{-17}$ mi.$^{-2}$ | $10^{-2}$ (—20 db) |
| Satellite | 300 | 100 in. | $10^{-15}$ mi.$^{-2}$ | 1 (0 db) |

## Table 8

### ACTIVE SATELLITE-EARTH-SATELLITE RELAY* (TWO-WAY)

| | Satellite-Earth | Earth-Satellite |
|---|---|---|
| Transmitter Power | 10W (10 dbw) | 10W (10 dbw) |
| Frequency | 300 MC | 300 MC |
| Satellite Antenna | Isotropic | Isotropic |
| Earth antenna (parabolic) | 240 ft. | 240 ft. |
| Fading Margin | 20 db. | 20 db. |
| C/N power ratio | 15 db. | 15 db. |
| Range—1 cps B.W. | 2 x $10^6$ mi | 2 x $10^6$ mi |
| Range—1 KC B.W. | 7 x $10^4$ | 7 x $10^4$ |
| Range—1 MC B.W. | 2 x $10^3$ | 2 x $10^3$ |
| Noise Power—1 cps B.W. | —198 dbw | —198 dbw |
| Noise Power—1 KC B.W. | —168 dbw | —168 dbw |
| Noise Power—1 MC B.W. | —138 dbw | —138 dbw |
| Recvd. Power—1 cps B.W. | —183 dbw | —183 dbw |
| Recvd. Power—1 KC B.W. | —153 dbw | —153 dbw |
| Recvd. Power—1 MC B.W. | —123 dbw | —123 dbw |
| Earth Repeater Gain—1 cps B.W. | 193 db gain reqd. to give 10 dbw power | |
| Earth Repeater Gain—1 KC B.W. | 163 db gain reqd. to give 10 dbw power | |
| Earth Repeater Gain—1 MC B.W. | 133 db gain reqd. to give 10 dbw power | |

* There is a degradation of C/N of 3 db because of two hoops.

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# Ratio Transformers

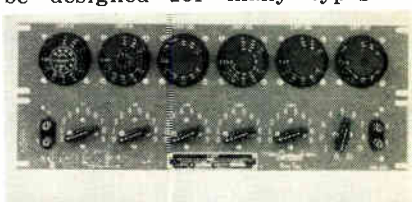
A MAJOR break-through in the design of sub-miniature military type co-axial ratio transformers has been recently accomplished. By the use of new techniques and materials, units with an overall diameter of 2½ in. have been developed which compare in performance with large rack and panel types. Six units can now be placed in line on a standard 19-in. rack panel. (See photo.)

Some of the units now available have the following characteristics:

1. Two decades and a single turn interpolating potentiometer;
2. Three decades and a single turn interpolating potentiometer;
3. Three decades and a 10 turn interpolating potentiometer;
4. Three decades and no potentiometer;
5. Three decades and a 10 position resistor step interpolation; and
6. Phase reversing first decade, followed by two decade dividers.

These small sub-miniature units are already in production for the computer in one major missile program and are being designed into several other programs.

Trade-named "RatioTrans"* and manufactured by Gertsch Products Inc., these units have been and can be designed for many types of



Lower unit is a standard rack type "RatioTrans,"* the upper indicates six comparable units mounted in the same space.

automatic data handling and machine positioning. Both rotary shaft driven and automatic switching types are available.

*TM

# What's New . . .

## Tandem Electrostatic Accelerators

A DESIGN refinement in particle accelerators steps up the ion beam energy as much as four times to increase the utility of such machines in basic nuclear research.

Dr. Robert J. Van de Graaff Massachusetts Institute of Technology who developed the particle accelerator bearing his name points to the two, three and four-stage tandem accelerator as the most feasible source of particle energies required for effective bombardment of the heaviest of the atomic nuclei.

Already in existence is the 10-mev two-stage tandem Van de Graaff, manufactured by High Voltage Engineering Corp., Burlington, Mass., which enables exploration of the nuclear energy level of certain heavy elements not previously possible. The tandem comprises two 5-mev Van de Graaff accelerators horizontally placed end to end with a common high voltage terminal. With the tandem principle, it is possible to apply constant voltage to the beam not once, but two, three or even four times, correspondingly increasing the positive-ion output energy, while retaining the precision and flexibility associated with constant-voltage acceleration.

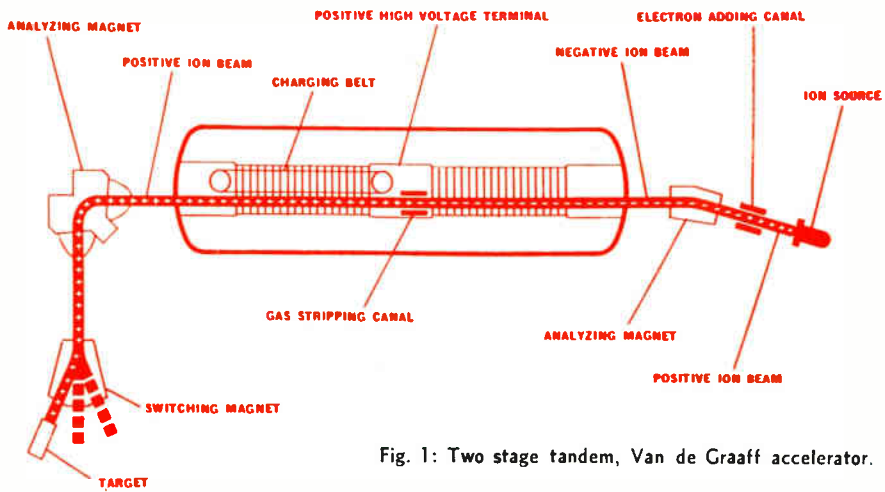



Fig. 1: Two stage tandem, Van de Graaff accelerator.

### POSITIVE-ION ENERGIES IN MEV

**for Three Different Arrangements of Tandem Accelerators**

| Positive Ion | Two-Stage | Three-Stage | Four-Stage |
|---|---|---|---|
| Hydrogen | 13.4 | 20.1 | 26.8 |
| Helium | 20.1 | 26.8 | 40.2 |
| Oxygen | 60.3 | 67.0 | 120.6 |

Assumption: Terminal potential = 6.7 megavolts.
Complete stripping of positive ions.

In standard electrostatic accelerators, positive ions are produced inside the high voltage terminal and accelerated to ground in one step. In a two-stage unit, negative ions are produced at ground, and accelerated to a high-voltage positive terminal. Inside the terminal, the negative ions are stripped of electrons, becoming positive ions, which then receive an additional acceleration from terminal to ground. Since the particle beam receives

(*Continued on page* 105)

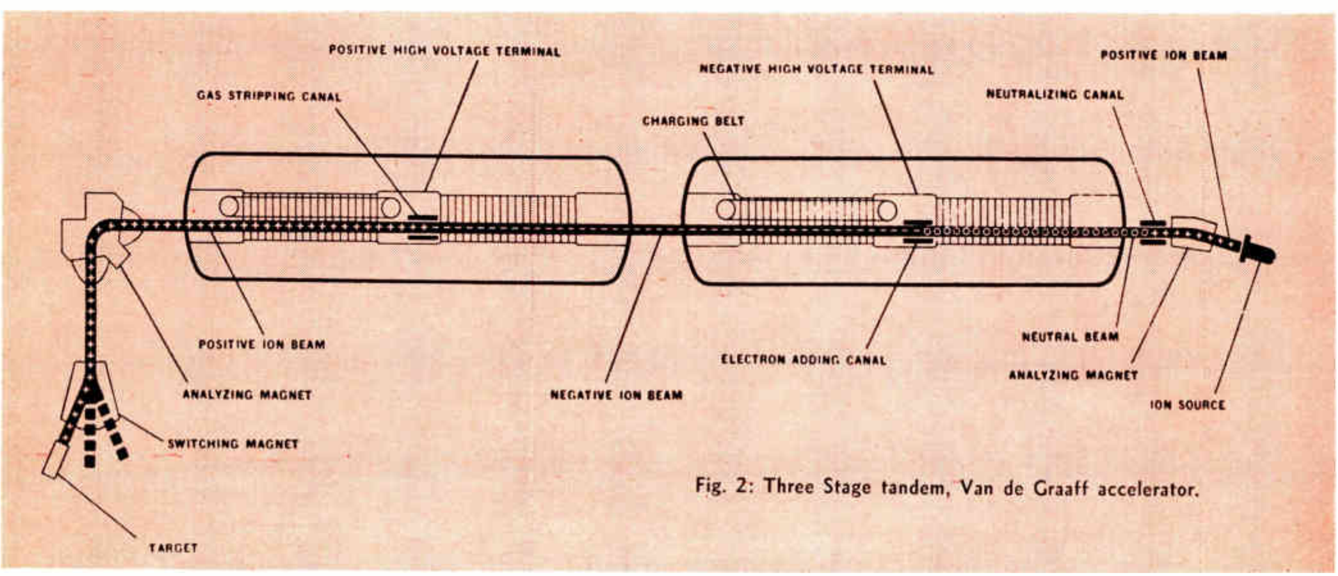


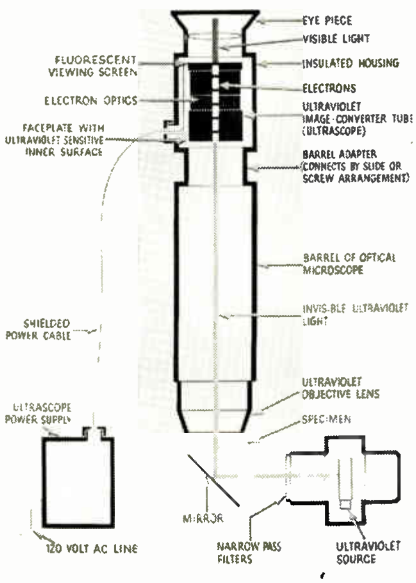

Fig. 2: Three Stage tandem, Van de Graaff accelerator.

# Ultrascope—
# For Medical Electronics

A NEW electron tube, called the "ultrascope," is expected to be a substantial help in medical and industrial research.

The tube is the "eye" of a new simple attachment for a microscope, which for the first time allows direct visual focusing of an image under ultraviolet light. It converts invisible ultraviolet images of specimens into visible pictures that can be interpreted quickly by medical research workers. The accessory replaces the regular eyepiece of a microscope adapted for ultraviolet viewing.

FUNCTIONAL DRAWING OF ULTRAVIOLET ACCESSORY VIEWER AS USED IN ULTRAVIOLET MICROSCOPY




**This simple drawing illustrates how specimens under ultraviolet light may be studied directly. The ultrascope unit, including power supply, is priced at $1500; it replaces a TV system costing $15,000.**

The device is a significant step along the road of cooperation between medicine and electronics.

This new microscope accessory is expected to be a valuable asset in hospitals, medical schools and biochemical manufacturing. It should also find application in many areas of industrial research for ultraviolet examination of organic materials, including latex, nylon, tobacco, paint and foods.

Cylindrical in shape, the new tube is 2¼ in. long and 1⅜ in. in diameter.

All methods of ultraviolet microscopy take advantage of the fact that specimens absorb ultraviolet rays in various degrees depending on the ultraviolet wavelength.

Evaluation tests of a prototype of this accessory at the National Institutes of Health reveal that this new device has a very satisfactory degree of resolution.

The Institutes of Health tests were conducted under the supervision of Dr. George Z. Williams, chief of clinical pathology and a recognized authority on ultraviolet microscopy (EI, May 1957, p. 61). The tests have produced "promising results."

Use of the accessory with the ultrascope has several important advantages over previous ultraviolet microcopy techniques. For the first time it offers a simple electronic tool for ultraviolet studies in medical and biological research.

Previously, this type of instrument has had to be constructed from large, separate component parts, oftentimes at great expense (TV camera chains for $15,000) and inconvenience.

A commercial model of the ultraviolet image-converter unit, equipped for direct viewing and photography, will be made available in the near future by Bausch & Lomb Optical Company of Rochester, N. Y.

The Bausch & Lomb U-V Photo-Microscope will be priced at about $3,250 including microscope, ultraviolet optics and image converter.

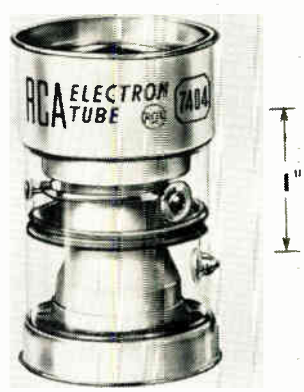
**In the Bausch & Lomb U-V Photo-Microscope, the Ultrascope is mounted at right angles to the usual viewing axis. A camera is in position to record the image, under ultra-violet light, which can now be focussed visually.**

Offered as an accessory, the B&L Grating Monochromator provides an excellent U-V light source. The B&L Image Converter Unit (ultrascope tube and 35mm camera) is available for use on existing monocular microscopes and is priced at about $1,500.

The ultraviolet image-converter tube, is the outgrowth of a quarter-century of RCA research and development on image tubes. Image-converter tubes, sensitive to infrared rays, were used in the famous "Sniperscope" of World War II and the Korean War. Mounted on gun sights, this device enabled soldiers to see enemy troops and vehicles in total darkness. Until

(*Continued on page* 219)

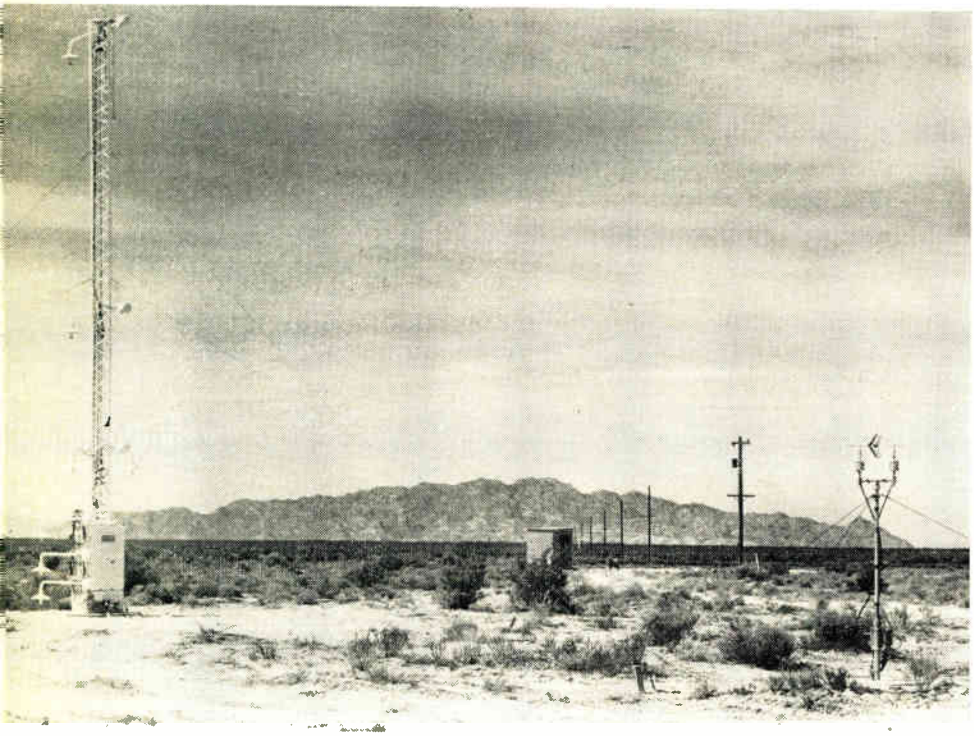
**This is the Ultrascope—the image-converter tube which allows direct visual focussing of an image under ultraviolet light.**



*A difficult problem in the field of instrumentation is the accurate measurement of atmospheric air temperature in the presence of solar radiation. This article describes the design of such a thermometer which is accurate to ±0.25 degrees*

# Radiation

Fig. 1: The thermometer assemblies are shown installed on 30 ft. towers.




**By J. D. HUMPHREYS**
*Quality Evaluation Lab.*
*U. S. Naval Ammunition Depot*
*Oahu, T. H.*


ONE of the most difficult problems in the field of instrumentation is the accurate measurement of atmospheric air temperature in the presence of solar radiation. In weather observations these measurements are usually made by means of a mercury thermometer located in a wooden shelter. The shelter is generally about 2 feet by 2 feet by 3 feet high and has louvred walls and a pitched roof. Such equipment is totally inadequate for the accurate determination of atmospheric temperature when subjected to conditions of high solar radiation.

### Shielded Thermometer

This article describes the design of and the laboratory tests on an aspirated, radiation shielded thermometer which is capable of measuring air temperature within a proven accuracy of ± 0.25° F including errors due to maximum solar radiation encountered on the earth's surface at the U. S. Army's Dugway Proving Ground in Utah. The instrument was developed in connection with an automatic meteorological digital telemeter system wherein a number of unattended remote stations collect and transmit data to a receiving-recording station.[1] Since the system is used for micro-climatological research, measurements are taken close to the ground and laboratory accuracy is mandatory. The thermometer assemblies can be seen installed on the 30 ft tower shown in a remote station photograph of Fig. 1.

Fig. 2 is a general view of the unit showing the hooded 2 in. diameter tube approximately 4 feet long. Aspiration air is drawn across a wire wound sensing element into this tube and into the 20 cfm electric-motor driven blower mounted on the opposite end. In passing through the blower the air is heated slightly due to local blower motor heating and if exhausted so that heated air enters the intake of an adjacent thermometer intolerable errors would result. This is prevented by stacking the theremometer sensing heads on one side of the tower and exhausting the aspiration air horizontally away from each sensing head on the other side as shown in Fig. 1. Exterior surfaces of the assembly are painted with a special high reflectivity gloss white enamel so that much of the radiant energy impinging thereon is reflected away.

Fig. 3 shows some of the external and internal

tics to determine radiant energy values versus altitude of the sun. The solid curves shown in Fig. 4 were plotted from pyroheliometer records for 28 June 1955 and 24 October 1955 representing extreme conditions recorded to date at the installation site. Since these curves present the energy levels received on a *horizontal* surface, it was necessary to modify them so that they approximate the values of radiant energy received on a surface *normal* to the sun rays throughout the day. By collecting normal to the sun readings with a portable solar radiation meter (GE, Type DW-69) on several unusually clear days it was established that:

1. When the sun is at the horizon the radiation normal to the sun is approximately 50% of the maximum value observed at 12 o'clock solar time.

# Shielded Thermometer Design

details of the sensing head. The cylindrical portion of the hooded shield surrounds an inner cylinder of slightly smaller diameter shown in the right portion of the rectangular insert of Fig. 3. The nickel wire thermometer element shown next to the shield is mounted inside. The superior performance characteristics of the complete assembly depends to a large degree on the excellent heat transfer and reflectivity characteristic of this light-weight inner shield. Because of these characteristics the shield operating temperature is practically identical to that of the atmospheric air drawn into the intake and it is relatively insensitive to heating caused by solar radiation. It is made of 2 mil polished metal foil and provides a large surface area to mass ratio.

Atmospheric air enters at the head assembly through two separate intakes, one at the upper annular opening and the other at the lower annular opening. Air entering the upper opening is drawn through the space between the inner and outer shields while air entering the lower opening is drawn through the center of the inner shield and passes over the thermometer element. With this arrangement the former air flow serves to stabilize the average temperature of the head assembly interior at approximately the same temperature as the atmosphere. Thus, the temperature of the latter air flow is virtually unaffected by solar radiation heating. As presented later, the results of special tests show the errors caused by solar radiation to be less than + 0.20° F.

### *Radiation Tests*

Of considerable interest in the development of the shielded thermometer was the construction of a suitable laboratory test facility to simulate the maximum energy received at the field installation for various angles of solar radiation.

Data were collected on solar radiation characteris-

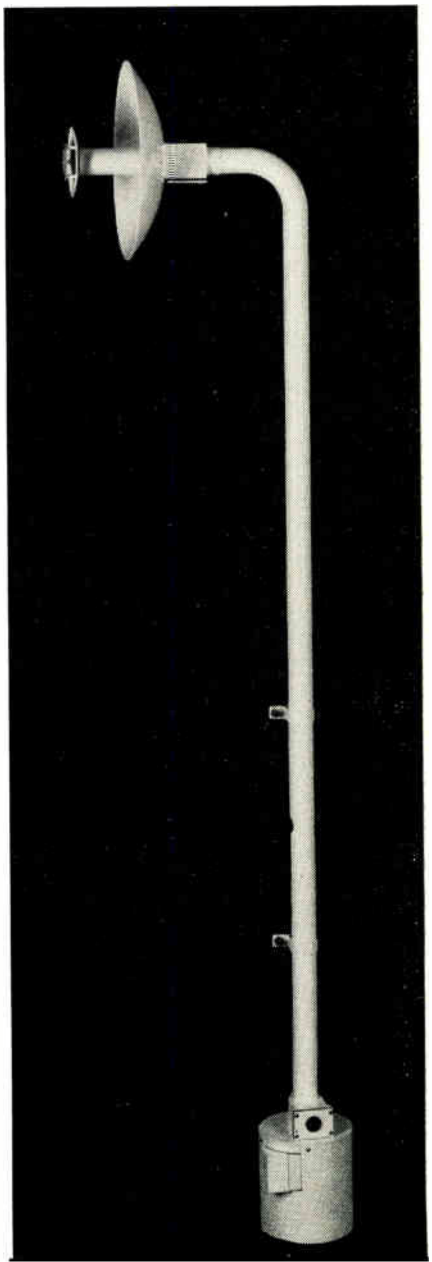


Fig. 2: Radiation shielded and aspirated thermometer unit.

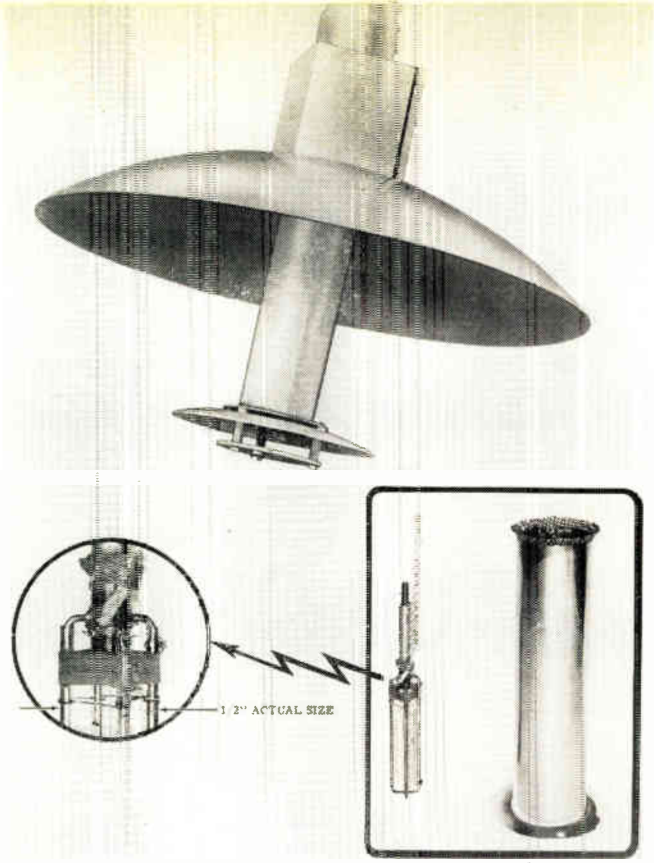



Fig. 3: Solar radiation shielded and wire-wound thermometer details.

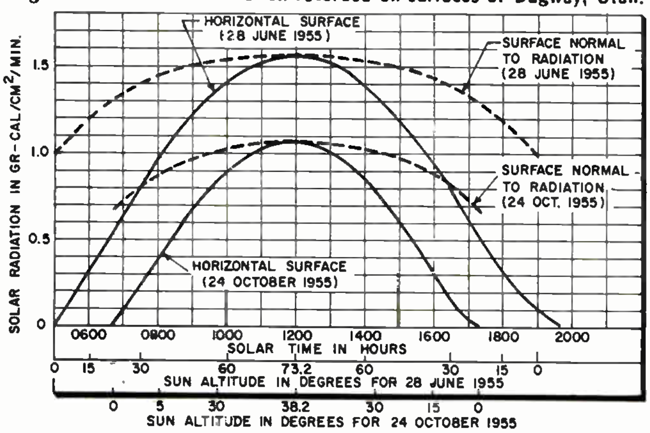
## Shielded Thermometer *(Continued)*

2. The shape of the curve of radiant energy versus time is parabolic. The dotted curves shown in Fig. 4 were developed for a surface normal to the sun in the above manner and values taken from these curves were used in the radiation tests on the thermometer assembly. Note that the abscissa contains two scales, one the solar altitude angle and the other solar time. These values were obtained from computations and data as presented in the American Ephemeris and Nautical Almanac Tables for the field installation latitude and longitude.

In preparing for the simulated radiation tests to evaluate the performance of the shielded thermometer assembly it was found necessary to set up test equipment in a completely sealed and unventilated room as shown in Fig. 5. The Radiation Shielded Thermometer was mounted on one wall with the aspirator blower on the outside, exhausting into the atmosphere. Two lamps (GE 375R40/1) for simulating solar radiation are shown in position at a desired altitude angle of the sun and set about 30 inches from the thermometer. The portable solar radiation meter was used to measure the incident radiant energy illuminating the shield. Special resistance bulb temperature sensors manufactured by Minneapolis-Honeywell can be seen in each corner of the room (near ends of arrow labeled ΔTo). These were shielded from possible radiation by aluminum foil sheets. A special Minneapolis-Honeywell precision differential temperature indicator shown in the lower left corner was connected to each temperature sensor and the shielded thermometer so that the difference in temperature between the left and right side of the room (ΔTo) and the difference in temperature betwen the left side and the test unit (ΔT1) could be observed as desired.

An interesting side light is that, although the sealed room provided a test environment relatively free of temperature gradients and drafts, the instrumentation used was so sensitive that the mere opening and closing of the door caused erratic test recordings. To obtain steady-state test conditions it was necessary to let the equipment and test personnel "soak" in this room with the doors closed for approximately 30 minutes before each test. In addition dispersion of equipment and personnel was required to prevent excessive convective heat drafts from affecting the thermometer readings.

Fig. 4: Incident solar radiation recorded on surfaces at Dugway, Utah.



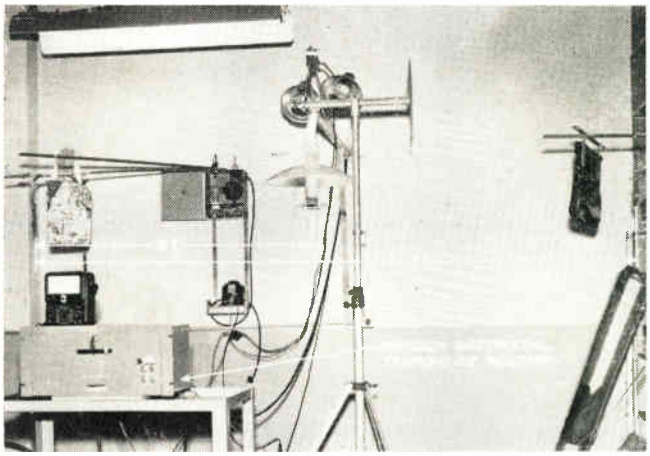



Fig. 5: Solar radiation test in unventilated, sealed room.

### *Performance Characteristics*

The characteristic performance of the shielded thermometer under conditions of solar radiation is shown in Fig. 6. The curves are identified and show the temperature errors introduced from values of radiant energy of 1.00, 1.50 and 1.56 GM-CAL/CM²/MIM for corresponding sun altitudes of 0, 45 and 73.2° obtained from the dotted curve of Fig. 4 for 28 June 1955. Other combinations of radiant energy and sun altitudes from dotted of curve of 24 October 1955 produced smaller errors than shown on Fig. 6

and so were not recorded. A peculiar, but constant, characteristic of the test environment is evident from the curves labeled $\Delta To$ (difference in temperature between left and right sides of room). After the lamps were turned on the steady-state air temperature of the right side of the room was consistently 0.1° F lower than the left side air temperature. Assuming a linear relationship from one side to the other, the air temperature entering the shielded thermometer is then $\frac{\Delta To}{2}$ degrees F lower than the air temperature on the left side. Thus the total thermometer error due to solar raditation is $\frac{\Delta To}{2} + \Delta T_1$ and from the curves is a maximum of $\frac{0.10}{2} + 0.15 = 0.20$ degrees F. Notice that this maximum solar radiation error occurs during the summer months while the sun is close to the horizon. This is to be expected since at these small angles the radiant energy impinges directly on the cylindrical portion of the shield and is not deflected by the hood.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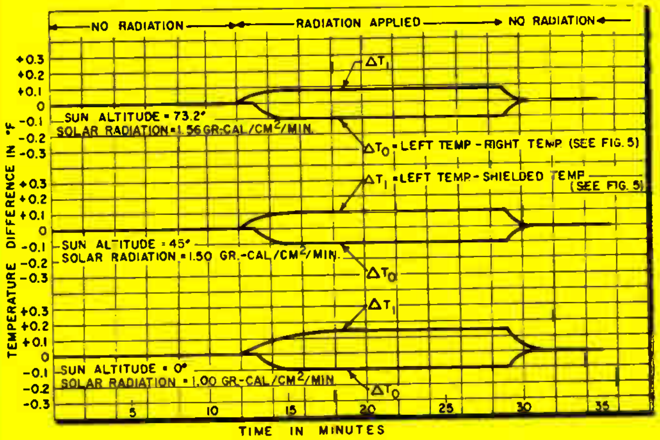



Fig. 6: Shielded thermometer performance characteristics are shown

**PERFORATED PAGES!**

In response to many reader requests the pages in the main editorial section have now been perforated. This will enable readers to easily remove material for their reference files. If the copy of Electronic Industries you receive already has pages removed that you want, please let us know. We'll be glad to provide the missing pages.

## Diodes for Parametric Amplifiers

NOISE temperatures as low as 50° K above absolute zero for a diode cooled by liquid nitrogen, and only 100° K above absolute zero operating at room temperature have been obtained by Hughes Aircraft Co. in a high gain 3000 MC parametric amplifier using sample diodes of a newly developed type.

Initial production of several hundred of these diodes per week is in effect and they are immediately available to the industry. The diode is the heart of the parametric amplifier but also has other important microwave applications such as switching and harmonic generation.

It is available in two rugged and hermetically-sealed versions — one for the region below 1000 MC and a second for the micro-wave region.

(*Continued on Page* 270)

## Tandem Accelerator

(*Continued from page* 100)

two stages of acceleration, the device may then be called a two-stage tandem accelerator.

Dr. Van de Graaff believes nuclear research to be the most promising field for tandems. In these multi-stage machines the precision and flexibility of constant-voltage particle acceleration will be available for an increased scope of nuclear investigations throughout the periodic table. ★ ★ ★

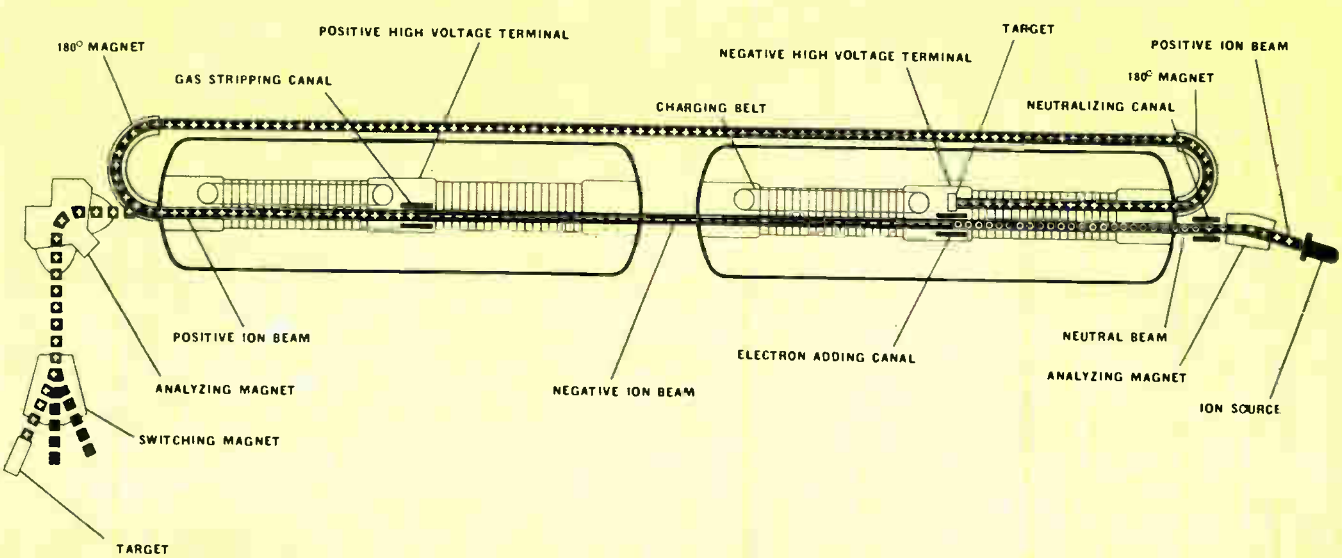



Fig. 3: Four stage tandem, Van de Graaff Accelerator.

# Standardizing Stereo - 1

*NSRC gets under way. Panel 1 met March 4. Chairmanships and scope of panels announced. Manufacturers suggest stereo transmission systems.*

## Duties of the Coordination Committee and Panels

*COORDINATION COMMITTEE*

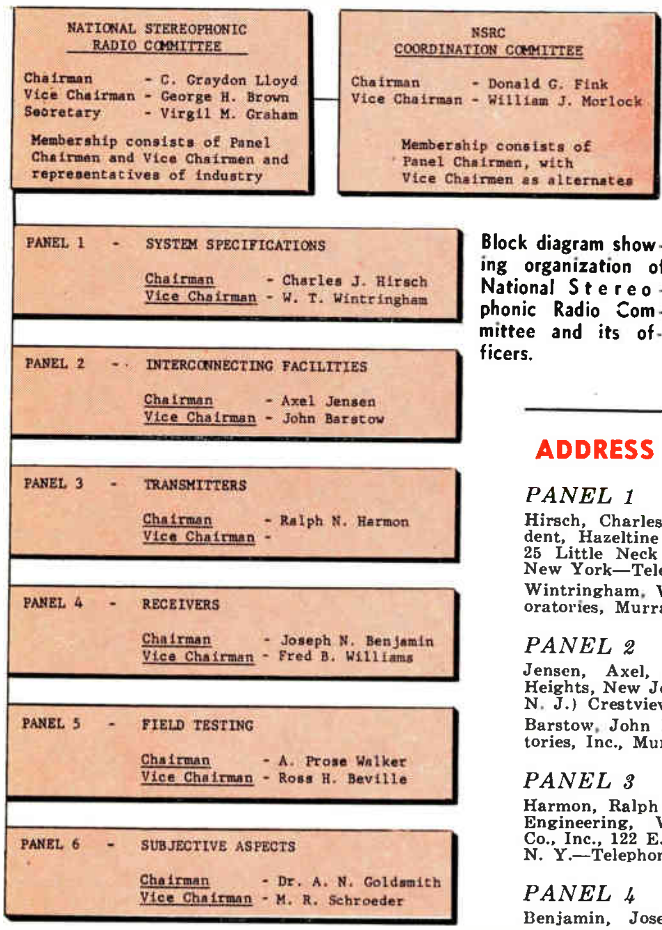
Scope: This committee shall coordinate the activities of the other panels, shall prepare definitions, and shall prepare the NSRC Final Reports for the approval of the NSRC.

*PANEL 1—SYSTEM SPECIFICATIONS*

Scope: Panel 1 shall consider system proposals for compatible stereophonic broadcasting; shall identify the technical issues in said proposals and refer them where necessary to other panels for detailed study; shall formulate a consistent set of transmission specifications for each form of broadcasting; and shall provide an overall evaluation of the system performance implied in the specifications.

*PANEL 2—INTERCONNECTING FACILITIES*

Scope: Panel 2 shall study and recommend technical characteristics of interconnecting lines, networks, studio-transmitter links and related stereo-transmission facilities between program origination points and the transmitters proper, said characteristics to include tolerable limits on crosstalk, relative time delay, frequency response, gain, and such other matters as must be controlled to assure a stereo signal of adequate quality at the transmitter input.




**Block diagram showing organization of National Stereophonic Radio Committee and its officers.**

### ADDRESS LIST — PANEL CHAIRMEN AND VICE CHAIRMEN

*PANEL 1*

Hirsch, Charles J., Executive Vice President, Hazeltine Research Corporation, 59-25 Little Neck Parkway, Little Neck 62, New York—Telephone: Flushing 7-8700.

Wintringham, W. T., Bell Telephone Laboratories, Murray Hill, New Jersey.

*PANEL 2*

Jensen, Axel, 21 Mea Drive, Berkeley Heights, New Jersey—Telephone: (Summit, N. J.) Crestview 3-5425.

Barstow, John M., Bell Telephone Laboratories, Inc., Murray Hill, New Jersey.

*PANEL 3*

Harmon, Ralph N., Dir. & Vice Pres. for Engineering, Westinghouse Broadcasting Co., Inc., 122 E. 42nd Street, New York 17, N. Y.—Telephone: MU 7-0808.

*PANEL 4*

Benjamin, Joseph N., President, David Bogen Company, P. O. Box 500, Paramus, New Jersey—Telephone: DIamond 3-5700.

Williams, Fred B., Director of Radio Engineering, Motorola Inc., 4545 Augusta Blvd., Chicago 51, Illinois.

*PANEL 5*

Walker, A. Prose, Manager-Engineering Department, National Association of Broadcasters, 1771 N Street, N.W., Washington 6, D. C.—Telephone: Decatur 2-9300.

Beville, Ross H., Vice President for Engineering, Radio Stations WWDC and WWDC-FM (Washington, D. C.), 8800 Brookville Road, Silver Springs, Md.—Telephone: TUckerman 2-7600.

*PANEL 6*

Goldsmith, Dr. A. N., Consulting Engineer, 597 Fifth Ave., New York 17, N. Y.—Telephone: PLaza 3-4150.

Schroeder, M. R., Acoustic Research Dept., Bell Telephone Laboratories, Murray Hill, New Jersey.

*PANEL 3—BROADCAST TRANSMITTERS*

Scope: Panel 3 shall study the system proposals referred to it by Panel with particular regard to (1) the feasibility of the proposed transmission method and (2) methods of adapting the proposals to existing broadcast transmitters.

*PANEL 4—BROADCAST RECEIVERS*

Scope: Panel 4 shall study the system proposals referred to it by panel 1 with particular regard to (1) the performance of existing monophonic receivers when tuned to the stereophonic signal (receiver compatibility), (2) the performance of stereophonic receivers designed for the stereophonic signal (stereo performance) and (3) the performance of stereophonic receivers when tuned to monophonic signals (reverse receiver compatibility).

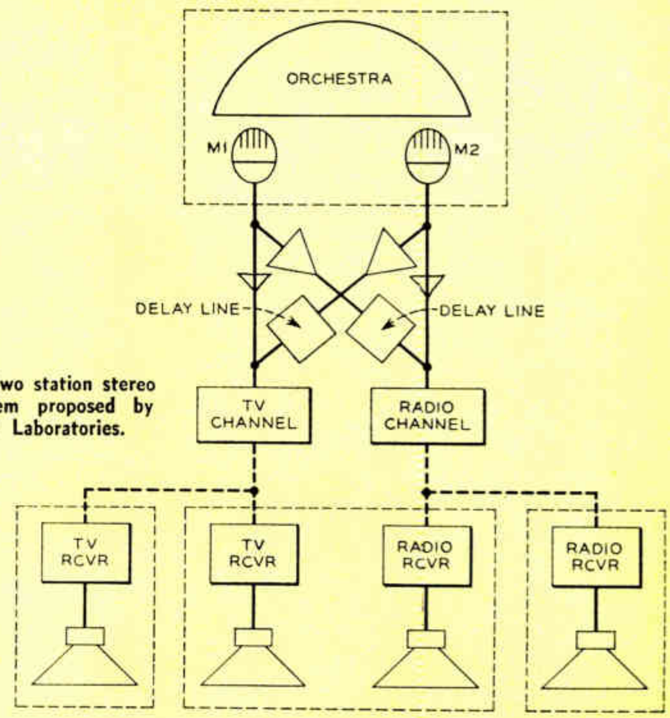
*PANEL 5—FIELD TESTING*

Scope: Panel 5 shall study and compare the system proposals referred to it by Panel 1, with particular regard to coverage, interference effects and other matters related to channel utilization; and shall conduct field tests with the advice and assistance of the other panels.

*PANEL 6—SUBJECTIVE ASPECTS*

Scope: Panel 6 shall provide to the other panels scientific information on the subjective aspects of stereophonic sound.

## Stereo and Compatible Single Channel Reception




**Block diagram of two station stereo broadcasting system proposed by Bell Telephone Laboratories.**

SEVERAL commercial radio and television stations have recently begun offering stereophonic sound programs, by broadcasting over two separate sound channels. In various experimental arrangements, the two channels required have been selected from different combinations of AM, FM, and TV channels. The listener then spaces the appropriate receivers properly in his home. Results have been sufficiently favorable that more and more broadcasters are now considering offering stereo programming.

The major obstacle to vastly increased use of this type of stereo broadcasting, however, is the person who listens with only one receiver. If the broadcaster tries for the full stereo effect, the sound the single channel listener hears comes from only one of the two widely-spaced microphone pickups, and he misses a portion of the program. What he does receive is poorly balanced, because of the placement of the pickups in relation to the sound sources. The broadcaster has had to dilute the stereo effect in order to preserve satisfactory reception for the single channel listener.

Now this single channel problem may be eliminated without affecting the stereo listener, through the use of a new "compatibility" circuit which has been developed by F. K. Becker of Bell Telephone Laboratories. The circuit depends for success on a psycho-acoustic phenomenon known as the "Precedence Effect". This effect operates in such a manner that when a single sound is reproduced through two separate loudspeakers, but is delayed several milliseconds (thousandths of a second) in one, the listener will "hear" the sound as if it came only from the speaker from which he heard it first. He will judge the second loudspeaker to be silent. The amount of the Precedence Effect depends somewhat on the length of delay built-in; at 10 milli-seconds, the sense of direction for an average observer is as if the echo were 8 to 10 decibels softer than the sound preceding it.

In stereo transmission over a radio station and a TV station, the circuits between the microphone pickups and their corresponding radio or TV transmitters are cross connected through two delay lines, each with its own buffer amplifier. Because of these cross connections, music or voice signals from the left microphone are transmitted directly to the left loudspeaker in the listener's home, while the same signal is slightly delayed before reaching the speaker to his right. The stereo listener will hear the sound as if it came only from the left loudspeaker because of the Precedence Effect. Conversely, the sound from the right microphone goes direct to the right speaker, but is delayed before reaching the left speaker, and is therefore unheard. Thus, the brain of the stereo listener localizes the sound he hears as coming direct from each of his two speakers, and full stereophonic effect is maintained.

However, monophonic reception is completely compatible with this,

(*Continued on page* 116)


# IRE Show Will Feature "Space" Theme

*Highlight of 4-day show and convention will be discussion on "Future Developments in Space" by ten leading national authorities. Over 850 exhibitors will be displaying their products to an expected 55,000 members and visitors.*

THE rapid strides which have been made in the past year in space technology and other major new fields of electronics have given a radically new look to the program of the 1959 IRE National Convention, scheduled for the Waldorf-Astoria Hotel and New York Coliseum on March 23-26.

Highlighting the 54 sessions will be a special Tuesday evening symposium at which ten of the nation's foremost experts will discuss "Future Development in Space." Present developments, too, will receive a good deal of attention in two additional sessions devoted to Space Electronics.

Two new entries of unusual interest have been included in the program this year: a symposium on Psychology and Electronics in the Teaching-Learning System, and a session on Theory and Practice in Russian Technology. Other sessions range over the fields of all 28 IRE Professional Groups and include such timely topics as Widening Horizons in Solid State Electronics, Frontiers of Industrial Electronics, Man-Machine System Design, and Military Electronics Looks Forward.


Ernst Weber, President, IRE


Donald B. Sinclair, Vice-Pres., IRE


Dr. W. R. G. Baker, Treas., IRE

Exhibit space at the mammoth New York Coliseum has been completely sold out, assuring visitors that the Radio Engineering Show will provide them with the most complete showcase of new apparatus and products ever assembled under one roof. Eight hundred fifty exhibitors will display thousands of the latest developments, many for the first time. For the convenience of visitors, the exhibits will be grouped as follows: Floor 1—Systems; Floor 2—Components; Floor 3—Instruments; Floor 4—Production.

Convention activities begin on Monday morning, March 23, with the Annual Meeting of IRE in the Grand Ballroom of the Waldorf. Donald B. Sinclair, vice president of the IRE, will be the principal speaker.

The social activities include a get-together cocktail party Monday evening and the Annual Banquet Wednesday evening, at which the 1959 IRE award winners will be honored. Because an attendance of over 55,000 is expected at the convention, members are being urged to send in their reservations for these functions immediately.

An entertaining program of tours, luncheons, fashion shows and matinees has been arranged for the wives of members.

Products will be displayed by more than 850 electronic manufacturers

## IRE TECHNICAL SESSIONS

A COMPREHENSIVE program of 54 technical sessions will attract at least 55,000 radio engineers and scientists. Thirty-three sessions are scheduled for the Waldorf-Astoria Hotel and 21 at the Coliseum.

One of the opening sessions on Monday afternoon will discuss engineering writing. The paper "Using the Psychological Approach in Scientific Writing" is being presented by John L. Kent of the Datex Corp. The paper points out how scientists, engineers and other technically trained persons can write better with less effort if they adopt the techniques described.

Trying to obtain additional financial backing for your firm? Casper M. Bower's Utilities & Industries Corp. paper entitled, "Obtaining Capital for the Smaller Electronic Firm—Methods and Pitfalls," describes how the small electronics firm may go about obtaining financial assistance. Mr. Bower also describes pitfalls that should be avoided in obtaining capital. This paper is only one of several being presented Monday afternoon for management in the Empire Room of the Waldorf-Astoria Hotel.

Mobile microphones have been a problem with broadcasters. Peter K. Onnigian, KBET-TV, describes a fully transistorized wireless microphone in his paper, "A New Wireless Microphone for TV Broadcasting." The unit described meets FCC rules for such devices. It requires no external antenna and eliminates trailing wires. It is approximately the size of a package of king sized cigarettes. During the Tuesday afternoon session, Mr. Onnigian will also describe a companion receiver which may be used with the unit.

Lately, some of the greatest strides in medicine have come about due to electronics. An increasing amount of interest is being shown in this field. V. K. Zworykin's paper, "Recent Advances in Medical Elec-

Haraden Pratt, Secretary, IRE

John D. Ryder, Editor, IRE

# IRE Show *(Continued)*

tronics" should be one of the highlights of the medical electronics sessions. In his paper he indicates ways for increasing further the effectiveness with which engineering knowledge may be applied to medical problems.

New microwave developments are cropping-up every day. One of the latest is the ability to obtain as many as 10 local oscillator frequencies from one tube. Charles W. Flynn, ITT Labs., describes the application of a commercially available traveling wave tube for this use in his paper, "A Mobile Frequency Local Oscillator." Paper is being presented Tuesday afternoon.

Engineers engaged in component design should place the sessions on components parts on top of their list. On Wednesday morning, C. H. Lewis is presenting an interesting paper called, "Trend of Things to Come." He points out in his paper that the conventional components will disappear and their function will be taken over by specially designed materials performing single and multi-purpose functions. He will describe in detail the knowledge and skills that must be acquired by electronics specialist of the future to keep pace with this fast moving segment.

One of the hottest moving areas in the electronics field is ultrasonics. Every day new applications and uses for this new "tool" are being found. There is some real interesting information being presented in the two ultrasonic engineering sessions. One being held Thursday morning and the second one Thursday afternoon. The sessions are a must for engineers working in the ultrasonic field.

With the increasing availability of automation equipment, the industrial electronics field has been spurting ahead. The Thursday morning session on industrial electronics should be of interest not only to those in the field, but those interested in entering the field of industrial electronics. Almost every day there is mention in the news-

*(Continued on page 222)*

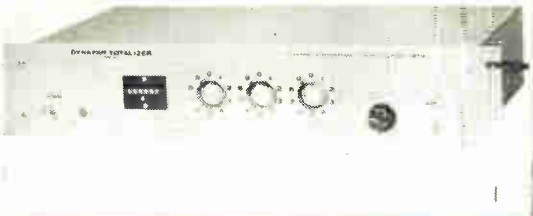
Aerial view of New York's Coliseum, again the site of this year's IRE National Convention

Complete
1959 IRE
TECHNICAL PAPERS PROGRAM
to be found on
page 222

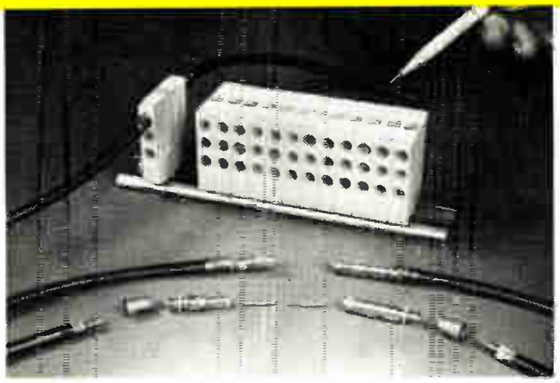
## 1959 IRE National Convention—Technical Program

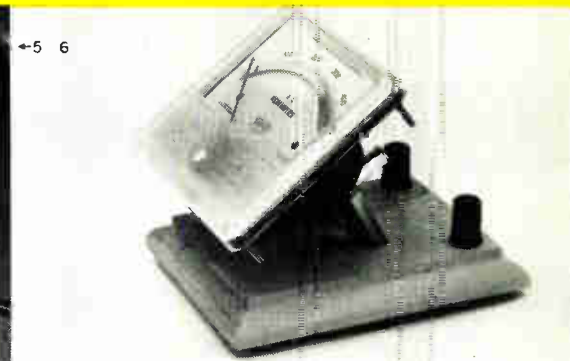
| | Waldorf-Astoria Hotel | | | | | | New York Coliseum | | |
|---|---|---|---|---|---|---|---|---|---|
| | Starlight Roof | Astor Gallery | Jade Room | Sert Room | Empire Room | Grand Ballroom | Morse Hall | Marconi Hall | Faraday Hall |
| Monday, March 23<br>2:30 - 5:00 p.m. | Session 1<br>Adaptive Control Processes and Allied Systems | Session 2<br>Vehicular Communications | Session 3<br>Engineering Writing and Speech | Session 4<br>Radio Frequency Interference | Session 5<br>Engineering Management Techniques | | Session 6<br>Production Techniques | Session 7<br>Navigation and Traffic Control | Session 8<br>Electronic Devices |
| Tuesday, March 24<br>10:00 a.m. -<br>12:30 p.m. | Session 9<br>New Techniques for Analysis | Session 10<br>Nuclear Instrumentation Techniques - I | Session 11<br>Broadcasting - I | Session 12<br>Contributions to Stereo Sound Reproduction | | Session 13 •<br>Engineering Management - II | Session 14<br>Medical Electronics - I | Session 15<br>Land and Space Electronics | Session 16<br>*Panel:* Widening Horizons in Solid State Electronics |
| Tuesday, March 24<br>2:30 - 5:00 p.m. | Session 17<br>Information Theory | Session 18<br>Nuclear Instrumentation Techniques - II | Session 19<br>Broadcasting - II | Session 20<br>Speech and Circuits | | | Session 21<br>Medical Electronics - II | Session 22<br>Reliability Techniques | Session 23<br>Microwave Tubes |
| Tuesday, March 24<br>8:00 - 10:30 p.m. | Session 24<br>*Panel:* Future Developments in Space | | | | | | | | |
| Wednesday, March 25<br>10:00 a.m.<br>12:30 p.m. | Session 25<br>The Statistical Theory of Signals and Circuits | Session 26<br>Radio and Television Receivers | Session 27<br>Component Parts - I | Session 28<br>Digital Telemetering | | Session 29 •<br>*Symposium:* Psychology and Electronics in the Teaching-Learning System | Session 30<br>Communication by Scatter System | Session 31<br>Mathematical Approaches for Reliability | Session 32<br>Microwave Devices |
| Wednesday, March 25<br>2:30 - 5:00 p.m. | Session 33<br>Electronic Computers: Systems and Applications | Session 34<br>Symposium on Sequential Circuit Theory | Session 35<br>Component Parts - II | Session 36<br>Space Electronics | | | Session 37<br>Communication by HF Radio and by Wire Line | Session 38<br>Propagation and Antennas - I | Session 39<br>Microwave Theory and Techniques |
| Thursday, March 26<br>10:00 a.m. -<br>12:30 p.m. | Session 40<br>Theory and Practice in Russian Technology | Session 41<br>Circuit Theory II - Analysis and Synthesis | Session 42<br>Ultrasonic Engineering - I | Session 43<br>Military Electronics - Looks Forward | Session 44<br>Frontiers of Industrial Electronics | | Session 45<br>Man-Machine System Design | Session 46<br>Antennas - II | Session 47<br>Instrumentation: Devices and Circuits |
| Thursday, March 26<br>2:30 - 5:00 p.m. | Session 48<br>Electronic Computers: Components and Circuits | Session 49<br>Circuit Theory III - Applications | Session 50<br>Ultrasonic Engineering - II | Session 51<br>Concepts and Programs | | | Session 52<br>Communication Engineering in Broadcasting | Session 53<br>Antennas - III | Session 54<br>Instrumentation for High Speed Data Acquisition |

• Sessions terminate at 12:00 Noon.



# See these Products at IRE





### 1—Digital Totalizer

Series 40A, transistorized digital totalizer operates from contactors, photocells, or other sensing devices which count objects. Handles wide range of input signals. Dynapar Corporation, Inc. **Booth 3116.**

Circle 161 on Inquiry Card, page 123

### 2—BW Oscillator

The QK634 is a voltage tunable, wide-band (8150 to 11000 MC) CW BWO. Minimum power output is 150 w. Nominal power output is 200 to 250 w. over the band. Raytheon Mfg. Co. **Booth 2611.**

Circle 162 on Inquiry Card, page 123

### 3—Meter Relay

Model 137 VHS non-indicating meter-relay will trigger control action on signal changes as small as 0.2 μa. or 0.1 mv. dc. It has adjustable contacts. Assembly Products, Inc. Booth 3815.

Circle 163 on Inquiry Card, page 123

### 4—Frequency Monitor

Model M-4990 guards the position of a broadcaster's transmitter frequency within ± 2 ppm. Signal may be connected to a monitor or transmitter over 20 m. away. Gates Radio Co. **Booth 1310.**

Circle 164 on Inquiry Card, page 123

### 5—Printed Circuit Board

Diallyl phthalate block. Right angle pins assemble to board on one side, to receptacle on the other. Sockets are solderless crimp-type, snap-locked contacts. Burndy Corp. **Booth 3107.**

Circle 165 on Inquiry Card, page 123

### 6—Panel Meters

Unimeter Series, dial component sections combine with separate basic movement sections for a variety of meters. Sections slide together, lock with a thumbscrew. Triplett Electrical Inst. Co. Booth 3613.

Circle 166 on Inquiry Card, page 123

### 7—Ceramics

AlSiMag ceramic developments include: multi-pin hermetically sealed headers, capacitors, alumina ceramics in complex shapes, wire guides for coils, missile components. American Lava Corp. **Booth 3901.**

Circle 167 on Inquiry Card, page 123

### 8—Checkout System

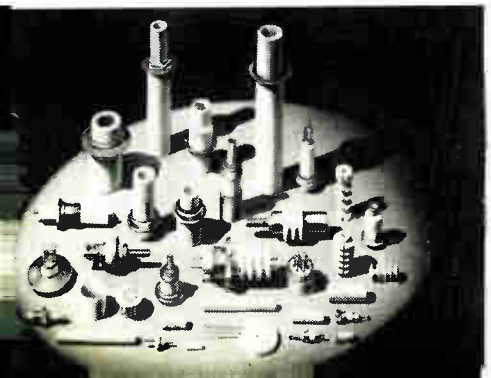
Automatic, high speed, test equipment designed to check out "Thor" ground support units. Unit is part of a multi-purpose checkout system for missiles and aircraft. Packard Bell Corp. Booth 1313.

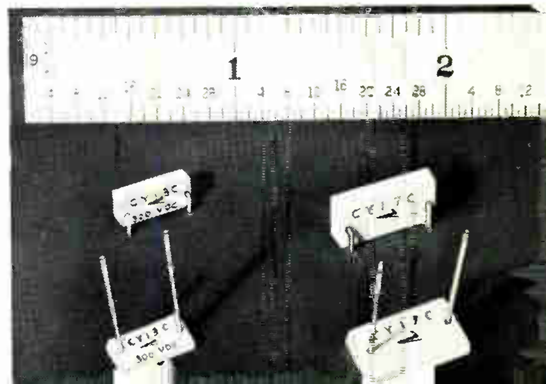
Circle 168 on Inquiry Card, page 123

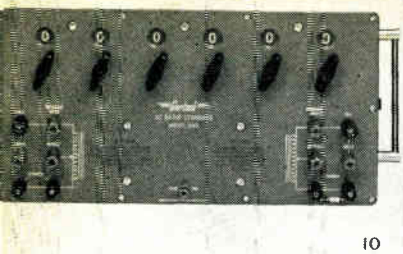
### 9—Capacitors

Radial lead capacitor, CY17C, has a dissipation factor less than 0.0005 with Q over 2500. Capacitance drift is less than 0.05% with a TC of 115 ±25 ppm/°C from −55° to +125°C. Vitramon, Inc. Booth 2401.

Circle 169 on Inquiry Card, page 123







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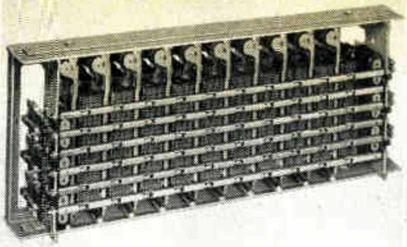

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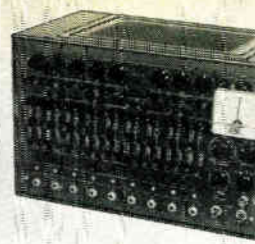

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# See these Products at IRE

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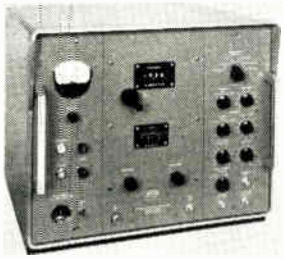

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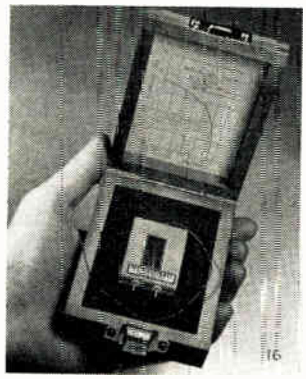

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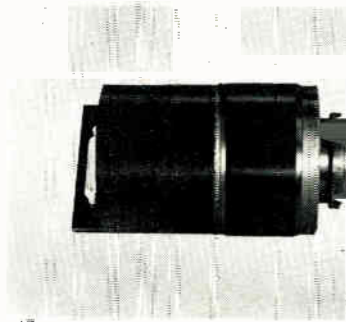

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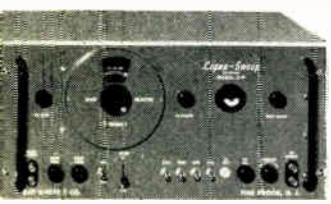

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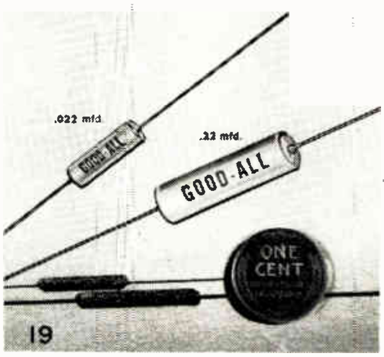


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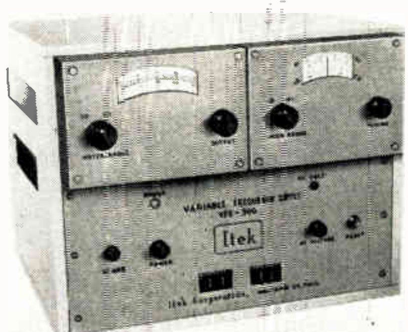


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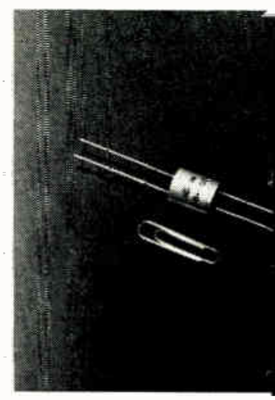

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## 10—Voltage Dividers

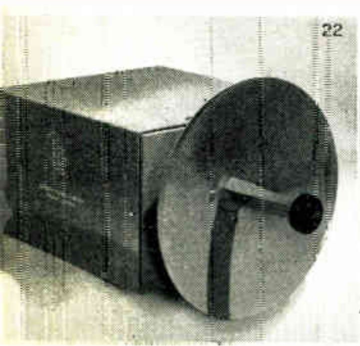
Model 1000, AC Ratio Standard, has ratio accuracies as good as 0.0001%. Has dual range for high or low voltage operation. Also: FM-7/DM-2, Frequency and Deviation Meter. Gertsch Products, Inc. **Booth 3701.**

**Circle 170 on Inquiry Card, page 123**

## 11—Crossbar Switch

Memory device for analog and digital computer uses Matrix principle. Used for programming and sequencing. Handles up to 1200 circuits. Life exceptancy 50 × $10^6$ operations. North Electric Co. **Booth 2125.**

**Circle 171 on Inquiry Card, page 123**



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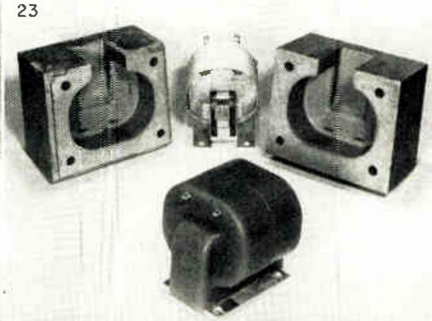

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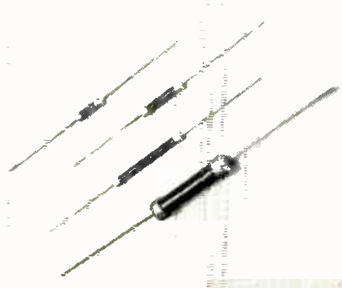

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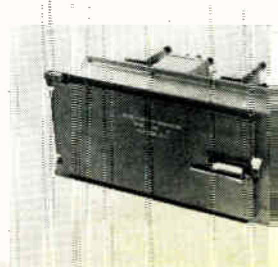

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## 12—Phase Meter

Model 200AB measures phase angles in the presence of noise and harmonic voltages. Also: Model 150 Power Oscillator which supplies 160 va at two frequencies. Industrial Test Equipment Co. **Booth 3206.**

Circle 172 on Inquiry Card, page 123

## 13—Analog Computer

Educational Electronic A n a l o g Computer, EC-1, for teaching and demonstrations and for lab use. Also the OR-1, a 5 in. oscilloscope featuring a 5ADP2, flat-faced CRT. Heath Co. **Room 267.**

Circle 173 on Inquiry Card, page 123

## 14—Silicone Rubber

Silastic RTV 502, silicone rubber, cures at room temp.—sets in 30 min. Also: Other silicon products for filling, potting, encapsulation, and impregnating. Dow Corning Corp. **Booth 4308.**

Circle 174 on Inquiry Card, page 123

## 15—Signal Generator

Microwave signal generator has direct digital readout, accuracy to ±1% and can be AM or FM modulated. Also: spectrum analyzer Model SA-84W. Polarad Electronics Corp. **Booth 3210.**

Circle 175 on Inquiry Card, page 123

## 16—Solar Cell

Silicon solar cells for calibrating artificial light sources in terms of solar energy radiation are considered the solar cell analog to the pyroheliometer standard. International Rectifier Corp. **Booth 2901.**

Circle 176 on Inquiry Card, page 123

## 17—Shaft Position Encoder

Type RD-13B Digisyn, is a 13-digit, photoelectric, shaft position encoder with a 10 v. output ± 10% from −40°F to +165°F., and provides a signal to null ratio of 100:1. Wayne-George Corp. **Booth 1417.**

Circle 177 on Inquiry Card, page 123

## 18—Sweep Oscillator

Model CP has variable sweep widths that cover Video, i-f, and VHF in 6 switched bands. Also: The Megalator, a transistorized amplitude modulator, dc to 1000 MC. Kay Electric Company. **Booth 2608.**

Circle 178 on Inquiry Card, page 123

## 19—Capacitors

Miniature capacitors, 50 v., are designed for operation at 85°C without derating and to 125°C with 50% derating. Units, from 0.001 µf. to 1.0 µf. Hermetically sealed. Good-All Electric Mfg. Co. **Booth 3716.**

Circle 179 on Inquiry Card, page 123

## 20—Power Supply

Variable Frequency Power Supply, VFS 300, provides 250va. output power, output frequency from 45 to 2000 CPS, and variable output voltage of 0 to 140 v RMS. 105-130 v ac, 50-60 CPS input. Itek Corp. **Booth 3220.**

Circle 180 on Inquiry Card, page 123

## 21—Transformers

Miniature, low-power, wide band, high frequency transformers have turns ratios from 1:1 to 1:10. Primary impedance levels are 50 ohms and 100 ohms. Military units meet MIL-T-27A. Aladdin Electronics Co. **Booth 3938.**

Circle 181 in Inquiry Card, page 123

## 22—Antenna

Variable Polarization Antenna, Model 157, for X-band features motor-driven remote control of polarization. Frequency range is 8,500 to 9,600 MC. Has 50 kw nominal peak power capacity. California Technical Ind. **Booth 1111.**

Circle 182 on Inquiry Card, page 123

## 23—Epoxy Compound

Hysol 6700 Series epoxy compounds are ready to use without adding hardening agents. Meet MIL-T-27B. Also: epoxy molding powder, Hysol 8610, a one component powder. Houghton Labs., Inc. **Booth 4213.**

Circe 183 on Inquiry Card, page 123

## 24—Resistor

High energy resistors handle up to 25 w. at 1000°F with no derating. Resistance ranges from 0.2 to 1.1 K ohms. Materials have low sensitivity to induced radio activity. The Carborundum Co. **Booth 2930.**

Circle 184 on Inquiry Card, page 123

## 25—Function Generator

Model 100, Diode Function Generator, has a punched card memory. Accuracy—0.1%; repeatability—0.02%; input and output range—±100 v; input impedance—1 megohm; Frequency response—dc to 10 KC. Electrol, Inc. **Booth 1625.**

Circle 185 on Inquiry Card, page 123

## 26—Dipole Feed

Model DIC-3045, ⅞-in., coaxial dipole feed has a frequency range from 3800 to 4150 MC. Max voltage standing wave ratio is 1.35 to 1.0. Diamond Antenna & Microwave Corporation. **Booth 3237.**

Circle 186 on Inquiry Card, page 123

## 27—Connector

Center screwlock, pin and socket connectors have from 34 to 104 contacts. Body material is molded from glass filled diallylphthalate (MIL-M-19833, Type GDI-30, Green). DeJur-Amsco Corp. **Booth 2307.**

Circle 187 on Inquiry Card, page 123

## 28—Control Tower

Mobile air traffic control tower, AN/MRN-15, is helicopter transportable. It contains all the electronic equipment needed for aircraft control and guidance at an airstrip. Craig Systems, Inc. **Booth 1325.**

Circle 188 on Inquiry Card, page 123

## 29—Differential Voltmeter

Model MV-212C, ac differential voltmeter, is designed for differential measurements from 0.7 v. to 300 v. in the frequency range from 20 CPS to 500 KC. Accuracy is 3%. Cohu Electronics, Inc. **Booth 3409.**

Circle 189 on Inquiry Card, page 123

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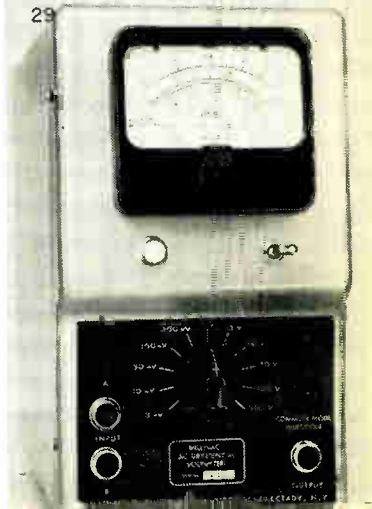

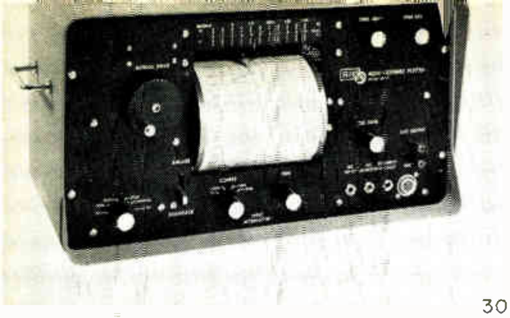

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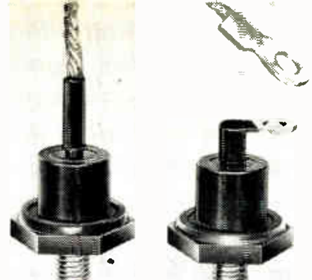

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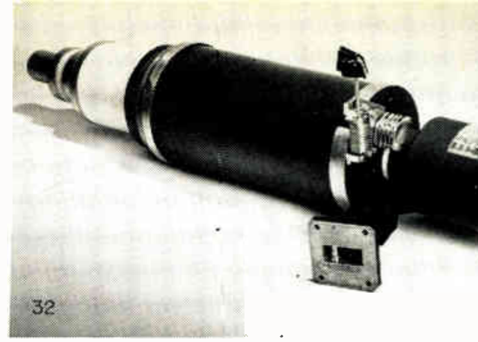

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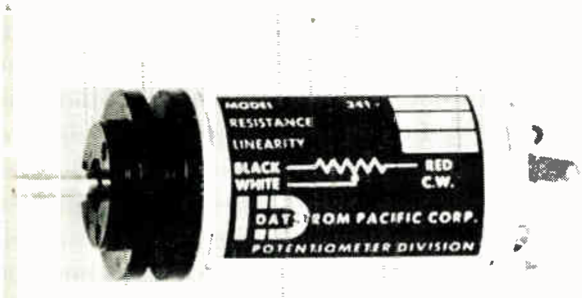
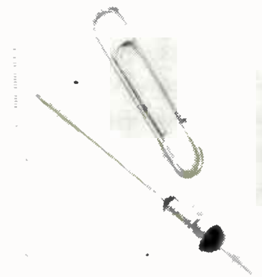
# See these Products at IRE



33

34 35

### 30—Response Plotter

Model ARP-2, audio response Plotter, makes permanent pen-written frequency response curves of any audio-range equipment. Also: meters and power supplies. Southwestern Industrial Electronics Co. Booth 3305.

**Circle 190 on Inquiry Card, page 123**

### 31—Power Rectifier

Silicon Power Rectifer for 165°C, service. Type 4A is 35 a.; Type 6A is 20 a. Also: other silicon power rectifiers, capacitors, and refractory metals. Fansteel Metallurgical Corp. Booth 4021.

**Circle 191 on Inquiry Card, page 123**

### 32—Klystron Tubes

Type Z-5095 is designed for pulsed operation and X-band service. Type Z-5214 is a continuous-wave, integral, 4-cavity design (7500 to 8500 MC). Also: 10 other tubes. General Electric Co. Booth 2924.

**Circle 192 on Inquiry Card, page 123**

### 33—Potentiometers

Ten-turn potentiometers are ½ in. x 1 in. Also: series 319 Wire-wound gangable pots; Series 318, printed circuit, "Squaretrim", Trimming Pots, Daystrom Pacific, Booth 1804.

**Circle 193 on Inquiry Card, page 123**

### 34—Frequency Generator

"L" band frequency generator has stability better than 1 part in 10[illegible] per day. Also: a precision crystal oven with temp control to ±0.02°C over 50°C ambient. Manson Laboratories, Inc. Booth 3225.

**Circle 194 on Inquiry Card, page 123**

### 35—Capacitor

Microminiature feed-through capacitor is thermal-shockproof. Also: a magnetic amplifier, electrically and spring driven gyros, and analog-to-digital shaft converters. Telecomputing Corp. Booth 2128.

**Circle 195 on Inquiry Card, page 123**

### 36—Tape Cable

Wiring assemblies are made by laying one section of Tape Cable on another and soldering the desired conductor intersections through the insulation. Tape Cable Corp. Booth 4133.

**Circle 196 on Inquiry Card, page 123**

### 37—Radar System Tester

Model AN/GPM-25 Radar System Tester is designed for testing bombing radar systems and as a navigation and weather radar tester. Unit is portable. General Mills, Mechanical Div. Booth 1900.

**Circle 197 on Inquiry Card, page 123**

### 38—Ultrasonics

The "Polaris", an industrial ultrasonic washing system, has a 1 kw 40 KC ultrasonic generator. Also: an ultrasonic dishwasher and the "Redstone", a roll-around unit. Narda Ultrasonics Corp. Booth 4532.

**Circle 198 on Inquiry Card, page 123**

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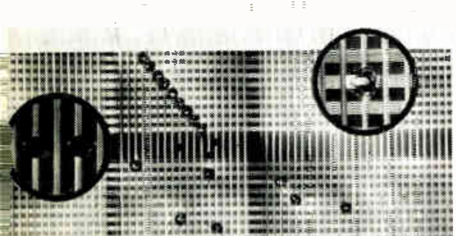

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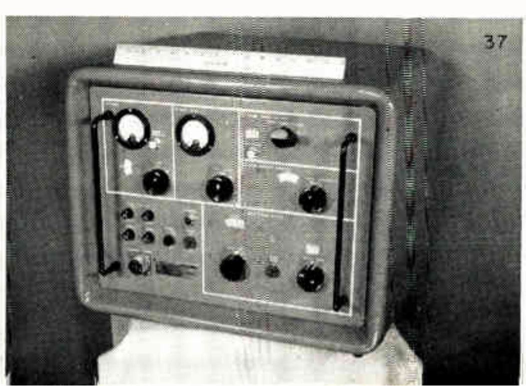

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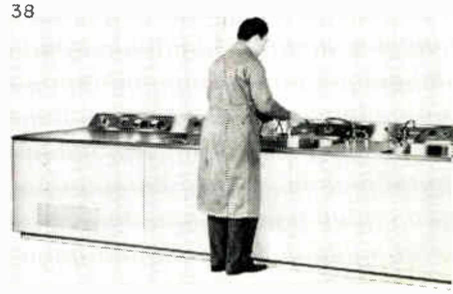
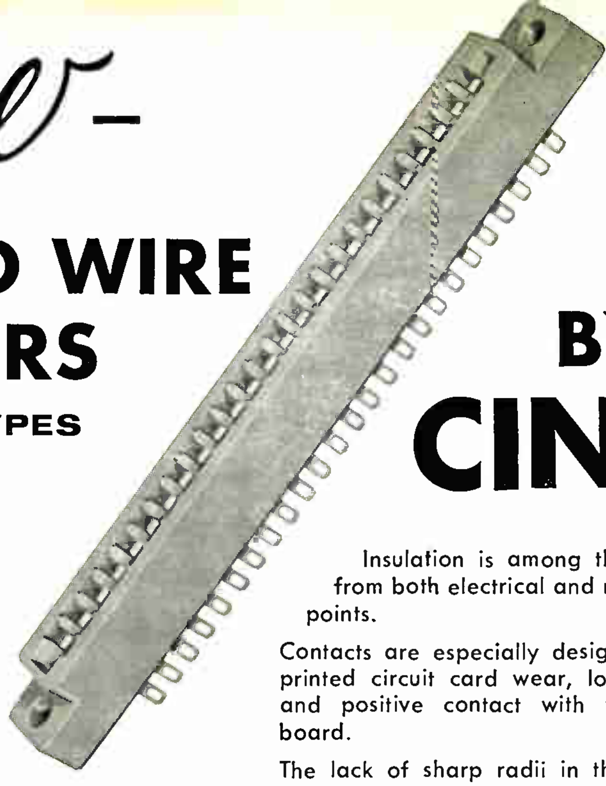


# *New* –

# MOLDED PRINTED WIRE EDGE CONNECTORS

# BY CINCH

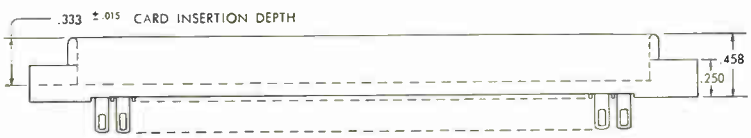
## SINGLE AND DUAL CONTACT TYPES

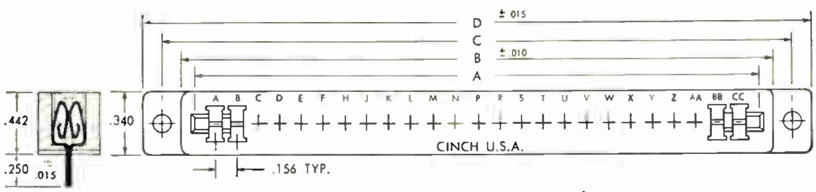


**Single Contact Type No. 29029 A or B***

Made in 6 through 25 contacts inclusive. Designed for nominal 1/16″ printed wire board, either single or two sided copper.

A polarizing contact made of brass, Sel-Rex gold plated, can be placed in any contact position. Insulation material is of glass filled Diallyl Phthalate (Type GDI-30 per Mil. M-19833). Contacts are of Beryllium Copper or Phosphor Bronze with Sel-Rex gold plate .00003 Minimum. Terminals are mounted on .156″ centers. Mounting holes are .128″ dia.



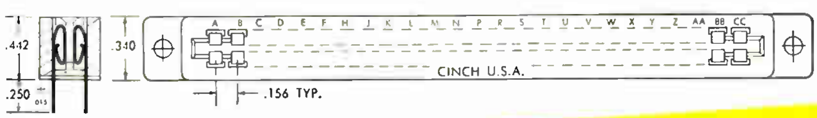




**Dual Contact Type No. 29028 A or B***

Made in 12 through 50 contacts in multiples of two. Designed for nominal 1/16″ printed wire board, copper clad on both sides.

Contacts, polarizing contact, insulation and mounting holes are the same as described for No. 29029.

*A—Phosphor Bronze Contact  *B—Beryllium Copper Contact




Insulation is among the best available from both electrical and mechanical standpoints.

Contacts are especially designed for minimum printed circuit card wear, low insertion force and positive contact with the printed wire board.

The lack of sharp radii in the contact design makes it possible to offer this contact in either Beryllium copper or Phosphor Bronze. Due to the use of heavier material in the contacts the tails are more rigid than those in similar connectors that are presently available.

| | AC RMS | DC |
|---|---|---|
| **VOLTAGE BREAKDOWN:** | | |
| Sea level (adj. terminals)..................... | 2500 | 3800 |
| Altitude 3.4 HG. 50,000 ft. (adj. terminals)..... | 900 | 1200 |
| Altitude 1.3 HG. 70,000 ft. (adj. terminals)..... | 600 | 850 |
| **VOLTAGE RATINGS:** | | |
| Sea level (adj. terminals)..................... | 830 | 1270 |
| Altitude 3.4 HG. 50,000 ft. (adj. terminals)..... | 300 | 400 |
| Altitude 1.3 HG. 70,000 ft. (adj. terminals)..... | 200 | 280 |
| **RECOMMENDED WITHSTANDING VOLTAGE:** | | |
| Sea level (adj. terminals)..................... | 1870 | 2850 |
| Altitude 3.4 HG. 50,000 ft. (adj. terminals)..... | 675 | 900 |
| Altitude 1.3 HG. 70,000 ft. (adj. terminals)..... | 450 | 640 |

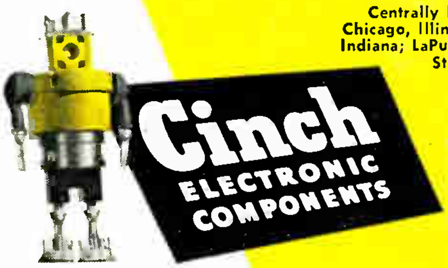
Current Rating 10 Amperes

| | |
|---|---|
| Contact resistance at 7.5 amperes measured with nominal thickness printed wire board. | 0.0027 Ohms Max. |
| Insulation resistance | 5000 Megohms Min. |
| Insulation resistance (immediately after 96 hours at 90-95% R.H. and 40°±2° per method 103A of Mil-STD-202A | 100 Megohms Min. |

In ordering use base number, 29029 or 29028, followed by the number of contacts, then contact material and then the letter indicating position of the polarizing contact. For example 29029-12-A-E, or 29028-16-B-E.

Contact tail as shown available now, wire wrap and dip solder type contacts in the near future.

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




**Single Contact Type No. 29029**

| BASE NO. | NUMBER OF CONTACTS | DIMENSIONS A | B | C | D |
|---|---|---|---|---|---|
| 29029 | 6 | 1.098 | 1.239 | 1.531 | 1.785 |
| 29029 | 7 | 1.254 | 1.395 | 1.687 | 1.941 |
| 29029 | 8 | 1.411 | 1.552 | 1.844 | 2.098 |
| 29029 | 9 | 1.567 | 1.708 | 2.000 | 2.254 |
| 29029 | 10 | 1.723 | 1.864 | 2.156 | 2.410 |
| 29029 | 11 | 1.879 | 2.020 | 2.312 | 2.566 |
| 29029 | 12 | 2.036 | 2.177 | 2.469 | 2.723 |
| 29029 | 13 | 2.198 | 2.333 | 2.625 | 2.879 |
| 29029 | 14 | 2.348 | 2.489 | 2.781 | 3.035 |
| 29029 | 15 | 2.504 | 2.645 | 2.937 | 3.191 |
| 29029 | 16 | 2.661 | 2.802 | 3.094 | 3.348 |
| 29029 | 17 | 2.817 | 2.958 | 3.250 | 3.504 |
| 29029 | 18 | 2.973 | 3.114 | 3.406 | 3.660 |
| 29029 | 19 | 3.129 | 3.270 | 3.568 | 3.816 |
| 29029 | 20 | 3.286 | 3.427 | 3.719 | 3.973 |
| 29029 | 21 | 3.442 | 3.583 | 3.875 | 4.129 |
| 29029 | 22 | 3.598 | 3.739 | 4.031 | 4.285 |
| 29029 | 23 | 3.754 | 3.895 | 4.187 | 4.441 |
| 29029 | 24 | 3.911 | 4.052 | 4.344 | 4.598 |
| 29029 | 25 | 4.067 | 4.208 | 4.500 | 4.754 |

**Dual Contact Type No. 29028**

| BASE NO. | NUMBER OF CONTACTS | DIMENSIONS A | B | C | D |
|---|---|---|---|---|---|
| 29028 | 12 | 1.098 | 1 239 | 1.531 | 1.785 |
| 29028 | 14 | 1.254 | 1.395 | 1.687 | 1.941 |
| 29028 | 16 | 1.411 | 1.552 | 1.844 | 2.098 |
| 29028 | 18 | 1.567 | 1.708 | 2.000 | 2.254 |
| 29028 | 20 | 1.723 | 1.864 | 2.156 | 2.410 |
| 29028 | 22 | 1.879 | 2 020 | 2.312 | 2.566 |
| 29028 | 24 | 2.036 | 2.177 | 2.469 | 2.723 |
| 29028 | 26 | 2.192 | 2.333 | 2.625 | 2.879 |
| 29028 | 28 | 2.348 | 2.489 | 2.781 | 3.035 |
| 29028 | 30 | 2.504 | 2.645 | 2.937 | 3.191 |
| 29028 | 32 | 2 661 | 2.802 | 3.094 | 3.348 |
| 29028 | 34 | 2.817 | 2.958 | 3.250 | 3.504 |
| 29028 | 36 | 2.973 | 3.114 | 3.406 | 3.660 |
| 29028 | 38 | 3.129 | 3 270 | 3.562 | 3.816 |
| 29028 | 40 | 3.286 | 3.427 | 3.719 | 3.973 |
| 29028 | 42 | 3.442 | 3.583 | 3.875 | 4.129 |
| 29028 | 44 | 3.598 | 3.739 | 4.031 | 4.285 |
| 29028 | 46 | 3.754 | 3.895 | 4.187 | 4.441 |
| 29028 | 48 | 3.911 | 4.052 | 4.344 | 4.598 |
| 29028 | 50 | 4.067 | 4.208 | 4.500 | 4.754 |

**CINCH MANUFACTURING COMPANY**

**1026 South Homan Ave., Chicago 24, Illinois**

**Division of United-Carr Fastener Corporation, Boston, Mass.**

**VISIT BOOTH NO. 2535 AT THE I.R.E. SHOW**

## Standardizing Stereo

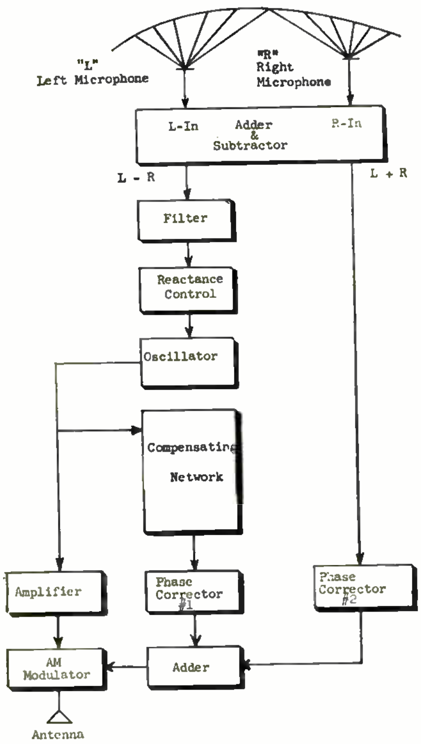
(*Continued from page* 107)
since a listener to each single channel hears the total sound from both microphones in a balanced reproduction. The slight delay built in apparently does not affect his reception at all, according to subjective tests performed at Bell Laboratories.

Typical operating conditions in listening tests conducted today had a time delay of 10 milliseconds, with the volume of the delayed channel 1½ db softer than that of the direct. (The Precedence Effect, which was first discovered in 1933, operates over a delay range of from 5 to 35 milliseconds).

This development should make it possible for many more broadcasters to offer double-channel stereo programming without diluting the stereo effect or penalizing the single channel listener, who now make up the majority of their audience.

## *AM Stereophonic Broadcasting*

AN AM stereophonic broadcasting system different from any yet introduced—and closely related




to the duplex radio transmission system Dr. Frank Conrad, Westinghouse radio pioneer, discovered in the twenties—has been shown by the Westinghouse Electric Corporation's television-radio division. The stereophonic signal is achieved by simultaneous amplitude and frequency modulation of the carrier.

The new system provides: 1) excellent compatibility for monophonic reception of the stereophonic signal on conventional AM receivers; 2) reasonable stereophonic reception and reproduction with two conventional AM receivers; and 3) high quality stereophonic reception and reproduction with inexpensive receivers specially designed for the system.

The new system is compatible with present FCC standards for AM broadcasting. The amplitude modulation is essentially that of the normal commercial broadcast band signal and the stereophonic information is supplied by varying the carrier frequency. The stereophonic information is contained in the band from 300 to 3000 cps. It is therefore, practical to use frequency modulation for the stereophonic information without interfering with adjacent AM channels.

Transmission of the AM and FM signals is accomplished in a manner that permits any standard AM receiver to pick up and reproduce, distortion-free, balanced monophonic sound, while a stereophonic receiver—with separation circuit and multiple speakers — will convert these AM and FM signals into true stereophonic sound.

An interesting additional feature of this system is that two standard AM receivers carefully tuned: one to the low side of the AM channel, the other to the high side—placed four to eight feet apart—can reproduce reasonable stereophonic sound.

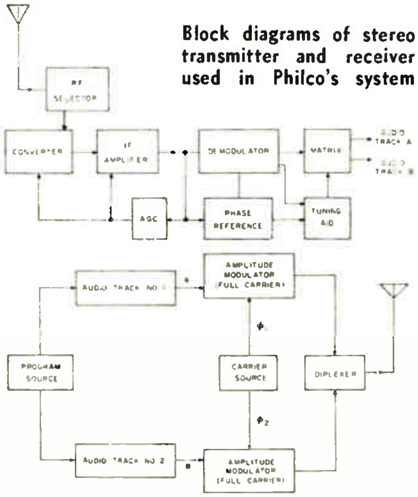
"Such compatibility," means that the millions of AM radio receivers now in daily use are in no danger of becoming technologically obsolete; they still can be used for monophonic reception of both regular and stereophonic broadcasts. And in homes where there are two AM radios, the owners can enjoy the naturalness of stereophonic sound by properly tuning both to the same AM station.

"The system standards will be submitted to the National Stereophonic Radio Committee for study. A proposal for a test demonstration is being submitted to the FCC. As soon as this authorization is received, Westinghouse Broadcasting Company will conduct a test program over one of its stations — probably Pittsburgh's

**Left: block diagram of Westinghouse's AM compatible stereophonic transmitter**

## AM Stereo Broadcasting

PHILCO Corp. has developed a new system of radio broadcasting designed to bring stereophonic sound into every American home. The system provides a signal which could be used for stereo reception and which would not affect present AM transmission to existing monophonic receivers. No new radio frequencies will be required, and stations will be able to switch from monophonic to stereophonic broadcasts at will. Block diagrams of transmitter and receiver for Philco's new stereo system are shown below. When field testing is approved company plans to cooperate with any licensed broadcaster and with NSRC.




**Block diagrams of stereo transmitter and receiver used in Philco's system**

pioneer KDKA—about the middle of March."

The system was developed by C. W. Baugh, Jr., Harold E. Sweeney, and others of the advanced development group. These engineers set up the following specifications for the AM-FM signal:

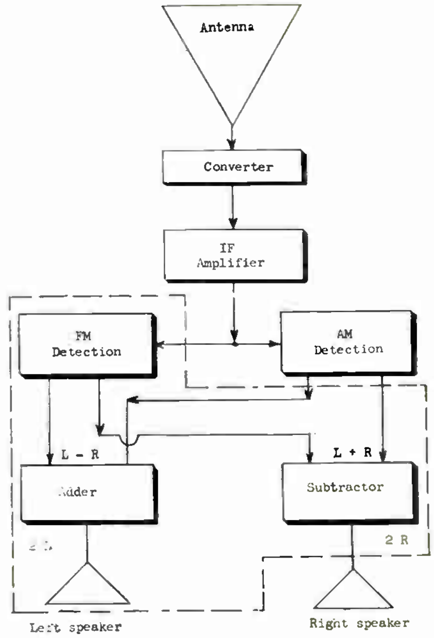
1. The signal carrier shall be both amplitude and frequency modulated.
2. The amplitude modulation is predominantly proportional to the algebraic sum of the two stereophonic signals (L-left microphone + R-right microphone) but includes a smaller signal that is a function of the stereophonic difference signal (L - R). This function to be developed by a compensating system.
3. The maximum amplitude modulation shall be limited to 95%.
4. The frequency modulation shall be from the components of the stereophonic difference signals between 300 and 3000 cps. The filter cut-off rate shall be 6 db/octave. The maximum deviation shall be 3 kc.
5. When only one stereophonic signal exists the maximum instantaneous amplitude shall occur simultaneously with the maximum instantaneous frequency deviation of the transmitted signal.

The compensating system reduces crosstalk of the FM signal into the AM channel of the radio receiver. Knowing the bandpass characteristics of the average broadcast receiver, it is possible to design a transmitter system that will reduce crosstalk. The precompensation used in the transmitter will fully correct the signal for the average IF passband.

In the transmitter block diagram the compensation network shown operates to modify the AM modulation as a function of the stereophonic signal. As a result, the envelope of the signal leaving the transmitter is precorrected so that a standard AM radio will receive and reproduce monophonic sound substantially independent of the stereophonic difference signals.

The phase corrector network #1 is used to equalize the audio phase shift so that the frequency modulation and the precorrection envelope

## Standardizing Stereo




**Block diagram of Westinghouse's AM compatible stereophonic receiver**

modulation are coincident in the transmitted signal. Phase corrector #2 puts the L + R modulation in time coincidence with the L — R modulation in the transmitted

*(Continued on page 238)*

# Do You Know Your . . . . . . . . . . . istors ?

**By Rudolf F. Graf**

THIS little quiz will test your familiarity with present day . . . . . . istors. As of now we know of only 19, but new ones are being announced frequently.

A total of 16 to 19 correct answers is excellent. Twelve to 15 is good and a score of 11 or less shows that a little more . . . . . . istor study is needed.

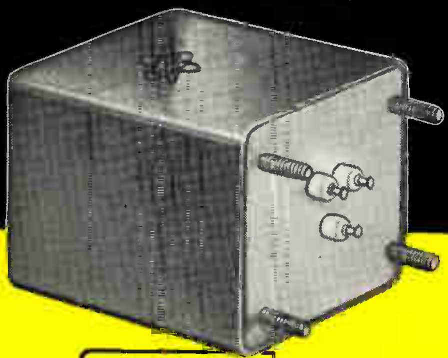
**1. CHRONISTOR**
**2. FERRISTOR**
**3. FILMISTOR**
**4. LUMISTOR**
**5. MAGNISTOR**
**6. PERSISTOR**
**7. PHOTOTRANSISTOR**
**8. RESISTOR**
**9. SENSISTOR**
**10. SPACISTOR**
**11. STABISTOR**
**12. SURGISTOR**
**13. THERMISTOR**
**14. THYRISTOR**
**15. TRANSISTOR**
**16. TWISTOR**
**17. UNIVISTOR**
**18. VAMISTOR**
**19. VARISTOR**

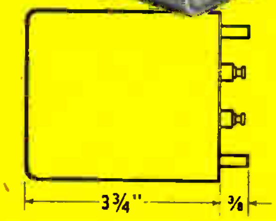
**A. High speed, high current switching transistor.**
**B. Hermetically sealed. Deposited carbon resistor.**
**C. Subminiature elapsed time indicator.**
**D. Newly developed four terminal high temperature semi-conductor.**
**E. A. semi-conductor device having a voltage dependent non-linear resistance.**
**F. Inrush current limiter to protect tube heaters.**
**G. Light sensitive semi-conductor.**
**H. Miniature two winding saturable reactor, for power levels up to tens of watts.**
**I. Small two winding saturable reactor operating on a high carrier frequency.**
**J. A stable multivibrator which replaced mechanical vibrators.**
**K. Temperature sensitive resistor.**
**L. Special type of silicone resistor.**
**M. Circuit element opposing a flow of current.**
**N. Semi-conductor based on the principle of electron flow within a solid.**
**O. A Voltage regulating silicon diode.**
**P. Memory device consisting of a tiny coil of magnet wire wound on a central conductor.**
**Q. Superconductive bi - metallic printed circuit memory element.**
**R. Precision resistor having a ribbon of metal fused to wall of steatite tube.**
**S. An electroluminescent material.**

**Answers to Quiz found on page 219**

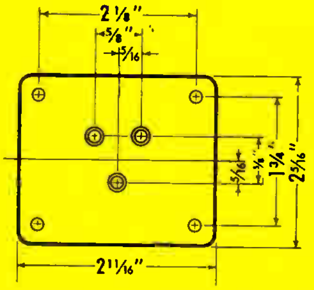
# FILTER COMPONENTS FOR CARRIER TELEGRAPH SYSTEMS

***For Telegraph—Teletype—Data Handling—Remote Control Functions, etc. . . . . . .***

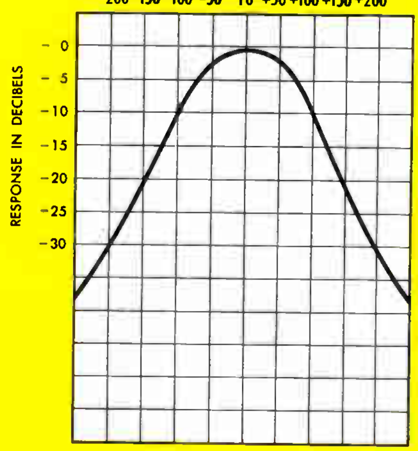





- ☐ Receive Band Pass Filters
- ☐ Transmit Band Pass Filters
- ☐ Oscillator Networks
- ☐ Discriminator Networks

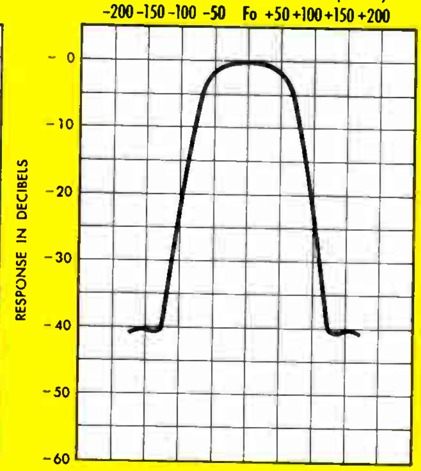



**TRANSMIT FILTERS**
90-0574 SERIES




ATTENUATION: (Typical)
Insertion power loss = less than 5db
Band width @ 3db relative: ±55 CPS
Band width @ 25db relative: ±170 CPS

**RECEIVE FILTERS**
90-0573 SERIES




ATTENUATION: (Typical)
Insertion power loss = less than 6.5db
Band width @ 3db relative: ±52 CPS
Band width @ 35db relative: ±130 CPS

IMPEDANCE: Input 600 ohms—Output 600 ohms
NOMINAL OPERATING LEVEL: 1 Volt
DC ISOLATION: Terminals to case—10,000 Megohms minimum at 500 volts
TEMPERATURE RANGE: −55°C to +85°C Ambient
CASE: Hermetically sealed
MOUNTING: 6-32x⅜ studs
TERMINALS: Teflon

C-A-C has produced many types of telegraph filters with a variety of channel spacing, e.g., 120 cycle, 150 cycle and others. Also available in impedance levels for completely transistorized equipment. Other miniaturized packages available. Please inquire.

***170 CYCLE SPACING—425 CPS TO 3315 CPS—***
***TRANSMIT PART #90-0574-00/17***
***RECEIVE PART #90-0573-00/17***

## C-A-C BUILDS TOROIDS FOR ALL APPLICATIONS

Over 2200 different types and sizes carried in stock - Inductance Values from .05 MH. to 60 HY.

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# WASHINGTON News Letter

**ONE OF EVERY $4**—In the Defense Department $40.9 billion budget for fiscal year 1960 (starting July 1) there is only $1,057,000,000 directly attributable to major procurement and production of the electronic and communications equipment. Pentagon officials, however, advised ELECTRONIC INDUSTRIES that the actual amount which would be expended for communications-electronic items would be much larger. It is estimated to be $1 of every $4 for the entire military procurement. Total communications-electronic procurement and production for the armed services may run as high as $7 billion. In the budget much of the electronic procurement requirement is "hidden" in aircraft procurement, missiles, research and development and other categories of the Defense Department funds.

**FCC FUNDS INCREASED** — Despite the economy trend in the Eisenhower budget, the FCC was allotted an additional $1,180,000 in fiscal 1960. The Commission in the upcoming year would receive an appropriation of $11 million as compared with $9,-820,000. Outlining the FCC's activities in general terms, President Eisenhower declared in his budget message that "Growth in workload coupled with the needed reduction in time lag between dates of receipt and dates when applications are reached for consideration require an increase in manpower for 1960." The FCC's broadcast regulatory activities would receive the highest proportionate share of the increased funds. For common carrier regulation there would be a boost of $100,000 and for safety and special radio services an increase of around $200,000.

**PAY TELEVISION BAN** — A joint Congressional resolution which would ban any pay television operation (except technical tests) whether interstate or intrastate and either by wire or radio, has been offered in the House by Chairman Oren Harris (D., Ark.) of the House Interstate & Foreign Commerce Committee. This committee has jurisdiction over the FCC. Under the resolution, the FCC could authorize technical tests of paid TV for limited purposes. If the resolution is enacted by the Senate and House, it would enforce the ban on pay TV since the commission would be authorized to bring a civil action against any violators. This Congressional policy coincides with the thinking of FCC Commissioners in previous rulings . . . to limit the present status of pay TV to technical tests.

**SPECTRUM CLASH**—The FCC inquiry into the uses of the spectrum from 25 to 890 megacycles will bring to the forefront the clash for spectrum space between television interests and non-broadcast services. Hearings may start in early March. The non-broadcast users of radio—the Bell System and mobile radio services—feel that the space allotted to uhf television is not being utilized effectively since there are very few uhf television stations in operation. The police, fire, taxicab, trucking, industrial radio services have unlimited expansion plans and consequently demands for greatly increased frequency allocations.

**MANY DEMANDS FOR SPECTRUM**—In the UHF TV space, the biggest potential requirement is the Bell System's application for 75 megacycles to serve mobile radio users. There are also many specialized requirements for this portion of the spectrum. Some of these are: ramp control of airfield service vehicles by airlines; electronic highways including traffic light control; ambulance coordination; doctors urban mobile radio service, and doctors rural dispatching service.

**RADIO ASTRONOMY RULES**—The FCC has denied the petition of aeronautical radio organizations for a "stay" of its new rules. The rules require applicants for new or changed radio stations within a radius of about 50 miles of the two observatories to notify the National Radio Astronomy Observatory of their plans. This will enable that organization to submit comments to the FCC before it acts on the applications. In essence the rules are to "guard against possible harmful interference" to the National Radio Astronomy Observatory at Green Bank, W. Va. and the Naval Radio Research Observatory at Sugar Grove, W. Va.

**OPPOSE SPACE ALLOCATIONS** — The National Association of Broadcasters, Aeronautical Radio, and the Air Transport Association have opposed the FCC recommendations for spectrum space in space communications. The FCC-formulated space communication recommendations are to be made by the United States at the upcoming international radio conference in Geneva. The NAB noted that the FCC listing of the 100-150 MC band for space communications affected part of the FM broadcast band. Arinc and ATA declared that the 108-130 MC band includes a number of general aviation frequencies, air traffic control and VOR operations.

*National Press Building*
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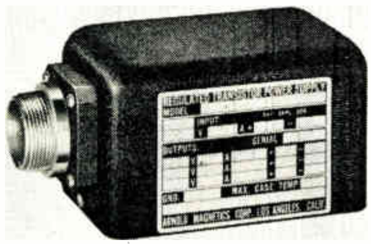
*ROLAND C. DAVIES*
*Washington Editor*

# New Products . . . for the Electronic Industries

## POWER INVERTER

Transistorized power inverter supplies ac sine wave power from a battery line source, and has short-circuit and input overvoltage protection. Nominal input voltage: 24, 26 or 28

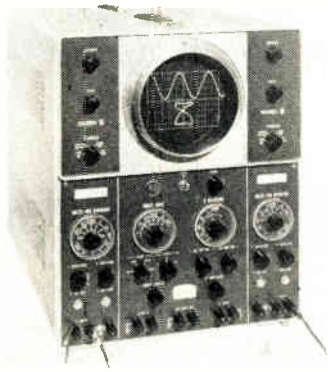


vdc; output voltage: 26 and 115 vac standard. Output frequency of 400 CPS is standard, with 1200, 1500 and 2000 CPS available. Output power: 40 va. Operating temperature range: −55°C to +71°C. Three standard terminations are available—A/N connector, wire-lead pigtail, and solder-lug terminals. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 251 on Inquiry Card, page 123

## DUAL-BEAM "SCOPE"

Oscilloscope, Type 411, displays x-y plots and simultaneously displays either the x- or y- signal against time. There are 9 major modes of display. Additional modes (27) are

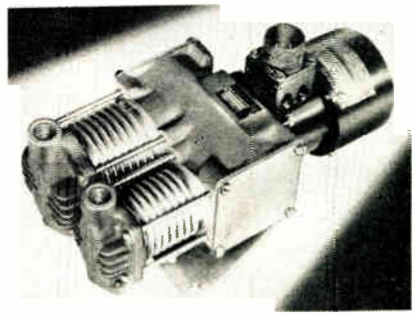


possible. Vertical resolution is 20 μv on each of the 2 channels. Frequency response is from dc to beyond 100 KC. Featured is a full-scale amplitude measuring range of from one mv to 500 v. in 17 steps. Overall accuracy (amplitude) on the Y-axis of the identical channels is within 5% of full scale. Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle 253 on Inquiry Card, page 123

## VACUUM PUMP

Motor driven air pump has a continuous duty cycle and is qualified for 1000 hr. minimum life. Operation is oil-free, and requires no lubrication. Operating temperature range is



−65°F to +200°F. Compressor capacity is 0.025 ppm at 30 psia outlet with 7 in. Hg. absolute inlet pressure. For vacuum it will reduce 800 cubic volume from 29.92 in. Hg. absolute to 0.5 in. Hg. absolute in 2 min. with outlet discharging to sea level. Motor is ¼ HP, 400 CPS, 3 phase, 207 v. and is fan cooled. Great Lakes Manufacturing Corp., 4223 Monticello Blvd., Cleveland 21, Ohio.

Circle 255 on Inquiry Card, page 123

## THERMOCOUPLE CALIBRATOR

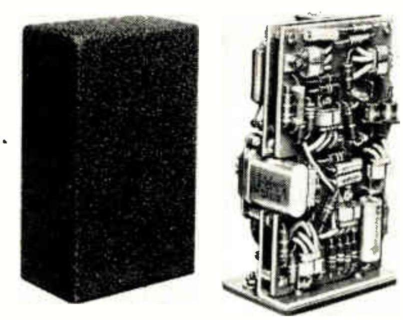
Model TC-2 for controlling and recording test temperatures. Thermocouples replace the stainless steel ice bath with test tubes and rack for cold junction compensation, with a constant-temperature, thermocouple reference junction. The 40 x 30 x 70 in. unit has: potentiometer, standard cell, null indicator, wet cell storage battery, 24 point rotary switch, Bureau of Standards calibrated thermocouple (12 points up to 2200°C), and

furnace control instrumentation. It has an F-4 modified furnace with a 4¾ in. ID Kanthal-wound double-core of 5-zone construction. Arcweld Manufacturing Co., Grove City, Penna.

Circle 252 on Inquiry Card, page 123

## VOLTAGE COMPARATOR

Test module, 200 Series Voltage Comparator, trips a DPDT relay output when the unknown signal input exceeds the value of the reference input. Using direct voltage comparison, it has applications in military ground support equipment, airborne instrumentation, modular test equipment, alarm/control systems and data gathering and processing systems. Transistorized, it features high sensitivity. Output relay contact rat-

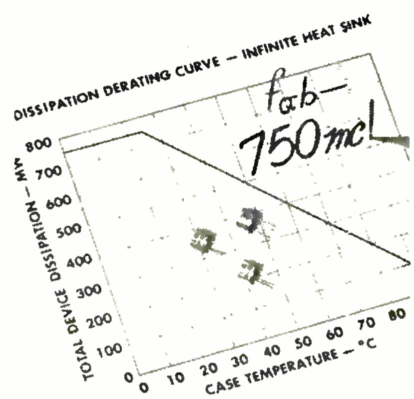


ings are 2a at 28vdc. Repeatability of trip point is ±1mv. and overload capacity is 1000 times rated sensitivity. Meets MIL-E-5400A and MIL-E-5272. Trio Laboratories, Inc., Plainview, L. I., N. Y.

Circle 254 on Inquiry Card, page 123

## GERMANIUM TRANSISTORS

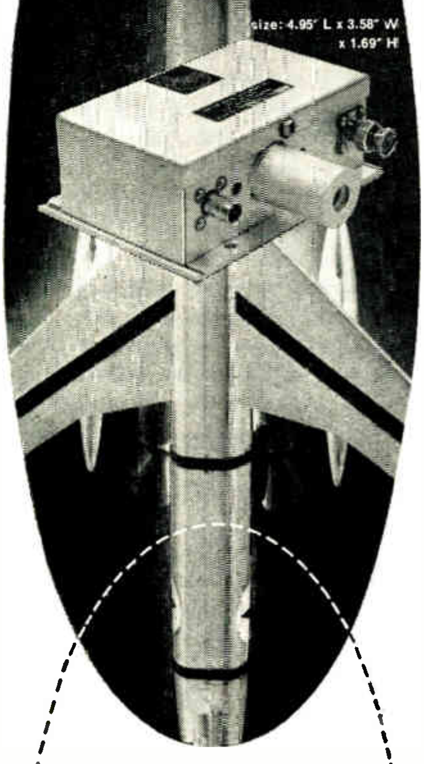
Germanium high frequency, diffused-base "mesa" transistors feature alpha cutoff frequencies up to 750 MC and power dissipations of 750 mw. The pnp transistors, 2N1141, 2N1142 and 2N1143 have minimum current gains of 12, 10 and 8 db at 100MC and operate at junction temperatures up to 100° with 750 mw power dissipation at 25°C case temperature. They are enclosed in a welded JETEC TO-5 outline pack-




age. Units exceed MIL-T-19500A. High dissipation is realized through direct contact between the header and the active element. Texas Instruments Incorporated, P. O. B. 312, Dallas, Tex.

Circle 256 on Inquiry Card, page 123

## MISSILE-PROVED RELIABILITY




*in the 215 mc to 245 mc telemetering band*

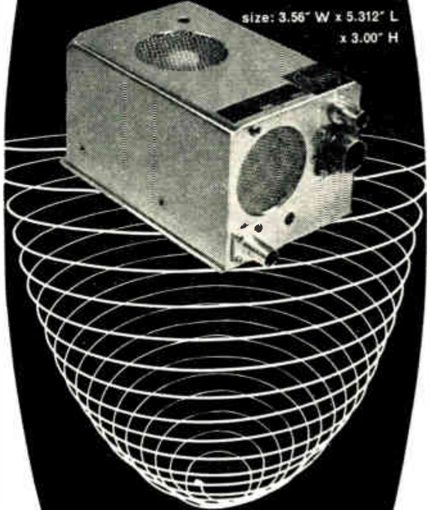
**The Model REL-09-HF** is a ruggedized miniature R-F power amplifier. With a solid history of reliability in current missile systems, the unit has proved capable of withstanding the most rigorous airborne applications. The 5-inch, 1-pound amplifier delivers an 11-watt output to a 52-ohm load with a 1.4-watt input drive.

*For full specs, write for Data File EI-504-1*

The REL-09 functioned smoothly as a part of the Vanguard satellite successfully launched into orbit.

Visit RHEEM at the IRE Show: Booths 3917 & 3919

## INCREASED SIGNAL POWER



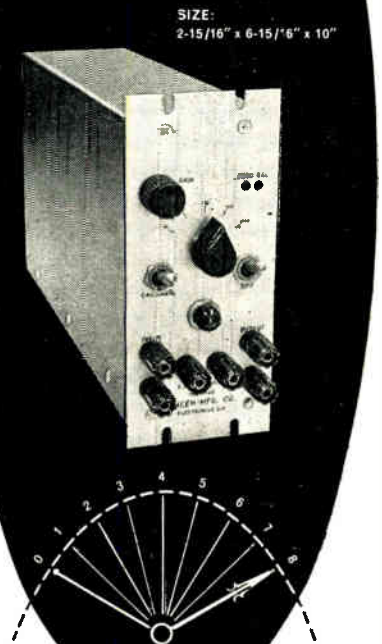

*in the 215 mc to 260 mc telemetering band*

**The Model REL-10** R-F Power Amplifier is a high-output unit for airborne applications. With power outputs from 10 to 100 watts, it dramatically increases the range of missile and aircraft telemetering systems...teams up with presently available FM transmitters...meets missile environmental requirements.

*For full specs, write for Data File EI-500-1*

The REL-10 functioned perfectly during 1,760 mile ride on Thor missile, on 75,000 mile journey into space in U. S. Lunar Probe, and in orbit as part of the Atlas Project Score satellite.

## ONLY ± SIX MICROVOLT INPUT DRIFT OVER AN EIGHT HOUR PERIOD




*high input impedance with extremely low drift*

**The Model REL-120** is a completely transistorized, direct-coupled, instrumentation d-c amplifier featuring:
(1) long life resulting from the use of such passive elements as transistors and diodes;
(2) low heat generation from an average required input power of only 10 watts; and
(3) a self-contained power supply that works directly from either 60 or 400 cycles.

*Write for Data File EI-501-1*

**RHEEM MANUFACTURING COMPANY**
*Defense and Technical Products Division*
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Rheem


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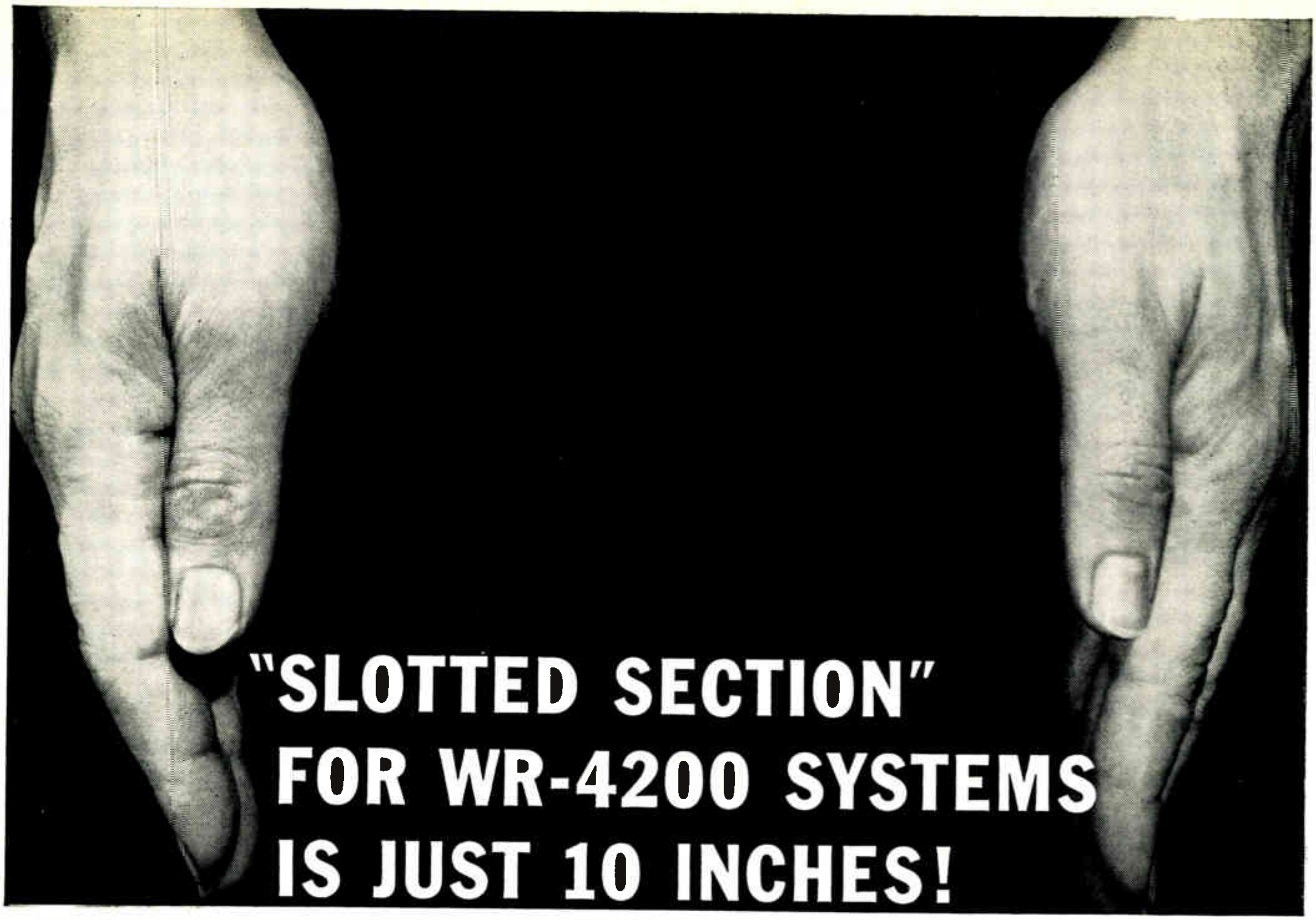



**and provides better measurements**
**and assures more accurate reading of VSWR**
**and allows direct reading of reflection coefficient angle**
**and high-power models automatically reject source harmonics**

Sound impossible? Not at all. Thanks to a major advance in the science of standing wave measurements!

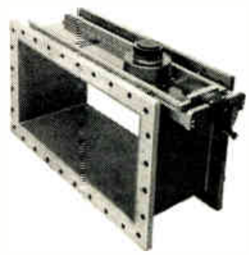
These new measuring devices, called Rotary Standing Wave Indicators, represent a bold solution for VSWR and impedance measurements for *waveguide* and *coaxial* systems from 100 mc/s through 7 kmc/s. The resulting reduction in insertion length alone completely makes *obsolete* the use of slotted sections in this frequency range. The PRD model 223 RSWI (shown here) for use with WR-2100 waveguide systems measures 10 inches as compared with slotted sections measuring over 4 feet!

The PRD Type 219 for use in coaxial systems from 100 to 1,000 mc/s weighs only 4½ pounds and adapts to most types of connectors: Types N, BNC, C, ⅞" coaxial, LT, and TNC.

The waveguide RSWI's are available on special order in two power-handling models: the -LW models are low-power broadband and can handle most laboratory bench-power requirements; the -HN models are high-power 12% bandwidth units and can operate under kw and megawatts of power. All the RSWI's are available for use in waveguide systems from WR-159 through WR-4200.

Specifications and details for the waveguide RSWI's can be found on page H-5 of the latest PRD catalog, E-8. Specs and data for the PRD Type 219 can be found on page B-13. If you do not happen to have ready access to this 160-page reference manual, a complimentary copy can be obtained through your local PRD representative or by dropping us a line on your *company letterhead.*

Complete information on the principles of rotation of a probe in the circular plane of polarization and a full, technical description of the Rotary Standing Wave Indicators are contained in the latest PRD REPORT, VOLUME 6, Number 1. For your free copy send your request to:



**Type 223-LW Waveguide Rotary Standing Wave Indicator for standing wave and reflectivity measurements in WR-2100 waveguide systems over the frequency range from 350 to 530 mc/s. Residual VSWR less than 1.03.**

**Type 219 Rotary Standing Wave Indicator for use in coaxial systems for standing wave and reflectivity measurements over the frequency range from 100 to 1,000 mc/s. Residual VSWR less than 1.03.**

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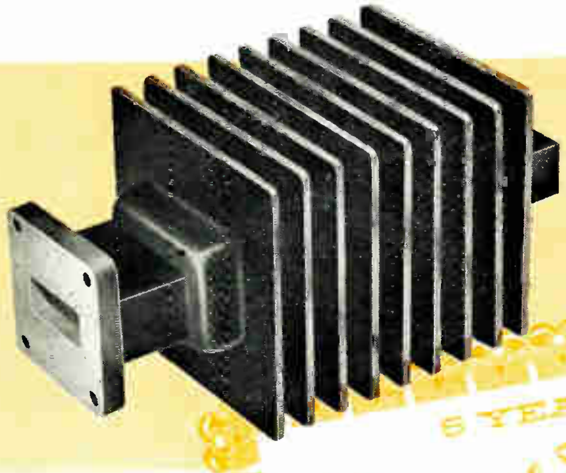

## 4063 VHP* DUMMY LOADS


**MODEL X4063**
**Equivalent to Jan DA-**

**The Bogart Model 4063 S Loads** has evolved from a need very high power dummy loads f tory use. Originally developed for Control Instrument Group, **the 4 time, the only family of high that have been approved by agencies. These units have bee fied in accordance with specific and MIL-T-945A.** Previously, the won wide acceptance by service br R-F silence during tuning and mainte tenance and standard test conditions. with the highest power radar systems, are lightweight, compact, resistant t tion and intended to last at least the lif with which they will be used. Reduced

...mmy Load requirements refer to Bogart

*PATENT PENDING

| Model No. | Equivalent JAN Nomenclature | Frequency Range (KMC/S) | Max. Peak ‡ Power (Mega-Watts) | Average Power (Watts) | Maximum VSWR | Approx. Length (Inches) | Width (Inches) | Height (Inches) | Approx. Weight (Lbs.) | Waveguide AN Type |
|---|---|---|---|---|---|---|---|---|---|---|
| L4063 | DA-147/U | 1.12-1.70 | 17.2 | 6000 | 1.15 | 33 | 9 | 11½ | 60 | RG-103/U |
| R4063 | Pending | 1.70-2.60 | 6.0 | 5000 | 1.10 | 21½ | 6½ | 8½ | 20 | RG-105/U |
| S4063 | DA-145/U | 2.60-3.95 | 3.2 * | 4500 | 1.10 | 14 | 5 | 6½ | 9 | RG-75/U |
| A4063 | Pending | 3.30-4.90 | 2.1 * | 2200 | 1.10 | 13 | 5½ | 6½ | 8 | WR229† |
| H4063 | DA-149/U | 3.95-5.85 | 1.3 * | 2000 | 1.10 | 9½ | 3½ | 4 | 5 | RG-95/U |
| C4063 | DA-144/U | 5.85-8.20 | 0.71 * | 1000 | 1.10 | 8 | 3 | 4 | 2½ | RG-106/U |
| B4063 | DA-148/U | 7.05-10.0 | 0.46 | 600 | 1.10 | 6½ | 2½ | 3 | 1 | RG-68/U |
| X4063 | DA-146/U | 8.20-12.4 | 0.29 | 500 | 1.10 | 6 | 2½ | 2½ | 1 | RG-67/U |
| KU4063 | DA-159/U | 12.4-18.0 | 0.16 | 250 | 1.15 | 4 | 2½ | 2½ | ½ | RG-107/U** |
| K4063 | DA-160/U | 18.0-26.5 | 0.058 | 150 | 1.15 | 4 | 2½ | 2½ | ½ | RG-121/U |
| KA4063 | DA-158/U | 26.5-40.0 | 0.031 | 75 | 1.15 | 4 | 2 | 2 | ½ | RG-96/U** |

*"These peak powers apply in .001 duty cycle applications." †RETMA DESIGNATION **ALUMINUM EQUIVALENT

‡"Peak powers are warranted at thirty (30) PSIG pressurization specification."

Above data subject to change without notice.

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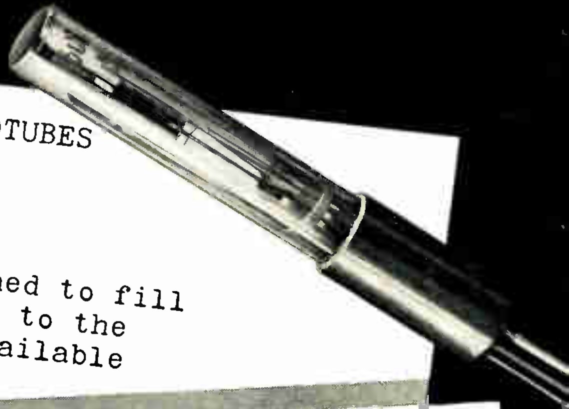
# Fallen Barriers...



"SOLAR" BLIND MULTIPLIER PHOTOTUBES
from

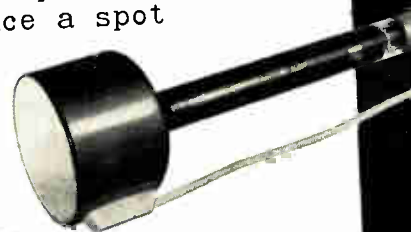
**PHOTOSENSITIVE DEVICES DEPARTMENT**

Several photocathodes have been designed to fill the need for high ultraviolet response to the presence of white light and are now available in a series of multiplier phototubes.

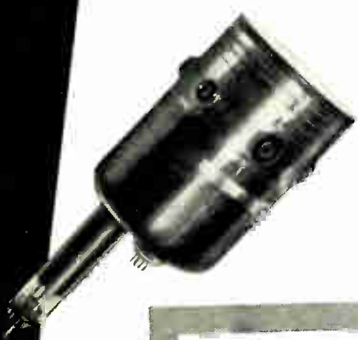
HIGH RESOLUTION CATHODE-RAY TUBES
from

**CATHODE-RAY TUBE ENGINEERING DEPARTMENT**

A family of cathode-ray tubes, practical to operate, low in price and consistently able to produce a spot size of less than .001" are now available in 3-, 5- and 7-inch diameter tubes.



RUGGEDIZED DIRECT VIEW STORAGE TUBE
from



**STORAGE TUBE ENGINEERING DEPARTMENT**

A compact, 4-inch direct view storage tube specifically ruggedized for military applications and designed for maximum storage time is ready for new equipment design.

ULTRA-FINE GRAIN SCREEN
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An extremely fine grain phosphor screen capable of resolving a .001" spot with minimum conical dispersion and electrically stable has been created to take advantage of new Du Mont electron gun design.

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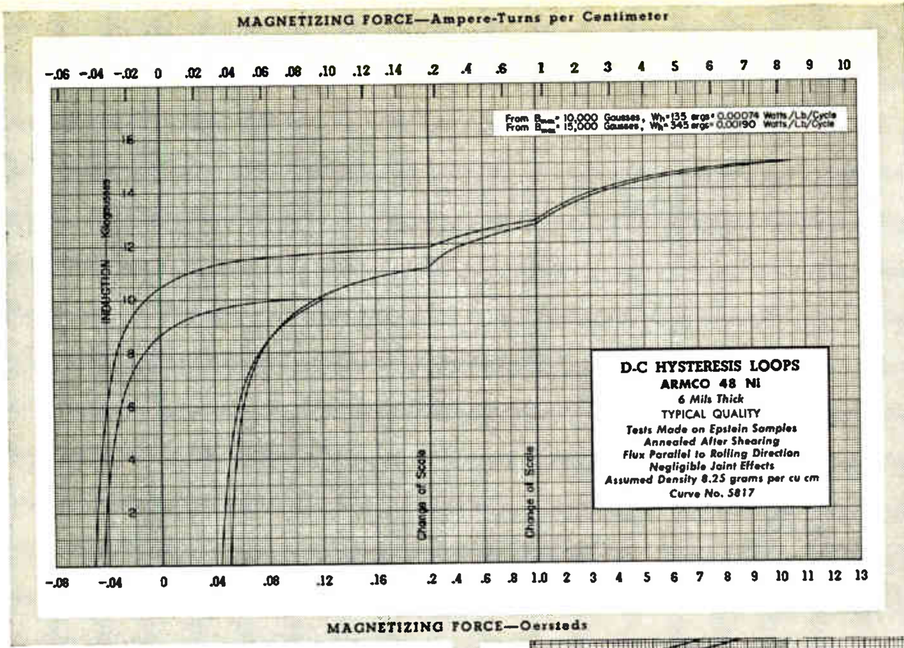
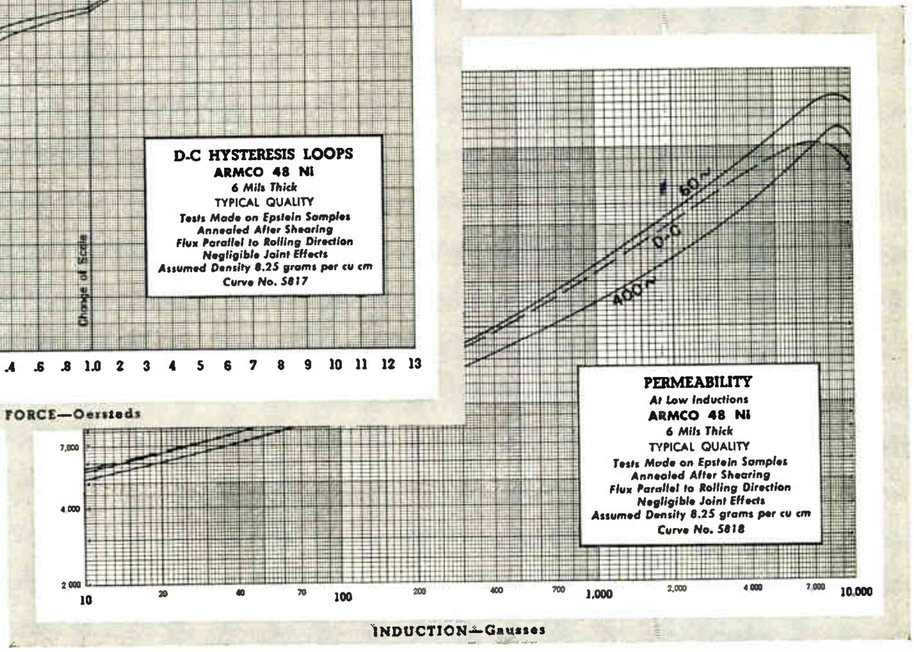
INDUSTRIAL TUBE SALES, ALLEN B. **DU MONT** LABORATORIES, INC., 750 Bloomfield Ave., Clifton, New Jersey, U.S.A.




New steels are born at Armco

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For high quality audio and instrument transformers, specialty motors, generators, and electronic equipment where high permeability is a must, Armco 48 Ni provides this performance-improving combination of advantages:

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**Low Hysteresis Loss** is assured by precise control of processing. An exceptionally high Figure of Merit, Q, makes Armco 48 Ni especially suitable for communications equipment.

**Extremely Low Coercive Force** enables you to minimize core losses for a wide range of frequencies. In the low and moderate range, $H_c$ for 48 Ni is only 10 to 30% of that for silicon steel.

Armco's special nickel-iron magnetic alloy, 48 Ni, is produced in thicknesses of 14, 10, 6, 4, and 2 mils, processed for either wound cores or stamped laminations. With it you can cut down on core size and weight, as well as reduce the energy losses of your products.

For useful design data on Armco 48 Ni and Armco 48 Orthonik, a square-loop nickel-iron magnetic alloy, just fill out and mail the coupon.

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1489 Curtis Street, Middletown, Ohio

Send me a copy of your design manual, "Armco Nickel-Iron Magnetic Alloys."

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Circle 308 on Inquiry Card, page 123

← Circle 307 on Inquiry card, page 123

*International*

# Electronic Sources

*Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering journals*

## ANTENNAS, PROPAGATION

**Propagation of Very High Frequencies on Rough Surfaces,** R. Schuenemann. "Hochfreq." May 1958. 3 pp. Discussed are multiple reflections and refractions as well as fading due to irregular propagation. (Germany.)

**The Radiation Pattern of a Delta Antenna with Major Vertical Loop,** W. Knappe. "Freq." Aug. 1958. 6 pp. In order to study the ionosphere, one needs a broad band antenna with a vertical directivity. The radiation pattern of a delta antenna is similar in bandwidth directivity to vertical rhombic antennas. The cost of a delta antenna is only half that of a rhombic. A detailed analysis of delta antennas is provided. (Germany.)

**Band Width and Gain of Short Antenna (h λ/10),** H. E. Froeling. "Freq." Sept. 1958. 12 pp. The author derives at equations which define the band width as well as the impedances of short antennas. The band width of a short antenna can only be increased when the vertical part of the antenna is increased, as well as the top capacity to a boundary condition and coinciding with the impedance. Numerous examples are given. (Germany.)

## AUDIO

**Theory of Cardioid Microphones,** I. P. Valkó. "Hochfreq." May 1958. 3 pp. After a brief summary of pressure and gradient microphones the author discusses the cardioid microphone which can be visualized as a 3-terminal network with 3 mechanical, respectively acoustical impedances. The cardioid-like characteristics and linear frequency response point out certain relations between the various impedances which hold through for any type of construction. (Germany.)

**A Gradient Telephone Set for Conference Calls,** C. Smetana. "Hochfreq." May 1958. 7 pp. To enable conference calls by use of microphones and loudspeaker, a gradient microphone with associated amplifiers is required. The author discusses construction and characteristics of the microphone and the remaining systems. (Germany.)

## CIRCUITS

**A Multiple-Branch System for Shunt Selection with Controlled Coupling,** M. E. Gertsenshtein, A. M. Pokras, L. G. Solovei. "Radiotek." Jan. 1959. 6 pp. A simple method is given for designing a branching network for parallel selection. The method permits practical designs to be based on computed data without any complex experimental procedure. The method is used to design a simple waveguide branching system for shunt selection with an input traveling-wave ratio of 0.95 in the center of the band. (U.S.S.R.)

**Controlling the Duration of the Output Pulse from a Blocking Oscillator,** B. S. Danilov. "Radiotek." Jan. 1959. 9 pp. The paper analyzes the processes which occur in a system consisting of two coupled blocking oscillators. It is shown that in such a system it is possible to achieve control of the generated pulse duration. (U.S.S.R.)

**On Selective RC Amplifiers,** O. G. Kozina, A. A. Frantsuzov. "Radiotek." Jan. 1959. 8 pp. The paper studies the behavior of a selective amplifier with a double Tee bridge in its feedback circuit for small variations of the bridge parameters. In particular, the effect of these variations on self-excitation is studied. A new feedback circuit is given. The computation of the circuit is analyzed, and the results are experimentally verified. (U.S.S.R.)

**A Voltage Controlled Continuously Variable Low-Pass Filter,** A. J. Seyler. "El. Eng." Jan. 1959. 8 pp. A continuously variable low-pass filter is described which has been designed and constructed by using the time series method and delay line techniques. (England.)

**Analysis and Synthesis of Some Discrete Contactless Circuits,** B. I. Rameev and Yu. A. Schreider. "Avto i Tel." Jan. 1959. 9 pp. Labeling schemes based on diode logical circuits used in the computer Strela are considered. Algebraic analysis and synthesis of the schemes mentioned are treated. Some ways of simplifying the said schemes are proposed. (U.S.S.R.)

**Transient Processes in Magnetic Circuits of Electromagnetic Clutches,** G. M. Fliedlider. "Avto i Tel." Jan. 1958. 14 pp. An engineering analysis method for transient processes in magnetic circuits of electromagnetic clutches is recommended. The magnetic circuit consists of some solid parts, the influence of eddy currents is being taken into consideration. The equations of these processes are analyzed; calculation formulae and an example of analysis are given and compared with experimental data. The influence of eddy currents on the anchor movement is defined. (U.S.S.R.)

**The Impulse Function in the Theory of Linear AC Networks,** V. Dolezal. "Hochfreq." May 1958. 6 pp. A theory is expounded which

### REGULARLY REVIEWED

**AUSTRALIA**

**AWA Tech. Rev.** AWA Technical Review
**Proc. AIRE.** Proceedings of the Institute of Radio Engineers

**CANADA**

**Can. Elec. Eng.** Canadian Electronics Engineering
**El. & Comm.** Electronics and Communications

**ENGLAND**

**ATE J.** ATE Journal
**BBC Mono.** BBC Engineering Monographs
**Brit. C.&E.** British Communications & Electronics
**E. & R. Eng.** Electronic & Radio Engineer
**El. Energy.** Electrical Energy
**GEC J.** General Electrical Co. Journal
**J. BIRE.** Journal of the British Institution of Radio Engineers
**Proc. BIEE.** Proceedings of Institute 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
**Radiotek.** Radiotekhnika
**Rad. i Elek.** Radiotekhnika i Elektronika
**Iz. Acad.** Bulletin of Academy of Sciences, USSR.

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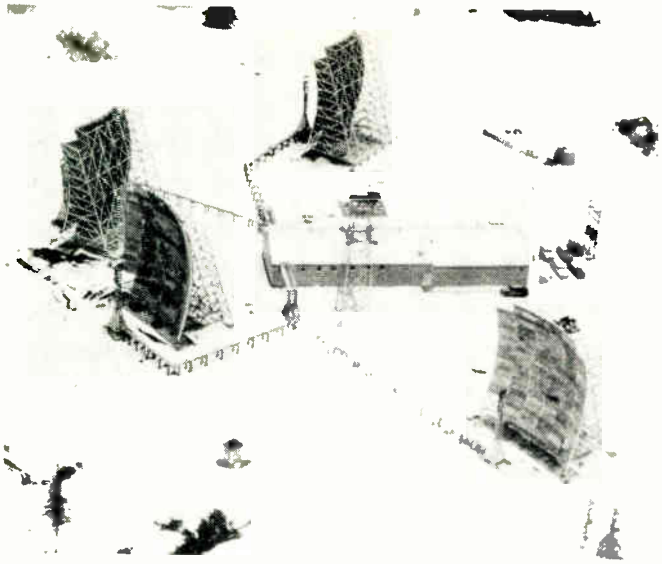

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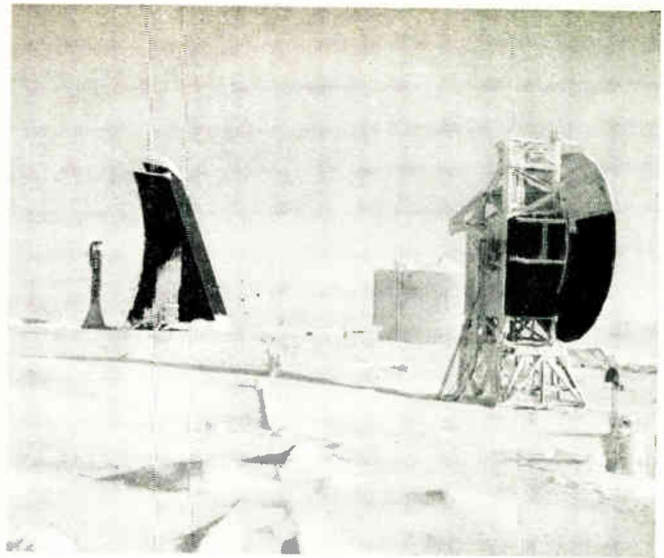

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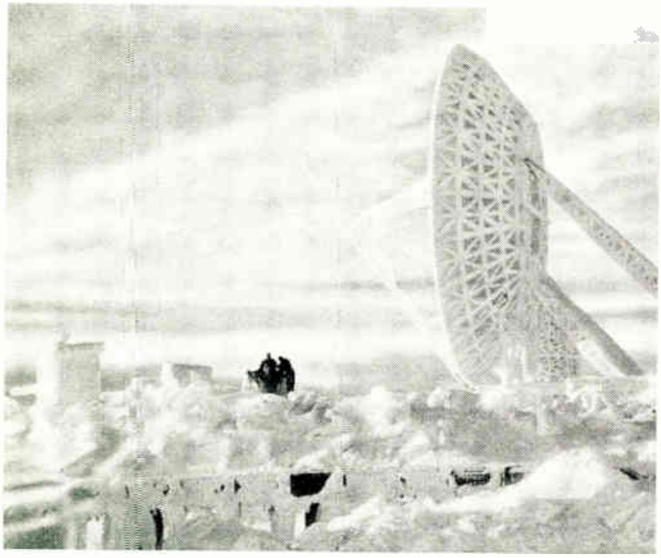

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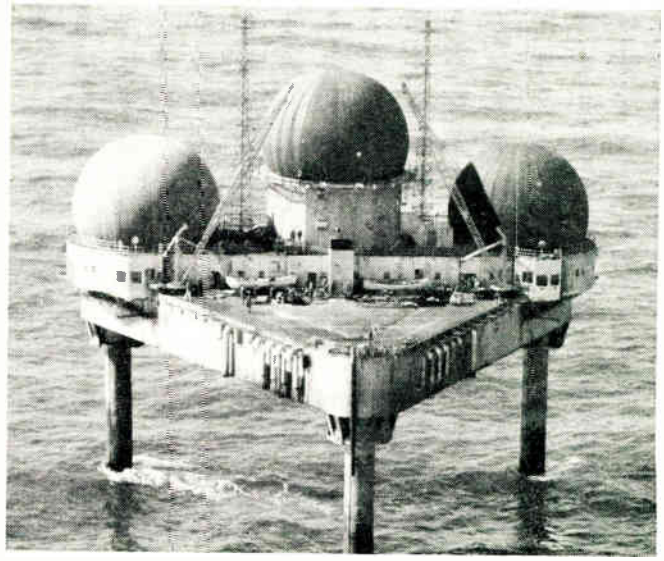

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deals with problems of linear networks excited by the pulses. The calculations only use classical mathematical methods. (Germany.)

**Properties of Mathieu-Function and Similar Functions Demonstrated on Feedback Mixers.** H. Jungfer. "Freq." June 1958. 10 pp.; July 1958, 6 pp. If the frequency is fed back to the mixer by a low pass filter, one achieves a frequency division of 2:1. The behavior of this circuit, including damping, can be calculated with the Neissner, respectively Mathieu differential equation. The theoretical values correspond very closely with the experimentally determined values. (Germany.)

**Design of a Low Noise Level First Stage for a Low Frequency Amplifier Using the Transistor OC603.** J. Schubert. "Freq." Sept. 1958. 9 pp. Discussed in great detail is the design of a low frequency transistor amplifier and the determination of optimum conditions as to noise and amplification factor. Comparison is made with electron tube preamplifiers. (Germany.)

**Band-Pass Amplifiers. Their Synthesis and Gain-Bandwidth Factor.** F. S. Attya. "Arc. El. Uber." June 1958. 14 pp. The paper investigates synchronous, staggered-tuned, single-tuned, quasi-Tchebysheff staggered-tuned, maximal flat damped staggered-tuned, etc., amplifiers. (Germany.)

**A Transistor Amplifier with High Input Impedance and Low Noise Figure.** A. E. Bachmann. "Arc. El. Uber." July 1958. 4 pp. The "Darlington" circuit of two transistors presents the property that the minimum noise figure appears for high values of the source impedance. The circuit consists of two dc coupled transistors and performs like a single transistor having a very high current gain and high input impedance. (Germany.)

**The Use of Non-Euclidian Geometry in the Network Theory.** E. F. Bolinder. "Arc. El. Uber." Aug. 1958. 4 pp. A survey is presented in network theory. An attempt is made to correlate the isolated applications found in the literature. Impedance transformations are set in correspondence, non-Eucledian transformations in the Poincaré and Cayley-Klein model of two- and three-dimensional hyperbolic space. (Germany.)

## COMMUNICATIONS

**Remote Control Equipment For Telecommunication Systems, The Transmission Of The Signals and Supervision,** G. Pietrzik, "Nach. Z." Dec. 1958. 5 pgs. In the equipment described here the pulses for remote control are transmitted either as 50 c/s AC pulses over two-wire lines without repeaters or as voice-frequency (2900 c/s) pulses over low-frequency lines, carrier-frequency channels or microwave link order-wire channels when equipped with repeaters. (Germany.)

**Retrospect On Telephone Communication Over The Germany Coaxial Cable Network,** W. Hoffmann and K. Witt. "Nach. Z." Dec. 1958. 7 pgs. The paper is a report of telephone communication over coaxial pairs in the German trunk cable network during the period from 1936 to 1958. (Germany.)

**Magneto-Ionic Fading In Pulsed Radio Waves Reflected At Vertical Incidence From The Ionosphere,** C. Abhirama Reddy, et. al. "J. BIRE." Nov. 1958. 7 pp. The results of a fairly extensive study of magneto-ionic fading in pulsed radio waves vertically reflected from the F2-region of the ionosphere are presented. Phase paths of the two interfering magneto-ionic components are calculated on the basis of ray theory assuming a parabolic distribution of ionization in the F2-region. The calculated frequencies of fading are found to agree fairly well with the observed values. (England.)

**Pulse Multifrequency Telemetering Device.** F. A. Katkov. "Avto i Tel." Jan. 1959. 8 pp. The paper deals with using pulse disturbances electromechanic vibrators to form frequency signals in multifrequency telemetering and telesignalization devices. Various circuits of telemetering and telesignalization devices for objects distributed along the general communication channel are proposed. (U.S.S.R.)

**Certain Problems of "Inclined-Return" Ionospheric Probing,** B. I. Osetrov. "Radiotek." Jan. 1959. 8 pp. Method is analyzed for performing inclined-return probing of the ionosphere on the basis of experimental studies. The paper points out the significance of the method with respect to increasing the stability of short-wave radio-communication and radio-broadcast stability. A brief analysis is made of the use of inclined-return probing for studying inhomogeneities in the ionosphere. (U.S.S.R.)

**On the Theory of Frequency Modulation.** R. P. Poilov. "Radiotek." Jan. 1959. 10 pp. The paper analyzes the theory governing a reactance-tube modulator which is designed for a wide-band frequency-rocking oscillator. Simple formulas are derived for computing the circuit elements. An equation is derived for the modulation characteristic, and a computation example is given. The validity of the computations is verified experimentally. (U.S.S.R.)

**The Influence of Unsymmetric RF Stages on Communication Channels Using Amplitude Modulation,** R. Hofer. "Arc. El. Uber." Sept. 1958. 13 pp. A mathematical method is developed that allows an approximation of the side band currents with an unsymmetrical amplitude versus frequency function of RF-amplifiers stages which have an amplitude-dependent source impedance. (Germany.)

**Computing Nonlinear Distortion and the Dynamic Range for a Panoramic Radio Receiver,** M. I. Svetlov. "Radiotek." Jan. 1959. 11 pp. The paper analyzes the nonlinear distortion which occurs in the wide-band stages of a panoramic receiver channel. It is shown that special types of cross-modulation distortion are the most dangerous. The corresponding computation formulas are derived, and methods are suggested for combating this type of distortion. A formula is derived for determining the dynamic range of the wide-band stages and of the receiver as a whole. (U.S.S.R.)

**Considerations About the Theory of Multiple Lines,** W. Oehrl, et al. "Arc. El. Uber." June 1958. 6 pp. The relationship between inductance and capacitance coefficients of multiple lines permits orthogonal transformation of a set of n intercoupled lines into a set of n equivalent lines. An example of the application is given for the case of two coupled lines. (Germany.)

**Basic Theorems of the Information Theory Applicable to the Communication Technique,** H. Wolter. "Arc. El. Uber." Aug. 1958. 11 pp. The paper brings into evidence an ambiguity in the proof of the sampling theorem and certain experimental inconsistencies concerning the expansion theory. It is further proven that sharply defined frequency limits would be contradictory to Maxwell's equations, and to the causality principle. (Germany.)

**Distribution of the Delay Time in Teleprinter Exchanges,** H. Stoermer. "Arc. El. Uber." Aug. 1958. 8 pp. The delays encountered in teleprinter exchanges differ from those in telephone communication due to the storage capacity of the perforated paper tape. By reference of a small model the paper shows how to modify the conventional delay theory and applying it to the planning of teleprinter exchanges. For the purpose of the investigation it is assumed that all messages have the same lengths. (Germany.)

## COMPONENTS

**Concerning Design of Frequency Contact Transformer to Control an Asynchronous Motor,** N. V. Meerov, et al. "Avto i Tel." Jan. 1959. 9 pp. The paper shows possibility and expediency of using a contact mechanic rectifier to design a frequency transformer and to control speed of an a-c motor. Main features of a current transformer operating in invertory regime are ascertained and some ways to solve the commutation problem are proposed. (U.S.S.R.)

**The Life of Ballasts for Gas-Discharge Lamps, II Capacitors,** T. Hehenkamp. "Phil. Tech." 8 Dec. 1958. 8 pp. A life test is discussed in which capacitors are loaded under 1.5 x to twice the normal field strength at periodically varying temperatures. (Netherlands, in English.)

**Physics and Techniques of Electro-Mechanical Filters.** W. Poschenrieder. "Freq." Aug. 1958. 9 pp. Initially, the theory of filters is discussed. It is followed by the theory of mechanical filters. The design of a torsion filter is detailed. (Germany.)

**The Sluggishness of Germanium Diodes and its Influence in Rectifier and Limiting Circuits.** W. Heinlein. "Freq." May 1958. 5 pp; June 1958. 8 pp. Experimental means are provided to determine the dynamic characteristics of germanium diodes. The limitations of germanium diodes for rectifiers and limiting circuits are discussed. (Germany.)

**The Flux Resetting Magnetic Amplifier,** J. Sherlock. "El. Energy." Jan. 1959. 9 pp. This article gives an account of the progress in this field using a particular type of amplifier. (England.)

**Features of Ferrite U Cores for Horizontal Output Transformers,** R. Falker and E. E. Huckling. "El. Rund." Jan. 1959. 6 pp. After a brief sketch of the operating conditions in which one uses ferrite U cores in horizontal transformers for TV receivers, and a summary of the important magnetic properties, measurement results are given for the behaviour of German and other ferrites in respect of permeability and loss variation over a temperature range. The results are discussed in relation to ferrite characteristics, and proposals made for uniform quality standards. (Germany.)

**Improving the Performance of Small Electrodynamic Vibration Generators,** I. M. Steel. "El. Energy." Jan. 1959. 6 pp. (England.)

**Transformer Leakage Field Analysis by Electrolytic Tank Analogue,** P. H. G. Allen. "El. Energy." Jan. 1959. 5 pp. The application of the electrolytic tank analogue to plotting magnetic fields, having circular symmetry is described. Taking the transformer reactance field as an example, the direct analogue is derived for a very elementary system. When this is represented in "orthogonal" terms, the analogue can be extended to include arbitrary systems of any configuration. Practical details include methods of current supply and potential measurement as well as of model construction. The computation of reactance and flux density values from analogue measurements is illustrated by a practical example. (England.)

## COMPUTERS

**Determination of the Attenuation in a Telephone Network,** G. Breitschneider. "Freq." Aug. 1958. 5 pp. The author describes a method to determine the attenuation in a random-connected system. He suggests the use of electronic computers to determine the system limits. (Germany.)

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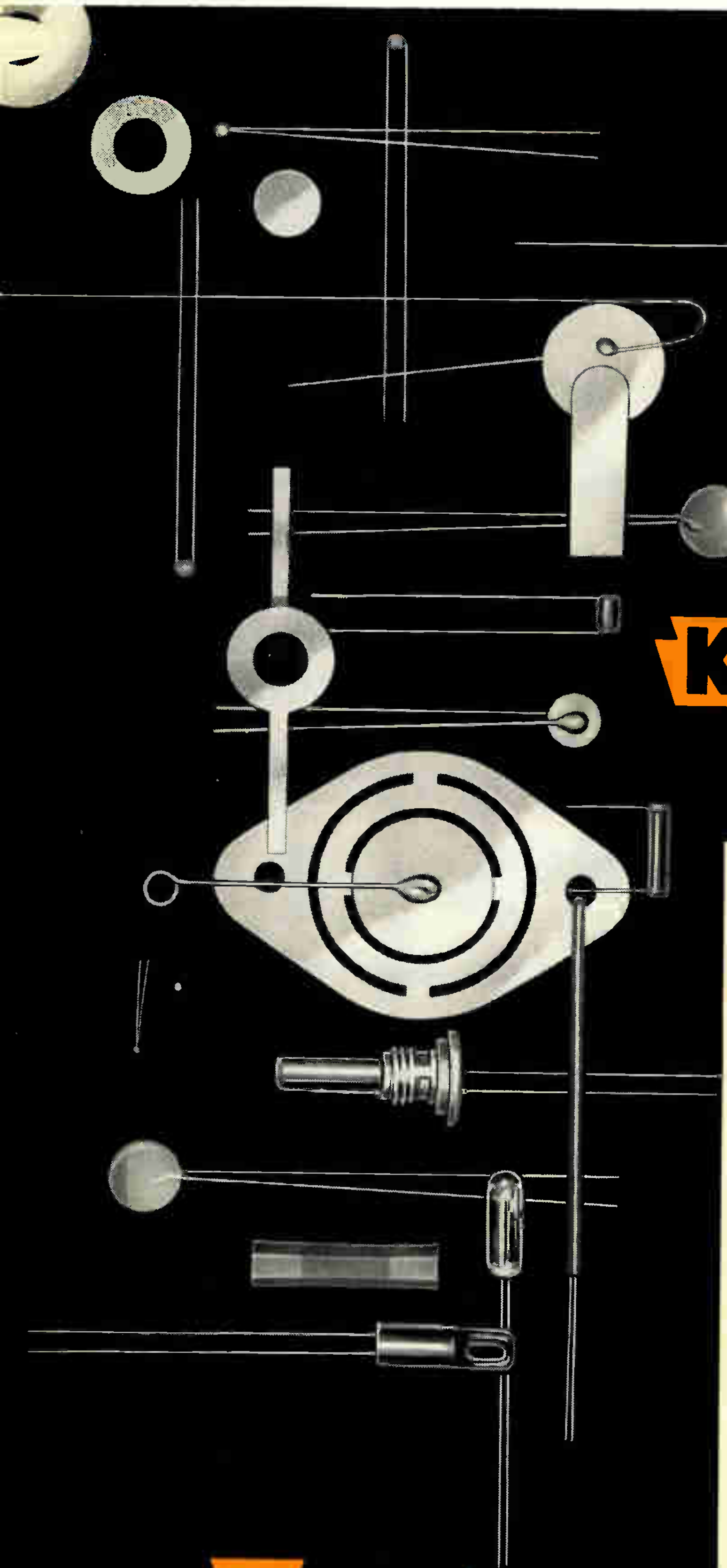

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**An Electronic Ratio Calculator, A. D. Boronkay.** "El. Eng." Jan. 1959. 3 pp. In electronic computers all-electronic ratio circuits are seldom used due to the difficulty of finding a strict analogue of a quotient. The system described in this article is based not on a strict physical analogue but on an approximation valid within certain limits; the principle being that an approximately linear relation exists between the phase-angle of the sum of the two signals and the amplitude ratio. The ratio measuring device consists of an adding circuit which sums the numerator and denominator, a phase sensitive circuit to provide an electrical quantity proportional to the sum vector and a phase sensitive controlled rectifier. (England.)

## CONTROLS

**Linear Thyratron Control Circuits, G. G. E. Low.** "El. Eng." Dec. 1958. 2 pp. A description is given of two simple circuits in which thyratrons are used in such a way as to provided a linear relationship between a slowly varying d. c. signal voltage at the grid and the average anode current. The anodes of the thyratrons are supplied from an a. c. source in the usual manner and clearly the circuits are limited to applications in which the variations in the signal voltage are slow compared with the frequency of the supply. (England.)

**Approximate Determination of Self-Oscillations in a Synchromotor Control System, D. P. Petelin.** "Avto i Tel." Jan. 1959. 7 pp. The paper treats the problem of self-oscillations in a synchromotor control system, its nonlinear element being characterized with the functions $\theta^2 \sin \theta$, $(\sin \theta)^2 p\theta$, $(\sin \theta)^2 p^2\theta$, $(\sin \theta)^2 p^3\theta$. (U.S.S.R.)

**Determination of Optimal Pulse Transfer Function of a Servosystem for a Certain Class of Disturbances, P. S. Matweev.** "Avto i Tel." Jan. 1959. 12 pp. The paper deals with determination of optimal pulse transfer function of a servosystem when disturbances of a certain class (preset harmonic and exponential time functions and stationary random functions) are applied to its input. The connection of correlation function with Green function is used to solve the problem. Determination is illustrated with two examples. (U.S.S.R.)

**Self-Oscillations in a Control Single-Loop System Having Two Symmetric Relays, Tu Syui-Jan and Tei Lui-Vy.** "Avto i Tel." Jan. 1959. 14 pp. Using the method of Tsypkin (1) accurate periods equations are deduced to determine symmetric periodic regimes in a single-loop system having two symmetric relays. Supposing that relays are separated with harmonic filters, accurate methods yield the same results as approximate methods based on harmonic balance. (U.S.S.R.)

**On Electronic Control of Low-Power Motors, H. Volz.** "El. Rund." Jan. 1959. 3 pp. Whereas previously most articles having discussed electronic control of low-power motors, the present work deals with simple circuits of low-power motor regulation. The calculations take into account all possible parasitic influences which can be reduced by suitable control. With the aid of a closed control loop these influences can be still further reduced. (Germany.)

**Transmitting Valves for Use in Industry, R. Hubner.** "El. Rund." Jan. 1959. 3 pp. The operation of oscillator valves in industry differs in many respects from that in communication transmitters, and it is understandable that valve manufacturers concerned themselves with the development of generator valves designed for the stringent demands of industry. Simple circuits are made possible by using a.c. plate operation, and a typical operation is calculated. The importance of choosing valves of robust design is emphasized. (Germany.)

**Remote Control for Communication Transmission Systems, G. Bischoff.** "Nach. Z." Jan. 1959. 5 pp. Remote control equipment is used in communication systems on cables, open wires and radio links. Its use and operation is explained by means of an example of a radio link. (Germany.)

**The Pros and Cons of Common Control Means, M. Hebel.** "Nach. Z." Jan. 1959. 13 pp. The pros and cons for the use of common control means in telephone switching circuits are reported in a form which takes into consideration the latest proposals and the results of increasing electronification. Draft proposals for a system design with a "quasi-direct control" of the switching and coupling means are described. The excellent trustworthiness of the constructional elements used at present is compared with new tendencies in the development. (Germany.)

**Modern Control Systems for Group of Lifts, S. T. Hunt.** "El. Energy." Jan. 1959. 10 pp. Considerable progress has been made in recent years in automatic control systems for banks of interconnected passenger-operated lifts. This article shows how the facilities provided by such installations have evolved and describes the principle of automatic traffic analysis by which the operation of the lifts is adjusted to meet different traffic requirements during the day. (England.)

## GENERAL

**On the Computation of Statistical Moments, K. B. Krukovskii-Sinevich.** "Radiotek." Jan. 1959. 5 pp. A formula is derived for the statistical moment of $k$-th order for a random process at the output of a passive linear four-terminal network. An example is used illustrating the use of higher-order moments for computing the probability density at the output of an autocorrelation receiver. (U.S.S.R.)

**Transient Performance in D-C Circuit Consisting of a Thermistor and Ohmic Resistance, A. G. Shashkov.** "Avto i Tel." Jan. 1959. 8 pp. Transfer function and stability conditions of the circuit consisting of a thermistor and ohmic resistance are obtained. The block-diagrams of the circuit are drawn. The construction of the transient processes in the circuit is described. The generally accepted idealization—the averaging of the thermistor temperature by its resistance—is assumed as basis. (U.S.S.R.)

**Correlation between LaPlace Transformation and Infinite Series, J. Wetzger.** "Freq." May 1958. 5 pp. Many technical problems in the field of thermo-dynamics, communication, and others, lead to progressions and frequently to infinite series. In order to study the behavior of an infinite series one can make use of the correlation between these series and function transformations. The paper highlights special properties of the LaPlace integrals. (Germany.)

**LaPlace Transformation Used to Express the Sum of a Converting Series, O. Heymann.** "Arc. El. Uber." July 1958. 5 pp. Expansion of the integrand by powers of the time-domain variable and subsequent integration lead to a transformed series which is asymptotic as a rule. Only a few terms are required to state the sum of the series with sufficient accuracy. (Germany.)

**Energy Balance within an Electron Beam, H. Rogelnik.** "Arc. El. Uber." Sept. 1958. 8 pp. The interaction between electron beams and electromagnetic fields leads to an exchange of field energy and kinetic energy of the charged particles. Within the second order perturbation theory of the one-dimensional electron beam the AC power conversion theorem becomes identical with CHU's power theorem for linear circuits. (Germany.)

**Microwave Generators with Closed Operating Space for Dielectric Heating of Victuals and Industrial Products, W. Schmidt.** "El. Rund." Jan. 1959. 4 pp. The method of operation and the measuring technique of a microwave generator (magnetron) with closed operating space for dielectric heating of victuals and industries products having been described in the first and second parts of the article, the third and last part deals with the mechanical construction of such a unit. (Germany.)

**On the Design of the Transition Region of Axisymmetric Magnetically Focussed Beam Valves, V. Bevc, et. al.** "J. BIRE." Dec. 1958. 13 pp. The assumption of a particular magnetic-field variation in the transition region of an axially symmetric beam-type device (e.g., klystron, travelling-wave tube) leads to the solution of the equations of electron motion by means of an analogue computer. To illustrate this novel method of solution, beam envelopes are presented for Brillouin flow, periodic magnetic focussing, and space-charge-balanced flow. By matching the beam envelopes with those obtained from the theory of the Pierce gun, dimensions are obtained for an electron gun that produces the required beam. (England.)

**A Vibrating-Head Scanner for Inspection and Indexing of Magnetic Recordings, J. S. Gill.** "El. Eng." Jan. 1959. 2 pp. When it is necessary to read a stationary or very slowly moving magnetic tape a conventional playback system cannot be used because the output is proportional to speed and falls to zero when the tape is stationary. In this article a vibrating playback head is described which can be used for reading stationary magnetic recordings. The principle has been successfully applied to the extraction of larynx excitation from recorded speech by direct visual interpretation of the waveform. (England.)

**The Use of Dekatrons for Pulse Distribution, G. H. Stearman.** "El. Eng." 3 pp. Feb. 1959. (England.)

## MATERIALS

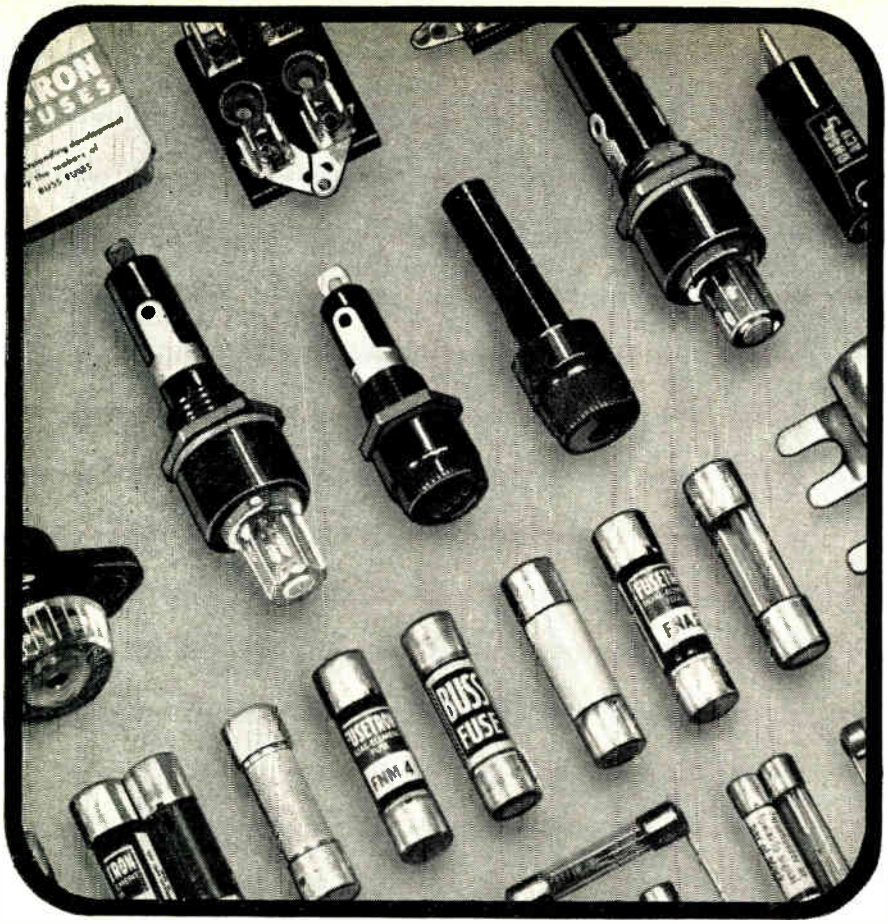
**A Comparison of Wool Wax and Petroleum Jelly as Impregnants for Paper Capacitors, J. S. Dryden and R. J. Meakins.** "Proc. AIRE." Oct. 1958. 3 pp. (Australia.)

**A Simple and Compact Arrangement for Measuring the B-Activity of Weak Radioactive Samples, K. Van Duuren.** "Phil. Tech." 8 Dec. 1958. 7 pp. (Netherlands, in English.)

## MEASURE & TESTING

**Teleprinter Signal Regenerator Equipped With Transistors, F. Obst and F. Ohmann.** "Nach. Z." Dec. 1958. 4 pgs. An electronic signal regenerator is described, which operates without vacuum or gas-filled valves and is equipped only with transistors. Its low power consumption permits an extremely condensed construction. The circuit on the basis of a counting method makes the regenerator suitable also for higher in formation rates. (Germany.)

**Selection of Matched Components from Random Samples, D. P. C. Thackeray.** "E. & R.

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In sizes up to 2 ampere, for circuits of 250 volts or less, they provide high speed action necessary to protect sensitive instruments or delicate apparatus.

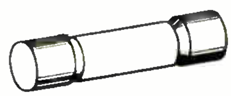
Listed as approved by Underwriters' Laboratories.

Test specifications — carry 110%, open at 135% in 1 hour or less. 1/500 to 2 ampere sizes also will open at 200% load in 5 seconds or less.

---

For high interrupting capacity fuses . . . *specify* . . **BUSS KTK fuses**

13/32 x 1½ inch.



Capable of safely interrupting 68,000 amperes at voltages of 500 or less, AC or DC.

Test specifications — Carry 110%, open at 135% in 1 hour or less.

| Voltage | Amperes |
|---|---|
| 500 or less. | 1/10 to 30. |

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

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

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS

McGRAW EDISON

Eng." Dec. 1958. 4 pp. Some problems in component selection are outlined, with especial reference to the selection of transistors from random samples, the selection of such samples from stocks, and the stocking of quantities which make such procedures possible. The methods are briefly illustrated by the example of a d.c. transistor amplifier, temperature and gain stabilized. An analogy is drawn between such procedures and those involved in the selection of personnel. (England.)

**A Sampling Comparator,** Arieh Fishemann-Arbel. "El. Eng." Dec. 1958. 5 pp. A sampling comparator compares the instantaneous value of two waveforms at constant intervals of time. The response of the comparator described in this article extends from d.c. to a practical limit of half the sampling frequency. Applications of the comparator to a delta modulator, and to a binary quantizer are given. (England.)

**Light Intensity Meters for Local and Remote Indication,** E. F. Hasler and G. Spurr. "El. Eng." Dec. 1958. 7 pp. Measurement of daylight illumination is necessary to the electricity supply industry for the prediction of the demand for artificial lighting. This article describes a method of measurement using a photocell as the grid leak of a block oscillator. Emphasis is placed on the simplicity, reliability and versatility of the principle. (England.)

**The Cathode-Ray Oscilloscope: A Survey,** J. F. Golding. "Brit. C. & E." Jan. 1959. 7 pgs. The cathode-ray oscilloscope has evolved from a simple indicating device into a precision measuring instrument. This article briefly describes the evolution of the instrument and the functions of the more common circuits used. Abridge specifications of the oscilloscopes available on the home market, are given in a table. (England.)

**Methods for Computing and Eliminating Modulation Noise Which Occurs During Frequency Conversion,** I. M. Zhlobinskii and L. G. Sodin. "Radiotek." Jan. 1959. 8 pp. The paper derives relationships for determining the frequency of the signal which produces modulation noise during frequency conversion. The conditions for eliminating this noise are analyzed. A graphical method is presented which permits a simple and rapid selection of the intermediate frequencies for an audio or panoramic radio receiver. (U.S.S.R.)

**Precision Multiplier,** L. N. Fitsner. "Avto. i Tel." Jan. 1959. 8 pp. Precision multiplier with static error equal to 0.01-0.02% of output voltage scale and usual high-speed is considered. Low error quantity is achieved by combination of rough and precise systems blocks. (U.S.S.R.)

**The Production and Measurement of Ultra-High Vacua,** A. Venema and M. Bandringa. "Phil. Tech." 8 Dec. 1958. 13 pp. (Netherlands, in English.)

**An Apparatus for Testing the Solderability of Wire,** J. A. Ten Duis. "Phil. Tech." 8 Dec. 1958. 4 pp. An apparatus for testing the solderability of wire has been developed and has now been in use for some years. An globule of solder is split in two by the wire under test, which has first been dipped in the flux. After some time, varying from 0.1 sec to more than 30 sec, the two halves flow abruptly together over the wire. This time is taken as a measure of the solderability of the wire. The apparatus has also been used for investigations into the influence of the composition and quantity of the solder, of the soldering temperature, of the composition of the flux and of the surface condition of the wire. These investigations were concerned in particular with the dip-soldering process employed for printed wiring. (Netherlands, in English.)

**Noise Measurements,** E. Luebcke. "Freq." Jul. 1958. 5 pp. The article classifies the various noise sources in the frequency spectrum up to 12,800 cycles. Level of noise is measured at various frequencies. (Germany.)

**A Precise Capacity Goniometer,** G. Ziehm. "Freq." Sep. 1958. 7 pp. To achieve accurate directional indications the coupling capacity between rotor and starter of ultra-high frequency goniometer must be sinusoidal as to angle of rotation. The conditions to achieve this are analyzed. (Germany.)

**Measurements of Quadripole Parameters and Material Constants with the Aid of Logarithmic Transmission Line Charts,** K. Jost and G. Schiefer. "Arc. El Uber." Jul. 1958. 6 pp. The numerical evaluation of the quadripole parameters and the material constants is greatly simplified by the adoption of a logarithmic transmission line chart. The method is outlined in detail. (Germany.)

**On the State of Oscilloscope Technique,** G. Heindl. "El. Rund." Jan. 1959. 3 pp. Whereas the amplifier circuits including delay networks, time-deflection circuits, and triggering having been described in the first and second parts of the article, the present third and last part considers the technique of cathode-ray tubes and their high voltage power supply, the power supply unit and the feature of modern oscilloscopes. (Germany.)

**A Demonstration Oscilloscope,** W. Auer and F. Unger. "El. Rund." Jan. 1959. 2 pp. An oscilloscope with a 21" TV picture tube for demonstration purposes is described. Up to four processes can be displayed simultaneously with the help of an electronic switch, each input having independent height, brightness, x shift control, and time marker pips. Frequency range is 2 c/s to 25 kc/s with full utilization of screen height. (Germany.)

**Continuous Measurements of the Capacity in Coaxial Cables During Their Manufacture,** D. Wolff. "Nach. Z." Jan. 1959. 4 pp. Known measurement methods for tests during the manufacture of coaxial cables with solid dielectrics are briefly described. On the basis of these methods, a novel method for continuous measurements of the capacity in coaxial cables by means of a water jacket as a test electrode, uses an electronic "impedance transformer" for an accurate limitation of the test length of the water electrode. The equivalent electric circuit for this test tube is given and is used for the design of the impedance transformer. The stability of multistage impedance transformers is briefly discussed. (Germany.)

**A Teleprinter Distortion Recorder,** R. Lutz. "Nach. Z." Jan. 1959. 3 pp. Recording equipment for the measurement of distortions in teleprinter signals is described. This equipment records on paper the distortions in the form of sequences. (Germany.)

**Reciprocity in Radio-Frequency Measurements,** G. D. Monteath. "E. & R. Eng." 3 pp. Jan. 1959. It is well known that the reciprocal theorem permits the interchange of source and detector in certain measurements. This article draws attention to advantages to be gained by making an appropriate choice. The interchange of source and detector in standing-wave measurement, a possibility which appears to have been overlooked, is shown to be permissible, and applications are discussed. (England.)

**High-Q Echo Boxes,** A. Cunliffe. "E. & R. Eng." 4 pp. Jan. 1959. The performance of tunable $H_0$ cylindrical echo boxes may deteriorate sharply when the length of the cavity is approximately that for which, theoretically, another mode has the same resonant frequency as the operating mode. The cause of this effect is investigated, and the modes for which the effect is likely to be greatest are named. Cavities should be designed so that the frequency-length curves for these particular modes do not cross the frequency-length curve for the operating mode. (England.)

**A Microwave Frequency Standard, Part I,** B. H. L. James and M. T. Stockford. "El. Eng." Jan. 1959. 6 pp. This article describes an equipment which produces positively identified signals for calibration purposes in the frequency range 7kMc/s to 20kMc/s: Both limits may be extended. (England.)

## RADAR, NAVIGATION

**Radio Links for the Control of Aeronautical Air-Ground Equipment,** W. S. McGuire. "Proc. AIRE." Oct. 1958. 10 pp. A multichannel radiotelephone link system is described over which aeronautical air-ground-air transmitters and receivers situated in isolated areas can be controlled. (Australia.)

**The Statistical Properties, the Frequency Spectrum and the Suppression of Low Frequencies in Signals for Radar PPI Displays,** H. Groll and E. Vollrath. "Nach. Z." 8 pp. Jan. 1959. The distribution of targets on radar PPI displays as well as a method for determining the number of targets is described. The representation of frequency spectra and their relationship with the signal contents is discussed with the aid of examples. A possibility for suppressing the low frequencies by means of a signal controlled carrier modulation as well as the resulting modified spectra are shown. (Germany.)

**Radar Systems with Electronic Sector Scanning,** D. E. N. Davies. "J. BIRE." Dec. 1958. 5 pp. A discussion of the application to radar of a system of electronic sector scanning, recently described in relation to underwater acoustic echo-ranging. (England.)

## SEMICONDUCTORS

**A Transistor with Thyratron Characteristics and Related Devices,** W. Von Munch. "J. BIRE." Nov. 1958. 8 pgs. A semi-conductor device with thyratron-like input characteristics is obtained by immersing, during the alloy process, a tungsten whisker into the collector contact of an npn-junction transistor with high base resistivity. Details of production and electrical performance are given. The radial voltage drop which is set up in the base layer causes a restriction of carrier transport to a region of small cross-section. (England.)

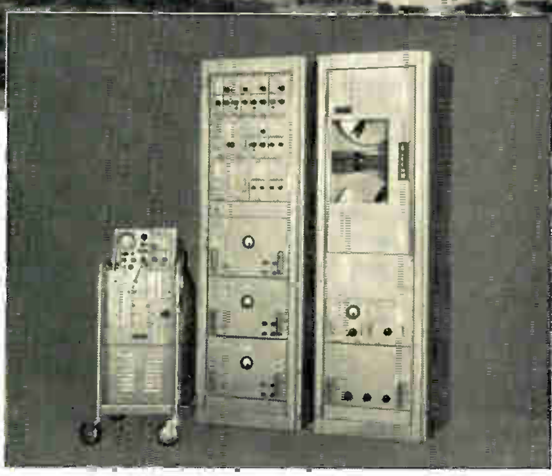
**The Complex Characteristics of a High Frequency Transistor in the Frequency Range from 0 to 2 mc,** G. Ledig. "Freq." May 1958, 12 pp.; Jan. 1958, 13 pp. The author discusses in detail the theoretical and practical aspects for obtaining the characteristics. (Germany.)

**A Temperature-Stabilized Photo-Transistor Relay Circuit,** J. C. Anderson and T. Winer. "El. Eng." Jan. 1959. 2 pp. A junction phototransistor can be used to operate a relay directly but the performance obtained varies widely with ambient temperature. In this article a circuit is described in which a photo-transistor and an ordinary junction transistor are used in a 'long-tailed pair' arrangement. In this way the variation in dark current with change in ambient temperature is much reduced, while high sensitivity is achieved; the transient response is also shown to be good. (England.)

**Properties of Hook Transistors in Switching and Amplifying Circuits,** L. M. Vallese. "J. BIRE." Dec. 1958. 8 pp. The circuit properties of hook and p-n-p-n transistor configurations are examined for applications to switching circuits and to linear amplifiers. (England.)

**Hall Effect in Semiconductor Compounds,** M. J. O. Strutt. "E. & R. Eng." Jan. 1959. 9 pp. (England.)

*(Continued on page 140)*

*THE MINCOM CV-100 VIDEO BAND MAGNETIC RECORDER/REPRODUCER is simple in construction, reliable in performance, easy to maintain*

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|---|---|
| Frequency Response: | 400 cycles to 1 megacycle ± 3 db (each track). |
| Tape Speed: | 120 ips. |
| Number of Tracks: | 7. |
| Tape Width: | ½ inch. |
| Running Time: | 12 minutes using 1 mil tape. |
| Reel Size: | 14 inch NARTB reels. |
| Timing Accuracy: | 0.005% (using Cyclelock). |
| Start Time: | 4 seconds. |
| Stop Time: | 2 seconds. |
| Rewind Time: | 2 minutes. |
| Flutter and Wow: | .1% peak, measuring all components from 0.1 cycle to 4,000 cycles. |
| Signal-to-Noise Ratio: | 30 db, peak signal to rms noise. |
| Crosstalk: | 35 db. |
| Input Level: | 0.1 volt peak-to-peak. |
| Input Impedance: | 93 ohms. |
| Output Level: | 2.0 volts peak-to-peak. |
| Output Impedance: | 93 ohms. |
| Power Requirements: | 117 volts single phase, 48-62 cps. |

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Already previewed and enthusiastically received, the MINCOM CV-100 is currently under construction for many branches of the defense establishment. If your specific need is for the precise video and radar reproduction offered by the CV-100, write or call MINCOM for complete details.

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Circle 314 on Inquiry Card, page 123

## Sources

(*Continued from page 137*)

### TELEVISION

**On Commuting Video Amplifiers with Minimum Lag.** R. B. Gurfinkel. "Radiotek." Jan. 1959. 3 pp. The paper studies the computation of a video amplifier with specified gain $M$, band width $W$ and minimum lag $t_1$ from input to output. Computing graphs are given for the quantities $M$, $W$ and $t_1$ which simplify the design of such amplifiers. (U.S.S.R.)

**Instruments Used for TV Transmission Measurements,** O. Macek. "Freq." Jul. 1958. 8 pp. This article illustrates the German TV standards and instruments used to maintain the described tolerances. (Germany.)

**The Use of Limiters in TV Apparatus,** W. Dillenburger. "Freq." Aug. 1958. 7 pp. After a brief discussion of the limitations of pick-up tubes the author describes the various ways of compensating for streaking, resulting from bright signals. Clamping and limiting circuits are the main subject. (Germany.)

**An NTSC-Color Modulator for the CCIR Standard.** F. Jaeschke. "Arc. El. Uber." Jun. 1958. 18 pp. Particular attention is paid to the problem of the conversion of the three monochrome signals supplied by the picture sender into the luminance and chrominance used for the coding by the NTSC system. A separate section of the paper deals with the facilities for adjusting and operating the modulator. Practical circuits are proposed. (Germany.)

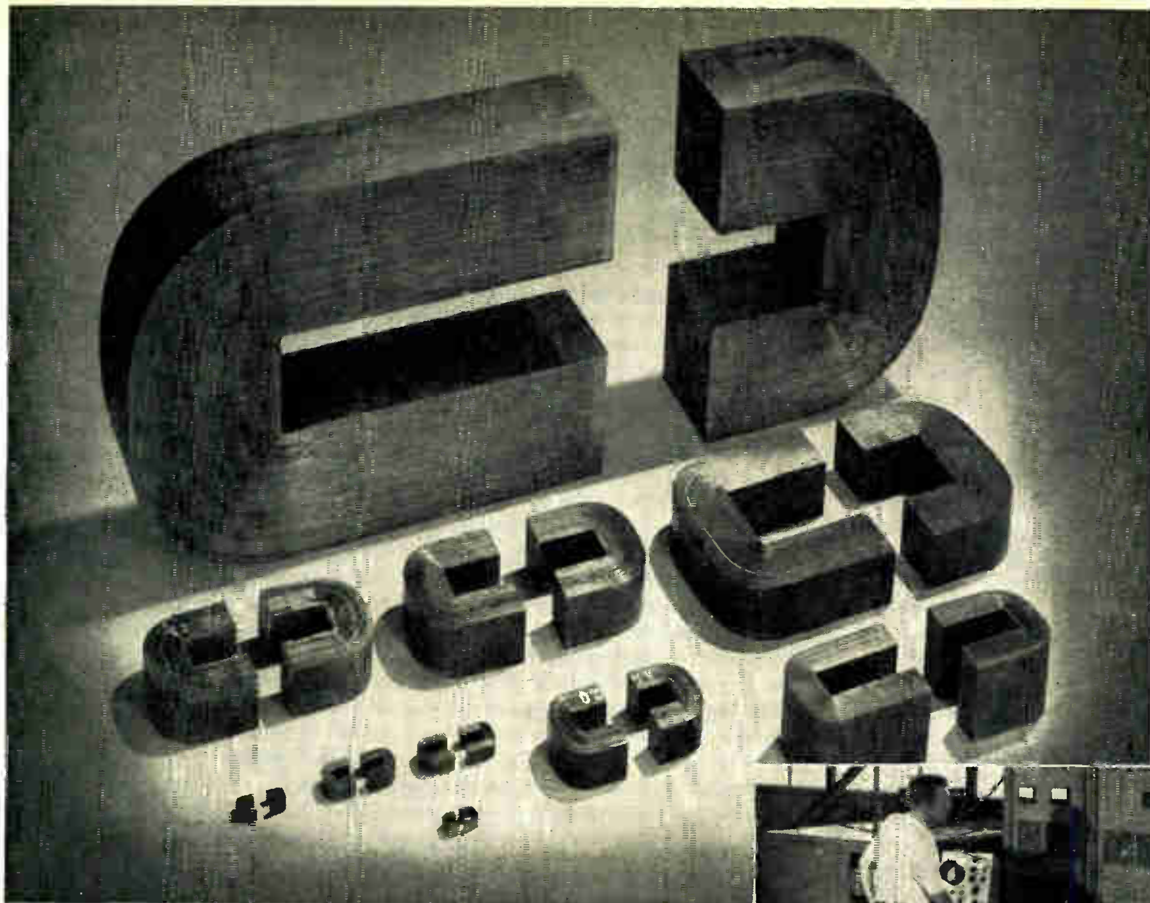
**Television Intermediate-Frequency Transmitters for Laboratory Use,** Paul Klopf. "Rundfunk." Dec. 1958. 12 pp. The author describes a television modulator for laboratory measurements and tests in connection with the residual-sideband transmission system for the 625-line CCIR standard. The author discusses, by means of test signals, test patterns and half-tone picture, the transmission quality via the modulator and an intermediate-frequency standard receiver. (Germany.)

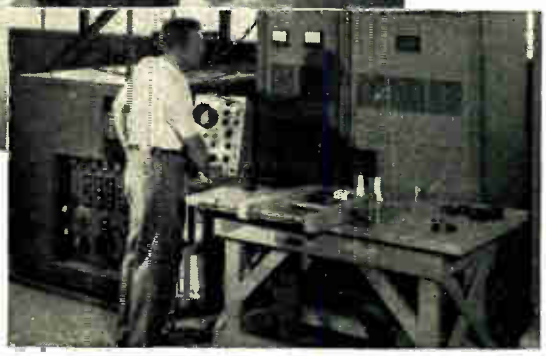
**Investigations in Connection with the Operation of Television Transmitters with Precision Carrier-Frequency Offset,** Herbert Hopf. "Rundfunk." Dec. 1958. 12 pp. (Germany.)

**A Contribution to the Planning and Construction of Television Outside-Broadcast and Film-Recording Vehicles,** G. Schadwinkel and H. Kading. "Rundfunk." Dec. 1958. 12 pp. The authors report about the planning and construction of television outside-broadcast and film-recording vehicles, as developed by the N.W.D.R. and its successors, where they are at present in use. They describe the single-vehicle system, that is to say, that whereby each vehicle is equipped with production and engineering control cubicles and apparatus room and is capable of carrying through a transmission independently. The conditions required of the vehicles are examined by means of a load diagram. (Germany.)

**A Television Waveform Generator Using Transistors,** F. Rozner. "El. Eng." Jan. 1959. 4 pp. This article describes a television waveform generator for use with transportable television broadcasting equipment. Very small size, weight and power consumption are achieved by the use of transistors and the complete elimination of thermionic devices throughout. The waveform generator uses digital techniques and, although this demands a large number of active elements, the resulting performance is, to a large degree, independent of the characteristics of individual transistors, h.t. variations, etc., and the stability and precision are adequate for broadcasting purposes. (England.)

* * *





WSW 7372 A

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The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

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The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

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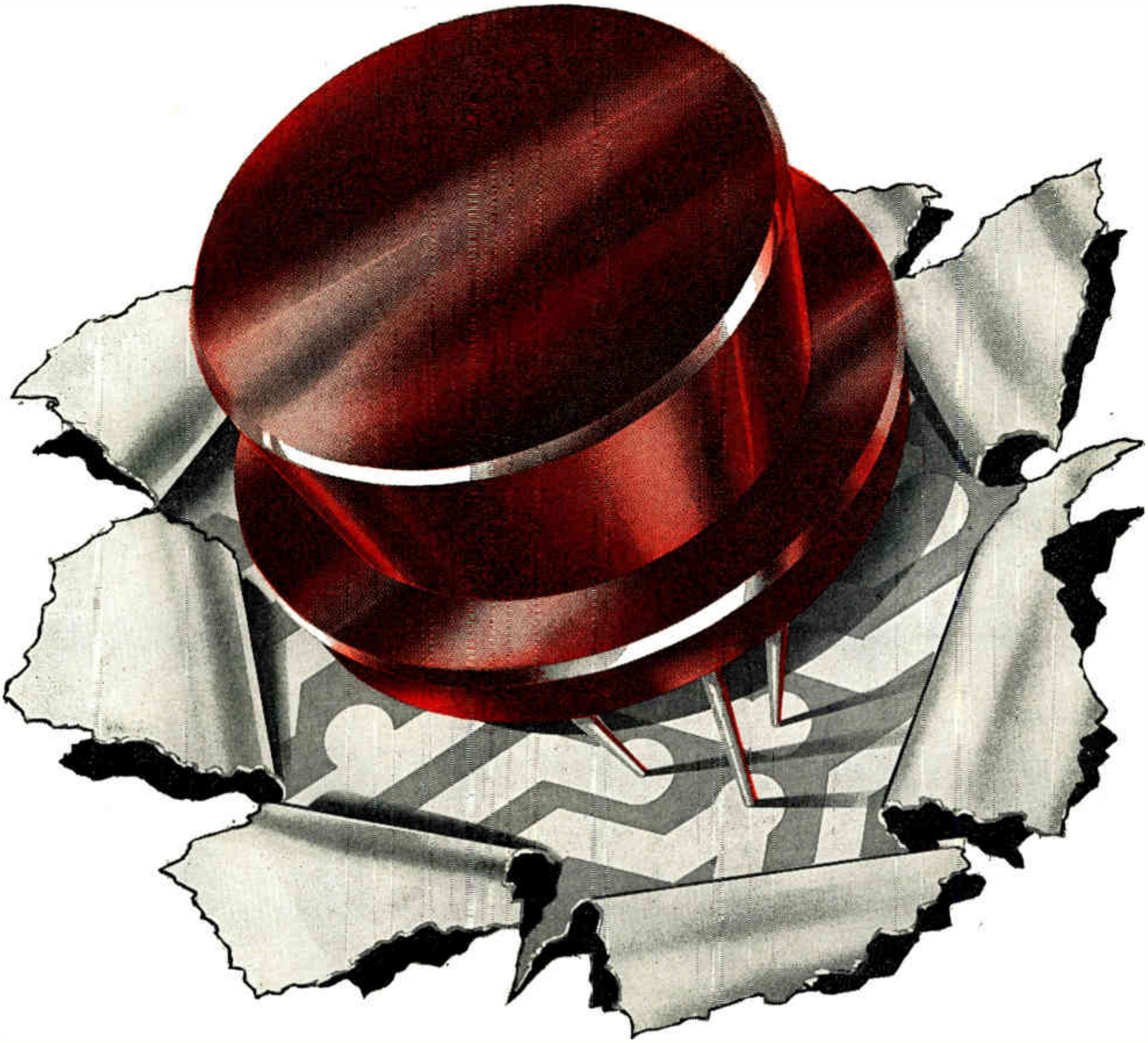
Circle 316 in Inquiry Card, page 123

# ELECTRONIC INDUSTRIES



## First Industry-Wide Transistor Interchangeability Guide!

*—Listing over 500 JEDEC types, with their direct replacements or nearest equivalents*

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# SILICON TRANSISTORS

# PNP · NPN

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## FOR LARGE SIGNAL APPLICATIONS

Temperature Range −65°C to +160°C

TO-5 (0.335" max., 0.260" max.) · E3-44

| | Type | $I_{EO}$ or $I_{CO}$ at $V_{CB}$ = 20 Vdc μA | $V_{CE}$ max. volts | $H_{FE}$† ave. | $r_b'$ f = 1Mc ohms | $r_c$ kilohms | Noise Figure db (max.) | $C_{ob}$ f = 100Kc ave. μμf | $f_{\alpha b}$ ave. Kc |
|---|---|---|---|---|---|---|---|---|---|
| PNP | 2N327A | 0.005 | −40 | 15 | 1200 | 500 | 30 | 65 | 200 |
| PNP | 2N328A | 0.005 | −35 | 30 | 1400 | 500 | 30 | 65 | 300 |
| PNP | 2N329A | 0.005 | −30 | 60 | 1500 | 500 | 30 | 65 | 400 |
| NPN | 2N619 | 0.005 | 50 | 15 | 2000 | 500 | 30 | 35 | 200 |
| NPN | 2N620 | 0.005 | 40 | 30 | 2500 | 500 | 30 | 35 | 350 |
| NPN | 2N621 | 0.005 | 30 | 60 | 2700 | 500 | 30 | 35 | 500 |

†for PNP, $I_B$ = −0.1mA; $V_{CE}$ = −0.5V; for NPN, $I_B$ = 0.5mA; $V_{CE}$ = 1.5V

## FOR SMALL SIGNAL APPLICATIONS

Temperature Range −65°C to +160°C

TO-5 (0.335" max., 0.260" max.) · E3-44

| | Type | $I_{EO}$ or $I_{CO}$ at $V_{CB}$ = 20 Vdc μA | $V_{CE}$ max. volts | $h_{fe}$* ave. | $h_{ie}$* max. ohms | $h_{oe}$* max. μmhos | Noise* Figure db | $C_{ob}$ f = 100Kc ave. μμf | $f_{\alpha b}$ ave. Kc |
|---|---|---|---|---|---|---|---|---|---|
| PNP | 2N1034 | 0.005 | −40 | 15 | 3000 | 70 | 30 | 65 | 200 |
| PNP | 2N1035 | 0.005 | −35 | 30 | 3000 | 85 | 30 | 65 | 300 |
| PNP | 2N1036 | 0.005 | −30 | 60 | 3000 | 100 | 30 | 65 | 400 |
| PNP | 2N1037 | 0.005 | −35 | 30 | 3000 | 85 | 15 | 65 | 250 |
| NPN | 2N1074 | 0.005 | 50 | 15 | 3500 | 70 | 30 | 35 | 200 |
| NPN | 2N1075 | 0.005 | 40 | 30 | 3500 | 85 | 30 | 35 | 350 |
| NPN | 2N1076 | 0.005 | 30 | 60 | 3500 | 100 | 30 | 35 | 500 |
| NPN | 2N1077 | 0.005 | 30 | 25 | 3500 | 85 | 15 | 35 | 300 |

*$V_C$ = 5V; $I_E$ = 3mA

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# 1959 Transistor Interchangeability Chart

***Listing over 500 JEDEC types, with their direct replacements or nearest equivalents***

CONFIDENT that interchangeability of transistors is an important trend that will benefit the entire industry, ELECTRONIC INDUSTRIES joins with the major transistor manufacturers in presenting this first comprehensive listing of transistors and their nearest types.

Of the 627 transistors registered with the Joint Electron Device Engineering Council (now Electronic Industries Association), more than 500 are tabulated in this listing. Only those types which manufacturers suggested as either equivalents or "nearest types" are included. Where the EIA type number is missing it means that, in the material submitted by the manufacturers, no equivalent was indicated as available. These are listed separately at the end of the chart.

The manufacturers who furnished this information point out that the data supplied is based on published electrical specifications. Since physical dimensions may vary considerably, and manufacturing techniques are not identical, it should not be assumed that cross-referenced transistors are exact equivalents.

Included in this tabulation are the transistor numbers and dimension diagrams, both of which follow the registry of the Joint Electron Device Engineering Council (e.g., 2N34, Fig. 5). To this has been added the intended application of the transistor and any special "notes" that might be significant in considering replacements. For exact comparison of electrical characteristics, the reader is referred to the ELECTRONIC INDUSTRIES' June 1958 Directory of Transistor Manufacturers and Types.

The manufacturers included in this survey are listed below, with the abbreviation that identifies each throughout the listings.

## MANUFACTURERS

AMPX—Amperex
BEN—Bendix Aviation Corp.
BO—Bogue Electric Mfg. Co.
CBS—CBS Hytron
CLE—Clevite Transistor Products
DEL—Delco Radio Division, General Motors Corp.
FAIR—Fairchild Semiconductor Prods.
GE—General Electric Co.
GP—Germanium Products Corp.
MAL—P. R. Mallory & Co., Inc.
MH—Minneapolis-Honeywell Regulator Co.
MOTR—Motorola, Inc.
MU—Mullard, Ltd.
PHIL—Philco Corp.
RAY—Raytheon Manufacturing Co.
RCA—Radio Corporation of America
SPR—Sprague Electronics Co.
SYL—Sylvania
TI—Texas Instruments, Inc.
TR—Transitron Electronic Corp.
TS—Tung-Sol
W—Westinghouse
WE—Western Electric Co.

## ABBREVIATIONS

AF—Audio Frequency
Ampl—Amplifier
CNVTR—Converter
EIA—Electronic Industries Assoc.
HF—High Frequency
IF—Intermediate Frequency
JETC—Joint Electron Tube Council
Osc—Oscillator
Pt—Point Contact
PWR—Power
RF—Radio Frequency
SI—Silicon
SW—Switch

# THERE'S A PHILCO TRANSISTOR FOR EACH OF YOUR CIRCUIT REQUIREMENTS

## SURFACE BARRIER TRANSISTORS (SBT*)

| TYPE | GAIN $h_{fe}$ | FREQUENCY $f_{max}$ in mc | APPLICATIONS |
|---|---|---|---|
| 2N128 | 40 | 60 | General communications; MIL specifications |
| 2N240 | 30 | Switching rates 20mc | High-speed switch; controlled hole storage and saturation characteristics; MIL specifications |
| 2N299 | 22db @ 10mc | 110 | Tuned amplifier; MIL specifications |
| 2N300 | 18 | 95 | Video amplifier; MIL specifications |
| 2N344 | 22 | 50 | General purpose; narrow beta spread (11-33) |
| 2N345 | 35 | 50 | General purpose; similar to 2N344 with higher beta; MIL specifications |
| 2N346 | 20 | 75 | General purpose; like 2N344 and 2N345 but higher frequency |
| SB100 | 20 | 45 | General purpose amplifier |

*Trademark Philco Corp. for Surface Barrier Transistor

## MICRO ALLOY TRANSISTORS (MAT*)

| TYPE | GAIN $h_{FE}$ | FREQUENCY $f_{max}$ in mc | APPLICATIONS |
|---|---|---|---|
| 2N393 | 95 | 60 | High-speed, high-gain switch; MIL specifications |
| 2N1122 | 95 | 60 | High-speed, high-voltage level switch |
| 2N1122A | 95 | 60 | Higher voltage level operation |

*Trademark Philco Corp. for Micro Alloy Transistor

## MICRO ALLOY DIFFUSED-BASE TRANSISTORS (MADT*)

| TYPE | GAIN | FREQUENCY $f_{max}$ in mc | APPLICATIONS |
|---|---|---|---|
| 2N499 | 10db @ 100mc | 320 | VHF amplifier; MIL specifications |
| 2N500 | 22mw PO @ 200mc | 400 | VHF oscillator; MIL specifications |
| 2N501 | $h_{FE}$ 35 | Switching rates 40mc | Ultra-fast switch; typical $t_r$ 9μsec; $t_s$ 9μsec; $t_f$ 7μsec; MIL specifications |
| 2N501A | $h_{FE}$ 35 | Switching rates 40mc | Rated at 100°C; MIL specifications |
| 2N502 | 10db @ 200 mc | 700 | VHF amplifier; MIL specifications |
| 2N502A | 10db @ 200 mc | 700 | Rated at 100°C; MIL specifications |
| 2N503 | 12.5db @ 100mc | 420 | VHF amplifier |
| 2N504 | 46db @ 455kc | Minimum 50 | IF amplifier; high level logic switch |
| 2N588 | 14db @ 50mc | 250 | General purpose RF-IF amplifier |

*Trademark Philco Corp. for Micro Alloy Diffused-base Transistor

## MICRO-MINIATURE TRANSISTORS

| TYPE | GAIN $h_{fe}$ | FREQUENCY $f_{\alpha b}$ in mc | APPLICATIONS |
|---|---|---|---|
| 2N207 | 100 | 2 | Low level amplifier; particularly suited for hearing aid use; N.F.* 15db max |
| 2N207A | 100 | 2 | Low level amplifier; particularly suited for hearing aid use; N.F.* 10db max |
| 2N207B | 100 | 2 | Hearing aid input stage; other extremely low noise applications; N.F.* 5db max |
| 2N534 | 150 | | High voltage amplifier switch |
| 2N535 | 100 | 2 | General purpose; 85°C max temperature rating; N.F.* 10db max |
| 2N535A | 100 | 2 | General purpose; 85°C max temperature rating; N.F.* 5db max |
| 2N535B | 100 | 2 | General purpose; 85°C max temperature rating; N.F.* 0db max |
| 2N536 | $h_{FE}$ 100 | 2 | Low level switch at pulse rates up to 150kc |

*Noise Factor at 1μv reference level across 1000 ohms

## SILICON ALLOY TRANSISTORS (SAT*)

| TYPE | GAIN $h_{fe}$ | FREQUENCY $f_{max}$ 15mc | APPLICATIONS |
|---|---|---|---|
| 2N495 | 15 | | General purpose; MIL specifications |
| 2N496 | $h_{FE}$ 10 | $f_T$ 11mc** | High-speed switching; MIL specifications |

*Trademark Philco Corp. for Silicon Alloy Transistor **Frequency for beta=1

## BILATERAL TRANSISTOR

| TYPE | GAIN $h_{FE}$* | FREQUENCY $f_{\alpha b}$ 500kc | APPLICATIONS |
|---|---|---|---|
| 2N462 | 45 | | Controlled pulse response (max $t_{on}$ and $t_{off}$ 12μsec) |

*Forward and inverse

## POWER TRANSISTORS

| TYPE | GAIN | FREQUENCY $f_{\alpha e}$ in kc | APPLICATIONS |
|---|---|---|---|
| 2N386 | 33db @ 5w PO | Minimum 7 | High-voltage general purpose amplifiers; relay actuators and power converters |
| 2N387 | 33db @ 5w PO | Minimum 6 | High-voltage general purpose amplifiers; relay actuators and power converters |

## MEDIUM FREQUENCY TRANSISTORS

| TYPE | GAIN $h_{FE}$ | FREQUENCY $f_{\alpha b}$ in mc | APPLICATIONS |
|---|---|---|---|
| 2N597 | 70 | 4.5 | High-voltage general purpose amplifier and switch; TO-9 case |
| 2N598 | 85 | 7.5 | 500kc logic switching; TO-9 case |
| 2N599 | 105 | 18 | Logic switching rates up to 1mc; core driver; TO-9 case |
| 2N600 | 85 | 7.5 | 500kc switching; 1 watt peak power dissipation for 0.1 sec; stud mount |
| 2N601 | 105 | 18 | High-power core driver; typical rise time 0.1 μsec; stud mount |
| 2N1123 | 70 | 4.5 | High-voltage power amplifier and switch; stud mount |

## PULSE AMPLIFIER TRANSISTORS

| TYPE | GAIN $h_{FE}$ | FREQUENCY | APPLICATIONS |
|---|---|---|---|
| 2N670 | $h_{fe}$ 100 | $f_{\alpha b}$ 700kc | High peak current pulse amplifier; relay driver |
| 2N671 | 100 | $f_{\alpha b}$ 650kc | High power version of 2N670; stud mount |
| 2N672 | 20 (Sat.) | 0.5 μsec max $t_r$ | High-current switching core driver; controlled rise, fall, and storage times |
| 2N673 | 20 (Sat.) | 0.5 μsec max $t_r$ | High power version of 2N672; stud mount |

## MEDIUM POWER TRANSISTORS

| TYPE | GAIN $h_{FE}$ | FREQUENCY $f_{\alpha b}$ in mc | APPLICATIONS |
|---|---|---|---|
| 2N223 | $h_{fe}$ 110 | 0.6 | Audio driver; exceptional beta linearity |
| 2N224 | 90 | 0.51 | Audio output; exceptional beta linearity; available as matched pair (2N225) |
| 2N226 | 60 | 0.4 | Audio output; exceptional beta linearity; available as matched pair (2N227) |
| 2N1124 | Min $h_{fe}$ 40 | Minimum 0.4 | E3-51 based high-voltage, general purpose industrial amplifier |
| 2N1125 | $h_{fe}$ 100 | Minimum 1 | E3-51 based high-voltage, medium frequency amplifier and switch |
| 2N1126 | Min $h_{fe}$ 40 | Minimum 0.4 | E3-51 based high-power, high-voltage, general purpose industrial amplifier; stud mount |
| 2N1127 | 100 | Minimum 1 | E3-51 based high-power, high-voltage, medium frequency amplifier and switch; stud mount |
| 2N1128 | $h_{fe}$ 100 | 1 | E3-51 based audio driver |
| 2N1129 | 165 | 0.75 | E3-51 based high gain transistor for amplifier and switching |
| 2N1130 | 125 | 0.75 | E3-51 based general purpose audio transistor |

# PHILCO® CORPORATION

## LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

# 1959 TRANSISTOR INTERCHANGEABILITY CHART

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N27 | NPN | AF Ampl | WE | 2N27 | | | |
| | | | SYL | | 2N35 | Fig. 5 | |
| | | | RCA | | 2N104 | Fig. 17 | |
| 2N28 | NPN | AF Ampl | WE | 2N28 | | | |
| | | | SYL | | 2N35 | Fig. 5 | |
| | | | RCA | | 2N104 | Fig. 17 | |
| 2N34 | PNP | AF Ampl | RCA | 2N34 | 2N109 | Fig. 5 | |
| | | | SYL | 2N34 | | | |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | GT | | GT20 | | |
| | | | RAY | | 2N465 | Fig. 30 | |
| | | | W | | 2N612 | | |
| 2N34A | PNP | AF Ampl | RCA | 2N34A | 2N109 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N465 | | |
| 2N35 | NPN | AF Ampl<br>IF Ampl | RCA | 2N35 | | Fig. 5 | |
| | | | SYL | 2N35 | | | |
| | | | GE | | 2N169A | Fig. 16 | |
| | | | GT | | GT35 | | |
| 2N36 | PNP | AF Ampl | CBS | 2N36 | | Fig. 6 | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | GT | | GT20 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N465 | | |
| 2N37 | PNP | AF Ampl | CBS | 2N37 | | Fig. 6 | |
| | | | GE | | 2N190 | | |
| | | | GT | | GT14 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N465 | | |
| 2N38 | PNP | AF Ampl | CBS | 2N38 | | Fig. 6 | |
| | | | GT | | GT34 | | |
| | | | RCA | | 2N109 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N464 | | |
| 2N38A | PNP | AF Ampl | CBS | 2N38A | | | |
| | | | GE | | 2N189 | Fig. 6 | |
| | | | RCA | | 2N109 | Fig. 8 | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N41 | PNP | AF Ampl | RCA | 2N41 | | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N43 | PNP | AF Ampl | GE | 2N43 | | Fig. 6 | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | 2N43 | | | |
| | | | RCA | | 2N109 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N43A | PNP | AF Ampl | GE | 2N43A | | Fig. 8 | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | 2N43A | | | |
| | | | RCA | | 2N206 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N44 | PNP | AF Ampl | GE | 2N44 | | Fig. 8 | |
| | | | RCA | | 2N109 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | 2N44 | | | |
| | | | RAY | | 2N464 | Fig. 30 | |
| | | | W | | 2N61 | Fig. 30W | |
| 2N44A | PNP | AF Ampl | GE | 2N44A | | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | | |
| | | | W | | 2N61 | Fig. 30W | |
| 2N45 | PNP | AF Ampl | GE | 2N45 | | Fig. 8 | Obsolete |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | | |
| | | | GT | 2N45 | | | |
| | | | RAY | | 2N464 | Fig. 30 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N46 | PNP | AF Ampl | RCA | 2N46 | | | Obsolete |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | RCA | | 2N105 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N47 | PNP | AF Ampl | PHIL | 2N47 | | Fig. 9 | |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | RCA | | 2N105 | | |
| 2N48 | PNP | AF Ampl | PHIL | 2N48 | | Fig. 9 | |
| | | | GE | | 2N189 | Fig. 8 | |
| | | | RCA | | 2N105 | | |
| 2N49 | PNP | AF Ampl | PHIL | 2N49 | | Fig. 9 | |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | RCA | | 2N105 | | |
| 2N54 | PNP | AF Ampl | W | 2N54 | | | |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N59 | Fig. 30W | |
| 2N55 | PNP | AF Ampl | W | 2N55 | | | |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N60 | Fig. 30W | |
| 2N56 | PNP | AF Ampl | W | 2N56 | | | |
| | | | GE | | 2N189 | Fig. 8 | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N61 | Fig. 30W | |
| 2N57 | PNP | PWR Ampl | W | 2N57 | | | |
| | | | MH | 2N57 | | | |
| 2N59 | PNP | AF Output | W | 2N59 | | Fig. 30W | High current |
| | | | RAY | | 2N466 | | |
| | | | GE | | 2N241A | | |
| | | | GE | | 2N321 | | |
| | | | GT | | GT109 | | |
| 2N60 | PNP | AF Output | W | 2N60 | | Fig. 30W | High current |
| | | | RAY | | 2N465 | | |
| | | | GE | | 2N188A | Fig. 8 | |
| | | | GE | | 2N320 | | |
| | | | GT | | GT109 | | |
| 2N61 | PNP | AF Output | W | 2N61 | | Fig. 30W | High current |
| | | | RAY | | 2N465 | | |
| | | | GE | | 2N187A | Fig. 8 | |
| | | | GE | | 2N319 | | |
| | | | GT | | GT109 | | |
| 2N62 | PNP | AF Ampl | PHIL | 2N62 | | | Obsolete |
| | | | RCA | | 2N109 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | | GT109 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N63 | PNP | AF Ampl | RAY | 2N63 | | | |
| | | | TS | 2N63 | | | |
| | | | GE | | 2N107 | Fig. 8 | |
| | | | GT | | GT14 | | |
| | | | RCA | | 2N217 | Fig. 15 | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | W | | 2N402 | Fig. 30 | |
| | | | RAY | | 2N464 | | |
| 2N64 | PNP | AF Ampl | RAY | 2N63 | | | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | GT | | GT20 | | |
| | | | RCA | | 2N217 | Fig. 15 | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N65 | PNP | AF Ampl | RAY | 2N65 | | | |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | RCA | | 2N217 | Fig. 15 | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N76 | PNP | AF Ampl | GE | 2N76 | | Fig. 8 | Obsolete |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | GT | | GT14 | | |
| | | | RCA | | 2N104 | Fig. 17 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N77 | PNP | AF Ampl | RCA | 2N77 | | Fig. 8 | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | GT | | 2N565 | | |
| | | | RAY | | 2N465 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N78 | NPN | RF Ampl<br>IF Ampl | GE | 2N76 | | Fig. 16 | |
| | | | GT | | 2N445 | Fig. 30 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| | | | SYL | | 2N139 | Fig. 17 | |
| | | | W | | 2N615 | | |
| 2N79 | PNP | AF Ampl | RCA | 2N79 | | Fig. 17 | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | GT | | GT20 | | |
| | | | RCA | | 2N206 | Fig. 15 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N80 | PNP | AF Ampl | CBS | 2N80 | | Fig. 6 | |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT81 | | |
| 2N81 | PNP | AF Ampl | GE | 2N81 | | Fig. 8 | Obsolete |
| | | | GE | | 2N189 | Fig. 8 | |
| | | | GT | | GT14 | | |
| 2N82 | PNP | AF Ampl | CBS | 2N82 | | | |
| | | | GT | | GT14 | | |
| 2N85 | PNP | AF Ampl | TR | 2N85 | | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | | GT81 | | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N86 | PNP | AF Ampl | TR | 2N86 | | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | | GT81 | | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N87 | PNP | AF Ampl | TR | 2N87 | | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | | GT81 | | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N88 | PNP | AF Ampl | TR | 2N88 | | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | GT | | GT20 | | |
| | | | RCA | | 2N105 | Fig. 20 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N89 | PNP | AF Ampl | TR | 2N89 | | | |
| | | | GT | | GT20 | | |
| | | | RCA | | 2N105 | Fig. 20 | |
| | | | W | | 2N402 | Fig. 30 | |

# 1959 TRANSISTOR INTERCHANGEABILITY CHART

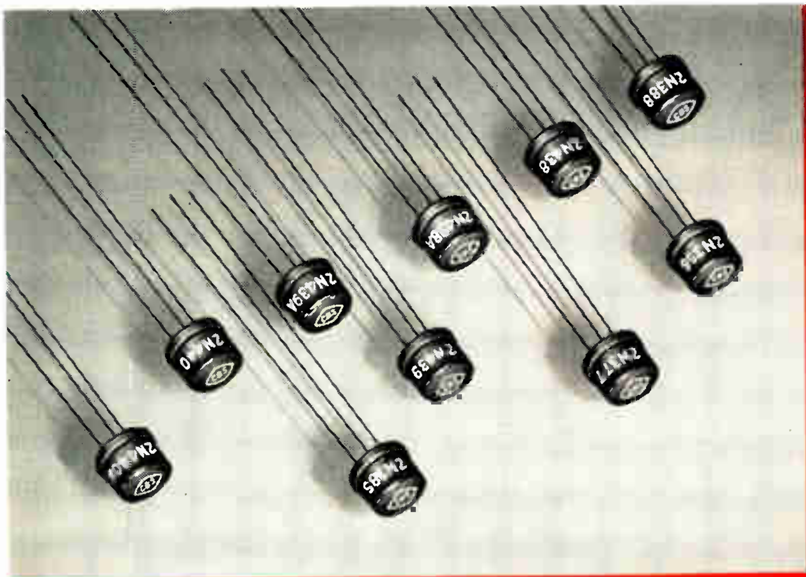
| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N90 | PNP | AF Ampl | TR | 2N90 | | | |
| | | | GT | | GT20 | | |
| | | | RCA | | 2N105 | Fig. 20 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N94 | NPN | HFRF Ampl | SYL | 2N94 | | Fig. 5 | |
| | | | GE | | 2N169A | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N94A | NPN | RF Ampl | SYL | 2N94A | | Fig. 5 | |
| | | SW | GE | | 2N169A | Fig. 16 | |
| | | | GT | | GT792R | | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N96 | PNP | AF Ampl | RCA | 2N96 | | | Obsolete |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | GE | | 2N322 | | |
| | | | GT | | GT14 | | |
| | | | RCA | | 2N206 | Fig. 15 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N97 | NPN | AF Ampl | BO | 2N97 | | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GT | | 2N444 | | |
| 2N97A | NPN | AF Ampl | BO | 2N97A | | Fig. 12 | |
| | | IF Ampl | GE | | 2N169A | Fig. 16 | |
| | | SW | | | | | |
| 2N98 | NPN | AF Ampl | BO | 2N98 | | Fig. 12 | |
| | | IF Ampl | GE | | 2N169A | Fig. 16 | |
| | | | GT | | 2N445 | | |
| 2N99 | NPN | IF Ampl | BO | 2N99 | | Fig. 12 | |
| | | | GE | | 2N169A | Fig. 16 | |
| | | | GT | | 2N445 | | |
| 2N100 | NPN | IF Ampl | BO | 2N100 | | Fig. 12 | |
| | | | GE | | 2N170 | Fig. 16 | |
| | | | GT | | 2N446 | | |
| 2N103 | NPN | AF Ampl | BO | 2N103 | | Fig. 12 | |
| | | IF Ampl | GE | | 2N170 | Fig. 16 | |
| | | | GT | | GT35 | | |
| 2N104 | PNP | AF Ampl | RCA | 2N104 | | Fig. 17 | |
| | | | GE | | 2N190 | Fig. 8 | |
| | | | GT | | 2N565 | | |
| | | | W | | 2N402 | Fig. 30 | |
| | | | RAY | | 2N464 | | |
| 2N105 | PNP | AF Ampl | RCA | 2N105 | | Fig. 20 | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | RAY | | 2N465 | | |
| | | | GT | | GT81 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N106 | PNP | AF Ampl | RAY | 2N106 | | Fig. 12 | |
| | | | GE | | 2N189 | Fig. 8 | |
| | | | W | | 2N402 | Fig. 30 | |
| | | | RCA | | 2N104 | Fig. 17 | |
| 2N107 | PNP | AF Ampl | GE | 2N107 | | Fig. 8 | |
| | | | GT | | GT222 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N402 | Fig. 30 | |
| | | | RAY | | CK722 | | |
| 2N109 | PNP | AF Output | RCA | 2N109 | | Fig. 17 | High current |
| | | | GE | | 2N188 | Fig. 8 | |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT109 | | |
| | | | SYL | 2N109 | | | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N464 | | |
| 2N111 | PNP | IF Ampl | RAY | 2N111 | | Fig. 12 | |
| | | RF Ampl | GE | | 2N135 | Fig. 8 | |
| | | | GT | | 2N519 | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N614 | | |
| 2N111A | PNP | IF Ampl | RAY | 2N111A | | | |
| | | RF Ampl | GE | | 2N135 | Fig. 8 | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N614 | | |
| 2N112 | PNP | RF Ampl | RAY | 2N112 | | Fig. 12 | |
| | | | GE | | 2N135 | Fig. 8 | |
| | | | GE | | 2N136 | Fig. 8 | |
| | | | GT | | 2N520 | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N615 | | |
| 2N112A | PNP | IF Ampl | RAY | 2N112A | | | |
| | | | GE | | 2N136 | Fig. 8 | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N615 | | |
| 2N113 | PNP | RF Ampl | RAY | 2N113 | | Fig. 12 | |
| | | | GE | | 2N137 | Fig. 8 | |
| | | | GT | | 2N521 | | |
| | | | SYL | | 2N139 | Fig. 17 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| | | | W | | 2N617 | | |
| 2N114 | PNP | RFSW | RAY | 2N114 | | Fig. 12 | |
| | | | GE | | 2N123 | Fig. 8 | |
| | | | GE | | 2N137 | Fig. 8 | |
| | | | GT | | 2N522 | | |
| | | | RCA | | 2N140 | Fig. 17 | |
| | | | W | | 2N617 | | |
| 2N116 | PNP | AF Ampl | CBS | 2N116 | | | |
| | | | GT | | GT81 | | |
| | | | RCA | | 2N175 | Fig. 17 | |

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N117 | NPN | AF Ampl | TI | 2N117 | | Fig. 12 | Silicon-High Temperature |
| | | | GE | | 2N332 | | |
| | | | TR | | 2N471 | | |
| | | | TR | 2N117 | | | |
| 2N118 | NPN | AF Ampl | TI | 2N118 | | Fig. 12 | Silicon-High Temperature |
| | | | GE | | 2N333 | | |
| | | | TR | 2N118 | | | |
| | | | TR | | 2N474 | | |
| 2N118A | NPN | AF Ampl | TI | 2N118A | | | Silicon-High Temperature |
| | | | TR | 2N118A | | | |
| | | | TR | | 2N474 | | |
| 2N119 | NPN | AF Ampl | TI | 2N119 | | | Silicon-High Temperature |
| | | | GE | | 2N335 | | |
| | | | TR | 2N119 | | | |
| | | | TR | | 2N479 | | |
| 2N120 | NPN | AF Ampl | TI | 2N120 | | | Silicon-High Temperature |
| | | | TR | | 2N335 | | |
| 2N123 | PNP | RFSW | GE | 2N123 | | Fig. 8 | |
| | | | GT | | GT123 | | |
| | | | RCA | | 2N404 | Fig. 30 | |
| | | | SYL | | 2N404 | Fig. 30 | |
| | | | RAY | | 2N426 | | |
| 2N124 | NPN | RFSW | TI | 2N124 | | Fig. 12 | |
| | | | GE | | 2N293 | Fig. 16 | |
| 2N125 | NPN | RFSW | TI | 2N125 | | Fig. 12 | |
| | | | GE | | 2N167 | Fig. 16 | |
| 2N126 | NPN | RFSW | TI | 2N126 | | Fig. 12 | |
| | | | GE | | 2N167 | Fig. 16 | |
| 2N127 | NPN | RFSW | TI | 2N127 | | Fig. 12 | |
| | | | GE | | 2N167 | Fig. 16 | |
| 2N128 | PNP | HF Ampl | PHIL | 2N128 | | Fig. 9 | "Surface Barrier Type" |
| | | | SYL | | 2N247 | Fig. 27S | |
| | | | GT | | 2N604 | | |
| | | | RCA | | 2N247 | | |
| 2N129 | PNP | HF Ampl | PHIL | 2N129 | | Fig. 9 | "Surface Barrier Type" |
| | | | SYL | | 2N247 | Fig. 27S | |
| | | | GT | | 2N603 | | |
| | | | RCA | | 2N247 | | |
| 2N130 | PNP | AF Ampl | RAY | 2N130 | | | |
| | | | GE | | 2N186 | Fig. 8 | |
| | | | GE | | 2N319 | | |
| | | | RCA | | 2N105 | Fig. 20 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N130A | PNP | AF Ampl | RAY | 2N130A | | | |
| | | | GT | | GT14 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N131 | PNP | AF Ampl | RAY | 2N131 | | | |
| | | | GE | | 2N187 | Fig. 8 | |
| | | | GE | | 2N319 | | |
| | | | RCA | | 2N105 | Fig. 20 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N131A | PNP | AF Ampl | RAY | 2N131A | | | |
| | | | GT | | GT20 | | |
| | | | W | | 2N402 | | |
| 2N132 | PNP | AF Ampl | RAY | 2N132 | | | |
| | | | GE | | 2N241 | Fig. 8 | |
| | | | GE | | 2N321 | | |
| | | | RCA | | 2N105 | Fig. 20 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N132A | PNP | AF Ampl | RAY | 2N132A | | | |
| | | | GT | | GT81 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N133 | PNP | AF Ampl | RAY | 2N133 | | | Low Noise |
| | | | GE | | 2N186 | Fig. 8 | |
| | | | RCA | | 2N175 | Fig. 17 | |
| 2N133A | PNP | AF Ampl | RAY | 2N133A | | | Low Noise |
| | | | GT | | GT74 | | |
| 2N135 | PNP | HF Ampl | GE | 2N135 | | Fig. 8 | |
| | | | SYL | | 2N139 | Fig. 17 | |
| | | | GT | | 2N520 | | |
| | | | RCA | | 2N139 | Fig. 17 | |
| | | | W | | 2N614 | | |
| | | | RAY | | 2N482 | | |
| 2N136 | PNP | HF Ampl | GE | 2N136 | | Fig. 8 | |
| | | | SYL | | 2N139 | Fig. 17 | |
| | | | GT | | 2N520 | | |
| | | | RCA | | 2N139 | Fig. 17 | |
| | | | W | | 2N615 | | |
| | | | RAY | | 2N482 | | |
| 2N137 | PNP | HF Ampl | GE | 2N137 | | Fig. 8 | |
| | | | GT | | 2N521 | | |
| | | | RCA | | 2N140 | Fig. 17 | |
| | | | RAY | | 2N484 | | |
| | | | W | | 2N615 | | |
| 2N138 | PNP | AF Output | RAY | 2N138 | | | High Current |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | RCA | | 2N406 | | |
| | | | SYL | | 2N406 | | |
| | | | W | | 2N61 | Fig. 30W | |
| 2N138A | PNP | AF Output | RAY | 2N138A | | | High Current |
| | | | GE | | 2N187 | Fig. 8 | |
| | | | RCA | | 2N406 | | |
| | | | SYL | | 2N406 | | |
| | | | W | | 2N60 | Fig. 30W | |

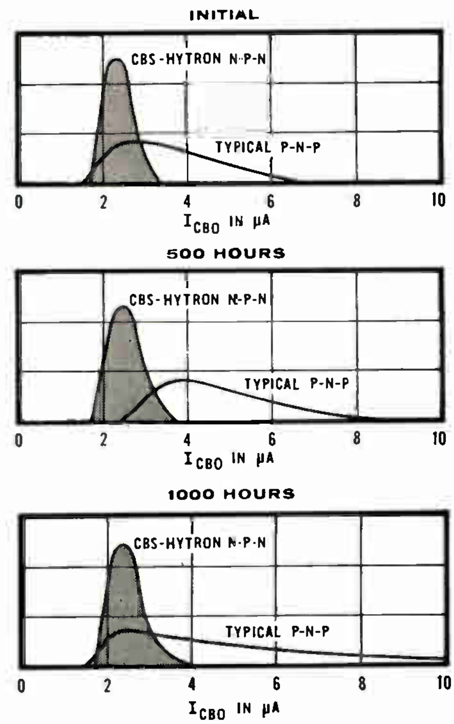
# NPN switching transistors PROVE MORE RELIABLE than PNP

Some design engineers specify PNP switching transistors because they consider them inherently more reliable. Actually NPN transistors can give you superior reliability along with their well-known higher speed. Life tests covering hundreds of thousands of CBS-Hytron NPN alloy-junction germanium switching transistors proved this during the past year. See graphs comparing these transistors with typical military-approved PNP transistors.

The superiority of CBS-Hytron NPN transistors is achieved by special processing: For example, advanced surface chemistry techniques seal out moisture and contamination. Precise control of alloying produces high back voltages. Thorough bake-out stabilizes gain. The result is reliable NPN computer-type switching transistors featuring fast switching . . . high voltage . . . low cutoff current . . . and low saturation resistance . . . in a welded JETEC TO-9 package.




**Comparative Life Tests**
**NPN vs. PNP Switching Transistors.**




**CBS-Hytron NPN Switching Transistors**

| Type | Minimum $BV_{CBO}$ (Volts) | Dissipation @ 25°C (Milliwatts) | Minimum $h_{FE}$ | @ $I_C$ (Ma) | Typical $f_{\alpha b}$ (Megacycles) | Application |
|---|---|---|---|---|---|---|
| 2N356 | 20 | 100 | 20 | 100 | 3 | Core Driver |
| 2N377 | 25 | 150 | 20 | 200 | 6 | Core Driver |
| 2N385 | 25 | 150 | 20 | 200 | 6 | Core Driver |
| 2N388 | 25 | 150 | 30 | 200 | 8 | Core Driver |
| 2N438 | 30 | 100 | 20 | 50 | 4 | Logic Circuit |
| 2N438A | 30 | 150 | 20 | 50 | 4 | Logic Circuit |
| 2N439 | 30 | 100 | 30 | 50 | 8 | Logic Circuit |
| 2N439A | 30 | 150 | 30 | 50 | 8 | Logic Circuit |
| 2N440 | 30 | 100 | 40 | 50 | 12 | Logic Circuit |
| 2N440A | 30 | 150 | 40 | 50 | 12 | Logic Circuit |

Operating and storage temperature, $T_j = -55$ to $+85$°C

A comprehensive line of these reliable CBS-Hytron NPN high-speed switching transistors is available now in production quantities. Check the table. Order types you need . . . or write for Bulletin E-293-302 giving complete data...today.

*More reliable products through Advanced-Engineering*

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**CBS-HYTRON**, Semiconductor Operations
A Division of Columbia Broadcasting System, Inc.



Circle 58 on Inquiry Card, page 123

# 1959 TRANSISTOR INTERCHANGEABILITY CHART

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N139 | PNP | HF Ampl | RCA | 2N139 | | Fig. 17 | |
| | | | GE | | 2N135 | Fig. 8 | |
| | | | GE | | 2N136 | Fig. 8 | |
| | | | GT | | GT160R | | |
| | | | SYL | 2N139 | | Fig. 17 | |
| | | | W | | 2N615 | | |
| | | | RAY | | 2N482 | | |
| 2N140 | PNP | HFOSC | RCA | 2N140 | | Fig. 17 | |
| | | | GE | | 2N136 | Fig. 8 | |
| | | | GE | | 2N137 | Fig. 8 | |
| | | | GT | | GT761R | | |
| | | | SYL | 2N140 | | | |
| | | | W | | 2N617 | | |
| | | | RAY | | 2N485 | | |
| 2N145 | NPN | IF Ampl | TI | 2N145 | 2N253 | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GE | | 2N292 | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N146 | NPN | IF Ampl | TI | 2N146 | 2N254 | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GE | | 2N292 | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N147 | NPN | IF Ampl | TI | 2N147 | 2N254 | Fig. 12 | |
| | | | GE | | 2N168A | Fig. 16 | |
| | | | GE | | 2N293 | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N148 | NPN | IF Ampl | TI | 2N148 | 2N253 | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GE | | 2N292 | Fig. 16 | |
| | | | GT | | GT948R | | |
| 2N148A | NPN | IF Ampl | TI | 2N148A | 2N254 | Fig. 12 | |
| | | | GE | | 2N169A | Fig. 16 | |
| 2N149 | NPN | IF Ampl | TI | 2N149 | 2N253 | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GE | | 2N292 | Fig. 16 | |
| | | | GT | | GT948R | | |
| 2N149A | NPN | IF Ampl | TI | 2N149A | 2N254 | Fig. 12 | |
| | | | GE | | 2N169A | Fig. 16 | |
| 2N150 | NPN | IF Ampl | TI | 2N150 | 2N253 | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GE | | 2N292 | Fig. 16 | |
| | | | GT | | GT948R | | |
| 2N150A | NPN | IF Ampl | TI | 2N150A | 2N254 | Fig. 12 | |
| | | | GE | | 2N169A | Fig. 16 | |
| 2N155 | PNP | PWR Ampl | CBS | 2N155 | | Fig. 25 | |
| | | | SYL | 2N155 | | Fig. 25 | |
| | | | CLE | | 2N257 | Fig. 25 | |
| | | | RCA | | 2N301 | Fig. 25 | |
| | | | BEN | | 2N235A | | |
| 2N156 | PNP | PWR Ampl | CBS | 2N156 | | Fig. 25 | |
| | | | SYL | | 2N242 | Fig. 25 | |
| | | | SYL | 2N156 | | Fig. 25 | |
| | | | RCA | | 2N301 | Fig. 25 | |
| 2N158 | PNP | PWR Ampl | CBS | 2N158 | | Fig. 25 | |
| | | | SYL | | 2N242 | Fig. 25 | |
| | | | RCA | | 2N301 | Fig. 25 | |
| | | | CLE | | 2N268A | | |
| | | | BEN | | 2N639A | | |
| 2N158A | PNP | PWR Ampl | CBS | 2N158A | | Fig. 25 | |
| | | | SYL | | 2N242 | Fig. 25 | |
| | | | CLE | | 2N268A | | |
| | | | BEN | | 2N639A | | |
| 2N160 | NPN | IF Ampl | BO | 2N160 | | Fig. 12 | Silicon |
| | | | GE | | 2N332 | Fig. 30 | |
| 2N160A | NPN | IF Ampl | BO | 2N160A | | Fig. 12 | Silicon |
| | | | GE | | 2N332 | Fig. 30 | |
| 2N161 | NPN | RF Ampl | BO | 2N161 | | Fig. 12 | Silicon |
| | | | GE | | 2N333 | Fig. 30 | |
| 2N161A | NPN | RF Ampl | BO | 2N161A | | Fig. 12 | Silicon |
| | | | GE | | 2N333 | Fig. 30 | |
| 2N162 | NPN | RF Ampl | BO | 2N162 | | Fig. 12 | Silicon |
| | | | GE | | 2N335 | Fig. 30 | |
| 2N162A | NPN | RF Ampl | BO | 2N162A | | Fig. 12 | Silicon |
| | | | GE | | 2N335 | Fig. 30 | |
| 2N163 | NPN | RF Ampl | BO | 2N163 | | Fig. 12 | Silicon |
| | | | GE | | 2N335 | Fig. 30 | |
| 2N163A | NPN | RF Ampl | BO | 2N163A | | Fig. 12 | Silicon |
| | | | GE | | 2N335 | Fig. 30 | |
| 2N164A | NPN | HF OSC | GE | 2N164A | | | Obsolete |
| | | | GE | | 2N168A | Fig. 16 | |
| | | | GT | | GT792R | | |
| 2N165 | NPN | HF OSC | GE | 2N165 | | | Obsolete |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GT | | GT948R | | |
| 2N166 | NPN | RF Ampl | GE | 2N166 | | Fig. 30 | Obsolete |
| | | | GE | | 2N170 | Fig. 16 | |
| | | | GT | | GT229 | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N167 | NPN | SW | GE | 2N167 | | Fig. 16 | |
| | | | GT | | GT167 | | |
| | | | RCA | | 2N269 | Fig. 15 | |
| 2N168 | NPN | RF Ampl | GE | 2N168 | | Fig. 16 | Obsolete |
| | | | GE | | 2N293 | Fig. 16 | |
| | | | GT | | GT792R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N168A | NPN | HF OSC | GE | 2N168A | | Fig. 16 | |
| | | | SYL | | 2N212 | Fig. 12 | |
| | | | SYL | 2N168A | | Fig. 16 | |
| | | | RCA | | 2N140 | Fig. 17 | |
| 2N169 | NPN | IF Ampl | GE | 2N169 | | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N169A | NPN | IF Ampl | GE | 2N169A | | Fig. 16 | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | SYL | 2N169A | | Fig. 16 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N170 | NPN | RF Ampl | GE | 2N170 | | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N172 | NPN | IF Ampl | TI | 2N172 | | Fig. 12 | |
| | | | GE | | 2N168A | Fig. 16 | |
| | | | GT | | GT792R | | |
| | | | SYL | | 2N212 | Fig. 12 | |
| | | | RCA | | 2N140 | Fig. 17 | |
| 2N173 | PNP | PWR Ampl | DLC | 2N173 | | Fig. 23 | |
| | | | SYL | 2N173 | | | |
| | | | CLE | | CTP1504 | | |
| | | | RCA | | 2N301 | Fig. 25 | |
| | | | BEN | | 2N677B | | |
| 2N174 | PNP | PWR Ampl | OLC | 2N174 | | Fig. 23 | |
| | | | SYL | 2N174 | | | |
| | | | CLE | | CTP1503 | | |
| | | | BEN | | 2N677B | | |
| 2N175 | PNP | AF Ampl | RCA | 2N175 | | Fig. 17 | Low Noise |
| | | | RAY | | 2N466 | | |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT74 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N176 | PNP | PWR Ampl | SYL | 2N176 | | Fig. 25 | |
| | | | MTR | 2N176 | | | |
| | | | RCA | | 2N301 | Fig. 25 | |
| | | | BEN | | 2N235A | | |
| 2N178 | PNP | PWR Ampl | MTR | 2N178 | | | |
| | | | CLE | | CTP1105 | | |
| | | | BEN | | 2N235A | | |
| 2N180 | PNP | AF Output | CBS | 2N180 | | Fig. 6 | High Current |
| | | | GE | | 2N188 | Fig. 8 | |
| | | | GT | | 2N565 | | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N60 | Fig. 30W | |
| | | | RAY | | 2N466 | | |
| 2N181 | PNP | AF Output | CBS | 2N181 | | | High Current |
| | | | GE | | 2N188A | Fig. 8 | |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N182 | NPN | IF Ampl SW | CBS | 2N182 | | Fig. 6 | |
| | | | GE | | 2N167 | Fig. 16 | |
| | | | GT | | 2N445 | Fig. 30 | |
| | | | RCA | | 2N269 | Fig. 15 | |
| 2N183 | NPN | SW | CBS | 2N183 | | Fig. 6 | |
| | | | GE | | 2N167 | Fig. 16 | |
| | | | GT | | 2N446 | Fig. 30 | |
| | | | RCA | | 2N269 | Fig. 15 | |
| 2N184 | NPN | SW | CBS | 2N184 | | Fig. 6 | |
| | | | GE | | 2N167 | Fig. 16 | |
| | | | GT | | 2N447 | Fig. 30 | |
| | | | RCA | | 2N269 | Fig. 15 | |
| 2N185 | PNP | AF Ampl | TI | 2N185 | | Fig. 12 | |
| | | | GE | | 2N188A | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | 2N61 | | Fig. 30W | |
| 2N186 | PNP | AF Output | GE | 2N186 | | Fig. 8 | High Current |
| | | | GT | | GT20 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N61 | Fig. 30 | |
| | | | RAY | | 2N464 | | |
| 2N186A | PNP | AF Output | GE | 2N186A | | Fig. 8 | High Current |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N61 | Fig. 30 | |
| 2N187 | PNP | AF Output | GE | 2N187 | | Fig. 8 | High Current |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N61 | Fig. 30 | |
| | | | RAY | | 2N465 | | |

# TUNG-SOL
## GERMANIUM TRANSISTORS


MEDIUM POWER OUTLINE TO-9

INVERTED HEADER DESIGN BRINGS YOU THESE BENEFITS . . .

improved thermal properties for longer life
superior mechanical characteristics for increased reliability

### MEDIUM POWER, MEDIUM FREQUENCY

| TYPE | Pc mw | VCE volts | VCB volts | Ic ma | Tj °C | Max. ICBO μa | hFE | fαb mc | Ge db |
|---|---|---|---|---|---|---|---|---|---|
| | MAXIMUM RATINGS (25° C) | | | | | TYPICAL VALUES (25° C) | | | |
| 2N381 | 200 | —25 | —25 | 200 | 85 | 20 | 36 | 1.2 | 31 |
| 2N382 | 200 | —25 | —25 | 200 | 85 | 20 | 54 | 1.5 | 33 |
| 2N383 | 200 | —25 | —25 | 200 | 85 | 20 | 72 | 1.8 | 35 |
| INDUSTRIAL TYPES | | | | | | | | | |
| 2N460 | 200 | — | —45 | 400 | 100 | 15. | 25 | 1.2 | 34 |
| 2N461* | 200 | — | —45 | 400 | 100 | 15 | 50 | 1.2 | 37 |

*Designed to meet MIL-T-19500/45

### MEDIUM POWER, HIGH FREQUENCY

| TYPE | Pc mw | VCE volts | VCB volts | Ic ma | Tj °C | Max. ICBO μa | hFE | fαb mc | Ge db |
|---|---|---|---|---|---|---|---|---|---|
| | MAXIMUM RATINGS (25° C) | | | | | TYPICAL VALUES (25° C) | | | |
| COMPUTER TYPES | | | | | | | | | |
| 2N404* | 120 | —24 | —25 | 100 | 85 | 5 | 30 | 12 | — |
| 2N425 | 120 | —20 | —30 | 400 | 85 | 5 | 30 | 4 | — |
| 2N426 | 120 | —18 | —30 | 400 | 85 | 5 | 40 | 6 | — |
| 2N427 | 120 | —15 | —30 | 400 | 85 | 5 | 55 | 11 | — |
| 2N428† | 120 | —12 | —30 | 400 | 85 | 5 | 80 | 17 | — |
| 2N578 | 120 | —14 | —20 | 400 | 85 | 5 | 15 | 5 | — |
| 2N579 | 120 | —14 | —20 | 400 | 85 | 5 | 30 | 8 | — |
| 2N580 | 120 | —14 | —20 | 400 | 85 | 5 | 45 | 15 | — |
| 2N581 | 120 | —14 | —18 | 100 | 85 | 5 | 30 | 8 | — |
| 2N582 | 120 | —14 | —25 | 100 | 85 | 5 | 60 | 18 | — |
| GENERAL PURPOSE TYPES | | | | | | | | | |
| 2N413 | 120 | —18 | —30 | 200 | 85 | 5 | 30 | 2.5 | 10 |
| 2N414 | 120 | —15 | —30 | 200 | 85 | 5 | 60 | 5 | 16 |
| 2N416 | 120 | —12 | —30 | 200 | 85 | 5 | 80 | 10 | 20 |
| 2N417 | 120 | —10 | —30 | 200 | 85 | 5 | 140 | 20 | 27 |

*Designed to meet MIL-T-19500/20
†Designed to meet MIL-T-19500/44

### POWER, MEDIUM FREQUENCY

| TYPE | Pc w | VCE volts | VCB volts | Ic ma | Tj °C | Max. ICBO mc | hFE | fαb mc | Ge db |
|---|---|---|---|---|---|---|---|---|---|
| | MAXIMUM RATINGS (25° C) | | | | | TYPICAL VALUES (25° C) | | | |
| AUDIO TYPES | | | | | | | | | |
| 2N242 | 15 | —45 | — | 2 | 85 | 1.0 | 50 | 0.4 | 34.0 |
| POWER SWITCH TYPES | | | | | | | | | |
| 2N378 | 50 | —20 | —40 | 5 | 100 | 0.5 | 30 | 0.3 | 24.0 |
| 2N379 | 50 | —40 | —80 | 5 | 100 | 0.5 | 30 | 0.3 | 28.5 |
| 2N380 | 50 | —30 | —60 | 5 | 100 | 0.5 | 50 | 0.4 | 30.0 |
| 2N459 | 50 | —60 | —105 | 5 | 100 | 0.5 | 30 | 0.3 | 28.5 |


POWER OUTLINE TO-3


HIGH POWER OUTLINE

### HIGH POWER, MEDIUM FREQUENCY

| TYPE | VCE volts | VCB volts | Ic A | Tj °C | Max. ICBO ma | hFE | fαe Kc |
|---|---|---|---|---|---|---|---|
| | MAXIMUM RATINGS (25° C) | | | | TYPICAL VALUES (25° C) | | |
| MILITARY TYPE | | | | | | | |
| TS 748 | Designed to meet MIL-T-19500/13A dated 8 January 1958 | | | | | | |
| INDUSTRIAL TYPES | | | | | | | |
| 2N173 | —50 | —60 | 15 | 95 | 8 | 52 | 10 |
| 2N174 | —70 | —80 | 15 | 95 | 8 | 37 | 10 |
| 2N174A | —70 | —80 | 15 | 95 | 8 | 37 | 10 |
| 2N277 | —40 | —40 | 15 | 95 | 8 | 52 | 10 |
| 2N278 | —45 | —50 | 15 | 95 | 8 | 52 | 10 |
| 2N441 | —40 | —40 | 15 | 95 | 8 | 30 | 10 |
| 2N442 | —45 | —50 | 15 | 95 | 8 | 30 | 10 |
| 2N443 | —50 | —60 | 15 | 95 | 8 | 30 | 10 |

### Exclusive Tung-Sol Cold Weld Seal!

All Tung-Sol Power and High Power transistors are sealed by advanced cold weld process for three-way quality boost . . .

True hermetic, copper-to-copper seal improves transistor thermal characteristics.

Elimination of heat-damage, heat-caused moisture and "splash" increase overall reliability.

Vacuum-tight, moisture-proof cold-weld seal lasts even through "breathing" over long life operation.

For detailed information on specific types or to fill a particular need, contact: Tung-Sol Electric Inc., Newark 4, New Jersey.

ts TUNG-SOL®



Circle 60 on Inquiry Card, page 123

# 1959 TRANSISTOR INTERCHANGEABILITY CHART

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N187A | PNP | AF Output | GE | 2N187A | | Fig. 8 | High Current |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N61 | Fig. 30W | |
| 2N188 | PNP | AF Output | GE | 2N188 | | Fig. 8 | High Current |
| | | | GT | | GT109 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RAY | | 2N465 | | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N188A | PNP | AF Output | GE | 2N188A | | Fig. 8 | High Current |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N189 | PNP | AF Ampl | GE | 2N189 | | Fig. 8 | |
| | | | GT | | GT14 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N402 | Fig. 30 | |
| | | | RAY | | 2N465 | | |
| 2N190 | PNP | AF Ampl | GE | 2N190 | | Fig. 8 | |
| | | | GT | | GT20 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N465 | | |
| 2N191 | PNP | AF Ampl | GE | 2N191 | | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N465 | | |
| 2N192 | PNP | AF Ampl | GE | 2N192 | | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N61 | Fig. 30W | |
| | | | RAY | | 2N466 | | |
| 2N193 | NPN | HF OSC | SYL | 2N193 | | Fig. 12 | |
| | | | GE | | 2N167 | Fig. 16 | |
| | | | GT | | GT948R | | |
| 2N194 | NPN | HF OSC | SYL | 2N194 | | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | RCA | | 2N219 | Fig. 15 | |
| 2N195 | PNP | AF Ampl | TR | 2N195 | | | |
| | | | GT | | GT82 | | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | RCA | | 2N217 | Fig. 15 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N196 | PNP | AF Ampl | TR | 2N196 | | | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | RCA | | 2N217 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N197 | PNP | AF Ampl | TR | 2N197 | | | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | RCA | | 2N217 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N198 | PNP | AF Ampl | TR | 2N198 | | | |
| | | | GT | | GT20 | | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | RCA | | 2N217 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N199 | PNP | AF Ampl | TR | 2N199 | | | |
| | | | GT | | GT14 | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RCA | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N200 | PNP | AF Ampl | TR | 2N200 | | | |
| | | | GT | | 2N566 | | |
| | | | RCA | | 2N206 | Fig. 15 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N204 | PNP | AF Ampl | TR | 2N204 | | | |
| | | | GT | | 2N564 | | |
| | | | RCA | | 2N206 | Fig. 15 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N205 | PNP | AF Ampl | TR | 2N205 | | | |
| | | | GT | | 2N566 | | |
| | | | RCA | | 2N206 | Fig. 15 | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N206 | PNP | AF Ampl | RCA | 2N206 | | Fig. 15 | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | GT | | 2N567 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N207 | PNP | AF Ampl | PHIL | 2N207 | 2N220 | Fig. 32 | |
| | | | GT | | GT81 | | |
| | | | RCA | | 2N105 | Fig. 20 | |
| 2N207A | PNP | AF Ampl | PHIL | 2N207A | | Fig. 32 | |
| | | | GE | | 2N241 | Fig. 8 | |
| | | | RCA | | 2N105 | Fig. 20 | |
| 2N207B | PNP | AF Ampl | PHIL | 2N207B | | Fig. 32 | |
| | | | GE | | 2N241 | Fig. 8 | |
| | | | RCA | | 2N105 | Fig. 12D | |
| | | | RAY | | 2N465 | | |
| 2N211 | NPN | HF OSC | SYL | 2N211 | | Fig. 12 | |
| | | | GE | | 2N293 | Fig. 16 | |
| | | | GT | | GT948R | | |
| 2N212 | NPN | HF OSC | SYL | 2N212 | | Fig. 12 | Converter |
| | | | GE | | 2N293 | | |
| | | | GT | | GT792R | | |
| 2N213 | NPN | AF Ampl | SYL | 2N213 | | Fig. 12 | |
| | | | GE | | 2N169A | Fig. 16 | |
| 2N215 | PNP | AF Ampl | RCA | 2N215 | | Fig. 15 | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | RAY | | 2N465 | | |
| | | | GT | | 2N565 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N216 | NPN | IF Ampl | SYL | 2N216 | | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GT | | GT948R | | |
| 2N217 | PNP | AF Ampl | RCA | 2N217 | | Fig. 15 | |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT109 | | |
| | | | SYL | 2N217 | | Fig. 15 | |
| | | | RAY | | 2N465 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N218 | PNP | IF Ampl | RCA | 2N218 | | Fig. 15 | |
| | | | GE | | 2N135 | Fig. 8 | |
| | | | GT | | GT760R | | |
| | | | RAY | | 2N482 | | |
| | | | W | | 2N615 | | |
| 2N219 | PNP | HF OSC | RCA | 2N219 | | Fig. 15 | |
| | | | GE | | 2N136 | Fig. 8 | |
| | | | RAY | | 2N485 | | |
| | | | GT | | GT761R | | |
| | | | W | | 2N617 | | |
| 2N220 | PNP | AF Ampl | RCA | 2N220 | | Fig. 15 | Low Noise |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT74 | | |
| | | | RAY | | 2N466 | Fig. 30 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N222 | PNP | AF Ampl | GT | 2N222 | | | |
| | | | SYL | | 2N34 | Fig. 5 | |
| | | | RAY | | 2N464 | | |
| 2N223 | PNP | AF Ampl | PHIL | 2N223 | 2N109 | Fig. 31 | |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RAY | | 2N466 | | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N224 | PNP | AF Output | PHIL | 2N224 | 2N217 | Fig. 31 | High Current |
| | | | GE | | 2N241A | Fig. 8 | |
| | | | RAY | | 2N466 | | |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N225 | PNP | AF Output | PHIL | 2N225 | | Fig. 31 | High Current |
| | | | GE | | 2N241A | Fig. 8 | Matched pair of 2N224'S Beta match 7% |
| | | | RAY | | 2N466 | | |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N226 | PNP | AF Output | PHIL | 2N226 | 2N404 | Fig. 31 | High Current |
| | | | GE | | 2N188A | Fig. 8 | |
| | | | GT | | GT109 | | |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RAY | | 2N465 | | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N227 | PNP | AF Output | PHIL | 2N227 | | Fig. 31 | High Current |
| | | | GE | | 2N188A | Fig. 8 | Matched pair of 2N226'S Beta match 7% |
| | | | GT | | GT109 | | |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N60 | Fig. 30W | |
| | | | RAY | | 2N466 | | |
| 2N228 | NPN | AF Output | SYL | 2N228 | | Fig. 12 | High Current |
| | | | GE | | 2N169 | Fig. 16 | |
| 2N229 | NPN | AF Ampl | SYL | 2N229 | | Fig. 12 | |
| | | | GE | | 2N169 | Fig. 16 | |
| | | | GT | | GT229 | | |
| 2N231 | PNP | IF Ampl | PHIL | 2N231 | | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N615 | Fig. 30 | |
| 2N232 | PNP | IF Ampl | PHIL | 2N232 | | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N615 | | |
| 2N233 | NPN | RF Ampl | SYL | 2N233 | | Fig. 12 | |
| | | | GT | | GT948R | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N233A | NPN | RF Ampl | SYL | 2N233A | | Fig. 12 | |
| | | | GT | | GT948R | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N234 | PNP | PWR Ampl | BEN | 2N234 | 2N234A | Fig. 25 | |
| | | | SYL | | 2N242 | Fig. 25 | |
| | | | CLE | | CTP1104 | | |
| | | | RCA | | 2N301 | | |

# MERCK HAS ALL FOUR FORMS OF

# Silicon

# IN PRODUCTION QUANTITIES

**MERCK DOPED SINGLE CRYSTAL SILICON**—offers doped float zone single crystals of high quality at low costs. Yields of usable material are reported to be especially high when device diffusion technics are used with these crystals. Float zone single crystals doped either "p" or "n" type with resistivities from 3 to 300 ohm cm. any range plus or minus 25% and a minimum lifetime of 100 microseconds are available in diameters of 18 to 20 mm., and random lengths of 2 to 10 inches.

**NOTE:** *Doped single crystals in other diameters, resistivities, or lifetimes not listed above can be furnished as specials.*

**MERCK HIGH RESISTIVITY "P" TYPE SINGLE CRYSTAL SILICON**—offers float zone single crystals of a quality unobtainable by other methods. Available with minimum resistivity of 1000 ohm cm. "p" type and a minimum lifetime of 200 microseconds, diameter 18 to 20 mm., random lengths 2 to 10 inches.

**MERCK POLYCRYSTALLINE BILLETS**—have not previously been melted in quartz, so that no contamination from this source is possible. Merck guarantees that single crystals drawn from these billets will yield resistivities over 50 ohm cm. for "n" type material and over 100 ohm cm. for "p" type material. Merck silicon billets give clean melts with no dross or oxides.

**MERCK POLYCRYSTALLINE RODS**—are ready for zone melting as received . . . are ideal for users with float zone melting equipment. Merck polycrystalline rods are available in lengths of 8½ to 10½ inches and in diameters of 18 to 20 mm. Smaller diameters can be furnished on special order. In float zone refining one can obtain from this material single crystals with a minimum resistivity of 1000 ohm cm. "p" type with minimum lifetime of 200 microseconds or the material can be doped by user to his specifications.

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*For additional information on specific applications and processes, write Merck & Co., Inc., Electronic Chemicals Division, Department EI-1, Rahway, New Jersey.*



ULTRA-PURE **Silicon** —a product of **MERCK**

**BASE BORON CONTENT BELOW ONE ATOM OF BORON PER SIX BILLION SILICON ATOMS**



Circle 70 on Inquiry Card, page 123

# 1959 TRANSISTOR INTERCHANGEABILITY CHART

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N234A | PNP | PWR Ampl | BEN | 2N234A | | Fig. 25 | |
| | | | SYL | | 2N242 | Fig. 25 | |
| | | | CLE | | CTP1104 | | |
| | | | RCA | | 2N301 | | |
| 2N235 | PNP | PWR Ampl | BEN | 2N235 | 2N235A | Fig. 25 | |
| | | | SYL | | 2N235A | Fig. 25 | |
| | | | CLE | | 2N257 | | |
| | | | RCA | | 2N301 | | |
| 2N235A | PNP | PWR Ampl | BEN | 2N235A | | Fig. 25 | |
| | | | SYL | 2N235A | | Fig. 25 | |
| | | | CLE | | 2N257 | | |
| | | | RCA | | 2N301 | | |
| 2N236 | PNP | PWR Ampl | BEN | 2N236 | 2N236A | Fig. 25 | |
| | | | SYL | | 2N242 | Fig. 25 | |
| 2N236A | PNP | PWR Ampl | BEN | 2N236A | | Fig. 25 | |
| | | | SYL | | 2N242 | Fig. 25 | |
| | | | CLE | | CTP1117 | | |
| 2N236B | PNP | PWR Ampl | BEN | 2N236B | | | |
| | | | SYL | 2N236B | | | |
| | | | CLE | | CTP1117 | | |
| 2N237 | PNP | PWR Ampl | TI | 2N237 | | Fig. 12 | |
| | | | GE | | 2N192 | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N242 | Fig. 25 | |
| | | | RCA | | 2N220 | Fig. 15 | |
| 2N238 | PNP | AF Ampl | TI | 2N238 | | Fig. 12 | |
| | | | GE | | 2N191 | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | RCA | | 2N217 | Fig. 15 | |
| | | | W | 2N402 | | Fig. 30 | |
| | | | RAY | | 2N465 | | |
| 2N240 | PNP | SW | PHIL | 2N240 | | Fig. 9 | |
| | | | SYL | | 2N217 | Fig. 15 | |
| | | | GT | | 2N604 | | |
| 2N241 | PNP | AF Output | GE | 2N241 | | Fig. 8 | High Current |
| | | | GT | | GT109 | | |
| | | | SYL | | 2N241A | Fig. 8 | |
| | | | RCA | | 2N217 | Fig. 15 | |
| | | | W | | 2N59 | Fig. 30W | |
| 2N241A | PNP | AF Output | GE | 2N241A | | Fig. 8 | High Current |
| | | | RAY | | 2N466 | | |
| | | | SYL | 2N241A | | Fig. 8 | |
| | | | RCA | | 2N217 | Fig. 15 | |
| | | | W | | 2N59 | Fig. 30 | |
| 2N242 | PNP | PWR Ampl | SYL | 2N242 | | | |
| | | | RCA | | 2N301 | | |
| | | | CLE | | 2N257 | | |
| | | | BEN | | 2N235A | | |
| 2N243 | NPN | PWR Ampl | TI | 2N243 | | | Silicon |
| | | | TR | | 2N342 | | |
| 2N244 | NPN | PWR Ampl | TI | 2N244 | | | Silicon |
| | | | TR | | 2N343 | | |
| 2N247 | PNP | RF Ampl | RCA | 2N247 | | Fig. 27 | "Drift" |
| | | | GT | | 2N606 | | |
| | | | GT | | 2N607 | | |
| | | | SYL | 2N247 | | Fig. 27S | |
| | | | RAY | | 2N417 | | |
| 2N248 | PNP | HF RF Ampl | TI | 2N248 | | Fig. 27 | fco = 50Mc |
| | | | GT | | 2N608 | | |
| | | | SYL | | 2N247 | Fig. 27S | fco = 1.5Mc |
| | | | RCA | | 2N247 | | |
| 2N249 | PNP | AF Output | TI | 2N249 | | Fig. 28 | High Current |
| | | | GE | | 2N188A | | |
| | | | SYL | | 2N270 | Fig. 27S | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N59 | Fig. 30W | |
| 2N250 | PNP | PWR Ampl | TI | 2N250 | | Fig. 25 | |
| | | | SYL | 2N250 | | Fig. 25 | |
| | | | CLE | | 2N257 | | |
| | | | RCA | | 2N301 | | |
| | | | BEN | | 2N235A | | |
| 2N251 | PNP | PWR Ampl | TI | 2N251 | | Fig. 25 | |
| | | | SYL | | 2N296 | Fig. 25 | |
| | | | CLE | | 2N268A | | |
| | | | RCA | | 2N301A | | |
| | | | BEN | | 2N639A | | |
| 2N252 | PNP | HF Cnvtr | TI | 2N252 | | | |
| | | | GT | | 2N606 | | |
| | | | RAY | | 2N485 | | |
| | | | RCA | | 2N140 | Fig. 17 | |
| | | | W | | 2N617 | | |
| 2N253 | NPN | IF Ampl | TI | 2N253 | | Fig. 12 | 455Kc |
| | | | GE | | 2N293 | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N254 | NPN | IF Ampl | TI | 2N254 | | Fig. 12 | 455Kc |
| | | | GE | | 2N293 | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N94A | Fig. 12 | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N255 | PNP | PWR Ampl | CBS | 2N255 | | Fig. 25 | |
| | | | SYL | 2N255 | | Fig. 25 | |
| | | | CLE | | CTP1108 | | |
| | | | RCA | | 2N301 | | |
| | | | BEN | | 2N234A | | |
| 2N256 | PNP | PWR Ampl | CBS | 2N256 | | Fig. 25 | |
| | | | SYL | 2N256 | | Fig. 25 | |
| | | | CLE | | CTP1109 | | |
| | | | RCA | | 2N301 | | |
| | | | BEN | | 2N234A | | |
| 2N257 | PNP | PWR Ampl | CLE | 2N257 | | Fig. 25 | |
| | | | SYL | 2N257 | | Fig. 25 | |
| | | | RCA | | 2N301 | | |
| | | | BEN | | 2N235A | | |
| 2N265 | PNP | AF Ampl | GE | 2N265 | | Fig. 8 | |
| | | | RAY | | 2N465 | | |
| | | | GT | | GT81 | | |
| | | | GT | | GT82 | | |
| | | | SYL | | 2N406 | Fig. 15 | |
| | | | RCA | | 2N406 | Fig. 15 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N266 | PNP | AF Ampl | GE | 2N266 | | Fig. 8 | |
| | | | W | | 2N61 | Fig. 30 | |
| 2N267 | PNP | RF Ampl | RCA | 2N267 | | Fig. 15 | "Drift" |
| | | | GT | | 2N606 | | |
| | | | SYL | | 2N247 | Fig. 27S | |
| | | | RCA | | 2N247 | | |
| 2N268 | PNP | PWR Ampl | CL | 2N268 | | Fig. 25 | 2 Watt |
| | | | SYL | 2N268 | | | |
| | | | RCA | | 2N301A | | |
| | | | BEN | | 2N639A | | |
| 2N268A | PNP | PWR Ampl | CLE | 2N268A | | Fig. 25 | 10 Watt |
| | | | SYL | | 2N268 | | 2 Watt |
| | | | BEN | | 2N639A | | |
| 2N269 | PNP | HF SW | RCA | 2N269 | | Fig. 15 | fco = 4Mc |
| | | | GE | | 2N123 | Fig. 9 | fco = 8Mc |
| | | | GT | | GT269 | | |
| | | | RAY | | 2N404 | | |
| 2N270 | PNP | AF Ampl | RCA | 2N270 | | Fig. 27 | |
| | | | GE | | 2N320 | | |
| | | | SYL | 2N270 | | Fig. 27S | |
| | | | W | | 2N59 | Fig. 30 | |
| 2N271 | PNP | HF Cnvtr | RAY | 2N271 | | | |
| | | | SYL | | 2N411 | Fig. 17 | |
| 2N271A | PNP | IF Ampl | RAY | 2N271A | | | |
| | | | SYL | | 2N139 | Fig. 17 | |
| 2N272 | PNP | RF SW | RAY | 2N272 | | | |
| | | | GT | | GT75 | | |
| 2N274 | PNP | RF Ampl | RCA | 2N274 | | Fig. 15 | "Drift" |
| | | | GT | | 2N606 | | |
| | | | GT | | 2N607 | | |
| 2N277 | PNP | PWR Ampl | DEL | 2N277 | | Fig. 23 | 55W |
| | | | SYL | | 2N278 | Fig. 23 | |
| | | | CLE | | CTP1508 | | |
| | | | BEN | | 2N677A | | |
| 2N278 | PNP | PWR Ampl | DEL | 2N278 | | Fig. 23 | 55W |
| | | | SYL | 2N278 | | Fig. 23 | |
| | | | CLE | | CTP1506 | | |
| | | | BEN | | 2N677A | | |
| 2N279 | PNP | AF Ampl | AMPX | 2N279 | | Fig. 35 | |
| | | | GE | | 2N187 | Fig. 8 | |
| | | | GT | | GT14 | | |
| | | | RCA | | 2N215 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N280 | PNP | AF Ampl | AMPX | 2N280 | | Fig. 35 | |
| | | | GE | | 2N188 | Fig. 8 | |
| | | | GT | | GT20 | | |
| | | | RCA | | 2N215 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N281 | PNP | AF Ampl | AMPX | 2N281 | | Fig. 35 | |
| | | | GE | | 2N241 | Fig. 8 | |
| | | | GT | | GT81 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N282 | PNP | AF Ampl | AMPX | 2N282 | | Fig. 35 | Matched pair of 2N281's |
| | | | GT | | GT109 | | |
| 2N283 | PNP | AF Ampl | AMPX | 2N283 | | Fig. 35 | |
| | | | GE | | 2N188 | Fig. 8 | |
| | | | GT | | 2N563 | | |
| | | | RCA | | 2N215 | | |
| 2N284 | PNP | AF Ampl | AMPX | 2N284 | | Fig. 35 | |
| | | | GE | | 2N188 | Fig. 8 | |
| | | | GT | | GT87 | | |
| 2N285 | PNP | PWR Ampl | BEN | 2N285 | 2N285A | | |
| | | | CLE | | CTP1117 | | |
| 2N285A | PNP | PWR Ampl | BEN | 2N285A | | | |
| | | | SYL | 2N285A | | | |
| | | | CLE | | CTP1117 | | |
| 2N291 | PNP | AF Ampl | TI | 2N291 | | | |
| | | | GE | | 2N188A | | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N270 | | |
| | | | RCA | | 2N270 | | |
| | | | W | | 2N59 | Fig. 30W | |
| 2N292 | NPN | IF Ampl | GE | 2N292 | | Fig. 16 | |
| | | | GT | | GT948R | | |
| | | | SYL | | 2N216 | Fig. 12 | |
| | | | SYL | 2N292 | | Fig. 16 | |
| | | | RCA | | 2N410 | Fig. 15 | |

# HIGH efficiency at
# HIGH operating temperatures

## SILICON POWER TRANSISTORS

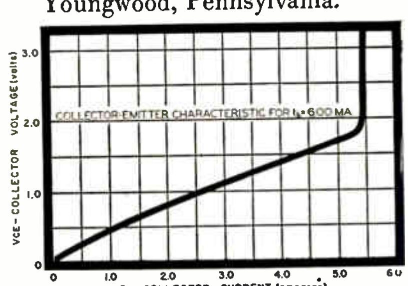
**Available Now in production quantities!**

The Westinghouse Silicon Power Transistor pictured above is a highly efficient device which greatly increases the range of applications for transistors which must operate without high losses in the "true power range." Thanks to a remarkably low saturation resistance—less than .750 ohms at 2 amperes and .5 ohms at 5 amperes—these transistors possess very low internal dissipation, and can be efficiently used in applications where they must handle as much as 1000 watts. For example, as a DC switch, handling 750 watts (150 volts at 5 amps) the internal dissipation is about 9 watts, with an efficiency of better than 99%.

Additionally, and unlike germanium units which are limited to approximately 85°C, these transistors can operate in ambient temperatures up to 150°C. Thus, even where the higher power rating is not required, these units may be used for their high temperature capabilities.

There are a great many applications for which this new type of silicon power transistor is ideally suited. It will find use in inverters or converters (AC to AC; AC to DC; DC to AC; DC to DC), regulated power supplies, servo output, and other aircraft circuits, as well as in certain amplifiers and switching applications.

Westinghouse Silicon Power Transistors are available in 2 and 5 ampere collector ratings. Both of these are available in 30, 60, 100, and 150 volt ratings in production quantities for your immediate applications. Sample quantities are available in higher voltage ratings. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pennsylvania.




**LOW SATURATION RESISTANCE**

Important improvements in silicon purification and transistor fabrication have produced a new series of Westinghouse Power Transistors of exceptionally low saturation resistance.

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

**Westinghouse**



Circle 62 on Inquiry Card, page 123

*Now from* **CLEVITE ...**

# HIGH POWER TRANSISTORS


*Clevite offers new types with improved reliability and power handling capacity.*

**EIA REGISTERED TYPES WITH:**

- Improved seal for long life.
- Saturation voltage less than 1 Volt at increased maximum rated current of 15 amperes.
- Average thermal resistance 0.7°C per watt.
- Current gain controls: 60-150 at 5 amperes.
- 100% test for resistance to transient burn out.
- Either standard pins or solder lugs.

**TECHNICAL DATA**

**Typical Electrical Characteristics at 25°C**

| 2N1147 Series has solder lugs<br>2N1146 Series has standard pins | 2N1147<br>2N1146 | 2N1147A<br>2N1146A | 2N1147B<br>2N1146B | 2N1147C<br>2N1146C |
|---|---|---|---|---|
| Collector to Emitter Voltage<br>Shorted Base (IC = 1 amp) | 30V<br>(Min) | 40V<br>(Min) | 60V<br>(Min) | 75V<br>(Min) |
| Saturation Voltage<br>(IC = 15 amps) | 1.0V<br>(Max) | 1.0V<br>(Max) | 1.0V<br>(Max) | 1.0V<br>(Max) |
| DC Current Gain<br>(IC = 5 amps) | 60-150 | 60-150 | 60-150 | 60-150 |
| DC Current Gain<br>(IC = 15 amps) | 35 | 35 | 35 | 35 |
| **Absolute Maximum Ratings** | | | | |
| Collector Current<br>Collector to Base Voltage<br>Collector to Emitter Voltage<br>Power Dissipation at 70°C<br>Case Temperature<br>Junction Temperature | 15 amps<br>40V<br>40V<br><br>25W<br>95°C | 15 amps<br>60V<br>60V<br><br>25W<br>95°C | 15 amps<br>80V<br>80V<br><br>25W<br>95°C | 15 amps<br>100V<br>100V<br><br>25W<br>95°C |

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**TRANSISTOR PRODUCTS**

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Intermetall G.m.b.H. • Texas Division


Circle 65 on Inquiry Card, page 123

# 1959 TRANSISTOR INTERCHANGEABILITY CHART

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N360 | PNP | AF Ampl | RAY | 2N360 | | | |
| | | | GT | | GT109 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N361 | PNP | AF Ampl | RAY | 2N361 | | | |
| | | | GT | | GT109 | | |
| | | | W | | 2N61 | Fig. 30 | |
| 2N362 | PNP | AF Ampl | RAY | 2N362 | | | |
| | | | GT | | GT81 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N363 | PNP | AF Ampl | RAY | 2N363 | | | |
| | | | GT | | GT81 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N364 | NPN | HF Ampl | TI | 2N364 | | | |
| | | | GT | | 2N444 | Fig. 30 | |
| 2N365 | NPN | HF Ampl | TI | 2N365 | | | |
| | | | GT | | 2N445 | Fig. 30 | |
| 2N366 | PNP | HF Ampl | TI | 2N366 | | | |
| | | | GT | | 2N446 | Fig. 30 | |
| 2N367 | PNP | AF Ampl | TI | 2N367 | | | |
| | | | GT | | GT34 | | |
| | | | W | | 2N612 | | |
| 2N368 | PNP | AF Ampl | TI | 2N368 | | | |
| | | | GT | | GT20 | | |
| | | | SYL | | 2N109 | Fig. 17 | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N369 | PNP | AF Ampl | TI | 2N369 | | | |
| | | | GT | | GT81 | | |
| | | | SYL | | 2N109 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N370 | PNP | HF Ampl | RCA | 2N370 | | | "Drift" |
| | | | GT | | 2N608 | | |
| | | | SYL | 2N370 | | | |
| 2N371 | PNP | HF Ampl | RCA | 2N371 | | | "Drift" |
| | | | GT | | 2N608 | | |
| | | | SYL | 2N371 | | | |
| 2N372 | PNP | HF Ampl | RCA | 2N372 | | | "Drift" |
| | | | SYL | 2N372 | | | |
| 2N373 | PNP | HF Ampl | SYL | 2N373 | | | |
| | | | RCA | 2N373 | | | |
| 2N374 | PNP | HF Cnvrtr | SYL | 2N374 | | | |
| | | | RCA | 2N374 | | | |
| 2N376 | PNP | PWR Ampl | MOTR | 2N376 | | Fig. 25 | |
| | | | CLE | | CTP1117 | | |
| | | | BEN | | 2N2368 | | |
| 2N377 | NPN | SW | SYL | 2N377 | | Fig. 30 | |
| | | | GT | | 2N357 | Fig. 30 | |
| 2N378 | PNP | PWR SW | TS | 2N378 | | Fig. 25 | |
| | | | SYL | | 2N242 | | |
| | | | CLE | | 2N257 | | |
| | | | RCA | | 2N301 | | |
| | | | BEN | | 2N639 | | |
| 2N379 | PNP | PWR SW | TS | 2N379 | | Fig. 25 | |
| | | | CLE | | 2N268A | | |
| | | | BEN | | 2N639A | | |
| 2N380 | PNP | PWR SW | TS | 2N380 | | Fig. 25 | |
| | | | CLE | | 2N268A | | |
| | | | RCA | | 2N301A | | |
| | | | BEN | | 2N639A | | |
| 2N381 | PNP | AF Output | TS | 2N381 | | Fig. 30 | |
| | | | SYL | 2N381 | | | |
| | | | GE | | 2N320 | | High Current |
| | | | RCA | | 2N270 | Fig. 27 | |
| | | | W | | 2N61 | Fig. 30W | |
| 2N382 | PNP | AF Output | TS | 2N382 | | Fig. 30 | |
| | | | SYL | 2N382 | | | |
| | | | GE | | 2N321 | | High Current |
| | | | RCA | | 2N270 | Fig. 27 | |
| | | | W | | 2N60 | Fig. 30W | |
| 2N383 | PNP | AF Output | TS | 2N383 | | Fig. 30 | |
| | | | SYL | 2N383 | | | |
| | | | GE | | 2N321 | | High Current |
| | | | W | | 2N59 | Fig. 30 | |
| 2N384 | PNP | VHF Ampl | RCA | 2N384 | | Fig. 15 | "Drift" |
| | | | SYL | 2N384 | | Fig. 15 | |
| 2N385 | NPN | HF SW | SYL | 2N385 | | Fig. 30 | |
| | | | GT | | 2N357 | | |
| 2N386 | PNP | PWR Ampl | PHIL | 2N386 | | Fig. 34 | |
| | | | SYL | | 2N296 | Fig. 25 | |
| | | | CLE | | 2N268A | Fig. 25 | |
| | | | RCA | | 2N301A | | |
| | | | BEN | | 2N638A | | |
| 2N387 | PNP | PWR Ampl | PHIL | 2N387 | | Fig. 34 | |
| | | | CLE | | CTP1112 | | |
| | | | BEN | | 2N638B | | |
| 2N388 | NPN | HF SW | SYL | 2N388 | | Fig. 30 | |
| | | | GT | | 2N358 | | |
| 2N389 | NPN | PWR Ampl | TI | 2N389 | | | |
| | | | TR | 2N389 | | | |

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N393 | PNP | RF Ampl | PHIL | 2N393 | 2N317 | Fig. 9 | |
| | | | SPR | 2N393 | | | |
| 2N394 | PNP | SW | GE | 2N394 | | | Obsolete |
| | | | GE | | 2N395 | | |
| | | | RCA | | 2N404 | | |
| | | | SYL | | 2N404 | Fig. 30 | |
| | | | GT | | 2N520 | Fig. 30 | |
| | | | W | | 2N615 | | |
| | | | RAY | | 2N404 | | |
| 2N395 | PNP | SW | GE | 2N395 | | | |
| | | | GT | | 2N521 | Fig. 30 | |
| | | | SYL | | 2N404 | | |
| | | | RCA | | 2N404 | | |
| | | | W | | 2N615 | | |
| | | | RAY | | 2N427 | | |
| 2N396 | PNP | SW | GE | 2N396 | | | |
| | | | GT | | 2N315 | | |
| | | | SYL | | 2N404 | | |
| | | | RCA | | 2N404 | | |
| | | | W | | 2N617 | | |
| | | | RAY | | 2N427 | | |
| 2N397 | PNP | SW | GE | 2N397 | | | |
| | | | GT | | 2N316 | | |
| | | | SYL | | 2N404 | | |
| | | | RCA | | 2N404 | | |
| | | | W | | 2N617 | | |
| | | | RAY | | 2N428 | | |
| 2N398 | PNP | SW | RCA | 2N398 | | Fig. 30 | |
| | | | GT | | GT34N | | |
| 2N399 | PNP | PWR Ampl | BEN | 2N399 | | | |
| | | | SYL | | 2N242 | | |
| | | | SYL | 2N399 | | | |
| | | | CLE | | CTP1137 | | |
| 2N400 | PNP | PWR Ampl | BEN | 2N400 | | | |
| | | | SYL | | 2N350 | Fig. 25 | |
| | | | CLE | | CTP1137 | | |
| 2N401 | PNP | PWR Ampl | BEN | 2N401 | | | |
| | | | SYL | | 2N350 | | |
| | | | SYL | 2N401 | | | |
| | | | CLE | | 2N257 | | |
| 2N402 | PNP | AF Ampl | W | 2N402 | | Fig. 30 | |
| | | | GE | | 2N188A | Fig. 8 | |
| | | | GT | | GT20 | | |
| | | | RCA | | 2N104 | Fig. 17 | |
| 2N403 | PNP | AF Ampl | W | 2N403 | | Fig. 30 | |
| | | | GE | | 2N187A | Fig. 8 | |
| | | | RAY | | 2N465 | | |
| | | | GT | | GT81 | | |
| | | | RCA | | 2N139 | Fig. 17 | |
| 2N404 | PNP | SW | RCA | 2N404 | | Fig. 30 | |
| | | | GE | | 2N396 | | |
| | | | SYL | 2N404 | | | |
| | | | GT | 2N404 | | | |
| | | | RAY | 2N404 | | | |
| 2N405 | PNP | AF Ampl | RCA | 2N405 | | Fig. 17 | |
| | | | GE | | 2N188A | | |
| | | | RAY | | 2N362 | | |
| | | | GT | | GT20 | | |
| | | | SYL | 2N405 | | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N406 | PNP | AF Ampl | RCA | 2N406 | | Fig. 15 | |
| | | | GE | | 2N188A | | |
| | | | GT | | GT20 | | |
| | | | SYL | 2N406 | | | |
| | | | W | | 2N403 | Fig. 30 | |
| | | | RAY | | 2N362 | | |
| 2N407 | PNP | AF Output | RCA | 2N407 | | Fig. 17 | High Current |
| | | | SYL | 2N407 | | | |
| | | | RAY | 2N631 | | | |
| | | | GE | | 2N241A | Fig. 8 | |
| | | | GT | | GT109 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N408 | PNP | AF Ampl | RCA | 2N408 | | Fig. 15 | |
| | | | GE | | 2N241A | | |
| | | | RAY | | 2N633 | | |
| | | | GT | | GT109 | | |
| | | | SYL | 2N408 | | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N409 | PNP | IF Ampl | RCA | 2N409 | | Fig. 17 | |
| | | | GE | | 2N135 | Fig. 8 | |
| | | | GT | | GT760R | | |
| | | | SYL | 2N409 | | | |
| | | | W | | 2N615 | | |
| | | | RAY | | 2N482 | | |
| 2N410 | PNP | IF Ampl | RCA | 2N410 | | Fig. 15 | |
| | | | GE | | 2N135 | | |
| | | | RAY | | 2N482 | | |
| | | | GT | | GT760R | | |
| | | | SYL | 2N410 | | | |
| | | | W | | 2N615 | | |
| 2N411 | PNP | HF Cnvtr | RCA | 2N411 | | Fig. 17 | |
| | | | GE | | 2N137 | | |
| | | | RAY | | 2N485 | | |
| | | | GT | | GT761R | | |
| | | | SYL | 2N411 | | | |
| | | | W | | 2N617 | | |

# 1959 TRANSISTOR INTERCHANGEABILITY CHART

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N412 | PNP | HF Cnvtr | RCA | 2N412 | | Fig. 15 | |
| | | | GE | | 2N137 | | |
| | | | RAY | | 2N485 | | |
| | | | GT | | GT761R | | |
| | | | SYL | 2N412 | | | |
| | | | W | | 2N617 | | |
| 2N413 | PNP | RF Ampl | RAY | 2N413 | | Fig. 30 | |
| | | | GE | | 2N135 | | |
| | | | GT | | 2N519 | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N413A | PNP | IF Ampl | RAY | 2N413A | | Fig. 30 | |
| | | | GE | | 2N135 | | |
| | | | GT | | GT760R | | |
| | | | SYL | 2N413A | | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N615 | | |
| 2N414 | PNP | RF Ampl | RAY | 2N414 | | Fig. 30 | |
| | | | GE | | 2N136 | | |
| | | | GT | | 2N520 | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| 2N414A | PNP | IF Ampl | RAY | 2N414A | | Fig. 30 | |
| | | | GE | | 2N136 | | |
| | | | GT | | GT761R | | |
| | | | SYL | 2N414A | | | |
| | | | RCA | | 2N218 | Fig. 15 | |
| | | | W | | 2N615 | | |
| 2N415 | PNP | RF Ampl | RAY | 2N415 | | Fig. 30 | |
| | | | GE | | 2N137 | | |
| | | | GT | | 2N521 | | |
| | | | RCA | | 2N247 | Fig. 27 | |
| 2N415A | PNP | IF Ampl | RAY | 2N415A | | Fig. 30 | |
| | | | GE | | 2N137 | | |
| | | | GT | | | | |
| | | | SYL | | 2N247 | Fig. 27 | |
| | | | RCA | | 2N247 | | |
| | | | W | | 2N617 | | |
| 2N416 | PNP | RF Ampl | RAY | 2N416 | | Fig. 30 | |
| | | | GE | | 2N137 | | |
| | | | GT | | 2N521 | | |
| | | | SYL | | 2N247 | | |
| | | | RCA | | 2N247 | | |
| | | | W | | 2N617 | | |
| 2N417 | PNP | RF Ampl | RAY | 2N417 | | Fig. 30 | |
| | | | GT | | 2N522 | | |
| 2N418 | PNP | PWR Ampl | BEN | 2N418 | | | |
| | | | SYL | | 2N296 | | |
| 2N419 | PNP | PWR Ampl | BEN | 2N419 | | | |
| | | | SYL | | 2N296 | | |
| | | | SYL | 2N419 | | | |
| 2N420 | PNP | PWR Ampl | BEN | 2N420 | | | |
| | | | SYL | 2N420 | | | |
| 2N422 | PNP | AF Ampl | RAY | 2N422 | | Fig. 30 | Low Noise |
| | | | GE | | 2N188A | | |
| | | | GE | | 2N230 | | |
| | | | GT | | GT81 | | |
| 2N424 | NPN | PWR Ampl | TI | 2N424 | | | Silicon |
| | | | GT | | GT269 | | |
| | | | TR | | ST402 | | |
| 2N425 | PNP | HF SW | RAY | 2N425 | | Fig. 30 | |
| | | | SYL | 2N425 | | | |
| | | | GE | | 2N395 | | |
| | | | GT | | 2N315 | | |
| | | | RCA | | 2N404 | Fig. 30 | |
| 2N426 | PNP | HF SW | RAY | 2N426 | | Fig. 30 | |
| | | | SYL | 2N426 | | | |
| | | | GE | | 2N396 | | |
| | | | GT | | 2N315 | | |
| | | | RCA | | 2N404 | | |
| 2N427 | PNP | HF SW | RAY | 2N427 | | Fig. 30 | |
| | | | SYL | 2N427 | | | |
| | | | GE | | 2N396 | | |
| | | | GT | | 2N316 | | |
| | | | RCA | | 2N404 | | |
| 2N428 | PNP | HF SW | RAY | 2N428 | | Fig. 30 | |
| | | | SYL | 2N428 | | | |
| | | | GE | | 2N397 | | |
| | | | GT | | 2N317 | | |
| | | | RCA | | 2N404 | | |
| 2N439 | NPN | HF SW | CBS | 2N439 | | Fig. 30 | |
| | | | GE | | 2N634 | | |
| | | | GT | | 2N446 | Fig. 30 | |
| | | | SYL | 2N439 | | Fig. 30 | |
| 2N440 | NPN | HF SW | CBS | 2N440 | | Fig. 30 | |
| | | | GE | | 2N635 | | |
| | | | GT | | 2N447 | | |
| 2N441 | PNP | PWR Ampl | DEL | 2N441 | | Fig. 23 | |
| | | | CLE | | CTP1509 | | |
| | | | BEN | | 2N677 | | |
| 2N442 | PNP | PWR Ampl | DEL | 2N442 | | Fig. 23 | |
| | | | CLE | | CTP1507 | | |
| | | | BEN | | 2N677 | | |
| 2N443 | PNP | PWR Ampl | DEL | 2N443 | | Fig. 23 | |
| | | | CLE | | CTP1505 | | |
| | | | BEN | | 2N677B | | |
| 2N446 | NPN | HF SW | GT | 2N446 | | Fig. 30 | |
| | | | GE | | 2N634 | | |
| 2N447 | NPN | HF SW | GT | 2N447 | | Fig. 30 | |
| | | | GE | | 2N635 | | |
| 2N450 | NPN | SW | GE | 2N450 | | | |
| | | | GT | | 2N520 | Fig. 30 | |
| | | | W | | 2N615 | | |
| | | | RAY | | 2N416 | | |
| 2N451 | NPN | PWR Ampl | GE | 2N451 | | | Silicon |
| 2N456 | PNP | PWR Ampl | TI | 2N456 | | | |
| | | | CLE | | CTP1137 | | |
| | | | BEN | | 2N639 | | |
| 2N457 | PNP | PWR Ampl | TI | 2N457 | | | |
| | | | CLE | | 2N268A | Fig. 25 | |
| | | | BEN | | 2N639A | | |
| 2N459 | PNP | PWR Ampl | TS | 2N459 | | | |
| | | | CLE | | CTP1104 | | |
| | | | BEN | | 2N6398 | | |
| 2N460 | PNP | AF Ampl | TS | 2N460 | | | |
| | | | GE | | 2N319 | | |
| | | | W | | 2N61 | Fig. 30 | |
| 2N461 | PNP | AF Ampl | TS | 2N461 | | | |
| | | | GE | | 2N320 | | |
| | | | W | | 2N60 | Fig. 30 | |
| 2N462 | PNP | SW | PHIL | 2N462 | | Fig. 31 | Bilateral Sw |
| | | | GE | | 2N188A | Fig. 8 | |
| | | | GT | | 2N593 | | |
| 2N464 | PNP | AF Ampl | RAY | 2N464 | | Fig. 30 | |
| | | | GT | | GT14 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N465 | PNP | AF Ampl | RAY | 2N465 | | Fig. 30 | |
| | | | GE | | 2N188A | | |
| | | | GE | | 2N320 | | |
| | | | GT | | GT20 | | |
| | | | W | | 2N402 | Fig. 30 | |
| 2N466 | PNP | AF Ampl | RAY | 2N466 | | Fig. 30 | |
| | | | GE | | 2N241A | | |
| | | | GE | | 2N321 | | |
| | | | GT | | GT81 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N467 | PNP | AF Ampl | RAY | 2N467 | | Fig. 30 | |
| | | | GT | | GT82 | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N481 | PNP | AF Ampl | RAY | 2N481 | | | |
| | | | GT | | GT761R | | |
| | | | W | | 2N617 | | |
| 2N482 | PNP | AF Ampl | RAY | 2N482 | | | |
| | | | GT | | GT760R | | |
| | | | W | | 2N614 | | |
| 2N483 | PNP | AF Ampl | RAY | 2N483 | | | |
| | | | GT | | GT760R | | |
| | | | W | | 2N615 | | |
| 2N484 | PNP | AF Ampl | RAY | 2N484 | | | |
| | | | GT | | GT760R | | |
| | | | W | | 2N615 | | |
| 2N485 | PNP | AF Ampl | RAY | 2N485 | | | |
| | | | GT | | GT761R | | |
| | | | W | | 2N617 | | |
| 2N486 | PNP | AF Ampl | RAY | 2N486 | | | |
| | | | GT | | GT761R | | |
| | | | W | | 2N617 | | |
| 2N499 | MADT | RF Ampl | PHIL | 2N499 | 2N384 | | |
| | | | SPR | 2N499 | | | |
| 2N500 | MADT | HF OSC | PHIL | 2N500 | 2N371 | | |
| | | | SPR | 2N500 | | | |
| 2N501 | MADT | HF SW | PHIL | 2N501 | 2N695 | | |
| | | | SPR | 2N501 | | | |
| 2N502 | MADT | VHF Ampl | PHIL | 2N502 | 2N700 | | |
| | | | SPR | 2N502 | | | |
| 2N503 | MADT | VHF Ampl | PHIL | 2N503 | 2N623 | | |
| | | | SPR | 2N502 | | | |
| 2N504 | MADT | SW | PHIL | 2N504 | | | |
| | | | GT | | 2N606 | | |
| | | | GT | | 2N607 | | |
| | | | SPR | 2N504 | | | |
| 2N508 | PNP | AF Ampl | GE | 2N508 | | | |
| | | | W | | 2N403 | Fig. 30 | |
| 2N515 | NPN | RF Ampl | SYL | 2N515 | | Fig. 12 | |
| | | | GT | | GT948R | | |
| 2N516 | NPN | RF Ampl | SYL | 2N516 | | Fig. 12 | |
| | | | GT | | GT948R | | |
| 2N517 | NPN | RF Ampl | SYL | 2N517 | | | |
| | | | GT | | GT948R | | |
| 2N519 | PNP | SW | GT | 2N519 | | Fig. 30 | |
| | | | GE | | 2N186 | Fig. 8 | |
| 2N520 | PNP | | GT | 2N520 | | | |
| | | | RAY | | 2N426 | | |

D A P

(ACTUAL SIZE)

# DIFFUSED ALLOY POWER TRANSISTORS

## Features

Faster Switching Times 0.5-5 μ Sec
Switching Currents up to 10 amperes
Flatter Frequency Response 40 Kc
Higher Breakdown Voltage up to 120 Volts
Current Gain of 40 at 5 amperes
Standard Power Transistor Package
Lower Base Resistance, 2 ohms
Lower Saturation Resistance, 0.1 ohm

## Uses

TV Horizontal Output
Hi-Fi Amplifiers
Core Drivers
High Current Switching
Power Converters
Ultrasonic Generators
Modulators

Because no other transistor offers this combination of features and uses, you will want to try out the DAP transistor in your circuits. Get full details now on new Bendix diffused alloy power transistors by writing SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

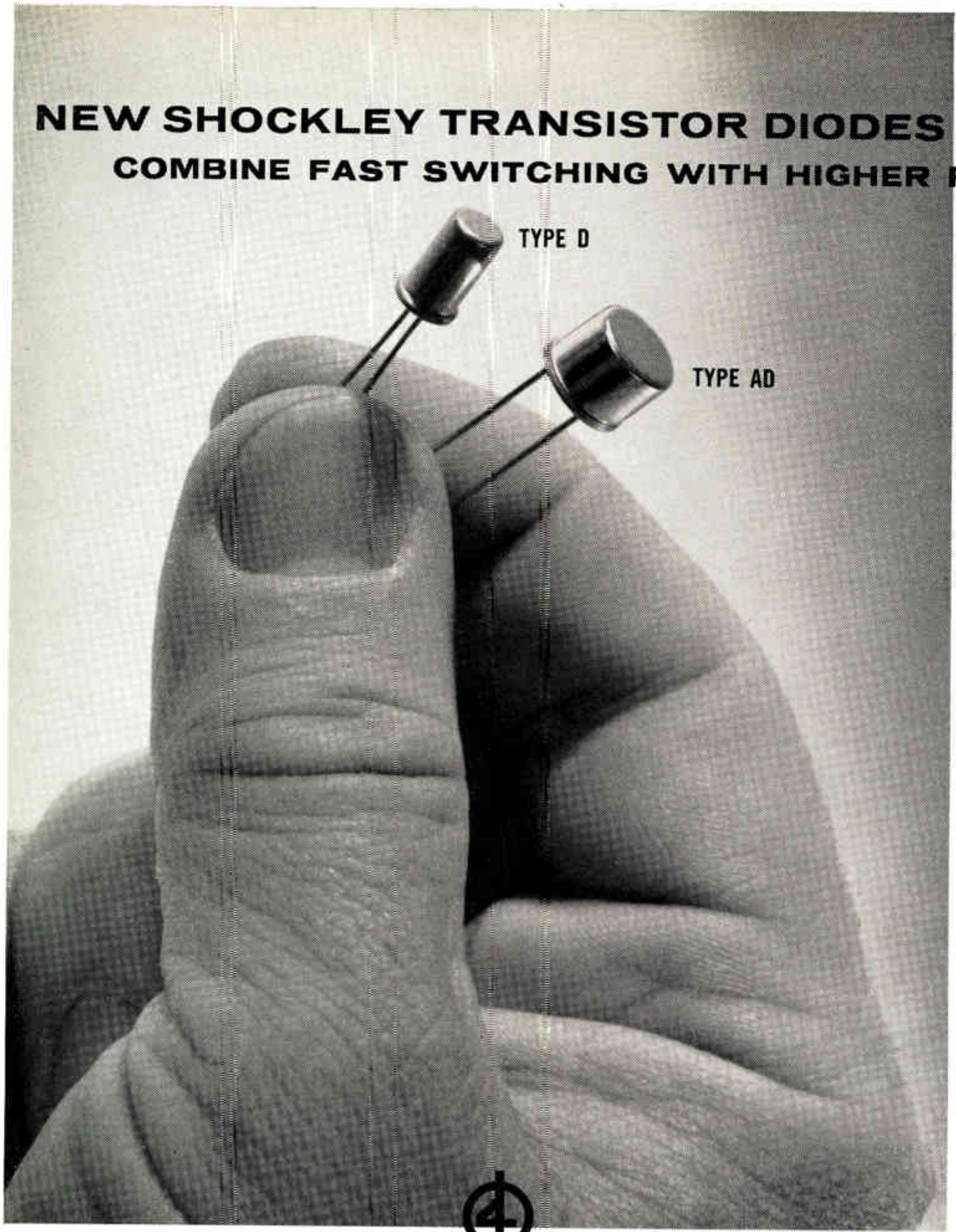
| | Ratings | | Typical Performance | | | |
|---|---|---|---|---|---|---|
| | Vdc | Pc (25°C) | B (Ic=5 Adc) | Vs (Ic=5 Adc) | fα | rbb′ |
| 2N1073 | 40 | 35 W | 40 | 0.5 Vdc | 1.5 mc | 2 ohms |
| 2N1073A | 80 | 35 W | 40 | 0.5 Vdc | 1.5 mc | 2 ohms |
| 2N1073B | 120 | 35 W | 40 | 0.5 Vdc | 1.5 mc | 2 ohms |

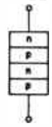
West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Canadian Distributor:
Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario
Export Sales and Service:
Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Red Bank Division Bendix AVIATION CORPORATION


Circle 66 on Inquiry Card, page 123

# NEW SHOCKLEY TRANSISTOR DIODES
## COMBINE FAST SWITCHING WITH HIGHER POWER HANDLING




Faster switching . . . determined by an "on" time constant of approximately 0.1 $\mu$s and an "off" time constant of approximately 0.2 $\mu$s . . . coupled with increased power handling ability, are now available with the Shockley 4-layer transistor diode — a two-terminal, self-actuated silicon switch with operating characteristics based on the principles of transistor action.

This new device is solving critical solid-state circuitry problems in many fields, requiring close tolerances . . . and unfailing reliability.

### TYPICAL APPLICATIONS

PULSE GENERATORS
PULSE AMPLIFIERS
OSCILLATORS
RELAY ALARM CIRCUITS
RING COUNTERS
DETONATOR FIRING CIRCUITS
MAGNETRON PULSING
SONAR PULSING
TELEPHONE SWITCHING
COMPUTER CIRCUITS

### CHARACTERISTICS OF SHOCKLEY 4-LAYER TRANSISTOR DIODES

*Available in production quantities*

| TYPE NO. | Switching Voltage ($V_s$) |
|---|---|
| **TYPE D** | |
| 4N20D | 20 ± 4 |
| 4N25D | 25 ± 4 |
| 4N30D | 30 ± 4 |
| 4N35D | 35 ± 4 |
| 4N40D | 40 ± 4 |
| 4N45D | 45 ± 4 |
| 4N50D | 50 ± 4 |
| 4N55D | 55 ± 4 |
| 4N60D | 60 ± 4 |
| 4N80D | 80 ± 8 |
| 4N120D | 120 ± 12 |
| 4N200D | 200 ± 20 |
| **TYPE AD** | |
| 4N30AD | 30 ± 4 |
| 4N40AD | 40 ± 4 |
| 4N50AD | 50 ± 4 |
| 4N200AD | 200 ± 20 |

| OTHER CHARACTERISTICS OF ALL UNITS | | |
|---|---|---|
| | TYPE D | TYPE AD |
| Holding Current ($I_h$) | 3 ± 2; 10 ± 5; 20 ± 5 and 35 ± 10 ma. < 1 or > 50 on special order. | 15 ± 10 and 35 ± 10 ma. |
| Holding Voltage ($V_h$) | 0.5 to 1 volt | 0.5 to 1 volt |
| Switching Current ($I_s$) | < 200 $\mu$ amps. | < 200 $\mu$ amps. |
| "On" Time Constant | 0.1 $\mu$s (Circuit will determine specific switching time) | 0.1 $\mu$s (Circuit will determine specific switching time) |
| Capacitance | Generally < 100 $\mu\mu$f. Exact value dependent on $V_s$ and applied voltage. | Generally < 100 $\mu\mu$f. Exact value dependent on $V_s$ and applied voltage. |
| Ambient Temperature | −60°C. to 100°C. | −60°C. to 100°C. |
| Current Carrying Capacity | 50 ma. steady d.c. or 2 amp. pulse current--50 $\mu$s (or less) pulse duration. | 300 ma. steady d.c. or 20 amp. pulse current--50 $\mu$s (or less) pulse duration. |
| Resistance ($R$) | $R_{off}$ - > 1 megohm<br>$R_{on}$ - < 7 ohms at $I_h$ + 25 ma.<br>- < 2 ohms at 2 amps.<br>(typical value 0.2 ohms) | $R_{off}$ - > 1 megohm<br>$R_{on}$ - < 7 ohms at $I_h$ + 25 ma.<br>- < 1 ohm at 3 amps.<br>(typical value 0.06 ohms) |

### ENGINEERING DATA AND ASSISTANCE

Our engineering staff, under the direction of Dr. William Shockley, will assist in solving circuitry problems using standard transistor diodes; also, will develop custom units to meet individual specifications. Write to Dept. 2-1.

*See our Exhibit*
**BOOTH 2606**
*IRE Show*

## Shockley Transistor Corporation

*Stanford Industrial Park, Palo Alto, Calif.*

A SUBSIDIARY OF BECKMAN INSTRUMENTS, INC.

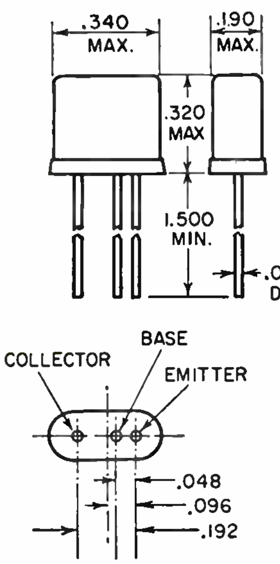
# 1959 TRANSISTOR INTERCHANGEABILITY CHART

| EIA NO. | TYPE | APPLICATION | MFR. | MFR. NO. | NEAREST TYPE | OUTLINE | NOTES |
|---|---|---|---|---|---|---|---|
| 2N521 | PNP | SW | GT | 2N521 | | | |
| | | | RAY | | 2N427 | | |
| | | | GE | | 2N397 | | |
| 2N522 | PNP | SW | GT | 2N522 | | | |
| | | | RAY | | 2N428 | | |
| 2N525 | PNP | AF Ampl | GE | 2N525 | | | |
| | | | GT | | 2N43 | | |
| | | | SYL | 2N525 | | | |
| 2N544 | PNP | RF Ampl | RCA | 2N544 | | Fig. 27 | "Drift" |
| | | | GT | | 2N606 | | |
| | | | GT | | 2N607 | | |
| | | | SYL | 2N544 | | Fig. 27S | |
| 2N554 | PNP | PWR Ampl | MOTR | 2N554 | | | |
| | | | SYL | 2N554 | | | |
| | | | CLE | | CTP1104 | | |
| | | | BEN | | 2N234A | | |
| 2N555 | PNP | PWR Ampl | MOTR | 2N555 | | | |
| | | | CLE | | 2N257 | | |
| | | | BEN | | 2N235A | | |
| 2N578 | PNP | SW | RCA | 2N578 | | Fig. 30 | High Current |
| | | | GE | | 2N396 | | |
| | | | GT | 2N578 | | | |
| | | | GT | | 2N316 | | |
| | | | RAY | | 2N658 | | |
| 2N579 | PNP | SW | RCA | 2N579 | | Fig. 30 | High Current |
| | | | GE | | 2N396 | | |
| | | | GT | 2N579 | | | |
| | | | GT | | 2N317 | | |
| | | | RAY | | 2N659 | | |
| 2N580 | PNP | SW | RCA | 2N580 | | Fig. 30 | |
| | | | GE | | 2N397 | | |
| | | | GT | 2N580 | | | |
| | | | GT | 2N317 | | | |
| | | | RAY | | 2N660 | | |
| 2N581 | PNP | SW | RCA | 2N581 | | Fig. 30 | |
| | | | GE | | 2N396 | | |
| | | | GT | 2N581 | | | |
| | | | GT | | 2N520 | | |
| 2N582 | PNP | SW | RCA | 2N582 | | Fig. 30 | |
| | | | GT | 2N582 | | | |
| | | | GT | | 2N522 | | |
| 2N583 | PNP | SW | RCA | 2N583 | | Fig. 15 | |
| | | | GT | | 2N520 | | |
| 2N584 | PNP | SW | RCA | 2N584 | | Fig. 15 | |
| | | | GT | | 2N522 | | |
| 2N585 | NPN | SW | RCA | 2N585 | | Fig. 30 | |
| | | | GT | 2N585 | | | |
| | | | GT | | 2N356 | | |
| | | | SYL | 2N585 | | | |
| 2N588 | MADT | IF Ampl | PHIL | 2N588 | 2N373 | | |
| | | | SPR | 2N588 | | | |
| 2N591 | PNP | Audio Driver | RCA | 2N591 | | | |
| | | | SYL | 2N591 | | | |
| 2N677 | | | BEN | 2N677 | | | |
| | | | SYL | 2N677 | | | |
| 2N677A | | | BEN | 2N677A | | | |
| | | | SYL | 2N677A | | | |
| 2N677B | | | BEN | 2N677B | | | |
| | | | SYL | 2N677B | | | |
| 2N677C | | | BEN | 2N677C | | | |
| | | | SYL | 2N677C | | | |

The following EIA registered types do not appear in the chart since the manufacturers, in the information submitted, indicated no replacements or substitutes for these transistors. They are listed here with the names of the manufacturers to complete the EIA list of registered types.

.............

| | | | | |
|---|---|---|---|---|
| | | | | 2N577--MU |
| | | | | 2N631--RAY |
| 2N22--WE | 2N110--WE | 2N330--RAY | 2N496--PHIL | 2N632--RAY |
| 2N23--WE | 2N141--SYL | 2N330A--RAY | 2N518--GE | 2N633--RAY |
| 2N24--WE | 2N142--SYL | 2N347--BO | 2N520--GE | 2N634--GE |
| 2N25--WE | 2N143--SYL | 2N348--BO | 2N523--GT | 2N635--GE |
| 2N26--WE | 2N144--SYL | 2N349--BO | 2N524--GE | 2N636--GE |
| 2N29--WE | 2N159--SPR | 2N354--PHIL | 2N526--GE | 2N658--RAY |
| 2N32--RCA | 2N159A--SPR | 2N355--PHIL | 2N527--GE | 2N660--RAY |
| 2N50--CLE | 2N179--MTR | 2N438--CBS | 2N529--GT | 2N661--RAY |
| 2N51--CLE | 2N214--SYL | 2N444--GT | 2N530--GT | 2N662--RAY |
| 2N52--CLE | 2N230--MAL | 2N445--GT | 2N531--GT | 2N696--FAIR |
| 2N53--CLE | 2N260--CLE | 2N452--GE | 2N532--GT | 2N697--FAIR |
| 2N68--SYL | 2N260A--CLE | 2N453--GE | 2N533--GT | 2N1017--RAY |
| 2N71--W | 2N261--CLE | 2N454--GE | 2N538--MH | 3N21--SYL |
| 2N73--W | 2N262--CLE | 2N489--GE | 2N538A--MH | 3N22--WE |
| 2N74--W | 2N290--DEL | 2N490--GE | 2N539--MH | 3N23--GP |
| 2N75--W | 2N327--RAY | 2N491--GE | 2N540--MH | 3N23A--GP |
| 2N95--SYL | 2N327A--RAY | 2N492--GE | 2N540A--MH | 3N23B--GP |
| 2N101--SYL | 2N328--RAY | 2N493--GE | 2N574--MH | 3N23C--GP |
| 2N102--SYL | 2N329--RAY | 2N494--GE | 2N574A--MH | 3N36--GE |
| 2N108--CBS | 2N329A--RAY | 2N495--PHIL | 2N575--MH | 3N37--GE |



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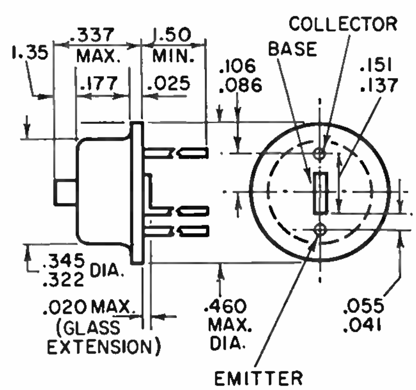

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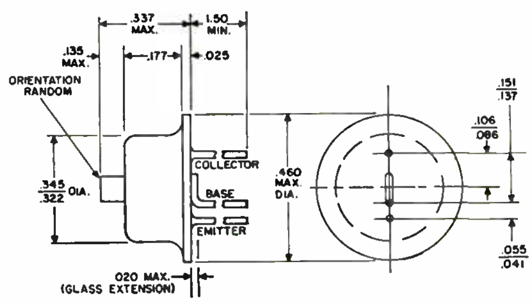
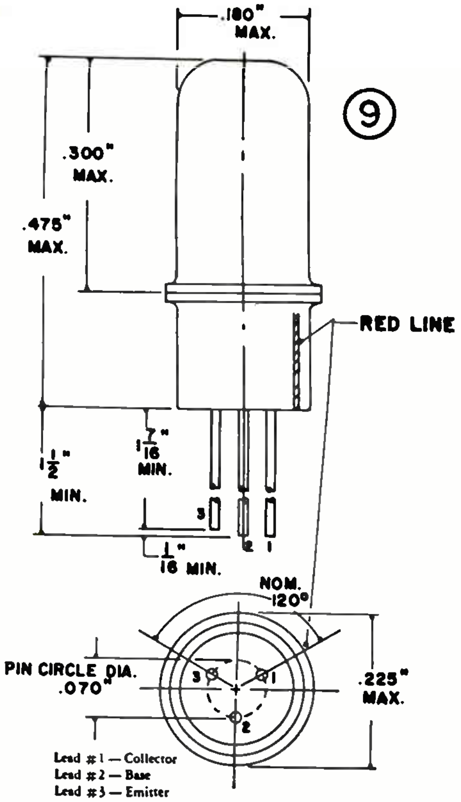
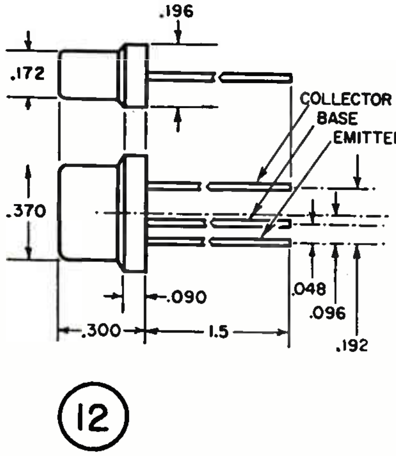
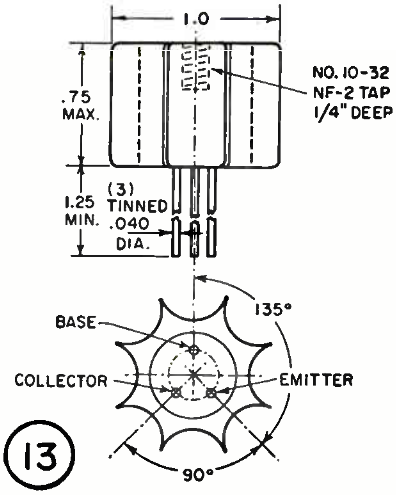


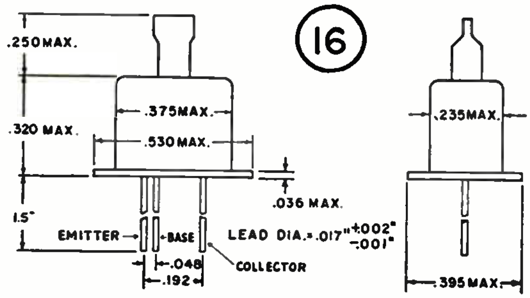
7

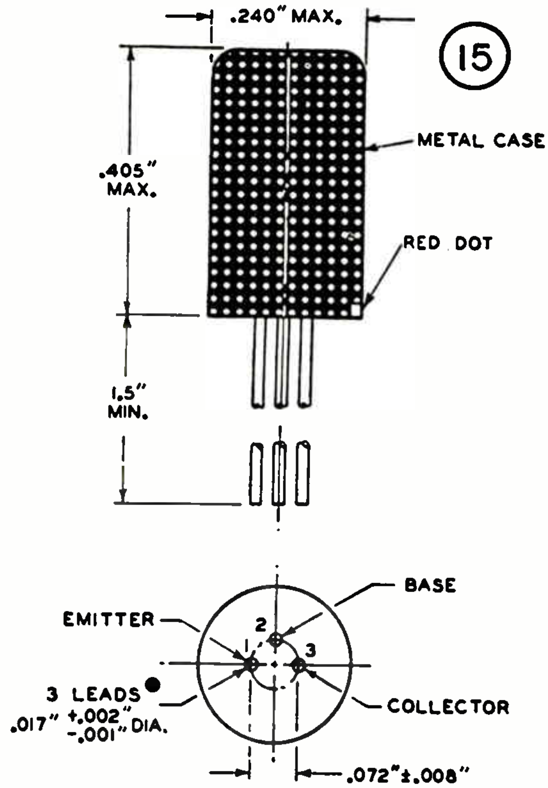
# 1959 TRANSISTOR INTERCHANGEABILITY CHART

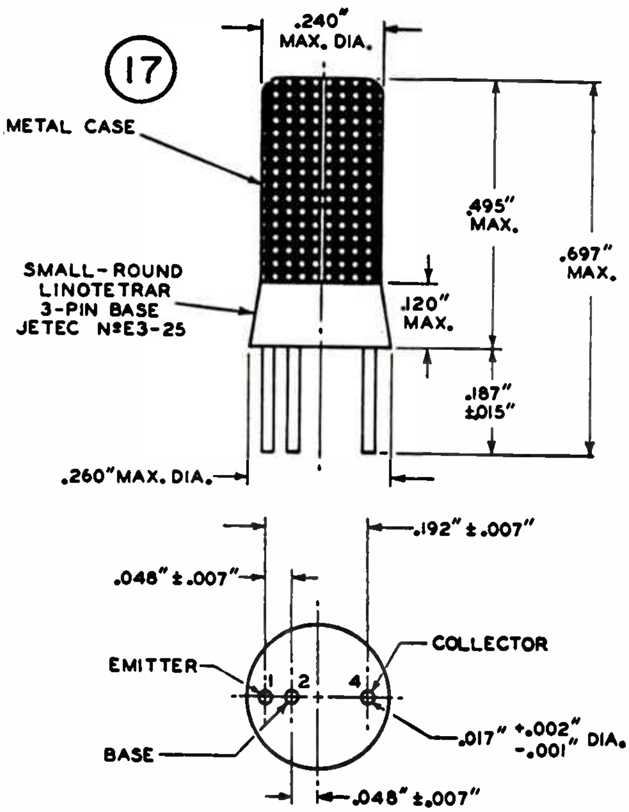


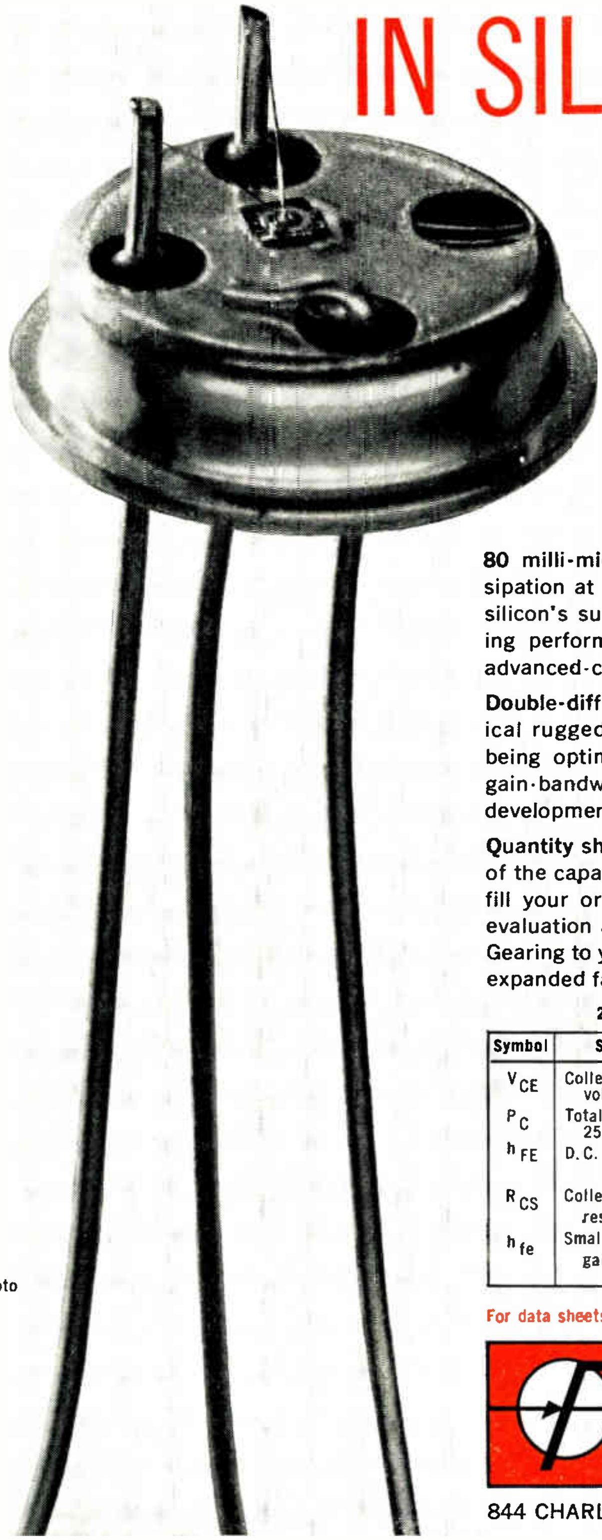



FROM FAIRCHILD

# MESA TRANSISTORS IN SILICON



Greatly enlarged photo of Fairchild 2N696 before capping

**80 milli-micro-second** rise time with 2 watts power dissipation at 25° C. This speed and power is combined with silicon's superior high-temperature reliability. The switching performance that this affords has a place in every advanced-circuit evaluation program.

**Double-diffused mesa-type construction** provides mechanical ruggedness and excellent heat dissipation besides being optimum for high-frequency performance (typical gain-bandwidth product 80 Mc). This type is under intense development everywhere. Fairchild has it in production.

**Quantity shipments now being made** give conclusive proof of the capabilities of Fairchild's staff and facilities. We can fill your orders promptly. You can start immediately on evaluation and building of complete prototype equipment. Gearing to your future production needs, Fairchild will have expanded facilities to over 80,000 square feet by early '59.

**2N696 and 2N697 — NPN SILICON TRANSISTORS**

| Symbol | Specification | Rating | Characteristics | Test Conditions |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter voltage (25°C.) | 40v | | |
| $P_C$ | Total dissipation at 25°C. Case temp. | 2 watts | | |
| $h_{FE}$ | D.C. current gain | | 2N696—20 to 60<br>2N697-40 to 120 | $I_C$=150ma<br>$V_C$=10v |
| $R_{CS}$ | Collector saturation resistance | | 3.5 Ω typical<br>10 Ω max. | $I_C$=150ma<br>$I_B$=15ma |
| $h_{fe}$ | Small signal current gain at f=20Mc | | 5 typical | $I_C$=50ma<br>$V_C$=10v |

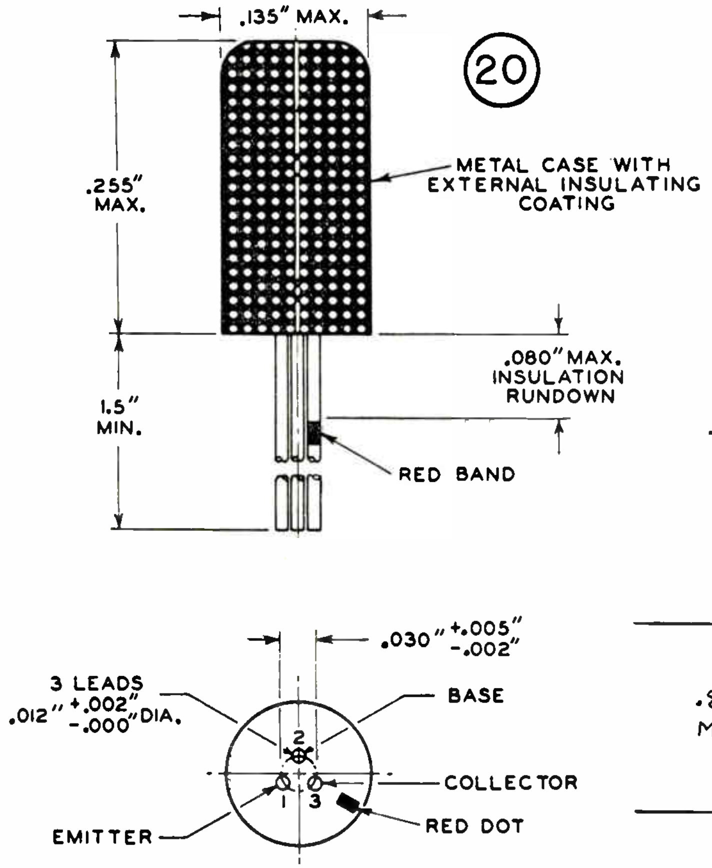
For data sheets, write Dept. J3

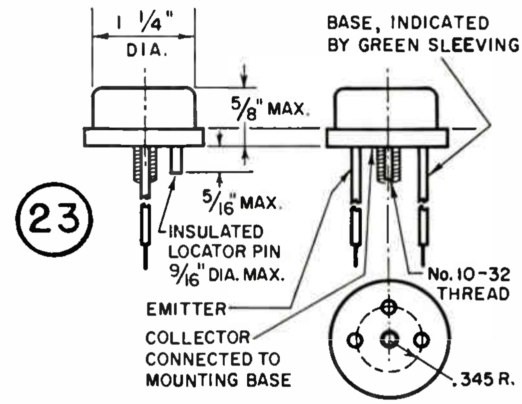
FAIRCHILD SEMICONDUCTOR CORPORATION

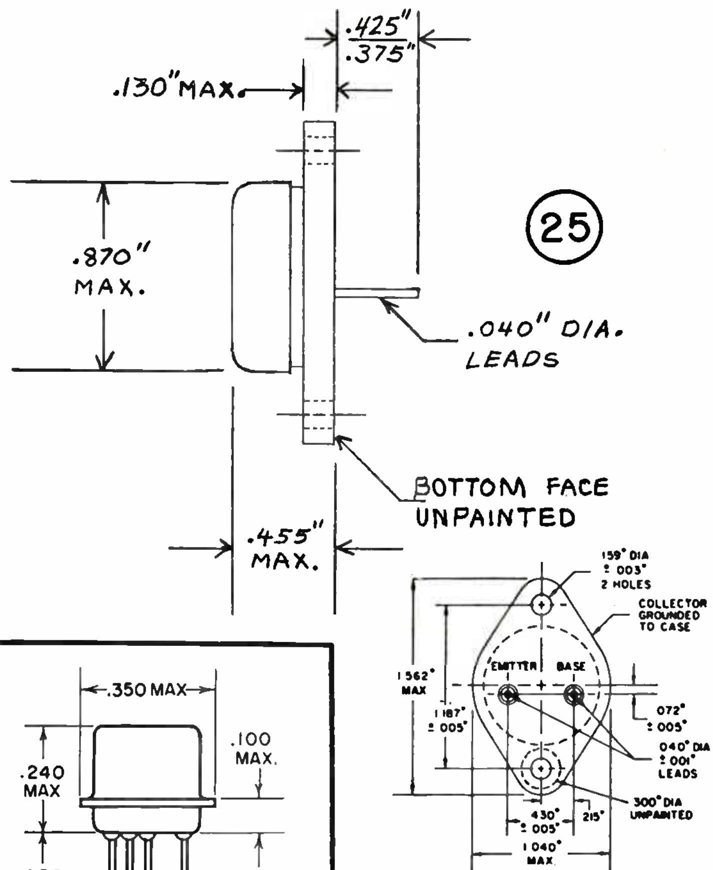
844 CHARLESTON RD. • PALO ALTO, CALIF. • DA 6-6695

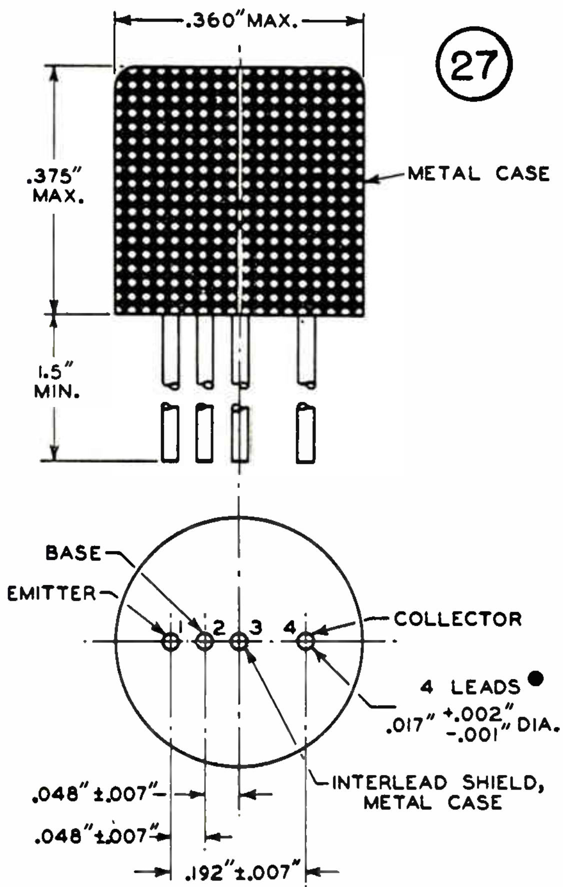


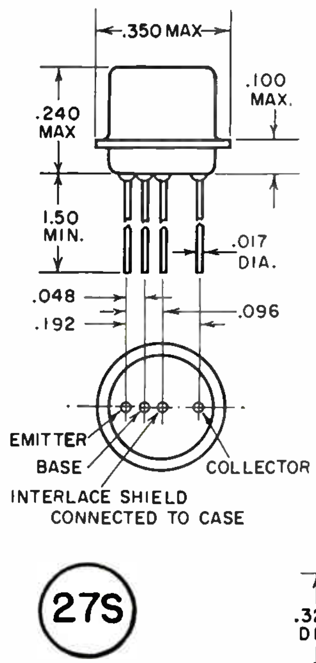
Circle 68 on Inquiry Card, page 123

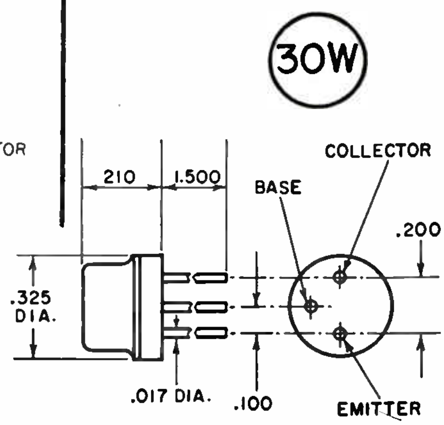

20
.135" MAX.
.255" MAX.
METAL CASE WITH EXTERNAL INSULATING COATING
.080" MAX. INSULATION RUNDOWN
1.5" MIN.
RED BAND
.030" +.005" -.002"
3 LEADS .012" +.002" -.000" DIA.
BASE
2
1
3
COLLECTOR
RED DOT
EMITTER

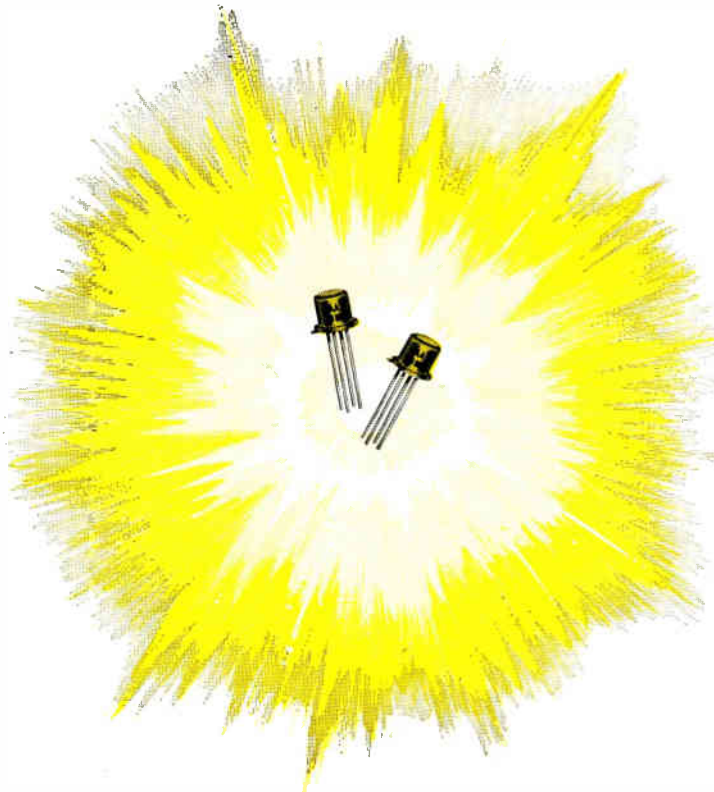

1 1/4" DIA.
BASE, INDICATED BY GREEN SLEEVING
5/8" MAX.
23
5/16" MAX.
INSULATED LOCATOR PIN 9/16" DIA. MAX.
No. 10-32 THREAD
EMITTER
COLLECTOR CONNECTED TO MOUNTING BASE
.345 R.


.425" .375"
.130" MAX.
.870" MAX.
25
.040" DIA. LEADS
BOTTOM FACE UNPAINTED
.455" MAX.
159" DIA ± 003" 2 HOLES
COLLECTOR GROUNDED TO CASE
EMITTER
BASE
1 562" MAX
1 187" ± 005"
072" ± 005"
040" DIA ± 001" LEADS
300" DIA UNPAINTED
430" ± 005"
215"
1 040" MAX


.360" MAX.
27
.375" MAX.
METAL CASE
1.5" MIN.
BASE
EMITTER
1
2
3
4
COLLECTOR
4 LEADS
.017" +.002" -.001" DIA.
INTERLEAD SHIELD, METAL CASE
.048" ±.007"
.048" ±.007"
.192" ±.007"


.350 MAX
.100 MAX.
.240 MAX
1.50 MIN.
.017 DIA.
.048
.192
.096
EMITTER
BASE
COLLECTOR
INTERLACE SHIELD CONNECTED TO CASE
27S


30W
COLLECTOR
210
1.500
BASE
.200
.325 DIA.
.017 DIA.
.100
EMITTER



300°C HIGH VACUUM BAKE-OUT ASSURES EXTREME RELIABILITY OF MOTOROLA MESA TRANSISTORS. This is just one of the many extra steps being taken to guarantee the integrity and reliability of the 2N700 (a 200 mc amplifier) and the 2N695 (a 5 millimicrosecond switch). Incorporate these "transistors of the future" in your circuits, now!

**2N700 UHF AMPLIFIER TRANSISTOR**

| | |
|---|---|
| f max | 1000 mcs |
| PG (Neut.) | 14 db at 200 mcs |
| $BV_{CB}$ @ 100 $\mu$a | 33 volts |
| NF @ 200 mcs | 9 db |
| Max Power | 75 mw at 25°C |

**2N695 ULTRA HIGH-SPEED SWITCH**

| | |
|---|---|
| $BV_{CBO}$ Min. | 18 volts |
| $BV_{EBO}$ Min. | 4.0 volts |
| $I_{CO}$ @ 5 volts | 1$\mu$a |
| $B_{h_{FE}}$ at 10ma | 0.3 volts |
| $I_C$ max | 50 ma |
| $P_C$ | 75 mw |

Operating Junction temperature 100°C

see the
**MOTOROLA MESAS**
at **IRE BOOTH**
no. **1105-6**

"DEPENDABLE QUALITY—IN QUANTITY"

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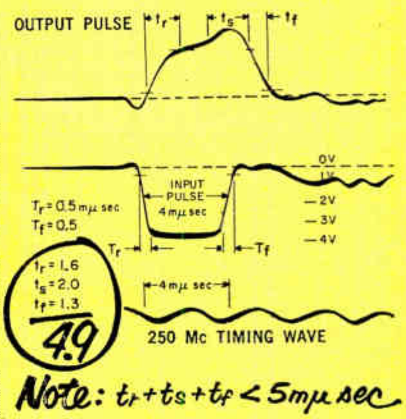
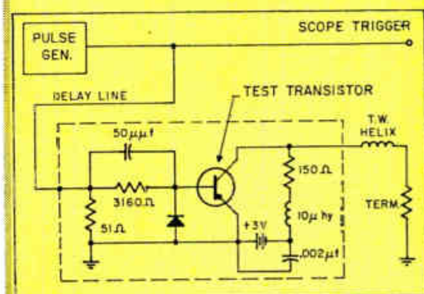
# WORLDS FASTEST SWITCHING TRANSISTOR!

## MOTOROLA MESA 2N695


**TEST CIRCUIT**

The above data is from an independent test conducted by Edgerton, Germeshausen & Grier, Inc., Boston, Mass.

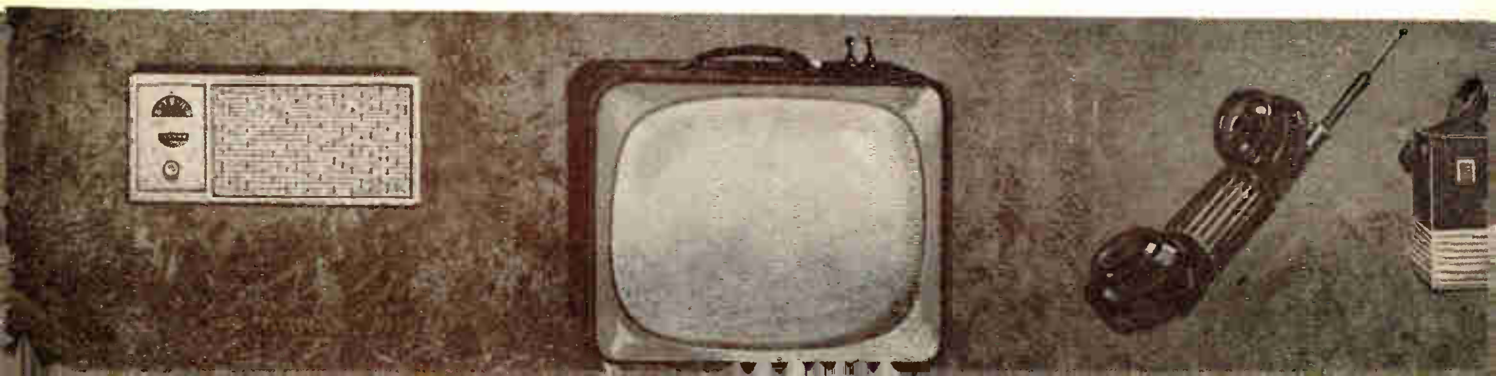
Available "off the shelf" From these distributors

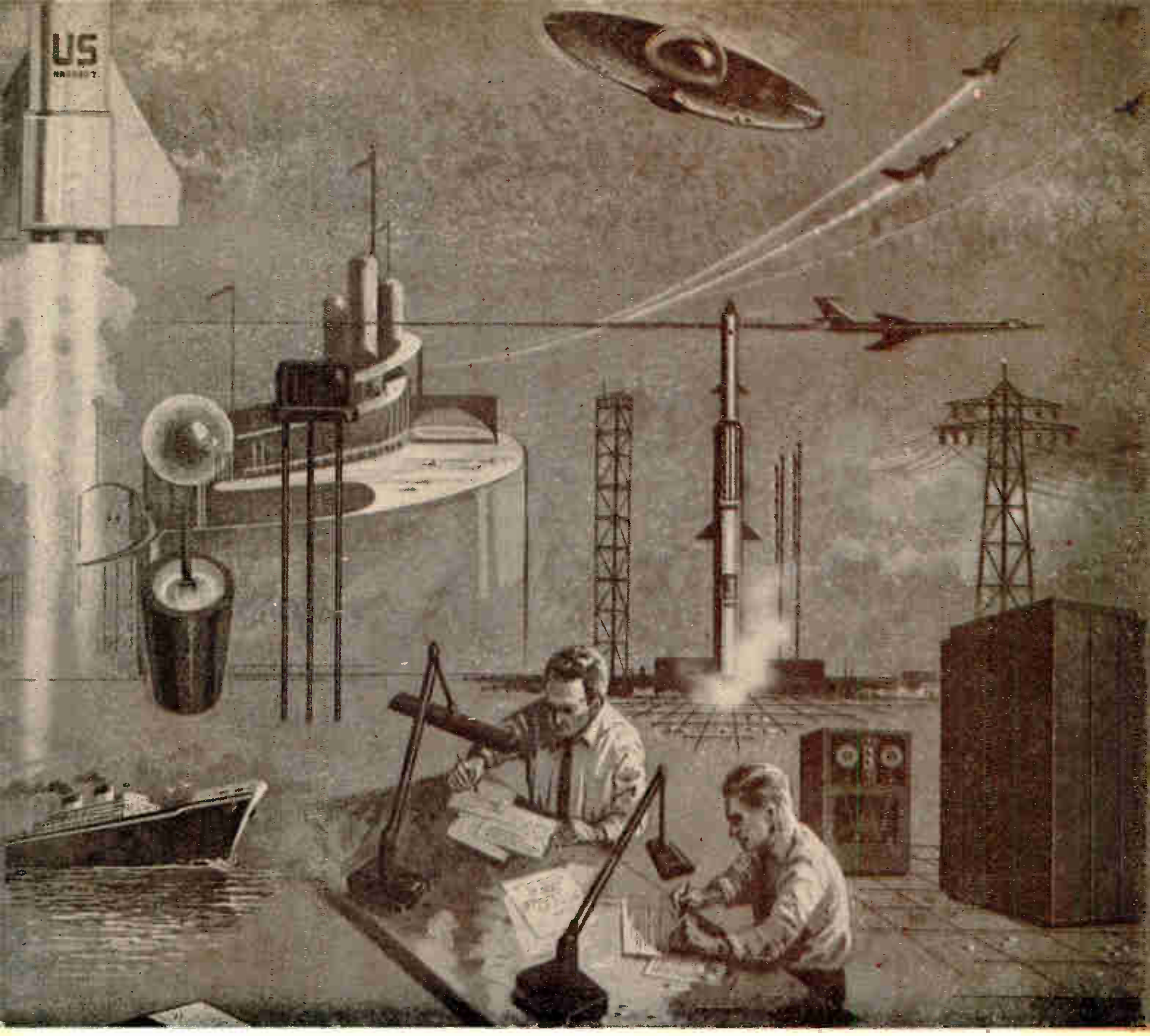
**ALAMOGORDO** Radio Specialties, HEmlock 7-0370 **BOSTON** Cramer Electronics, COpley 7-4700 **CAMDEN** General Radio Supply Co., WOodlawn 4-8383 **CHICAGO** Allied Radio Corp., HAymarket 1-6800 Newark Electric Company, STate 2-2944 **JAMAICA, N. Y.** Lafayette Radio, AXtel 1-7000 **LOS ANGELES** Kierulff Electronics, RIchmond 7-0271 **NEW YORK** Milgray Electronics, REctor 2-4400 Radio Wire Television, WOrth 6-5300 **OAKLAND** Elmar Electronics, HIgate 4-7011 **PHOENIX** Radio Specialties, ALpine 8-6121 **SAN DIEGO** San Delco, CYpress 8-6181 **WASHINGTON, D. C.** Electronic Industrial Sales, HUdson 3-5200.



Circle 69 on Inquiry Card, page 123








| | | | | | | |
|---|---|---|---|---|---|---|
| GERMANIUM BILATERAL TRANSISTORS | GERMANIUM DRIFT TRANSISTORS | GERMANIUM PHOTOTRANSISTORS | GERMANIUM COMPLEMENTARY SYMMETRY TRANSISTORS | GERMANIUM HIGH VOLTAGE TRANSISTORS | SUBMINIATURE GERMANIUM GOLD BONDED DIODES | SILICON PNP ALLOY JUNCTION TRANSISTORS |
| .LETIN -170 | BULLETIN G-180 | BULLETIN 2N469 | BULLETIN 2N529 | BULLETIN GT-1200 | BULLETIN GD-10 | BULLETIN S-100 |

"YEARS AHEAD IN RELIABILITY"

**GENERAL TRANSISTOR**
C O R P O R A T I O N
91-27 138TH. PLACE • JAMAICA 35. NEW YORK

# DELCO POWER TRANSISTORS

## NEW TYPES


## MILITARY
## COMMERCIAL

TYPICAL CHARACTERISTICS AT 25°C

| EIA | 2N297A* | 2N297A | 2N665** | 2N553 |
|---|---|---|---|---|
| Collector Diode Voltage (Max.) | 60 | 60 | 80 | 80 volts |
| HFE ($I_c$=0.5A) (Range) | 40-100 | 40-100 | 40-80 | 40-80 |
| HFE ($I_c$=2A) (Min.) | 20 | 20 | 20 | 20 |
| $I_{co}$ (2 volts, 25°C) (Max.) | 200 | 200 | 50 | 50 μa |
| $I_{co}$ (30 volts, 71°C) (Max.) | 6 | 6 | 2 | 2 ma |
| $F_{ae}$ (Min.) | 5 | 5 | 20 | 20 kc |
| T (Max.) | 95 | 95 | 95 | 95°C |
| Therm Res. (Max.) | 2 | 2 | 2 | 2° C/W |

*Mil. T 19500/36 (Sig. C.)
**Mil. T 19500/58 (Sig. C.)

NOTE: Military Types pass comprehensive electrical tests with a combined acceptance level of 1%.

Delco Radio announces new PNP germanium transistors in 2N553 series — the 2N297A and 2N665, designed to meet military specifications. These transistors are ideal as voltage and current regulators because of their extremely low leakage current characteristics. All are highly efficient in switching circuits and in servo amplifier applications, and all are in *volume* production! Write today for complete engineering data.

**See you at IRE Show, Booth 1512.**

# DELCO RADIO

**Division of General Motors • Kokomo, Indiana**

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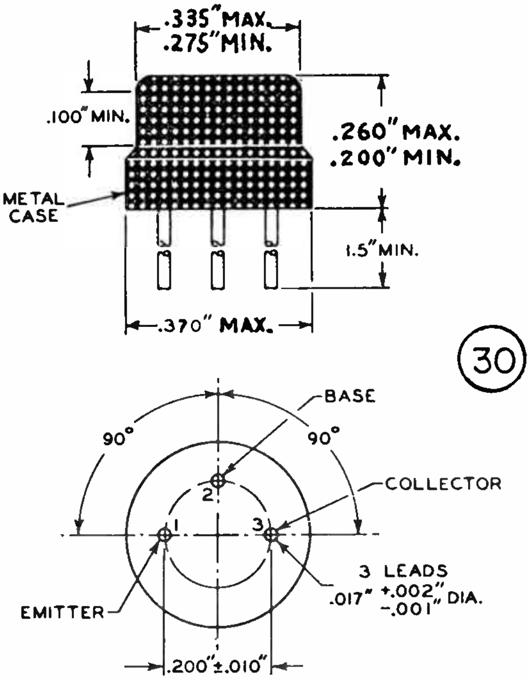
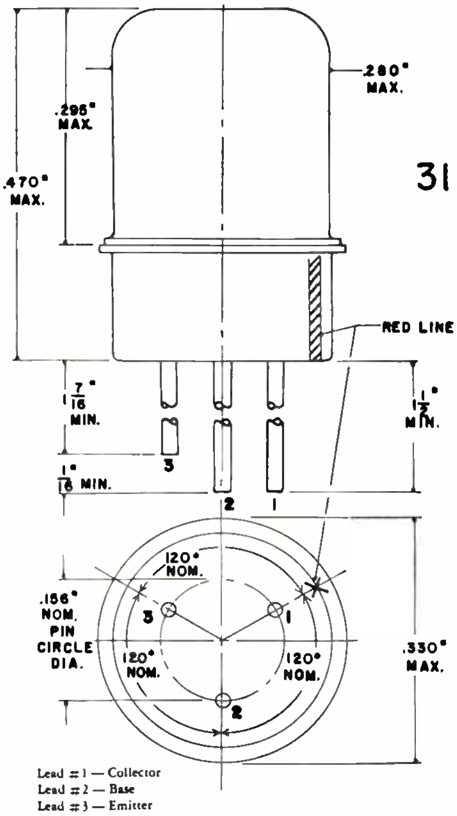
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

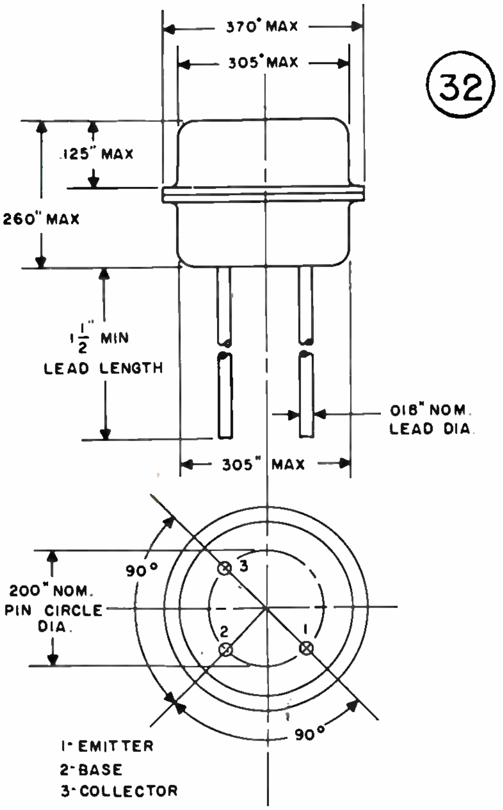
 Circle 71 on Inquiry Card, page 123 


.335"MAX.
.275"MIN.
.100" MIN.
.260" MAX.
.200" MIN.
METAL CASE
1.5" MIN.
.370" MAX.
BASE
90°
90°
COLLECTOR
2
1
3
3 LEADS
.017" +.002" -.001" DIA.
EMITTER
.200"±.010"

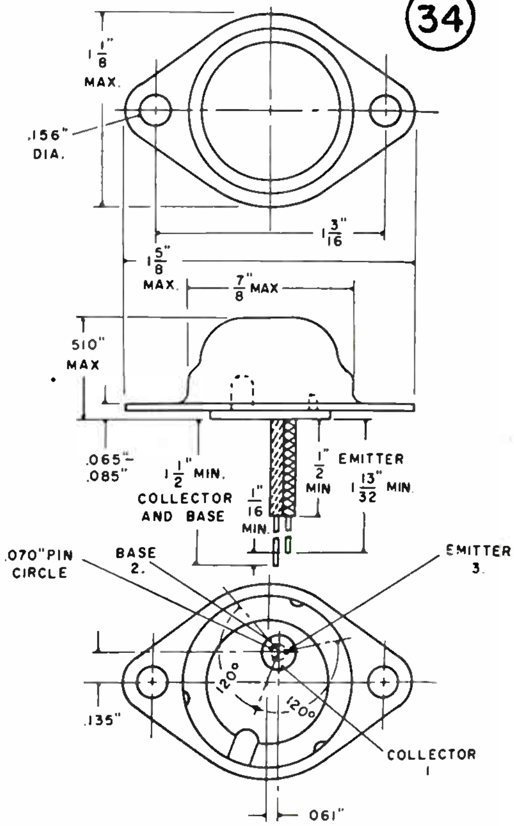
30


.280" MAX.
.295" MAX.
.470" MAX.
RED LINE
7/16" MIN.
1 1/2" MIN.
1/16" MIN.
3
2
1
120° NOM.
.156" NOM. PIN CIRCLE DIA.
120° NOM.
120° NOM.
.330" MAX.
Lead #1 — Collector
Lead #2 — Base
Lead #3 — Emitter

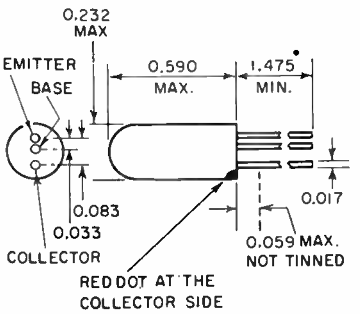
31


370" MAX
305" MAX
125" MAX
260" MAX
1 1/2" MIN
LEAD LENGTH
018" NOM.
LEAD DIA.
305" MAX
200" NOM.
PIN CIRCLE
DIA.
90°
90°
1- EMITTER
2- BASE
3- COLLECTOR

32


1 1/8" MAX.
.156" DIA.
1 3/16"
1 5/8" MAX.
7/8" MAX
510" MAX
.065"-.085"
1 1/2" MIN.
COLLECTOR AND BASE
1/16" MIN.
1/2" MIN
EMITTER
1 13/32" MIN.
.070" PIN CIRCLE
BASE 2.
EMITTER 3.
.135"
120°
120°
COLLECTOR 1
061"

34

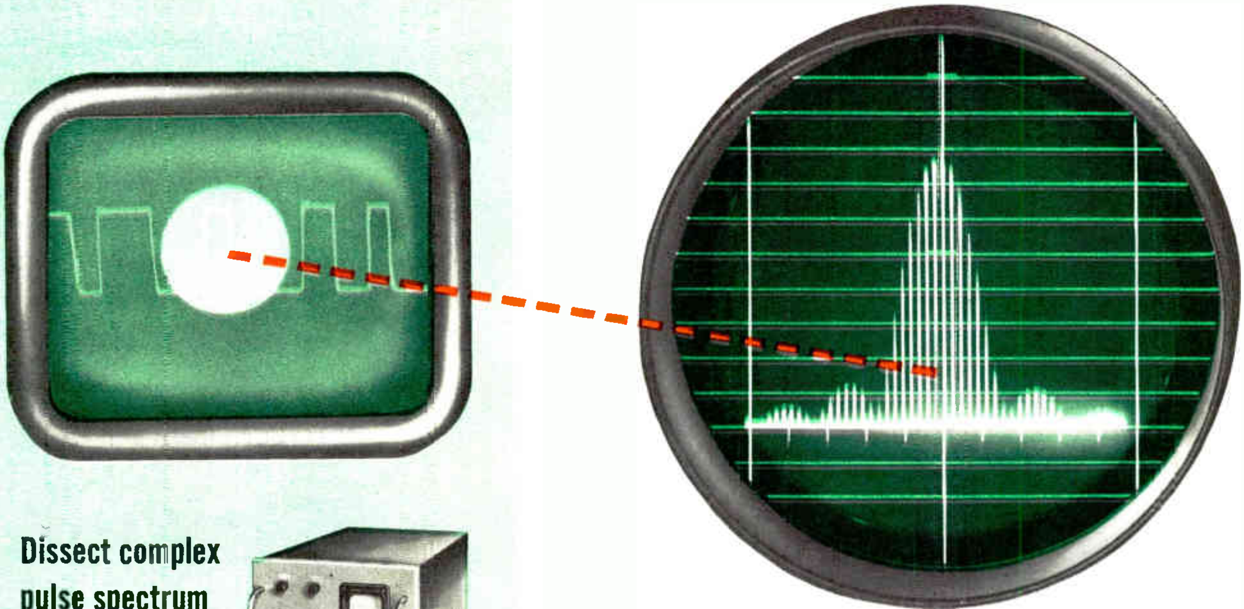

0.232 MAX
EMITTER
BASE
0.590 MAX.
1.475" MIN.
0.083
0.033
COLLECTOR
0.017
0.059 MAX. NOT TINNED
RED DOT AT THE COLLECTOR SIDE

35

 Circle 317 on Inquiry Card, page 123 

# VISUAL MICROWAVE ANALYSIS—10 to 44,000 mc

## COMPLEX SPECTRUM DECODING



Dissect complex pulse spectrum visually by means of Polarad Model SD-1

## MULTI-PULSE SPECTRUM SELECTOR

Used with any Polarad analyzer, this Model SD-1 Spectrum Selector permits complete analysis of any complex pulse modulated microwave signals. The unit decodes and isolates any segment of a complex pulse train and permits corresponding spectrum analysis of that segment.

Model SD-1 Spectrum Selector displays pulse groups up to 180 microseconds duration (Model SD-1X: 350 microseconds).

**Applications:**
Design and operation of radar, telemetry equipment, IFF systems and beacons.

Analyze complex spectrum visually using any of Polarad's wide band

## MICROWAVE ANALYZERS

**Model TSA Spectrum Analyzer** —25 kc resolution. 400 kc to 25 mc dispersion. 5 sensitive plug-in tuning units.

**Model TSA-S Combination Synchroscope-Spectrum Analyzer** —Displays pulse waveform or frequency spectrum. 5 kc to 5 mc adjustable bandwidth, 400 kc to 25 mc dispersion. 5 sensitive plug-in tuning units.

**Model TSA-W Wide Dispersion Spectrum Analyzer** — 100 kc to 70 mc dispersion. 7 kc and 50 kc resolution. Logarithmic amplitude display. 5 sensitive plug-in tuning units.

**Model SA-84 Multi-band Spectrum Analyzer** — 10 to 40,880 mc in a single unit. 25 kc resolution, 400 kc to 25 mc dispersion. Simple band switch, slide-rule dial. Military approved.

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Handbook of Spectrum Analyzer Techniques" and "Notes on Microwave Measurements"

**POLARAD ELECTRONICS CORPORATION**
43-20 34th Street, Long Island City 1, N. Y.
Representatives in principal cities

MAIL THIS CARD

EI

**POLARAD ELECTRONICS CORPORATION:**

POLARAD

Please send me information and specifications on:

- ☐ Model SD-1 Multi-Pulse Spectrum Selector
- ☐ Microwave Spectrum Analyzers
- ☐ Model B Microwave Code Generator (see reverse side of this page)

My application is:__________

Name__________

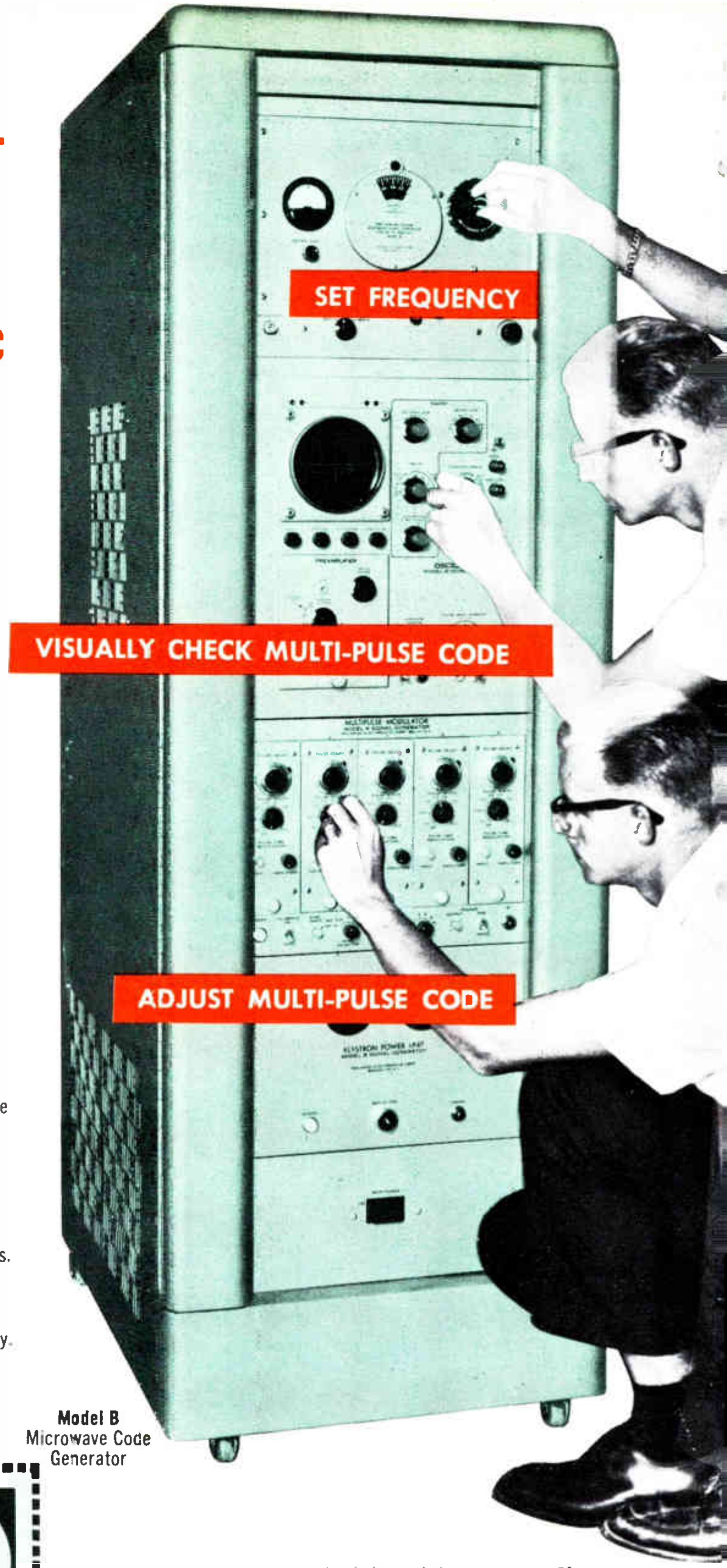
Title__________ Dept.__________

Company__________

Address__________

City__________ Zone_____ State__________

# COMPLETE FACILITIES– CODED MICROWAVE SIGNALS 950 to 10,750 mc




**Model B**
Microwave Code Generator

## APPLICATIONS:

**One integrated instrument:**

**Provides** a complete system for simulating and testing missile and telemetry systems, IFF and radar, microwave beacons, direction finding and navigational equipment and microwave relay links.

**Performs** general purpose signal generator and oscilloscope measurements, multi-pulse testing and analysis.

## SET FREQUENCY

Frequency range 950 to 10,750 mc is covered by four interchangeable microwave oscillator units, all stored in the instrument. Each has UNI-DIAL control, precision power monitor circuit to maintain 1 milliwatt power output reference level, and non-contacting short-type chokes to assure long life.

## VISUALLY CHECK MULTI-PULSE CODE

Calibration of r-f pulse width, delay and group repetition rate is simplified by ability to view pulse train on a precision oscilloscope with a built-in wide band r-f detector.

## ADJUST MULTI-PULSE CODE

Code modulation is achieved with five independently adjustable pulse channels providing: **pulse repetition rate** variable, 10-10,000 pps; **width** variable 0.2 to 2 microseconds; **delay** variable 0-300 microseconds. **Pulse rise and decay,** 0.1 microsecond.

**NO ADJUSTMENT NECESSARY** on self-contained power supplies. Klystron power unit adjusts to proper voltage automatically for each interchangeable tuning unit. Built-in AC regulator. Equipped with an electronically regulated low-voltage DC supply.

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.

**POLARAD ELECTRONICS CORP**
43-20 34th St., Long Island City 1, N. Y.

POLARAD

**MAIL THIS CARD**
for detailed specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

**POLARAD ELECTRONICS CORPORATION**
43-20 34th Street, Long Island City 1, N. Y.
Representatives in principal cities


Iere's a compact honey! The new RCA "VC" *(Very Compact)* Picture Tubes—now 2 nches shorter than their prototypes!

Now commercially available in the new "VC" 110° designs are the RCA-17DKP4 and RCA-21EQP4, all-new premium types. They utilize conventional 110° components and ircuitry. And, with only slight changes in focusing-voltage control, they are unilaterally nterchangeable with previous 110° types. RCA "VC" 110° types employ the same heater athode assembly that has been used and proven for reliability over the past decade in RCA Picture tubes.

So, when the need arises for a slim, *very compact* TV-set design, contact your RCA Field Representative. Your pass words are RCA "VC" 110° Picture Tubes. For technical data, vrite RCA Commercial Engineering, Section C-50-DE, Harrison, N. J.

**RADIO CORPORATION OF AMERICA**
***Electron Tube Division*** ***Harrison, N. J.***

**RCA FIELD OFFICES**

EAST: 744 Broad Street
Newark 2, N. J.
HUmboldt 5-3900

MIDWEST: Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.
WHitehall 4-2900

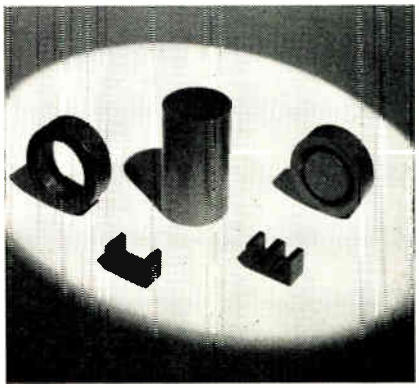
WEST: 6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

Circle 73 on Inquiry Card, page 123

# New Products

## MAGNETIC CORE FERRITE

Ferrite material, MN-31, has high initial and maximum permeabilities, high saturation magnetization, and low losses from 10 to 500 KC. Properties include: Initial Permeability

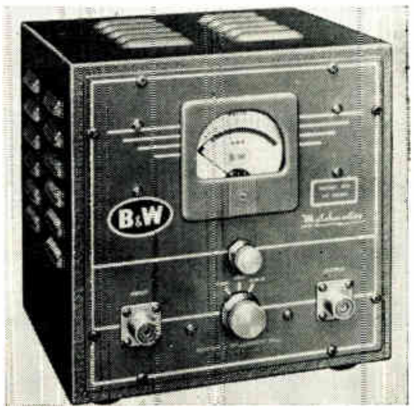


(at 21°C and 50 KC), 2100; Max. Permeability (at 2000 gauss), 13500; Flux Density (at 7 oersteds w/Rowland Ring Test Circuit and Fluxmeter), 4300 gauss; Flux Excursion (for 1 oersted), 3500 gauss; Retentivity ($B_r$), 1700 gauss. Coercivity ($H_c$), 0.13 oersted; Loss Factor ($1/\mu Q$) at 50 KC, 7.5 x $10^{-6}$, and at 500 KC, 30 x $10^{-6}$; Temperature Coefficient of Initial Permeability (%/°C), app. 0.2°C; Curie Temperature, over 180°C; DC Resistivity, 250 ohm-cm. Kearfott Co., Inc., 1500 Main Ave., Clifton, N. J.

Circle 257 on Inquiry Card, page 123

## DUMMY LOAD

The Matchmaster unit consists of a dummy load with direct reading r-f watt meter and standing-wave-ratio bridge (SWR). It is useful in electronic labs or factories for measuring the SWR in antenna feed lines, ad-



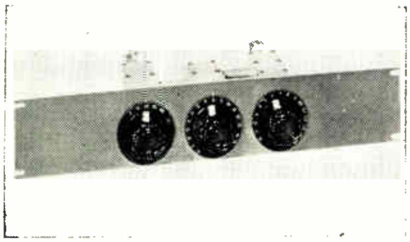

justment of radio transmitter power output before going in the air and many other applications. All components are contained in a cabinet 6 x 8 x 8 in. Barker & Williamson, Inc., Bristol, Pa.

Circle 258 on Inquiry Card, page 123

# New Products

## R-F ATTENUATOR

A 50 ohm, r-f Attenuator is a variable step attenuator which operate from dc to 500 MC. They are rotary adjustable. Each resistor is mounted in a cavity which eliminates reac-



tive components over the useful frequency range of the unit. The resistors are of a stabilized variety, precured to minimize long-term drift and installed to prevent element value shift due to soldering heat. Three types of 50 ohm units are available and 4 types at 75 ohm impedance. Combinations of up to 4 units can be supplied on standard 3½ x 19 in. rack mounted panels. The unit extends 5 in. behind panel. Ortho Filter Corp., 196 Albion Ave., Paterson 2, N. J.

**Circle 259 on Inquiry Card, page 123**

## GALVANOMETER AMPLIFIER

Galvanometer Amplifier, Model T6GA matches low power signals of 1 v. or more directly to high frequency, high current galvanometer oscillographs. Specifications include: Voltage gain: Adjustable from 0 to 1.0; output (37 ohm load): ±2.4 v. at 65 ma dc to 8 KC, limits at ±100 ma; output impedance: 2 ohms dc to 10 KC; controls: 6 gain controls, 1 power off-on switch; input impedance: 47 K; isolation: individually floating channels for use with un-


grounded loads; noise: less than 3 mv peak-to-peak; drift: less than 3mv/°F; power requirements: 115 v. ± 10 v., 50 to 440 CPS, 45 w. Minneapolis-Honeywell, Boston Div., 40 Life St., Boston, Mass.

**Circle 260 on Inquiry Card, page 123**



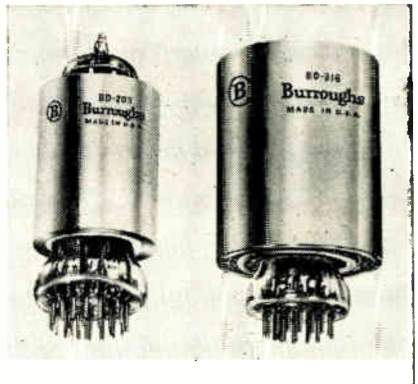


**Circle 87 on Inquiry Card, page 123**

## New Products

### BEAM SWITCHING TUBES

Miniature beam switching tubes, shielded (Type BD 316) and unshielded (Type BD 203), operate at transistor voltages, and retain the characteristics of regular beam

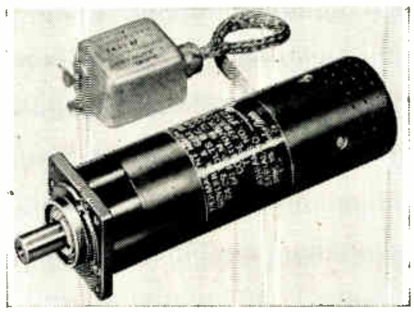



switching tubes. Dimensions are reduced by 35%. They may be used in direct contact with each other. They are 10 position tubes for distribution, counting, coding and decoding, sampling and conversion. Each tube may replace 20 or more transistors or other components. They can be arranged to switch in sequence or at random, can be preset to any position, and interconnected as distributors to any number of positions. Burroughs Corp., Electronic Tube Div., P. O. Box 1226, Plainfield, N. J.

**Circle 261 on Inquiry Card, page 123**

### CONSTANT SPEED MOTOR

High temperature, continuous duty, 1¼ in. PM governed motor with gear reduction and filter for precise timing applications, does not deviate more than 3% from 60 RPM with 60 oz. in. load and 24 to 29vdc supplied under any combination of the following MIL-E-5272 conditions: Temperature: −55°C to +122°C, procedure



I; vibration: Procedure 1; shock: Procedure II; acceleration: 10g, procedure I or II. Type 13 R-9102-00 also meets MIL I-6181B radio noise specs. John Oster Manufacturing Co., Avionic Div., 1 Main St., Racine, Wis.

**Circle 262 on Inquiry Card, page 123**

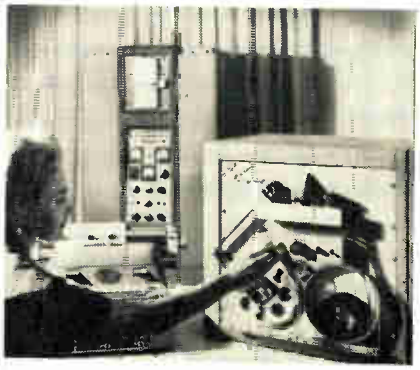
 Circle 88 on Inquiry Card, page 123 

Circle 111 on Inquiry Card, page 123

# New Products

## TAPE READER

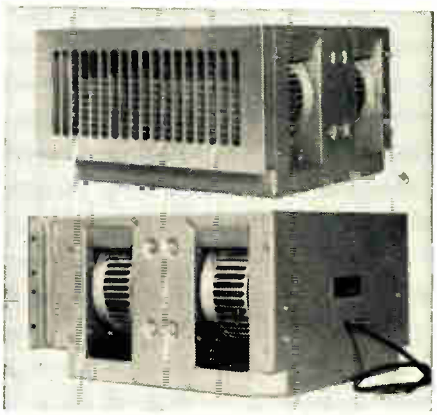
Photo-electric paper tape reader, Model PR-2, operates at 400 characters per sec and will stop or start on 1 character. Any 5, 6 or 7 channel numeric code can be read and translated to G-15 code. In addition to positive and negative numbers, the external code may include control characters and certain special characters. It will accept up to 500 ft. rolls of tape. While the G-15 computer is equipped with its own searchable, magazine loaded, photo-electric reader for data and program input, the PR-2 accessory extends input versatility by allowing entry of data from a wide range of recorders. Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.



Circle 263 on Inquiry Card, page 123

## RECESSED BLOWER

Two-speed packaged blower for use where side exhaust is required or where air is to be diverted into a duct system. The blower has a panel size 8¾ in. deep and fits standard 19 in. racks. It has an air delivery of 800 cfm at high speed and 600 cfm at low. The motor meets the intent of MIL-E-4158A. The filter is permanent; the grille stainless steel. The blower is normally used for bottom-rack mounting. McLean Engineering Laboratories, Princeton, N. J.



Circle 264 on Inquiry Card, page 123

## New Products

### TELEMETRY ANTENNA

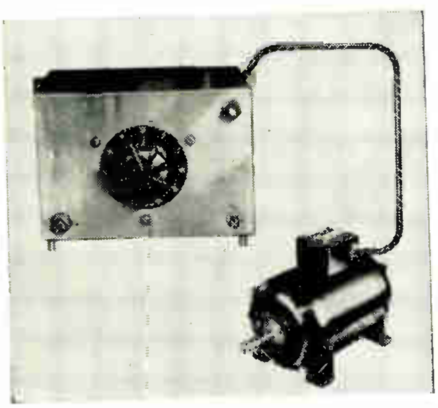
TACO G-1054 design features circular polarization, choice of helical feeds, a 6, 8 or 10 ft. dia. parabolic reflector, and a manually controlled mount for ground or vehicle installa-

tion. Gain is 23 to 26 db over an isotropic source, nominal beam width is 8° to 14°. Frequency range is 940-980 MC. VSWR of the complete antenna is less than 1.3. Azimuth adjustment is 360°; elevation adjustment 0-90°. Used for orbital and into-space telemetering or TV-Studio Transmitter Links (STLT) by feeding the dish with a 1990-2110 MC feed. Technical Appliance Corp., Box GC 38, Sherburne, N. Y.

Circle 265 on Inquiry Card, page 123

### ADJUSTABLE SPEED DRIVE

"Motorformer Series" adjustable-speed drives has 17 different models ranging from 1/20 to ¾ HP. All models feature smooth control from zero to maximum rated speed. Conservative rating of rectifiers and motors assures continuous operation at



any speed. The entire controlled rectifier is contained in a compact enclosure that is designed for either bench use or wall mounting. Servo-Tek Products Co., 1086 Goffle Road, Hawthorne, N. J.

Circle 266 on Inquiry Card, page 123



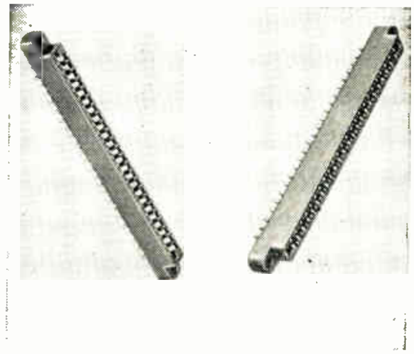


Circle 91 on Inquiry Card, page 123

# New Products

## CARD RECEPTACLES

Printed circuit card receptacle connectors, "RELI-ACON" have 24, 22, 18, 15 and 10 contact single side receptacles, and 48, 44, 36, 30 and 20 contact double side receptacles, all

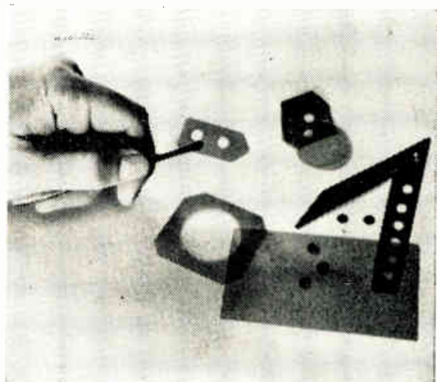


having 0.156 centers. They accommodate Class 1 (broad limits) tolerances on NEMA nominal 0.062 in. laminates. Maximum contact resistance is 4 mohm measured on a 0.054 in. card after insertion of a 0 074 in. card. The double side card receptacle maintains a minimum of 1 oz. per contact on a 0.054 in. thick card after 1000 insertions of a circuit board having a thickness of 0.074 in. Methode Mfg. Corp., 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 267 on Inquiry Card, page 123

## EPOXY MATERIAL

Epoxy material, "Filmex", is a tissue-thin epoxy sheet that can be die-cut, provides a bond exceeding 5000 lbs in shear strength and may be used for bonding practically any materials such as glass, ceramics, or metals and is not affected by temperatures to 400°F. A translucent ma-



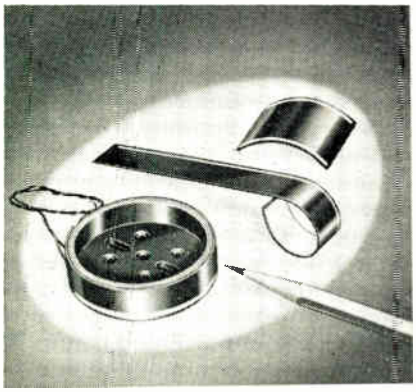
terial, it is completely flexible and ranges in thickne s from 0.0015 to 0.020 in. It melts in place at 200°F, and then is cured for 40 min. at 392°F. Mansol Ceramics Co., 140 Little St., Belleville, N. J.

Circle 268 on Inquiry Card, page 123

## New Products

### PHOTOCELLS

Three-dimensional selenium photovoltaic "contour photocells" can be shaped into almost any form, mounted on a rotating shaft in a position control servomechanism, or used as a

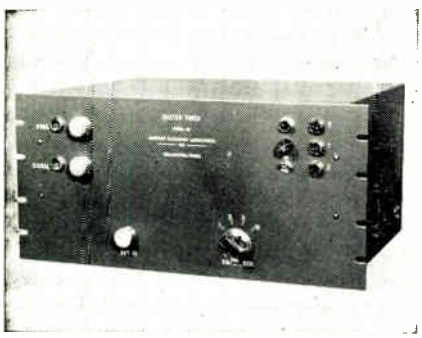


form of non-linear function generator, when formed into a photosensitive cam. These cells may be used in electronic photoelectric devices for control applications, production flow processes, and automatic inspection and sorting. They can be produced to any requirement (curved, cylindrical or other configurations) in 3-dimensional shapes with as little as 1 in. radius of curvature. International Rectifier Corp., El Segundo, Calif.

Circle 269 on Inquiry Card, page 123

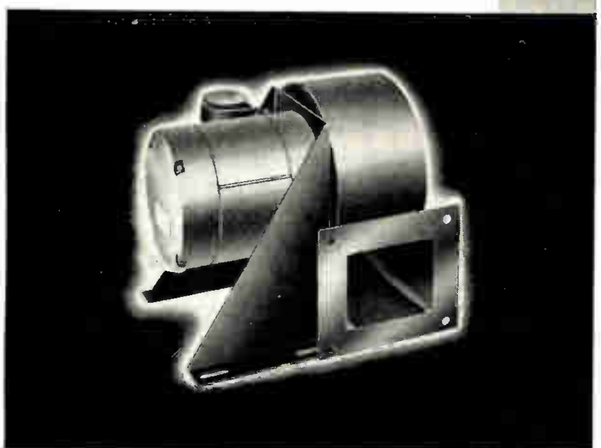
### RASTER TIMERS

Expanded sweeps have no loss of detail on either side of the observed event with the "101" Series Raster Timers, used to study phenomena occuring in time from 10 msec. to 50 sec. They provide a sweep raster of 10 traces on a dc oscilloscope. Traces are time calibrated with controlled markers. Bandwidth is dc to 200 KC. They are available in 2 models with



total sweep length from 10 ms to 100 ms and 1 sec. to 50 sec., and provide 5 in. scope tubes with about 40 in. of effective trace per raster. American Electronic Labs., Inc., 121 N. 7th St., Philadelphia 6, Pa.

Circle 270 on Inquiry Card, page 123

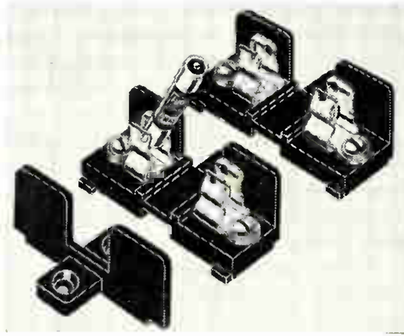




## New Products

### ADD-ON FUSE BLOCKS

Add-On Fuse Blocks, for protection of solenoids, small motors, or control apparatus on multiple circuit equipment, can be assembled into a block of any number of poles. The

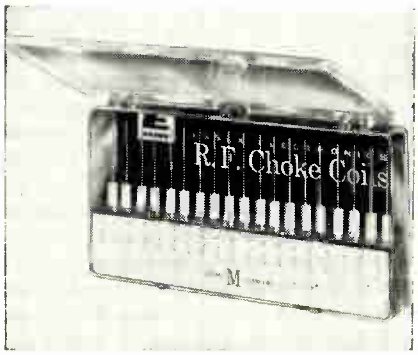


single pole blocks interlock and each unit is locked in place by a single screw. Additions may be made at either end. Poles may be added or removed without disconnecting terminal leads on other units. Each fuse may be a circuit disconnect. Clips permit raising one end of the fuse to a right angle position to the block. Bussmann Mfg. Div., McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.

Circle 271 on Inquiry Card, page 123

### CHOKE KITS

R-F chokes (63 chokes) in the prefered series of inductance values, packaged in 3 clear-plastic boxes for the immediate selection of choke parameters. Each kit has a block which holds the chokes in proper position, permanently mounted to a blackboard which contains complete technical data for each choke. Series "S" Kit has 19 chokes from 0.1 $\mu$H to 100 $\mu$H. Se-



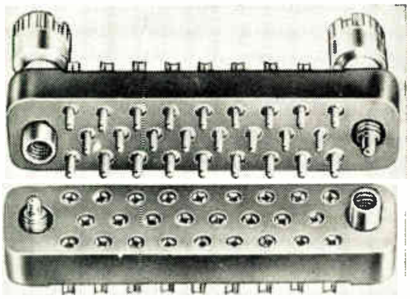

ries "M" Kit has 19 chokes from 1.0 $\mu$H to 1000 $\mu$H. Series "L" Kit has 25 chokes from 1.0 $\mu$H to 10,000 $\mu$H. Inductance values are preferred values. Essex Electronics, 550 Springfield Ave., Berkeley Heights, New Jersey.

Circle 272 on Inquiry Card, page 123

# New Products

## CONNECTORS

Series of subminiature precision connectors, SMI-C have a stainless steel reinforcing retainer under each screwlocking element to remove torque stresses from the molded

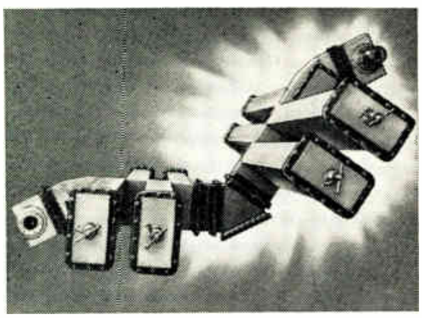


bodies. Positive re-entrancy of the male pins is assured each time by a flanged guide female contact. Self-alignment action is also assisted by provision of wider countersink on upper end of contact. They are available in contacts of 7, 11, 14, 20, 26, 34 or custom configurations. The connectors may be used for critical environmental conditions and extremes of military applications. U. S. Components, Inc., 454 E. 148th St., New York 55, N. Y.

**Circle 273 on Inquiry Card, page 123**

## DUPLEXER

Duplexer has a reject attenuation greater than 100 db. Designed for operation in the 755 to 985 MC band, it is especially suited to tropospheric scatter applications. The duplexer enables the same antenna to be used simultaneously for both transmitting



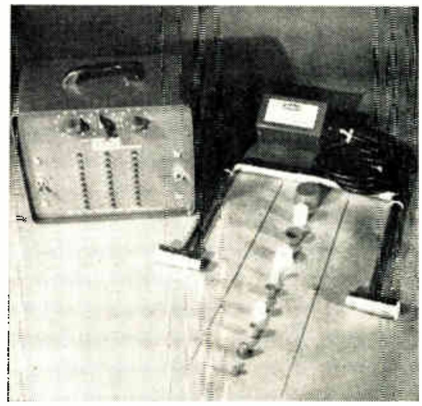
and receiving. It is made of high strength aluminum alloy. The transmitter and receiver ports are equipped with transitions which are fitted with coaxial inputs. D. S. Kennedy & Co., Cohasset, Mass.

**Circle 274 on Inquiry Card, page 123**

# New Products

## SOLID STATE COUNTERS

Totalizing and predetermined electronic counters for laboratory or production control. Solid state and cold cathode components in the circuitry eliminate warm-up time and tube re-

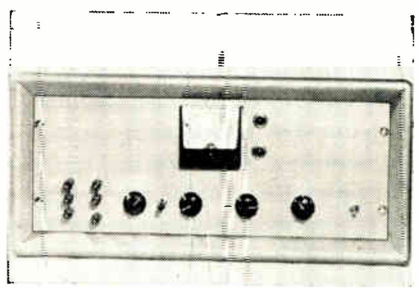


placement. Unit has no moving parts. The 3, 4, or 5-decade counters measure 9 x 7 x 6 in.; weight about 7 lbs. Available accessories include: magnetic pick-ups, infra-red beam pick-ups, stylus pick-ups and impulse shaping pre-amplifiers. These accessories obtain operating power from the counter itself. Instrument Div., Redford Corp., Lake Luzerne, N. Y.

Circle 279 on Inquiry Card, page 123

## MAGNETIC CORE TESTER

Production and laboratory instrument, Model RK-100 for testing tape wound cores, ferrite cores, and relays. Two units may be operated synchronously for core plane and coincident current testing. Features include: 2.0% meter for rough settings—precision resistors for current measurements—0.1 ma. to 1.0 a. current pulses—0.1 μsec to 1 msec cur-

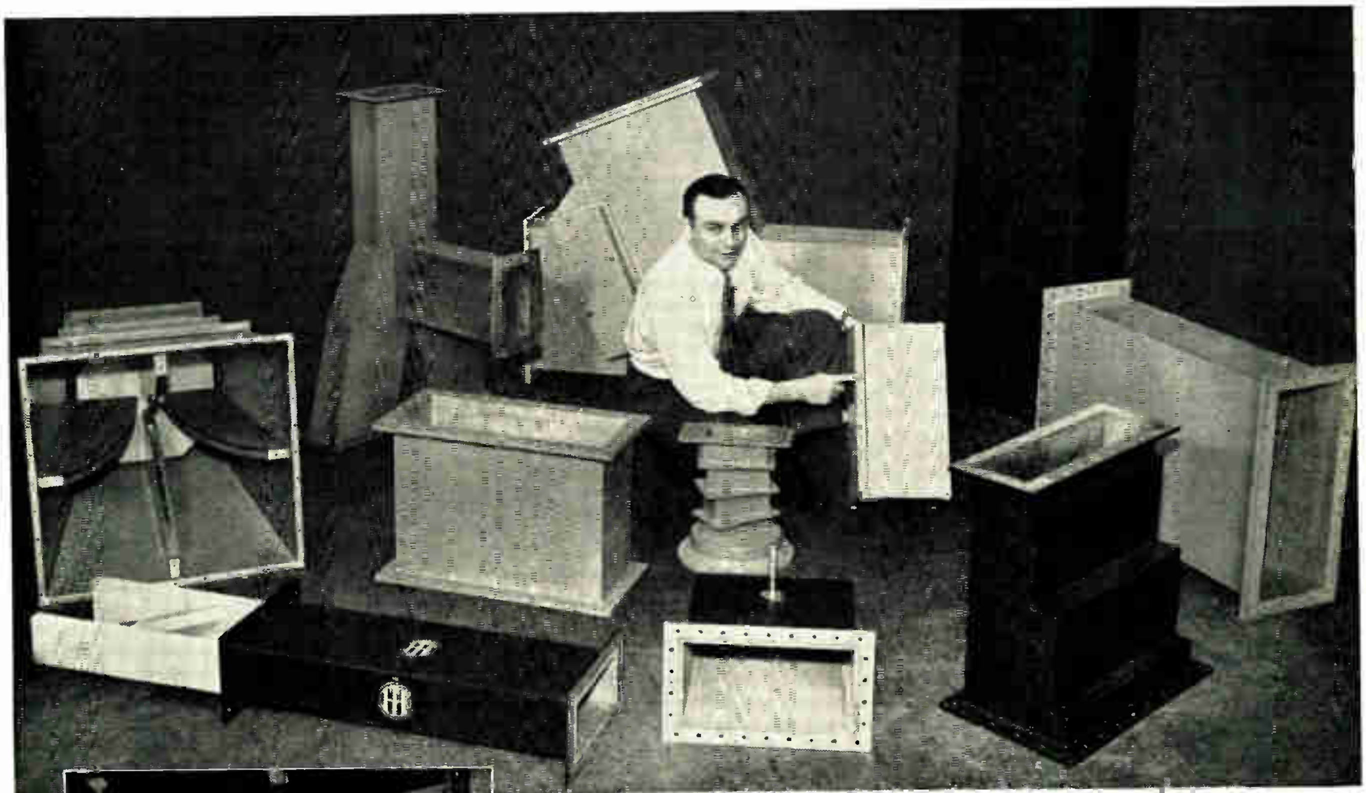


rent rise time—9 pulse logical patterns—handling of switching times to 35 msec—requires only 1 winding on core being tested. Arkay Engineering, Inc., 225 Santa Monica Blvd., Santa Monica, Calif.

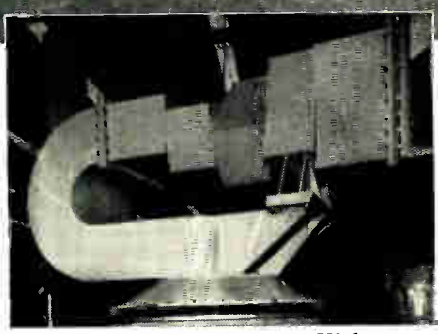
Circle 280 on Inquiry Card, page 123

# NEED LARGE WAVEGUIDE?

## Look to I-T-E to meet all your needs: conventional types or special designs

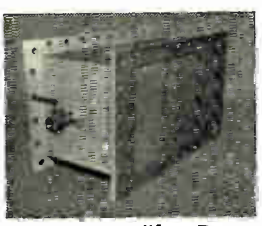


**A complete large waveguide service.** These units reflect I-T-E's design and production capabilities with large waveguide. Noncontacting short circuit section shown is available with servo-controlled motor drive. For proper electrical continuity, all waveguide flanges are held to 0.001 in. flatness (total indication) . . . are perpendicular within 0.030 (for two flanges, total indication). Available in sizes WR770 through WR2300.



**Rotary joint and step twist.** High-power rotary joint designed for low VSWR. Binomial stepped 90° twist has 1.02:1 VSWR over wide band.

**Waveguide transformer** features low VSWR, high power, economy.



**Gas barrier** utilizes Rexolite window for maximum RF transmission.

I-T-E is staffed and equipped to meet your requirements for large waveguide used in multimegawatt radar and scatter communications systems. For conventional needs, I-T-E manufactures an extensive line of standard configurations. And where special problems exist, depend on I-T-E waveguide engineers to originate special designs exactly suited to your wants and at reasonable cost.

Productionwise, I-T-E can provide faster deliveries, thanks to its fully equipped waveguide shop. Custom-designed tools and fixtures assure both flaw-free fabrication and production-line efficiency. Every step—from the initial sheet metal work to final finishing—is performed under one roof . . . under one responsibility. You benefit from lower VSWR, plus maximum strength with lightness and economy.

Let I-T-E's broad design experience and unique production facilities work to solve your waveguide problems. Address your inquiries to I-T-E's Special Products Division. And ask for your copy of free-space vs. guide wave lengths conversion tables for large waveguide.

**I-T-E CIRCUIT BREAKER COMPANY**
**Special Products Division • 601 E. Erie Avenue • Philadelphia 34, Pa.**

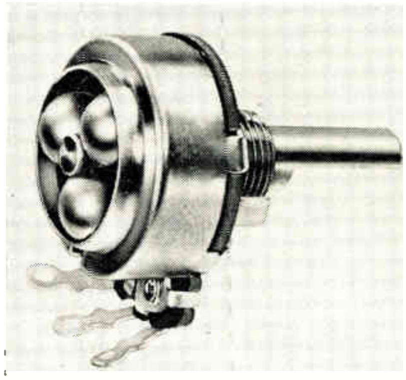


Circle 97 on Inquiry Card, page 123

# New Products

## VARIABLE RESISTOR

Vernier variable resistor has ball bearing rotation for fine tuning applications. Contact arm rotates 1° per 13.5° shaft rotation. Total contact arm rotation is 300° ±5°. Total shaft



rotation approximately 4000°. Type VA-45 is 15/16 in. dia., ¼ to ½ w. Resistance range is 250 ohms through 10 megohms (linear taper). Voltage rating across end terminals is 500 vdc and voltage rating bushing to terminals 1000 volts ac for 1 min. hi-pot test with 750 vdc operating maximum. Chicago Telephone Supply Corp ration, Elkhart, Ind.

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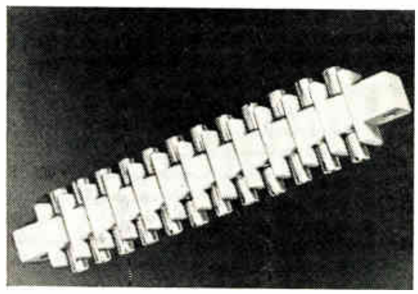
## TERMINAL BLOCKS

Type 7TB12, through-connection terminal block, is made to Navy drawing 9000, S6505B, 73214, Rev. H. It provides feed-thru conections top and bottom, and comes in several different lengths and number of terminals. It is moulded of glass-filled Alkyd plastic (Type MAI-60) as per MIL-M-14E. The moulded-in threaded studs are



of manganese-bronze. It is supplied with slotted brass nuts made to specifications, packaged separately or supplied assembled. Kulka Electric Corp., 633-643 So. Fulton Ave., Mt. Vernon, N. Y.

**Circle 276 on Inquiry Card, page 123**

## New Products

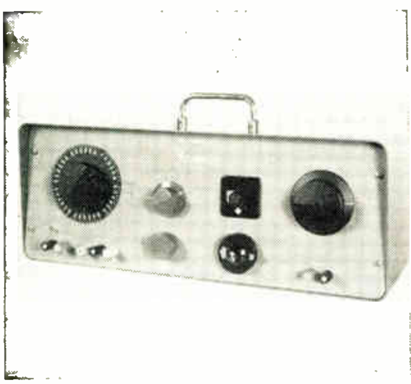
### FIELD INTENSITY RECEIVER

Calibrated microwave field intensity receiver for measurements of microwave power in the 1000 to 10000 MC freq. range, measures the absolute level of radiated or conducted interference, and the susceptibility of other instruments and components to such interference. It features 4 interchangeable plug-in tuning units, Simultaneous tuning of the receiver and signal calibrator; a calibrated meter for r-f signals; audio, video and recorder outputs; and an aural tuning aid circuit for detecting weak or unmodulated signals. Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y.

**Circle 277 on Inquiry Card, page 123**

### SYSTEM ERROR BRIDGE

Theta-Bridge measures the angular position of any synchro or resolver inaccessibly located within a complex system without any mechanical coupling. It is also used to simulate a perfect synchro or resolver input to a system. Three dials display angular position digitally to three decimal places over a 360° range. Specifications: Accuracy, 10 seconds of arc. Readability, 0.001°. Size, 19 in. wide by 10½ in. high by 8 in. deep. Theta Instrument Corp., 48 Pine St., East Paterson, N. J.

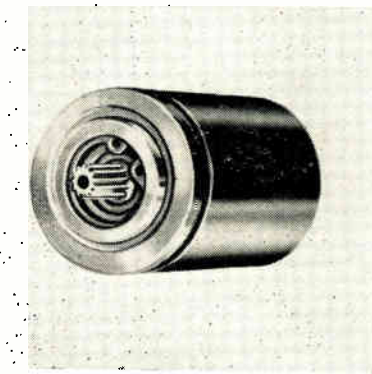


**Circle 278 on Inquiry Card, page 123**

## New Products

### SERVO MOTOR

Size 8 servo motor for transistorized applications in aircraft and missiles, the BT 705-1, features a high torque to inertia ratio, short length, Control phase has a high-impedance center-



tapped winding for transistor use, and develops 0.33 oz. in stall torque in a standard size 8 BuOrd frame. The 2-phase winding is 26 v. on the fixed phase and the center-tapped control phase is 20/0/20 v. Power input is 2.7 w/phase at stall; operating temperature range —55°C to 150°C; speed at max. power output 3500 RPM; rotor moment of inertia 0.65 gm. cm², and weight 1.6 oz. Meets Mil Specs. Induction Motors Corp., 570 Main St., Westbury, N. Y.

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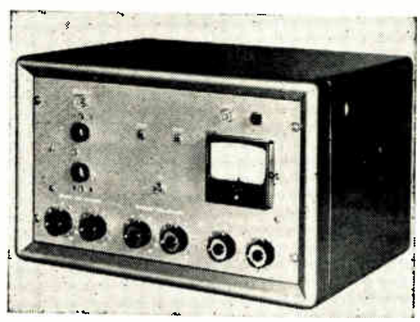
### TIME SEQUENCE CONTROL

Control instrument for time interval testing of components is completely automatic, eliminates operator errors, and makes possible repeatability of test readings. It may be set to control 3 separate timing operations simultaneously. Operating on 3 channels, the standard instrument handles any time up to 130 sec. on the selected channels. The instrument may be equipped with an auto-



matic reject alarm, or a measuring meter relay. Originally designed for laboratory work, it may be used for line production testing. Mid-Eastern Electronics, Inc., 32G Commerce St., Springfield, N. J.

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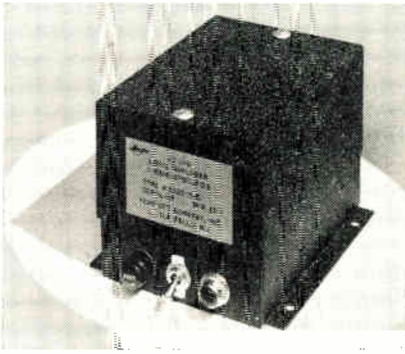
## New Products

### SERVO AMPLIFIER

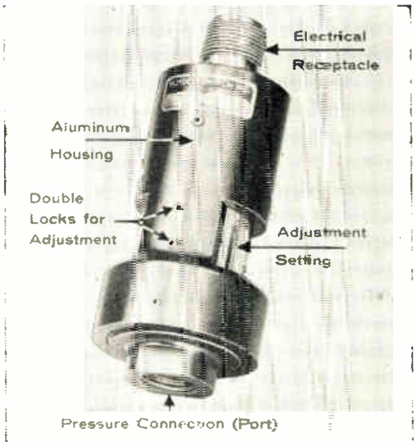
Transistorized Model A3300-01 has an internal dc power supply and provides 90° phase shift. Power supplied to the load is in pulse form of constant amplitude, and width, or



time duration of the pulse is proportional to the amplitude of the input signal. Gain is established at values between 80 and 1600, with external resistors. It may be modified for 400 CPS where max. power input is 16 w. Input impedance is 5 K-100 K ohms; signal frequency, 60 CPS; max. signal input, 30 v. RMS; voltage output, 40 v., 60 CPS. Kearfott Co., Inc., 1500 Main Ave., Clifton, N. J.
Circle 283 on Inquiry Card, page 123

### PRESSURE SWITCH

Pressure Switch/Transducer, Series 1500, is for use in aircraft, missiles and rockets. Moving parts are contained in an aluminum housing, environmentally-sealed by O-rings, at each end. It can sense pressure levels of from 0.5 to 4,000 psi. Eight switches cover the pressure span. Exact calibration is obtained with an external adjustment, which is locked by 2 set




screws. Meets MIL-E-5272A. Assembly is resistant to corrosive operating media. Optional mounting bracket provides vibration isolation up to 2,000 CPS and up to 50 g's. Haydon Switch, Inc., Waterbury 20, Conn.
Circle 284 on Inquiry Card, page 123

## New Products

### TRANSFORMER KIT

Miniature, Pulse Transformer Lab Kit has 10, 3-winding pulse transformers providing pulse widths from 0.1 to 10 μsec. Range can be extended to 40 μsec. The first 2 windings of all transformers are in a 1-to-1 ratio. On 6, the 3rd winding is in a 1-to-1 ratio with 3 taps, and on 4, the 3rd winding is in a 1-to-5 ratio with 3 taps. A combination of 20 different ratios is possible. Designed for blocking oscillator circuits, computer circuits, and interstage coupling. High permeability, low-loss cores are used. They plug into a standard miniature 9 pin tube socket. New York Transformer Co., Alpha, N. J.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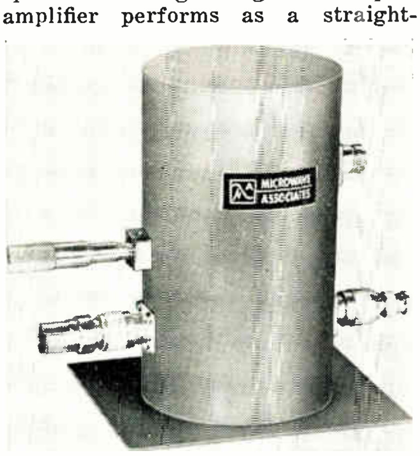
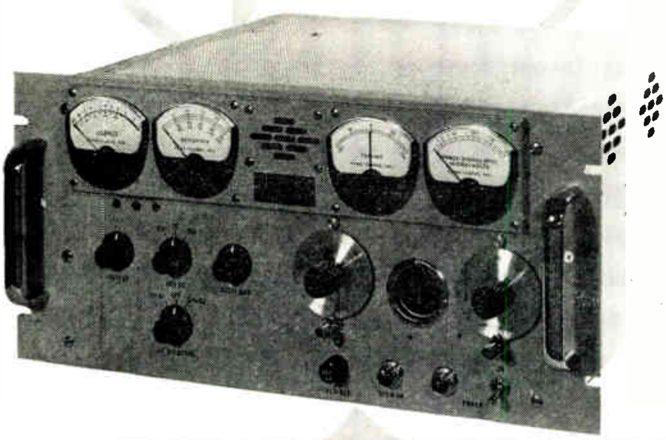
### PREAMPLIFIER

Low noise, parametric r-f, preamplifier, Model MA-1C, when coupled to conventional UHF receivers (350-500 MC band) achieves low noise performance. Overall receiver noise figures below 1.0 db (approximately 80° Kelvin) are achieved with bandwidths of approximately 1% through the specified tuning range. The preamplifier performs as a straight-through parametric low noise amplifier with r-f output obtained at the signal frequency. It is normally used in conjunction with an existing receiving installation. Microwave Associates, Inc., Burlington, Mass.




Circle 286 on Inquiry Card, page 123









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Circle 106 on Inquiry Card, page 123

## New Products

### RADIATION DOSAGE METER

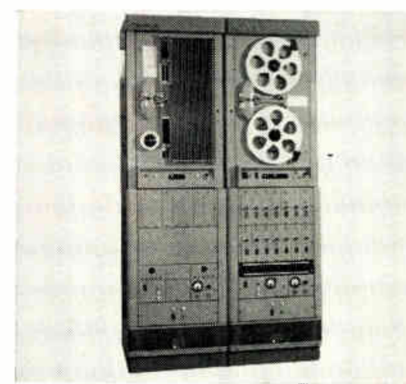
Model AEI-101 determines the total



## New Products

### RECORDER/REPRODUCER

Magnetic tape continuous-loop recorder/reproducer Type 5-781 for repetitive study of highly transient data, random occurrences, and time-delay applications, provides selective

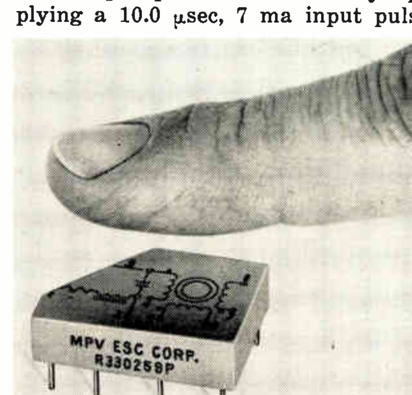


or simultaneous erase for 14 analog, FM, or PDM record/reproduce channels. It is compatible with the Type 5-752 reel recorder. Featured are: full-speed operation at 60 IPS in less than 1 sec., full stop in less than 0.5 sec., simplified tape threading, automatic tape tensioning, and closed-loop tape drive, for precise control of tape movement over the magnetic read/write heads under the drive capstan. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle 289 on Inquiry Card, page 123

### SHIFT REGISTER

Miniature Shift Register, Model SR-104, is a one-core-per-binary-bit unit with a 5 KC information rate and a signal-to-noise ratio of 10:1. The operating temperature range is from −55°C to 125°C. A 14.0 μsec, 22v. output pulse is obtained by applying a 10.0 μsec, 7 ma input pulse



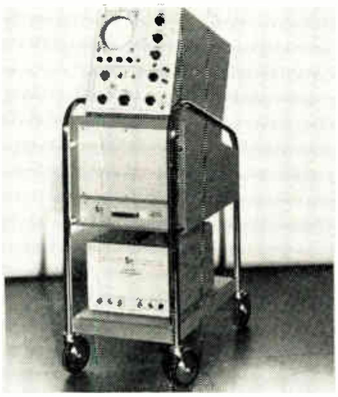

and subsequently an 8.0 μsec., 300 ma shift pulse. It is encapsulated in an epoxy compound and occupies 0.2 cu. in ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.

Circle 290 on Inquiry Card, page 123

## New Products

### OSCILLOSCOPE

Type 507 oscilloscope is designed for high-voltage surge testing. CR tube vertical-deflection factor is app. 50 v/cm at 24-kv accelerating potential. The 10-step input switch selects

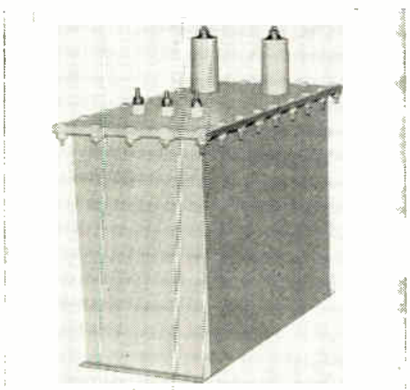


attenuation of 10% of the input signal per step; has a 72-ohm characteristic impedance. Vertical-input system withstands crest voltages of 3 kv of the standard 1.5 by 40 μsec surge testing waveform. It has 11 calibrated sweep rates: from 20 mμsec/cm, to 50 μsec/cm. Sweeps can be triggered internally or by external signal and can be operated single-shot. Tektronix, Inc., P. O. Box 831, Portland 7, Ore.

**Circle 291 on Inquiry Card, page 123**

### POWER SUPPLY

Model PS-30T, 30 kv dc., full-wave voltage-doubler type, power supply, operates on 117 v., 60 CPS or 400 CPS input; delivers 1 ma. continuous and 1.75 ma. peak current. Ripple is 1.5% at 1 ma. and regulation is approx. 7% from no load to full load. The unit incorporates 1B3 rectifier tubes



and FCI plastic dielectric capacitors, is hermetically sealed and oil filled. It is housed in a 5¼ x 11⅜ x 9½ in. case with oil-tight, solder-seal terminals. Film Capacitors, Inc., 3400 Park Ave., New York 56, N. Y.

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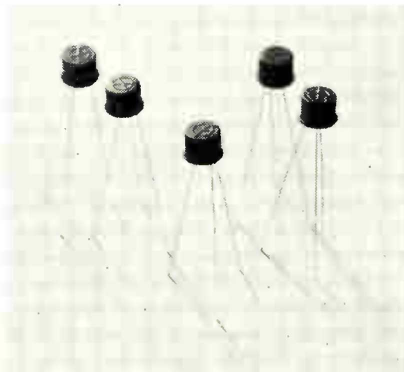
# New Products

## SILICON TRANSISTORS

Types 2N1131 and 2N1132 are pnp silicon transistors closely matching the 2N696 and 2N697 types. Typical rise time is 80 milli-micro-seconds. Dissipation ratings are 2 watts at

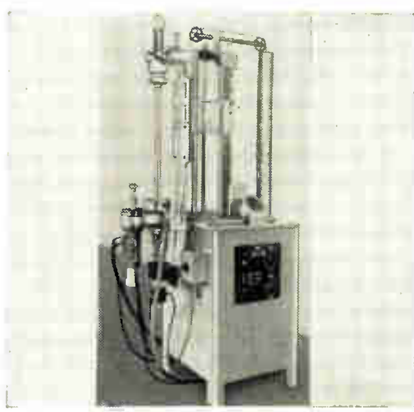


25°C and 1 watt at 100°C. Existence of these closely related devices of opposite polarity affords opportunities for circuit designs based on complementary symmetry. Fairchild Semiconductor Corp., 844 Charleston Rd., Palo Alto, Calif.

Circle 293 on Inquiry Card, page 123

## FLOATING ZONE FIXTURE

Floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacuum or inert gas. Designed for production, the Model HCP provides flexibility for lab studies. Featured are: Continuously variable up, down, and rotational speeds, independently control-



led, and an arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Lepel High Frequency Labs., Inc., Woodside, N. Y.

Circle 294 on Inquiry Card, page 123


## the *most* dramatic development in indicator tube history

Another electronic achievement by Burroughs Corporation provides extended tube life, by thousands of hours, for the new ultra long life Nixie indicating tube. This latest technical advance is the result of a new manufacturing process and a special combination of inert gases in the tube bulb.

There are three distinct ultra long life Nixie tube sizes available — miniature, standard and super. These complement the regular line of Nixie tubes where extraordinary life is required.

Continued pioneering in the development of indicating tubes coupled with extensive production facilities has enabled Burroughs to develop the most "perfect" in-line indicating tube ever mass produced.

The Nixie tubes are gas-filled, cold-cathode, ten-digit ("0" thru "9") numerical indicator tubes having a common anode. They are **all electronic**, in-line readout devices which provide an ideal means of converting electro-mechanical or electronic signals directly into readable characters.

**NIXIE Tube Exclusive Features:**

- **All Electronic**
- **Lowest Cost**
- **Lowest Power**
- **Lightest Weight**
- **Most Readable for Number Size**
- **Smallest Volume any Number Size**
- **Maximum Temperature, Shock and Vibration Specs**
- **And Now, Longest Life**

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Circle 46 on Inquiry Card, page 123

ELECTRONIC TUBE DIVISION

*Plainfield, New Jersey*

EN

# New Products

## PHASE SHIFTER

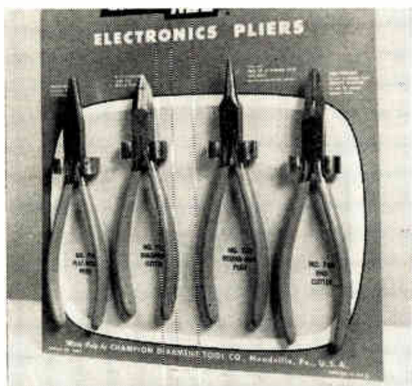
Phase Shifter, Type Q-4, 400 CPS, provides any phase shift from 90° leading to 90° lagging for testing electronic equipment and control circuits, watthour meters, rotating

standards, wattmeters, power-factor indicators, induction relays, and instrument transformers. Direct-reading scales on the instrument, are calibrated in deg. for the electrical angle of displacement and in corresponding power-factor values. True-power-factor can be read directly. Ratings are: 1000 va continuous duty; input 120/240 v.; output, 120 or 240 v, 3 phase. Knopp Inc., 1307 66th St., Oakland 8, Calif.

**Circle 295 on Inquiry Card, page 123**

## ELECTRONIC PLIERS

Channellock pliers are designed for all types of electronics work. Features include slender, long-reach jaws and handles, precision-matched jaws and points, hand-honed specially hardened cutting edges and easy-to-handle blue plastic-coated grips. This line includes a flat-nose plier, a diagonal cutter with wire-stripping notch, a




round-nose plier and a long-reach end cutter. The pliers are forged from high grade, properly heat treated steel and have a full-polished finish. Champion DeArment Tool Co., Meadville, Pa.

**Circle 296 on Inquiry Card, page 123**

## New Products

### JUNCTION TRANSISTOR

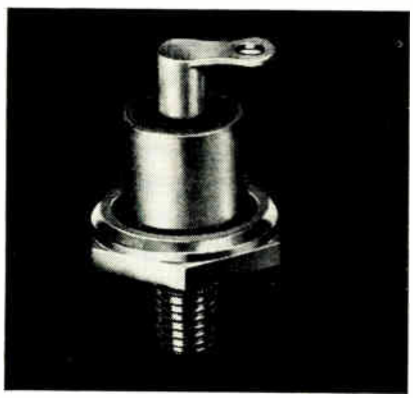
The 2N1010, transistor, for AF amplifiers, is a germanium alloy-junction transistor, npn type, suited for use in the input stages of high-fidelity preamplifiers, tape recorders,


microphone preamplifiers, and hearing aids in which low noise factor is important. Designed to operate from extremely small input signals, it has a noise factor of 5 db with a generator resistance of 1000 ohms and an integrated noise bandwidth of 15 KC. Typical small-signal current gain is 35. Alpha-cutoff frequency is 2 MC. Semi-conductor and Materials Div., Radio Corp. of America, Somerville, N. J.

**Circle 297 on Inquiry Card, page 123**

### SILICON RECTIFIER

Types 6A, a 20 a. silicon power rectifier, is for high temp service at voltages from 50 to 400 v. It will carry a full 20 a. load in half-wave circuits and up to 60 a. in bridge circuits. It may be operated at ambient temperatures up to 165°C and is unaffected by storage temperatures



from −65°C to +200°C. It has a standard 14-28 threaded mounting stud and may be mounted in any position. The entire unit is hermetically sealed. Fansteel Metallurgical Corp., Dept. EIP, North Chicago, Illinois.

**Circle 298 on Inquiry Card, page 123**

# New Products

## TEST SETS

Series 5700 DC Hypot tests high voltage electronic tubes, cables and bushings, and the dielectric strength of insulating materials to ASTM standards. Controls are located on a

waist high panel sloped for easy reading. Two 4½ in. meters on the panel indicate output voltage and leakage current. Safety features are incorporated. The output test potential is continuously variable from zero to maximum and indicated by metering directly in the final output. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

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## SIGNAL GENERATOR

Portable, Standard Signal Generator, Model 560 — FM, is designed for the mobile communications industry. It provides frequency modulation from an internal 1000 CPS source or can be modulated externally up to 15 KC. Direct reading individually calibrated scales cover frequency ranges of 25-54, 140-175, 400-470, and 890-960 MC. A fine frequency control is provided capable of varying carrier

frequency ± 8 KC. Peak deviation to ± 16 KC is read directly on a meter. Output can be varied from 0.1 to 100,000 µv across a 50 ohm termination. Measurements Div., McGraw-Edison Co., Boonton, N. J.

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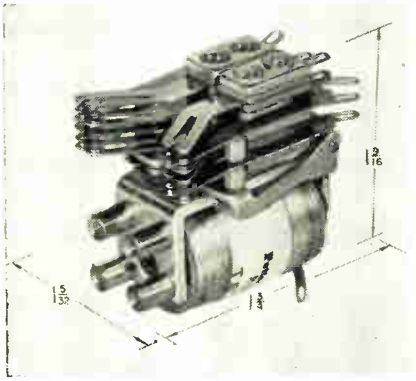
## New Products

### SHORT COIL RELAY

Modified version of the short coil TS telephone type relay features bifurcated contact arms with as many as 20 arms per relay (10 arms per stack). The TS operates on as little



as 100 mw per movable arm and can be furnished to operate on voltages up to 110 vdc. It will switch up to 4 a. at 155 v. 60 CPS, resistive loads. It is mounted with tapped #4-40 studs on ⅜ x ⅝ in. centers, and measures 1¾ in. long x 1 5/32 in. wide x 1 9/16 in. high. Weighs app. 3 oz. Relays are furnished with pierced solder lugs or taper tabs. Potter & Brumfield, Inc., Princeton, Ind.

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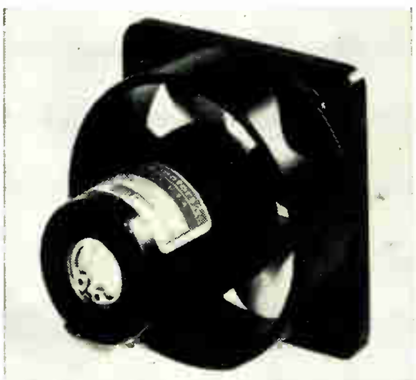
### AXIAL BLOWER

Miniature Tubeaxial fan, Model S2223-3 for spot cooling equipment in restricted spaces, uses a 1 in. dia. motor, at 16,500 RPM, deliver 40 CFM at 0 in. S.P., operates from 200 v, 3 phase, 400 CPS. It can withstand ambient temperatures of up to 125°C with a minimum life of 2000 hrs. It meets MIL-E-5272. It passes shock, vibration, salt spray (50 hrs), hu-



midity (10 days), and fungus (28 days) while having a 1500 v. hi-pot for 1 min. and performance tested after each phase of environmental testing. Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I., N. Y.

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# New Products

## SWEEP OSCILLATOR

Magna-Sweep, an all-electronic sweeping oscillator, has sweep widths of 1000 MC and wider. Frequency range is 5MC to 1000 MC. It may be used for standard frequency align-

ment procedures for TV, radar, or communications systems. Specs include: Sweep width, 1000 MC, continuously variable over frequency range; Center frequency, variable through frequency range; Sweep rate, variable around 30 CPS; r-f output, 0.1 v. across 50 ohms (min.); Sweep output, regular sawtooth, amplitude approx. 20 v.; Frequency markers, frequency marks plus a precision wavemeter. Kay Electric Co., Dept. E.I, Maple Ave., Pine Brook, N. J.

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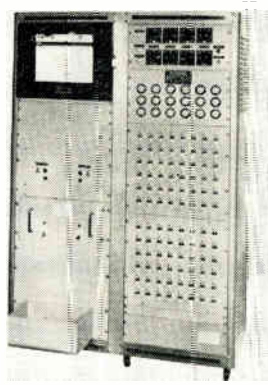
## STRAIN GAGE PLOTTERS

Models 220 and 221 are for plotting structural tests and engine load tests. They can scan and record up to 20 channels/sec. and plot up to 96 channels. They automatically plot individual graphs for each channel while the test is in progress. There are 3 zero positions/channel, separate range selectors and gage factor selectors. Switching is accomplished by



heavy-duty rotary type multideck switches. They can be modified for millivolt inputs such as thermocouples. Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland.

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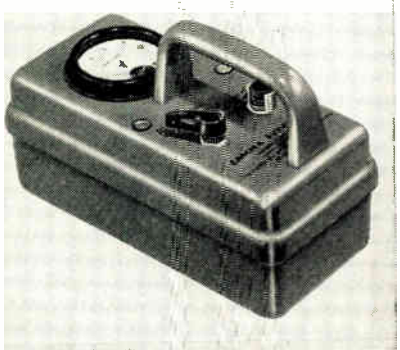
### GAMMA DOSE RATE METER

Model 592B determines leakage and true dose rate associated with X-ray installations; radioisotopes in laboratories, hospitals and industrial plants; and for radiation dosage



measurements by regulatory agencies. The unit has two controls: a range switch and a zeroing knob, and a 3-in. meter. The zero knob is protected against inadvertent movement. High impedance circuitry is hermetically sealed and range switching is performed in the low impedance portion of the circuit. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

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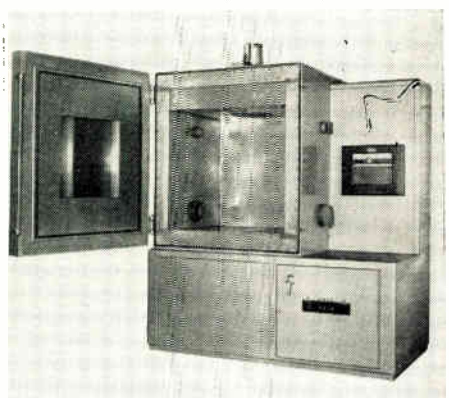
### TEST CHAMBER

Model FB-30-5-5 temperature testing chamber has interior dimensions, 40 x 38 x 36 in. Features are: standard range +300° to —100°F; viewing window, 24 x 24 in.; cascade system with Freon-13 and Freon-22; adjustable input controls. Performance: room temperature to +70°F in 38 min.; —70°F to room temperature in 13 min. Heat dissipation up to 2 kw



at —70°F. Temperature to —100°F can be attained in less than 1 hr. Chamber interior is stainless steel. Control within 2°F of set point is standard. Conrad, Inc., 141 Jefferson St., Holland, Mich.

**Circle 356 on Inquiry Card, page 123**


At the zero second everything must function without failure. ANDREW HELIAX cable is used in postassembly and preflight checkouts of missile radio frequency systems. The cable forms a closed circuit over which interrogation and response signals are transmitted between checkout equipment and airborne radio frequency packages. The HELIAX cable runs from a mobile trailer to connecting points on the missile.

The ruggedness of HELIAX makes it well suited to this challenging task, where its low VSWR, low RF leakage and low attenuation give accurate measurement of systems performance. Flexibility permits the cable to be taken down, recoiled and subsequently reused many times.

If you require similar characteristics in a cable, consider the special advantages of HELIAX.

HELIAX is normally supplied as an assembly, complete with end fittings factory attached, reducing installation labor and improving quality.

Complete uniformity throughout its entire length gives HELIAX *superior* electrical characteristics.

HELIAX is always less difficult, less costly to install, *easier to handle.*

HELIAX is available in ⅞" size (Type H0) and 1⅝" size (Type H1).

WRITE FOR FREE SAMPLE LENGTH

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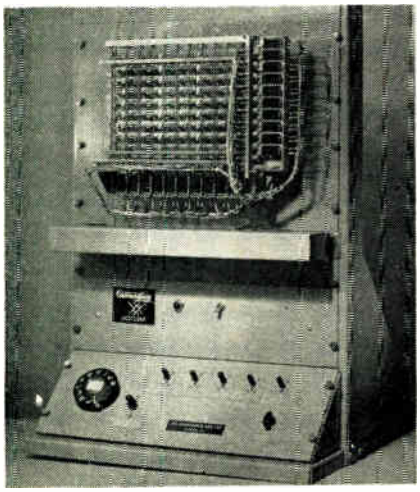
## New Products

### CROSSBAR SCANNER

Model SC-4, Self-Stepping Crossbar Scanner with optional remote dial control, is basically, an F Crossbar Switch with simplified drive circuitry for connecting sequentially a 6-wire

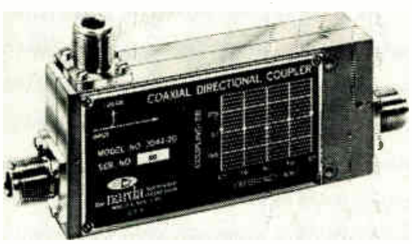


circuit with each of 100 sets of 6-wire terminals, at speeds up to 50 sets per second. It is designed for fast, quiet operation without adjustment over millions of operations, with low crosstalk between adjacent circuits at frequencies up to 10 megacycles. James Cunningham, Son & Co., Inc., P. O. Box 516, Rochester 2, N. Y.

**Circle 357 on Inquiry Card, page 123**

### COAX COUPLER

Flat coaxial couplers limit frequency response variation to 0.2 db over a full octave and present a deviation of mean value from nominal of ±0.3 db. Five calibration points on the nameplate form a curve for determining intermediate points. Calibration accuracy is ±0.1 db. Connectors are Series N female, with others available. Six models, 3040 through 3045, cover frequency bands from 240 to 11,000 MC with a nominal coupling value of 20 db; 4 models




have 10 db values, covering 500 to 8000 MC. Primary VSWR is 1.1 to 1.25, and secondary VSWR is 1.2 to 1.3, depending on the model. Narda Microwave Corp., 118-160 Herricks Rd., Mineola, N. Y.

**Circle 358 on Inquiry Card, page 123**

# New Products

## TV CAMERA

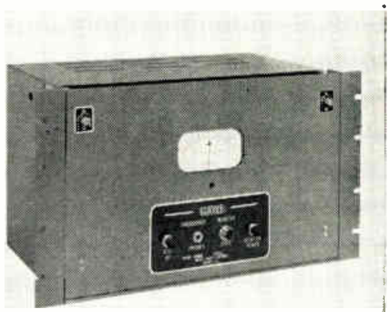
TV camera, Model 1986CN, can operate in noise environments up to ±145 db without an acoustical housing. It has been used in sound levels above 190 db. Applications include

use on rocket or jet engine test stands. It features a video-signal amplifier with subminiature tubes mounted in a heat sink. It provides full 600-line resolution. Used with a camera control unit, it automatically adjusts to changing light conditions over a 2000:1 range. Kin Tel Div., Cohu Electronics, 5725 Kearny Villa Rd., Box 623, San Diego, Calif.

Circle 246 on Inquiry Card, page 123

## FREQUENCY MONITOR

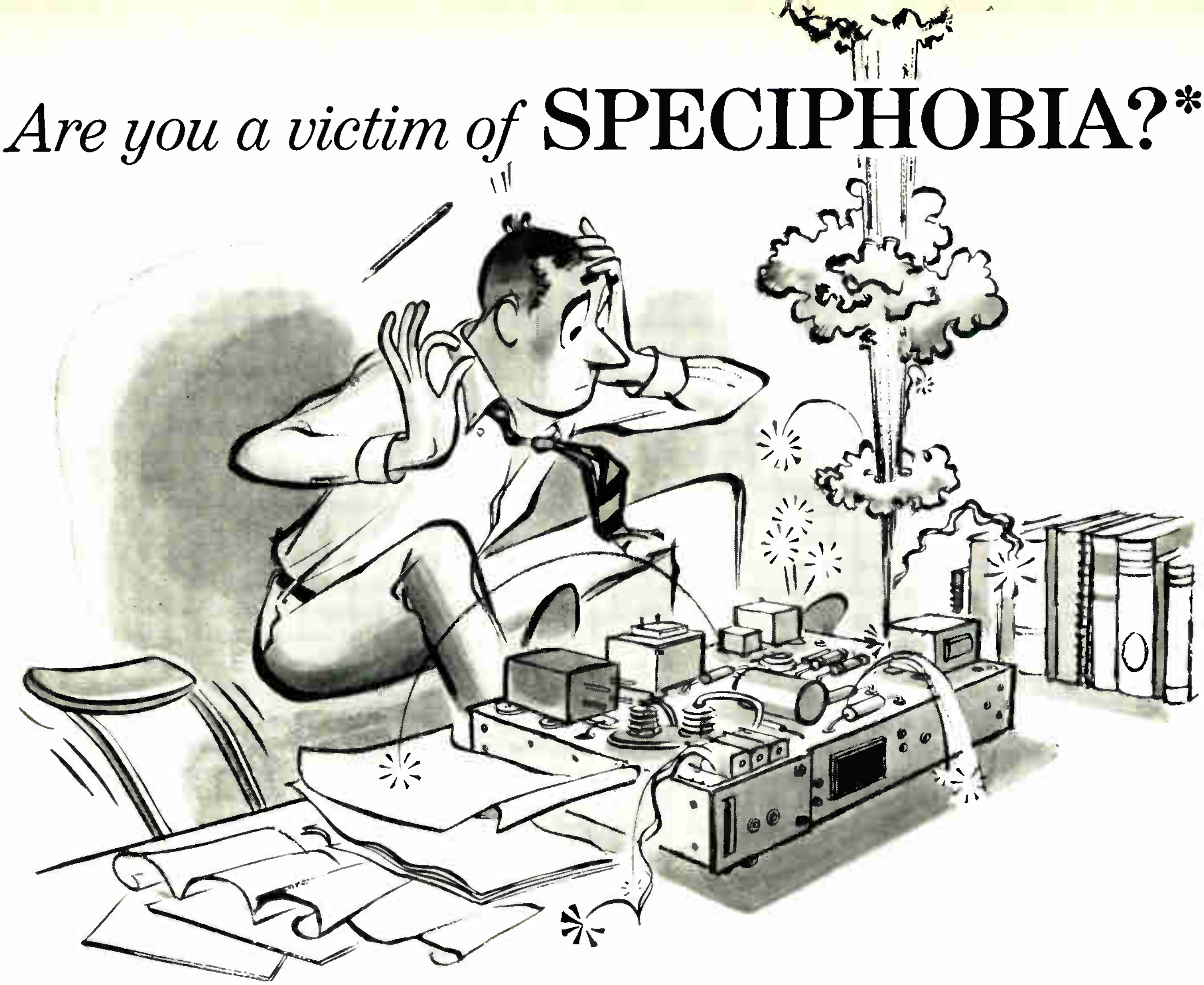
AM frequency monitor guards transmitter frequency with an accuracy of ±2 ppm. Printed circuits aid in precision monitoring. A vacuum-type crystal unit eliminates air gap adjustments and speeds installation. A blanket heater provides even heat distribution to crystal and oscillator components. The signal may be



connected direct to the monitor, or transmitter 20 miles or more from remote control (unattended) transmitter sites. It is 10½ in. high, 19 in. wide and 10⅝ in. deep. Gates Radio Co., Quincy, Ill.

Circle 247 on Inquiry Card, page 123

# *Are you a victim of* SPECIPHOBIA?*



** That martyred, hands-tied feeling you get when your specification is loaded.*

Did your contract specify that you use unproved devices instead of tubes? For a reason? Or just because something "new" was available? (Which meant derating your whole circuit just to get the performance you *know* tubes will give!) Well, mister designer, you are a victim of speciphobia!

Don't feel bad. Lots of circuit designers are in the same quandary. But why not *do* something about it? Summon your manly courage, and go ask this specifier whether he wants novelty (at an awful price), or:

**...known performance, known reliability, safe design, good logistics, systems flexibility, and economy (all of which you can prove). In short...a design that doesn't apologize!**

Then, when he innocently asks "... Why of course. How can you get this?", just tell him to get out of orbit and specify tubes. As a matter of fact, *General Electric 5-Star Receiving Tubes.* And tell him that you'll apply them with all your up-to-date know how on how to care for an electronic circuit.

If he's still skeptical, just ask him to come see us. We've got some data we'd be glad to show, and match with anything he's got. And while we're at it, don't forget to have us show him the tubes we're working on for the circuits you'll be designing next. Want *small size?* Well, you ain't seen nothin' yet! Receiving Tube Dept., Owensboro, Ky.

*P. S.* **Come on over to Booth 2908 at the IRE Show, and we'll show you tubes doing things that make other devices blush. Look for the 7-foot tube!**

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**

2-411-102

Circle 124 on Inquiry Card, page 123

# New Tech Data for Engineers

### Variable Delay Lines

Data sheet on 30 MC to 10,000 MC delay lines list 4 specific high frequency delay lines: 1 variable and 3 fixed. The variable has a bandwidth of 125 MC and a time delay of 0 to 50 mμsec. The fixed have delays of 10, 50, and 200 mμsec. with bandwidths of 500, 50 and 30 MC respectively. Impedance ranges are from 50 to 120 ohms. Other characteristics are listed. Control Electronics Co., Inc., 10 Stepar Place, Huntington Station, L. I., N. Y.

**Circle 199 on Inquiry Card, page 123**

### Synchro Coupling Problems

Tech Bulletin discusses problems associated with coupling a synchro under test to a precision Angular Divider. Angular and parallel misalignments are treated to produce a rotational standard with essentially zero transmission error. Theta Instrument Corp., 48 Pine St., East Paterson, N. J.

**Circle 200 on Inquiry Card, page 123**

### High Temperature Wire

The 1959 catalog, 64 pages on Teflon insulated wires and cables has 8 sections of engineering information and prices on high-temperature magnet wire, lead wire, cables, tubing, and Teflon tape, and detailed general information on the products. Also contains mil specs, temperature ranges, wire and cable constructions, colors, tests, and design criteria for high temperature wiring. American Super-Temperature Wires, Inc., Winooski, Vt.

**Circle 201 on Inquiry Card, page 123**

### Semiconductors

Products catalog includes a transistor chart, transistor replacement chart, and price lists. Included are data sheets on germanium transistors and silicon rectifiers. Bendix Aviation Corp., Semiconductor Products, Red Bank Div., 201 Westwood Ave., Long Branch, N. J.

**Circle 202 on Inquiry Card, page 123**

### Magnetic Amplifiers

Bulletin E PD 1296 gives specs on the Vickers 1290 Series Super Power gapless core magnetic amplifiers, consisting of 18 standard sizes with power outputs of 500 va to over 32 kva. Includes tables of electrical characteristics, curves, basic circuit diagrams, and dimensions. Vickers, Inc., Electric Products Div., 1815 Locust St., St. Louis, Mo.

**Circle 203 on Inquiry Card, page 123**

### Rocket Flight Measurement

How the flights of intermediate range rockets and guided missiles at the White Sands, New Mexico, Missile Range are measured by Univac Scientific Computer is described in an illustrated booklet, U1561, published by Remington Rand Div., Sperry Rand Corp., 315 4th Ave., New York 10, N. Y. The story is illustrated.

**Circle 204 on Inquiry Card, page 123**

### Cable Assemblies

A 12-page catalog covers standard molded-type cable assemblies and field, special, and coaxial types. Thirty four standard types are illustrated utilizing common connector ends and standard molded terminal ends. There are 3 pages of tabular reference data giving types, cable numbers, corona levels and special remarks. H. H. Buggie, Inc., Box 817, Toledo 1, Ohio.

**Circle 205 on Inquiry Card, page 123**

### Pulse Control Instruments

An 8-page condensed catalog of unitized pulse control instruments provides capsule technical descriptions of more than 25 Burroughs pulse control instruments, including pulse generators, flip-flops, coincidence detectors, delays, mixers, counters and power supplies. Burroughs Corp., Electronic Tube Div., P. O. Box 1226, Plainfield, N. J.

**Circle 206 on Inquiry Card, page 123**

### Voltage Regulator

Bulletin #6.04 (6 pages) from Electric Regulator Corporation, Pearl St., Norwalk, Conn., describes a 60-finger regulator for direct control of voltage of main fields of large alternators and generators; line load regulation; power amplification; impedance matching, and system stabilization. Basic types and available variations, circuitry, and typical applications are described.

**Circle 207 on Inquiry Card, page 123**

### Transducers

Three bulletins, 58-131-135, and 58-140, describe a series of pressure transducers. Model DP-7 measures differential pressures in terms of an electrical output. Models GP-15D and DP-15D convert hydraulic pressure into a proportional electric signal. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

**Circle 208 on Inquiry Card, page 123**

### Management Practice

The Unwritten Laws of Engineering, a 50-page booklet published by ASME, is for engineers interested in learning good management practice and for technical administrators as a refresher in the techniques of sound management. General Transistor Corp., 91-27 138th Place, Jamaica, N. Y.

**Circle 209 on Inquiry Card, page 123**

### Relays

Engineer's Fact File on Mercury Plunger Relays includes load ratings, contact data, coil characteristics, mounting dimensions, diagrams, illustrations, and technical articles on application engineering. Ebert Electronics Corp., 212-31M Jamaica Ave., Queens Village 28, N. Y.

**Circle 210 on Inquiry Card, page 123**

### Radioisotopes in Research

Tech Bulletin #3 describes the use of radioactivity in measuring the amount of a substance in a mixture where ordinary analytical methods cannot be used because the amount is so minute. Nuclear-Chicago Corporation, 223 W. Erie Street, Chicago 10, Illinois.

**Circle 211 on Inquiry Card, page 123**

### Potentiometer Definitions

Brochure lists functional potentiometer definitions as a guide to users of Clarostat products, and avoids misinterpretation of terminology between supplier and buyer. Clarostat Manufacturing Co., Inc., Dover, New Hampshire.

**Circle 212 on Inquiry Card, page 123**

### Pulse Height Analyzers

"Let's Analyze the Situation" is title of new bulletin comparing features of commercially available Multi-Channel Pulse Height Analyzers. Radiation Instrument Development Laboratory, Inc., 5737 South Halsted Street, Chicago 21, Illinois.

**Circle 213 on Inquiry Card, page 123**

### Toggle Switch

An 8-page catalog lists 200 models of toggle and trigger switches by Sargent Electric Corp., 630 Merrick Rd., Lynbrook, N. Y. Ten of the series are treated in detail with dimensional outlines, illustrations, electrical and mechanical specifications and applications.

**Circle 214 on Inquiry Card, page 123**

*(Continued on Page 216)*

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REFERENCE DATA FILE Folio 59-1 SANGAMO

a continuing series on technical topics of specific interest to engineers

# What is the true value of high purity aluminum foil in electrolytic capacitors?

Since the word "purity" is relative, the term "high purity" in describing the foil used in electrolytic capacitors has been often misused. Twenty years ago, 99.80% aluminum was the highest purity commercially available. A few years later, 99.85% aluminum anodes became available and for a period of time were considered "high purity" foil.

Today, 99.99% aluminum is readily available for applications where the cost differential between 99.99% and standard purity anodes is justifiable. In some technical circles, purities of 99.85% to 99.87% aluminum are still referred to as "high purity". At Sangamo Electric Company high purity means 99.99% aluminum or better anode foil.

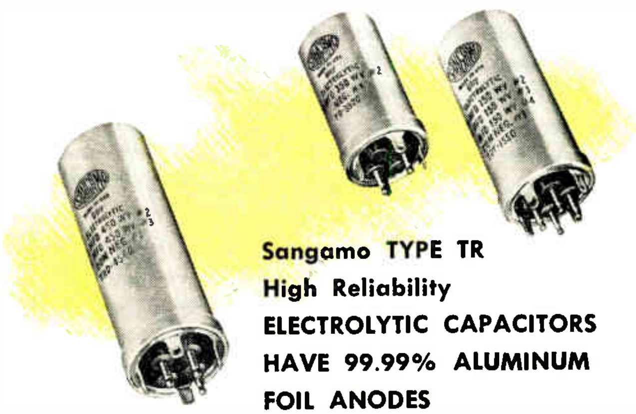
From the engineer's viewpoint, the advantage of 99.99% aluminum over 99.87% aluminum in electrolytic capacitors is both tangible and intangible. Most of the benefits are derived from the fact that there are fewer crystals of metal impurities on the surface of the higher purity foil. Crystal impurities such as iron do not form an insulating dielectric oxide and produce points of high electrical leakage. In a circuit, where capacitors of lower anode aluminum purity are used, voltages are set up between the dissimilar metals and deformation, or point corrosions, slowly takes place. This action decreases the shelf life of the capacitor.

Other benefits provided from the use of 99.99% aluminum foil include longer life, better high temperature operation and lower dissipation factor. When variable factors are equal, the summary advantages of 99.99% anodes versus 99.87% anodes can be shown as follows:

| | 99.87% Anodes | 99.99% Anodes |
|---|---|---|
| DC leakage | Per Mil-C-62A or EIA-RS-154 | EIA-TR-140 or about ½ leakage for 99.87% anodes |
| Shelf life | 2 years | 2½—3 years |
| Estimated life expectancy | 4—7 years | 7—12 years |

Where extremely low leakage is important, where temperature of operation is between 65°C and 85°C, or where exceptional long life is required and something better than standard electrolytic capacitors is desired, 99.99% aluminum anodes are well worth the additional cost.

Capacitor manufacturers, like Sangamo, pay a premium of approximately 60% more for 99.99% aluminum foil. To obtain this near-perfect purity, the aluminum ingots used to produce 99.99% anodes must be reprocessed from a good supply of bauxite and a well run electro-chemical process.



Sangamo TYPE TR High Reliability ELECTROLYTIC CAPACITORS HAVE 99.99% ALUMINUM FOIL ANODES

The use of 99.99% high purity aluminum anodes in Sangamo Type TR Twist-Tab Electrolytics, surgically clean papers, and a highly effective end seal gives these capacitors excellent operating life and superior electrical characteristics. They are designed to operate in a temperature range from −20°C to 85°C and are available in ratings from 3 to 450 volts D.C.

Engineering Catalog Number 2227 gives full information and is available upon request for your files.

SC59-1

**SANGAMO ELECTRIC COMPANY, Springfield, Illinois**

--designing towards the promise of tomorrow



Circle 125 on Inquiry Card, page 123

# New Tech Data for Engineers

(*Continued from Page* 116)

### Calculator

A pocket-sized Circular slide rule for engineers and plant and office executives is offered by General Industrial Co., 5738 Elston Ave., Chicago 30, Ill. Complete easy-to-follow instructions are included with each rule.

Circle 215 on Inquiry Card, page 123

### Ceramic Capacitor Guide

Ceramic Capacitor Cross-Reference Guide lists over 600 Centralab ceramic capacitors by type and rating, stocked in production quantities. Equivalent units of other manufacturers, where available, are listed next to the Centralab capacitors. The guide contains separate sections devoted to general purpose discs and tubulars, temperature compensating discs and tubulars, high voltage discs, dual capacitors, buffer capacitors, low voltage capacitors, stand-off and feed-thru, transmitting, high accuracy and trimmer capacitors. Centralab Div., Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 216 on Inquiry Card, page 123

### Magnetic Amplifier Manual

Magnetic Amplifier Design Manual, Engineering Bulletin #403-A, has 45 schematic diagrams and graphs describing magnetic amplifier design and application techniques. Covered are: Signal mixing, voltage and current comparators, automatic pilot systems, electrohydraulic valve drives, gyro and position pickoffs, insulation and cable barriers checker, integrators, limiters, sweep generator potentiometric amplifier circuit, relay tester, LaPlace transforms, transform generation, velocity servos, etc. Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich.

Circle 217 on Inquiry Card, page 123

### Miniature Transformers

Short form catalog lists miniature, subminiature, transistor, MIL-T-27A and industrial transformer specs available from distributor stock. Microtran Co., Inc., 145 E. Mineola Avenue, Valley Stream, N. Y.

Circle 218 on Inquiry Card, page 123

### Industrial TV Cameras

A 4-page illustrated bulletin describing industrial television cameras gives complete specifications for 2 cameras in the company's line. Included are camera accessories, such as remote-control pan-tilt and iris-focus units, an autozoom lens, and acoustical and weatherproof camera housings. KIN TEL Div., Cohu Electronics, Box 623, San Diego, Calif.

Circle 219 on Inquiry Card, page 123

### Magnetic Recording

Treatise, "The Tape Recorder as an Instrumentation Device" discusses the fundamentals and chief applications of magnetic instrumentation recording, traces the burgeoning need for precise measurement, and points out how magnetic-tape devices are uniquely suited to meet it. Included in the booklet's 74 pages are a discussion of the principles of magnetic recording, the physical elements of instrumentation recorders, and the four major recording processes — direct, frequency modulation, pulse-duration modulation, and digital. Ampex Corp., Instrumentation Div., 934 Charter St., Redwood City, Calif.

Circle 220 on Inquiry Card, page 123

### PTFE Tubing

A 3-color, 4-page brochure contains prices, tolerances, sizes and application information on PTFE (polytetrafluoroethylene) tubing. A gatefold chart lists electrical, mechanical, chemical and thermal properties of the high temperature tubing. Cross-reference charts are provided for "Super - Thin," "Thin - Wall" and "ASTM Wall" PTFE tubings by AWG size and footage and dimensional tolerances for PTFE tubings by AWG. Irvington Div., Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul, Minn.

Circle 221 on Inquiry Card, page 123

### Phenolics

An 8 - page, illustrated brochure, CDC-358, describes General Electric's complete line of phenolic resins, varnishes and molding powders. It includes product features, special properties, and detailed technical data on phenolic molding powders, laminating varnishes, foundry resins, Methylon coating resins, and industrial resins and varnishes. General Electric Co., Pittsfield, Mass.

Circle 222 on Inquiry Card, page 123

### Microfilm

Brochure describes the Copiflash, a portable 35 mm microfilming camera and the Camcopy Reader. The Copiflash will film wiring diagrams, maps, contracts, etc. The Reader has an 11½ x 18½ in. black ground glass screen for reading the microfilm. Camcopy, Inc., Box 27, Matawan, New Jersey.

Circle 223 on Inquiry Card, page 123

### Capacitors

Bulletin ME-58, Synchro Corporation, Electronic Division, Hicksville, Ohio, contains information on Dry electrolytic capacitors. Included are specifications, dimensional drawings, and details of mountings.

Circle 224 on Inquiry Card, page 123

### Temperature-Millivolt Tables

Chart of Temperature - Millivolt Conversion Tables for thermocouples from Thermo Electric Co., Inc., Saddle Brook, N. J. for Fahrenheit-Centigrade temperature conversion, in 5° increments, to mv values for 8 different thermocouple calibrations. The 2-color chart is punched for a 3-ring binder, or may be used as a wall chart. Values based on reference junction temperatures of 75°F and 25°C. Correction factors for other reference junction temperatures are provided. Temperatures are from —320°F to +3270°F and —200°C to +1800°C.

Circle 225 on Inquiry Card, page 123

### Germanium Diodes

Bulletin 158 from Ohmite Mfg. Co., 3683 Howard St., Skokie, Ill., describes their line of gold-bonded germanium diodes. It lists types for general purpose and computer use, where from 1 to 4 operating characteristics are specified. Special computer types with 10 specified characteristics are also shown. Featured is a system to classify diodes for ease in selection by number and value of characteristics.

Circle 226 on Inquiry Card, page 123

### Logic Modules Notes

"Simplified Design of Digital Logic Using Magnalog System," is 7th in a series of semiconductor application notes from Semiconductor Div., Dept. K, Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill. The 8-page, 2-color brochure describes 12 typical applications for Magnalog logic modules. Each application with power supply circuitry is illustrated by a logic diagram, wiring diagram and waveshape photo. Included are recommendations for designing: "Basic Logic," "Or," "Not-And," "And," "Modified And," "Bistable," "One" Generator, "Shift Register," "Binary Counter," "Binary Half-Adder," and "Binary Full Adder."

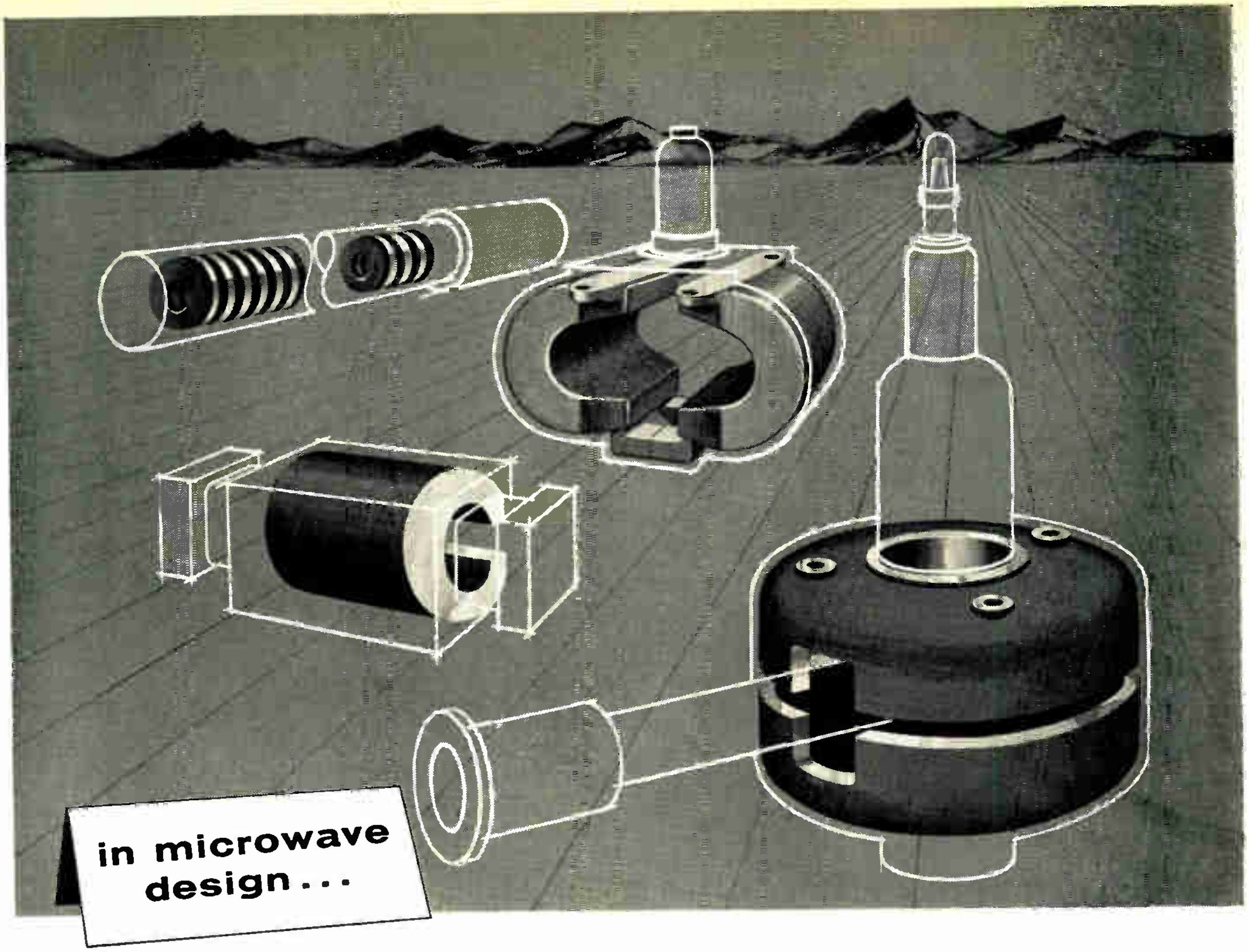
Circle 227 on Inquiry Card, page 123

### Literature Lists

Two literature lists on fiber research, one on electron microscope work and the other on X-ray diffraction investigations, are offered by Instruments Div., Philips Electronics, Inc., 750 So. Fulton Ave., Mt. Vernon, N. Y. The tabulation of electron microscope papers includes 79 articles which appears in domestic and foreign publications and lists 6 textbooks and reference books. Fifty eight articles are tabulated in the X-ray diffraction list.

Circle 228 on Inquiry Card, page 123

(*Continued on Page* 118)

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


Circle 126 on Inquiry Card, page 123

# New Tech Data for Engineers

(*Continued from Page* 212)

### Crystal-Counter Chart

An 8½ x 11 in. chart shows the working range for crystals and counters in X-ray Spectograph applications. It covers the atomic scale of elements from 10 to 100 and is divided into two parts, one deals with K lines and the other with L lines. Instruments Div., Philips Electronics, Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

Circle 229 on Inquiry Card, page 123

### Right Angle Connectors

Illustrated 6-page brochure gives specifications, outline dimensions and general information on right angle pin and socket connectors for printed circuit applications. Electronic Sales Division, DeJur-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, New York.

Circle 230 on Inquiry Card, page 123

### Relays

A series of relays, Models TT and TS, are described in Bulletin No. 160 from Ohmite Manufacturing Co., 3679 Howard St., Skokie, Ill. The relays feature "Molded Module" contact springs, which are molded into a single assembly, high sensitivity, and high ambient operating capability.

Circle 231 on Inquiry Card, page 123

### Ceramics

Bulletin 116, a 4-page catalog, describes a line of off-the-shelf high temp ceramic tool components including: bushings, washers, discs, plates, rods, and v-blocks. It has: dimensions, tolerances, and mechanical and electrical properties of the hi-temp ceramic components. Duramic Products, Inc., 262-72 Mott St., New York 12, N. Y.

Circle 232 on Inquiry Card, page 123

### Pulse Transformers

A 24-page catalogue, "Pulse Transformers" contains tables, charts, and schematics, and a brief history of low-level pulse transformers, their measurements, specifications, applications, interchangeability, dielectric ratings, manufacturing, and other data. Also included is information on some of PCA's 2,000 standard design transformers, case types and specifications data. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.

Circle 233 on Inquiry Card, page 123

### Design Data

Data sheets, Telehint #7 and #8, from Illumitronic Engineering Co., 680 E. Taylor Ave., Sunnyvale, California, give ways of calculating inductance, determination of Q and complete design of final output circuits.

Circle 234 on Inquiry Card, page 123

### Silicone Guide

The 1959 illustrated reference guide describes what silicones can best meet the needs of problems ranging from adhesives to release agents, resins to rubbers, dielectrics to water repellents; contains graphic examples showing where they are currently used, and information on how to get specific data on the silicone material best suited to any application. It features an expanded indexing system. Dow Corning Corp., Midland, Mich.

Circle 235 on Inquiry Card, page 123

### Coils & Transformers

Inductance values, curves (Q vs freq.), outline drawings, and general information on their line of torroids, transformers, filters, and magnetic amplifiers are contained in Catalog 858 issued by Communication Accessories Co., Lee's Summit, Mo.

Circle 236 on Inquiry Card, page 123

### Fans & Blowers

The 1959 McLean catalog features packaged fans, blowers, and accessory equipment used for cooling electronic apparatus. The 36-page catalog contains new and improved models and information, construction features and specifications of the entire line. McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J.

Circle 237 on Inquiry Card, page 123

### DC Motor Operation

Catalog 11058, Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J., is a 16-page compilation of technical data. It has a discussion of the basic methods for operating dc motors from ac power sources and typical schematic diagrams. Included are: Specifications and speed and torque ratings.

Circle 238 on Inquiry Card, page 123

### Power Supply

Two page, 2-color, bulletin describes the Model 104, transistor regulated power supply for general laboratory applications. Quan-Tech Laboratories, Morristown, N. J.

Circle 239 on Inquiry Card, page 123

### Packaged Circuits

Packaged Circuit guide, 16 pages, contains replacement information on packaged circuits used in equipment of over 200 manufacturers. It also describes 9 new packaged electronic circuits. Centralab Div. of Globe-Union, Inc., 900 East Keefe Ave., Milwaukee, Wis.

Circle 240 on Inquiry Card, page 123

### Power Supplies

A 36-page catalog from Lambda Electronics Corp., 11-11 131 St., College Point 56, New York, has information and specs on the company's line of transistor-regulated and tube-regulated power supplies and outline drawings of the equipment.

Circle 241 on Inquiry Card, page 123

### Sonic Energy Cleaning

A 3-color report, "How to Appraise Sonic Energy Cleaning," has been published by the Pioneer-Central Div. of Bendix Aviation Corp., Hickory Grove Rd., Davenport, Iowa. Five subjects are covered: what sonic energy is, how it cleans, how its efficiency can be evaluated, an analysis of applications, and an outline of the division's services to potential users.

Circle 242 on Inquiry Card, page 123

### Transistor Sockets

Bulletin 112 contains outline drawings and general specifications for Series 3300 combination transistor sockets. Sockets are designed to accommodate transistors with triangular round or in-line pin configurations. Elco Corp., M St. below Erie Ave., Philadelphia, Penna.

Circle 243 on Inquiry Card, page 123

### Button Cell Batteries

A 4-page, colored, illustrated brochure highlights the features, design potentials, and specifications of the VO-Series, nickel cadmium, button cell battery line produced by the Alkaline Battery Div., Gulton Industries, Inc., Metuchen, N. J.

Circle 244 on Inquiry Card, page 123

### Converter-Inverters

Spectrol Electronics Corp., 1704 South Del Mar Ave., San Gabriel, Calif., has released a 4-page, 2-color data file describing their Transidyne line of converter-inverters. Has features, specs, and styles of the 4 basic series.

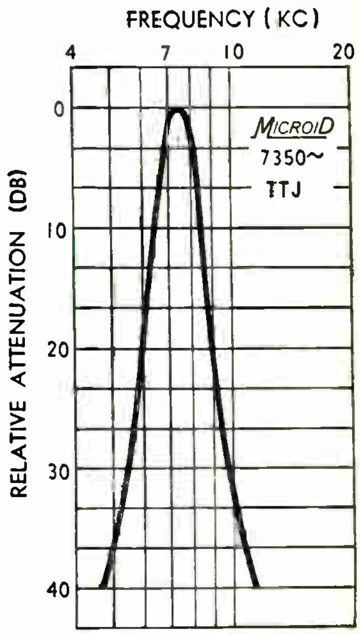
Circle 245 on Inquiry Card, page 123


Burnell & Co. may not be experts in the art of head shrinking. But when it comes to toroids, filters and related networks, Burnell has the know-how to solve an infinite variety of small space problems. The new MICROID ® filters by Burnell & Co. are a notable achievement in the shrinking of filters which can be designed for low pass or band pass applications.

For example, as a low pass filter, Type TCLJ starts at 400 cps. Physical size is 11/16" x 1-11/16" x 1/2" max. For higher frequencies from 7,500 cycles up to 100 kc, size is 3/4" x 1" x 1/2".

The band pass filter, Type TTJ pictured here, ranges from 7,350 cycles up to 100 kc. Physical size is 1/2" x 19/32" x 15/16", weight .3 ounces, band width 15% at 3 db and + 60% − 40% at 40 db. Wherever space and performance are critical requirements, miniaturized MICROID ® low pass and band pass filters provide utmost reliability as well as more unit surface economy on printed circuit boards. Completely encapsulated, they are ideally suited to withstand high acceleration, shock and vibration environments. Write for special filter bulletin to help solve your circuit problems.

**See these and other subminiature components on display at Booth 2919-2921, IRE Exhibit.**

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PACIFIC DIVISION
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720 MISSION ST.
SOUTH PASADENA, CALIF.
RYAN 1-2841
TELETYPE PASACAL 7528



Circle 127 on Inquiry Card, page 123

## New Tech Data

(*Continued from page* 216)

### Diodes

The Shockley Transistor Corp., Stanford Industrial Park, Palo Alto, Calif., has published data sheets on their 4-layer Transistor diodes. Characteristics of standard devices, Types D and AD, include: Switching voltage and current, holding voltage and current, resistance capacitance, current carrying capacity, and ambient temperature.

Circle 363 on Inquiry Card, page 123

### Digital Instruments

Three lines of digital instruments for measuring ac and dc voltage, voltage ratio, and resistance are described in the Spring, 1959, Short Form Catalog issued by Non-Linear Systems, Inc., Del Mar, Calif. Selection guides simplify selecting accessories from the line.

Circle 364 on Inquiry Card, page 123

### Cathode Ray Indicator

Two-page bulletin describes an X-Y coordinate indicating device having identical high gain dc-coupled amplifiers on both the horizontal and vertical axes. Includes physical and electrical specs of the instrument. Technitrol Engineering Co., 1952 E. Allegheny Ave., Phila., Pa.

Circle 365 on Inquiry Card, page 123

### Reflectors

Microwave passive aluminum reflectors are featured in a 20-page, 2-color catalog from Tower Construction Co., Sioux City, Iowa. Included are types of design, construction details and test procedures.

Circle 366 on Inquiry Card, page 123

### Plastic Laminate

New Products Bulletin describes the characteristics and specifications for Duralar, an all new plastic laminate, used to fabricate printed charts, diagrams and signs. Duralith Corporation, 1025 Race Street, Philadelphia 7, Pa.

Circle 367 on Inquiry Card, page 123

### Potentiometers

A 48-page catalog from Markite Corp., Dept. 100, 155 Waverly Place, New York, N. Y. describes the company's line of precision potentiometers. Featuring a conductive plastic element the line includes: rotary rectilinear, linear, non-linear, single-element and dual element units.

Circle 368 on Inquiry Card, page 123

### Wire and Cable

Catalog from General Electric Co., Wire and Cable Dept., Bridgeport, Conn., features wire and cable for aircraft, missiles, and rockets. Included are descriptions, sizes, resistances and weights. Insulations used are also described.

Circle 369 on Inquiry Card, page 123

## Ultrascope

(*Continued from page* 101)

recently, the development and production of image-converter tubes had been confined to military purposes and was handled in conjunction with the Engineer Research and Development Laboratories, Corps of Engineers, U. S. Army, at Fort Belvoir.

The ultraviolet accessory viewer consists of two units. One unit, which fits on to the barrel of a microscope, contains the ultrascope and an eyepiece; the other unit is a compact power supply. A cable connects the power supply to the ultrascope tube.

Invisible rays from an ultraviolet lamp are projected through the specimen under observation, and through an ultraviolet objective lens. An invisible ultraviolet image of the specimen is formed on the faceplate of the image-converter tube. The faceplate transmits ultraviolet rays and has on its inner surface a photosensitive material which converts the ultraviolet image into a corresponding pattern of electrons. This electron pattern is, in turn, focused on the fluorescent viewing screen at the opposite end of the tube.

A visible image of the specimen appears on the viewing screen in yellow-green light and is observed through a lens of the desired magnification. Because the human eye is most sensitive to yellow-green light, that color range provides comfortable viewing during prolonged observations.

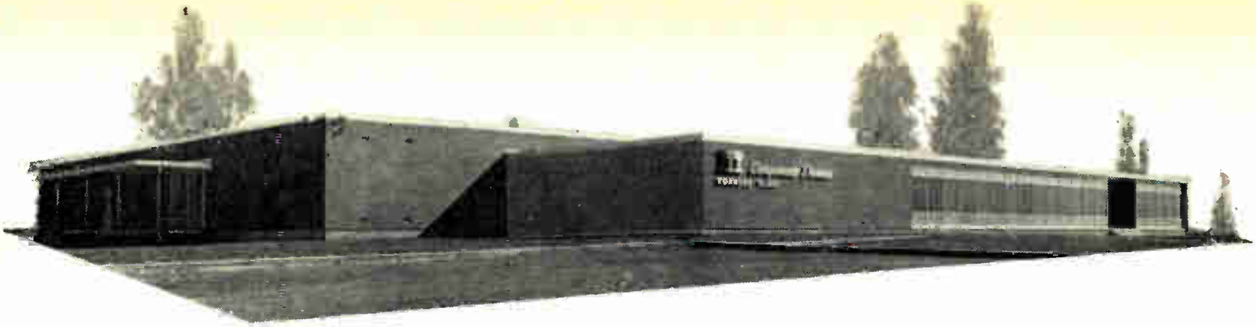
The unit is also easily adapted to photomicrography and thus can provide film records of the specimen under study.

---

## . . . . istor Answers

(*From quiz on page* 117)

| | | |
|---|---|---|
| 1—C | 8—M | 15—N |
| 2—I | 9—L | 16—P |
| 3—B | 10—D | 17—J |
| 4—S | 11—O | 18—R |
| 5—H | 12—F | 19—E |
| 6—Q | 13—K | |
| 7—G | 14—A | |



## ROANOKE. VA.

This new, ultra modern plant, formally dedicated March 17, 1959 as the newest link in the **ITT** Components Division manufacturing network, is devoted to the development and production of **ITT** Traveling Wave Tubes and Iatron* Storage Tubes.

# ITT

INTERNATIONAL TELEPHON

A.

POWER TRIODE

B.

IATRON* STORAGE TUBE

C.

TRAVELING WAVE TUBE

**ITT** Components Division provides a wide range of special purpose tubes for communications, industrial and military requirements, backed by the research, development and manufacturing experience of the worldwide International Telephone and Telegraph Corporation.

**A.** ITT Power Triodes, for CW and pulse operation are used as modulators, amplifiers and oscillators in communications or industrial service. Water cooled and air cooled types.

**B.** Iatron* Storage Tubes, recently developed by **ITT** Components Division, have high-persistence screens for radar and display devices where extreme brightness is required.

**C.** Traveling Wave Tubes, developed by **ITT** and manufactured by **ITT** Components Division for microwave communications, and military applications.

**D.** Kuthe KU-73 ceramic envelope hydrogen thyratron, an essential element in radar modulation, is one of many hydrogen filled tubes available.

**E.** Evaporative Cooled Power Triodes feature high anode dissipation, exceptionally high anode overload capacity—greatly reduces liquid cooling requirements.

**F.** Super-powered Triodes, developed by **ITT** and manufactured by **ITT** Components Division for use as modulators, amplifiers and oscillators in communication or industrial services.

*IATRON - Trademark of International Telephone & Telegraph Corporation.


D.

KU 73 CERAMIC THYRATRON

E.

HIGH DISSIPATION POWER TRIODE

F.

SUPER-POWER TRIODE

NEWARK, N. J.

ıthe Laboratories, Inc., Newark, N. J. a ıit of ITT Components Division, is the ›rld's largest manufacturer of hydrogen ıyratrons and hydrogen diodes.

CLIFTON, N. J.

ITT Power Tubes, selenium and silicon rectifiers are among the products manufactured at the ITT Components Division plant in Clifton, N. J.

PALO ALTO, CALIFORNIA

Specialized research and production facilities in Palo Alto, California, are the source of ITT tantalum capacitors and seals manufactured by techniques developed over years of experience and research.

# Components Division

.ND TELEGRAPH CORPORATION

**ITT** Components Division products — Silicon Rectifiers, Selenium Rectifiers and Diodes; Tantalum Capacitors and Seals—are widely used in specialized military and industrial equipment where rugged construction, minimum size, maximum operating efficiency and temperature stability are critical, as well as in home entertainment appliance devices requiring economy, ease of assembly and minimum space.

**A.** ITT Silicon Power Rectifiers feature dual positive hermetic sealing—high temperature stability—advanced diffusion techniques—compactness and high efficiency.

**B.** ITT Wet Anode Tantalum Capacitors are superior products, competitively priced, readily available through a nationwide network of industrial distributors. Glass to metal positive seals, small, light-weight, yet able to withstand shock and vibration, without loss of electrical stability.

**C.** Over 20,000 designs of custom built and standard ITT high density selenium rectifier stacks feature exceptional output to size and weight ratio, in all types of industrial and military service.

**D.** ITT high voltage selenium rectifiers are enclosed units for any required voltage rating and current ratings from 5 to 40 ma, with paper, phenolic, glass, or metal hermetically sealed enclosures.

**E.** Silicon Zener Regulators are designed for severe commercial and military requirements. Each unit is fully evaluated to insure stability of characteristics over the temperature range from —65° C to 165° C. Hermetically sealed for environmental protection.

**F.** Compression seals, solder seals, pressure, stand-off and speed-nut terminals, condenser end seals and transistor closures, designed for uniform seal integrity under severe conditions.

F. GLASS SEALS

E. ZENER DIODES

D. HIGH VOLTAGE RECTIFIERS

See us at
Booths 2510-2520 & 2615-2625
IRE SHOW

C. HIGH TEMPERATURE RECTIFIERS

A. SILICON POWER RECTIFIERS

B. TANTALUM CAPACITORS

**ITT** *Components Division*

# IRE Show

(*Continued from page* 110)

papers of a new plant or a new process going automatic. This field promises to provide significant social and industrial contributions during this generation. Even the straight-laced banker has given way to automation in his field.

Are you a computer engineer? If so, you had better attend all of the sessions concerning electronic computers. The way your field is moving these sessions are a must to you. Papers being presented will cover many new applications, components, and circuits for applications in the field of computers. One of your big problems is system checkout and fault finding. The paper, "Automatic Checkout Equipment Featuring Test Programs for Diagnostic Checking," by R. B. Whitely and L. J. Lauler, Lockheed Aircraft Corp., will give you some good ideas on this problem.

## TECHNICAL PROGRAM

### Monday Afternoon—March 23

#### Adaptive Control Processes and Allied Systems

**Waldorf-Astoria—Starlight Roof**

On Adaptive Control Processes, R. Bellman and R. E. Kalaba.
A Dynamic Programming Approach to Adaptive Control Processes, M. Freimer.
On the Optimum Synthesis of Multipole Systems in the Wiener Sense, H. C. Hsieh and C. T. Leondes.
On Adaptive Control Systems, L. Braun, Jr.
Extension of Phase Plane Analysis to Quantized Systems, P. H. Ellis.

#### Vehicular Communications

**Waldorf-Astoria—Astor Gallery**

An Analysis of Radio Flutter in Future Communications, N. W. Feldman.
Radio Set, AN/GRC-59, Rugged, Reliable Design for Tactical Usage, W. F. Given.
A New Approach to Compactness in Mobile Radiotelephone Design, W. Ornstein.
A New Manual Mobile Telephone System, A. F. Culbertson.
Performance of "Low-Plate-Potential" Tube Types at Mobile-Communications Frequencies, R. J. Nelson and C. Gonzalez.

#### Engineering Writing and Speech

**Waldorf-Astoria—Jade Room**

Using the Psychological Approach in Scientific Writing, J. L. Kent.
An Effectual Approach to an Orally Presented Paper, I. J. Fong.
A Self-Improvement Program for Engineering Writers, A. H. Cross.
Read Your Speech, E. W. Still.
Subjectivity versus Objectivity in the Technical Report, S. Cohen.

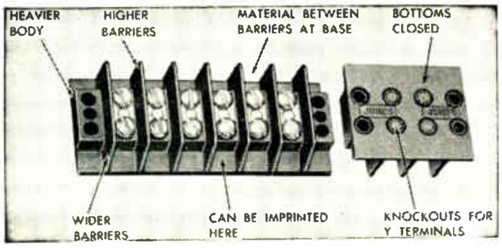
#### Radio Frequency Interference

**Waldorf-Astoria—Sert Room**

Standard Measurement Parameters for Phenomena Distributed in Time and Frequency, E. W. Chapin.
Magnetic Field Pickup for Low-Frequency Radio-Interference Measuring Sets, M. Epstein and R. B. Shulz.
Microwave Duplexer Tube Characteristics Under Spurious Radiation Conditions, I. Reingold.
Technical Considerations in the Assignment of Operating Frequencies in a Communications System, O. M. Salati and R. A. Rosien.

(*Continued on page 224*)

# AT LAST—The IDEAL BARRIER TERMINAL STRIP

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Wider and higher barriers for increased creepage distances. Closed bottoms for complete insulation. Material between barriers at the base adds to the strength and maintains the same creepage distance between contact to contact and contact to ground. Can be imprinted here. No insulating or marker strip required. Three series—540, 541 and 542 having the same terminal spacing as our 140, 141 and 142 series.

Complete listing in the new Jones No. 22 catalog. Write for your copy today.

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**HOWARD B. JONES DIVISION**
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CHICAGO 24, ILLINOIS
DIVISION OF UNITED-CARR FASTENER CORP.

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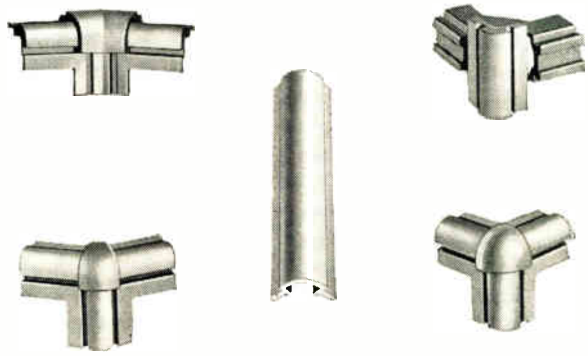
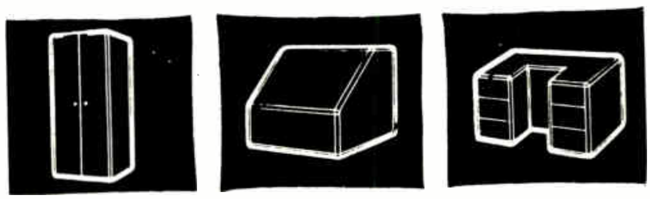
# with BUD IMLOK

## EXTRUSIONS AND CONNECTORS



**YOU CAN QUICKLY AND ECONOMICALLY ASSEMBLE A VARIETY OF CABINETS, CASES AND RACKS**

**WITHOUT TOOLING COSTS**



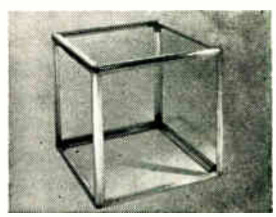
The IMLOK system of metal cabinet construction is ideal for research and prototype work. With the simplest of tools, precision cases, cabinets and racks can all be quickly and economically built, to your own design.

Assembling connector and extrusion

More than 50 different styles of connectors, extrusions and accessories are readily locked together to form the framework of any type of housing. Standard gauge aluminum sheets are cut and fitted to complete the enclosure.

Locking connector and extrusions

The Bud Imlok system can solve your special housing need. For complete details, parts list and prices write for Bulletin 1858 . . . or better still—see the Bud Imlok products at your distributors.



Completed framework

BUD — THE MARK OF PERFECTION

**BUD RADIO, INC.**
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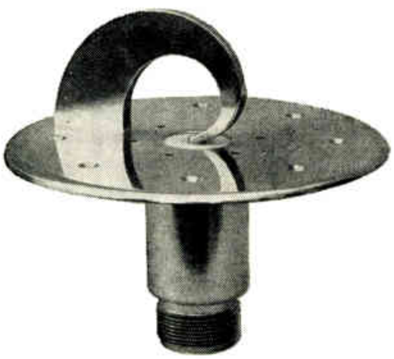
HI-POWER • HI-FREQUENCY TRANSMISSION LINE SYSTEMS

# SCIMITAR ANTENNAS
## 350-12000 MCS



These extremely broadbanded antennas (with exceptionally low VSWR characteristics), are representative of TAMAR's numerous operational transmission line system components.

**SPEC. SHEETS AVAILABLE UPON REQUEST**

**TAMAR ELECTRONICS, INC.**
1805 COLORADO AVE. • SANTA MONICA, CALIF.

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# IRE Technical Papers

*(Continued from page 222)*

Precipitation Static at High Altitude, L. A. Hartman and F. B. Pogust.
Precipitation-Generated Interference in Jet Aircraft, R. L. Tonner and J. E. Nanevicz.

### Engineering Management Techniques

Waldorf-Astoria—Empire Room

The "Maximum" Manager in Research and Development, M. A. Williamson.
Marketing Factors in Research and Development, H. M. Rainie, Jr.
Obtaining Capital for the Smaller Electronics Firm—Methods and Pitfalls, C. M. Bower.
Simulation Techniques for Understanding R & D Management, E. B. Roberts.

### Production Techniques

New York Coliseum—Morse Hall

Microcircuitry—A New Approach to Miniaturization, Productibility, and Reliability, W. D. Fuller.
Insulated Flexible Printed Wiring Techniques, W. B. Wilkens.
A Semi-automatic Transistor Testing Machine, E. Millis.
The Development of Automatic Machinery for Making Electron-Tube Stems, M. M. Bell.
Microminiaturization, D. W. Moore.

### Navigation and Traffic Control

New York Coliseum—Marconi Hall

Loran-B Precision Navigation, W. J. Romer.
A Synthetic Future Environment for Analysis of Radar Beacon System Capacity, A. Ashley and F. H. Bottle, Jr.
Air Traffic Control Computer, A. G. Van Alstyne and M. H. Northman.
Use of Airport Surface Detection Radar as a Tool in Airport Research, M. A. Warskow.
An Improved Instrument Low Approach System Compatible with Tacan, M. Korpeles and E. G. Parker.

### Electronic Devices

New York Coliseum—Faraday Hall

The Field Effect Tetrode, H. A. Stone, Jr.
A Theory of the Tecnetron, A. V. J. Martin.
A Simple and Flexible Method of Fabricating Diffused NPN Silicon Power Transistors, L. D. Armstrong and H. D. Harmon.
A Twenty-Ampere Switching Transistor, T. P. Nowolk.
Drift Considerations in Low-Level Direct-Coupled Transistor Circuits, J. R. Biard and W. T. Motzen.
Video Crystal Tester, Y. J. Lubkin.

## Tuesday Morning—March 24

### New Techniques for Analysis

Waldorf-Astoria—Starlight Roof

Simplified Method of Determining Transient Response from Frequency Response of Linear Networks and Systems, V. S. Levadi.
A New Method of Analysis of Sampled-Data Systems, A. Papoulis.
Statistical Filter Theory for Time-Varying Systems, E. C. Stewart and G. L. Smith.
On the Phase Plane Analysis of Non-Linear Time-Varying Systems, R. Whitbeck.
On the Use of Growing Harmonic Exponentials to Identify Static Nonlinear Operators, J. H. Lory, D. C. Lai, and W. H. Huggins.

### Nuclear Instrumentation Techniques—I

Waldorf-Astoria—Astor Gallery

A Transistorized Nuclear Reactor Count Rate Channel, J. H. Cawley.
Transistorized Source-Range Reactor Instrumentation, R. R. Hoge.
A Two-Dimensional Kicksorter, R. Chase.
A Transistorized Pulse Height Analyzer, R. T. Graveson.

### Broadcasting—I

Waldorf-Astoria—Jade Room

FM Carrier Techniques in the RCA Color Video Tape Recorder, R. D. Thompson.
A Deleter-Adder Unit for TV Vertical Interval Test Signals, J. R. Popkin-Clurman and F. Davidoff.
An Electro-Servo Control System Capable of Correcting Zero Point Zero Five Microsecond Rotational Errors, W. Barnhart.
Transistorized Video Switching, J. W. Wentworth, C. R. Monro, and A. C. Luther, Jr.
A New Approach to Low Distortion in a Transistor Power Amplifier, H. J. Paz.

Nicolaas Bloembergen
Co-winner, Morris Liebmann Memorial Prize

### Contributions to Stereo Sound Reproduction

Waldorf-Astoria—Sert Room

The "Null Method" of Azimuth Alignment in Multitrock Mognetic Tope Recording, A. G. Evons.
Three-Chonnel Stereo Playback of Two Trocks Derived from Three Microphones, P. W. Klipsch.
Study of o Two-Chonnel Cylindrical Ceramic Tronsducer for Use in Stereo Phonogroph Cartridges, C. Germano.
The Single Stereophonic Amplifier, B. B. Bauer ond J. M. Hollywood.
A Frame-Grid Audio Pentode for Stereo Output, J. L. McKain ond R. E. Schwab.
Design Considerotions for Stereo Cortridges, J. H. McConnell.
Stotus Report on Stereophonic Recording ond Reproducing Equipment, W. S. Bachmon.

### Engineering Management—II

Waldorf-Astoria—Grand Ballroom

The Advonced Reseorch Projects Agency—Operotions and Plans, J. E. Clork.
Plonning ond Monoging a Multi-Compony Electronic Systems Program, E. G. Fubini.
Intro-Company Systems Monogement, H. H. Goode.

### Medical Electronics—I

New York Coliseum—Morse Hall

A Dato System for Physiological Experiments in Satellites, M. A. McLennan.
A Logical Structure for Diagnosis Based on Probobility, S. Rush.
Microwove Radiation as a Tool in Biophysical Research C. Susskind, B. S. Jacobson, and S. B. Prausnitz.
The Reliability Problem in Machines and in Noture, W. B. Bishop and J. A. LoRochelle.
Respiratory Control of Heart Rate: Laws Derived from Anolog Computer Simulation, M. E. Clynes.

### Land and Space Electronics

New York Coliseum—Marconi Hall

Applicotion of Sotellite Doppler Shift Measurements.
Part I—Sotellite Freguency Measurements, O. P. Loyden and H. D. Tanzman.
Part II—Slont Range at Nearest Approoch, H. P. Hutchinson.
Sputnik II as Observed by C-Band Radar, D. K. Barton.
Free-Rotor-Gyro Stabilized Inertial Reference Plotform, T. Mitsutomi.
Ground Clutter Isodops for Coherent Bistotic Rador, H. A. Crowder.
Lond Vehicle Guidance by Radar, Y. Chu ond P. N. Buford.

### Widening Horizons in Solid-State Electronics

New York Coliseum—Faraday Hall

Ferrites and Microwave Solids, C. L. Hogan.
Solid-State Energy Sources, W. J. Vander Grinten.
Advanced Semiconductors, W. M. Webster, Jr.

### Tuesday Afternoon

### Information Theory

Waldof-Astoria—Starlight Roof

Information Rate from the Viewpoint of Inductive Probability, L. S. Schwortz, B. Harris, and A. Hauptschein.
Binory Relay Communication and Decision Feedbock, J. J. Metzner.

(Continued on page 226)



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# IRE Technical Papers

*(Continued from page 225)*

Results of a Geometric Approach to the Theory and Construction of Non-binary, Multiple Error, and Failure Correcting Codes, B. M. Dwork and R. M. Heller.
An Application of the Theory of Games to Radar Reception Problems, N. J. Nilsson.
Perception Simulation Experiments, F. Rosenblatt.

### Nuclear Instrumentation Techniques—II

Waldorf-Astoria—Astor Gallery

A Transistorized Cold Cathode Decade Counter, H. Sadowski and M. E. Cassidy.
A High Sensitivity Semi-conductor Diode Modulator for DC Current Measurement, H. E. DeBolt.
Control Concepts for Nuclear Ramjet Reactors, R. E. Finnigan.
Low Background Nuclear Counting Equipment, H. D. LeVine, R. T. Graveson, and A. L. Charlton.

### Broadcasting—II

Waldorf-Astoria—Jade Room

Possibilities of Major Simplifications in Color Television Live Cameras and Recording Devices Through the Use of Chroma Field Switching and Subsequent Automatic Color Balance, W. L. Hughes.
Report of TASO Committee 3.3 on Correlation of Picture Quality and Field Strength, C. M. Braum and W. L. Hughes.
Report of TASO Committee 5.4 on Forecasting Television Service Fields, A. H. LaGrone.
A New Wireless Microphone for TV Broadcasting, P. K. Onnigian.
A Television Program Automation System Using Beam Switching Tubes with Shift Register Circuitry, F. C. Grace.

### Speech and Circuits

Waldorf-Astoria—Sert Room

Speech Band-width Compression with Vocoders, F. H. Slaymaker.
Audio Applications of a Sheet-Beam Deflection Tube, J. N. Van Scoyoc.
A Drift-Free Direct Coupled Amplifier Utilizing a Clipper-RC Feedback Loop, J. N. Van Scoyoc and E. S. Gordon.
The Application of the Silicon Capacitor in Automatic Sweep Circuits and "Signal Seeking" Receivers, J. Black.
An Analysis of a Transistorized Class "B" Vertical Deflection System, Z. Wiencek and J. E. Bridges.

### Medical Electronics—II

New York Coliseum—Morse Hall

Recent Advances in Medical Electronics, V. K. Zworykin.
An Electronic Electrode, J. W. Moore and J. del Castillo.
Transistor Waveform Generators, G. N. Webb and R. N. Glackin.
Cardiac Pacing-Stimulation by Very Portable Equipment, D. G. Kilpatrick.
The Design of a Fetal Phonocardiotachometer, H. S. Sawyer.

### Reliability Techniques

New York Coliseum—Marconi Hall

Development and Utilization of Redundant Systems, S. Nozick.

**Franklin H. Blecher**
**1958 Browder J. Thompson Memorial Prize**

*(Continued on page 228)*



Circle 129 on Inquiry Card, page 123

# 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 37/64"

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.

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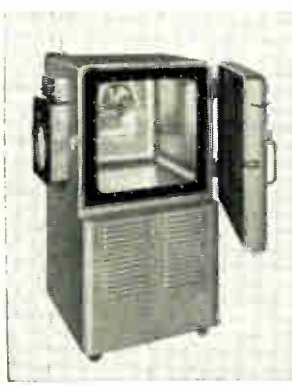

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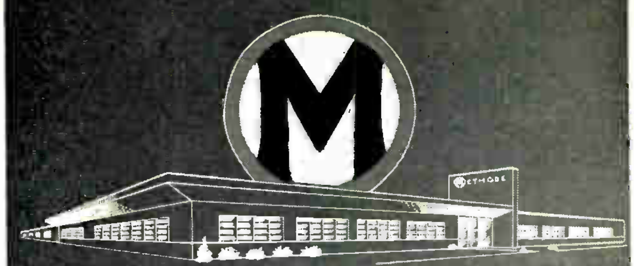

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| *Problems:* | *Solutions:* |
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| 1 82 Kits of Parts, too few for production tooling, too many for hand means. | 1 A separate precision circuit organization. |
| 2 39 printed boards per kit. | 2 Close customer liaison. |
| 3 31 different circuit configurations. | 3 Personnel and know-how geared to military quality requirements. |
| 4 Close mechanical tolerances. | 4 Outstanding plant and equipment. |
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Circle 140 on Inquiry Card, page 123

# IRE Technical Papers

(Continued from page 226)

High Reliability Statistically Demonstrated, B. L. Weller.
Circuit Redundancy, J. H. S. Chin.
An Original Reliability Program for a Development Project, K. S. Packard.
Failure Indication Considered as a Problem in Sequential Analysis, W. B. Bishop.

## Microwave Tubes

**New York Coliseum—Faraday Hall**

Microwave Detection with Vacuum Tube Diodes, N. E. Dye, J. Hessler, Jr., A. J. Knight, R. A. Miesch, and G. Papp.
Priming Techniques for Reducing Jitter on Pulsed Reflex Klystrons, P. A. Crandell.
A Multiple Frequency Local Oscillator, C. W. Flynn.
Selective Signal Suppression and Limiting in Traveling-Wave Tube Amplifiers, H. J. Wolkstein and E. Kinaman.
A New Backward-Wave Oscillator for the 4 to 5-Millimeter Region, J. A. Noland and L. D. Cohen.

## Tuesday Evening

## Future Developments in Space

**Waldorf-Astoria—Starlight Roof**

Space Philosophy, L. V. Berkner.
Engineering Needs, F. H. Griswold.
Space Vehicles, G. H. Stoner.
Space Engineering, O. G. Villard, Jr.
Communications and Data Transmission, G. S. Shaw.
Space Navigation, L. E. Root.
Military Applications, J. M. Gavin.
Biophysical Problems of Space Travel, T. C. Helvey.
Medical Aspects, O. H. Schmitt.
Space Science, H. E. Newell.

## Wednesday Morning—March 25

## The Statistical Theory of Signals and Circuits

**Waldorf-Astoria—Starlight Roof**

Coding a Discrete Information Source with a Distortion Measure, C. E. Shannon.
The Probability Density of the Output of a Filter when the Input is a Random Telegraphic Signal, J. A. McFadden.
On the Solution of an Eigenvalue Equation of the Wiener-Hopf Type Defined in Finite and Infinite Ranges, R. Mittra.
Optimum Estimation of Impulse Response in the Presence of Noise, M. J. Levin.
An Approximate Method of Computing Modulation Products, J. L. Ekstrom.

## Radio and Television Receivers

**Waldorf-Astoria—Astor Gallery**

Considerations in Transistor Automobile Receiver Front End Design, R. Martinengo.
A Five-Transistor Automobile Receiver Employing Drift Transistors, R. A. Santilli and C. F. Wheatley.

**Dr. E. Leon Chaffee**
**IRE Medal of Honor**

Improvements in Detection, Gain Control, and Audio Driver Circuits of Transistorized Broadcast Band Receivers, R. V. Fournier and D. Thorne.
Application of Rotationally Non-symmetrical Electron Lenses to TV Image Reproduction, D. Taylor, N. Parker, and N. Frihart.
A High Sensitivity Ultrasonic Microphone, P. Desmares and R. Adler.

### Component Parts—I

Waldorf-Astoria—Jade Room

Progress Report on Ad Hoc Group Study on Specifications, E. J. Nucchi.
Trend of Things to Come, C. H. Lewis.
Review of the Capacitor, Art L. Kahn.
Electronic Materials—An Industry-Wide Problem, A. M. Hadley.
A New Method for Maintaining Uniform Cooling Airflow during Maintenance and Operation, A. Perlmutter.

### Digital Telemetering

Waldorf-Astoria—Sert Room

Digital-to-Analog Conversion and Multiplexing, D. Block and M. Palevsky.
A High-Speed Airborne Digital Data Acquisition System, S. Cogan and W. K. Hodder.
A System for Editing and Computer Entry of Flight Test Data, S. F. Higgins.
The use of a Fractional Bistable Multivibrator Counter in the Design of an Automatic Discriminator Calibrator, M. W. Williard and G. F. Anderson.
Analysis of Multiplex Error in FM/FM and PAM/FM/FM Telemetry, J. Schenck and W. F. Kennedy.
Comments Relative to the Application of PCM to Aircraft Flight Testing, R. S. Djorup.

### Symposium: Psychology and Electronics in the Teaching-Learning System

Waldorf-Astoria—Grand Ballroom

Teaching Machines, B. F. Skinner.
Teaching Physics by Television, H. E. White.
Preliminary Studies in Automated Teaching, R. F. Mager.
Problems and Possibilities of Electronic Systems in Higher Education, C. R. Carpenter.

*(Continued on page 230)*

# IRE Technical Papers

(Continued from page 228)

### Communication by Scatter System

New York Coliseum—Morse Hall

Predicting the Performance of Long-Distance Tropospheric Communication Circuits, A. P. Barsis, K. A. Norton, and P. L. Rice.
A Study of the Economic and Technical Feasibility of Utilizing Tropospheric Scatter Links in the National Network of Korea, C. A. Parry.
A Formalized Procedure for the Prediction and Analysis of Multichannel Tropospheric Scatter Circuits, C. A. Parry.
Multibeam Transhorizon Tropospheric Communications, J. H. Vogelman, J. L. Ryerson, and M. Bickelhaupt.
Simplified Base Band Diversity Combiner, R. T. Adams.

### Mathematical Approaches for Reliability

New York Coliseum—Marconi Hall

The Reliability Game, R. F. Edwards.
Operational Reliability Model for a Reconnaissance System, L. L. Philipson.
What Price Reliability? J. Klion and J. J. Naresky.
System Efficiency and Reliability, R. E. Barlow and L. C. Hunter.
Analysis of System Reliability from the Standpoint of Component Usage and Replacement, B. J. Flehinger.

### Microwave Devices

New York Coliseum—Faraday Hall

A Microwave Meacham Bridge Oscillator, W. R. Sooy, F. L. Vernon, and J. Munushian.
A Linear Phase or Amplitude Modulator for Microwave Signals, J. Gindsberg.
Special Consideration in the Design of a Tunable Multielement Waveguide Filter, R. L. Sleven.
Strip Transmission Line Corporate Feed Structures for Antenna Arrays, D. Alstadter and F. O. Houseman, Jr.
Low-Loss S-Band and L-Band Circulators for Use with Masers and Reactance Amplifiers, F. Arams, G. Kroyer, and S. Okwit.

## Wednesday Afternoon

### Electronic Computers: Systems and Applications

Waldorf-Astoria—Starlight Roof

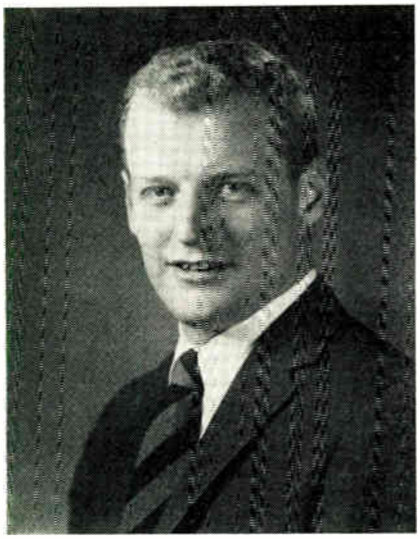
Radar System Simulation Techniques, J. M. Lambert and A. J. Heidrich.
Application of the NCR 304 Data Processor to the Synthesis of a Digital Computer Building Block, G. H. Goldstick and M. Kawahara.
Automatic Checkout Equipment Featuring Test Programs for Diagnostic Checking, R. B. Whiteley and L. J. Lauler.
Systems Organization of a Special Purpose Airborne Digital Computer, H. H. Schiller.
The Automatic Position Survey Analyzer and Computer, F. J. Alterman.

### Symposium on Sequential Circuit Theory

Waldorf-Astoria—Astor Gallery

A Survey of the Theory of Finite-State Logical Machines, D. Huffman.

**Paul R. Weimer**
**V. K. Zworykin Television Prize**



Richard D. Thornton
1959 W. R. G. Baker Award

Mathematical Models for Sequential Machines, S. Seshu.
Information Transfer in Asynchronous Systems, D. E. Muller.

### Component Parts—II

**Waldorf-Astoria—Jade Room**

A Practical, Comprehensive Component Application Program, C. G. Wallance.
Army Electronic Research: Theory to Reality, L. J. D. Rouge.
A Review of the Influence of Recent Material and Technique Development on Transformer Design, H. Nordenberg.
Improvements Made in Electronic Parts During the Past Ten Years, H. V. Noble.
An Analysis of Printed Wire Edge Connectors, D. R. Sheriff.

### Space Electronics

**Waldorf-Astoria—Sert Room**

A Time Redundancy Instrumentation System for an ICBM Re-Entry Vehicle, R. E. Schmidt, J. R. White, and R. A. Porter.
A General Purpose FM Transmitter for Airborne Telemetry, P. E. Tucker and R. T. Murphy.
The Tricot System, D. F. Gumb.
A Circularly Polarized Feed for an Automatic Tracking Telemetry Antenna, R. C. Baker.

### Communication by HF Radio and by Wire Line

**New York Coliseum—Morse Hall**

Design Considerations for Space Communications, J. E. Bartow, G. N. Krassner, and R. C. Riehs.
Inverse Ionosphere, G. D. Hulst.
A Frequency Stepping System for Overcoming the Disastrous Effects of Multipath-Distortion on High Frequency FSK Communications Circuits, A. R. Schmidt.
A High-Stability Linear Phase Voice Frequency Multiplex, D. Karp, R. M. Lerner, J. F. Mercurio, Jr., and W. E. Morrow, Jr.
A 2500-Band Time-Sequential Transmission System for Voice Frequency Wire Line Transmission, J. C. Myrick and G. Holland.

### Propagation and Antennas—I

**New York Coliseum—Marconi Hall**

Tropospheric Scatter Propagation Characteristics, A. J. Svien and J. C. Domingue.
Optimum Antenna Height for Ionospheric Scatter Propagation, R. G. Merrill.
Terrain Return Measurements at X-, Ku-, and Ka-Band, R. C. Taylor.
Theory of Radar Return from Terrain, W. H. Peake.
A New Concept in High-Frequency Antenna Design, R. H. DuHamel and D. G. Berry.
Large Antenna Systems for Propagation Studies, I. Kamen.

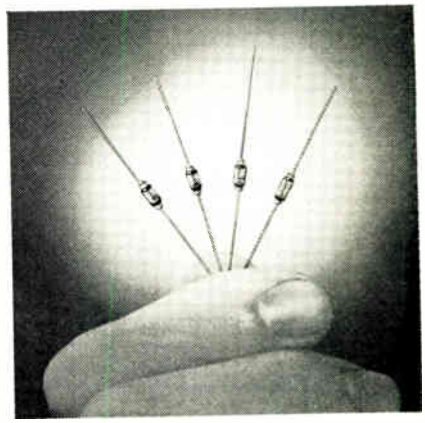
### Microwave Theory and Techniques

**New York Coliseum—Faraday Hall**

Some Comments on the Classification of Waveguide Modes, A. E. Karbowiak.
Noise Figure of Receiver Systems Using Parametric Amplifiers, J. Sie and S. Weisbaum.
Low-Noise Parametric Amplifiers and Converters, T. B. Warren.
Microwave Techniques in Measurement of Lifetime in Germanium, A. P. Ramsa, H. Jacobs, and F. A. Brand.

*(Continued on page 234)*









Circle 141 on Inquiry Card, page 123

# **Amperex®** *tubes*

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AMPEREX 'preferred' tube types have proven themselves in the world's finest *monophonic* amplifiers. Now AMPEREX is paving the way with tubes for the world's finest *Stereophonic systems.* Developed in the research laboratories of Philips of the Netherlands, and applications-engineered by Amperex for the American electronics industry, these ultra-advanced tubes have proven their reliability and unique design advantages in late model amplifiers and tuners of the world's leading high fidelity manufacturers. Sold by franchised dealers everywhere . . . available for off-the-shelf deliveries in any quantity.

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### POWER AMPLIFIER TYPES

**6CA7/EL34**—Exceptionally linear, high-power output pentode with low-voltage drive requirements. Up to 100 watts in push-pull.

**EL84/6BQ5**—Unique AF power pentode combining high gain and linearity with 9-pin miniature construction. Up to 17 watts in push-pull.

**EL86/6CW5**—Low voltage, high current version of the type EL84/6BQ5. Up to 20 watts in push-pull.

**ECL82/6BM8**—Triode-pentode. Up to 8 watts in push-pull.

**UCL82/50BM8**—Series string (100 ma. 50v) version of ECL82/6BM8.

**PCL82/16A8**—Series string (300 ma. 16v) version of ECL82/6BM8.

### VOLTAGE AMPLIFIER TYPES

**EF86/6267**—High-gain pentode with exceptionally low hum, noise and microphonics.* Particularly suitable for pre-amplifier and input stages. Similar to the Z739 and the 5879.

**ECC81/12AT7**—Medium-gain dual triode with low hum, noise and microphonics. Replaces the 12AT7 without circuit changes.

**ECC82/12AU7**—Low-gain dual triode with low hum, noise and microphonics. Replaces the 12AU7 without circuit changes.

**ECC83/12AX7**—High-gain dual triode with low hum, noise and microphonics. Replaces the 12AX7 without circuit changes.

**ECF80/6BL8**—High-gain triode-pentode with low hum, noise and microphonics.

### RF AMPLIFIER TYPES

**6DJ8/ECC88**—Frame grid, sharp cut-off twin triode. Particularly suitable for cascode circuits, RF & IF amplifiers, mixer & phase inverter stages. Features high transconductance and low noise.

***6ES8**—Similar to 6DJ8/ECC88. Has remote cut-off characteristics.

***6ER5**—Frame grid shielded triode with remote cut-off characteristics. Suitable for RF amplifiers in TV & FM tuners. Features high transconductance and low noise.

**†ECC85/6AQ8**—High gain dual triode for FM tuners with shield between sections for reducing oscillator radiation.

**EBF89/6DC8**—Duo diode-pentode with remote cut-off characteristics. Suitable for RF & IF amplifiers.

**ECF80/6BL8**—High gain triode-pentode for RF amplifiers.

### RECTIFIER TYPES

**EZ80/6V4**—Indirectly heated, full-wave rectifier with 6.3 v, 0.6 amp. heater, 90 ma. output capacity and 9-pin miniature construction.

**EZ81/6AC4**—Indirectly heated, full-wave rectifier with 6.3 v, 1 amp heater, 150 ma. output capacity and 9-pin miniature construction.

**GZ34/5AR4**—Indirectly heated, full-wave rectifier with 5 v, 1.9 amp heater and 250 ma. output capacity. Octal base. Replaces the 5U4G without circuit changes with the advantage of lower tube voltage drop because of the unipotential cathode.

### *Also Available:* INDICATOR TUBE TYPES

**EM84/6FG6**—Indicating pattern is a varying length bar. For use in broadcast receivers and tape recorders.

**DM70/1M3**—Subminiature type with "exclamation mark" indicating pattern. Features low filament consumption (25 ma.).

### GERMANIUM DIODES

**1N542**—Matched pair. Replaces 6AL5 in FM detector circuits.

**1N87A**—High RF rectification efficiency diode. Suitable for AM detector circuits.

Circle 136 on Inquiry Card, page 123

**300, 450 & 600 ma series string versions available.*

*†300, 150 & 100 ma series string versions available.*

FROM GENERAL INSTRUMENT CORPORATION

## life expectancy over 100,000 hours

## 3 times normal current density

*no elaborate protective devices required*

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# Tri-AMP

SELENIUM RECTIFIERS

3* AMP/IN²

**THE DIFFERENCE AT A GLANCE!**

| New Tri-AMP 3-phase Bridge | | Standard Type 3-phase Bridge | |
|---|---|---|---|
| Dimensions | Amp. | Dimensions | Amp. |
| 4" x 4" *Fan Cooled | 54 | 4" x 4" Fan Cooled | 16.8 |
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Conventional selenium rectifiers are obsolete now that General Instrument has developed the amazing new Radio Receptor TRI-AMP — a completely new selenium semiconductor operating at triple the current density of standard stacks. Even more important, these stacks give complete reliability over a life span of more than 100,000 hours.

TRI-AMP rectifiers have all the advantages of selenium, and elaborate protective devices required by other semiconductors for overvoltage and overcurrent aren't necessary.

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**See us in March at the IRE Show in New York, Booths 2211-2217**

Circle 322 on Inquiry Card, page 123

## IRE Technical Papers

*(Continued from page 231)*

Microwave Mixer Performance at Higher Intermediate Frequencies, M. Cohn and J. B. Newman.

### Thursday Morning—March 26

#### Theory and Practice in Russian Technology

**Waldorf-Astoria—Starlight Roof**

Highlights of Soviet Information Theory, P. E. Green, Jr.
Digital Computer Activities in the Soviet Union, N. R. Scott.
Theory and Practice in Automatic Control, W. E. Vannah.

#### Circuit Theory II—Analysis and Synthesis

**Waldorf-Astoria—Astor Gallery**

Sensitivity of Transmission Zeros in RC Network Synthesis, F. F. Kuo.
Synthesis of Active Networks—Driving-Point Functions, N. DeClaris.
Linear Modular Sequential Circuits and Their Application to Multiple Level Coding, B. Friedland and T. E. Stern.
Taylor-Cauchy Transforms for Analysis of a Class of Nonlinear Systems, Y. H. Ku, A. A. Wolf, and J. H. Dietz.

#### Ultrasonic Engineering—I

**Waldorf-Astoria—Jade Room**

Automatic Ultrasonic Flaw Detection, E. G. Cook.
Cavitation Erosion of Sonic Radiating Surfaces, H. F. Osterman.
Piezoelectric and Dielectric Properties of Ceramics in the Potassium-Sodium Niobate System, L. Egertan and D. M. Dillon.
Transducer Properties of Lead Titanate Zirconate Ceramics, D. Berlincourt, B. Jaffe, H. Jaffe, and H. Krueger.

#### Military Electronics Looks Forward

**Waldorf-Astoria—Sert Room**

Measurement of Missile Miss Distance, A. E. Hayes, Jr.
Radar Testing for a War Environment, R. W. Hanford.
Trends in Inertiol Navigation, F. Stevens.
Space Vehicle Electromagnetic Communications and Tracking, H. Hoffman, Jr.

#### Frontiers of Industrial Electronics

**Waldorf-Astoria—Empire Room**

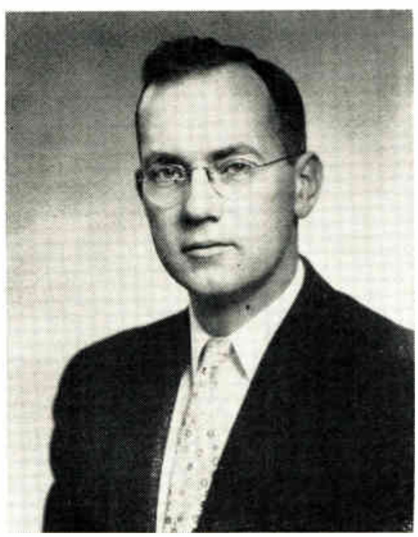
Some Characteristics of the Industrial Electronic Business, H. A. Strickland, Jr.
Automation Trends in the Bank Industry, B. Miller.
Industrial Electronics—The Growing Servant of Mankind, T. A. Smith.

#### Man-Machine System Design

**New York Coliseum—Morse Hall**

Communiction Display and Control—A New Concept, R. J. Meyer.
The Effect of Loop Characteristics upon Human Gain, J. S. Sweeney and A. Graham.
The Influence of Nonlinear Transfer Function on

**Charles H. Townes**
**Co-Winner, Morris Liebmann Memorial Prize**



Jack W. Herbstreit
Harry Diamond Memorial Award

Cathode-Ray Tube Visual Detection Threshold, C. W. Miller and W. R. Minty.
Human Factors in the Design of the NRL Nuclear Reactor Control System, H. J. Berliner, M. P. Young, and G. F. Wall.

### Antennas—II

New York Coliseum—Marconi Hall

Electrically Small DF Antenna, E. McCann and H. H. Hibbs.
Experiments and Calculations on Surface-Wave Antennas, R. G. Molech and S. J. Blank.
Ferrite Excited Slots with Controllable Amplitude and Phase, H. E. Shanks and V. Galindo.
Improved Feed Design for Amplitude-Monopulse Radar Antennas, J. P. Shelton.
The Directional Coupler Antenna, C. Fink.
Arbitrarily Polarized Planar Antennas, F. J. Goebels, Jr. and K. C. Kelly.

### Instrumentation: Devices and Circuits

New York Coliseum—Faraday Hall

Printed Circuit DC Motors for Electronic and Instrument Applications, R. P. Burr and J. Henry-Baudot.
A 100 CPS X-Y Recorder, J. P. Brady, Jr.
A Proposed Automatic Test Set for the Measurement of Communication Cable Parameters, H. N. Aviles.
A Precision 60-MC Logarithmic Amplifier, S. Cohen, H. Laskin, E. Schecker, and B. Woodward.
Design and Development of a Noise and Field Instrument for 1000- to 12,000-MC Frequency Range, A. Borck and M. Rodriguez.

## Thursday Afternoon

### Electronic Computers: Components and Circuits

Waldorf-Astoria—Starlight Room

Magnetic Drum Time Compression Recorder, W. R. Chynoweth and R. M. Page.
Fast Microwave Logic Circuits, D. J. Blattner and F. Sterzer.
Multiple-Input Analog-to-Digital Converter with 12-Bit Accuracy and Fast, Nonsequential Switching, H. S. Horn.
Asynchronous Electronic Switching Circuits, M. Kliman and O. Lowenschuss.
The Cycle Splitter—A Wide-Band Precision Frequency Multiplier, B. E. Keiser.

### Circuit Theory III—Applications

Waldorf-Astoria—Astor Gallery

Panoramic Spectrum Analyzer in Real Time, B. D. Steinberg and W. G. Ehrich.
A Long-Memory Delay-Line Analog Recirculator, M. S. Zimmerman, W. G. Ehrich, and D. E. Sunstein.
Choice of the Shape of the Input to a Spectrum Analyzer in Terms of Its Effect on Transient Selectivity and Signal Detectability, W. Gersch.
A Minimum Distortion Tapered-Transmission-Line Transformer for Pulse Application, H. Amemiya.
Transistor Digital Tape Record Circuit, A. E. Hayes, Jr.

### Ultrasonic Engineering—II

Waldorf-Astoria—Jade Room

*(Continued on page 236)*

# IRE Technical Program

(Continued from page 235)

Thickness-Shear Mode Barium Titanate Ceramic Transducers for Ultrasonic Delay Lines, J. E. May, Jr.
Vibrations of Ferroelectric Transducer Elements Loaded by Masses and Acoustic Radiation, F. Rosenthal and V. D. Mikuteit.
Effect of Electrical and Mechanical Terminating Resistance on Loss and Bandwidth According to the Conventional Equivalent Circuit of a Piezoelectric Transducer, or How to Get the Most Out of Your Ultrasonic Delay Line, R. N. Thurston.
Measuring the Characteristics of Present-Day Ultrasonic Delay Lines, J. J. G. McCue and M. Axelbank.
Ultrasonic Welding Equipment, J. N. Antonevich.

### Concepts and Programs

Waldorf-Astoria—Sert Room

An Orbit Program for Engineering Use, H. R. Smith and B. H. Bloom.
A Study and Design Evaluation of the Throw-Away Maintenance Concept, J. J. Andrea and M. V. Ratynski.
Amplitude Modulated Video Integrator, R. E. Ellis.
The Significance of Specifications in Government-Sponsored Technical Development Programs, J. Cryden.

### Communication Engineering in Broadcasting

New York Coliseum—Morse Hall

Transmission of Television Signals over a Broad-Band Tropospheric Scatter Link, L. Pollock.
Installation and Operational Aspects of a Private Television Microwve System, A. Shelton.
Mobile Microwave Television Pickup Operational Experiences, G. E. Hamilton.
Effect of Frequency Cutoff Characteristics on Spiking and Ringing of TV Signals, A. D. Fowler and J. D. Igleheart.
50-Kilowatt Antenna Switching System, J. W. Smith.

### Antennas—III

New York Coliseum—Marconi Hall

Log Periodic Feeds for Lens and Reflectors, R. H. DuHamel and F. R. Ore.
Broad-Band Conical Helix Antennas, H. S. Barsky.
Very Broad-Band Feed for Paraboloidal Reflectors, J. R. Tomlinson and M. N. Fullilove.
Far Field Patterns of Circular Paraboloidal Reflectors, G. Doundoulakis and S. Gethin.
Effects of Random Errors on the Performance of Antenna Arrays of Many Elements, L. A. Rondinelli.
The Hourglass Scanner, a New Rapid Scan, Large Aperture Antenna, M. N. Fullilove, W. G. Scott, and J. R. Tomlinson.

### Instrumentation for High-Speed Data Acquisition

New York Coliseum—Faraday Hall

A 64-Channel Millimicrosecond Time Analyzer, T. P. Long.
Magnetic Recording and Reproduction of Pulses, D. F. Eldridge.
An Improved Method of Calibrating FM Magnetic Tape Transports, L. Bohnstedt.
Ratrase, a High-Capacity, Low-Level Automatic Data Handling System, G. F. Mooney.
A Data Processing System Using Glow Tubes, S. K. Chao.

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## Solid-State Digest

The 1959 Solid-State Conference held in Philadelphia, Pa., Feb. 12-13 broke all previous attendance records. More than 2100 engineers registered. The technical papers presented during the two-day session have been assembled in a printed 104-page book in digest form. Copies are priced at $4.00 each and may be obtained from H. G. Sparks, The Moore School of Electrical Engineering, University of Pennsylvania, 200 South 33rd St., Philadelphia 4, Pa.

# First Digital Voltmeter With Mathematically Perfect Logic . . .


The first stepping switch voltmeter with mathematically perfect logic . . . and the first to be completely transistorized! It's the NLS V-34, the latest instrument to be developed by the originators of the digital voltmeter. The exclusive new digital logic of the NLS V-34 allows readings to be made without cycling stepping switches through all nine positions in each decade. For the first time, "needless nines" are eliminated . . . the result: longer switch life and shorter measuring time. Check the exclusive features listed below.

## "NO NEEDLESS NINES"

### FOR FASTER MEASUREMENTS AND GREATEST RELIABILITY

**MATHEMATICALLY PERFECT LOGIC**—No numbers change that absolutely do not have to change. Stable measurements can be made of varying voltages.

**STEPPING SWITCHES SEALED IN OIL**—Each stepping switch is mounted in an individual oil-filled container. No manual lubrication needed. Oil bath extends life by factor of ten.

**PLUG-IN STEPPING SWITCH MODULES**—Stepping switches can be replaced as quickly as plugging in the meter.

**FIRST COMPLETELY TRANSISTORIZED DIGITAL VOLTMETER**—Even logic functions are performed by semi-conductors. Switch points reduced to one-half those required by "completely transistorized" competitive meters. Only the NLS V-34 is transistorized to the fullest possible extent.

SPECIFICATIONS

Range to ±1000 volts . . . Ratio to ±.9999 . . . 10 Megohm input impedance . . . 0.01% accuracy . . . Automatic range and polarity changing . . . five-digit model also available.

See the NLS V-34 at the 1959 I.R.E. Show . . . and write today for complete information.

*Originators of the Digital Voltmeter*

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**1959 IRE SHOW — Booths 3041-2**

## COMPARISON CHART

The few steps required by the NLS V-34 to make a typical measurement (3rd column) are compared with the many required by competitive meters. Note the blue "needless nines" in the middle column.

| NO. OF STEPS | COMPETITIVE METERS | NLS V-34 |
|---|---|---|
| 0 | +.8888 | +.8888 |
| 1 | +.8889 | —.8888 |
| 2 | +.8880 | —.9888 |
| 3 | +.8890 | —.0888 |
| 4 | +.8800 | —.1888 |
| 5 | +.8900 | —.1988 |
| 6 | +.8000 | —.1088 |
| 7 | +.9000 | —.1188 |
| 8 | +.0000 | —.1198 |
| 9 | —.0000 | —.1108 |
| 10 | —.0001 | —.1118 |
| 11 | —.0002 | —.1119 |
| 12 | —.0003 | —.1110 |
| 13 | —.0004 | —.1111 |
| 14 | —.0005 | |
| 15 | —.0006 | |
| 16 | —.0007 | |
| 17 | —.0008 | |
| 18 | —.0009 | |
| 19 | —.0019 | |
| 20 | —.0029 | |
| 21 | —.0039 | |
| 22 | —.0049 | |
| 23 | —.0059 | |
| 24 | —.0069 | |
| 25 | —.0079 | |
| 26 | —.0089 | |
| 27 | —.0099 | |
| 28 | —.0199 | |
| 29 | —.0299 | |
| 30 | —.0399 | |
| 31 | —.0499 | |
| 32 | —.0599 | |
| 33 | —.0699 | |
| 34 | —.0799 | |
| 35 | —.0899 | |
| 36 | —.0999 | |
| 37 | —.1999 | |
| 38 | —.1099 | |
| 39 | —.1199 | |
| 40 | —.1109 | |
| 41 | —.1119 | |
| 42 | —.1110 | |
| 43 | —.1111 | |

THE MEASUREMENT IS COMPLETED IN JUST 13 STEPS BY THE NLS V-34

**NLS—The Digital Voltmeter That Works . . . And Works . . . And Works!**



Circle 340 on Inquiry Card, page 123

## Standardizing Stereo

(*Continued from page* 117)

signal. The phase correction may be considered as a delay correction.

The simplicity of the radio receiver designed to reproduce two stereophonic sound channels that are broadcast over a single commercial broadcast AM channel is shown in the block diagram of an AM compatible stereophonic receiver. As mentioned, this method provides for the balanced monophonic information (L + R) to be carried by the envelope and the stereophonic information (L — R) by the frequency. The detectors separate these AM and FM signals; the adder and subtractor combine them to obtain the left and right signals; the speakers reproduce sounds in spatial relation to their locations at the point of origin. The FM detector, the adder, the subtractor, and the extra speaker when added to a standard AM radio receiver convert it into an AM compatible stereophonic receiver.

## Parametrics & Masers

### —*Questions & Answers*

**What is a parametric amplifier?**

It is a solid state amplifier notable for excellent noise performance at microwave frequencies. It employs as the principal source of energy not a DC power supply as does the conventional electron tube amplifier, but rather high frequency energy derived from a so-called "pump." Depending on the particular type of parametric amplifier, this pump must supply energy at a fixed and stable frequency, from about two to many times higher than the frequency of the signal we wish to amplify. In the tube amplifier the energy transformation from the DC source to the signal is provided by the electron beam. In contrast to this, the parametric amplifier employs a solid state element to transform energy from the high frequency pump to the signal. In almost all cases of practical significance to date, this solid state element has been a special type of semiconductor diode. When excited by the pump, this diode behaves like a capacitor, with the terminal capacitance varying at the pump frequency. In the simplest parametric amplifier this capacitance is pumped at twice the signal frequency. The amplification process then has a simple mechanical analogue, namely that of a child "pumping-up" the excursions of a swing by raising and lowering his center of gravity twice during each complete cycle of the swing.

The excellent noise properties of this amplifier stem in part from the absence of a hot cathode and a spatial motion of electrons both of which form important sources of noise in tube amplifiers.

**What is a maser amplifier?**

It is a microwave amplifier yielding the ultimate in noise performance in present technology. This noise performance is greatly superior to the best obtainable with electron tubes, transistors or parametric amplifiers. In contrast to these types, the maser makes use of the quantized nature of matter, that is, of the fact that molecules or atoms in many types of materials exist in discrete energy levels or oscillatory states. Amplification is obtained by the interaction between an electromagnetic field and these discrete energy levels. A spatial transport of electrons is not utilized and a major source of noise, thereby, eliminated.

While many different schemes of maser operation are possible and have indeed been investigated, the so-called "Three-Level Solid State Maser" is beginning to emerge as the most useful and practical amplifier. In one of its more successful forms, it employs synthetic ruby of precisely controlled chemical composition as active material. To create within this material three energy levels having the separation and population densities required for amplification, it must be cooled to liquid helium temperature, immersed in a strong and quite uniform DC magnetic field and subjected to high frequency radiation. The source of this high frequency radiation is again called the "pump," although its action is basically different from that of the pump used in the parametric amplifier.

Maser amplifiers have been operated at microwave frequencies from about 1000 to 10,000 MC. In this frequency range the effective sky temperature is low enough to permit the fullest utilization of the low noise properties of maser amplifiers.

**Applications of Parametric Amplifiers and Masers.**

Both are low noise microwave amplifiers and are therefore useful as first stages in very sensitive microwave receivers. The noise performance of the maser is greatly superior to that of the parametric amplifier. On the other hand, the maser is a more costly and complex device since, for the present at least, it requires refrigeration. There are many applications, however, in which the increase in range made possible by the greater sensitivity of the maser amplifier is

(*Continued on page* 240)

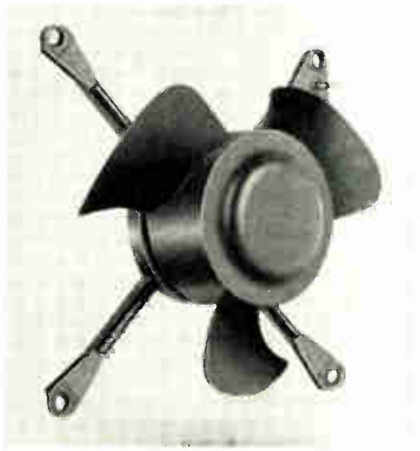
(*Continued from page* 239)
well worth the additional complexity. Most of these applications occur in the 1000 to 10,000 MC range where the effective sky temperature is very low and where the receiving antenna is essentially pointed at the sky as in missile defense, radio astronomy and satellite communications. Another condition for the fullest utilization of maser noise performance is that the noise contributed by transmission loss between the receiving antenna and the maser amplifier be kept as low as possible.

Below 1000 MC, sky noise becomes sufficiently high that masers can no longer be used efficiently. Frequencies in this vicinity are used for "scatter" or "over-the-horizon" propagation. Here, the parametric amplifier appears quite attractive, since its noise performance is sufficiently better than that of vacuum tubes in this range
(*Continued on page* 243)

## "Inside Out" Motor

A design concept developed by Rotron Manufacturing Co., Inc., Woodstock, N. Y,, for their line of Military type cooling fans is incorporated in their latest commercial blower, the Muffin. The design reverses the standard rotor-stator positions; the stator is placed inside the rotor.

The basic fan has just two parts. The rotor, fan blades, and shaft make up one part; the stator, bearings, and mounting bracket the other. The pieces in each part are



reinforced with fiberglass and held together by the encapsulating resin.

The "inside out" concept and cantilevered bearings permit a reduction in length to 1½ in. The 5 in. sq. fan, driven by the 60 cycle, shaded-pole motor, moves over 100 CFM at comparatively high pressures and within the limits of 42 db on the A scale.

Circle 336 on Inquiry Card, page 123 ⟶

# TELERAD is your best, most reliable source for prompt delivery to meet immediate FLEXIBLE waveguide needs


**TELE-FLEX**...standard moulded sections, the ideal waveguide for use where vibration mounts are not practical.


**TELE-TWIST** . . . permits quick twisting for immediate field use on "E" and "H" plane bends.

**TELE-FORM** . . . the finest pre-formed waveguide for use where extremely tight radii must be held.

*Catalog on request.*

**FOR OVER 15 YEARS**
Telerad Manufacturing Corporation has been a dependable source for reliable microwave components and equipment, built to military standards.

Telerad products embrace L, S, C, X and K bands.

DUPLEXERS • MIXERS • ATTENUATORS • FEEDS

CAVITIES • DIRECTIONAL COUPLERS • LOADS

FREQUENCY METERS • SIGNAL GENERATORS

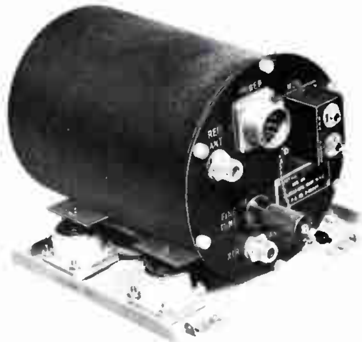
POWER METERS • PHASE SHIFTERS • TUBE MOUNTS

ROTARY JOINTS • THERMISTOR MOUNTS

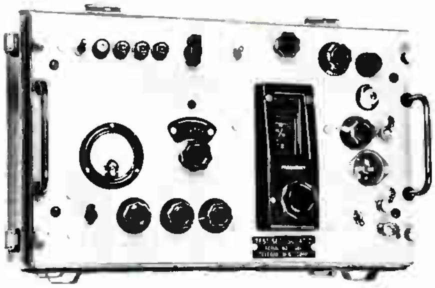
RADAR BEACONS • RADAR TRANSMITTERS

WAVE GUIDE SWITCHES

**HETERODYNE FREQUENCY METER** . . . accurate to .01% frequency measurement 100-10,000 mc (TFM-186).



**GUIDED MISSILE BEACONS**... high sensitivity, proven reliability, available in S and L bands.



**X-BAND POWER METER** . . . frequency meter and calibrated signal generator, self-contained, immediate delivery (TSG-147D).

*Telerad*
*DESIGNERS and MANUFACTURERS*
*1440 Broadway, New York 18, N. Y.*
*BRyant 9-0892*

**MANUFACTURING CORPORATION**

*Dallas:* Southern Industrial Electronics, 429 Exchange Building
*Chicago:* Lee Falkenburg, Airborne Sales, 1665 North Milwaukee Avenue
*Canada:* Instronics, Ltd., P.O. Box 51, Stittsville, Ontario

# ATTENTION: Aircraft and Missile Manufacturers and Designers . . . for Missiles and Drones contact TELERAD

## New High-Sensitivity S-Band Beacons and High Power (1000 watt) Multiple-Pulse Decoder Circuitry Beacons

**New**

**HIGH POWER, HIGH-SENSITIVITY, S-BAND DECODER TYPE GUIDED MISSILE BEACON** . . . A reliable beacon of ruggedized construction with decoder circuitry accepting two and three pulse interrogation code groups and rejecting unwanted signals. Designed particularly for use with radars using coders such as the KY-94/GPA but subject to some modification to meet individual customer requirements.

**Model:** SRTS-2003CH
**Receiver frequency:** 2700-2900 mc
**Image rejection:** 50 db minimum
**Triggering sensitivity:** −65 dbm minimum
**Code selection:** two-pulse or 3 three-pulse
**Transmitter frequency:** 2700-2900 mc
**Transmitter pulse width:** 0.75±0.25 μ sec
**Transmitter repetition rate:** 100-1000 pps
**Transmitter peak power:** 1000W
**Modulator:** rugged thyratron type
**Altitude:** to 70,000 ft.
**Size:** 6½ x 7½ x 9¾ (475 cu. in.)
**Weight:** 15¼ lbs.
(with heat dissipating case)
**Power supplies available:**
28± 2 v transistorized converter drawing 4 A and requiring no external heat sink, or 115 V 400 cycle supply.

**HIGH-SENSITIVITY S-BAND BEACONS** . . . New superheterodyne S-Band Beacons for guided missile and drone-control applications. These receivers feature lightweight, small size, excellent reliability, ruggedized construction.

**RECEIVER-TRANSMITTER**
**Over-all triggering sensitvity:** −65 DBM
**Receiver frequency:** 2700-2900 mc
**Receiver frequency stability:** ±2 megacycles per second
**Image rejection:** 50 db minimum
**Peak transmitter power output:** 100 watts minimum
**Transmitter pulse width:** 0.75 microseconds
**Transmitter repetition rate:** 200-1,000 pps
**Transmitter stability:** ±2 megacycles per second
**Transmitter frequency range:** 2850 to 2950 mc
**Size:** 9″ x 5¼″ x 5″
**Weight:** 8 lbs.
**POWER SUPPLY**
**Input Voltage:** 115 volts at 400 cycles
**Input Power:** 80 watts
**Size:** 7″ x 5″ x 4¾″
**Weight:** 5½ lbs.
A 28 volt DC supply is available on special order

**MODEL 19SC "S" BAND BEACON**—Small; Lightweight

**RECEIVER**
**Frequency range:** 2825-2925 MC/Sec.
**Stability:** ±2MC Sec.
**Triggering sensitivity:** − 40 DBM
**Interrogation:**
(a) Single 1 microsecond pulse
(b) Double 1 microsecond pulses spaced 3 microseconds
**Interrogation rate:** 100-1500 cycles per second
**TRANSMITTER**
**Frequency range:** 2850-2950 MC/Sec.
**Stability:** ±2 MC/Sec.
**Transmitted pulse width:** 0.75 ± 0.1 microsecond
**Peak power output:** 50 watts
**POWER SUPPLY**
**Input voltage:** 6.5 ± .5 V.D.C. @ 2.5 amperes
**Output voltage:** 150 V.D.C.
**DUPLEXER**
**Isolation:** 20 DB (Min.)
**ENVIRONMENTAL AND MECHANICAL SERVICE CONDITIONS**
**Acceleration:** 100 G in the longitudinal direction, 25 G in other directions
**Shock:** 100 G in the longitudinal direction and the other mutually perpendicular directions
**Vibration:** 10 to 55 c.p.s. @ .08 inch
**Temperature:** +32° to +158° F
**Humidity:** Up to 100%
**Pressure:** 15 lbs. sq. in. gauge
**Size (Receiver-Transmitter):** 6¼″ L. x 2½″ Diam.
**Weight (Receiver-Transmitter):** 2 lbs.
**Size (Power Supply):** 5″ L. x 2½″ Diam.
**Weight (Power Supply):** 2 lbs.

**NEW HIGH-POWER "S" BAND TRANSMITTER CAVITY MODEL STS-42**—Small Size; Lightweight

**Frequency range:** 2700-2900 MC
**Peak Power Output:** 1 Kw (Min.)
**Frequency stability:** 4 MC
**Vibration:** 10-2000 C.P.S.@ 10G
**Size:** 4¾″ L. x 1¾″ W. x 2¼″ H.
**Shock:** 50 G
**Weight:** 1 lb.
**Temperature range:** −50° C to +70° C

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*Call or write Telerad today in connection with your beacon or drone project*

(*Continued from page* 240)
to make possible considerable extensions in range and, with it, great reductions in system costs. Parametric amplifiers should also find applications in radio relay communications at microwaves where the antennas, because of their low elevation, receive some ground noise and in radar and missile guidance applications where the utmost in receiver sensitivity is not required.

From prepared statement distributed exclusively at the 1959 Solid State Conference, Feb. 12-13, 1959, Philadelphia, Pa., by E. D. Reed, Bell Telephone Laboratories Inc., Murray Hill, N. J.

## *Engineering Enrollments Sagging, Despite Demands*

For the first time in seven years, and despite still-critical demands for engineering talent, enrollment in American engineering schools is on the decline.

The 153 accredited American engineering colleges had 2.9% less students in the fall of 1958 than in the fall of 1957. And the freshman class which entered last fall was 11.6% smaller—59,164 instead of 67,071—than 1957.

Declining enrollments have not yet affected the number of engi-

(*Continued on page* 244)

(*Continued from page* 243)

neering graduates—31,216 in 1957-58 compared with 27,748 the previous year. But the numbers are far short of the record graduation of eight years ago, when World War II veterans were finishing their delayed college careers.

These engineering enrollment figures come from the annual official survey students and degrees conducted by the American Society for Engineering Education in co-operation with the U. S. Office of Education. Final results were reported today by Justin C. Lewis, Head of Higher Education Statistics, and Dr. Henry Armsby, Chief for Engineering Education, both of the U. S. Office of Education.

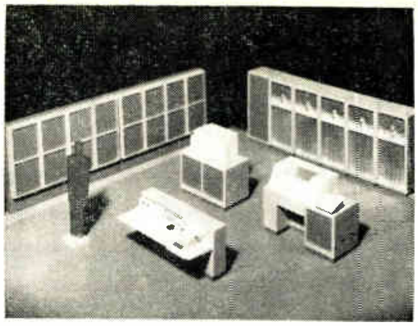
Fears of dropping engineering enrollments were confirmed by the official figures. Engineering students are now less than 7.7% of all American college students, compared with nearly 8.5% in 1957. Enrollment of second-year students is down 6% from last year, and third-year students are down 4%. Only in the fourth- and fifth-year category does this year's enrollment total as large as last year's. This gives promise of more graduates in June 1959; but there may be fewer in the years thereafter.

Graduate study in engineering continues to increase sharply, and enrollment is now at record levels, according to the ASEE—Office of Education figures. This fall 27,456 students were enrolled in master's degree programs, an increase of 14.7% over 1957; and 4,762—up 14.3%—were studying for doctor's degrees.

Last year 5,751 master's degrees were given in engineering, nearly 10% of all master's degrees given in the United States during the year. There were 653 doctor's degrees, 8% of doctor's degrees given in all fields.

Electrical engineering with slightly over 56,000 undergraduate students is by for the most popular engineering field; just over 8,700 bachelor's degrees in electrical engineering were awarded in 1957-58.

Electrical engineering is also most popular among graduate students, with chemical engineering second and mechanical engineering third.



**Honeywell 800 computer performs 30,000 three-address operations per second — handles 8 separate programs simultaneously**

## Computer Handles 8 Jobs at One Time—Checks Work

A new medium-scale computer, the Honeywell 800, can process up to 8 data-handling or scientific computation jobs simultaneously. It uses "Traffic Control" to allow the central processor to communicate simultaneously with as many as 16 input or output devices, eliminating bottlenecks caused by the comparatively slow speeds of supporting equipment. Paralleled jobs can be separately started and stopped as though they were being performed on separate machines.

Orthotronic Correction is used to reconstruct lost, damaged or garbled data instantly and automatically. The system also incorporates an extensive checking network, including double-reading of all source data, parity checks within each word, and record to permit verification of accuracy whenever information is transferred within the system.

Deliveries of the all-transistorized system from Minneapolis-Honeywell Regulator Co., Datamatic Div., Newton Highlands, Mass., are scheduled for the last quarter of 1960.

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## Indian Program Lures Electronics Industry

Indian leaders and officials of the U. S. Bureau of Indian Affairs are developing greater economic activity around the reservations so that Indian people can improve their basic living standards.

The Bureau's Industrial Development Program extends certain types of services and aid to manufacturers seeking new plant sites. The Bureau also has authority, under a special vocational training program for American Indians, to reimburse manufacturers for a portion of the costs involved in training new Indian workers.

Information is now being gathered in towns adjacent to Indian reservations in States west of the Mississippi River, as well as in the States of Mississippi, North Carolina, Florida, Michigan and Wisconsin.

Six years ago, the Bulova Watch Company—prompted by the North Dakota Indian Affairs Commission—established a jewel-bearing plant at Rolla, North Dakota. Two-thirds of the 150 employees are Chippewas from the nearby Turtle Mountain Reservation, who perform highly exacting bench and machine work in manufacturing bearings for the aircraft industry.

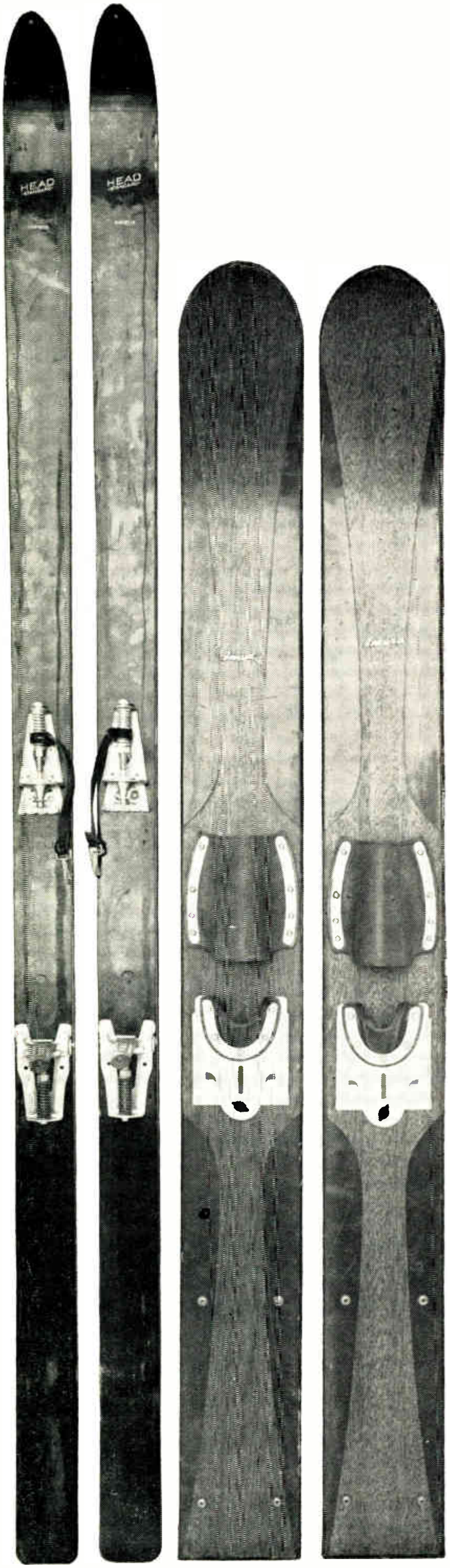
Plant manager Delbert Anderson reports, "Bulova is happy with production at the Rolla Plant. As for performance of our Indian workers, let me say that 8 out of 12 of our production supervisors are Indians."

A well-known electronics firm, the Simpson Electric Division of the American Gage & Machine Company, Chicago, Illinois, located a plant near the Lac du Flambeau Reservation in Wisconsin prior to the beginning of the present Program. Their experience has proved invaluable to the Bureau in organizing the Program. Simpson Electric employs 200 workers in precision assembly and testing operations—one half of whom are local Indians.

Harold Redding, plant superintendent, says, "We consider our Lac du Flambeau plant a definite success. Our labor turnover is far below the average for the industry, so is absenteeism. Our operation has, incidentally, dispelled any notion that American Indians are not equal in ability and dependability to any other group of workers."

The Branch of Industrial Development of the Bureau of Indian Affairs invites inquiries from industries concerning plant establishment or expansion. All inquiries are treated with strictest confidence.

Chief of the Branch of Industrial Development is J. N. Lowe, Bureau of Indian Affairs, Department of the Interior, Washington 25, D. C.



# ENGINEERS MOVE FORWARD FAST AT LINK

Talented engineers who are *looking* forward to careers with genuine opportunity will find that they can keep *moving* forward at Link Aviation.

Located in Binghamton, in the heart of Upstate New York's all-season vacationland, Link's activities are steadily expanding. New positions exist for men with productive experience in several fields:

- *Staff scientists,* for advanced work on analog computers, airborne instrumentation, industrial controls and precision measurements
- *Mechanical engineers,* for electronic and electro-mechanical packaging
- *Design engineers,* for work on analog computers, systems, and components
- *Senior optics development engineers*
- *Applied mathematicians*

Link Aviation, Inc., is engaged in projects whose scope far exceeds its long-standing reputation for flight-simulation equipment. Engineers are stimulated by this diversity. And they like the recognition given them, in such forms as excellent salaries, exceptional insurance and retirement plans, and tuition-free advanced university courses.

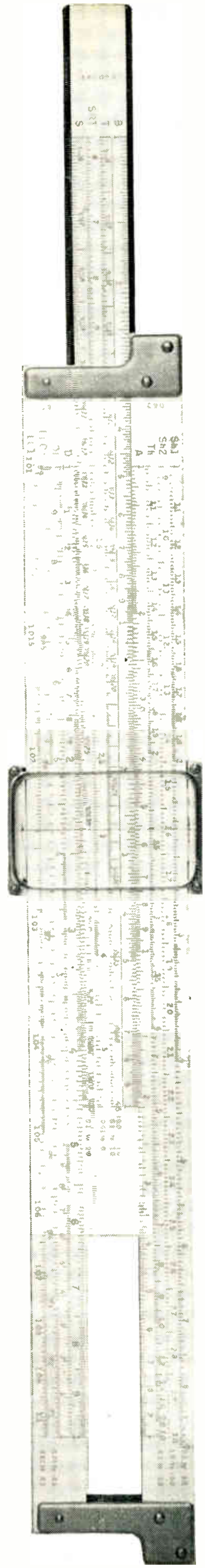
If you want to progress in this direction contact us at once.

Write to: Mr. A. R. Wieland,
Link Aviation, Inc.,
Binghamton, New York

LINK | GENERAL PRECISION EQUIPMENT CORPORATION GPE

LINK AVIATION, INC.

A subsidiary of General Precision Equipment Corporation



# "Today's Electronic Engineer"

***What is the age of the "average" engineer? What is his income? How much life insurance does he carry? How much is his house worth? How many children does he have? What is the worth of his liquid assets? EI wondered about this personal side of the engineer and set out to find the answers. We did, from thousands of engineers across the country.***

IN recent years electronic engineers have become the "prized possessions" of their organizations rather than merely creative, educated and talented employees. The tremendous growth pattern of this industry involving the production of both consumer and military items has been the cause for engineering talent shortages in many areas. As a result, electronic manufacturing and development organizations have been forced into competitive recruitment programs as a means of self-survival. At technical shows and conventions the "engineers wanted" bulletin boards and the "recruitment suites" are now an accepted part of the proceedings. Much has been written by many companies to "sell" the engineer on the advantages they offer. Salaries, paid vacations, extended education, health benefits, pension plans, profit sharing plans are all part of a "fringe" benefit program that engineers look for in accepting new positions today. Some organizations with adequate resources undertook extensive research programs to develop data that in turn would enable them to attract new scientific talent. Other organizations with lesser amounts of wherewithal undertook proportionately more modest programs.

In all of this activity several significant points did emerge. Companies knew that they needed an ever increasing amount of scientific talent in order to continue producing and to grow and prosper. Companies also learned to develop effective recruitment techniques and incentives. But also, it became apparent that many organizations were not quite certain about the personality characteristics of the engineers they wanted to reach and about the occupational advantages that they enjoyed. In an effort to provide such information on both an informative and statistical basis, ELECTRONIC INDUSTRIES conducted a readership survey during the 4th quarter of 1958. (See Today's *Electronic Engineer*, page 1, December 1958.) The data collected was transcribed onto IBM cards and the cards in turn were then manipulated to show data by age groups and by regions where the engineers are employed. Below and on the succeeding pages we are proud to present the results of this analysis. Age groups are the ordinates, regions the abscissas. Under totals we show the number of questionnaires involved and the percentage with relation to 100%. Under the regional listing we show only the number of questionnaire returns from that region.

We should like to emphasize that this presentation is only one way to utilize this data. Because the basic information has been punched onto IBM cards there are a great many other ways in which to cross correlate this information.

| *Age Groups* | % | |
|---|---|---|
| Under 25 | 4 | 75% under 40 years of age |
| 25 - 29 | 18 | |
| 30 - 34 | 32 | |
| 35 - 39 | 21 | |
| 40 - 44 | 12 | |
| 45 - 49 | 6 | |
| 50 - 54 | 4 | |
| 55 and over | 3 | |

*Education*

| | | |
|---|---|---|
| Degrees | 92% | |
| B.A, B.S. | 71% | hold one or more (44% hold B.S.E.E.) |
| M.A., M.S. | 18% | hold one or more |
| Ph.D. | 3% | hold one or more |

*Military Service*

67.6% have served in the armed forces

- A. Navy 41%
- B. Army 39% (3% served in more than 1 branch)
- C. Air Force 20%
- D. Marines 3%

*Miscellaneous Information*

16% are ham operators
8% are licensed pilots

(*Continued on page* 251)

ENGINEERS

# Why engineering staff turnover at General Electric's Heavy Military Electronics Dept. is less than 3½%*

## A Success Story of Particular Interest To The Engineer Capable of More Creative Productivity

There are many reasons for Heavy Military's remarkable turnover record. We believe that the preponderant factor is Heavy Military's policy of advancement based *solely* on individual contributions. Where a man goes — how fast he goes—is not determined by artificial standards: degrees, "salary norms," age, seniority. Recognition and renumeration, under our Salary Administration Plan, increase directly with accomplishment. And there are *two* parallel paths of advancement: as specialist consultant — or as manager-supervisor, with equal compensation and status.

The result? Professional achievements that have steadily enlarged Heavy Military's responsibilities. This has meant a 5-fold growth of the professional staff; a 4-fold increase in number of engineering management and supervisory positions in just 4 years.

***Does this environment of vigorous accomplishment appeal to you?***

If so, look into Heavy Military's openings on long-range projects in *all* the areas listed to the right:

**Radiometry**
- 3-D Radar Systems
- Ultra-Range Radars

**Data Processing**
- Sophisticated Display
- Digital Detector Trackers
- Integrated Air-Defense Environments
- Air-Space Management Systems

**Unconventional Communications Systems**
- Synchronous and Scatter Systems
- Secure Communications
- High-Speed Data Links
- Space Communications

**Advanced Sonar Systems**
- Long-Range Search Sonar
- Doppler Sonar
- Secure Underwater Communications
- Mine Warfare Sonar

*Your confidential resume will receive careful attention.*
*Write to:* MR. GEORGE B. CALLENDER, DIV. 24MC
HEAVY MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

COURT STREET, SYRACUSE, N. Y.

* *A 4-year average including transfers to other G-E components, retirements, etc.*

APPROXIMATE ANNUAL INCOME - 5 YEARS AGO?

| Age - under 25 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 55 | 98.2 | 10 | 16 | 6 | 3 | 1 | 19 |

| Age 25 - 29 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 269 | 83.5 | 17 | 106 | 34 | 12 | 38 | 62 |
| 5,000 - 5,999 | 35 | 10.9 | 5 | 11 | 5 | 1 | 3 | 10 |
| 6,000 - 7,499 | 8 | 2.5 | 2 | 3 | 2 | | | 1 |
| 7,500 - 9,999 | 6 | 1.9 | | 2 | 1 | | 2 | 1 |
| 10,000 - 12,499 | 2 | .6 | | | 1 | | 1 | |
| 12,500 - 14,999 | 2 | .6 | | 1 | | | | 1 |
| 15,000 - 17,499 | | | | | | | | |
| 17,500 and over | | | | | | | | |

Median - $5,000

| Age 30 - 34 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 270 | 43.8 | 22 | 85 | 37 | 22 | 44 | 60 |
| 5,000 - 5,999 | 185 | 30.0 | 16 | 71 | 25 | 8 | 19 | 46 |
| 6,000 - 7,499 | 116 | 18.8 | 4 | 55 | 11 | 7 | 11 | 28 |
| 7,500 - 9,999 | 35 | 5.7 | 2 | 16 | 6 | | 4 | 7 |
| 10,000 - 12,499 | 7 | 1.1 | | 4 | | 1 | | 2 |
| 12,500 - 14,999 | 2 | 0.3 | | | | | | 2 |
| 15,000 - 17,499 | | | | | | | | |
| 17,500 and over | 2 | 0.3 | | 1 | | | 1 | |

Median - $5,792

| Age 35 - 39 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 75 | 18.0 | 14 | 22 | 10 | 6 | 8 | 15 |
| 5,000 - 5,999 | 114 | 27.3 | 7 | 34 | 23 | 3 | 23 | 24 |
| 6,000 - 7,499 | 107 | 25.7 | 6 | 43 | 14 | 7 | 19 | 18 |
| 7,500 - 9,999 | 89 | 21.3 | 12 | 32 | 11 | 4 | 6 | 24 |
| 10,000 - 12,499 | 18 | 4.3 | 2 | 9 | 3 | 1 | | 3 |
| 12,500 - 14,999 | 7 | 1.7 | | 4 | 1 | | | 2 |
| 15,000 - 17,499 | 5 | 1.2 | 2 | | | | 2 | 1 |
| 17,500 and over | 2 | 0.5 | | 2 | | | | |

Median - $7,226

| Age 40 - 44 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 31 | 13.5 | 2 | 9 | 4 | 4 | 8 | 4 |
| 5,000 - 5,999 | 42 | 18.3 | 6 | 12 | 7 | 1 | 4 | 12 |
| 6,000 - 7,499 | 53 | 23.0 | 2 | 16 | 4 | 3 | 11 | 18 |
| 7,500 - 9,999 | 62 | 26.9 | 7 | 28 | 4 | 1 | 11 | 11 |
| 10,000 - 12,499 | 26 | 11.3 | 1 | 16 | 2 | 2 | 1 | 4 |
| 12,500 - 14,999 | 9 | 3.9 | | 3 | 2 | | | 4 |
| 15,000 - 17,499 | 5 | 2.2 | 1 | 1 | 2 | | 1 | |
| 17,500 and over | 2 | 0.9 | | 1 | 1 | | | |

Median - $6,312

| Age 45 - 49 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 11 | 10.3 | 2 | 4 | 1 | 2 | | 2 |
| 5,000 - 5,999 | 19 | 17.7 | | 6 | 2 | 4 | 3 | 4 |
| 6,000 - 7,499 | 23 | 21.5 | 4 | 8 | 4 | | 2 | 5 |
| 7,500 - 9,999 | 28 | 26.2 | 1 | 10 | 6 | 1 | 2 | 8 |
| 10,000 - 12,499 | 16 | 14.9 | 1 | 10 | 2 | | 1 | 2 |
| 12,500 - 14,999 | 3 | 2.8 | | | 1 | | | 2 |
| 15,000 - 17,499 | 2 | 1.9 | | | 2 | | | |
| 17,500 and over | 5 | 4.7 | 1 | 3 | | | | 1 |

Median - $7,512

| Age 50 - 54 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 3 | 4.3 | 1 | | | | | 2 |
| 5,000 - 5,999 | 7 | 10.0 | | 1 | 4 | | 1 | 1 |
| 6,000 - 7,499 | 11 | 15.7 | 2 | 6 | | | | 3 |
| 7,500 - 9,999 | 27 | 38.6 | 2 | 12 | 5 | | 1 | 7 |
| 10,000 - 12,499 | 9 | 12.8 | | 2 | 2 | 2 | 1 | 2 |
| 12,500 - 14,999 | 6 | 8.6 | 1 | 3 | 2 | | | |
| 15,000 - 17,499 | 3 | 4.3 | | 3 | | | | |
| 17,500 and over | 4 | 5.7 | 1 | 2 | | | | 1 |

Median - $8,704

| Age 55 and over | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 1 | 2.2 | | | | | 1 | |
| 5,000 - 5,999 | 3 | 6.5 | | | | | 1 | 2 |
| 6,000 - 7,499 | 7 | 15.2 | 2 | 1 | 2 | | 1 | 1 |
| 7,500 - 9,999 | 8 | 17.4 | | 1 | 4 | | 2 | 1 |
| 10,000 - 12,499 | 5 | 10.9 | 1 | 2 | 1 | | 1 | |
| 12,500 - 14,999 | 4 | 8.7 | | 3 | 1 | | | |
| 15,000 - 17,499 | 4 | 8.7 | 1 | 2 | 1 | | | |
| 17,500 and over | 14 | 30.4 | 1 | 10 | 1 | | 2 | |

Median - $10,500

APPROXIMATE ANNUAL INCOME - TODAY?

| Age - under 25 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 2 | 2.3 | | 2 | | | | |
| 5,000 - 5,999 | 14 | 16.5 | 2 | 5 | 2 | 1 | | 4 |
| 6,000 - 7,499 | 54 | 63.5 | 8 | 21 | 5 | 4 | 6 | 10 |
| 7,500 - 9,999 | 14 | 16.5 | 2 | 3 | 1 | | | 8 |
| 10,000 - 12,499 | 1 | 1.2 | | | | | | 1 |
| 12,500 - 14,999 | | | | | | | | |
| 15,000 - 17,499 | | | | | | | | |
| 17,500 and over | | | | | | | | |

Median - $6,750

| Age 25 - 29 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 3 | .9 | | 2 | | | | 1 |
| 5,000 - 5,999 | 26 | 7.6 | 3 | 6 | 7 | 2 | 3 | 5 |
| 6,000 - 7,499 | 130 | 38.2 | 8 | 43 | 15 | 7 | 23 | 33 |
| 7,500 - 9,999 | 153 | 45.0 | 10 | 64 | 23 | 6 | 16 | 34 |
| 10,000 - 12,499 | 25 | 7.4 | 3 | 12 | 1 | | 1 | 8 |
| 12,500 - 14,999 | 3 | .9 | | | 1 | | 1 | 1 |
| 15,000 - 17,499 | | | | | | | | |
| 17,500 and over | | | | | | | | |

Median - $7,675

| Age 30 - 34 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 2 | .3 | | 1 | | | | 1 |
| 5,000 - 5,999 | 9 | 1.5 | | 1 | 4 | | 3 | 1 |
| 6,000 - 7,499 | 71 | 11.5 | 4 | 23 | 10 | 4 | 12 | 18 |
| 7,500 - 9,999 | 295 | 48.0 | 24 | 107 | 42 | 27 | 38 | 57 |
| 10,000 - 12,499 | 167 | 27.2 | 12 | 71 | 17 | 7 | 16 | 44 |
| 12,500 - 14,999 | 46 | 7.5 | 2 | 20 | 3 | | 6 | 15 |
| 15,000 - 17,499 | 18 | 2.9 | 2 | 6 | 1 | | 2 | 7 |
| 17,500 and over | 7 | 1.1 | | 2 | 2 | | 1 | 2 |

Median - $7,700

| Age 35 - 39 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 1 | .3 | | | | | | 1 |
| 5,000 - 5,999 | 3 | .7 | | | 1 | 1 | 1 | |
| 6,000 - 7,499 | 32 | 7.9 | 5 | 11 | 7 | 1 | 3 | 5 |
| 7,500 - 9,999 | 124 | 30.8 | 7 | 41 | 24 | 6 | 25 | 21 |
| 10,000 - 12,499 | 132 | 32.8 | 16 | 46 | 19 | 7 | 17 | 27 |
| 12,500 - 14,999 | 73 | 18.1 | 8 | 25 | 6 | 6 | 9 | 19 |
| 15,000 - 17,499 | 27 | 6.7 | 6 | 10 | 2 | | 2 | 7 |
| 17,500 and over | 11 | 2:7 | | 6 | 2 | | | 3 |

Median - $11,250

*(Continued on page 252)*

| Age 40 - 44 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | 4 | 1.8 | 1 | 2 | 1 | | | |
| 6,000 - 7,499 | 16 | 7.1 | 2 | 5 | 3 | 1 | 2 | 3 |
| 7,500 - 9,999 | 65 | 28.8 | 3 | 15 | 9 | 5 | 14 | 19 |
| 10,000 - 12,499 | 68 | 30.1 | 8 | 25 | 5 | 1 | 14 | 15 |
| 12,500 - 14,999 | 34 | 15.0 | 2 | 19 | 2 | 2 | 4 | 5 |
| 15,000 - 17,499 | 24 | 10.6 | 2 | 12 | 3 | 2 | | 5 |
| 17,500 and over | 15 | 6.6 | 1 | 6 | 3 | | | 5 |
| Median - $11,030 | | | | | | | | |

| Age 45 - 49 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 1 | .9 | 1 | | | | | |
| 5,000 - 5,999 | 1 | .9 | | | | | | 1 |
| 6,000 - 7,499 | 8 | 7.4 | 1 | 2 | 1 | 3 | | 1 |
| 7,500 - 9,999 | 33 | 30.6 | 1 | 14 | 4 | 3 | 4 | 7 |
| 10,000 - 12,499 | 28 | 25.9 | 4 | 6 | 6 | 1 | 1 | 10 |
| 12,500 - 14,999 | 17 | 15.8 | | 9 | 2 | | 3 | 3 |
| 15,000 - 17,499 | 11 | 10.2 | 1 | 7 | 2 | | | 1 |
| 17,500 and over | 9 | 8.4 | 1 | 4 | 3 | | | 1 |
| Median - $10,983 | | | | | | | | |

| Age 50 - 54 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | 1 | 1.4 | 1 | 1 | | | | |
| 6,000 - 7,499 | 5 | 7.2 | | 1 | 3 | | | 1 |
| 7,500 - 9,999 | 12 | 17.1 | 2 | 5 | 1 | | 1 | 3 |
| 10,000 - 12,499 | 18 | 25.7 | 1 | 5 | 3 | 1 | 1 | 7 |
| 12,500 - 14,999 | 15 | 21.4 | | 9 | 2 | | 1 | 3 |
| 15,000 - 17,499 | 10 | 14.3 | 1 | 5 | 2 | 1 | | 1 |
| 17,500 and over | 9 | 12.9 | 2 | 4 | 2 | | | 1 |
| Median - $12,235 | | | | | | | | |

| Age 55 and over | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | | | | | | | | |
| 6,000 - 7,499 | 3 | 5.9 | 1 | | | | 1 | 1 |
| 7,500 - 9,999 | 9 | 17.6 | | 5 | 1 | | 2 | 1 |
| 10,000 - 12,499 | 10 | 19.6 | 1 | 2 | 3 | | 3 | 1 |
| 12,500 - 14,999 | 7 | 13.7 | 1 | 4 | 2 | | | |
| 15,000 - 17,499 | 7 | 13.7 | | 3 | 3 | | | 1 |
| 17,500 and over | 15 | 29.4 | 2 | 11 | 1 | | 1 | |
| Median - $13,927 | | | | | | | | |

APPROXIMATE ANNUAL INCOME - 5 YEARS FROM NOW?

| Age - under 25 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | 1 | 1.2 | | 1 | | | | |
| 6,000 - 7,499 | 2 | 2.4 | | | 1 | 1 | | |
| 7,500 - 9,999 | 25 | 29.8 | 4 | 12 | 2 | 1 | 1 | 5 |
| 10,000 - 12,499 | 46 | 54.7 | 7 | 15 | 4 | 2 | 5 | 13 |
| 12,500 - 14,999 | 8 | 9.5 | 1 | 3 | | 1 | | 3 |
| 15,000 - 17,499 | | | | | | | | |
| 17,500 and over | 2 | 2.4 | | | 1 | | | 1 |
| Median - $10,760 | | | | | | | | |

| Age 25 - 29 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | 1 | .3 | | | 1 | | | |
| 6,000 - 7,499 | 16 | 4.8 | 2 | 6 | 4 | | 2 | 2 |
| 7,500 - 9,999 | 65 | 19.6 | 4 | 18 | 10 | 8 | 7 | 18 |
| 10,000 - 12,499 | 127 | 38.3 | 10 | 45 | 17 | 3 | 18 | 34 |
| 12,500 - 14,999 | 84 | 25.3 | 1 | 38 | 9 | 4 | 13 | 19 |
| 15,000 - 17,499 | 30 | 9.0 | 2 | 17 | 4 | | 1 | 6 |
| 17,500 and over | 9 | 2.7 | 2 | 2 | 1 | | 1 | 3 |
| Median - 11,652 | | | | | | | | |

| Age 30 - 34 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 1 | .2 | | 1 | | | | |
| 5,000 - 5,999 | 1 | .2 | | 1 | | | | |
| 6,000 - 7,499 | 7 | 1.1 | | 1 | 3 | | 2 | 1 |
| 7,500 - 9,999 | 46 | 7.5 | 3 | 12 | 6 | 3 | 8 | 14 |
| 10,000 - 12,499 | 146 | 23.9 | 12 | 50 | 21 | 16 | 18 | 29 |
| 12,500 - 14,999 | 206 | 33.8 | 13 | 80 | 30 | 16 | 27 | 40 |
| 15,000 - 17,499 | 131 | 21.5 | 12 | 52 | 13 | 2 | 17 | 35 |
| 17,500 and over | 72 | 11.8 | 4 | 30 | 6 | | 6 | 26 |
| Median - $13,762 | | | | | | | | |

| Age 35 - 39 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | 2 | .5 | | | | | | 2 |
| 6,000 - 7,499 | 3 | .8 | 1 | | | | 1 | 1 |
| 7,500 - 9,999 | 22 | 5.5 | 2 | 9 | 7 | 1 | 2 | 1 |
| 10,000 - 12,499 | 73 | 18.3 | 6 | 22 | 14 | 4 | 16 | 11 |
| 12,500 - 14,999 | 109 | 27.4 | 8 | 35 | 17 | 9 | 18 | 22 |
| 15,000 - 17,499 | 105 | 26.4 | 12 | 41 | 12 | 4 | 8 | 28 |
| 17,500 and over | 84 | 21.1 | 12 | 32 | 11 | 3 | 10 | 16 |
| Median - $14,770 | | | | | | | | |

| Age 40 - 44 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | | | | | | | | |
| 6,000 - 7,499 | 4 | 1.8 | 1 | 2 | 1 | | | |
| 7,500 - 9,999 | 15 | 6.8 | 2 | 6 | 3 | 1 | | 3 |
| 10,000 - 12,499 | 42 | 18.9 | 3 | 8 | 6 | 2 | 8 | 15 |
| 12,500 - 14,999 | 60 | 27.0 | 3 | 20 | 6 | 2 | 17 | 12 |
| 15,000 - 17,499 | 49 | 22.1 | 5 | 20 | 2 | 3 | 8 | 11 |
| 17,500 and over | 52 | 23.4 | 4 | 25 | 8 | 3 | 1 | 11 |
| Median - $14,582 | | | | | | | | |

| Age 45 - 49 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 2 | 1.9 | 1 | | | | | 1 |
| 5,000 - 5,999 | | | | | | | | |
| 6,000 - 7,499 | 1 | 1.0 | | | | | | 1 |
| 7,500 - 9,999 | 7 | 6.7 | | 3 | 1 | 2 | | 1 |
| 10,000 - 12,499 | 22 | 20.9 | 2 | 8 | 3 | 2 | 3 | 4 |
| 12,500 - 14,999 | 23 | 21.9 | | 10 | 3 | 2 | 2 | 6 |
| 15,000 - 17,499 | 26 | 24.8 | 3 | 8 | 6 | 1 | 2 | 6 |
| 17,500 and over | 24 | 22.8 | 2 | 13 | 3 | | 1 | 5 |
| Median - $14,782 | | | | | | | | |

| Age 50 - 54 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | | | | | | | | |
| 5,000 - 5,999 | | | | | | | | |
| 6,000 - 7,499 | 2 | 3.2 | 1 | 1 | | | | |
| 7,500 - 9,999 | 2 | 3.2 | | | 2 | | | |
| 10,000 - 12,499 | 12 | 19.0 | 2 | 4 | 2 | | 1 | 3 |
| 12,500 - 14,999 | 13 | 20.6 | 1 | 3 | 2 | | 2 | 5 |
| 15,000 - 17,499 | 19 | 30.2 | 1 | 7 | 4 | 1 | | 6 |
| 17,500 and over | 15 | 23.8 | 1 | 9 | 3 | 1 | | 1 |
| Median - $15,790 | | | | | | | | |

| Age 55 and over | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under 5,000 | 2 | 5.0 | | | | | 1 | 1 |
| 5,000 - 5,999 | | | | | | | | |
| 6,000 - 7,499 | 1 | 2.6 | | 1 | | | | |
| 7,500 - 9,999 | 4 | 10.3 | 1 | 1 | | | 1 | 1 |
| 10,000 - 12,499 | 4 | 10.3 | | 2 | 1 | | 1 | |
| 12,500 - 14,999 | 5 | 12.8 | | 3 | 1 | | 1 | |
| 15,000 - 17,499 | 9 | 23.1 | | 2 | 3 | | 2 | 2 |
| 17,500 and over | 14 | 35.9 | 1 | 10 | 2 | | 1 | |
| Median - $17,220 | | | | | | | | |

ARE YOU MARRIED OR SINGLE?

| Age - under 25 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 47 | 54.7 | 5 | 18 | 4 | 3 | 2 | 15 |
| Not Married | 39 | 45.3 | 7 | 14 | 4 | 2 | 4 | 8 |

| Age 25 - 29 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 287 | 81.3 | 20 | 103 | 40 | 13 | 39 | 72 |
| Not Married | 66 | 18.7 | 5 | 30 | 9 | 2 | 7 | 13 |

*(Continued on page 254)*


 Circle 505 on "Opportunities" Inquiry Card, page 125 

| Age 30 - 34 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 568 | 91.0 | 41 | 205 | 74 | 36 | 73 | 139 |
| Not Married | 56 | 9.0 | 3 | 29 | 5 | 3 | 6 | 10 |

| Age 35 - 39 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 398 | 94.8 | 40 | 139 | 60 | 20 | 56 | 83 |
| Not Married | 22 | 5.2 | 4 | 8 | 2 | 1 | 2 | 5 |

| Age 40 - 44 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 102 | 92.7 | 8 | 38 | 19 | 6 | 8 | 23 |
| Not Married | 8 | 7.3 | 1 | 4 | | 2 | | 1 |

| Age 45 - 49 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 224 | 95.7 | 18 | 85 | 25 | 11 | 34 | 51 |
| Not Married | 10 | 4.3 | 1 | 2 | 2 | | 3 | 2 |

| Age 50 - 54 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 68 | 97.1 | 7 | 29 | 12 | 2 | 3 | 15 |
| Not Married | 2 | 2.9 | | | 1 | | | 1 |

| Age 55 and over | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Married | 54 | 98.2 | 5 | 28 | 10 | 7 | 4 | |
| Not Married | 1 | 1.8 | | | | | 1 | |

## HOW MANY CHILDREN?

| Age - under 25 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 15 | 39.5 | 1 | 9 | 1 | 1 | | 3 |
| 1 | 15 | 39.5 | 2 | 5 | 2 | | 1 | 5 |
| 2 | 6 | 15.8 | | | | 1 | 1 | 4 |
| 3 | 2 | 5.2 | 1 | | | 1 | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| Median - 1 | | | | | | | | |

| Age 25 - 29 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 33 | 13.2 | 7 | 8 | 3 | 2 | 4 | 9 |
| 1 | 82 | 32.8 | 3 | 39 | 10 | 3 | 16 | 11 |
| 2 | 91 | 36.4 | 6 | 26 | 16 | 7 | 11 | 25 |
| 3 | 31 | 12.4 | 1 | 8 | 5 | 1 | 4 | 12 |
| 4 | 12 | 4.8 | 2 | 5 | 1 | | 2 | 2 |
| 5 | 1 | 0.4 | | | 1 | | | |

| Age 30 - 34 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 25 | 4.7 | 1 | 11 | 3 | 2 | 3 | 5 |
| 1 | 121 | 22.7 | 10 | 44 | 14 | 5 | 16 | 32 |
| 2 | 186 | 34.8 | 8 | 68 | 23 | 12 | 31 | 44 |
| 3 | 130 | 24.3 | 8 | 47 | 17 | 10 | 16 | 32 |
| 4 | 60 | 11.2 | 10 | 12 | 14 | 6 | 3 | 15 |
| 5 | 8 | 1.5 | 1 | 4 | | | 1 | 2 |
| 6 | 3 | 0.6 | | 3 | | | | |
| 7 | 1 | 0.2 | | 1 | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| Median - 2 | | | | | | | | |

| Age 35 - 39 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 12 | 3.1 | 1 | 3 | 2 | 1 | 2 | 3 |
| 1 | 67 | 17.6 | 3 | 25 | 11 | 3 | 9 | 16 |
| 2 | 136 | 35.7 | 14 | 48 | 23 | 7 | 17 | 27 |
| 3 | 106 | 27.8 | 11 | 36 | 14 | 6 | 20 | 19 |
| 4 | 42 | 11.0 | 8 | 12 | 5 | 2 | 4 | 11 |
| 5 | 10 | 2.6 | 2 | 1 | 2 | | 3 | 2 |
| 6 | 5 | 1.3 | | 3 | 1 | | | 1 |
| 7 | 1 | 0.3 | | 1 | | | | |
| 8 | 1 | 0.3 | | 1 | | | | |
| 9 | 1 | 0.3 | | | 1 | | | |

| Age 40 - 44 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 8 | 3.7 | 1 | 3 | | | 1 | 3 |
| 1 | 36 | 16.6 | 3 | 16 | 3 | 1 | 5 | 8 |
| 2 | 101 | 46.5 | 8 | 41 | 10 | 2 | 16 | 24 |
| 3 | 39 | 18.0 | 4 | 13 | 4 | 4 | 6 | 8 |
| 4 | 23 | 10.6 | 1 | 6 | 3 | 2 | 5 | 6 |
| 5 | 4 | 1.8 | | | 1 | 1 | | 2 |
| 6 | 2 | 0.9 | 1 | | 1 | | | |
| 7 | 3 | 1.4 | | | 2 | 1 | | |
| 8 | 1 | 0.5 | | 1 | | | | |
| 9 | | | | | | | | |
| Median - 2 | | | | | | | | |

| Age 45 - 49 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 5 | 5.3 | | 3 | | 1 | 1 | |
| 1 | 12 | 12.8 | 1 | 4 | 4 | | 1 | 2 |
| 2 | 37 | 39.3 | 2 | 16 | 7 | 1 | 1 | 10 |
| 3 | 28 | 29.8 | 4 | 9 | 2 | 2 | 3 | 8 |
| 4 | 7 | 7.4 | 1 | 2 | 1 | | 1 | 2 |
| 5 | 3 | 3.2 | | | 1 | | 1 | 1 |
| 6 | 1 | 1.1 | | 1 | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | 1 | 1.1 | | | | 1 | | |

| Age 50 - 54 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 1.6 | | 1 | | | | |
| 1 | 15 | 24.2 | 2 | 7 | 2 | 1 | | 3 |
| 2 | 27 | 43.6 | 4 | 11 | 5 | | 1 | 6 |
| 3 | 11 | 17.7 | | 4 | 3 | 1 | 1 | 2 |
| 4 | 6 | 9.7 | | 3 | | | 1 | 2 |
| 5 | 1 | 1.6 | | | | | | 1 |
| 6 | 1 | 1.6 | 1 | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| Median - 2 | | | | | | | | |

| Age 55 and over | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0 | 3 | 6.0 | | 2 | | | 1 | |
| 1 | 16 | 32.0 | 1 | 8 | 5 | | 2 | |
| 2 | 15 | 30.0 | 1 | 7 | 1 | | 3 | 3 |
| 3 | 11 | 22.0 | 2 | 5 | 3 | | 1 | |
| 4 | 3 | 6.0 | | 1 | 1 | | | 1 |
| 5 | 1 | 2.0 | 1 | | | | | |
| 6 | 1 | 2.0 | | 1 | | | | |

## IN HOW MANY INDIVIDUAL PLANTS OR COMPANIES HAVE YOU WORKED SINCE LEAVING SCHOOL?

| Age - under 25 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| One | 63 | 75.0 | 8 | 24 | 7 | 5 | 5 | 14 |
| Two | 14 | 16.7 | 2 | 4 | 1 | | 1 | 6 |
| Three | 3 | 3.6 | 1 | 1 | | | | 1 |
| Four | 2 | 2.3 | 1 | 1 | | | | |
| Five | 1 | 1.2 | | 1 | | | | |
| Median - 1 | | | | | | | | |

| Age 25 - 29 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| One | 166 | 47.3 | 6 | 59 | 22 | 6 | 31 | 42 |
| Two | 113 | 32.2 | 10 | 43 | 18 | 6 | 10 | 26 |
| Three | 50 | 14.3 | 7 | 19 | 6 | 3 | 4 | 11 |
| Four | 12 | 3.4 | 2 | 5 | 1 | | | 4 |
| Five | 5 | 1.4 | | 4 | | | 1 | |
| | 4 | 1.1 | | 2 | 1 | | | 1 |

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age 30 - 34** | | | | | | | | |
| One | 168 | 26.9 | 13 | 57 | 18 | 19 | 25 | 36 |
| Two | 175 | 28.0 | 14 | 63 | 23 | 11 | 23 | 41 |
| Three | 145 | 23.2 | 7 | 61 | 19 | 7 | 18 | 33 |
| Four | 77 | 12.3 | 7 | 34 | 11 | 1 | 10 | 14 |
| Five | 29 | 4.6 | 1 | 8 | 4 | 1 | 2 | 13 |
| Six | 18 | 2.9 | 2 | 9 | 3 | | 1 | 3 |
| Seven | 8 | 1.3 | | 2 | | | 1 | 5 |
| Eight | 3 | 0.5 | | | 1 | | | 2 |
| Nine or more | 2 | 0.3 | | | | | | 2 |
| Median - 2 | | | | | | | | |
| **Age 35 - 39** | | | | | | | | |
| | 77 | 18.4 | 4 | 33 | 15 | 7 | 8 | 10 |
| | 95 | 22.8 | 10 | 32 | 9 | 5 | 19 | 20 |
| | 88 | 21.1 | 9 | 28 | 12 | 6 | 13 | 20 |
| | 78 | 18.7 | 13 | 27 | 13 | 1 | 9 | 15 |
| | 37 | 8.9 | 5 | 9 | 6 | | 6 | 11 |
| | 18 | 4.3 | 1 | 9 | 4 | | 1 | 3 |
| | 9 | 2.2 | 1 | 2 | | 1 | 1 | 4 |
| | 9 | 2.2 | | 4 | 2 | | | 3 |
| | 6 | 1.4 | 1 | 2 | | | 1 | 2 |
| Median - 3 | | | | | | | | |
| **Age 40 - 44** | | | | | | | | |
| One | 18 | 7.7 | 3 | 5 | 3 | | 5 | 2 |
| Two | 37 | 15.9 | 3 | 15 | 3 | 3 | 6 | 7 |
| Three | 62 | 26.6 | 5 | 27 | 8 | 3 | 6 | 13 |
| Four | 34 | 14.6 | 2 | 13 | 4 | 2 | 3 | 10 |
| Five | 28 | 12.0 | 2 | 8 | 3 | 3 | 4 | 8 |
| Six | 22 | 9.4 | 1 | 5 | 4 | | 6 | 6 |
| Seven | 9 | 3.9 | | 4 | 1 | | 2 | 2 |
| Eight | 11 | 4.7 | 1 | 5 | | | 2 | 3 |
| Nine or more | 12 | 5.2 | 2 | 4 | 1 | | 3 | 2 |
| Median - 3 | | | | | | | | |
| **Age 45 - 49** | | | | | | | | |
| | 11 | 10.1 | 3 | 4 | 4 | | | |
| | 19 | 17.4 | 1 | 8 | 4 | 3 | 2 | 1 |
| | 17 | 15.6 | 3 | 5 | 4 | | | 5 |
| | 20 | 18.4 | 1 | 10 | 2 | 3 | 2 | 2 |
| | 10 | 9.2 | | 4 | 2 | | 2 | 2 |
| | 8 | 7.3 | | 2 | 1 | 1 | | 4 |
| | 6 | 5.5 | | 1 | 2 | | | 3 |
| | 6 | 5.5 | | 3 | | 1 | 1 | 1 |
| | 12 | 11.0 | 1 | 5 | | | 1 | 5 |
| Median - 4 | | | | | | | | |
| **Age 50 - 54** | | | | | | | | |
| One | 5 | 7.2 | | 5 | | | | |
| Two | 10 | 14.5 | 1 | 6 | | | | 3 |
| Three | 7 | 10.2 | 1 | 5 | | | | 1 |
| Four | 8 | 11.6 | 1 | 4 | 1 | 1 | | 1 |
| Five | 7 | 10.2 | 1 | 1 | 1 | | | 4 |
| Six | 13 | 18.8 | 1 | 4 | 6 | | 1 | 1 |
| Seven | 4 | 5.8 | 1 | 2 | | | 1 | |
| Eight | 9 | 13.0 | | 1 | 5 | 1 | 1 | 1 |
| Nine or more | 6 | 8.7 | 1 | 1 | | | | 4 |
| Median - 5 | | | | | | | | |
| **Age 55 and over** | | | | | | | | |
| | 2 | 3.7 | | 1 | | | 1 | |
| | 9 | 16.6 | 2 | 7 | | | | |
| | 5 | 9.3 | | 3 | 1 | | 1 | |
| | 7 | 13.0 | 2 | 4 | 1 | | | |
| | 7 | 13.0 | 1 | 4 | 1 | | | 1 |
| | 4 | 7.4 | | 1 | 2 | | 1 | |
| | 3 | 5.5 | | 1 | 2 | | | |
| | 6 | 11.1 | | 3 | 1 | | 1 | 1 |
| | 11 | 20.4 | | 4 | 2 | | 3 | 2 |
| Median - 5 | | | | | | | | |

### DOES YOUR COMPANY PROVIDE PENSIONS?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Yes | 66 | 77.6 | 8 | 23 | 7 | 4 | 5 | 19 |
| No | 19 | 22.4 | 4 | 9 | | 1 | 1 | 4 |
| **Age 25 - 29** | | | | | | | | |
| Yes | 291 | 84.3 | 20 | 111 | 39 | 14 | 43 | 64 |
| No | 54 | 15.7 | 4 | 17 | 10 | 1 | 3 | 19 |
| **Age 30 - 34** | | | | | | | | |
| Yes | 510 | 82.9 | 30 | 181 | 64 | 39 | 72 | 124 |
| No | 105 | 17.1 | 13 | 49 | 13 | | 7 | 23 |
| **Age 35 - 39** | | | | | | | | |
| Yes | 345 | 83.1 | 28 | 122 | 49 | 20 | 49 | 77 |
| No | 70 | 16.9 | 15 | 22 | 13 | 1 | 9 | 10 |
| **Age 40 - 44** | | | | | | | | |
| Yes | 185 | 80.8 | 14 | 67 | 22 | 10 | 33 | 39 |
| No | 44 | 19.2 | 4 | 20 | 4 | | 3 | 13 |
| **Age 45 - 49** | | | | | | | | |
| Yes | 83 | 78.3 | 6 | 31 | 14 | 7 | 6 | 19 |
| No | 23 | 21.7 | 3 | 9 | 4 | 1 | 2 | 4 |
| **Age 50 - 54** | | | | | | | | |
| Yes | 57 | 82.6 | 7 | 25 | 9 | 2 | 2 | 12 |
| No | 12 | 17.4 | | 4 | 4 | | 1 | 3 |
| **Age 55 and over** | | | | | | | | |
| Yes | 41 | 80.4 | 4 | 22 | 6 | 6 | 3 | |
| No | 10 | 19.6 | | 4 | 4 | 1 | 1 | |

### HAVE YOU ESTABLISHED YOUR OWN PRIVATE PENSION?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Yes | 18 | 22.8 | | 7 | 1 | 3 | 2 | 5 |
| No | 61 | 77.2 | 11 | 24 | 5 | 1 | 3 | 17 |
| **Age 25 - 29** | | | | | | | | |
| Yes | 92 | 30.5 | 6 | 30 | 12 | 6 | 14 | 24 |
| No | 210 | 69.5 | 14 | 81 | 30 | 7 | 25 | 53 |
| **Age 30 - 34** | | | | | | | | |
| Yes | 189 | 33.9 | 13 | 63 | 29 | 13 | 22 | 49 |
| No | 369 | 66.1 | 26 | 142 | 42 | 20 | 51 | 88 |
| **Age 35 - 39** | | | | | | | | |
| Yes | 138 | 38.3 | 16 | 49 | 18 | 9 | 18 | 28 |
| No | 222 | 61.7 | 25 | 77 | 35 | 9 | 31 | 45 |
| **Age 40 - 44** | | | | | | | | |
| Yes | 80 | 38.5 | 8 | 29 | 9 | 0 | 13 | 21 |
| No | 128 | 61.5 | 9 | 50 | 12 | 10 | 21 | 26 |
| **Age 45 - 49** | | | | | | | | |
| Yes | 43 | 47.2 | 1 | 17 | 8 | 6 | 3 | 8 |
| No | 48 | 52.3 | 6 | 17 | 7 | 2 | 5 | 11 |
| **Age 50 - 54** | | | | | | | | |
| Yes | 29 | 49.2 | 4 | 13 | 5 | 1 | | 6 |
| No | 30 | 50.8 | 2 | 11 | 8 | | 2 | 7 |
| **Age 55 and over** | | | | | | | | |
| Yes | 22 | 52.4 | 2 | 13 | 2 | 4 | 1 | |
| No | 20 | 47.6 | 3 | 8 | 4 | 3 | 2 | |

The states included in the various territorial breakdowns are as follows: NEW ENGLAND—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut. MIDDLE ATLANTIC—New York, New Jersey, Pennsylvania. EAST NORTH CENTRAL—Ohio, Indiana, Illinois, Michigan, Wisconsin. WEST NORTH CENTRAL—Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas. SOUTH—Delaware, Maryland, Dist. of Col., Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas. WEST—Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska.

## DOES YOUR COMPANY PROVIDE HEALTH BENEFITS?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Yes | 83 | 96.5 | 12 | 30 | 8 | 5 | 6 | 22 |
| No | 3 | 3.5 | | 2 | | | | 1 |
| **Age 25 - 29** | | | | | | | | |
| Yes | 337 | 96.0 | 25 | 129 | 47 | 14 | 43 | 79 |
| No | 14 | 4.0 | | 4 | 1 | 1 | 3 | 5 |
| **Age 30 - 34** | | | | | | | | |
| Yes | 593 | 95.8 | 42 | 221 | 73 | 36 | 78 | 143 |
| No | 26 | 4.2 | 2 | 11 | 5 | 2 | 1 | 5 |
| **Age 35 - 39** | | | | | | | | |
| Yes | 394 | 94.0 | 41 | 139 | 54 | 21 | 53 | 86 |
| No | 25 | 6.0 | 3 | 7 | 8 | | 5 | 2 |
| **Age 40 - 44** | | | | | | | | |
| Yes | 217 | 93.9 | 17 | 80 | 24 | 9 | 36 | 51 |
| No | 14 | 6.1 | 2 | 5 | 3 | 2 | | 2 |
| **Age 45 - 49** | | | | | | | | |
| Yes | 99 | 90.8 | 8 | 40 | 17 | 7 | 4 | 23 |
| No | 10 | 9.2 | 1 | 2 | 2 | | 4 | 1 |
| **Age 50 - 54** | | | | | | | | |
| Yes | 57 | 82.6 | 7 | 25 | 9 | 2 | 2 | 12 |
| No | 12 | 17.4 | | 4 | 4 | | 1 | 3 |
| **Age 55 and over** | | | | | | | | |
| Yes | 47 | 92.2 | 5 | 23 | 8 | 7 | 4 | |
| No | 4 | 7.8 | | 1 | 2 | 1 | | |

## HAVE YOU ESTABLISHED YOUR OWN PRIVATE HEALTH BENEFITS?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Yes | 18 | 23.1 | 2 | 7 | 1 | 1 | 2 | 5 |
| No | 60 | 76.9 | 9 | 23 | 6 | 3 | 3 | 16 |
| **Age 25 - 29** | | | | | | | | |
| Yes | 101 | 33.2 | 6 | 38 | 17 | 6 | 10 | 24 |
| No | 203 | 66.8 | 14 | 75 | 25 | 8 | 29 | 52 |
| **Age 30 - 34** | | | | | | | | |
| Yes | 149 | 28.2 | 8 | 56 | 23 | 13 | 22 | 27 |
| No | 379 | 71.8 | 26 | 139 | 48 | 21 | 46 | 99 |
| **Age 35 - 39** | | | | | | | | |
| Yes | 113 | 32.3 | 14 | 46 | 16 | 5 | 17 | 15 |
| No | 237 | 67.7 | 26 | 75 | 35 | 11 | 32 | 58 |
| **Age 40 - 44** | | | | | | | | |
| Yes | 68 | 34.3 | 5 | 25 | 9 | 4 | 9 | 16 |
| No | 130 | 65.7 | 10 | 52 | 13 | 6 | 23 | 26 |
| **Age 45 - 49** | | | | | | | | |
| Yes | 29 | 35.8 | 2 | 10 | 7 | 2 | 4 | 4 |
| No | 52 | 64.2 | 5 | 18 | 9 | 4 | 4 | 12 |
| **Age 50 - 54** | | | | | | | | |
| Yes | 24 | 42.9 | 3 | 10 | 6 | | 1 | 4 |
| No | 32 | 57.1 | 3 | 12 | 6 | 1 | 2 | 8 |
| **Age 55 and over** | | | | | | | | |
| Yes | 21 | 55.3 | 3 | 8 | 6 | 3 | 1 | |
| No | 17 | 44.7 | 2 | 10 | 1 | 2 | 2 | |

## HOW MUCH INSURANCE DO YOU CARRY?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| $1,000 - 5,999 | 13 | 16.4 | 3 | 6 | 1 | | 1 | 2 |
| 6,000 - 10,999 | 23 | 29.1 | 6 | 8 | 1 | 1 | | 7 |
| 11,000 - 15,999 | 17 | 21.4 | 2 | 7 | 1 | 2 | 2 | 3 |
| 16,000 - 20,999 | 14 | 17.7 | 1 | 5 | 2 | 1 | 1 | 4 |
| 21,000 - 25,999 | 6 | 7.6 | | 2 | 1 | 1 | 1 | 1 |
| 26,000 - 30,999 | 2 | 2.6 | | | | | 1 | |
| 31,000 - 40,999 | 2 | 2.6 | | | | | | 2 |
| 41,000 - 50,999 | 1 | 1.3 | | | 1 | | | |
| 51,000 - 75,999 | 1 | 1.3 | | | | | | 1 |
| 76,000 - 100,999 | | | | | | | | |
| Mean - $15,050 | | | | | | | | |
| Median - 12,000 | | | | | | | | |

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age 25 - 29** | | | | | | | | |
| | 12 | 3.5 | 1 | 3 | 1 | | 2 | 5 |
| | 54 | 15.6 | 3 | 16 | 14 | 1 | 7 | 13 |
| | 67 | 19.4 | 3 | 33 | 9 | 5 | 6 | 11 |
| | 74 | 21.4 | 7 | 24 | 7 | 2 | 9 | 25 |
| | 46 | 13.3 | 3 | 16 | 9 | 4 | 6 | 8 |
| | 37 | 10.7 | 1 | 16 | 3 | 1 | 5 | 11 |
| | 35 | 10.2 | 4 | 13 | 3 | 1 | 8 | 6 |
| | 13 | 3.8 | 1 | 4 | 2 | 1 | 2 | 3 |
| | 6 | 1.8 | 1 | 2 | 1 | | 1 | 1 |
| | 1 | .3 | | | | | | |
| Mean - $21,559 | | | | | | | | |
| Median - 20,000 | | | | | | | | |

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age 30 - 34** | | | | | | | | |
| $1,000 - 5,999 | 21 | 3.5 | 1 | 12 | 4 | 1 | 1 | 2 |
| 6,000 - 10,999 | 63 | 10.3 | 4 | 20 | 9 | 4 | 8 | 18 |
| 11,000 - 15,999 | 76 | 12.3 | 5 | 32 | 7 | 4 | 12 | 16 |
| 16,000 - 20,999 | 99 | 16.1 | 7 | 31 | 15 | 7 | 11 | 28 |
| 21,000 - 25,999 | 85 | 13.9 | 3 | 44 | 7 | 6 | 9 | 16 |
| 26,000 - 30,999 | 71 | 11.4 | 5 | 27 | 11 | 2 | 13 | 13 |
| 31,000 - 40,999 | 103 | 16.9 | 9 | 36 | 13 | 9 | 12 | 24 |
| 41,000 - 50,999 | 50 | 8.3 | 6 | 16 | 9 | 4 | 5 | 10 |
| 51,000 - 75,999 | 27 | 4.5 | | 7 | | 1 | 4 | 15 |
| 76,000 - 100,999 | 11 | 1.8 | 2 | 3 | 1 | | 3 | 2 |
| 101,000 and over | 5 | 1.0 | 2 | 1 | 2 | | | |
| Mean - $29,482 | | | | | | | | |
| Median - 21,000 | | | | | | | | |

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age 35 - 39** | | | | | | | | |
| | 11 | 2.7 | | 1 | 5 | | 1 | 4 |
| | 38 | 9.3 | 3 | 11 | 9 | 3 | 8 | 4 |
| | 43 | 10.6 | 1 | 18 | 10 | 5 | 2 | 7 |
| | 62 | 15.0 | 5 | 16 | 12 | 2 | 11 | 16 |
| | 50 | 12.4 | 4 | 20 | 8 | 1 | 8 | 9 |
| | 50 | 12.4 | 8 | 18 | 4 | 2 | 8 | 10 |
| | 62 | 15.0 | 6 | 24 | 5 | 4 | 6 | 17 |
| | 48 | 11.8 | 8 | 18 | 6 | 4 | 4 | 8 |
| | 29 | 7.2 | 3 | 10 | | | 8 | 8 |
| | 11 | 2.7 | 3 | 4 | | | 1 | 3 |
| | 3 | .9 | | 1 | 2 | | | |
| Mean - $27,412 | | | | | | | | |
| Median - 25,000 | | | | | | | | |

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age 40 - 44** | | | | | | | | |
| $1,000 - 5,999 | 3 | 1.4 | 1 | 2 | | | | |
| 6,000 - 10,999 | 22 | 9.7 | 2 | 7 | 2 | 2 | 5 | 4 |
| 11,000 - 15,999 | 33 | 14.6 | 3 | 10 | 2 | 4 | 6 | 8 |
| 16,000 - 20,999 | 32 | 14.2 | 3 | 9 | 5 | 1 | 6 | 8 |
| 21,000 - 25,999 | 27 | 11.9 | 1 | 11 | 3 | 2 | 5 | 5 |
| 26,000 - 30,999 | 31 | 13.8 | 1 | 11 | 6 | 2 | 3 | 8 |
| 31,000 - 40,999 | 27 | 12.0 | 4 | 10 | 2 | | 3 | 8 |
| 41,000 - 50,999 | 30 | 13.2 | 3 | 13 | | | 7 | 7 |
| 51,000 - 75,999 | 12 | 5.3 | 1 | 8 | 2 | | | 1 |
| 76,000 - 100,999 | 7 | 3.1 | | 4 | 2 | | | 1 |
| 101,000 and over | 2 | .8 | | | | | | 2 |
| Mean - $30,929 | | | | | | | | |
| Median - 25,000 | | | | | | | | |

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age 45 - 49** | | | | | | | | |
| | 2 | 1.8 | | | | 1 | 1 | |
| | 16 | 14.8 | | 8 | 2 | 1 | 2 | 3 |
| | 15 | 13.9 | | 7 | 1 | 2 | | 5 |
| | 16 | 14.8 | 3 | 5 | 3 | | 2 | 3 |
| | 11 | 10.2 | | 6 | 2 | | 1 | 2 |
| | 9 | 8.3 | 4 | 3 | 1 | | | 1 |
| | 12 | 11.1 | | | 4 | 1 | 1 | 6 |
| | 10 | 9.3 | | 5 | 2 | 2 | | 1 |
| | 8 | 7.5 | | 6 | 1 | | | 1 |
| | 7 | 6.5 | 2 | 2 | 2 | | | |
| | 2 | 1.8 | | | | | 1 | 1 |
| Mean - $33,370 | | | | | | | | |
| Median - 25,000 | | | | | | | | |

| Age 50 - 54 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| $1,000 - 5,999 | | | | | | | | |
| 6,000 - 10,999 | 8 | 11.6 | 1 | 3 | 3 | | | 1 |
| 11,000 - 15,999 | 7 | 10.1 | 1 | 2 | 2 | 1 | | 1 |
| 16,000 - 20,999 | 10 | 14.5 | | 5 | | | 1 | 4 |
| 21,000 - 25,999 | 11 | 15.9 | 1 | 3 | | 1 | | 6 |
| 26,000 - 30,999 | 9 | 12.9 | | 4 | 2 | | 1 | 2 |
| 31,000 - 40,999 | 9 | 12.9 | 2 | 2 | 2 | | 1 | 2 |
| 41,000 - 50,999 | 7 | 10.2 | | 5 | 2 | | | |
| 51,000 - 75,999 | 4 | 5.9 | 1 | 2 | 1 | | | |
| 76,000 - 100,999 | 2 | 3.0 | 1 | 1 | | | | |
| 101,000 and over | 2 | 3.0 | | 2 | | | | |

Mean - $34,565
Median - 25,000

| Age - over 55 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| | 3 | 5.8 | 1 | 1 | 1 | | | |
| | 7 | 13.4 | | 2 | 1 | | 2 | 2 |
| | 6 | 11.5 | 1 | 3 | | | 1 | 1 |
| | 9 | 17.3 | | 3 | 2 | | 3 | 1 |
| | 3 | 5.8 | | 2 | | | 1 | |
| | 5 | 9.6 | | 4 | 1 | | | |
| | 6 | 11.5 | 1 | 4 | 1 | | | |
| | 5 | 9.6 | 1 | 2 | 2 | | | |
| | 3 | 5.8 | | 2 | | | 1 | |
| | 3 | 5.8 | | 2 | 1 | | | |
| | 2 | 3.9 | 1 | 1 | | | | |

Mean - $35,654
Median - 25,000

IF THINKING OF JOINING ANOTHER COMPANY - PERCENTAGE INCREASE IN SALARY EXPECTED FOR JOB IN YOUR LOCAL AREA?

| Age 25 - 29 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 5% | 9 | 2.6 | 1 | | 2 | | | 6 |
| 6% | 3 | 0.9 | | 1 | 2 | | | |
| 7% | 2 | 0.6 | | 1 | | | | 1 |
| 8% | 7 | 2.0 | | 1 | 1 | 2 | 1 | 2 |
| 10% | 107 | 31.6 | 7 | 31 | 16 | 5 | 17 | 31 |
| 12% | 4 | 1.2 | | 3 | | | | 1 |
| 15% | 85 | 25.0 | 7 | 37 | 12 | 4 | 9 | 16 |
| 18% | 1 | 0.3 | | | | | 1 | |
| 20% | 73 | 21.5 | 4 | 31 | 7 | 2 | 11 | 18 |
| 25% | 35 | 10.3 | 5 | 17 | 3 | 1 | 2 | 7 |
| 30% | 8 | 2.4 | | 4 | 2 | 1 | 1 | |
| 33% | 1 | 0.3 | | | 1 | | | |
| 35% | 1 | 0.3 | | 1 | | | | |
| 50% | 3 | 0.9 | | 1 | 1 | | 1 | |
| 60% | 1 | 0.3 | | | 1 | | | |

Median - 15%

| Age 35 - 39 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0% | 1 | 0.3 | | 1 | | | | |
| 2% | 1 | 0.3 | | | | | | 1 |
| 5% | 5 | 1.3 | | | 1 | | 1 | 3 |
| 6% | 1 | 0.3 | | | | | | 1 |
| 7% | 1 | 0.3 | | | | | | 1 |
| 8% | 1 | 0.3 | | | | | | 1 |
| 10% | 97 | 25.2 | 11 | 24 | 11 | 5 | 13 | 33 |
| 12% | 3 | 0.8 | 1 | | | | | 2 |
| 15% | 87 | 22.6 | 6 | 36 | 13 | 7 | 13 | 12 |
| 20% | 92 | 23.9 | 9 | 38 | 21 | 2 | 13 | 9 |
| 22% | 1 | 0.3 | | 1 | | | | |
| 25% | 52 | 13.5 | 8 | 20 | 4 | 5 | 6 | 9 |
| 30% | 15 | 3.9 | 1 | 7 | 3 | | 2 | 2 |
| 35% | 2 | 0.5 | | 1 | | 1 | | |
| 40% | 3 | 0.8 | 1 | | 1 | | | 1 |
| 50% | 18 | 4.7 | 2 | 7 | 3 | | 3 | 3 |
| Over 100% | 4 | 1.0 | | 1 | | | 1 | 2 |

Median - 15%

| Age 45 - 49 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0% | 1 | 1.0 | | 1 | | | | |
| 5% | 3 | 3.1 | | 1 | 1 | | | 1 |
| 10% | 19 | 19.3 | 1 | 10 | 3 | 1 | 2 | 2 |
| 12% | 1 | 1.0 | | 1 | | | | |
| 15% | 9 | 9.2 | | | 4 | 2 | 1 | 2 |
| 20% | 22 | 22.4 | 3 | 7 | 1 | 2 | 1 | 8 |
| 25% | 18 | 18.4 | | 8 | 3 | 1 | 3 | 3 |
| 30% | 10 | 10.2 | 2 | 3 | 1 | | 1 | 3 |
| 40% | 3 | 3.1 | | | 1 | 1 | | 1 |
| 50% | 8 | 8.2 | 1 | 3 | 2 | | | 2 |
| Over 100% | 4 | 4.1 | 1 | 1 | 2 | | | |

Median - 20%

| Age 55 and over | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 10% | 4 | 11.1 | | 2 | 2 | | | |
| 12% | 1 | 2.8 | | | | | 1 | |
| 15% | 5 | 13.9 | | 2 | | | 1 | 2 |
| 20% | 10 | 27.8 | 2 | 4 | 2 | | 1 | 1 |
| 25% | 4 | 11.1 | 1 | 2 | | | 1 | |
| 30% | 2 | 5.5 | | 2 | | | | |
| 40% | 1 | 2.8 | | | | | | 1 |
| 50% | 8 | 22.2 | | 5 | 2 | | 1 | |
| 99% | 1 | 2.8 | | | 1 | | | |

Median - 20%

| Age - under 25 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 5% | 1 | 1.2 | | | | | | 1 |
| 10% | 26 | 32.1 | 2 | 7 | 3 | 2 | 4 | 8 |
| 15% | 20 | 24.7 | 4 | 6 | 2 | | 1 | 7 |
| 18% | 2 | 2.5 | | 2 | | | | |
| 20% | 21 | 26.0 | 3 | 10 | 1 | 3 | | 4 |
| 25% | 6 | 7.4 | 2 | 3 | 1 | | | |
| 30% | 3 | 3.7 | | 1 | | | 1 | 1 |
| 40% | 1 | 1.2 | | 1 | | | | |
| Over 100% | 1 | 1.2 | 1 | | | | | |

Median - 15%

| Age 30 - 34 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0% | 1 | 0.2 | | 1 | | | | |
| 4% | 1 | 0.2 | | | | | 1 | |
| 5% | 21 | 3.6 | 1 | 7 | 2 | | 1 | 10 |
| 6% | 1 | 0.2 | | | | | 1 | |
| 7% | 5 | 0.8 | 1 | | 1 | 1 | 1 | 1 |
| 8% | 5 | 0.8 | | 1 | 1 | | 1 | 2 |
| 9% | 1 | 0.2 | | | | | | 1 |
| 10% | 166 | 28.4 | 9 | 51 | 26 | 10 | 28 | 42 |
| 11% | 1 | 0.2 | 1 | | | | | |
| 12% | 13 | 2.2 | 1 | 8 | 1 | | 1 | 2 |
| 13% | 1 | 0.2 | | 1 | | | | |
| 15% | 135 | 23.1 | 17 | 52 | 18 | 9 | 13 | 26 |
| 17% | 3 | 0.5 | | 1 | 1 | | 1 | |
| 18% | 2 | 0.3 | | 1 | 1 | | | |
| 20% | 136 | 23.2 | 9 | 55 | 13 | 11 | 17 | 31 |
| 25% | 49 | 8.4 | 2 | 17 | 7 | 4 | 8 | 11 |
| 30% | 21 | 3.6 | | 11 | 2 | 1 | 1 | 6 |
| 35% | 3 | 0.5 | | 2 | 1 | | | |
| 40% | 5 | 0.8 | 1 | 2 | | | | 2 |
| 45% | 1 | 0.2 | | | | | | 1 |
| 50% | 13 | 2.2 | 2 | 5 | 1 | 2 | | 3 |
| Over 100% | 1 | 0.2 | | 1 | | | | |

Median - 15%

| Age 40 - 44 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 3% | 1 | 0.5 | | | | | | 1 |
| 5% | 8 | 3.8 | | 3 | 1 | | 2 | 2 |
| 6% | 3 | 1.4 | | | | 1 | 1 | 1 |
| 7% | 1 | 0.5 | | | | 1 | | |
| 10% | 52 | 24.4 | 4 | 17 | 5 | 2 | 6 | 18 |
| 15% | 40 | 18.9 | 3 | 10 | 5 | 2 | 12 | 8 |
| 20% | 42 | 19.7 | 4 | 21 | 2 | 1 | 6 | 8 |
| 25% | 30 | 14.1 | 2 | 9 | 5 | 2 | 6 | 6 |
| 30% | 17 | 8.0 | 2 | 9 | | 1 | 2 | 3 |
| 35% | 2 | 0.9 | | 1 | 1 | | | |
| 40% | 4 | 1.8 | 1 | 2 | 1 | | | |
| 50% | 9 | 4.2 | | 2 | 3 | 1 | | 3 |
| Over 100% | 4 | 1.8 | | 2 | 1 | | 1 | |

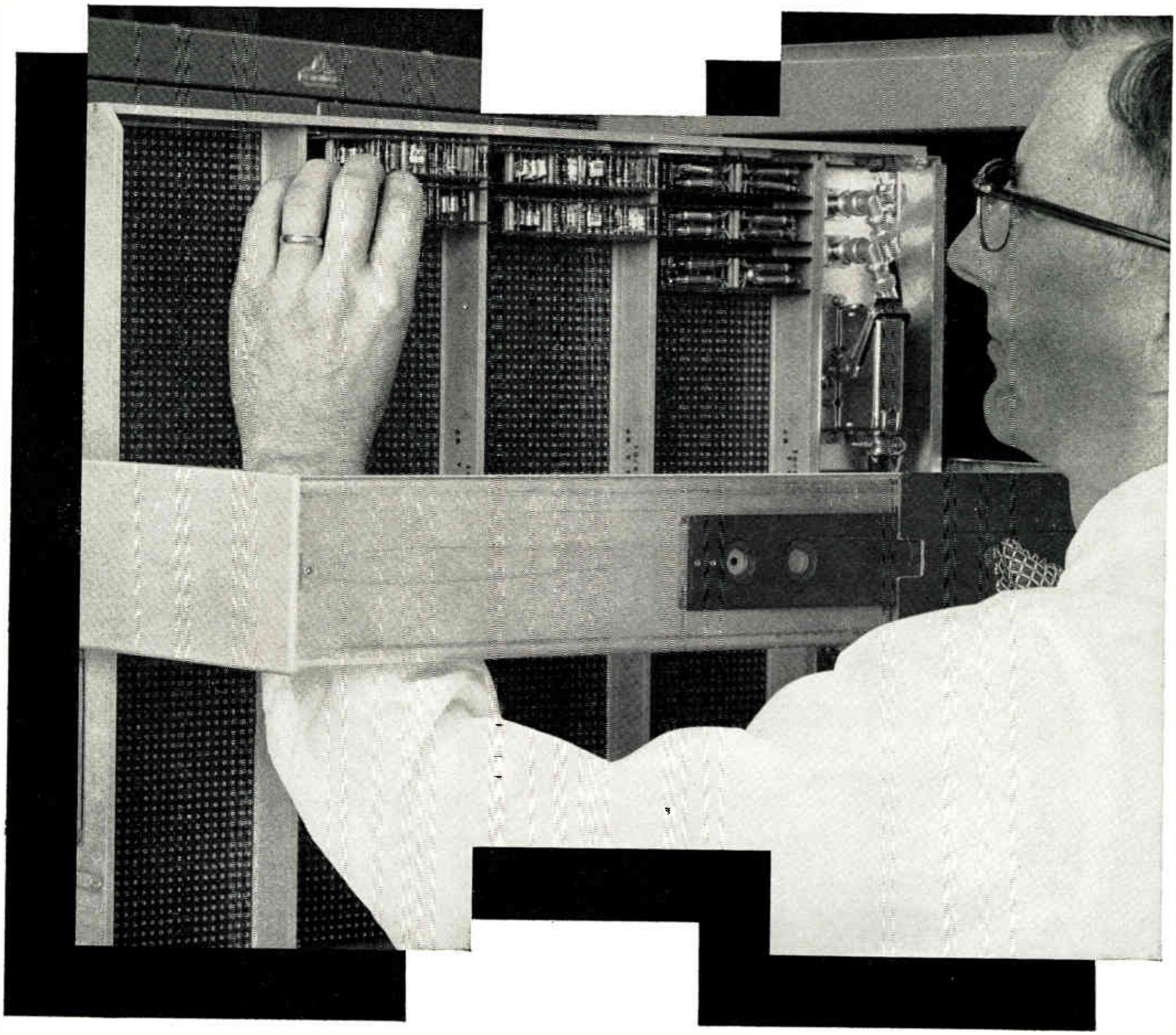
Median - 20%

| Age 50 - 54 | Total No. | % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 0% | 1 | 1.6 | | | | | 1 | |
| 5% | 1 | 1.6 | | | 1 | | | 2 |
| 10% | 12 | 19.7 | 1 | 6 | 4 | | | 1 |
| 12% | 1 | 1.6 | | | | | | 1 |
| 15% | 3 | 5.0 | 1 | 1 | | | | 2 |
| 20% | 10 | 16.4 | 1 | 4 | 3 | | | 4 |
| 25% | 17 | 27.9 | 1 | 7 | 3 | 1 | 1 | |
| 30% | 3 | 5.0 | 1 | 1 | 1 | | | |
| 33% | 1 | 1.6 | | 1 | | | | |
| 35% | 1 | 1.6 | | | | 1 | | |
| 40% | 1 | 1.6 | | 1 | | | | |
| 50% | 6 | 9.8 | | 4 | 2 | | | |
| 60% | 1 | 1.6 | | | | | | 1 |
| Over 100% | 3 | 5.0 | | 2 | | | | 1 |

Median - 25%

*(Continued on page 260)*

# Packing circuits to circle



### IF THINKING OF JOINING ANOTHER COMPANY - PERCENTAGE INCREASE IN ANOTHER PART OF U. S.?

| Age - Under 25 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 5% | 1 | 1.2 | | | | | | 1 |
| 10% | 4 | 4.9 | | | | | 2 | 2 |
| 14% | 1 | 1.2 | | 1 | | | | |
| 15% | 19 | 23.5 | 3 | 4 | 3 | 2 | 2 | 5 |
| 18% | 1 | 1.2 | | | | | | 1 |
| 20% | 16 | 19.8 | 2 | 6 | 2 | | 1 | 5 |
| 25% | 22 | 27.2 | 4 | 12 | 1 | 1 | | 4 |
| 30% | 2 | 2.5 | 1 | 1 | | | | |
| 35% | 3 | 3.7 | | 2 | | 1 | | |
| 40% | 4 | 4.9 | | 1 | | 1 | 1 | 1 |
| 50% | 5 | 6.2 | 1 | 2 | 1 | | | 1 |
| Over 100% | 3 | 3.7 | 1 | | | | | 1 |
| Median - 20% | | | | | | | | |

| Age 30 - 34 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 5% | 5 | 0.9 | 1 | 3 | | | | 1 |
| 8% | 2 | 0.4 | | | | | 1 | 1 |
| 10% | 35 | 6.2 | 2 | 11 | 3 | | 7 | 12 |
| 12% | 4 | 0.7 | | 1 | | 1 | 1 | 1 |
| 15% | 67 | 11.9 | 5 | 19 | 11 | 2 | 12 | 18 |
| 17% | 1 | 0.2 | | | | | 1 | |
| 18% | 3 | 0.5 | | | 2 | | | 1 |
| 20% | 128 | 22.9 | 8 | 49 | 17 | 10 | 16 | 28 |
| 22% | 2 | 0.4 | | | | | 1 | 1 |
| 25% | 107 | 19.1 | 13 | 36 | 14 | 9 | 18 | 17 |
| 30% | 80 | 14.3 | 5 | 31 | 14 | 8 | 6 | 16 |
| 33% | 5 | 0.9 | | 2 | 2 | 1 | | |
| 35% | 13 | 2.3 | | 8 | 2 | | 1 | 2 |
| 40% | 33 | 5.9 | 3 | 13 | 5 | 2 | 2 | 8 |
| 50% | 56 | 10.0 | 4 | 25 | 2 | 4 | 7 | 14 |
| 60% | 3 | 0.5 | | 1 | | 1 | | 1 |
| 70% | 1 | 0.2 | | 1 | | | | |
| 75% | 1 | 0.2 | | | 1 | | | |
| Over 100% | 14 | 2.5 | 3 | 4 | 1 | | | 6 |
| Median - 25% | | | | | | | | |

| Age 40 - 44 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 3% | 1 | 0.5 | | | | | | 1 |
| 5% | 2 | 1.0 | | 1 | | | | 1 |
| 10% | 13 | 6.4 | | 3 | 2 | 1 | 5 | 2 |
| 15% | 17 | 8.3 | | 7 | 4 | | 2 | 4 |
| 20% | 37 | 18.1 | 4 | 13 | 2 | 1 | 7 | 10 |
| 22% | 2 | 1.0 | | 1 | | 1 | | |
| 23% | 1 | 0.5 | 1 | | | | | |
| 25% | 46 | 22.6 | 6 | 15 | 2 | 3 | 10 | 10 |
| 30% | 21 | 10.3 | | 8 | 1 | 2 | 4 | 6 |
| 33% | 3 | 1.5 | | 2 | | | | 1 |
| 35% | 7 | 3.4 | | 4 | 1 | | | 2 |
| 40% | 7 | 3.4 | | 4 | 1 | | 1 | 1 |
| 50% | 38 | 18.6 | 2 | 13 | 8 | 2 | 6 | 7 |
| 60% | 1 | 0.5 | | | 1 | | | |
| 90% | 1 | 0.5 | | | | | | 1 |
| Over 100% | 7 | 3.4 | 1 | 2 | | 1 | 1 | 2 |
| Median - 25% | | | | | | | | |

| Age 50 - 54 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 7% | 1 | 1.7 | | | 1 | | | |
| 10% | 2 | 3.3 | | | | | 1 | 1 |
| 15% | 4 | 6.7 | 1 | 1 | 1 | | | 1 |
| 20% | 5 | 8.3 | | 3 | 2 | | | |
| 25% | 11 | 18.3 | | 5 | 1 | | | 5 |
| 30% | 7 | 11.7 | 2 | 2 | 1 | 1 | | 1 |
| 35% | 3 | 5.0 | 1 | 1 | 1 | | | |
| 40% | 2 | 3.3 | | 1 | | | 1 | |
| 45% | | | | | | | | |
| 50% | 16 | 26.6 | 1 | 8 | 4 | 1 | | 2 |
| 60% | 1 | 1.7 | | | | | | 1 |
| 75% | 1 | 1.7 | | 1 | | | | |
| Over 100% | 7 | 11.7 | | 4 | | | | 3 |
| Median - 30% | | | | | | | | |

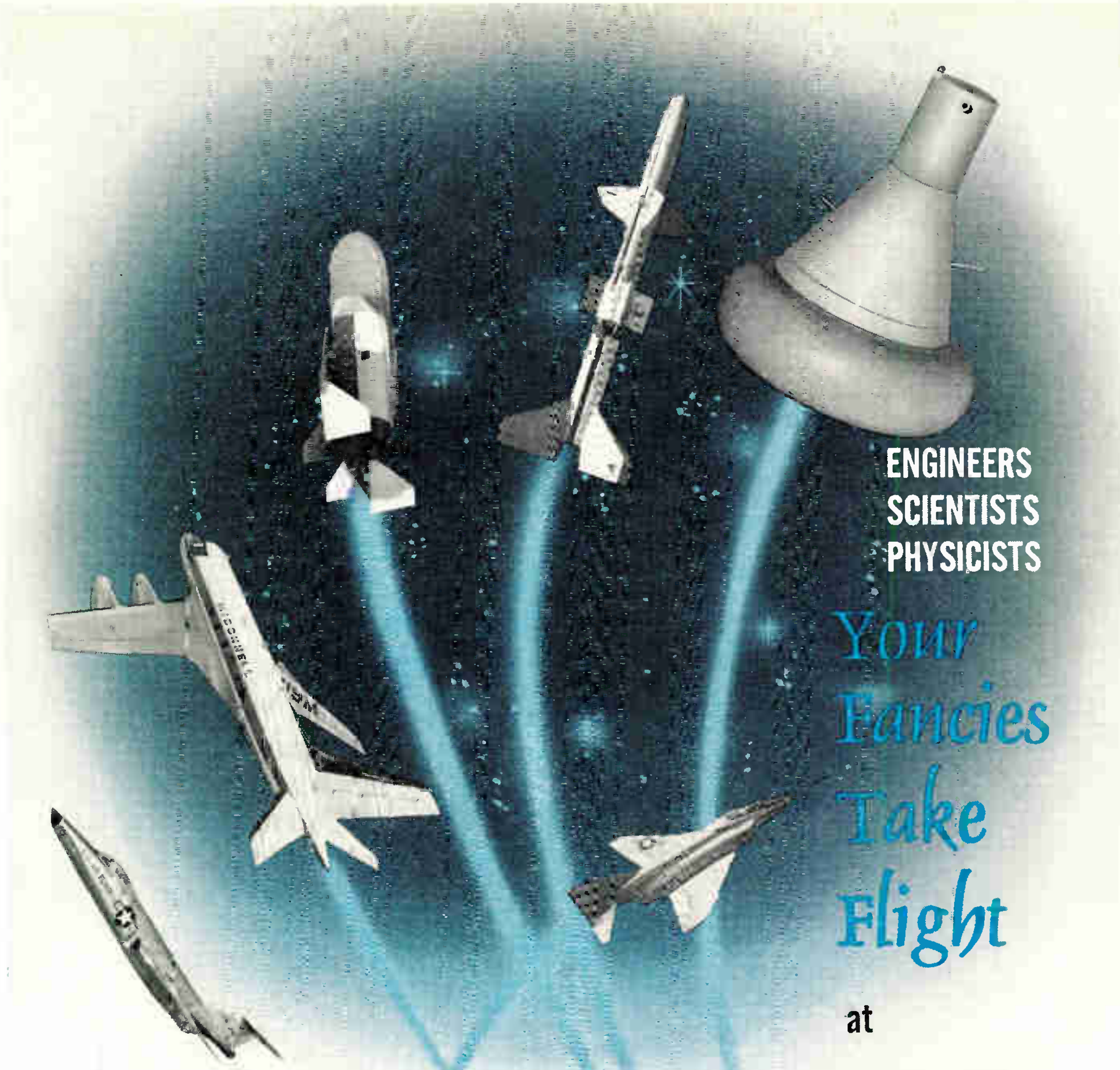
| Age 25 - 29 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 5% | 12 | 3.7 | | | | | 1 | 11 |
| 6% | 1 | 0.3 | | 1 | | | | |
| 7% | 1 | 0.3 | | | | | | 1 |
| 8% | 2 | 0.6 | | | | | 1 | 1 |
| 10% | 24 | 7.3 | | 6 | 4 | 1 | 1 | 12 |
| 11% | 1 | 0.3 | | | | | | 1 |
| 12% | 7 | 2.1 | | 3 | 2 | | 1 | 1 |
| 15% | 31 | 9.4 | 2 | 12 | 6 | 1 | 9 | 1 |
| 16% | 1 | 0.3 | | | | 1 | | |
| 18% | 4 | 1.2 | | | 1 | 1 | 1 | 1 |
| 20% | 92 | 28.0 | 9 | 42 | 15 | 3 | 6 | 17 |
| 23% | 1 | 0.3 | | | 1 | | | |
| 25% | 61 | 18.6 | 4 | 27 | 9 | 1 | 10 | 10 |
| 28% | 1 | 0.3 | | | | 1 | | |
| 30% | 34 | 10.4 | 4 | 10 | 5 | 2 | 7 | 6 |
| 33% | 1 | 0.3 | | | | 1 | | |
| 35% | 15 | 4.6 | 2 | 4 | 1 | 1 | 3 | 4 |
| 40% | 9 | 2.7 | | 8 | | | | 1 |
| 50% | 22 | 6.7 | 1 | 10 | 2 | | 2 | 7 |
| 60% | 1 | 0.3 | | | 1 | | | |
| 75% | 4 | 1.4 | | 1 | 1 | | 1 | 1 |
| Over 100% | 3 | 0.9 | | 2 | 1 | | | |
| Median - 20% | | | | | | | | |

| Age 35 - 39 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 5% | 2 | 0.5 | | | | | | 2 |
| 10% | 20 | 5.3 | 1 | 4 | 4 | 1 | 6 | 4 |
| 15% | 38 | 10.1 | 3 | 10 | 2 | 3 | 6 | 14 |
| 20% | 76 | 20.1 | 7 | 28 | 12 | 4 | 12 | 13 |
| 22% | 1 | 0.3 | | | 1 | | | |
| 25% | 80 | 21.1 | 8 | 33 | 11 | 6 | 8 | 14 |
| 30% | 50 | 13.2 | 4 | 20 | 9 | 2 | 9 | 6 |
| 33% | 4 | 1.1 | 1 | 2 | 1 | | | |
| 35% | 16 | 4.2 | 3 | 4 | 4 | 1 | 3 | 1 |
| 40% | 16 | 4.2 | | 5 | 2 | | 2 | 7 |
| 45% | 1 | 0.3 | | | | | 1 | |
| 50% | 46 | 12.2 | 10 | 17 | 6 | 2 | 5 | 6 |
| 60% | 2 | 0.5 | | 2 | | | | |
| 70% | 1 | 0.3 | | 1 | | | | |
| 75% | 5 | 1.3 | | 2 | 2 | | | 1 |
| 80% | 2 | 0.3 | | 2 | | | | |
| Over 100% | 19 | 5.0 | 1 | 4 | 2 | 1 | 3 | 8 |
| Median - 25% | | | | | | | | |

| Age 45 - 49 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 10% | 6 | 6.2 | | 2 | 2 | 1 | | 1 |
| 15% | 3 | 3.1 | | | 1 | | | 2 |
| 20% | 20 | 20.6 | 1 | 10 | 2 | 2 | 3 | 2 |
| 25% | 13 | 13.4 | 1 | 5 | 3 | | | 4 |
| 30% | 14 | 14.4 | 2 | 4 | 2 | 3 | 1 | 2 |
| 35% | 5 | 5.2 | | 3 | 1 | | | 1 |
| 40% | 6 | 6.2 | | 2 | | 1 | 1 | 2 |
| 50% | 14 | 14.4 | 1 | 3 | 3 | | 3 | 4 |
| 60% | 2 | 2.1 | | 1 | | 1 | | |
| 70% | 1 | 1.0 | | 1 | | | | |
| 75% | 3 | 3.1 | 1 | 2 | | | | |
| Over 100% | | | | | | | | |
| Median - 30% | | | | | | | | |

| Age 55 and over | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| 15% | 2 | 6.5 | | 1 | | | | 1 |
| 20% | 3 | 9.7 | | 2 | | | 1 | |
| 25% | 9 | 29.0 | | 4 | 2 | | 3 | |
| 30% | 3 | 9.7 | | | 2 | | 1 | |
| 50% | 9 | 29.0 | 1 | 5 | 1 | | | 2 |
| 75% | 1 | 3.2 | | 1 | | | | |
| Over 100% | 4 | 12.9 | 1 | 14 | 7 | | 6 | 3 |
| Median - 30% | | | | | | | | |

(*Continued on page 262*)

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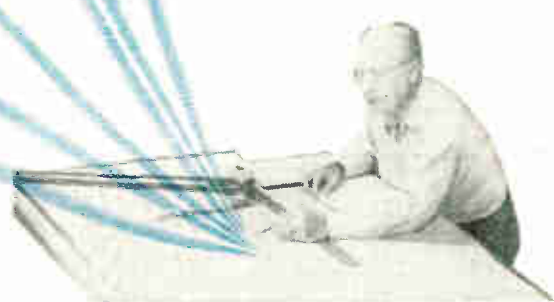


IF YOU WERE CONSIDERING CHANGING TO ANOTHER COMPANY BUT FINANCIAL GAIN WAS NOT THE MOST IMPORTANT REASON -- WHAT OTHER FACTOR WOULD BE OF PRIME INTEREST TO YOU?

**Age - under 25**

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | | | | | | | | |
| More interesting work | 44 | 53.7 | 8 | 16 | 3 | 4 | 2 | 11 |
| Pleasant work conditions | 4 | 4.9 | | | | | 2 | 2 |
| Caliber of people | 4 | 4.9 | | 1 | | | | 3 |
| Security-advancement | 18 | 22.0 | 4 | 7 | 1 | 1 | | 5 |
| Geographical location | 16 | 19.5 | | 6 | 2 | | 2 | 6 |
| Have all at present | | | | | | | | |
| Company's reputation | 1 | 1.2 | | | | 1 | | |
| Position | 8 | 9.8 | 1 | 5 | | 1 | | 1 |
| Can accomplish more | | | | | | | | |
| Company's future-growth | | | | | | | | |
| Better organized firm | 2 | 2.4 | 1 | | | | 1 | |
| Increased opp'ty to learn | 6 | 7.3 | 1 | 3 | 1 | | 1 | |
| Small size bus. for self | | | | | | | | |
| Fairness of promotion | 1 | 1.2 | | | | | | 1 |
| Share-the-profit plan | 1 | 1.2 | | | | | | 1 |
| Management I could admire | 2 | 2.4 | | 1 | | | | 1 |
| Job satisfaction | 1 | 1.2 | | 1 | | | | |
| Design-development work | 4 | 4.9 | | 3 | | | | 1 |
| Good Facilities | 2 | 2.4 | | | 1 | | 1 | |
| Close location-easy access | 1 | 1.2 | | | | 1 | | |
| Management's attitude | | | | | | | | |
| Fringe benefits-pension | 3 | 3.7 | 1 | 1 | | | | 1 |
| Salary | 1 | 1.2 | | 1 | | | | |
| Opp'ty. for mng't. post | 1 | 1.2 | | | 1 | | | |
| Size of company | | | | | | | | |
| Type of product | 1 | 1.2 | | | | | | 1 |

**Age 25 - 29**

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | 12 | 3.6 | 2 | 4 | 4 | | 2 | |
| More interesting work | 127 | 38.0 | 11 | 58 | 23 | 6 | 18 | 11 |
| Pleasant work conditions | 60 | 18.0 | 5 | 9 | 5 | 2 | 3 | 36 |
| Caliber of people | 13 | 3.9 | | 3 | 1 | 2 | 3 | 4 |
| Security-advancement | 86 | 25.7 | 4 | 39 | 16 | 4 | 12 | 11 |
| Geographical location | 62 | 18.6 | 2 | 24 | 6 | 3 | 13 | 14 |
| Have all at present | 7 | 2.1 | | 1 | | | | 6 |
| Company's reputation | 8 | 2.4 | 1 | 3 | 2 | 2 | | |
| Position | 21 | 6.3 | 1 | 5 | 5 | 1 | 5 | 4 |
| Can accomplish more | 1 | .3 | | | 1 | | | |
| Company's future-growth | 5 | 1.5 | 2 | 2 | | | | 1 |
| Better organized firm | 9 | 2.7 | 2 | 2 | 1 | | 3 | 1 |
| Increased opp'ty to learn | 20 | 6.0 | 2 | 10 | 4 | | | 4 |
| Small size bus. for self | | | | | | | | |
| Fairness of promotion | 1 | .3 | | 1 | | | | |
| Share-the-profit plan | | | | | | | | |
| Management I could admire | 4 | 1.2 | 1 | 2 | 1 | | | |
| Job satisfaction | 1 | .3 | | | | 1 | | |
| Design-development work | 14 | 4.2 | 1 | 5 | 1 | 1 | 2 | 4 |
| Good Facilities | 26 | 7.8 | 2 | 8 | 6 | | 4 | 6 |
| Close location-easy access | 1 | .3 | | 1 | | | | |
| Management's attitude | 9 | 2.7 | 1 | 5 | | | 2 | 1 |
| Fringe benefits-pension | 18 | 5.4 | | 7 | 3 | 1 | 4 | 3 |
| Salary | 6 | 1.8 | 1 | 3 | 1 | | 1 | |
| Opp'ty. for mng't. post | 8 | 2.4 | 2 | 5 | | 1 | | |
| Size of company | 2 | .6 | | | | | 1 | 1 |
| Type of product | 2 | .6 | | | | | 1 | 1 |

**Age 30 - 34**

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | 33 | 5.6 | 1 | 9 | 8 | 2 | 3 | 10 |
| More interesting work | 237 | 40.4 | 21 | 88 | 25 | 15 | 26 | 62 |
| Pleasant work conditions | 40 | 6.8 | 3 | 14 | 4 | 2 | 7 | 10 |
| Caliber of people | 22 | 3.8 | | 11 | 2 | | 3 | 6 |
| Security-advancement | 152 | 25.9 | 11 | 44 | 29 | 7 | 23 | 38 |
| Geographical location | 96 | 16.4 | 4 | 33 | 15 | 6 | 18 | 20 |
| Have all at present | 4 | .7 | | 1 | | | 1 | 2 |
| Company's reputation | 17 | 2.9 | | 6 | 3 | 2 | 5 | 1 |
| Position | 29 | 4.9 | 2 | 13 | 3 | 1 | 4 | 6 |
| Can accomplish more | 5 | .8 | | 1 | 1 | | 2 | 1 |
| Company's future-growth | 18 | 3.1 | 1 | 9 | | | 2 | 6 |
| Better organized firm | 16 | 2.7 | 1 | 5 | 2 | 1 | 1 | 6 |
| Increased opp'ty to learn | 22 | 3.8 | 1 | 9 | 2 | 1 | 4 | 5 |
| Small size bus. for self | 1 | .2 | | | | | 1 | |
| Share-the-profit plan | 5 | .8 | | 1 | 3 | | 1 | |
| Management I could admire | 12 | 2.0 | 1 | 6 | 1 | 1 | 2 | 1 |
| Job satisfaction | 8 | 1.4 | | 1 | 1 | | 2 | 4 |
| Design-development work | 13 | 2.2 | 2 | 6 | | 1 | 2 | 2 |
| Good Facilities | 38 | 6.5 | 2 | 13 | 6 | 8 | 4 | 5 |
| Close location-easy access | 9 | 1.5 | 1 | 4 | 2 | | 2 | |
| Management's attitude | 12 | 2.0 | 1 | 5 | 1 | 1 | 2 | 2 |
| Fringe benefits-pension | 17 | 2.9 | 2 | 12 | 1 | | | 2 |
| Salary | 3 | .5 | | 2 | | 1 | | |
| Opp'ty. for mng't. post | 21 | 3.6 | 3 | 7 | 2 | 1 | 2 | 6 |
| Size of company | 7 | 1.2 | 2 | | 1 | | 2 | 2 |
| Type of product | 4 | .7 | | 1 | | 1 | | 2 |
| Part ownership-stock | 4 | .7 | | 4 | | | | |
| Voice in company policy | 3 | .5 | | 2 | | | 1 | |

**Age 35 - 39**

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | 23 | 6.0 | 2 | 8 | 5 | 1 | 1 | 6 |
| More interesting work | 136 | 35.5 | 11 | 54 | 11 | 7 | 22 | 31 |
| Pleasant work conditions | 34 | 8.9 | 1 | 8 | 4 | 1 | 7 | 13 |
| Caliber of people | 14 | 3.6 | 2 | 4 | 1 | | 2 | 5 |
| Security-advancement | 80 | 20.9 | 7 | 27 | 15 | 8 | 7 | 16 |
| Geographical location | 43 | 11.2 | 5 | 15 | 5 | 3 | 11 | 4 |
| Have all at present | 7 | 1.8 | 5 | | | | 2 | |
| Company's reputation | 18 | 4.7 | 1 | 6 | 1 | 2 | 2 | 6 |
| Position | 16 | 4.2 | 2 | 3 | 4 | 1 | 1 | 5 |
| Can accomplish more | 8 | 2.1 | | 3 | | 1 | 2 | 2 |
| Company's future-growth | 26 | 6.8 | 4 | 8 | 5 | 2 | 4 | 3 |
| Better organized firm | 17 | 4.4 | 1 | 10 | 3 | | 2 | 1 |
| Increased opp'ty to learn | 21 | 5.5 | 2 | 8 | 2 | 3 | 1 | 5 |
| Small size bus. for self | 2 | .5 | | 1 | | | | 1 |
| Share-the-profit plan | 2 | .5 | | 1 | 1 | | | |
| Management I could admire | 10 | 2.6 | 2 | 2 | | 1 | 1 | 4 |
| Job satisfaction | 5 | 1.3 | | 3 | 1 | | 1 | |
| Design-development work | 10 | 2.6 | 1 | 6 | | | | 3 |
| Good Facilities | 22 | 5.7 | | 9 | 3 | 1 | 4 | 5 |
| Close location-easy access | 4 | 1.0 | | 1 | 1 | | | 2 |
| Management's attitude | 10 | 2.6 | 2 | 3 | 2 | 1 | 1 | 1 |
| Fringe benefits-pension | 4 | 1.0 | | 1 | 1 | 1 | 1 | |
| Salary | 1 | .3 | | | | | | 1 |
| Opp'ty. for mng't. post | 17 | 4.4 | 2 | 4 | 5 | 1 | 3 | 2 |
| Size of company | 3 | .8 | 1 | 1 | | | 1 | |
| Type of product | 4 | 1.0 | 1 | | | | 1 | 2 |
| Part ownership-stock | 4 | 1.0 | | 1 | 2 | | | 1 |
| Voice in company policy | 3 | .8 | | 2 | | | | 1 |

**Age 40 - 44**

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | 14 | 6.5 | 2 | 5 | 1 | 1 | 3 | 2 |
| More interesting work | 63 | 29.2 | 3 | 23 | 7 | 4 | 13 | 13 |
| Pleasant work conditions | 16 | 7.4 | 1 | 6 | 1 | | 2 | 6 |
| Caliber of people | 8 | 3.7 | 2 | 3 | 1 | | 1 | 1 |
| Security-advancement | 39 | 18.0 | 3 | 16 | 3 | 2 | 7 | 8 |
| Geographical location | 22 | 10.2 | 2 | 8 | 4 | 1 | 3 | 4 |
| Have all at present | 4 | 1.8 | 2 | | | | 1 | 1 |
| Company's reputation | 16 | 7.4 | | 8 | 4 | | 2 | 4 |
| Position | 13 | 6.0 | | 3 | 3 | | 3 | 4 |
| Can accomplish more | 3 | 1.4 | | | 1 | | 1 | 1 |
| Company's future-growth | 14 | 6.5 | 2 | 4 | 1 | | 3 | 4 |
| Better organized firm | 7 | 3.2 | | 3 | | | 2 | 2 |
| Increased opp'ty to learn | 2 | .9 | 1 | | 1 | | | |
| Share-the-profit plan | 2 | .9 | 1 | | | | | 1 |
| Management I could admire | 3 | 1.4 | | 2 | | | | 1 |
| Job satisfaction | 3 | 1.4 | | 1 | | | | 1 |
| Design-development work | 4 | 1.8 | | 1 | | | 1 | 2 |
| Good Facilities | 20 | 9.3 | | 8 | | 3 | 5 | 4 |
| Close location-easy access | 3 | 1.4 | | 2 | | | | 1 |
| Management's attitude | 3 | 1.4 | | 1 | | | 1 | 1 |
| Fringe benefits-pension | 7 | 3.2 | 1 | 2 | 1 | | 1 | 2 |
| Salary | 3 | 1.4 | 1 | 1 | 1 | | | |
| Opp'ty. for mng't. post | 15 | 6.9 | 1 | 5 | 2 | 2 | 2 | 3 |
| Size of company | 4 | 1.8 | | 2 | 1 | | | 1 |
| Type of product | 5 | 2.3 | 1 | 3 | | | | 1 |
| Part ownership-stock | 1 | .5 | | 1 | | | | |

**Age 45 - 49**

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | 2 | 2.0 | | 1 | | | 1 | |
| More interesting work | 39 | 39.4 | 4 | 18 | 3 | 4 | 1 | 9 |
| Pleasant work conditions | 11 | 11.1 | | 5 | 3 | 1 | 1 | 1 |
| Caliber of people | 5 | 5.0 | | 3 | | 1 | | 1 |
| Security-advancement | 18 | 18.2 | 3 | 5 | 2 | 2 | 2 | 4 |
| Geographical location | 9 | 9.1 | | 2 | 3 | 2 | 1 | 1 |
| Have all at present | 3 | 3.0 | | 1 | 1 | | 1 | |
| Company's reputation | 6 | 6.1 | 1 | 3 | | | | 2 |
| Position | 5 | 5.0 | | 3 | | | | 2 |
| Can accomplish more | 3 | 3.0 | | 1 | 1 | | | 1 |
| Company's future-growth | | | | | | | | |
| Better organized firm | 10 | 10.1 | | 2 | 1 | 1 | 1 | 5 |
| Increased opp'ty to learn | 4 | 4.0 | | 2 | 1 | | 1 | |
| Share-the-profit plan | | | | | | | | |
| Management I could admire | 3 | 3.0 | | 1 | 2 | | | |
| Job satisfaction | 1 | 1.0 | | 1 | | | | |
| Design-development work | 1 | 1.0 | | | 1 | | | |
| Good Facilities | 5 | 5.0 | 1 | | 1 | | 1 | 2 |
| Close location-easy access | 1 | 1.0 | | | | | 1 | |
| Management's attitude | | | | | | | | |
| Fringe benefits-pension | 3 | 3.0 | | 1 | 1 | | | 1 |
| Salary | 1 | 1.0 | | | | 1 | | |
| Opp'ty. for mng't. post | 1 | 1.0 | | 1 | | | | |
| Size of company | 1 | 1.0 | | | | | | 1 |
| Type of product | | | | | | | | |

## IF YOU WERE CONSIDERING CHANGING TO ANOTHER COMPANY BUT FINANCIAL GAIN WAS NOT THE MOST IMPORTANT REASON -- WHAT OTHER FACTOR WOULD BE OF PRIME INTEREST TO YOU?

| Age 50 - 54 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | 4 | 6.2 | | | | 1 | 1 | 2 |
| More interesting work | 18 | 28.1 | 2 | 8 | 2 | 1 | 1 | 4 |
| Pleasant work conditions | 2 | 3.1 | 1 | | | | | 1 |
| Caliber of people | 2 | 3.1 | 2 | | | | | |
| Security-advancement | 8 | 12.5 | | 3 | 1 | 1 | | 3 |
| Geographical location | 9 | 14.0 | | 4 | 2 | | | 3 |
| Have all at present | | | | | | | | |
| Company's reputation | 5 | 7.8 | | 3 | 1 | | | 1 |
| Position | 2 | 3.1 | 1 | 1 | | | | |
| Can accomplish more | 3 | 4.7 | | | 2 | | | 1 |
| Company's future-growth | 3 | 4.7 | 1 | | 2 | | | |
| Better organized firm | 2 | 3.1 | | 1 | 1 | | | |
| Increased opp'ty to learn | 1 | 1.6 | | 1 | | | | |
| Small size bus. for self | | | | | | | | |
| Share-the-profit plan | | | | | | | | |
| Management I could admire | 2 | 3.1 | 1 | | | | | 1 |
| Job satisfaction | | | | | | | | |
| Design-development work | 4 | 6.2 | | 2 | 2 | | | |
| Good Facilities | 7 | 10.9 | | 5 | | 1 | | 1 |
| Close location-easy access | 1 | 1.6 | | 1 | | | | |
| Management's attitude | 3 | 4.7 | | 2 | | | | 1 |
| Fringe benefits-pension | | | | | | | | |
| Salary | 1 | 1.6 | | | 1 | | | |
| Opp'ty. for mng't. post | 3 | 4.7 | | 2 | 1 | | | |
| Size of company | 1 | 1.6 | | | | | | 1 |
| Type of product | 1 | 1.16 | 1 | | | | | |
| Part ownership-stock | 2 | 3.1 | | 2 | | | | |
| Voice in company policy | 1 | 1.6 | 1 | | | | | |

| Age 55 and over | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Freedom to follow ideas | 3 | 8.6 | | 1 | 2 | | | |
| More interesting work | 7 | 20.0 | | 6 | | | 1 | |
| Pleasant work conditions | 2 | 5.7 | | 1 | | | | 1 |
| Caliber of people | 1 | 2.8 | | 1 | | | | |
| Security-advancement | 5 | 14.3 | | 2 | | | 1 | 2 |
| Geographical location | 2 | 5.7 | | | 1 | | 1 | |
| Have all at present | 3 | 8.6 | 1 | 1 | | | 1 | |
| Company's reputation | | | | | | | | |
| Position | | | | | | | | |
| Can accomplish more | 1 | 2.8 | | | | | 1 | |
| Company's future-growth | | | | | | | | |
| Better organized firm | 1 | 2.8 | | | | | | 1 |
| Increased opp'ty to learn | 2 | 5.7 | | 1 | | | | |
| Small size bus. for self | | | | | | | | |
| Share-the-profit plan | 1 | 2.8 | | | 1 | | | |
| Management I could admire | 1 | 2.8 | | 1 | | | | |
| Job satisfaction | | | | | | | | |
| Design-development work | | | | | | | | |
| Good Facilities | 5 | 14.3 | | 2 | 3 | | | |
| Close location-easy access | | | | | | | | |
| Management's attitude | 1 | 2.8 | | 1 | | | | |
| Fringe benefits-pension | 2 | 5.7 | | 1 | | | 1 | |
| Salary | 1 | 2.8 | 1 | . | | | | |
| Opp'ty. for mng't. post | | | | | | | | |
| Size of company | 1 | 2.8 | | 1 | | | | |
| Type of product | 1 | 2.8 | | 1 | | | | |
| Part ownership-stock | | | | | | | | |
| Voice in company policy | | | | | | | | |

Totals do not add to 100% due to multiple answers

## WHAT IS THE PRESENT APPROXIMATE VALUE OF YOUR LIQUID ASSETS?

| Age - under 25 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under $500 | 18 | 20.9 | 4 | 5 | 1 | 2 | 3 | 3 |
| 500 - 1,999 | 35 | 40.7 | 4 | 13 | 3 | 2 | 2 | 11 |
| 2,000 - 3,999 | 19 | 22.1 | 3 | 8 | 3 | | 1 | 4 |
| 4,000 - 5,999 | 9 | 10.5 | 1 | 4 | 1 | 1 | | 2 |
| 6,000 - 8,999 | 3 | 3.5 | | 1 | | | | 2 |
| 9,000 - 12,999 | 2 | 2.3 | | 1 | | | | 1 |
| 13,000 - 17,999 | | | | | | | | |
| 18,000 - 23,999 | | | | | | | | |
| 24,000 - 30,999 | | | | | | | | |
| Median - $1,571 | | | | | | | | |

| Age 25 - 29 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| | 69 | 19.7 | 6 | 16 | 10 | 2 | 8 | 27 |
| | 133 | 38.1 | 12 | 47 | 17 | 9 | 26 | 22 |
| | 58 | 16.6 | | 27 | 9 | 2 | 5 | 15 |
| | 40 | 11.5 | 2 | 16 | 6 | 1 | 5 | 10 |
| | 24 | 6.9 | 1 | 15 | 3 | 1 | 2 | 2 |
| | 15 | 4.3 | 1 | 5 | 2 | | | 7 |
| | 7 | 2.0 | 1 | 5 | | | | 1 |
| | 2 | 0.6 | 1 | 1 | | | | |
| | 1 | 0.3 | | | 1 | | | |
| Median - $1,695 | | | | | | | | |

| Age 35 - 39 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under $500 | 31 | 7.6 | 1 | 9 | 8 | 1 | 2 | 10 |
| 500 - 1,999 | 106 | 25.8 | 10 | 33 | 12 | 6 | 18 | 27 |
| 2,000 - 3,999 | 80 | 19.5 | 9 | 31 | 8 | 2 | 12 | 18 |
| 4,000 - 5,999 | 75 | 18.3 | 9 | 25 | 10 | 6 | 13 | 12 |
| 6,000 - 8,999 | 35 | 8.5 | 4 | 11 | 8 | 2 | 6 | 4 |
| 9,000 - 12,999 | 25 | 6.1 | 6 | 8 | 4 | 1 | 3 | 3 |
| 13,000 - 17,999 | 15 | 3.7 | 2 | 6 | 2 | 1 | 1 | 3 |
| 18,000 - 23,999 | 16 | 3.9 | | 8 | 2 | 1 | 2 | 3 |
| 24,000 - 30,999 | 12 | 2.9 | 1 | 5 | 3 | 1 | | 2 |
| 31,000 and over | 15 | 3.7 | 1 | 6 | 3 | | 1 | 4 |
| Median - $3,700 | | | | | | | | |

| Age 30 - 34 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| | 79 | 12.8 | 4 | 22 | 12 | 7 | 8 | 26 |
| | 199 | 32.3 | 18 | 72 | 31 | 11 | 25 | 42 |
| | 121 | 19.6 | 8 | 40 | 16 | 8 | 16 | 33 |
| | 64 | 10.4 | 3 | 27 | 7 | 3 | 10 | 14 |
| | 44 | 7.1 | 3 | 15 | 5 | 5 | 6 | 10 |
| | 40 | 6.5 | 1 | 18 | 3 | 4 | 5 | 9 |
| | 27 | 4.4 | 2 | 11 | 1 | 1 | 4 | 8 |
| | 14 | 2.3 | 1 | 8 | 2 | | 1 | 2 |
| | 11 | 1.8 | 1 | 8 | | | | 2 |
| | 17 | 2.8 | 2 | 10 | 1 | | 3 | 1 |
| Median - $2,496 | | | | | | | | |

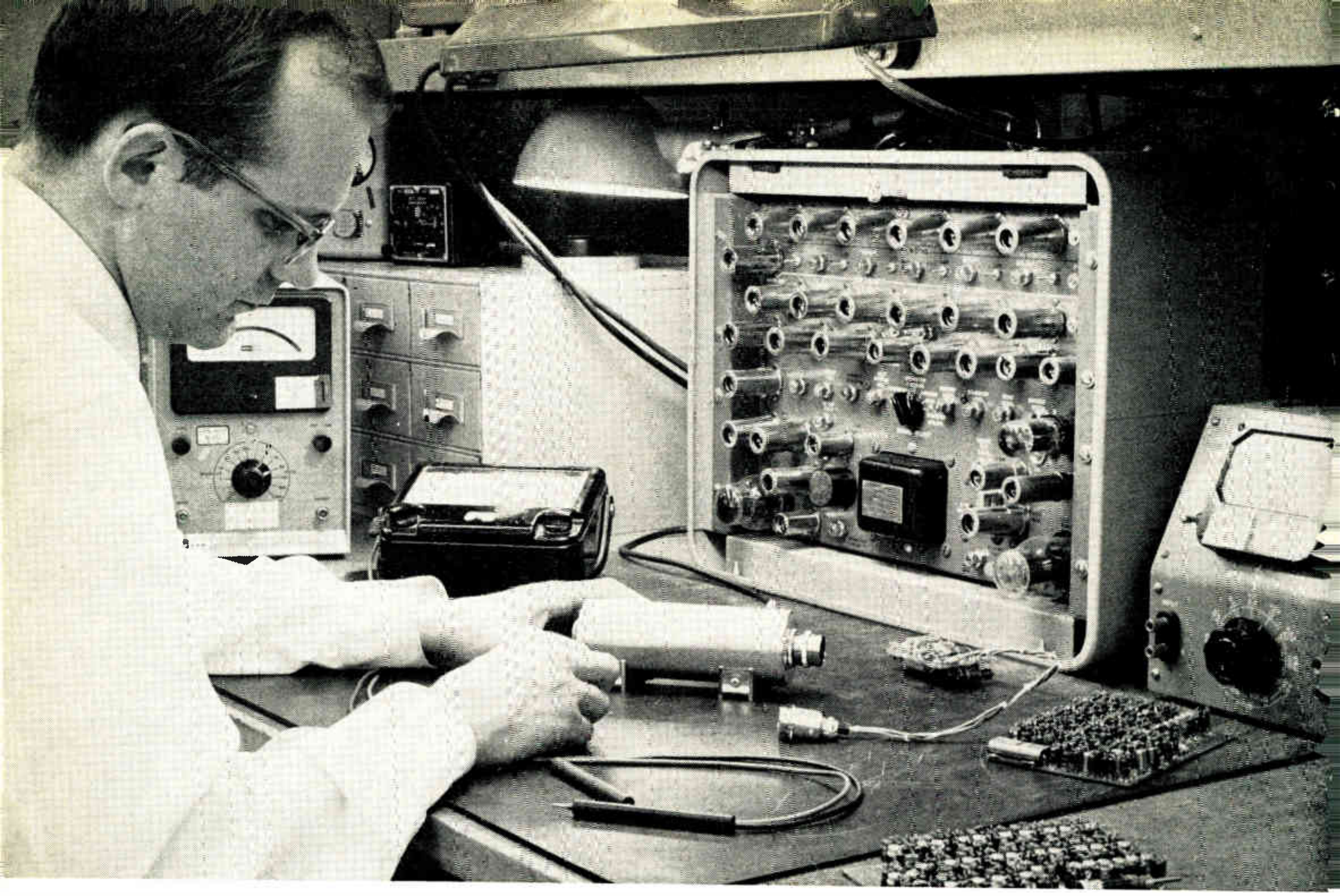
| Age 40 - 44 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under $500 | 9 | 3.9 | | 4 | | 1 | 1 | 3 |
| 500 - 1,999 | 37 | 16.0 | 2 | 14 | 2 | 3 | 8 | 8 |
| 2,000 - 3,999 | 55 | 23.8 | 2 | 16 | 9 | 3 | 4 | 21 |
| 4,000 - 5,999 | 41 | 17.8 | 3 | 16 | 4 | 3 | 9 | 6 |
| 6,000 - 8,999 | 21 | 9.1 | 3 | 8 | 2 | 1 | 4 | 3 |
| 9,000 - 12,999 | 22 | 9.5 | 1 | 12 | 2 | | 5 | 2 |
| 13,000 - 17,999 | 18 | 7.8 | 4 | 6 | 3 | | 2 | 3 |
| 18,000 - 23,999 | 7 | 3.0 | | 2 | 2 | | 2 | 1 |
| 24,000 - 30,999 | 11 | 4.8 | 3 | 5 | | | | 3 |
| 31,000 and over | 10 | 4.3 | 1 | 2 | 3 | | 2 | 2 |
| Median - $4,732 | | | | | | | | |

| Age 45 - 49 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| | 6 | 5.6 | | 4 | | | | 2 |
| | 17 | 15.7 | 3 | 5 | 1 | 1 | 2 | 5 |
| | 25 | 23.2 | 3 | 6 | 5 | 2 | 4 | 5 |
| | 9 | 8.3 | 1 | 2 | 1 | 1 | | 4 |
| | 9 | 8.3 | | 3 | 2 | | 1 | 3 |
| | 8 | 7.4 | 1 | 4 | 2 | | | 1 |
| | 10 | 9.3 | | 5 | 1 | 3 | | 1 |
| | 5 | 4.6 | | 2 | 2 | | | 1 |
| | 6 | 5.6 | | 4 | 2 | | | |
| | 13 | 12.0 | 1 | 7 | 2 | | 1 | 2 |
| Median - $5,334 | | | | | | | | |

| Age 50 - 54 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Under $500 | 1 | 1.4 | | | | | | 1 |
| 500 - 1,999 | 14 | 20.0 | 2 | 6 | 1 | 1 | 1 | 3 |
| 2,000 - 3,999 | 11 | 15.7 | 1 | 5 | 1 | | 1 | 3 |
| 4,000 - 5,999 | 8 | 11.4 | | 4 | 2 | | | 2 |
| 6,000 - 8,999 | 5 | 7.2 | 1 | 2 | | | | 2 |
| 9,000 - 12,999 | 2 | 2.8 | 1 | | 1 | | | |
| 13,000 - 17,999 | 4 | 5.7 | | | 1 | | 1 | 1 |
| 18,000 - 23,999 | 7 | 10.0 | | 3 | 3 | | | 1 |
| 24,000 - 30,999 | 5 | 7.2 | | 2 | 1 | | | 2 |
| 31,000 and over | 13 | 18.6 | 2 | 7 | 3 | | | 1 |
| Median - $6,600 | | | | | | | | |

| Age 55 and over | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| | 1 | 1.9 | | 1 | | | | |
| | 2 | 3.9 | 1 | 1 | | | | |
| | 1 | 1.9 | | | 1 | | | |
| | 6 | 11.5 | | 1 | 1 | | 2 | 2 |
| | 3 | 5.8 | | 1 | 1 | | 1 | |
| | 5 | 9.6 | 1 | 2 | 1 | | 1 | |
| | 4 | 7.7 | 1 | 1 | 2 | | | |
| | 3 | 5.8 | | 2 | | | 1 | |
| | 5 | 9.6 | | 2 | 1 | | 1 | 1 |
| | 22 | 42.3 | 1 | 15 | 3 | | 2 | 1 |
| Median - $25,400 | | | | | | | | |

*(Continued on page 266)*



PLEASE CHECK ANY OF THE FOLLOWING ACTIVITIES IN WHICH YOU PARTICIPATE?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Civic Organization | 3 | 5.2 | 1 | | | | | 2 |
| Social Welfare | 3 | 5.2 | 1 | 1 | 1 | | | |
| Veterans' Organizations | | | | | | | | |
| Church Groups | 20 | 34.5 | 2 | 6 | 3 | 1 | 3 | 5 |
| Fraternal & Service Org. | 21 | 36.2 | 3 | 11 | 1 | 2 | | 4 |
| Country Club | 1 | 1.7 | | | 1 | | | |
| Prof. Bus. Ass'n. | 20 | 34.5 | | 8 | 2 | 1 | 2 | 7 |
| Other Sports Clubs | 14 | 24.1 | 4 | 5 | 2 | 1 | | 2 |
| Other Organizations | 7 | 12.1 | 1 | 1 | | 1 | | 4 |
| **Age 25 - 29** | | | | | | | | |
| Civic Organization | 37 | 12.8 | 2 | 15 | 6 | 4 | 9 | 1 |
| Social Welfare | 23 | 7.9 | 2 | 11 | 7 | | 3 | |
| Veterans' Organizations | 21 | 7.2 | 1 | 8 | 3 | 2 | 5 | 2 |
| Church Groups | 152 | 52.4 | 7 | 43 | 22 | 7 | 25 | 27 |
| Fraternal & Service Org. | 85 | 29.3 | 6 | 30 | 15 | 4 | 13 | 17 |
| Country Club | 15 | 5.2 | 1 | 12 | 1 | | 1 | |
| Prof. Bus. Ass'n. | 125 | 43.1 | 11 | 54 | 16 | 6 | 9 | 29 |
| Other Sports Clubs | 78 | 26.9 | 7 | 27 | 14 | | 10 | 20 |
| Other Organizations | 50 | 17.2 | 5 | 15 | 11 | 3 | 5 | 11 |
| **Age 30 - 34** | | | | | | | | |
| Civic Organization | 118 | 22.7 | 8 | 37 | 15 | 4 | 13 | 14 |
| Social Welfare | 81 | 15.6 | 4 | 26 | 12 | 7 | 12 | 20 |
| Veterans' Organizations | 41 | 7.9 | 3 | 14 | 10 | | 7 | 7 |
| Church Groups | 256 | 49.2 | 21 | 78 | 40 | 18 | 44 | 55 |
| Fraternal & Service Org. | 118 | 22.7 | 7 | 49 | 11 | 11 | 18 | 22 |
| Country Club | 32 | 6.2 | 1 | 15 | 5 | | 6 | 5 |
| Prof. Bus. Ass'n. | 238 | 45.8 | 16 | 83 | 29 | 19 | 32 | 61 |
| Other Sports Clubs | 93 | 17.9 | 5 | 41 | 7 | 3 | 11 | 43 |
| Other Organizations | 90 | 17.3 | 9 | 34 | 9 | 9 | 5 | 24 |
| **Age 35 - 39** | | | | | | | | |
| Civic Organization | 96 | 27.5 | 8 | 31 | 16 | 5 | 19 | 17 |
| Social Welfare | 60 | 17.2 | 6 | 20 | 13 | 3 | 8 | 10 |
| Veterans' Organizations | 28 | 8.0 | | 14 | 4 | 2 | 2 | 6 |
| Church Groups | 159 | 45.6 | 17 | 50 | 26 | 13 | 26 | 27 |
| Fraternal & Service Org. | 72 | 20.6 | 8 | 28 | 11 | 2 | 8 | 15 |
| Country Club | 25 | 7.2 | 4 | 11 | 2 | 2 | 2 | 4 |
| Prof. Bus. Ass'n. | 180 | 51.6 | 21 | 56 | 28 | 12 | 28 | 35 |
| Other Sports Clubs | 65 | 18.6 | 9 | 20 | 9 | 2 | 11 | 14 |
| Other Organizations | 74 | 21.2 | 10 | 23 | 15 | 3 | 8 | 15 |
| **Age 40 - 44** | | | | | | | | |
| Civic Organization | 59 | 28.1 | 4 | 26 | 10 | 4 | 7 | 9 |
| Social Welfare | 55 | 26.2 | 8 | 16 | 6 | 3 | 11 | 12 |
| Veterans' Organizations | 15 | 7.1 | | 3 | 2 | 1 | 2 | 7 |
| Church Groups | 120 | 57.1 | 12 | 48 | 13 | 5 | 22 | 21 |
| Fraternal & Service Org. | 60 | 28.6 | 7 | 24 | 7 | 2 | 7 | 13 |
| Country Club | 23 | 11.0 | 2 | 9 | 6 | 1 | 2 | 3 |
| Prof. Bus. Ass'n. | 102 | 48.6 | 8 | 37 | 16 | 3 | 14 | 25 |
| Other Sports Clubs | 40 | 19.0 | 4 | 17 | 3 | 2 | 7 | 7 |
| Other Organizations | 35 | 16.7 | 2 | 9 | 4 | 2 | 11 | 7 |
| **Age 45 - 49** | | | | | | | | |
| Civic Organization | 27 | 26.5 | 3 | 13 | 5 | 1 | | 4 |
| Social Welfare | 30 | 29.4 | 4 | 9 | 5 | 2 | 2 | 7 |
| Veterans' Organizations | 6 | 5.9 | | 1 | | 2 | 1 | 2 |
| Church Groups | 52 | 51.0 | 5 | 19 | 7 | 4 | 4 | 12 |
| Fraternal & Service Org. | 23 | 22.5 | 1 | 12 | 3 | 2 | 1 | 4 |
| Country Club | 15 | 14.7 | 2 | 6 | 3 | 1 | 2 | 1 |
| Prof. Bus. Ass'n. | 58 | 56.9 | 4 | 18 | 12 | 6 | 5 | 12 |
| Other Sports Clubs | 13 | 12.7 | | 4 | 3 | 1 | | 5 |
| Other Organizations | 20 | 19.6 | 1 | 6 | 6 | 2 | 3 | 2 |
| **Age 50 - 54** | | | | | | | | |
| Civic Organization | 9 | 14.0 | 2 | 4 | 2 | | | 1 |
| Special Welfare | 10 | 15.6 | 1 | 4 | 4 | | | 1 |
| Veterans' Organization | 4 | 6.2 | 1 | 1 | | | | 2 |
| Church Groups | 28 | 43.7 | 6 | 9 | 6 | 1 | | 6 |
| Fraternal & Service Org. | 20 | 31.2 | 4 | 7 | 2 | | | 7 |
| Country Club | 8 | 12.5 | 1 | 4 | | | 1 | 2 |
| Prof. Bus. Ass'n. | 30 | 46.9 | 3 | 8 | 7 | 2 | 1 | 9 |
| Other Sports Clubs | 13 | 20.3 | 1 | 7 | 2 | | 1 | 2 |
| Other Organizations | 13 | 20.3 | 1 | 6 | 3 | | | 3 |
| **Age 55 and over** | | | | | | | | |
| Civic Organization | 9 | 19.6 | | 6 | 1 | | 1 | 1 |
| Social Welfare | 8 | 17.4 | | 3 | 2 | | 2 | 1 |
| Veterans' Organizations | 2 | 4.3 | | 2 | | | | |
| Church Groups | 15 | 32.6 | | 9 | 4 | | 2 | |
| Fraternal & Service Org. | 19 | 41.3 | 4 | 7 | 5 | | 2 | 1 |
| Country Club | 7 | 15.2 | 1 | 3 | 2 | | 1 | |
| Prof. Bus. Ass'n. | 20 | 43.5 | 2 | 10 | 3 | | 4 | 1 |
| Other Sports Clubs | 13 | 28.3 | 1 | 10 | | | 1 | 1 |
| Other Organizations | 11 | 23.9 | | 4 | 3 | | 3 | 1 |

Note: Total adds to more than 100% due to multiple answers.

Note: Total adds to more than 100% due to multiple answers

WHAT SOURCES DO YOU PRESENTLY USE TO KEEP ABREAST WITH THIS CHANGING INDUSTRY?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Company training program | 18 | 20.9 | 3 | 7 | 4 | 1 | 1 | 2 |
| Engineering associations | 37 | 43.0 | 5 | 16 | 3 | 3 | 3 | 7 |
| Engineering conventions | 33 | 38.3 | 6 | 16 | 2 | 1 | 1 | 7 |
| Trade Shows | 40 | 46.5 | 6 | 21 | 2 | | 3 | 8 |
| Conversation with others | 71 | 82.5 | 10 | 26 | 7 | 5 | 5 | 18 |
| Trade magazines | 80 | 93.0 | 11 | 30 | 8 | 5 | 6 | 20 |
| Post graduate courses | 42 | 48.8 | 5 | 20 | 1 | 2 | 3 | 11 |
| Other | 11 | 12.8 | 2 | 2 | 1 | 1 | | 5 |
| **Age 25 - 29** | | | | | | | | |
| Company training program | 117 | 33.1 | 5 | 57 | 9 | 7 | 19 | 20 |
| Engineering associations | 163 | 46.2 | 14 | 63 | 26 | 10 | 19 | 31 |
| Engineering conventions | 144 | 40.8 | 15 | 61 | 11 | 8 | 13 | 36 |
| Trade Shows | 148 | 41.9 | 14 | 56 | 14 | 4 | 12 | 48 |
| Conversation with others | 292 | 82.7 | 22 | 112 | 40 | 14 | 37 | 67 |
| Trade magazines | 341 | 96.6 | 24 | 127 | 48 | 15 | 43 | 84 |
| Post graduate courses | 159 | 45.0 | 14 | 67 | 11 | 6 | 16 | 45 |
| Other | 43 | 12.2 | 4 | 10 | 9 | | 9 | 11 |
| **Age 30 - 34** | | | | | | | | |
| Company training program | 192 | 30.8 | 12 | 79 | 16 | 15 | 32 | 38 |
| Engineering associations | 340 | 54.5 | 21 | 130 | 44 | 26 | 40 | 69 |
| Engineering conventions | 318 | 50.9 | 26 | 131 | 37 | 15 | 34 | 75 |
| Trade shows | 281 | 40.8 | 19 | 107 | 39 | 8 | 26 | 82 |
| Conversation with others | 480 | 77.0 | 36 | 178 | 61 | 32 | 61 | 112 |
| Trade magazines | 597 | 95.6 | 42 | 220 | 75 | 39 | 77 | 144 |
| Post graduate courses | 260 | 41.6 | 17 | 99 | 20 | 14 | 27 | 83 |
| Other | 73 | 11.7 | 6 | 26 | 9 | 3 | 9 | 20 |
| **Age 35 - 39** | | | | | | | | |
| Company training program | 151 | 36.0 | 11 | 53 | 18 | 11 | 25 | 33 |
| Engineering associations | 232 | 55.2 | 23 | 80 | 32 | 14 | 38 | 45 |
| Engineering conventions | 242 | 57.6 | 27 | 90 | 33 | 14 | 30 | 48 |
| Trade shows | 195 | 46.4 | 22 | 62 | 32 | 6 | 22 | 51 |
| Conversation with others | 327 | 77.8 | 31 | 113 | 46 | 19 | 48 | 70 |
| Trade magazines | 396 | 94.3 | 42 | 138 | 61 | 20 | 54 | 81 |
| Post graduate courses | 107 | 25.5 | 12 | 42 | 7 | 5 | 10 | 31 |
| Other | 73 | 17.4 | 8 | 25 | 9 | 6 | 12 | 13 |
| **Age 40 - 44** | | | | | | | | |
| Company training program | 88 | 37.6 | 5 | 30 | 8 | 5 | 22 | 18 |
| Engineering associations | 132 | 56.4 | 9 | 49 | 16 | 6 | 21 | 31 |
| Engineering conventions | 138 | 59.0 | 10 | 60 | 16 | 6 | 20 | 26 |
| Trade shows | 123 | 52.6 | 8 | 52 | 13 | 3 | 13 | 34 |
| Conversation with others | 190 | 81.2 | 17 | 73 | 21 | 9 | 27 | 43 |
| Trade magazines | 223 | 95.3 | 18 | 82 | 26 | 11 | 36 | 50 |
| Post graduate courses | 54 | 23.1 | 3 | 20 | 6 | 3 | 6 | 16 |
| Other | 43 | 18.4 | 6 | 17 | 1 | 3 | 8 | 8 |
| **Age 45 - 49** | | | | | | | | |
| Company training program | 31 | 28.2 | | 13 | 4 | 3 | 3 | 8 |
| Engineering associations | 68 | 61.8 | 6 | 28 | 9 | 5 | 5 | 15 |
| Engineering conventions | 57 | 51.8 | 5 | 24 | 5 | 5 | 5 | 13 |
| Trade shows | 58 | 52.7 | 6 | 24 | 10 | 2 | 2 | 14 |
| Conversation with others | 77 | 70.0 | 8 | 31 | 11 | 6 | 4 | 17 |
| Trade magazines | 106 | 96.4 | 9 | 41 | 18 | 8 | 8 | 22 |
| Post graduate courses | 20 | 18.2 | 2 | 6 | 4 | 3 | | 5 |
| Other | 25 | 22.7 | 2 | 11 | 5 | 3 | | 4 |

(Continued on page 268)

J. B. WASSALL, DIRECTOR OF ENGINEERING, WITH LOCKHEED SINCE 1937

# A message of importance to career-minded engineers:

"Lockheed aircraft continue to blaze new trails for manned flight. The new Electra is America's first prop-jet airliner. A Navy version of the Electra will be the country's first turbine-powered submarine hunter.

"Already, our design groups plan the supersonic jet transports of 1965. Meanwhile, new speed and altitude records set by a Lockheed F-104 Starfighter move manned flight to the fringes of outer space.

"Within and beyond lie many problems for our engineers: problems in aero and thermodynamic characteristics at supersonic speeds, in radar, in optics, in infrared, in data processing for airborne detection systems and in all phases of design. Additional long-range problems exist in military systems analysis, nuclear and space craft systems, commercial air transport studies, and industrial operations research.

"There are openings now for thoroughly qualified electronics and aero-thermodynamics and design engineers and operations research specialists.

"If you are interested in a Lockheed career in California, write us today. Address E. W. Des Lauriers, Manager Placement Staff, Dept. 106, 1708 Empire Avenue, Burbank."

Lockheed

**ENGINEERS:** *Write Mr. Des Lauriers for your copy of a paper on "Airborne Early Warning in the Missile Age" presented by Robert A. Bailey, Chief Engineer, California Division, Lockheed Aircraft Corporation, at the 6th USAF World Wide Weapons Meet.*

THE CALIFORNIA DIVISION OF LOCKHEED AIRCRAFT CORPORATION • BURBANK, CALIFORNIA

| Age 50 - 54 | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Company training program | 25 | 35.7 | 4 | 8 | 2 | | 1 | 10 |
| Engineering associations | 41 | 58.5 | 4 | 15 | 9 | 1 | 2 | 10 |
| Engineering conventions | 45 | 64.3 | 4 | 21 | 8 | 2 | 2 | 8 |
| Trade shows | 44 | 62.8 | 3 | 15 | 10 | 2 | 3 | 11 |
| Conversation with others | 57 | 81.4 | 7 | 26 | 9 | 2 | 2 | 11 |
| Trade magazines | 69 | 98.5 | 7 | 28 | 13 | 2 | 3 | 16 |
| Post graduate courses | 12 | 17.1 | 2 | 1 | 1 | | 1 | 7 |
| Other | 14 | 20.0 | 2 | 4 | 3 | | | 5 |

| Age 55 and over | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| Company training program | 18 | 32.7 | | 7 | 5 | | 6 | |
| Engineering associations | 37 | 67.3 | 3 | 19 | 7 | | 5 | 3 |
| Engineering conventions | 39 | 70.9 | 4 | 19 | 7 | | 5 | 4 |
| Trade shows | 33 | 60.0 | 4 | 13 | 7 | | 6 | 3 |
| Conversation with others | 43 | 78.2 | 5 | 21 | 9 | | 4 | 4 |
| Trade magazines | 51 | 92.7 | 4 | 26 | 10 | | 7 | 4 |
| Post graduate courses | 8 | | | 1 | 1 | | 5 | 1 |
| Other | 10 | 18.2 | | 4 | 1 | | 5 | |

## DO YOU OWN OR RENT?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Own | 10 | 13.0 | | 3 | 1 | | | 6 |
| Rent | 67 | 87.0 | 10 | 25 | 6 | 3 | 6 | 17 |
| **Age 25 - 29** | | | | | | | | |
| Own | 174 | 51.0 | 10 | 60 | 23 | 10 | 28 | 43 |
| Rent | 167 | 49.0 | 15 | 69 | 23 | 4 | 18 | 38 |
| **Age 30 - 34** | | | | | | | | |
| Own | 488 | 79.2 | 37 | 171 | 64 | 35 | 61 | 120 |
| Rent | 128 | 20.8 | 6 | 59 | 15 | 3 | 18 | 27 |
| **Age 35 - 39** | | | | | | | | |
| Own | 353 | 84.6 | 39 | 124 | 48 | 19 | 50 | 73 |
| Rent | 64 | 15.4 | 5 | 21 | 13 | 2 | 8 | 15 |
| **Age 40 - 44** | | | | | | | | |
| Own | 208 | 89.3 | 16 | 79 | 25 | 9 | 29 | 50 |
| Rent | 25 | 10.7 | 3 | 8 | 2 | 2 | 8 | 2 |
| **Age 45 - 49** | | | | | | | | |
| Own | 98 | 89.1 | 9 | 35 | 18 | 8 | 7 | 21 |
| Rent | 12 | 10.9 | | 7 | 1 | | 1 | 3 |
| **Age 50 - 54** | | | | | | | | |
| Own | 64 | 91.4 | 6 | 28 | 10 | 2 | 3 | 15 |
| Rent | 6 | 8.6 | 1 | 1 | 3 | | | 1 |
| **Age 55 and over** | | | | | | | | |
| Own | 45 | 86.5 | 5 | 22 | 9 | | 5 | 4 |
| Rent | 7 | 13.5 | | 3 | 1 | | 3 | |

## IF YOU OWN YOUR HOME, WHAT IS ITS APPROXIMATE VALUE?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Less than $10,000 | | | | | | | | |
| 10,000 - 14,999 | 5 | 55.6 | | 1 | | | | 3 |
| 15,000 - 19,999 | 4 | 44.4 | | 2 | | | | 2 |
| 20,000 - 24,000 | | | | | | | | |
| 25,000 - 29,999 | | | | | | | | |
| 30,000 - 39,999 | | | | | | | | |
| Median - $15,000 | | | | | | | | |
| **Age 25 - 29** | | | | | | | | |
| Less than $10,000 | 7 | 4.1 | | 4 | 1 | | 1 | 1 |
| 10,000 - 14,999 | 48 | 27.9 | 3 | 18 | 6 | 3 | 11 | 7 |
| 15,000 - 19,999 | 87 | 50.6 | 5 | 25 | 12 | 7 | 13 | 25 |
| 20,000 - 24,000 | 23 | 13.4 | | 8 | 3 | | 3 | 9 |
| 25,000 - 29,999 | 4 | 2.3 | 1 | 1 | 1 | | | 1 |
| 30,000 - 39,999 | 3 | 1.7 | 1 | 2 | | | | |
| Median - $16,775 | | | | | | | | |
| **Age 30 - 34** | | | | | | | | |
| Less than $10,000 | 11 | 2.3 | | 4 | 1 | | 5 | 1 |
| 10,000 - 14,999 | 94 | 19.3 | 9 | 29 | 10 | 12 | 21 | 13 |
| 15,000 - 19,999 | 208 | 42.7 | 19 | 81 | 25 | 15 | 20 | 48 |
| 20,000 - 24,999 | 104 | 21.4 | 6 | 34 | 14 | 5 | 4 | 41 |
| 25,000 - 29,999 | 41 | 8.4 | 2 | 13 | 11 | 2 | 7 | 6 |
| 30,000 - 39,999 | 22 | 4.5 | 1 | 7 | 3 | 1 | 3 | 7 |
| 40,000 - 49,999 | 6 | 1.2 | | 3 | | | | 3 |
| 50,000 and over | | | | | | | | |
| Median - $18,345 | | | | | | | | |
| **Age 35 - 39** | | | | | | | | |
| Less than $10,000 | 10 | 2.8 | | 1 | 2 | | 5 | 2 |
| 10,000 - 14,999 | 62 | 17.6 | 3 | 21 | 13 | 3 | 9 | 13 |
| 15,000 - 19,999 | 105 | 29.8 | 10 | 43 | 12 | 6 | 16 | 18 |
| 20,000 - 24,999 | 94 | 26.6 | 13 | 36 | 7 | 7 | 10 | 21 |
| 25,000 - 29,999 | 55 | 15.6 | 10 | 15 | 10 | 2 | 7 | 11 |
| 30,000 - 39,999 | 19 | 5.4 | 3 | 6 | 3 | 1 | 2 | 4 |
| 40,000 - 49,999 | 4 | 1.1 | | 1 | | | 1 | 2 |
| 50,000 and over | 4 | 1.1 | | 1 | 1 | | | 2 |
| Median - $20,000 | | | | | | | | |
| **Age 40 - 44** | | | | | | | | |
| Less than $10,000 | 4 | 1.9 | 1 | 1 | 1 | | | 1 |
| 10,000 - 14,999 | 41 | 19.7 | 4 | 14 | 6 | 2 | 6 | 9 |
| 15,000 - 19,999 | 55 | 26.5 | 4 | 15 | 5 | 4 | 13 | 14 |
| 20,000 - 24,999 | 56 | 26.9 | 5 | 29 | 4 | 1 | 5 | 12 |
| 25,000 - 29,999 | 20 | 9.6 | 1 | 9 | | 1 | 1 | 8 |
| 30,000 - 39,999 | 24 | 11.5 | 1 | 9 | 6 | 1 | 3 | 4 |
| 40,000 - 49,999 | 6 | 2.9 | | 2 | 2 | | 1 | 1 |
| 50,000 and over | 2 | 1.0 | | | 1 | | | 1 |
| Median - $20,350 | | | | | | | | |
| **Age 45 - 49** | | | | | | | | |
| Less than $10,000 | 3 | 3.1 | | 1 | | 1 | | 1 |
| 10,000 - 14,999 | 16 | 16.3 | 2 | 7 | 2 | 1 | 2 | 2 |
| 15,000 - 19,999 | 22 | 22.5 | 1 | 10 | 4 | 2 | 1 | 4 |
| 20,000 - 24,999 | 16 | 16.3 | 3 | 3 | | 2 | 2 | 6 |
| 25,000 - 29,999 | 23 | 23.5 | 1 | 8 | 7 | 2 | 2 | 3 |
| 30,000 - 39,999 | 10 | 10.2 | | 4 | 4 | | | 2 |
| 40,000 - 49,999 | 6 | 6.1 | 2 | 2 | | | | 2 |
| 50,000 and over | 2 | 2.0 | | | 1 | | | 1 |
| Median - $22,500 | | | | | | | | |
| **Age 50 - 54** | | | | | | | | |
| Less than $10,000 | | | | | | | | |
| 10,000 - 14,999 | 5 | 7.8 | | 2 | | 1 | 1 | 1 |
| 15,000 - 19,999 | 14 | 21.9 | 3 | 7 | 1 | | 1 | 2 |
| 20,000 - 24,999 | 14 | 21.9 | 2 | 6 | 3 | | | 3 |
| 25,000 - 29,999 | 15 | 23.4 | 1 | 8 | 3 | | | 3 |
| 30,000 - 39,999 | 12 | 18.8 | | 2 | 2 | 1 | 1 | 6 |
| 40,000 - 49,999 | 2 | 3.1 | | 2 | | | | |
| 50,000 and over | 2 | 3.1 | | 1 | 1 | | | |
| Median - $24,000 | | | | | | | | |
| **Age 55 and over** | | | | | | | | |
| Less than $10,000 | 1 | 2.2 | 1 | | | | | |
| 10,000 - 14,999 | 4 | 8.9 | | 2 | 2 | | | |
| 15,000 - 19,999 | 6 | 13.3 | 1 | 3 | | | 1 | 1 |
| 20,000 - 24,999 | 12 | 26.7 | 1 | 5 | 2 | | 2 | 2 |
| 25,000 - 29,999 | 4 | 8.9 | | 1 | 1 | | 1 | 1 |
| 30,000 - 39,999 | 9 | 20.0 | 1 | 7 | 1 | | | |
| 40,000 - 49,999 | 5 | 11.1 | | 2 | 2 | | 1 | |
| 50,000 and over | 4 | 8.9 | 1 | 2 | 1 | | | |
| Median - $24,999 | | | | | | | | |

## HOW MANY AUTOMOBILES DO YOU OWN?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| 1 | 79 | 95.2 | 12 | 30 | 7 | 4 | 6 | 20 |
| 2 | 4 | 4.8 | | | 1 | | | 3 |
| Median - 1 | | | | | | | | |
| **Age 25 - 29** | | | | | | | | |
| 1 | 294 | 84.5 | 21 | 120 | 45 | 14 | 39 | 55 |
| 2 | 53 | 15.2 | 4 | 10 | 3 | 1 | 6 | 29 |
| Median - 1 | | | | | | | | |
| **Age 30 - 34** | | | | | | | | |
| 1 | 430 | 70.0 | 29 | 165 | 58 | 28 | 53 | 97 |
| 2 | 178 | 29.0 | 15 | 61 | 19 | 10 | 24 | 49 |
| 3 | 4 | 0.7 | | 1 | | | | 3 |
| 4 or more | 2 | 0.3 | | | | 1 | 1 | |
| Median - 1 | | | | | | | | |
| **Age 35 - 39** | | | | | | | | |
| 1 | 256 | 62.1 | 27 | 88 | 40 | 16 | 40 | 45 |
| 2 | 151 | 36.6 | 15 | 52 | 19 | 5 | 17 | 43 |
| 3 | 4 | 1.0 | 1 | 2 | | | 1 | |
| 4 or more | 1 | 0.3 | | | 1 | | | |
| Median - 1 | | | | | | | | |
| **Age 40 - 44** | | | | | | | | |
| 1 | 125 | 54.1 | 12 | 49 | 14 | 5 | 25 | 20 |
| 2 | 98 | 42.4 | 7 | 34 | 11 | 4 | 11 | 31 |
| 3 | 6 | 2.6 | | 1 | 2 | 1 | | 2 |
| 4 or more | 2 | 0.9 | | 1 | | | 1 | |
| Median - 1 | | | | | | | | |
| **Age 45 - 49** | | | | | | | | |
| 1 | 49 | 44.5 | 4 | 22 | 6 | 4 | 3 | 10 |
| 2 | 53 | 48.2 | 5 | 18 | 12 | 4 | 4 | 10 |
| 3 | 6 | 5.5 | | 2 | | | 1 | 3 |
| 4 or more | 2 | 1.8 | | | 1 | | | 1 |
| Median - 2 | | | | | | | | |
| **Age 50 - 54** | | | | | | | | |
| 1 | 29 | 42.6 | 3 | 12 | 8 | 1 | 1 | 4 |
| 2 | 34 | 50.0 | 3 | 13 | 4 | 1 | 2 | 11 |
| 3 | 4 | 5.9 | | 4 | | | | |
| 4 or more | 1 | | | | | | | 1 |
| Median - 2 | | | | | | | | |
| **Age 55 and over** | | | | | | | | |
| 1 | 23 | 43.4 | 1 | 11 | 6 | | 4 | 1 |
| 2 | 24 | 45.3 | 3 | 12 | 3 | | 4 | 2 |
| 3 | 4 | 7.5 | | 2 | 1 | | | 1 |
| 4 or more | 2 | 3.8 | 1 | 1 | | | | |
| Median - 2 | | | | | | | | |

## WHICH TYPE OF MUSIC DO YOU PREFER?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Opera | 9 | 10.5 | 2 | 5 | | | | 2 |
| Classical | 64 | 74.4 | 12 | 22 | 6 | 3 | 5 | 16 |
| Popular | 33 | 38.4 | | 11 | 5 | 1 | 4 | 12 |
| Jazz | 24 | 27.9 | 5 | 9 | 1 | 3 | | 6 |
| **Age 25 - 29** | | | | | | | | |
| Opera | 36 | 10.3 | 3 | 12 | 5 | 3 | 4 | 9 |
| Classical | 260 | 74.3 | 19 | 101 | 38 | 7 | 31 | 64 |
| Popular | 152 | 43.4 | 9 | 56 | 19 | 9 | 24 | 35 |
| Jazz | 91 | 26.0 | 7 | 36 | 15 | 2 | 19 | 12 |
| **Age 30 - 34** | | | | | | | | |
| Opera | 69 | 11.2 | 4 | 32 | 3 | 5 | 10 | 15 |
| Classical | 436 | 70.7 | 35 | 167 | 54 | 24 | 56 | 100 |
| Popular | 291 | 47.2 | 17 | 93 | 40 | 25 | 46 | 70 |
| Jazz | 129 | 20.9 | 9 | 51 | 16 | 6 | 14 | 33 |
| **Age 35 - 39** | | | | | | | | |
| Opera | 35 | 8.4 | 5 | 15 | 7 | | 2 | 6 |
| Classical | 314 | 75.3 | 34 | 117 | 41 | 16 | 43 | 63 |
| Popular | 200 | 48.0 | 15 | 60 | 36 | 13 | 35 | 41 |
| Jazz | 69 | 16.5 | 2 | 23 | 14 | 3 | 7 | 20 |
| **Age 40 - 44** | | | | | | | | |
| Opera | 39 | 17.0 | 4 | 15 | 1 | 1 | 10 | 8 |
| Classical | 178 | 77.7 | 16 | 68 | 21 | 6 | 28 | 39 |
| Popular | 120 | 52.4 | 7 | 42 | 14 | 7 | 22 | 28 |
| Jazz | 41 | 17.9 | 4 | 13 | 4 | 1 | 8 | 11 |
| **Age 45 - 49** | | | | | | | | |
| Opera | 9 | 8.3 | | 6 | 1 | 1 | | 1 |
| Classical | 70 | 64.8 | 5 | 26 | 9 | 7 | 6 | 17 |
| Popular | 69 | 63.9 | 5 | 28 | 15 | 5 | 3 | 13 |
| Jazz | 8 | 7.4 | 1 | 3 | 1 | | 1 | 2 |
| **Age 50 - 54** | | | | | | | | |
| Opera | 16 | 23.5 | 2 | 9 | 1 | 1 | | 3 |
| Classical | 52 | 76.4 | 5 | 24 | 8 | 1 | 2 | 12 |
| Popular | 31 | 45.6 | 4 | 10 | 5 | 1 | 2 | 9 |
| Jazz | 8 | 11.8 | | 4 | 1 | | | 3 |
| **Age 55 and over** | | | | | | | | |
| Opera | 17 | 32.7 | | 8 | 2 | | 5 | 2 |
| Classical | 40 | 76.9 | 3 | 19 | 8 | | 7 | 3 |
| Popular | 27 | 51.9 | 3 | 13 | 6 | | 4 | 1 |
| Jazz | 5 | 9.6 | | 3 | | | 2 | |

## DO YOU ATTEND CHURCH AS OFTEN AS ONCE A MONTH?

| | Total No. | Total % | New Engl. | Middle Atl. | E.N. Cent. | W.N. Cent. | South | West |
|---|---|---|---|---|---|---|---|---|
| **Age - under 25** | | | | | | | | |
| Yes | 43 | 50.6 | 3 | 13 | 6 | 3 | 5 | 13 |
| No | 42 | 49.4 | 9 | 19 | 2 | 2 | 1 | 9 |
| **Age 25 - 29** | | | | | | | | |
| Yes | 209 | 59.7 | 14 | 74 | 33 | 11 | 34 | 43 |
| No | 141 | 40.3 | 10 | 58 | 16 | 4 | 11 | 42 |
| **Age 30 - 34** | | | | | | | | |
| Yes | 377 | 60.5 | 31 | 121 | 54 | 29 | 58 | 84 |
| No | 246 | 39.5 | 13 | 112 | 25 | 10 | 21 | 65 |
| **Age 35 - 39** | | | | | | | | |
| Yes | 228 | 54.9 | 24 | 68 | 40 | 17 | 33 | 46 |
| No | 187 | 45.1 | 19 | 77 | 22 | 4 | 25 | 40 |
| **Age 40 - 44** | | | | | | | | |
| Yes | 152 | 65.2 | 15 | 54 | 18 | 8 | 26 | 31 |
| No | 81 | 34.8 | 4 | 33 | 8 | 3 | 11 | 22 |
| **Age 45 - 49** | | | | | | | | |
| Yes | 72 | 65.5 | 6 | 26 | 9 | 6 | 7 | 18 |
| No | 38 | 34.5 | 3 | 16 | 10 | 2 | 1 | 6 |
| **Age 50 - 54** | | | | | | | | |
| Yes | 40 | 58.0 | 6 | 12 | 9 | 2 | 1 | 10 |
| No | 29 | 42.0 | 1 | 17 | 3 | | 2 | 6 |
| **Age 55 and over** | | | | | | | | |
| Yes | 25 | 47.2 | 1 | 13 | 6 | | 4 | 1 |
| No | 28 | 52.8 | 4 | 14 | 4 | | 4 | 2 |

## Diodes

*(Continued from page 105)*

Newly developed modular line production techniques make these diodes available at a price in the same range as good microwave mixer crystals.

The exceptionally low noise performance of amplifiers using the new diode is already in a range competitive in many applications with the solid state maser. The latter holds the record for absolute minimum noise performance.

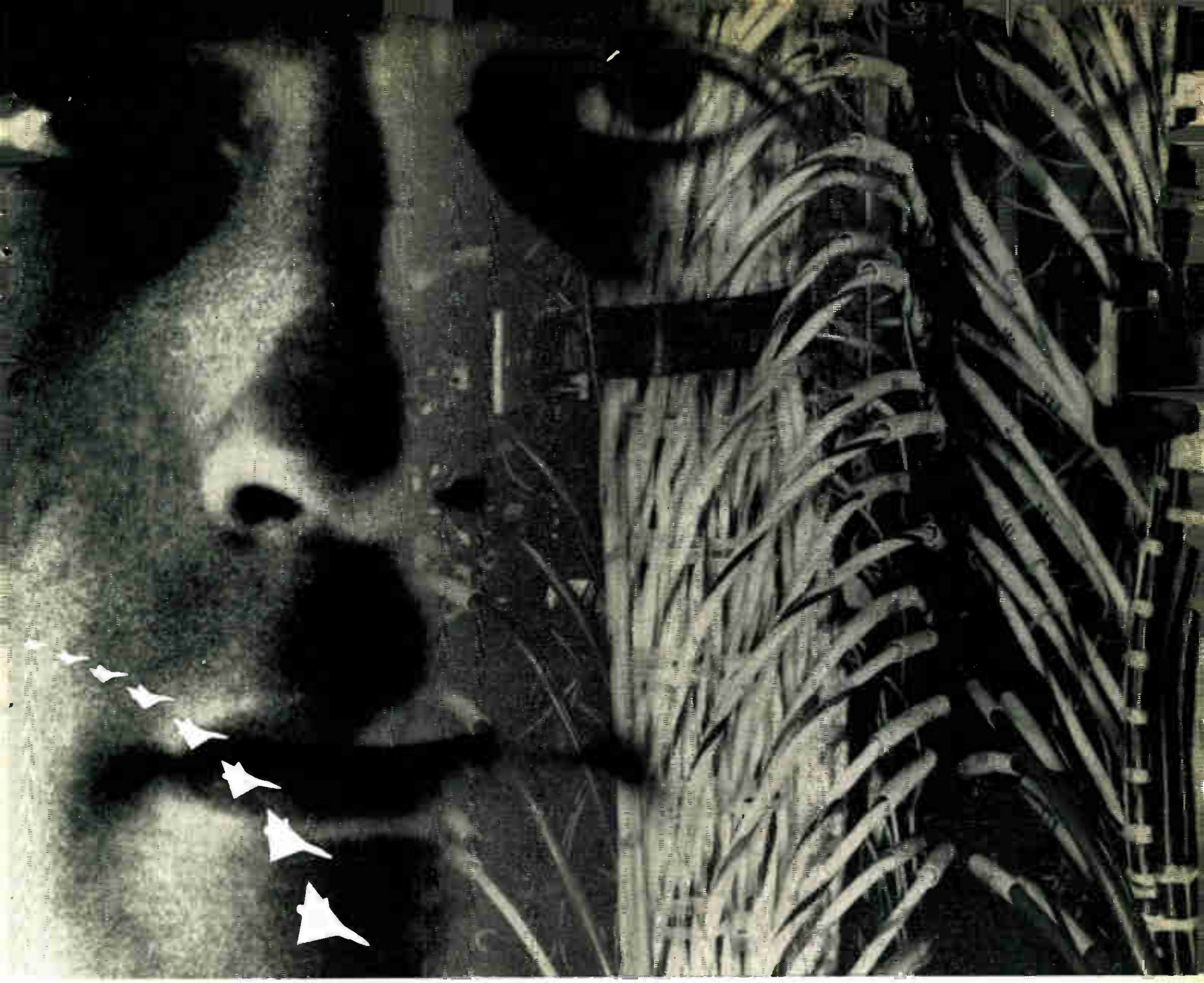
The parametric amplifier does not require low temperatures for operation. It does, however, have two channels of amplification, usually called the signal and idler channels. These channels were used simultaneously to obtain the low noise temperatures mentioned above. As a further comparison, the best reported low noise microwave tubes have noise temperatures of about 300° K at 3000 MC, but have the advantage of single channel amplification and electrical tunability.

The development of the Hughes diode resulted from a cooperative effort between the development laboratories and the semiconductor divisions of Hughes. The amplifier was designed and operated by Dr. R. C. Knechtli and R. Weglein for the noise measurements. It is related to the type of amplifier developed by Dr. Uenohara at the Bell Telephone Laboratories.

With the noise temperatures of 50° K and 100° K obtained at liquid nitrogen and room temperatures, respectively, the 3000 MC amplifier gives 30 db of amplification with 2 MC bandwidth or 10 db of amplification with 25 MC bandwidth. Such amplifiers would, of course, be useful in many applications of microwave and UHF receivers where greater sensitivity or lower receiver noise is required.

The production models of the Hughes diode, designated HPA-2800 and HPA-2810 have a nominal cutoff frequency of 70,000 MC at maximum back bias with a nominal zero-bias capacitance of 2.5μμf, it was disclosed. Its exceptional noise performance is attributed to its low equivalent series resistance at microwave frequencies.



# Industry News

**Dr. James B. Fisk,** Executive Vice President of Bell Telephone Labs., has been elected President of the company. Bell Labs. is the research and development unit of the Bell Telephone Systems.

**Dr. Patrick Conley** has been appointed Manager of the Westinghouse Electric Corp.'s Air Arm Div. Previously, Dr. Conley was technical Director on the defense products group headquarters staff in Washington, D. C.

**Thomas Finlay** has been named Sales Manager of the Precision Potentiometer Div. of Spectrol Electronics Corp. He was formerly Assistant Sales Manager.


T. Finlay


R. Leary

**Raymond T. Leary,** Sales Manager of the Distributor Div. of Cornell-Dubilier Electric Corp., has been elected a Vice President of the corporation.

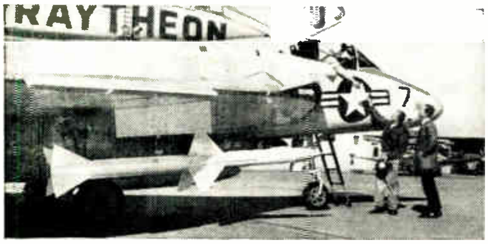
**Albert W. Brandmaier** has been named Director of European operations for Consolidated Electrodynamics Corp. He will represent the corporation in licensing and manufacturing negotiations between CEC and companies in Europe and the United Kingdom, and direct European marketing operations and activities of FmbH, wholly owned German subsidiary in Frankfort am Main.

**Vice Admiral Charles B. Momsen** (Ret.) has been named as a Consultant on the Staff of the Vice President in Charge of Engineering of the Bendix Aviation Corp. Adm. Momsen is known for his work on the "Momsen Lung"—a submarine escape device.

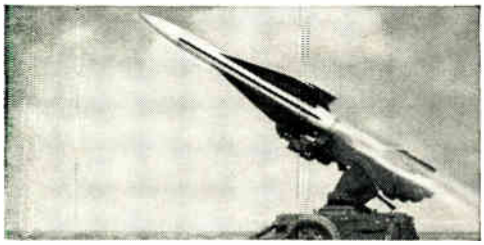
**Stanley N. Golembe,** formerly Executive Vice President, has been elected President of Power Sources, Inc.

(*Continued on Page* 274)

## Raytheon Missile Projects




SPARROW III—the Navy's tenacious, lightning-fast, air-to-air missile—is intended for extensive use by Navy fighter aircraft in fleet air defense. Sparrow III is a Raytheon prime contract.



HAWK—the Army's defense against low-altitude attackers—carries out its destruction in the blind zone of conventional radars. Hawk development and production is under Raytheon prime contract.


TARTAR—A substantial contract for vital electronic controls for this Navy destroyer-launched missile is held by Raytheon. This equipment—a tracking radar and associated units—enables it to "lock on", cling to target's path, despite evasive tactics.


ADVANCED PROJECTS in aeronautical structures as well as missile guidance and control are now underway in Raytheon laboratories. New facilities are continually being added for this work.


PRELIMINARY NEW DESIGNS of tomorrow's missiles will result from the advanced work being done by today's missile engineers. Raytheon plays an important role in this area.

Raytheon diversification offers

# JOB STABILITY FOR CREATIVE MISSILEMEN

Here is an opportunity to free yourself of worry about a job that's here today, gone tomorrow.

**Diversified assignments**—only possible in a company with Raytheon's wide range of missile activities—means security not found in one- or two-project companies. You apply your creative energies to the many projects you work on, and they in turn are your "insurance" against falling into a rut.

**Individual recognition** comes quickly from Raytheon's young, engineer-management—men who are keenly aware of the engineer's needs and contributions to missile progress.

**Dynamic Raytheon growth**—the fruit of this management's progressive policies—is best illustrated by the fact that Raytheon is already the only electronics company with two prime missile contracts—Navy Sparrow III and Army Hawk.

**The next step is up to you.** Why not get frank answers and helpful information on the type of job suited to your background and talents, its location, salary and other important details. Write, wire or telephone collect: The number is CRestview 4-7100 in Bedford, Massachusetts. Please ask for W. F. O'Melia.

***RAYTHEON OPPORTUNITIES NOW OPEN IN:***

**WEAPONS SYSTEM ANALYSIS • CONTROL SYSTEMS • PACKAGING • MICROWAVE • RADAR • SPECIFICATIONS • MISSILE AERODYNAMICS • WIND TUNNEL TESTING • AERODYNAMIC HEATING • ROCKET ENGINEERING • VIBRATION MEASUREMENT and DATA REDUCTION**

**RAYTHEON MANUFACTURING COMPANY**
**Missile Systems Division, Bedford, Mass.**

RAYTHEON *MISSILE SYSTEMS DIVISION*

*Excellence in Electronics*



Circle 508 on "Opportunities" Inquiry Card, page 125

# Industry News

(*Continued from page 272*)

**George B. Rathmann** is now Project Manager of the Advanced Research Projects Agency (ARPA) contract for solid propellant research at Minnesota Mining & Mfg. Co.

**Edward H. Michaelsen** has been elected Vice President of Phelps Dodge Copper Products Corp. He will head up the company's international activities.

The new corporate office, Manager of Electronics Requirements, The Martin Co., will be filled by **John M. Pearce**, former Vice President and General Manager of The Hoover Electronics Co.

J. Pearce

L. DeVore

**Dr. Lloyd T. DeVore**, former General Manager of the Electronics Div., Stewart-Warner Corp., will serve as Corporate Vice President and Director of a new Hoffman Electronics Corp. Div. to be known as the Hoffman Science Center. Temporary facilities will be established in Santa Barbara, Calif., pending construction of a modern research facility in that area.

**Thomas L. Taggart** has been appointed Vice President and Treasurer of the Ampex Corp. He has been the Treasurer for the last 5 years and during the first 3 years served concurrently as Manager of the Finance Div.

**Dr. Allen E. Puckett**, has been named a Vice President and Director of the Systems Development Labs. of Hughes Aircraft Co. **Robert J. Shank**, Vice President in Charge of Engineering, has been appointed to the new position of Vice President in Charge of Systems Management, and **Dr. Nathan I. Hall**, Vice President and Director of Systems Development Labs. to Vice President in Charge of Engineering.

# Industry News

Recent appointments at Texas Instruments Inc. include: **H. J. Wissemann,** Assistant Vice President as General Manager of the Apparatus Div.; **E. O. Vetter** as an Assistant Vice President; and **J. R. Juncker** as Military Relations Engineer for the Semiconductor-Components Div.

**Dr. Mervin J. Kelly,** Chairman of the board of Bell Telephone Labs. has been elected a Director of Tung-Sol Electric Inc. He is also a Director of Sandia Corp., The Prudential Insurance Co. of America and Bausch and Lomb Optical Co.

M. Kelly

J. Degen

**Joseph F. Degen** has been appointed Vice President—Manufacturing of Daystrom-Weston Divisions, Daystrom, Inc. He was formerly Vice President of Manufacturing for Weston Instruments Div.

Three new executive assignments within the Radio Corp. of America are: **George W. Chane,** Vice President, Finance and Management Engineering; **Ernest B. Gorin,** Vice President and Treasurer—with responsibility for banking and investments, treasury, corporate secretary, and stockholder relations matters; and **Howard L. Letts,** Vice President and Controller.

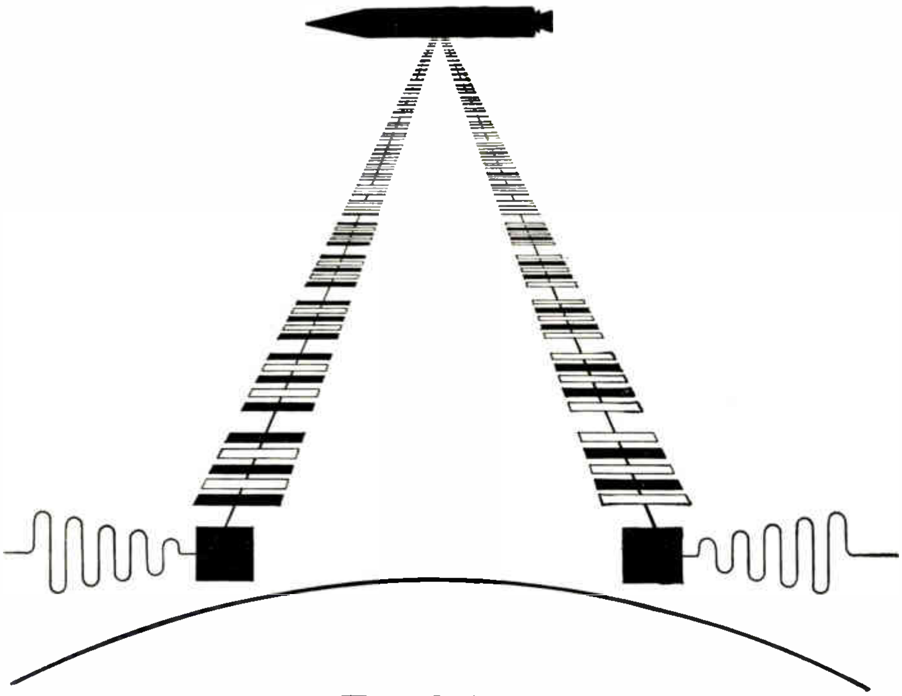
**Raymond W. Smith** and **Harold A. Strickland, Jr.,** have been elected Vice Presidents of the General Electric Co. Mr. Smith is General Manager of the Transformer Div., Pittsfield, Mass. Mr. Strickland is General Manager of the Industrial Electronics Div., New York City.

**Henry F. Dever,** Vice President of Minneapolis-Honeywell Regulator Co. and President of its Brown Instruments Div., has been elected President of the 200-member Metal Manufacturers' Assoc. of Philadelphia. He previously was Treasurer.





Circle 510 on "Opportunities" Inquiry Card, page 125





# News of Reps

### REPS WANTED

Manufacturer, **TWT solenoids, current regulated power supplies, actuating solenoids, custom r-f and i-f chokes, transformers and coils,** seeks representative for the Buffalo-Rochester area, the Chicagoland area, Texas, and the Pacific Northwest. (Box R3-1, Editor, Electronic Industries.)

A manufacturer of cooling equipment is looking for reps to cover Western Wisconsin and Minnesota. Method of manufacturing can be seen at booth 3825, IRE show. Contact Ben Eckenhoff, McLean Engineering Co., Princeton, N. J.

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Laboratory for Electronics, Inc. has appointed 3 new sales reps for their Microwave Instruments and Components. They are: **William F. Hemminger Co.** for Florida; **Harold M. Hassmann** for the Gentile, Wright-Patterson Air Force areas; and **J. Y. Schoonmaker Co.** for Oklahoma, Arkansas, Louisiana and Texas, except El Paso.

PIC Design Corp., has 3 new sales reps, and 1 new sales export company. They are: **Frank Tye Sales,** Illinois; **Forristal-Young Sales Co.,** Missouri, Iowa, Nebraska, Kansas; **C. D. Daniels Co.,** Oklahoma; and **Teletech International Corp.,** all foreign sales.

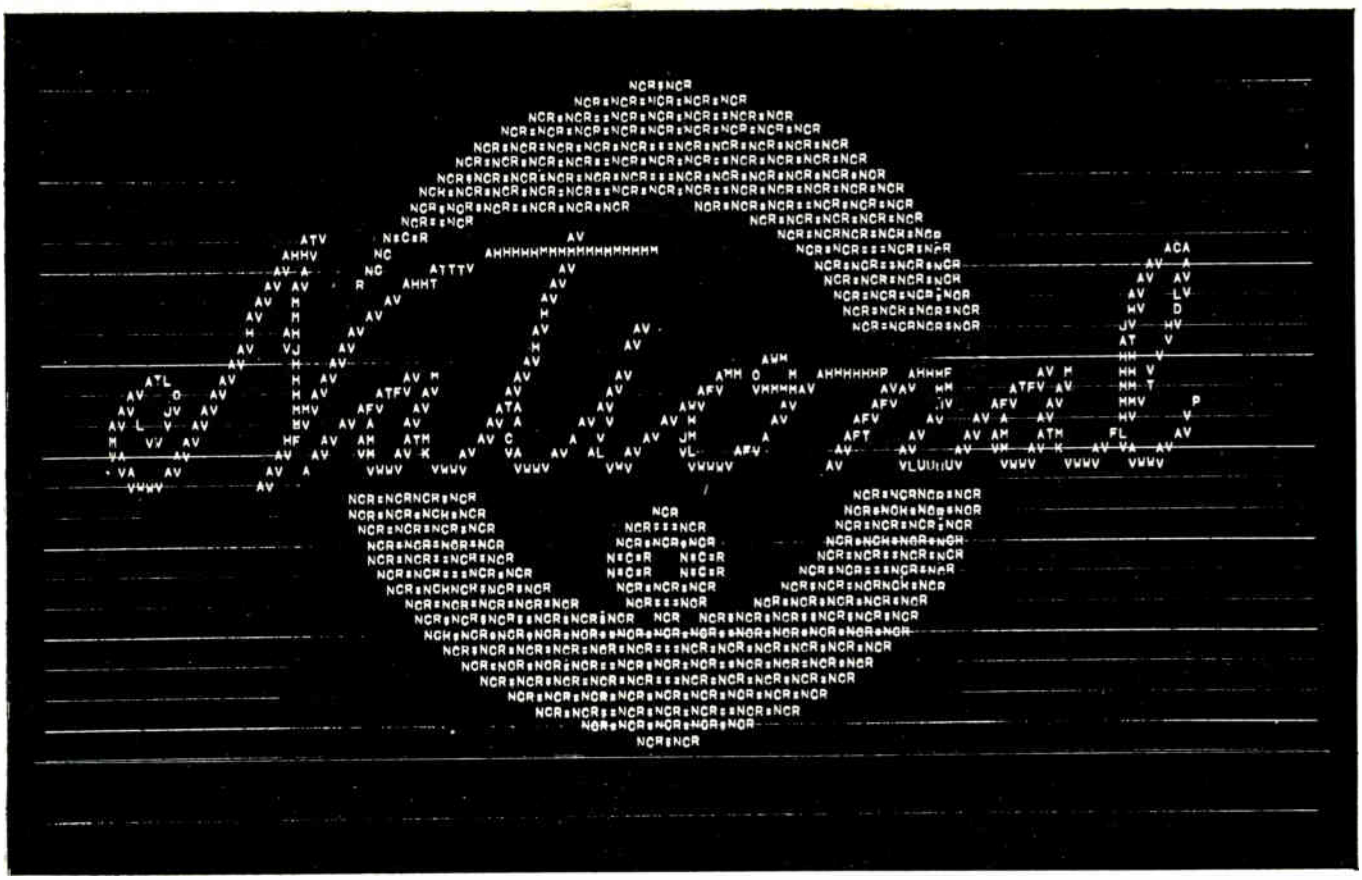
**Samuel K. MacDonald, Inc.,** Philadelphia, Pa., has been appointed sales rep for Columbus Electronics Corp., Yonkers, N. Y. in Southern New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia and Washington, D. C.

Schaevitz Engineering has appointed 3 new sales reps: **Testco,** Seattle, Wash., will represent the company in Washington, Oregon, Idaho and Montana. **Ensco,** Kansas City, will handle the Missouri, Kansas, Iowa and Nebraska areas. **Southwest Electronic Industries,** Dallas, Tex., will cover Texas, except El Paso, and Oklahoma, Arkansas and Louisiana.

Five new sales reps are now with Formica Corp., Cincinnati. They are: **Shelton F. Jones,** New York; **C. Leo Masuret,** Milwaukee office; **Thomas K. O'Brien, Jr.,** Chicago; **Doane T. Pickering Jr.,** Minneapolis; and **Kenneth W. Thomas,** Cincinnati office.

**The Tompkins Co.** has been appointed rep in the Mountain States and most of the Central states by The Barden Corp.

*(Continued on Page* 278)



# COMPUTER ENGINEERS

## HERE ARE THE TYPES OF ENGINEERS WE NEED:

- **SENIOR SYSTEMS ENGINEERS**
- **SENIOR CIRCUIT DESIGNERS**
- **SENIOR LOGICAL DESIGNERS**
- **SENIOR ELECTRONIC DESIGN ENGINEERS**

### COMPUTER ENGINEERS:

***Senior Systems Engineers***—Strong Theoretical and Design Knowledge in Electronic Engineering, including familiarity with electro-mechanical digital machines. Prefer experience with commercial application of digital-processing equipment, will consider scientific or defense application. Operational experience a distinct asset. Advance degree desired.

***Your Work at NCR***—analyze and direct product improvement of digital computers.

***Senior Circuit Designers***—experienced in the design, development and analysis of transistorized computer circuits, including application of magnetic cores to high-speed memories.

***Your Work at NCR***—opportunities involving decision making concerning reliability, cost and component selection are offered.

***Senior Circuit and Logical Designers***—similar experience and duties as noted for Senior Circuit Designers plus evaluation and debugging arithmetic and control areas of computer systems.

### DATA-PROCESSING ENGINEERS:

***Senior Electronic Design Engineers***—experienced in the development of logical design using standard computer elements.

***Your Work at NCR***—to evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding.

### WHERE YOU WILL WORK . . .

at NCR's NEW Engineering Research Center, Dayton, Ohio.

You'll be working under the most stimulating and advanced R and D facilities with broad creative freedom in the engineering field which is *yours*.

### HOW DO I APPLY?

Simply send your résumé to: Mr. K. C. Ross, Professional Personnel Section E, The National Cash Register Company, Dayton 9, Ohio.

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Circle 512 on "Opportunities" Inquiry Card, page 125

# News of Reps

(*Continued from Page* 276)

**Thomas E. Neal** is now General Sales Rep for Engelhard Industries, Inc. in Florida, Alabama, Georgia, and South Carolina. **The Mosher & Peyser Co.** is now New England Sales Rep for Columbus Electronics Corp. and **O. F. Masin Co.** is now the New York area sales rep.

McLean Engineering Laboratories has named **Engineering Services Co.** as rep in the Kansas City, St. Louis area for their line of packaged cooling equipment.

New reps for the Newport Antenna Div., Cornell-Dubilier Electric Corp. are: **Album-Orren Sales Co., Appel-Cornwell and Assoc., Brown-Sachs & Co., Warren Katz & Assoc., Sidney Lemberger & Son, J. L. Levenberg & Assoc., McClintock Sales Co., Inc., Jack Rosen, A. Walt Runglin Co.,** and **L. W. Erlichman Co.**

The Daven Co. has appointed **Norman W. Kathrinus & Co.** as its rep in Missouri, Southern Illinois and Kansas.

**Ridgway Engineering, Inc.** has been appointed sales rep for Baird-Atomic, Inc., in Indiana, Illinois, Wisconsin, Western Kentucky and Eastern Iowa.

Radiation Counter Labs, Inc. has appointed the **Hyde Electronics Co.** as rep in Montana, Wyoming, Idaho, Colorado, Utah, New Mexico, Western Kansas, and El Paso, Tex.

Penta Laboratories, Inc., Santa Barbara, Calif. has appointed **Cartwright & Bean** as sales reps in the Southeastern United States, and **J. L. Peirce Co.** as reps in Michigan.

Instrument Development Labs., Inc., has appointed **John A. Moots & Assoc.** rep in the greater Dayton, Ohio, area.

**Air Equipment Sales Co.** will now handle Southwestern operations of the Singer Military Products Div. Territory includes Texas, Oklahoma, Arkansas, Louisiana, Kansas, and Kansas City, Mo.

**Lawrence C. Freeman & Assoc.** is now rep for General Communication Co. and Railway Communications, Inc. in New York City, Long Island, and New Jersey.

**Robert B. Stahlhut**, St. Louis., has been appointed rep for Price Electric Corp. for the St. Louis, Kansas City, and Wichita areas.

Neely Enterprises' annual sales conference brings together Field Engineers and Staff from 8 offices. Norman B. Neely, President, in front row, left of center. To his left is R. L. Boniface, V.P. & Gen. Mgr. To his right are: R. L. Morgan, V.P., Engr'g, and R. H. Brunner, Sales Mgr.

Electrical Specialty Co., San Francisco is now rep in 11 western states for the Resistance-Wire Div. of C. O. Jelliff Mfg. Corp.

Aerol Assoc. is now sales rep in 13 western and southwestern states for electronic connector manufacturer, H. H. Buggie, Inc.

E. W. Humphreys is now West Coast rep for the 'Texilene' line of electrical wire and cable fillers of E. W. Twitchell, Inc.

Ferrotran Electroncis Co., Inc., has appointed Featherstone & Salisbury Co. rep for Northern California and Northern Nevada.

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ENGINEERS

## SYLVANIA penetrates important new areas which will keep you ahead of the field

Fast-moving, new developments in semiconductor devices — many of them the work of Sylvania Semiconductor Division scientists and engineers—have created a stimulating climate which will keep you substantially ahead of the field. Vital new areas are now being probed where your abilities and talents can play an important part — with commensurate rewards and recognition for you.

**SEMICONDUCTOR DEVICE ENGINEERS**

Experienced in design, development or production engineering, transistors, silicon devices, crystal diodes or rectifiers.

**MICROWAVE ENGINEERS**

Experienced in semiconductor device work or microwave circuit development. Microwave experience, even though not in devices, is acceptable.

**FIELD ENGINEERS**

To provide technical liaison between development and production engineers and customers who are electronic equipment manufacturers. Must have background in semiconductors and communication circuitry.

*Please send your resume in confidence to:* Mr. Joseph Reilly

SEMICONDUCTOR DIVISION
**SYLVANIA**
SYLVANIA ELECTRIC PRODUCTS INC.
100 Sylvan Road • Woburn, Massachusetts

Circle 504 on "opportunities" Inquiry Card, page 125

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ENGINEERS/EE/ME/AE

# FOCAL POINT FOR CAREERS IN SYSTEMS ENGINEERING

## General Electric's New Defense Systems Dept.

From many diverse disciplines in engineering and the sciences, capable men are coming together to form the nucleus of the new Defense Systems Department — *an organization devoted exclusively to conceiving, integrating and managing prime defense programs, such as:*

ATLAS | DYNA-SOAR
SENTRY | and other highly classified systems which cannot be listed here.

Whether you are a systems engineer now or not, the inauguration of this new department presents a rare opportunity for bringing *your own career* into sharp focus in systems engineering.

*Immediate assignments in*

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WEAPONS ANALYSIS
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COMPUTER LOGICAL DESIGN
PRELIMINARY DESIGN
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ADVANCED SYSTEMS DEVELOPMENT
SYSTEMS EVALUATION
THEORETICAL AERODYNAMICS

*Please direct your inquiry in strictest confidence to Mr. E. A. Smith, Dept. 3D.*

DSD

DEFENSE SYSTEMS DEPARTMENT
GENERAL ELECTRIC
300 South Geddes Street
Syracuse, New York

# ELECTRONIC INDUSTRIES Advertisers—March 1959



*(Continued on page 282)*

For product information, use inquiry card on page 123

(*Continued from page* 281)


*In Operations Edition only.

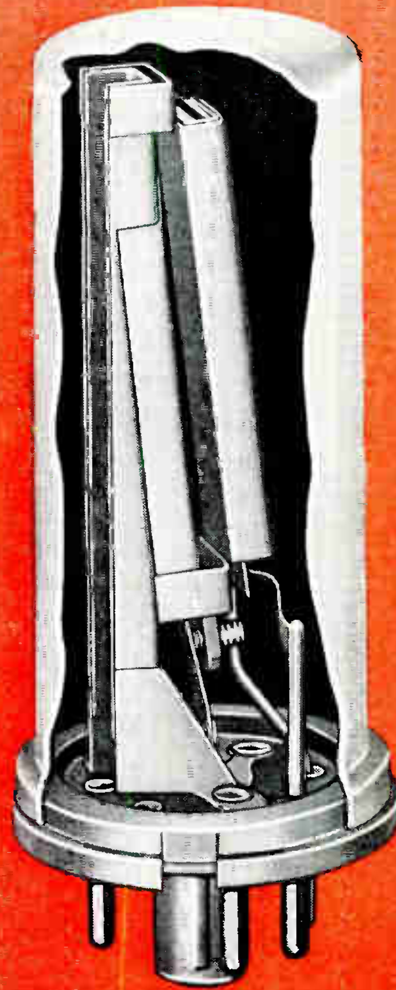
While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

*For product information, use inquiry card on page 123*

# Dependability and long life
# previously available
# only in high-cost relays...

# G-V RED/LINE

## low-cost thermal timing relays



ıe sound design, sturdy construction and reliable operation long ;sociated with G-V Hermetically Sealed Thermal Relays is available a low-cost form, fully qualified for industrial control . . . light ıd inexpensive enough for electronic and communications circuits. elays of 2 seconds to 3 minutes • Energizing voltages - 6.3 to 230 C 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 Nichrome 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**

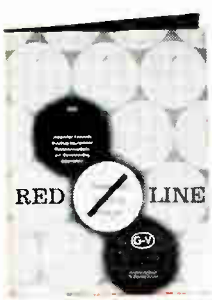
Directly interchangeable with all other octal-size relays.

**AVAILABLE FROM STOCK**

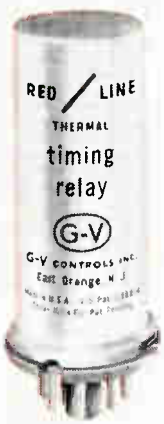
For rapid delivery, Red Line Relays are manufactured and stocked in both normally open and normally closed types, in the standard heater voltages and delay intervals listed. Relays for other voltages and delay intervals can be provided on special order.

| 6.3 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



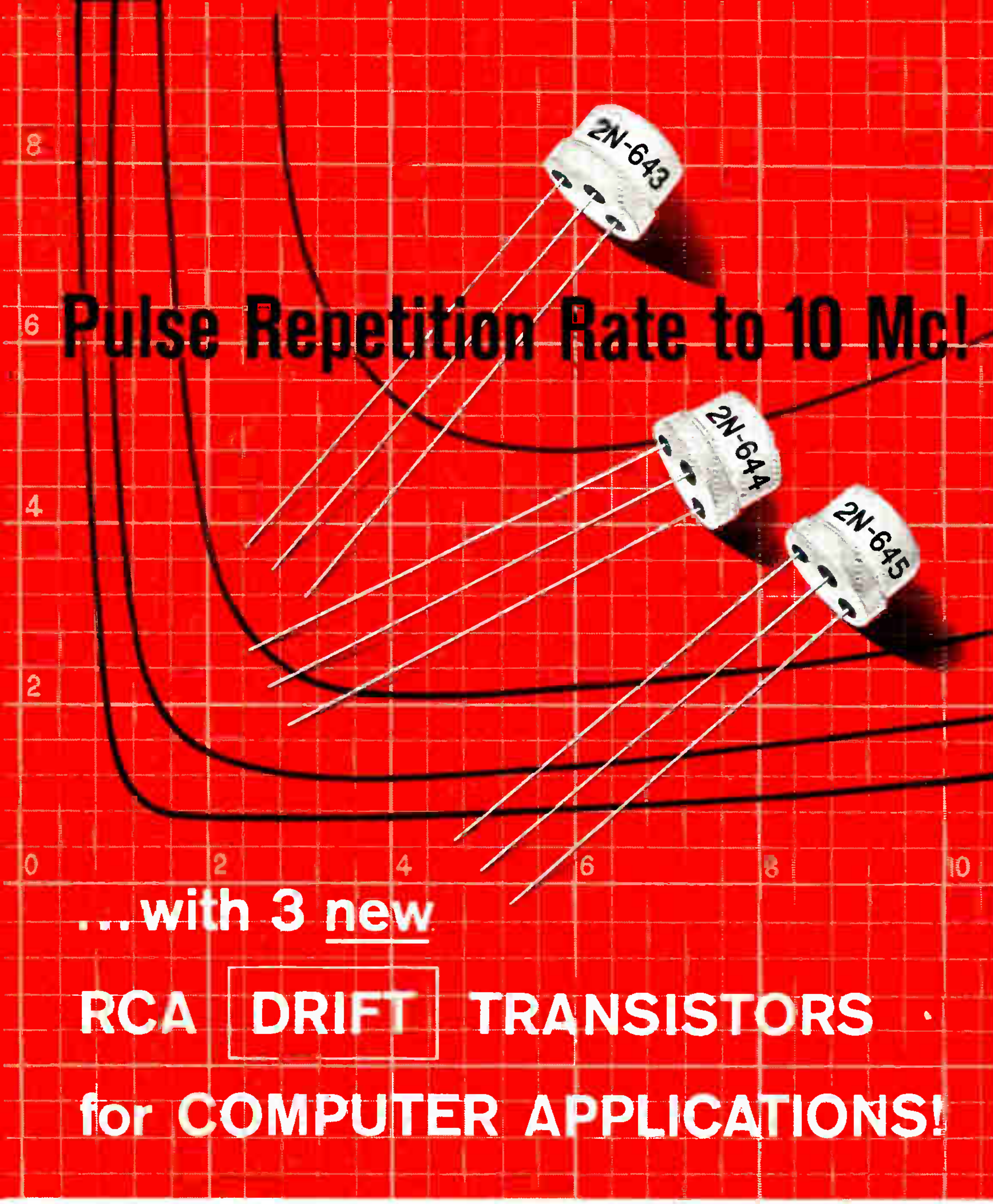

Write for Publication 131.

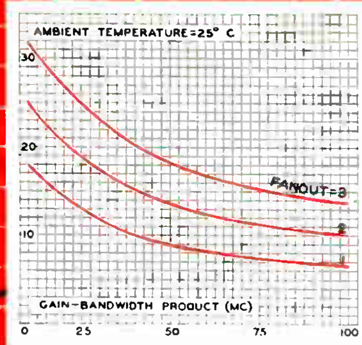



G-V

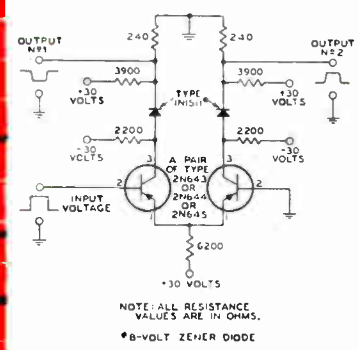
**G-V CONTROLS INC.**
LIVINGSTON, NEW JERSEY

Circle 2 on Inquiry Card, page 123




Curves illustrate typical delay time per stage vs. gain-bandwidth product and fanout for the switching circuit shown below.




| TYPE | 2N643 | 2N644 | 2N645 |
|---|---|---|---|
| Minimum gain-bandwidth product* Mc | 20 | 40 | 60 |
| Minimum collector** breakdown volts | 30 | 30 | 30 |
| Minimum DC current transfer ratio* | 20 | 20 | 20 |
| Maximum collector capacitance μμf | 5 | 5 | 5 |

*Collector Volts = -7, collector ma = -5
**Collector Current = 100 μa

## RCA-2N643, RCA-2N644, and RCA-2N645 feature controlled minimum gain-bandwidth products, of 20, 40, and 60 Mc

RCA continues to pioneer superior-quality semiconductor devices with the new RCA-2N643, RCA-2N644, and RCA-2N645 "Drift" transistors. These three new units feature controlled minimum gain-bandwidth products permitting the design of extremely high-speed non-saturating switching circuits with rise, fall, and propagation time in the order of 20 millimicroseconds.

For your high-speed switching circuits requiring pulse repetition rates up to 10 Mc. investigate the superior design possibilities and benefits available to you with the new RCA "Drift" transistors–RCA-2N643, RCA-2N644, and RCA-2N645–hermetically sealed in cases utilizing dimensions of Jetec TO-9 outline. Your RCA field representative has complete details. Call him today. For technical data, write RCA Commercial Engineering, Section C-50-NN, Somerville, N. J.

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