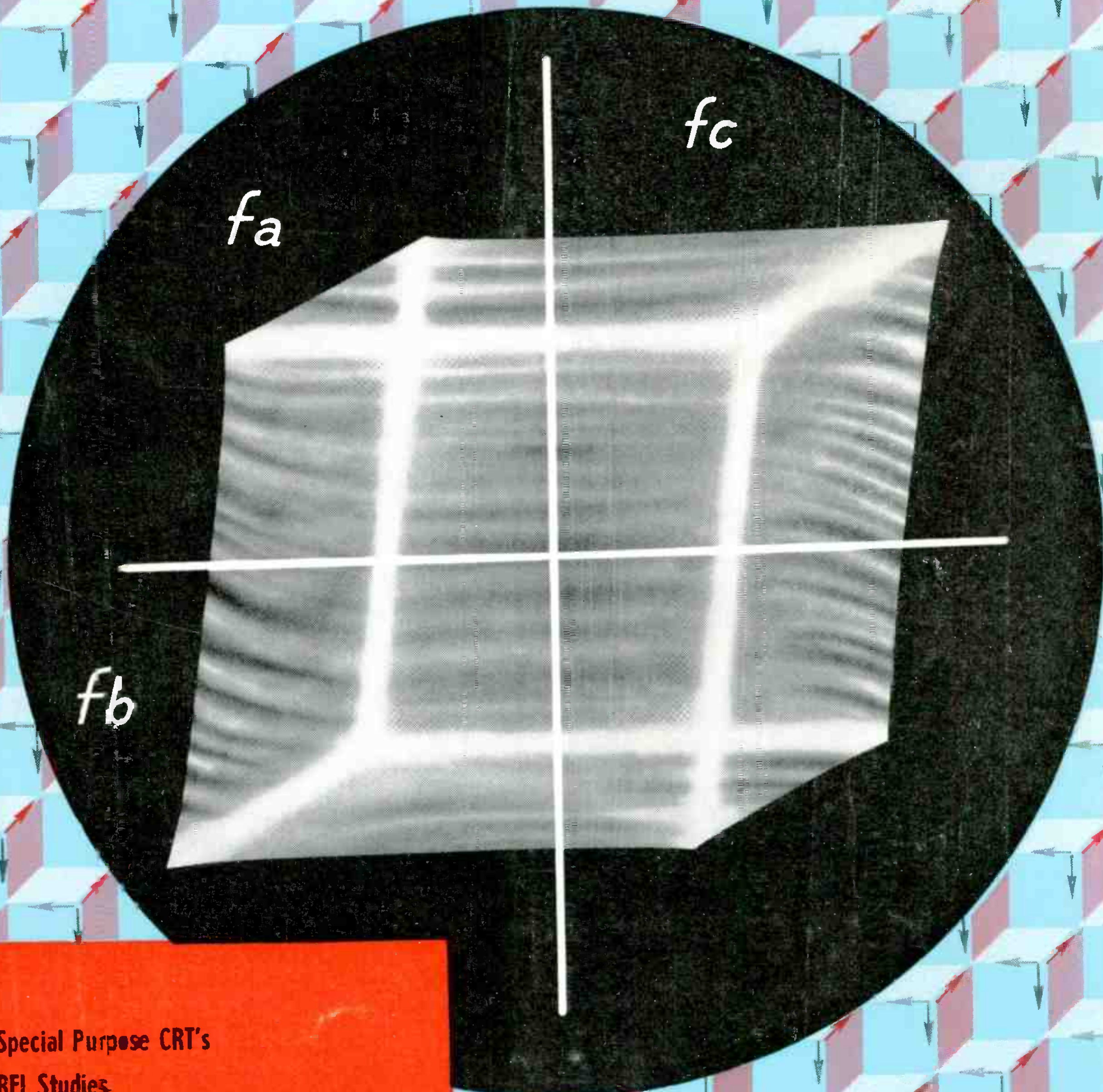
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION



- Special Purpose CRT's
- RFI Studies
- Transistor Interchangeability Chart
- Today's Electronic Engineer

March
1960

ELECTRONIC INDUSTRIES

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

NO PAYOLA

PERIODICALLY, during the past two years, we have presented "Editorial Staff Studies" in ELECTRONIC INDUSTRIES. Most of you will recall having read one or more of these. Some of the topics or subjects that these reports have covered include: Medical Electronics, Ultrasonics, Wire & Cable Data, Semiconductor Diode and Transistor Specification Charts, Transistor Interchangeability Data, Today's Electronic Engineer, Thermoelectricity, Human Factors in Engineering, and many others.

In this our March issue we are again presenting several new staff studies. First there is "Special Purpose Cathode Ray Tubes" starting on page 163. A new, revised, and up-dated "Transistor Interchangeability Chart" begins on page 181. Finally there is a follow-up sequel to "Today's Electronic Engineer" which starts on page 311.

These editorial staff studies represent our editorial efforts to provide useful and needed information to practicing or working electronic design engineers. Each of these studies require a considerable amount of time to research information sources and to prepare the material as obtained for publication. Usually at least six months are involved for each report and frequently this period extends to nine or twelve months. In practice, each editorial staff report is assigned to an editor who functions more or less as the "senior project engineer." Other staff editors feed him any leads, information, clippings or data on the subject that they acquire. The report editor may engage in mail questionnaire programs, undertake a considerable number of field trips, and become involved with innumerable phone calls before he can collect all the information required for his editorial staff study. Thus we can see that each study, in providing needed and useful information, also involves considerable time, effort, and expense for its publication.

Recently, we became aware of a field situation which prompted this editorial. One company reported that it had received a letter, presumably from a freelance writer, which stated that for a fee the writer could assure the company of prominent mention in one of our editorial staff studies. Of course, nothing could be further from the truth!

ELECTRONIC INDUSTRIES is a Chilton publication and as such is directly subject to the "printed" policies of the Chilton Comany. The policies, published in booklet form, are inviolable and mandatory for every Chilton employee. We believe it desirable for all of our readers to know of the existence of this policy and below we have reproduced the seven points of editorial policy that are binding on all 17 Chilton magazines.

In the future, we would greatly appreciate receiving information from any reader who is approached in person or by letter by anyone who is not an official member of the ELECTRONIC INDUSTRIES editorial staff. The names of all staff individuals are to be found on the masthead, appearing on page 2 of each issue.

Chilton's Editorial Policy

To make each magazine a vital force for adult education.

To give readers accurate, useful and timely information to help them in their business or professional lives.

To respect the rights and dignity of the individual.

To maintain by all ethical means a position of aggressive leadership in each of the fields we serve.

To select editorial matter on the basis of reader values only. The acceptability of editorial matter is never based on advertising considerations.

To draw a sharp line between editorial matter and advertising space. Payment, in any form, will never be accepted for material in our editorial columns.

To edit each magazine in the best interests of the field it serves. Our responsibilities to readers come first. We will spare no effort in searching for news, technical, market and merchandising information that will help them in their business or profession.

ELECTRONIC INDUSTRIES, March, 1960. Vol. 19, No. 3. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Accepted as controlled circulation publication at Phila., Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00 Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 19, No. 3 March, 1960

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

BPA NBP

Highlights of this issue

Electron Gun Finds New Role — page 163

Sixty years ago, Sir J. J. Thomson first used the cathode ray as a precision measuring device. Today, the demands of rapid data processing combine this precision with the inherent speed of electronics to devise tubes that can keep pace. Here's a rundown on the most interesting applications.

RFI is Everybody's Business — page 131

The radio frequency interference problem is gaining the prominence it justly deserves. Up to now engineers "let George do it" when the RFI problem came up. Now the responsibility is being placed on all electronic engineers. See "Making Transmitters RFI-Free" beginning on page 132, and "Consider Interference in Systems Design" beginning on page 142.

Transistor Interchangeability Chart — page 181

A comprehensive cross-referencing of transistors and their nearest equivalents. A pioneering service of ELECTRONIC INDUSTRIES, the listings identify all manufacturers, and also include dimension drawings so that both electrical and physical interchangeability can be checked.

1960 International IRE Convention — page 125

The annual IRE Show and Convention is now International. Over 60,000 engineers will visit the show this year. Featured are over 850 exhibits and 275 technical papers. One of the highlights is a symposium, "Electronics—Out of this World" conducted by Ernst Weber and a panel of space experts.

Molecular Electronics — page 100

New concepts and capabilities in solid state devices. "Growing" radio receivers, amplifiers, from pools of molten semiconductor materials—termed possible.

Points to Consider When . . . Using the Tunnel Diode — page 110

Little over a year has passed since the tunnel diode was first reported by Esaki. But, recognizing the tunnel diode's potential, the semiconductor industry has swung into serious application developments. This article presents some general considerations on their use as amplifiers.

A One Megabit Storage — page 114

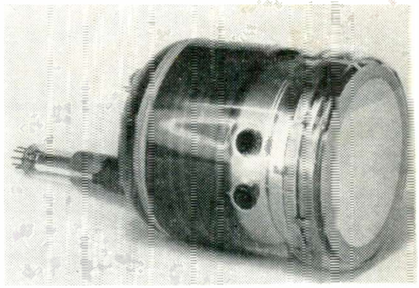
A survey indicated the need for larger capacity memories in the medium computer field. Design engineers took an existing magnetic drum memory and increased its capabilities 8 times. Their ideas and innovations, given here, will prove useful to other design engineers.

Controlling Alternator Frequency — page 104

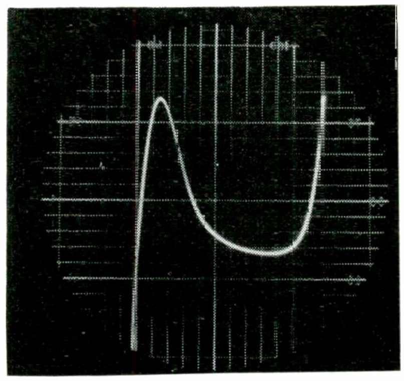
Many pieces of airborne equipment depend for their accuracy on rigid control of the alternator power supply frequency. This new system holds the frequency within 0.4 CPS at 400 CPS by nulling a line frequency signal and a precise reference frequency through an electrical differential.

The AC Potentiometer—A New Circuit Component — page 120

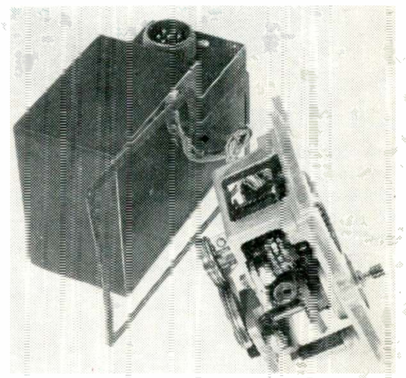
Autotransformers have a number of very desirable characteristics. These characteristics are also desirable in a precision potentiometer. The union of the two produces an extremely useful new component.



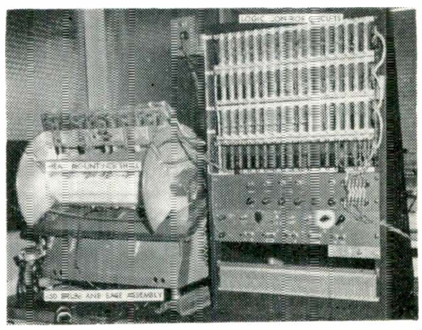
Electron gun



Tunnel Diodes

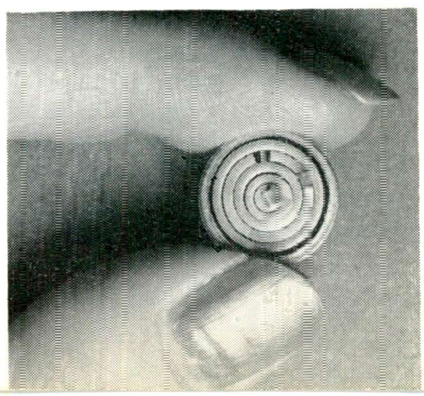


Alternator Frequency



One Megabit Storage

Molecular Electronics



RADARSCOPE

FOR ROCKET TELEMETRY

New communication system, the "Direct Re-entry Telemetry System," developed by ITT Laboratories, transmits through the white-hot envelope of ionized air that builds up around a space vehicle re-entering the earth's atmosphere. It assures uninterrupted communications from satellites through the complete flight. It is being demonstrated here by ITT vice-pres. A. M. Levine.

THE ELECTRONIC INDUSTRY is now the fifth largest industry in the country. It has been predicted that it will step into first place within 10 years.

TOP GOVERNMENT DEFENSE contractor is General Dynamics Corp. In Fiscal Year 1959 General Dynamics got awards totaling $1.66 billion, or 7.2% of the U. S. total. Over 80% of General Dynamic's awards were in the aircraft and missile program.

SMALL BUSINESS CONCERNS were awarded 8,517 contracts valued at over $390 million from U. S. Government procurements during the six month period ending December 1959. This is a 24% increase over awards during the corresponding 1958 period. For the year as a whole, the amount awarded to small business firms was up over 25% over the year before.

INTEREST IN AM STEREO BROADCASTING should be needled by an application made last month to the FCC by Kahn Research Laboratories. Kahn is requesting permission for broadcast stations to use their system of AM stereo broadcasting during the prime listening hours. Even inexpensive ac-dc receivers are adequate for receiving the signal. In fact, cheaper receivers have certain advantages in their narrow bandwidth so far as handling a single side band.

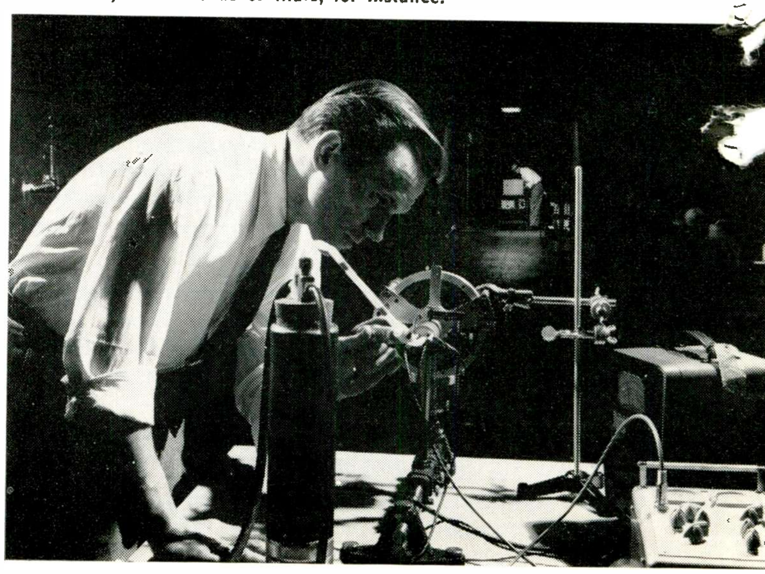
THE GOVERNMENT IS PLANNING to convert the SAGE System to air traffic control, if possible. The reason—Khrushchev says the USSR will build no more bombers. If this is true, and the Government feels that it is, it's obvious that we either will have to scrap our huge investment in SAGE or find a new use for it.

AIRCRAFT AND MISSILE CONTRACTS account for 64% of the awards of $500,000 or more made by the government to leading defense contractors.

RESEARCH CONTRACT has been awarded to Westinghouse by the Air Force to develop production processes for dentritically grown single crystal semiconductor materials. The contract will exploit discoveries made under a former contract by Westinghouse Research Laboratories. The semiconductor materials to be used will be silicon and galium arsenide. The dentritic process greatly speeds the manufacture of the semiconductor materials, producing a thin ribbon-like strip having a shiny, mirror-like finish.

SPACE DETECTIVES

In this 86-ft. long tunnel at Sperry Gyroscope Co. engineers study the behavior of infra-red radiation. Walls of the tunnel are blackened to control background radiation. Facilities allow the researchers to investigate IR under atmospheres which exist on other planets in the solar system—Venus or Mars, for instance.



LEASING OF PRODUCTION EQUIPMENT by electrical and electronics manufacturing firms spurted far ahead in 1959. It reached a total of $23.6 million worth of equipment on lease, a gain of 39% over 1958. Predictions are that equipment leasing will double in 1960. Some of the reasons: More companies will lease equipment to avoid the pinch of tight money; more and more companies will be affected by increasing technological progress, which is speeding obsolescence of machinery.

IT WILL BE INTERESTING to see how Motorola fares in their efforts to crack the closed-circuit TV field. Perhaps no field has had no more false alarms than closed-circuit TV. Each year since 1950 closed-circuit TV manufacturers have been optimistic about sales in the following year. The optimism has been understandable, for the number of possible applications is endless. But somehow closed-circuit TV has never really found the mass market that its proponents have insisted existed. In explaining the repeated delays, one of the most frequent obstacles pointed to has been the lack of service and installation facilities. Motorola shines in this department, with over 800 service shops across the country.

AUTOMATION is creating a need for a new kind of maintenance man, a highly trained engineer-technician, to cope with complex electronic control systems. GE's James J. Durkan points out that "for computers and programming control systems there is need for a trained engineer-technician as trouble-shooter and repair man. He may merely locate a faulty seal component, a black box, and replace it with a new one. But he must be well trained in the design of the control system and understand its importance and timeliness to the productive process."

NEW APPROACH is being tried by Daystrom Inc. to find and hire the most capable scientific minds. Daystrom is establishing a technical advisory committee of university scientists, similar to the programs that the Dept. of Defense uses for review of R&D progress. Each of the men chosen by Daystrom is an authority in one of the fields in which Daystrom operates. The initial assignments for the committee will be to review the company's R&D program and to provide the latest information on the status of basic and applied research which is being carried on in universities throughout the country. Arrangements such as this have two-fold advantages: With the increased income scientists can be induced to stay on the campus, and the time lag between practice and theory is greatly decreased.

THE FCC has received complaints from the American Trucking Association that AT&T and Western Union are placing "a double stranglehold on the use of microwaves." The brief was filed by ATA at a hearing on a request for rate increases by the two companies. The two firms are seeking increases which should give them a 10% return on their private line lease circuits. The ATA brief charged that AT&T and Western Union are opposing the licensing of microwave rights to private business, and at the same time have refused to make microwave available to their customers at lower rates. The ATA brief warned that "unless the commission takes a firm hand and . . . compels AT&T and Western Union to pass on to the public the savings resulting from the use of microwaves, these carriers will be free to determine where, when and whether such savings should be reflected in the course of service the public must pay.

COSTS OF RESEARCH AND DEVELOPMENT for many of today's major weapons have reached a point where they exceed production costs, says Aerospace Industries Association's Orval R. Cook.

SUPER-ACCURATE GYRO

At G.E.'s General Engineering Lab engineers Karl F. Schoch (r.) and James F. Young examine components of new high accuracy gyro. The golf-ball size sphere will rotate at high speed in a vacuum—suspended solely by a magnetic field. Technique makes use of the behavior of metals at temperatures near absolute zero.

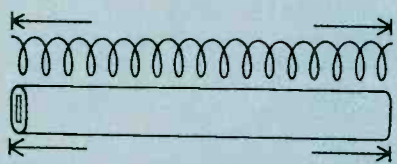
See us March 21-24 at the I.R.E. Show/Booths 1619-1621

BOURNS TRIMPOT® WITH BUILT-IN TEMPERATURE STABILITY

Stable settings under extreme temperature conditions is an outstanding feature of the Trimpot® potentiometer. This thermal stability is built-in through all phases of design and production—

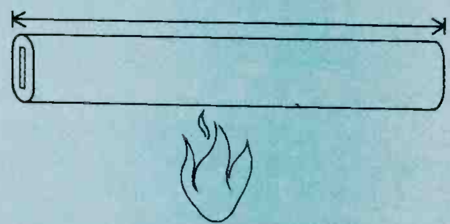
MATCHED COEFFICIENTS OF THERMAL EXPANSION

Resistance wire and mandrels have matched coefficients of thermal expansion to reduce the "strain gage effect." Linear expansion rates for the mandrel and wire match so closely that the temperature coefficient value for the entire wirewound element approximates that of the wire itself.



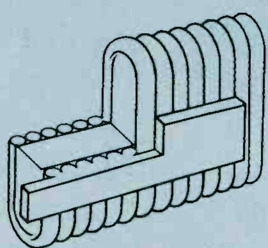
THERMALLY STABLE CERAMIC MANDRELS

Bourns takes advantage of high thermal stability of ceramic materials for element mandrels. Today, all Bourns Trimpot potentiometers provide the improved performance and reliability afforded by ceramic materials.



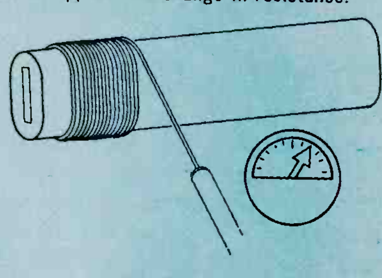
EXCLUSIVE SILVERWELD® TERMINATION

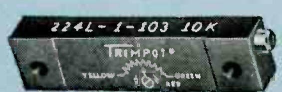
Silverweld is an actual metal-to-metal fusion of element wire and external terminal. In doing away with mechanical or soft-solder joints, Bourns eliminates potential hot spots thus extending the potentiometer's temperature range. The fusion of the Silverweld terminal to many turns of wire on the resistance element avoids the problem of single wire termination. Silverweld is virtually indestructible under thermal stresses.



EXCLUSIVE TENSION CONTROL EQUIPMENT

Bourns has developed specialized winding equipment that provides constant and precise control of wire tension during winding operations. "Necking" of the wire or resistance-altering stresses never occur. Instead the wire remains uniform—well able to withstand temperature variations with no appreciable change in resistance.





Specify Trimpot — the original leadscrew-actuated potentiometer with reliability on which you can depend. 20 basic models — 4 terminal types — 3 mounting styles.

BOURNS

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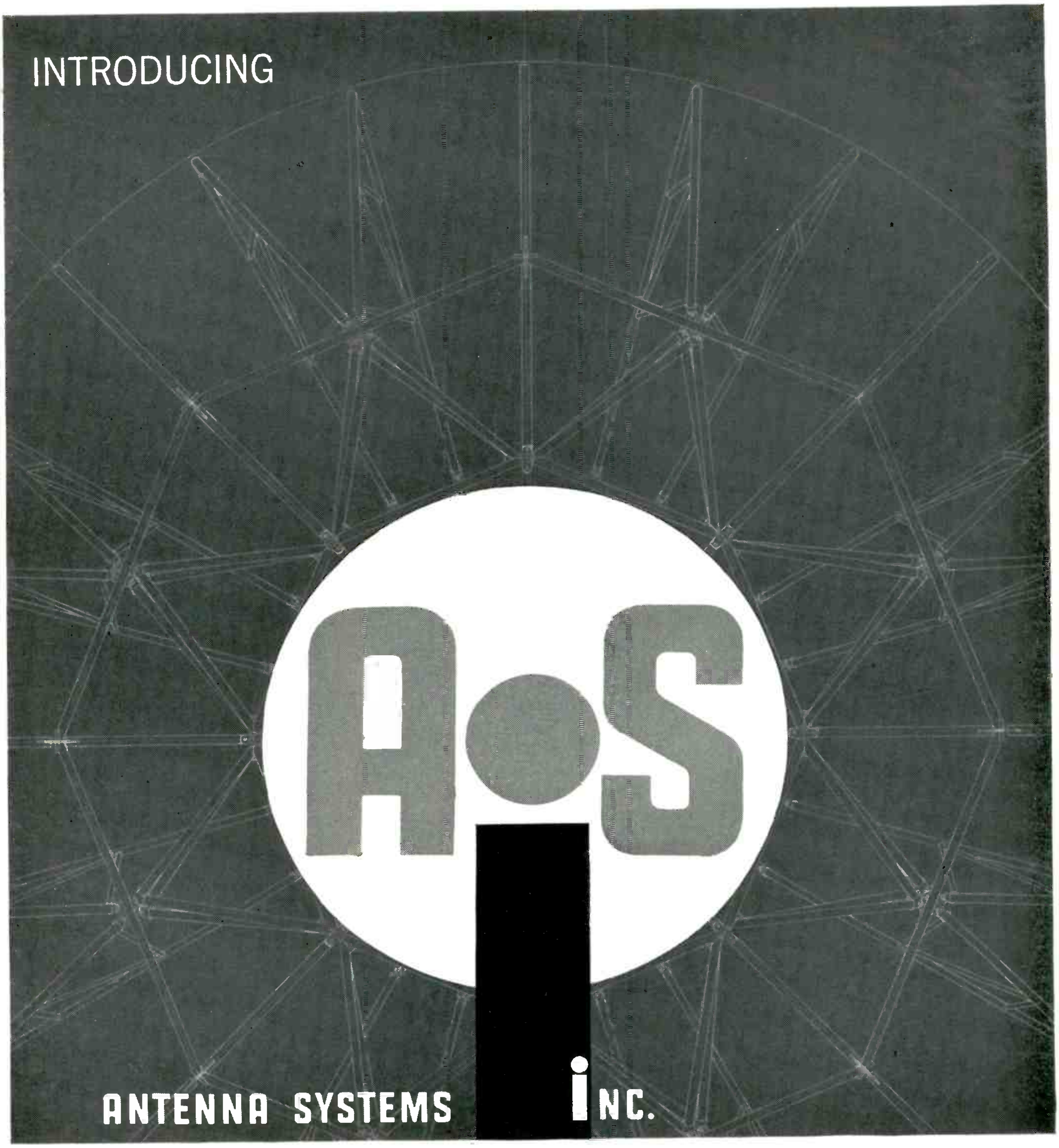


A new corporation devoted exclusively to the design, fabrication and installation of antenna systems in the fields of scatter communications, missile tracking, space tracking, radar and surveillance, radio astronomy and special antenna products.

A word from the new president, Charles Creaser . . .
"Ours is primarily an engineering organization which is employee-owned and employee-run. Our objective can be stated simply: it is to lead in the development and introduction of new and improved techniques and processes. We are equipped to handle the entire antenna system — reflectors, mounts, feeds, pedestals, waveguide, rotary joints — everything from transmitter and receiver on."

. . . and from the vice-president, Bill VanderWolk
"We're off to an exciting start. We've taken a new approach to antenna marketing by building a new, 30-foot parabolic dish for space tracking and communications, which promises to be more accurate than anything yet built. Very soon, we'll have the finished product, built and operating, to show to industry and government. Instead of offering a design and a promise of performance, we'll prove ours first.

For more information, please send for our folder **ANTENNA SYSTEMS INC.** Hingham Industrial Center, Hingham, Mass.

Circle 3 on Inquiry Card

As We Go To Press . . .

A Fast Printer-Plotter System

The Printer-Plotter System plots out graphical or printed data at 300,000 points per minute from computer-processed magnetic tape. Developed by Briggs Associates, Inc., Norristown, Pa., this unit is said to be 5000 times faster than today's speediest commercially-available method for automatically plotting graphical data, the tape-fed X-Y plotter.

Relatively slow print-out speed has been a major problem, handicapping computer capabilities. This system is said to permit computers to print out data almost as rapidly as they can process it.

The high-speed printer-plotter system was designed by Briggs Associates, Inc. The system will be turned over to G.E.'s MSVD for use on the Atlas Missile program

As a straight printer, without plotting, the Briggs System is four times faster than the best conventional system now available. In a publishing or direct-mail application, for example, the system could print out 90,000 magazine or other address labels per hour—more than twice the capability of the fastest technique now available.

Space Travel Trainer

Astronauts will spend up to two weeks under the conditions of outer space, without leaving the ground. R&D work for a new space cabin simulator is being conducted by American Machine & Foundry Co.'s Mechanics Research Div.

The space cabin simulator will be equipped with the complex air conditioning and cabin pressurizing equipment necessary to keep astronauts alive at temperatures hundreds of degrees below zero, and at zero gravity when the human body would be completely weightless.

Communications for Man in Space

Sometime between Sept. 1960 and Dec. 1961 a Project Mercury capsule containing an astronaut is scheduled to be thrust into space. Before its launching, however, every effort must be made to safeguard the life of the astronaut. Scientists at the National Bureau of Standards are assisting by contributing to the planning of a reliable world-wide ground communications network essential to the smooth functioning of NASA's man-in-space program.

Communications experts at Boulder's Central Radio Propagation Laboratory (CRPL) will be responsible for recommending the most reliable radio path to relay vital tracking information on the capsule back to the computer site. Engineering requirements for the whole system will be completely analyzed by NBS scientists. They will determine the most usable frequencies. Peak performance of circuits will be assured by the choice of proper transmitter power and suitable antenna types.

Preliminary plans propose that Project Mercury stations be established to form a communication network, with 21 radio paths, that will circle the globe.

New Standard Issued for Stereo & Hi-Fi

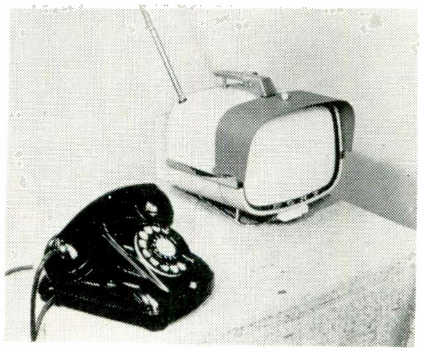
A recommended standard for measuring the music output of stereophonic and high fidelity audio amplifiers was issued by the Engineering Department of the Electronic Industries Association.

Designed to alleviate confusion over various methods of measuring the audio power of home phonographs, the standard was developed by Engineering Committee R-20. It is being made available to all phonograph manufacturers. However, its adoption is voluntary on part of the manufacturer.

Copies of the standard, giving details of test conditions, definition of terms and test procedure are available at 25 cents a copy from the EIA Engineering Department, 11 West 42nd Street, New York 36, New York. The publication has been designated EIA Standard RS-234.

Japanese Produce Transistorized TV

Sony Corp. is now ready to disclose the production model of a transistorized TV set with an 8-in. picture tube. It operates on a self-contained rechargeable battery or on a regular home power supply, contained in a portable cabinet. This model will be put on the Japanese market some time this month. Its retail price is still under study, but is expected to be sold for about $200.



The Sony Corp. of Japan has completed a production model of a TV set which is all transistorized. Set has 8-inch crt and operates on batteries or ac power

As stated by the President of Sony Corp., Sony is taking a prudent attitude in the world marketing of its new product because of the difference in TV systems or channel frequencies and problems connected with repair servicing. Therefore, Sony has no intention of exporting this item until thoroughly field tested.

"Quick Reaction" Contract Award

A "quick reaction" contract to provide engineering, laboratory and model shop work associated with printed circuit electronics has been awarded to the Avion Div. of ACF Industries, Inc., by the Goddard Space Flight Center of the National Aeronautic and Space Administration. The new contract is an open-end agreement under which specific projects are yet to be assigned.

These contracts are so named because they call for the supplier to provide rapid delivery of precision equipment to customers in industry, all branches of the Armed Forces, and other Government agencies such as NASA.

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TUBULAR

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...the newest and most reliable miniature tubular aluminum electrolytic capacitors made!

Now . . . *for the first time* . . . an extended-life electrolytic in miniature tubular case styles. Sprague's New Type 40D Extended-Life Electrolytics are designed to give more than 10 years of service under normal operating conditions in actual circuit applications.

○ Broader Application

Though similar in many respects to Sprague's famous extended-life electrolytics for telephone and communications systems, these capacitors have the added advantage of low temperature characteristics previously unavailable in an aluminum electrolytic. As a result, Type 40D offers much broader industrial and military application.

○ Special Construction

Type 40D capacitors are specially constructed to assure freedom from open circuits even after extended periods of operation in the millivolt signal range. Ultra-low leakage currents are the result of special design and processing techniques based on the use of the highest purity anode and cathode foils.

○ Hand or Machine Assembly

For applications which require an insulated case, Sprague furnishes an outer insulation of either flexible plastic for hand assembly or rigid phenolic for machine insertion on printed wiring boards.

Get details on Type 40D Extended-Life Electrolytics by writing for Bulletin 3205 to Technical Literature Section, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

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Circle 4 on Inquiry Card

ELECTRONIC SHORTS

▶ Brig. Gen. David Sarnoff, RCA Chairman, predicts that electronics will eventually develop a "dashboard" for the human body similar to those on autos and airplanes. It will be a home device, like scales, that will register not only weight but heart beats, blood pressure, pulse rate, temperature, and other basic data. Moreover, it will carry an alarm system to advise the user when to consult a doctor. The device will record the daily results on magnetic tape to help the doctor in his diagnosis.

▶ The Office of Technical Services, U. S. Dept. of Commerce reports the development of 5 small electronic receiving tubes which can be produced at the rate of 900 tubes per hour. The metal-ceramic receiving tubes, developed under Air Force-sponsored research, include a CD-16 twin triode, a CD-18 sharp cutoff pentode, a CD-19 triode, and a CD-22 beam power triode.

▶ The Navy is testing an automatic system, The Helicopter Stability Augmentation System, which will make light helicopters more practical in anti-submarine warfare, air-sea rescue operations, etc. The 9-pound system, which uses rate gyros as primary components, was developed by Autonetics Div., North American Aviation, Inc.

▶ Francis M. McDermott, Exec. Director, Air Traffic Control Assoc., testified before the Senate Aviation Subcommittee that "the air traffic control profession is functioning at a level of sustained pressure and tension unequalled in aviation." Although new electronic equipment has increased the systems capability for handling more aircraft, we cannot foresee electronic aids replacing the air traffic control service.

▶ What will the passenger plane of the future be like? Here are some of the ideas of R. C. Sebold, VP-Engineering, Convair Div., General Dynamics Corp., San Diego, Calif. It will be a Mach 3 transport traveling at 60,000 to 80,000 ft. It will be windowless—the passengers looking "out" through closed circuit TV. Seats will pivot, like rocking chairs, for greater comfort in climbing and descending, and advanced electronic computers will constantly monitor all the aircraft's systems during flight.

▶ The General Electric Microwave Lab. has developed a 100-w., S-band, ceramic-to-metal, traveling wave tube incorporating new concepts in fabrication and design. The tube and magnet weigh 22 lbs. They are water-cooled, and may be mounted in any position. It was developed for Wright Air Development Center, U. S. Air Force.

▶ "Electron tube sales should reach an all-time high of $900 million this year," predicts Douglas Y. Smith, VP and General Manager, RCA Electron Tube Div. "As an illustration of the tube's importance to the nation's space program," he said, "a single test launching at Cape Canaveral may require as many as 100,000 electron tubes inside the rocket and at ground control stations."

▶ DuPont is now commercially producing a new plastic, "Teflon" 100, an FEP-fluorocarbon resin, which can be extruded or molded in thermoplastic processing equipment. Like the TFE resins, "Teflon" 100 is virtually immune to chemical attack, has excellent electrical insulating, anti-stick, and frictional characteristics, and will not absorb moisture. They are rated for continuous service at temps up to 400°F.

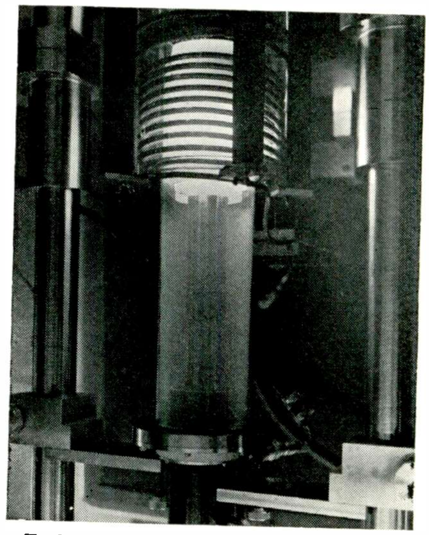
▶ American Machine & Foundry Co. is sponsoring "Tomorrow" a series of special TV programs showing how new developments in science and technology affect peoples' lives. The series will be produced by CBS News in association with M.I.T. in recognition of the Institute's centennial celebration.

▶ A long-range surveillance radar subsystem is being installed in the Arctic for the U. S. Air Force's Ballistic Missile Early Warning System. It will detect intercontinental ballistic missiles as they rise over the horizon at distances of several thousands of miles. The BMEW system is designed to provide about a fifteen-minute warning for the North American Air Defense Command.

▶ Consolidated Systems Corp., Div. of Bell & Howell/CEC, is prototype testing a mass spectrometer that will be placed in orbit in a satellite by NASA in 1961 to measure elements of the exosphere. It will measure ions, molecules, atoms, and free radicals encountered by the 35-inch-dia. satellite between 150 and 600 mi. above the earth.

As We Go To Press (cont.)

CRYSTAL GROWING



Technique developed by Knapic Electro-Physics, Inc., Palo Alto Calif., simultaneously grows silicon and germanium monocrystals by a modified Czochralski technique. Shown are four ½ in. dia. crystals growing simultaneously.

Tunnel Diodes Available

General Transistor Corp., Jamaica, L. I., N. Y., is bringing out tunnel diodes using germanium as the semiconductor material. GT has a pilot production line in operation for engineering samples and has already begun shipments of test quantities.

Call for Papers

The National Electronics Conference will be held at the Hotel Sherman, Chicago, Ill. on October 10, 11, and 12.

Authors of papers should submit abstracts of 100 to 150 words and a 400 or 500 word summary, or completed paper for review. Deadline for papers is May 1, 1960. Submit papers to:

Prof. Thomas F. Jones, Jr.
NEC Program Chairman
School of Electrical Engineering
Purdue University
Lafayette, Indiana

The 1960 Audio Engineering Society Convention will be held on October 11, 12, 13, and 14 at the Hotel New Yorker, New York City.

All titles, summaries, and manuscripts and/or your suggestions should be submitted as soon as possible to:

Dr. Harry F. Olson, Chairman
Convention Committee, AES
RCA Laboratories
Princeton, New Jersey

4 reasons why you should buy Hughes high voltage silicon cartridge rectifiers

To meet your requirements for IN1730-34, IN2382-85, IN596-98 and IN1406-13 rectifiers . . . Hughes offers you a universal series with the following advantages over competitive devices:

1 Better High Altitude Performance— Since the case is insulated and provides a long leakage path between leads, the probability of flashover or corona at high altitudes is reduced.

2 Improved Circuit Performance— Fewer diodes are required in each unit to obtain the PIV ratings . . . thereby lowering losses, which in turn, provide better voltage regulation and higher efficiencies.

3 Savings In Space. The case material is a plastic of high dielectric strength, making it possible to mount units in close proximity to each other.

4 Greater Dependability—These assemblies utilize series strings of Hughes hermetically sealed glass diodes . . . packaged in a non-combustible cartridge. All internal connections are welded together to insure shock and vibration resistance.

These standard Hughes units are available in voltage ratings from 600 to 10,000 volts. In addition, Hughes offers you many custom assemblies designed to meet your special requirements.

ORDER TODAY! To obtain delivery of Hughes Cartridge Rectifiers just call or write the Hughes Semiconductor Sales Office or Distributor nearest you. Or, for a complete Cartridge Rectifier data sheet (Number: D.S. 82) please write Hughes, Semiconductor Division, Marketing Department, Newport Beach, California.

For export write: Hughes International, Culver City, Calif.

Creating a new world with ELECTRONICS

HUGHES

SEMICONDUCTOR DIVISION

Circle 5 on Inquiry Card

HUGHES FAMILY OF DIRECT-VIEW STORAGE TUBES

World's most complete line of storage tubes!

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

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

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

STORAGE TUBE CHARACTERISTICS

	SCREEN DIAMETER	STANDARD PHOSPHOR	DEFLECTION
TONOTRON TUBES			
H1021	3"	P1	Electrostatic
7221	5"	P20	Electrostatic
7222	5"	P20	Electrostatic
7033	5"	P20	Electromagnetic
H1044	21"	P20	Electromagnetic
H1028	4"	P1	Electrostatic
H1033	10"	P20	Electromagnetic
H1034	10"	P20	Electrostatic
H1041	7"	P20	Electrostatic
H1042	7"	P20	Electromagnetic
MEMOTRON TUBE			
6498	5"	P1	Electrostatic
TYPOTRON TUBE			
6577	5"	P1	Electrostatic

10 additional TONOTRON tubes and 4 additional TYPOTRON tubes available.

For full and complete information on how Hughes storage tubes may fill your particular needs and applications, write or wire: HUGHES, Vacuum Tube Products Division, 2020 Short Street, Oceanside, California.

For export information, write: Hughes International, Culver City, California.

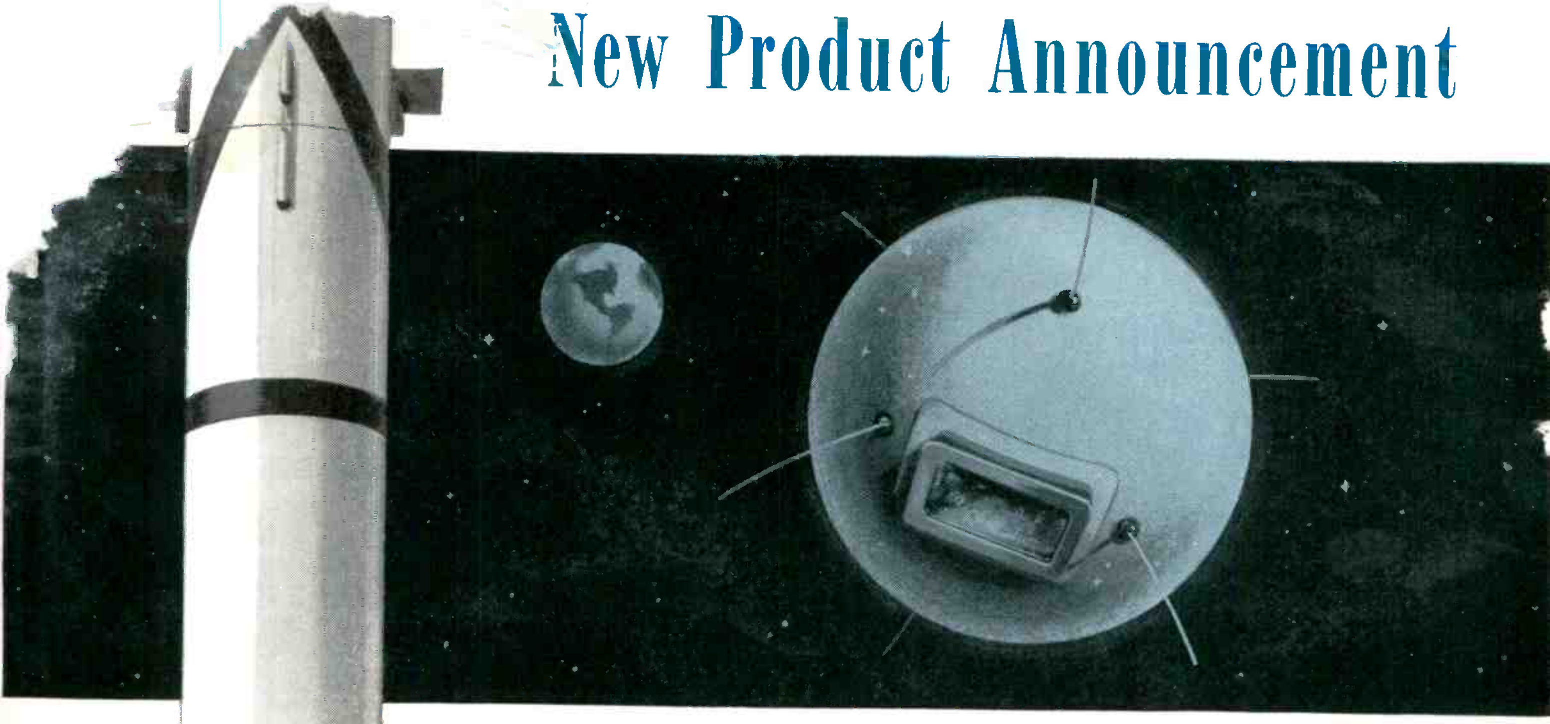
Creating a new world with ELECTRONICS

HUGHES

VACUUM TUBE PRODUCTS DIVISION

Circle 7 on Inquiry Card

New Product Announcement



STEMCO TYPE MX* THERMOSTATS

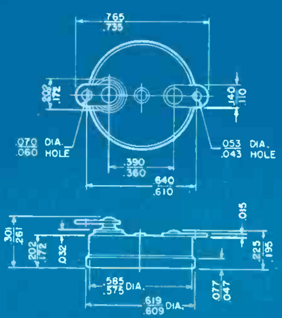
especially designed for missile, avionic and electronic applications

New Stemco Type MX Thermostats are miniature snap-acting units designed to *open* on a temperature rise. Being compact, lightweight units able to withstand high G's under wide ambient temperature ranges, Type MX thermostats are ideal for missile, avionic and other electronic applications where close temperature control is mandatory.

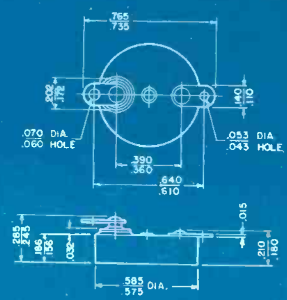
Basic design flexibility of the Stemco Type MX Series means the units can be supplied from regular production runs in a wide variety of models, both semi-enclosed or hermetically sealed. Ceramic or metal bases for semi-enclosed units, round enclosures or CR-7 crystal cans for hermetically sealed units. Several types of terminal arrangements, mounting provisions, brackets, etc., are available.

Stemco Type MX thermostats give you performance . . . small cubage . . . rugged reliability . . . *at a production price.*

* 2° to 6°F differentials available



TYPE MX *Hermetically Sealed* — Electrically independent bimetal disc. Rated at 1 amp at 115 VAC and 28 VDC, based on 250,000 operations.



TYPE MX *Semi-Enclosed* — Metal base shown; also ceramic base types. Bulletin 6100 for data on hermetically sealed and semi-enclosed types.

AA-7285

Circle 8 on Inquiry Card

STEVENS *manufacturing company, inc.*
Mansfield, Ohio

STEMCO® THERMOSTATS

Coming Events in the electronic industry

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

Mar. 1-2: Seminar—Optical Tooling Methods in Manufacturing, ASTE; Los Angeles, Calif.

Mar. 3-4: Seminar—Metal Forming Methods for Tomorrow's Manufacturing, ASTE; Los Angeles, Calif.

Mar. 4-5: Meeting, The American Physical Society; Houston, Texas.

Mar. 6-9: Gas Turbine Power Conference and Exhibit, ASME; Rice Hotel, Houston, Texas.

Mar. 8: Annual Meeting, Assoc. of Electronic Parts & Equipment Manufactures, Inc., Chicago, Ill.

Mar. 8-9: Seminar—Some Problems of Machining Space Age Metals, ASTE; San Francisco, Calif.

Mar. 8-11: Audio Engineering Society Conv., Audio Engineering Society; Alexandria Hotel, Los Angeles, Calif.

Mar. 9-11: Temperature Measurement Symp., ISA; Deshler Hilton Hotel, Columbus, Ohio.

Mar. 9-11: 3rd Naval Science Symposium, "Naval Problems in Electromagnetic Radiation," Office of Naval Research; Naval Ordnance Test Station, Pasadena, Calif.

Mar. 10-11: National Flight Propulsion Meeting (Classified), IAS; Cleveland, Ohio.

Mar. 14-18: 32nd Institute on Industrial Relations, National Assoc. of Manufacturers, Hollywood Beach Hotel, Hollywood, Florida.

Mar. 17-18: Synchro Design and Testing Symp., U. S. Navy, Bureau of Naval Weapons; Dept. of Commerce Auditorium, Washington 25, D. C.

Mar. 21-24: IRE International Convention, IRE (all PG's); Coliseum & Waldorf - Astoria, Hotel, New York, N. Y.

Mar. 21-24: Meeting, The American Physical Society; Detroit, Mich.

Mar. 22: 9th Annual SSB Dinner & Hamfest, SSB Amateur Radio Association; Hotel Statler-Hilton, New York, N. Y.

Mar. 23-24: Seminar—Metal Forming Methods for Tomorrow's Manufacturing, ASTE; Hartford, Conn.

Mar. 23-24: 10th Annual Iron & Steel Conf., ISA (Metals & Ceramics Div.); Pick-Roosevelt Hotel, Pittsburgh, Penna.

Mar. 23-26: Electrical Industry Show and Lighting Exposition, Electrical Maintenance Engineers Assoc. of Calif.; Shrine Exposition Hall, Los Angeles, Calif.

Mar. 24-25: 1st Annual Symp., Human Factors in Electronics, IRE (PGHE); Bell Tel. Labs. Aud., 463 West St., New York, N. Y.

Mar. 28-29: Spring Meeting, The Material Handling Institute, Inc.; Pittsburgh-Hilton Hotel, Pittsburgh, Penna.

Mar. 29-31: American Power Conf., Illinois Institute of Technology; Hotel Sherman, Chicago, Ill.

Mar. 30-April 3: Industry Show, Danbury Chamber of Commerce; Berkshire Hall, Danbury State Teachers College, Danbury, Conn.

Mar. 31-April 1: ASME Textile Engineering Conf., ASME; North Carolina State College, Raleigh, N. C.

Apr. 3-7: Annual Convention, NAB; Conrad Hilton Hotel, Chicago, Ill.

> **Correct Your EI Coming Events Calendar**
>
> The 1960 Western Electronic Show and Convention (WESCON) will be held Aug. 23-26 at the Los Angeles Memorial Sports Arena. (Not at the Pan Pacific Auditorium, as previously reported.)

Apr. 3-8: 6th Nuclear Congress, EJC, IRE (PGNS) (28 sponsors), N. Y. Coliseum, New York City. Papers deadline Sept. 1, 1959.

Apr. 4-6: Southwest District Meeting. AIEE, Shamrock Hilton Hotel, Houston, Texas.

Apr. 4-6: 43rd National Open Hearth Steel Conf., Metallurgical Soc. of AIME; Palmer House, Chicago, Ill.

Apr. 5: Automatic Recording Spectropolarimeter, Society for Applied Spectroscopy; Stevens Institute, Hoboken, N. J.

Apr. 5: Annual Dinner Meeting, Broadcast Pioneers; Conrad Hilton Hotel, Chicago, Ill.

Apr. 5-7: 3rd National Chemical & Petroleum Instrumentation Symp., ISA; Rochester, N. Y.

Apr. 5-9: Electrical Engineers' Exhibition, Electrical Engineers (ASEE) Exhibition Ltd. (Brit.); Museum House, London, England.

Apr. 6-8: National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences; Biltmore Hotel, Los Angeles, Calif.

Apr. 11-13: Spring Assembly Meeting, Radio Technical Commission for Marine Services; Washington, D. C.

Apr. 12-13: 14th Annual Spring Tech. Conf. on Electronic Data Processing, IRE (Cinn. Section), ARS; Hotel Alms, Cincinnati, Ohio.

Apr. 12-14: 32nd Annual Meeting, Petroleum Industry Electrical Assoc., Petroleum Electrical Supply Assoc.; Municipal Auditorium, Kansas City, Mo.

Apr. 13-14: ASME-AIEE Railroad Conf., ASME, AIEE; Penn Sheraton Hotel, Pittsburgh, Penna.

Apr. 18-19: Conf. on Automatic Techniques, AIEE, ASME, IRE (PGIE); Sheraton Cleveland Hotel, Cleveland, Ohio.

Apr. 19: Joint Dinner Meeting, Association of Electronic Parts & Equipment Manufacturers; Chicago, Ill.

Apr. 19-21: International Symp. on Active Networks and Feedback Systems, Microwave Research Institute of the Polytechnic Institute of Brooklyn, IRE, AFOSR, U. S. Army (Sig. Corps.), ONR; Engineering Societies Bldg., 33 West 39th St., New York, N. Y.

Apr. 20: 16th Annual Quality Control Conf., Rochester Society for Quality Control; University of Rochester, Rochester, N. Y.

Apr. 20-22: S. W. IRE Regional Conf. and Electronics Show (SWIRCO), also: National Medical Electronics Conference, IRE (Region 6); Shamrock Hilton Hotel, Houston, Texas.

Apr. 20-22: 3rd Conf. on Biological Waste Treatment, Manhattan College, New York, N. Y.

Apr. 20-22: National Symp. on Manned Space Stations, IAS, NASA, RAND CORP.; Ambassador Hotel, Los Angeles, Calif.

Apr. 21-22: Management Conference, ASME, SAM; Statler-Hilton Hotel, New York, N. Y.

Apr. 21-22: Seminar — Dimensional Metrology, ASTE; Detroit, Mich.

Apr. 21-22: 7th Annual Conv., Society of Technical Writers and Editors; Drake Hotel, Chicago, Ill.

Apr. 21-28: Tool Show and Annual Conv., ASTE; Detroit, Mich.

Apr. 25-26: Maintenance & Plant Engineering Show, ASME; Chase-Park Plaza, St. Louis, Mo.

Apr. 25-27: MPI 16th Annual Meeting, Metal Powder Association; Drake Hotel, Chicago, Ill.

Apr. 25-28: Meeting, The American Physical Society; Washington, D. C.

Apr. 25-29: Metals Engineering Meeting, ASME; Hotel Biltmore, Los Angeles, Calif.

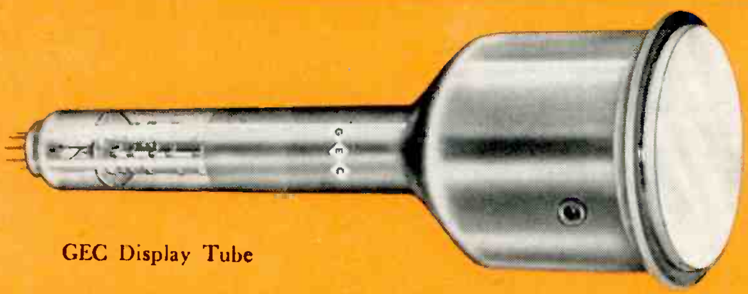
Apr. 25-29: Annual Meeting & Welding Exposition, American Welding

(Continued on page 70)

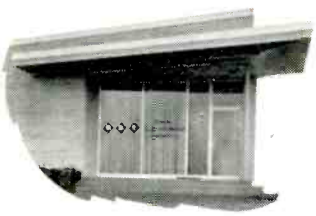
GEC ....WHERE TUBE RESEARCH BEGINS

GEC VIDICON Pickup Tube

GEC Scan Conversion Tube



GEC Display Tube



Research at GEC has been playing an important role in the advancement of pickup, transformation and visual display tubes. GEC is pioneering further in development of pickup tubes sensitive to all parts of the spectrum, particularly near and far infrared. Continuing research in high resolution pickup, conversion and display tubes is a major activity in GEC's development program. General Electrodynamics Corporation has demonstrated its ability in successful mass production of high sensitivity vidicons, and results of continuing research in this field will soon be available to industry.

If your project is being held up by a tube that doesn't exist, contact GEC . . . . *where tube research begins.*

GEC GENERAL ELECTRODYNAMICS CORPORATION

4430 FOREST LANE • GARLAND, TEXAS • BROADWAY 6-1161

Circle 9 on Inquiry Card

Circle 112 on Inquiry Card→

*NEW!

PD-100 Series

microdiode™

(Super miniaturized Silicon Diode)

1. HIGH POWER DISSIPATION—250 milliwatts.

2. HIGH CONDUCTANCE—up to 100 mA @ 1 volt.

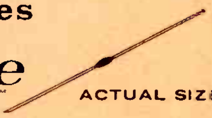
3. HIGH VOLTAGE—200v operating voltage.

4. FAST RECOVERY—200K @ .3 microseconds.

5. HIGH TEMPERATURE—Operating range -65° C to 150° C.

6. HIGH RELIABILITY.

PSI PD-100 Series microdiode™



Type Number	Min. Sat. Voltage @ 100 μA (v)	Min. Fwd. Current @ +1.0v (mA)	Maximum Reverse Current (μA)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time (μs)
PD-101	50	5	1.0 (10v)	25 (10v)	100K	1.0
PD-102	50	20	.5 (10v)	25 (10v)	100K	0.3
PD-103	50	100	.5 (10v)	25 (10v)	100K	0.3
PD-104	100	5	.5 (10v)	25 (10v)	100K	0.3
PD-105	100	20	.5 (10v)	25 (10v)	100K	0.3
PD-106	100	50	.5 (10v)	25 (10v)	100K	0.3
PD-107	100	100	.5 (10v)	25 (10v)	100K	0.3
PD-108	200	10	.5 (10v) 5.0 (100v)	25 (10v)	200K	0.3
PD-109	200	10	.025 (10v) 1. (100v)	5 (10v)	200K	0.3

RATINGS

Maximum Power Dissipation: 250 mw @ 25°C (derate linearly to 150°C)

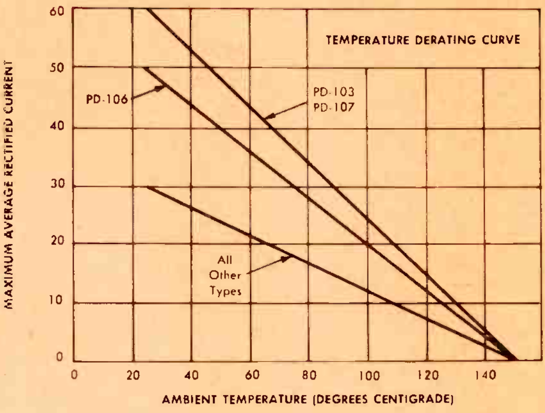
Maximum Storage & Operating Temperature Range: —65°C to 150°C

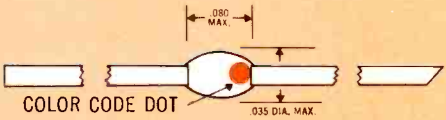
Peak Pulse Current
1 μsec., 1% duty cycle: 2.0 amperes

Typical Inverse Capacitance @ — 10V: 2μμf.

Handling Instructions: Lead Bending — Do not bend closer than .030" from body.

Color Code: Color dot system reading from cathode or pointed lead end.
Soldering: Heat sink diode body during soldering.





PHYSICAL CHARACTERISTICS:

HERMETICALLY SEALED—Bonded Surface films.

TERMINALS—.004x.019 gold plated leads. Lead length ½ inch minimum.

MARKING—Cathode end designated by dot on the body and also by pointed lead. Type number designated by color of the body and color of dot on the cathode end.

ALL DIMENSIONS SHOWN IN INCHES.


ADVANCED
SEMICONDUCTOR PRODUCTS
FROM PSI

Zener Diodes
500 mW Power Dissipation

ACTUAL SIZE

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.

Also Available PS6313-6327 covering 7.5_v to 145_v Zener Voltages.

EIA TYPES	Zener (Breakdown) Voltage @ 5 mA: 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)	Maximum Dynamic Resistance (ohms) 1
1N702	2.0	3.2	75	100	−1	60
1N703	3.0	3.9	50	100	−1	55
1N704	3.7	4.5	5	100	−1	45
1N705	4.3	5.4	5	100	−1.5	35
1N706	5.2	6.4	5	100	−1.5	20
1N707	6.2	8.0	5	50	−3.5	10

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

Also Available 1N708-1N725 covering 5.6_v to 30_v Zener Voltages.

EIA Type[1]	Zener Voltage E_z (Volts)[2]	Max. Inverse Current $E_B = -1V$ μa: 25°C	150°C	Max. Dynamic Resistance $I_Z = 20mA$ $I_{AC} = 1$ mA Ohms) (Max.)
1N746	3.3	10	30	28
1N747	3.6	10	30	24
1N748	3.9	10	30	23
1N749	4.3	2	30	22
1N750	4.7	2	30	19
1N751	5.1	1	20	17
1N752	5.6	1	20	11
1N753	6.2	0.1	20	7
1N754	6.8	0.1	20	5
1N755	7.5	0.1	20	6
1N756	8.2	0.1	20	8
1N757	9.1	0.1	20	10
1N758	10.0	0.1	20	17
1N759	12.0	0.1	20	30

1. ±10% Zener Voltage Tolerance
2. E_Z measured at Test Current $I_Z = 20mA$

All of the above types can be supplied in ±5% Tolerance. Add "A" suffix to indicate units with ± 5% Tolerance of center Zener Voltage Value.

* *NEW!*

VOLTAGE REFERENCE DIODES

½ ACTUAL SIZE

EIA Type Number	REFERENCE VOLTAGE @ 7.5 m.a. @ 25°C. (volts): Min.	Avg.	Max.	Max. Voltage change from 25°C Reference Voltage (volts) −55°C to + 100°C	Max. Dynamic[1] Resistance (ohms)
1N2765	6.46	6.80	7.14	±0.050	20
1N2766	12.92	13.60	14.28	±0.100	40
1N2767	19.38	20.40	21.42	±0.150	60
1N2768	25.84	27.20	28.56	±0.200	80
1N2769	32.30	34.00	35.70	±0.250	100
1N2770	38.76	40.80	42.84	±0.300	120

1. Measured with 1 mA AC superposed on 7.5 mA DC
Max. Operating Temp. @ Iz=7.5 mA: −65°C to +175°C.

PSI High-Q ® **Varicap** ®

ACTUAL SIZE

VARICAP TYPE	Capacitance* @ 4VDC 50MC (μμf)	Quality Factor Min. (Q) @ 4VDC 50MC	Max. Working Voltage (VDC)	Minimum Saturation Voltage @ 100 μADC (VDC)	Maximum Inverse Current @ 50VDC (μADC)
PC-112-10	10	50	80	90	1.0
PC-113-22	22	50	80	90	1.0
PC-114-47	47	50	80	90	1.0

CAPACITANCE CHANGE: From 2VDC to 80VDC, 4.0 to 1 Min.

VARICAP TYPE	Capacitance* @ 4VDC 50MC (μμf)	Quality Factor Min. (Q) @ 4VDC 50MC	Max. Working Voltage (VDC)	Minimum Saturation Voltage @ 100μADC (VDC)	Maximum Inverse Current @ 75VDC (μADC)
PC-115-10	10	100	100	110	1.0
PC-116-22	22	100	100	110	1.0
PC-117-47	47	100	100	110	1.0

CAPACITANCE CHANGE: From 2VDC to 100VDC, 5.2 to 1 Min.
*All capacitance values are ±20% All values at 25°C

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

An entirely new approach to the design of electronic tuning, automatic frequency control, harmonic generation and numerous other circuits is made possible by the introduction of these new silicon voltage-variable capacitors. The Q specifications of 50 and 100 at 4VDC at 50 mc. for the first time combine wide tuning range and high Q. Twenty-three other Varicap types ranging from 7 to 100 μμf also available. Details on request.

All High Q Varicap types are available on good delivery schedules.

Fast Recovery Silicon Diffusion Computer Diodes

ACTUAL SIZE

Type Number	Minimum Saturation Voltage * @ 100 μa (volts)	Minimum Forward Current @ + 1.0 volt (mA)	Maximum Reverse Current (μa): 25°C	100°C	Reverse Recovery Characteristics: Reverse Resistance (ohms)	Maximum Recovery Time (μs)
MILITARY TYPES						
1N643†	200	10	.025 (10v) 1 (100v)	5 (10v) 15 (100v)	200K	0.3
1N662‡	100	10	1 (10v) 20 (50v)	20 (10v) 100 (50v)	100K	0.5
1N663*	100	100	5 (75v)	50 (75v)	200K	0.5

†Mil-E-1/1171 (SigC) ‡Mil-E-1/1139 (SigC) *Mil-E-1/1140 (SigC)

Type Number	Minimum Saturation Voltage * @ 100 μa (volts)	Minimum Forward Current @ + 1.0 volt (mA)	Maximum Reverse Current (μa): 25°C	100°C	Reverse Resistance (ohms)	Maximum Recovery Time (μs)
1N789	30	10	1 (20v)	30 (20v)	200K	0.5
1N790	30	10	5 (20v)	30 (20v)	200K	0.25
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
1N794	60	10	5 (50v)	30 (50v)	200K	0.25
1N795	60	50	5 (50v)	30 (50v)	200K	0.5
1N796	60	100	5 (50v)	30 (50v)	100K	0.5
1N797	120	10	1 (100v)	30 (100v)	200K	0.5
1N798	120	10	5 (100v)	30 (100v)	200K	0.25
1N799	120	50	5 (100v)	30 (100v)	200K	0.5
1N800	120	100	5 (100v)	30 (100v)	100K	0.5
1N801	150	10	1 (125v)	30 (125v)	200K	0.5
1N802	150	50	5 (125v)	50 (125v)	200K	0.5
1N803	200	10	5 (175v)	50 (175v)	200K	0.5
1N804	200	50	10 (175v)	50 (175v)	200K	0.5
1N659	60	6	5 (50v)	25 (50v)	400K	0.3
1N660	120	6	5 (100v)	50 (100v)	400K	0.3
1N661	240	6	10 (200v)	100 (200v)	400K	0.3
1N625	30	4 @ 1.5v	1 (20v)	30 (20v)	400K	1 μsec
1N626	50	4 @ 1.5v	1 (35v)	30 (35v)	400K	1 μsec
1N627	100	4 @ 1.5v	1 (75v)	30 (75v)	400K	1 μsec
1N628	150	4 @ 1.5v	1 (125v)	30 (125v)	400K	1 μsec
1N629	200	4 @ 1.5v	1 (175v)	30 (175v)	400K	1 μsec

*Maximum DC working inverse voltage is 85% of minimum saturation voltage.

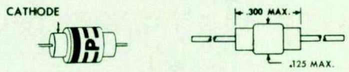
OTHER SPECIFICATIONS:
Peak Pulse Current, 1 μsec, 1% duty cycle: 3.0 Amps.
Storage and Operating Temperature Range: −65°C to 200° C.

Silicon Very High Voltage

Cartridge Rectifiers

EIA Type	Length Inches	Absolute Max. Rtgs. H/W Res. Load at 75°C Ambient		Electrical Characteristics at 25°C Ambient	
		Peak Inverse Voltage Volts	Max. Rectified DC Output Current MA	Forward DC Volt Drop at Rated DC Current Volts	Reverse DC Current at Rated PIV MA
IN1139	4 5/16	3600	65	27.0	.025
IN1140	2½	3600	65	18.0	.025
IN1141	4 5/16	4800	60	36.0	.025
IN1142	2½	4800	50	24.0	.025
IN1143	4 5/16	6000	50	45.0	.025
IN1143A	4 5/16	6000	65	30.0	.025
IN1144	6 1/16	7200	50	54.0	.025
IN1145	4 5/16	7200	60	36.0	.025
IN1146	6 1/16	8000	45	60.0	.025
IN1147	6 1/16	12000	45	60.0	.025
IN1148	6 1/16	14000	50	52.0	.025
IN1149	6 1/16	16000	45	60.0	.025

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



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 Varicaps.) 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.

10451 West Jefferson Boulevard, Culver City, California

ORegon 8-9013, OSborne 9-4561 • TWX: HAWTHORNE CAL 7414

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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)		Maximum Average Rectified Current (mA)	
			@ 25°C	@ 150°C	@ 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 @ 25	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.

* *NEW!*

Fast Recovery Low Capacitance Computer Diodes

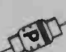
ACTUAL SIZE

Type Number	Min Sat. Voltage @ 100 μa (v)	Min. Fwd. Current @ 1.0v (mA)	Maximum Reverse Current (μa)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res. (ohms)	Max. Recov. Time (μs)
1N925	40	5	1.0 (10v)	20 (10v)	20K	0.15
1N926	40	5	0.1 (10v)	10 (10v)	20K	0.15
1N927	65	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15
1N928	120	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15

Inverse Capacitance: Maximum 4.0μμf @ 0 volts
Typical 1.1 μμf @ —10 volts

Silicon

High Conductance Diodes



ACTUAL SIZE

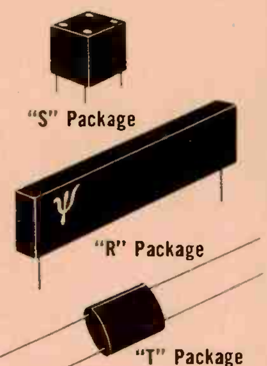
PSI or EIA TYPE NUMBER	Minimum Saturation Voltage @ 100 μa @ 25°C (volts)	Maximum Forward Voltage DC @ 25°C (volts)		Maximum Inverse Current at Maximum DC Operating Voltage (μa @ volts)		Maximum Average Rectified Current (mA)	
		@ 100 mA	@ 200 mA	@ 25°C	@ 150°C	@ 25°C	@ 150°C
1N482	40	1.1		.250 @ — 30v	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.

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.



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

⅔ ACTUAL SIZE

DIMENSIONS

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

Please Note: All specifications and information contained herein are current as of: *February 15, 1960.*

***Since preparation of these pages, many *new* and exciting devices and types have been added to the PSI line *and are now available.* Call your nearest PSI sales office for latest information!** *Standard Modulator Quads . . . Bridge Rectifiers and Rings . . . 10 to 20 KV High Voltage Cartridge Rectifiers . . . and many others!*

Silicon
Subminiature Rectifiers

ACTUAL SIZE

MEDIUM POWER TYPES

EIA TYPE NUMBER *	MAXIMUM RATINGS Peak Inv. Voltage (v)	Maximum Avg. Rectified Current (mA)[1] @ 25°C	@ 150°C	ELECTRICAL CHARACTERISTICS Minimum Saturation Voltage @ 100°C	Maximum Reverse Current @ PIV (μA) @ 25°C	@ 100°C	Max. Fwd. Voltage Drop @ Ib = 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

* *All above types available as Air Force Approved Units.*

400 MILLIAMPERE PSI TYPES

400 mA @ 25°C—150 mA @ 150°C

PSI TYPE NUMBER	MAXIMUM RATINGS 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] @ 100°C (μa)
TYPE				@ 25°C	@ 150°C
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

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.

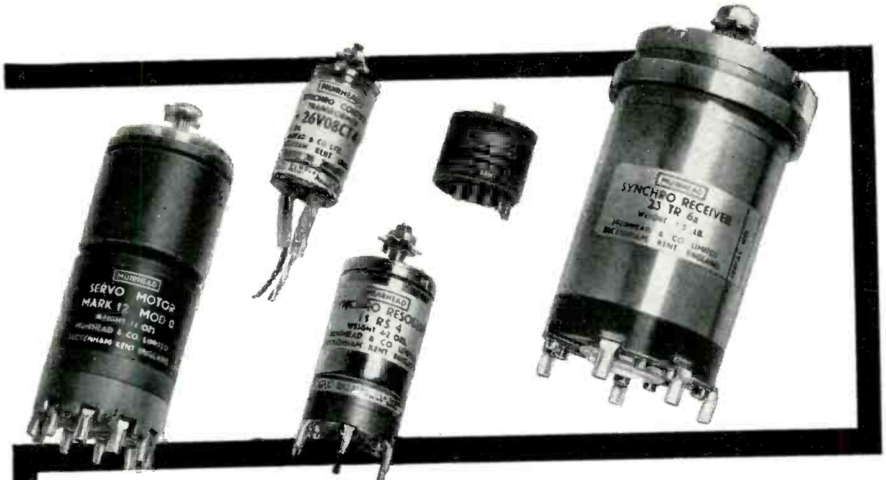
500 MA TYPES IN MINIATURE PACKAGE ALSO AVAILABLE.

New Types! Silicon
HighVoltage Rectifiers

⅔ ACTUAL SIZE

EIA TYPE NUMBER	Peak Inverse Voltage (volts)	Average Rectified Current (mA) @ 25°C	@ 100°C	MAX RMS Input Voltage (volts)	MAX DC Fwd Voltage Drop @ 100 mA DC 25°C	Dimensions (inches) L.	Dia.
1N1730	1000	200	100	700	5	.5	.375
1N1731	1500	200	100	1050	5	.5	.375
1N1732	2000	200	100	1400	9	1.0	.375
1N1733	3000	150	75	2100	12	1.0	.375
1N1734	5000	100	50	3500	18	1.0	.5
1N2382	4000	150	75	2800	18	1.0	.5
1N2383	6000	100	50	4200	27	1.5	.5
1N2384	8000	70	35	5600	27	1.5	.5
1N2385	10000	70	35	7000	39	2.0	.5

Maximum DC Reverse Current @ Rated PIV 10μA @ 25°C, 100μA @ 100°C.
Maximum Surge Current (8msec.): 2.5 Amps.
Continuous DC Voltage same as PIV.
Operating temperature range —55°C to 150°C.



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The two are synonymous. And the reason? MUIRHEAD make a speciality of manufacturing all types of synchros and servomotors —and have done so for more than 20 years.

MUIRHEAD synchros and servomotors are precision built to meet the exacting requirements of Bu. Ord., N.A.T.O. and British Military specifications in sizes from 08 to 23.

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Precision Electrical Instruments

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A representative selection of our products will be on show, together with a working demonstration of the new Automatic Recording Wave Analyser. This instrument is designed to carry out automatic amplitude/frequency analyses of steady signals and amplitude/frequency/time analyses of non-steady signals.

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Scientists, Engineers, Technicians,
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As We Go To Press . . .

(Continued)

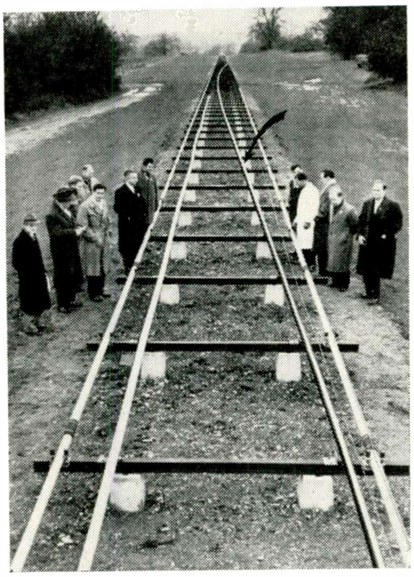
Tubes or Transistors?

"Transistors have a long way to go before they overcome their growing pains," R. E. Moe, of the General Electric Company, Owensboro, Ky., told a symposium on new electron tube developments during the Winter General Meeting of the American Institute of Electrical Engineers. His observations were made in a paper, "Tubes or Transistors — A Realistic Assessment."

Mr. Moe said that there is no doubt that transistors will take over some of the application areas previously served by tubes. However, the fact is there are many, many fields where tubes are and still continue to be superior. The use of tubes or transistors will depend on operating conditions and circuit requirements, he said.

At the same meeting two Westinghouse Electric Corp. engineers delivered a paper, "Shall an Electron Tube or a Semiconductor Device be Used?" The authors were E. E. Scheneman and S. K. Waldorf. They said the answer to this question depends on the needs of the electronic equipment designer.

TV THROUGH A PIPE



IT&T Corp. is sending live TV over half a mile through this 3 in. pipe at Hertsfordshire County, England. They are believed to be the first transmitted by circular waveguide or by pulse code modulation for such a distance. Even greater distances are possible with repeaters. In commercial use, the pipe would be buried.

Better Ferroelectric Materials Reported

Charles F. Pulvari, Researcher for the Air Force, in 1955 proved the feasibility of ferroelectric information storage devices. He goes further in the development of improved, practical ferroelectric materials in a report just released. The report is titled "Research on Barium Titanate and Other Ferroelectric Materials for Use as Information Storage Media."

This report may be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington, D. C., for $3.50. Order PB 151835.

Another report by W. M. Becker, R. W. Clark, and M. S. Hall, to the Air Force describes a search for a better notation scheme, improved ferroelectric materials, and a faster electro-optical switch for digital computers. The report is titled "Research on Automatic Computation Techniques and Components." It is also available from OTS, U. S. Department of Commerce, Washington 25, D. C. Cost is $3.00, order PB 151834.

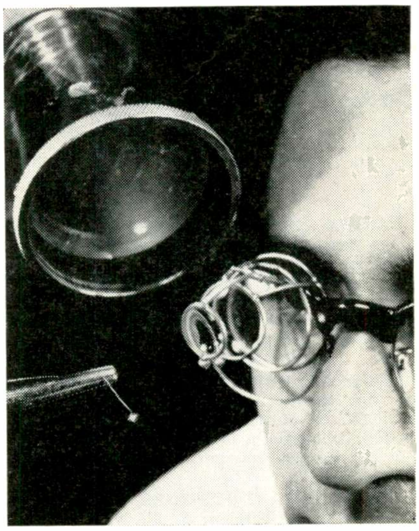
Contractors Hold Seminar

The newly organized GCMA (Government Contracts Management Association of America) held the first of a series of Seminars on the negotiation and administration of contracts in the defense industry.

The first Seminar was on subcontracting for the Defense Program. It covered such subjects as selection of sources, preparation of bid request, bid analysis and methods, and objectives of negotiation and administration. The Seminar was headed by Mr. F. E. Cassot, Purchasing Agent, Air Armament Division Hustler, Sperry Gyroscope Company.

GCMA was founded last year to act as an exchange center of ideas and experience to augment the skills of individuals in the defense industry who are members. According to Mr. Stanley Fried, GCMA President, "For people engaged in defense programs, management and administration of Government contracts represents an extremely complex problem."

RADIATION DETECTOR



"Solid State Ionization Chamber" is smaller than the head of a pin. Developed by Hughes Aircraft Co. Labs at Los Angeles and Newport Beach, Calif., it measures the number and energy of atomic particles. It uses "doped" silicon which emits a measurable pulse when struck with a charged nuclear particle.

Loran-C System Tests Favorable

Tests have been completed on a navigation system called Loran-C. This radio navigation system will permit ships to determine their positions accurately at long ranges (well over 1000 miles) from the transmitters. Test results were very favorable.

The system was under evaluation by Jansky and Bailey, Inc., Washington, D. C. The evaluation was sponsored by the Office of Naval Research under a contract administered by the U. S. Coast Guard.

The East Coast Loran-C system was studied. Transmitting stations are located in Massachusetts, North Carolina, and Florida. The system is operated by the Coast Guard.

The North Carolina station sends out a series of radio pulses which are picked up by the Massachusetts and Florida stations, as well as by the ships using the system. After receipt of the master pulses, the Florida and Massachusetts stations originate similar pulses after a closely controlled time interval. The ships, in turn, measure the time differences between the receipt of pulses from the North Carolina and Massachusetts stations and from the North Carolina and Florida stations. This information is used to develop a geographical position.

Electronic Industries' News Briefs

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

EAST

BENDIX AVIATION CORP. has received orders for automatic flight control systems to equip the first turbine-powered planes specifically designed for commercial air freight. Its transistorized PB-20 flight control systems will be incorporated in fleets of new Canadair Forty-Four turbo-prop cargo carriers.

GENERAL PRECISION, INC., GPL Div., has won an award by the Aeronautical Systems Center of the Air Material Command, Dayton, Ohio, for a contract of over $3.7 million for airborne navigation systems.

ULTRASONIC INDUSTRIES, INC., 141 Albertson Ave., Albertson, L. I., N. Y., is the name of a new company formed by Paul M. Platzman. The company is already in production on their line of ultrasonic cleaning equipment.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP. has received additional funding of more than $1.3 million for the defensive electronic countermeasures "checkout" system for Air Force B-58 bomber. This award brings the grand total to $8.8 million.

GENERAL TRANSISTOR CORP., Jamaica, N. Y., is bringing out tunnel diodes. They have a pilot production line in operation for engineering samples and have already begun shipments of test quantities.

MONITOR SYSTEMS, INC., a div. of EPSCO, Inc., has completed their new plant in Ft. Washington Industrial Park, Ft. Washington, Pa.

ASSOCIATED TESTING LABORATORIES, INC., environmental testing laboratory and manufacturer of environmental test equipment, will move into a new plant in Wayne, N. J., early this year.

SYLVANIA ELECTRIC PRODUCTS, INC., has raised the temperature capabilities of its full line of S- and X-band microwave diodes. As a result of improved processing techniques, standard microwave diode heat capabilities up to 150°C. are now available to design engineers at no increase in cost.

GENERAL ELECTRIC CO., Syracuse, N. Y., has received a $3.7 million Air Force contract for continuing world-wide service for ground electronic equipment. It was awarded to GE's Heavy Military Electronics Dept.

ALLEN B. DU MONT LABS., INC., Clifton, N. J. has received a sub-contract from Bendix Products Div.-Missiles, for the production of telemetry equipment and associated test equipment for the Talos Guided Missile. Contract amount is about $1.6 million.

SPRAGUE ELECTRIC CO., No. Adams, Mass., has announced a price decrease ranging from 5 to 10% in the price of its metal-clad solid-electrolyte tantalum capacitors.

TRANSITRON ELECTRONIC CORP., Wakefield, Mass., has announced the purchase of the former Maverick Mills plant in Boston containing some 400,000 sq. ft. of space. Extensive alterations and a modernization program are already underway. The company expects that between 2000 and 3500 persons will be employed there.

ERIE RESISTOR CORP. has announced the opening of Electron Research, Inc., a wholly owned subsidiary, for the purpose of manufacturing semiconductor components and devices. The new company is located at 530 W. 12th St., Erie, Pa.

ATLAS E-E CORP. has officially changed their name to **ATLEE CORP.**

EFCON, INC., manufacturers of electrostatic and solid tantalum electrolytic capacitors, has moved into their new 20,000 sq. ft. building located at Roosevelt Field, Garden City, L. I., N. Y.

PERKIN-ELMER CORP., Electro-Optical Div., has just received contracts totaling $2 million for the production of alignment theodolites for the USAF TM-76B MACE missile program. The Baltimore Div. of The Martin Co. is prime contractor for the MACE weapon system.

CARLISLE CORP., Carlisle, Pa., has just acquired the International Wire Products Corp. of Midland Park, N. J. The company will function as a wholly owned subsidiary of Carlisle.

GENERAL TELEPHONE & ELECTRONICS CORP. has announced the formation of General Telephone & Electronics Laboratories, Inc., a wholly-owned subsidiary which will be engaged in a wide range of scientific research activities in the communications and electronics fields.

RAYTHEON CO. has been awarded a $4,835,000 contract by the Dayton Air Force Depot for production of 7600 high powered magnetrons to be used in SAGE height finding radars.

AVION DIV., ACF INDUSTRIES, INC., has just received a "quick reaction" contract to provide engineering, laboratory and model shop work associated with printed circuit electronics. It was issued by Goddard Space Flight Center of the National Aeronautic and Space Administration.

WESTON INSTRUMENTS, Div. of Daystron, Inc., has received a half-million dollar order from the Air Force Material Command, Wright-Patterson Air Force Base, for bearing distance heading indicators.

MID-WEST

G. H. LELAND, INC., have taken an option on 15 of the 70 acres of the proposed Scholz Industrial Park in Vandalia, Ohio. Construction plans call for building in stages, with the first unit estimated at 50,000 sq. ft. and ultimately comprising 150,000 sq. ft.

VICTOREEN INSTRUMENT CO., Cleveland, Ohio, will build a complete radioactivity detection and control system for the Atomic Energy's nuclear plant near Hallam, Nebr. The contract was received from Atomics International, a division of North American Aviation, Inc.

MONSANTO CHEMICAL CO., says they have begun operation of the first computer-controlled chemical plant in the U. S. The plant is located in Luling, La.

FANSTEEL METALLURGICAL CORP., No. Chicago, Ill., now has tantalum powder available for $30.00 per lb. They have started a program to provide immediate shipment of tantalum products from stock.

COLLINS RADIO CO. has received a contract totalling about $1 million from the U. S. Army Signal Corps for a microwave and tropospheric scatter communication system to be installed in the Washington, D. C. area.

WEST

TALLY REGISTER CORP., maker of punched paper tape data processing, storage, acquisition equipment, has occupied a new plant. The new offices and manufacturing area are located at 1310 Mercer in Seattle's Westlake district.

RADIO CORP. OF AMERICA has dedicated a new Surface Communications Systems Laboratory in Tucson, Ariz. The new facility will provide a modern scientific quarters for the type of work RCA has been doing during the past four years for the Signal Corps at near-by Ft. Huachuca.

TEXAS INSTRUMENTS, INCORPORATED, has been awarded a contract for the production of 37 telemetry systems for the Bomarc C-2 missile by the Boeing Airplane Co., Seattle, Wash.

SERVOMECHANISMS, INC., has formed a separate research division. Headquarters for the research division will be at the company's Santa Barbara facility.

AMERICAN AVIONICS, INC., Los Angeles electronics manufacturer, has completed the first in a planned series of acquisitions by purchasing a dominant stock interest in Lance Industries, Inc., California manufacturer's representative concern.

LITTON INDUSTRIES, Beverly Hills, Calif., has acquired Electronic Systems Div. of General Controls Co. The Electronic Systems Div. specializes in design and production of air data computers and navigation and flight control subsystems.

TELECOMPUTING CORP., of Los Angeles, has offered to acquire all of the outstanding stock of Narmco Industries, Inc., San Diego, manufacturer of resins, coatings, adhesives, metal bondings, and plastic sporting goods. The acquisition is subject to the approval by Narmco shareholders.

CANNON ELECTRIC CO., Los Angeles, Calif., has opened a new manufacturing division in Phoenix, Ariz. Called the Special Products Div., the new factory combines all engineering, manufacturing, and testing facilities for production of Cannon plug/harness systems, missile/umbilical plugs and "Canseal" hermetically sealed plugs.

SIERRA ELECTRONIC CORP. has announced plans for a major expansion of its plant in Menlo Park, Calif. The company will add 50,000 sq. ft. to its engineering and manufacturing facilities in the Bohannon Industrial Park section of Menlo Park, Calif.

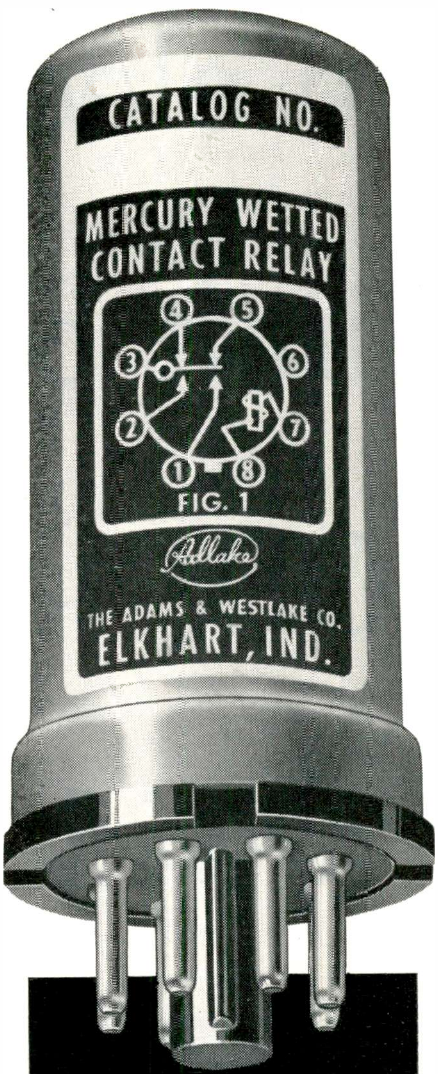
IRON FIREMAN MANUFACTURING CO., Electronics Div., Portland, Ore., has received contracts calling for delivery of approximately $1 million worth of drone gyroscopes from Radioplane, a Div. of Northrop Corp. in Van Nuys, Calif.

AEROLAB DEVELOPMENT CO., Pasadena, Calif., specialists in aerophysics research, has been acquired by Ryan Aeronautical Co., San Diego, Calif. Aerolab will continue operations at Pasadena as a wholly owned Ryan subsidiary.

TASKER INSTRUMENTS CORP., Hollywood, Calif., has broken ground for modern electronics facilities in Van Nuys. The new building will consolidate the corporation's administrative, engineering and production departments, which are now located in Hollywood and Burbank.

THE ADAMS & WESTLAKE COMPANY, ORIGINAL AND LARGEST MANUFACTURER OF MERCURY PLUNGER-TYPE RELAYS, ANNOUNCES A LINE OF . . .

mercury wetted contact relays*



Rated A+ for these applications

A+ Adlake

- computing systems
- signaling devices
- tabulating machines
- high speed switching

SPEEDS: Up to 100 operations per second.

CONTACT RATING: 250 volt-amperes, 500 volts maximum. 5 amperes maximum (with suitable contact protection).

LIFE: Billions of operations.

MAINTENANCE: None. All ADLAKE relays are maintenance-free.

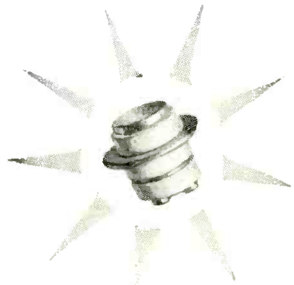
WRITE for bulletin "MW," The Adams & Westlake Company, Department 41-AW Elkhart, Indiana.

* Manufactured under license agreement with Western Electric Company, Inc.

Circle 12 on Inquiry Card

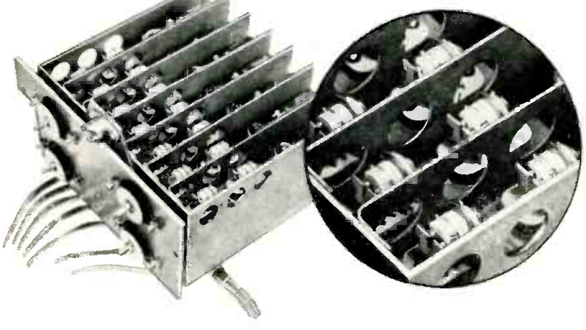
Good electronic design

you limit compromise by

PROOF:  G-E 7077

over a wide spectrum of

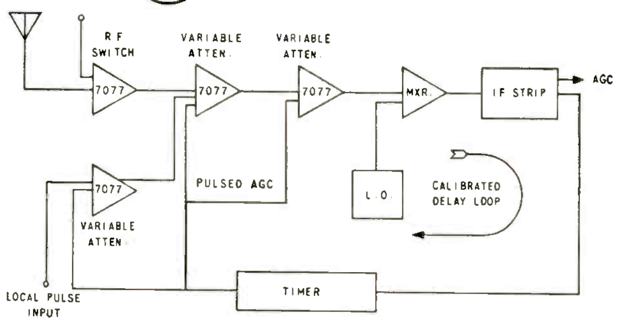
LOCKHEED



WIDE-BAND TAPE RECORDER.

For Lockheed, California Division, 28 General Electric 7077's serve as pre-amplifiers in a 14-channel 500-kc 60"-per-second tape recorder that stores wide-band information from an air defense exercise five times as rapidly as before. Extreme requirements of frequency, timing accuracy, and reproducibility are met by the 7077's low noise, high impedance, and high G_m. Also, the tube's small size matches the miniaturization needs of the Lockheed tape-recorder equipment.

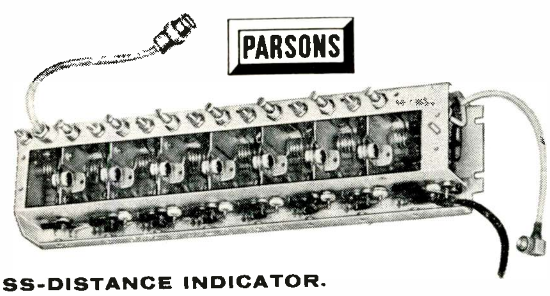
MOTOROLA



GROUND-SURVEYING RADAR.

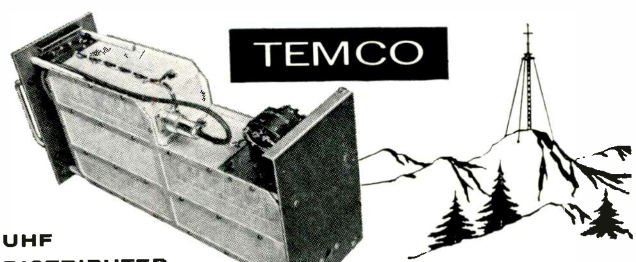
Motorola's Western Military Electronics Center in Phoenix uses four General Electric ceramic 7077's for high-speed RF switching and pulse attenuation in a 440-mc distance measuring circuit where timing to *one billionth of a second* is needed for pulse delay measurement. Minimum plate-to-cathode capacitance, high gain, low noise, and a configuration that makes the tube ideal for grounded-grid service, were reasons back of Motorola's choice of the G-E 7077.

involves trade-offs...but using ceramic tubes. meets designers' targets frequency and function.



MISS-DISTANCE INDICATOR.

Ralph M. Parsons Company uses seven General Electric ceramic 7077's in tuned stages as high-gain, low-noise RF amplifiers in its PARAMI system for determining air-intercept missile accuracy. A 324-mc circuit, the Parsons PARAMI system has a gain-bandwidth product approaching the limit of the state of the art.



UHF DISTRIBUTED AMPLIFIER.

Many receivers—one antenna, with Temco Electronics' broadband distributed amplifier. Arranged in six five-stage units, 30 G-E 7077's are used as RF amplifiers, operating over a 750 mc bandwidth, between 250 and 1000-mc. Fills the frequency gap between TWT's and existing distributed amplifiers.

Phone your nearest General Electric Receiving Tube Department Office:

New York: WIsconsin 7-4065, 6, 7, 8 **Chicago: SPring 7-1600** **Los Angeles: GRanite 9-7765**

Progress Is Our Most Important Product

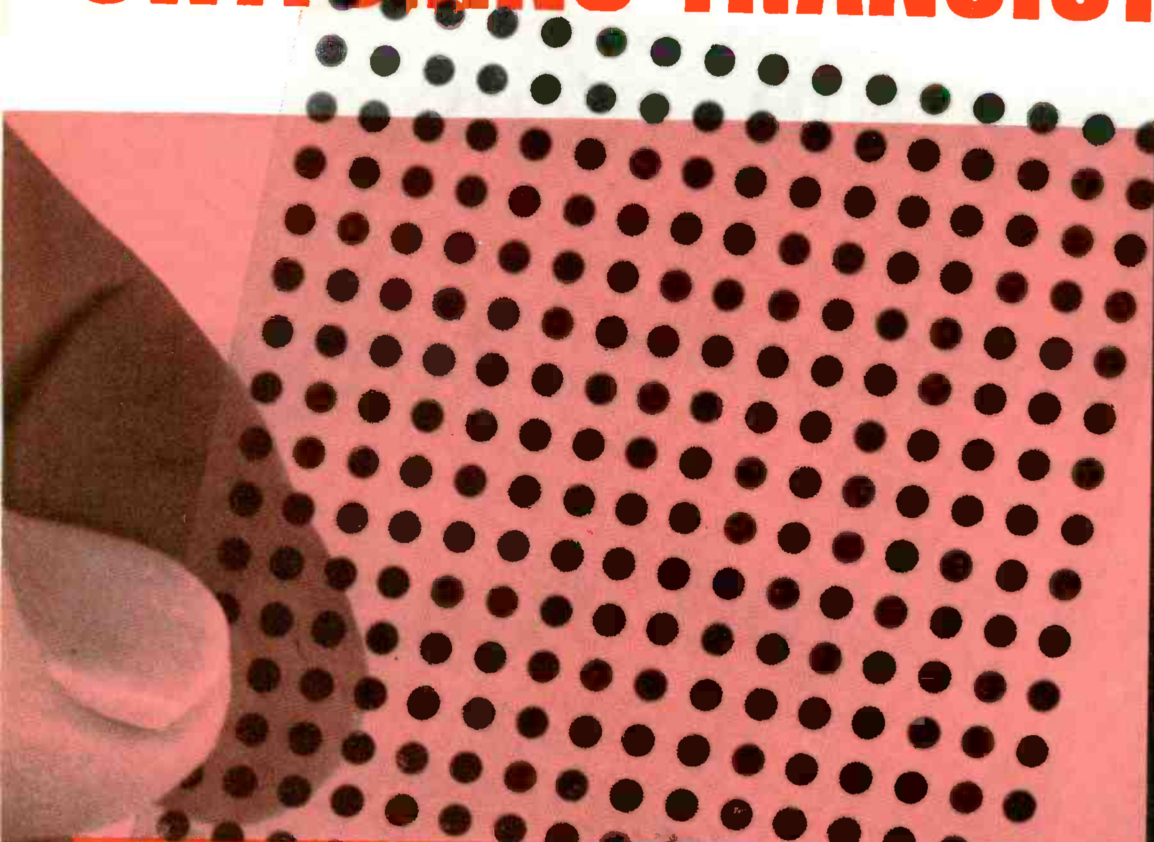
GENERAL ELECTRIC

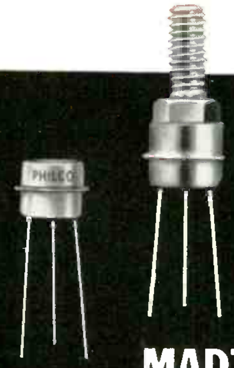
Circle 13 on Inquiry Card

431-202

PHILCO ANNOUNCES

THE FASTEST HIGH-CURRENT SWITCHING TRANSISTORS!

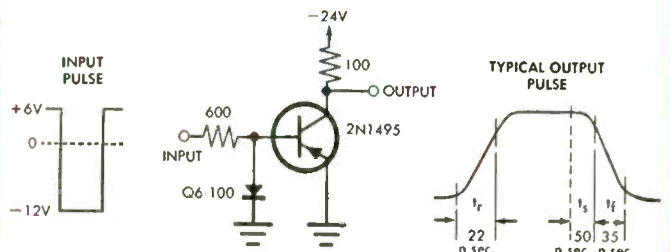




MADT*

2N1495 • 2N1496
2N1204 • 2N1494

These Diffused-base Transistors are capable of utilizing the full speed of new magnetic film memory planes



TYPICAL 240 ma SWITCHING CIRCUIT WITH TURN ON CURRENT OF 20 ma AND TURN OFF CURRENT OF 10 ma

These new Philco MADTs are the result of a revolutionary new development of the Precision-Etch process, which gives high switching speed at high currents. *They are capable of switching 400 milliamperes of current at a 10 mc clock-rate* . . . and are the only transistors available today that permit full utilization of high-speed magnetic film memory planes. The typical f_T of 120 mc at 100 ma makes these units particularly suitable for video drivers, pulse line drivers and other high-current switching circuits. The ultra high-frequency response at the levels normally encountered in current-switching logic circuits, coupled with high dissipation capabilities, makes these units desirable for this class of circuit application.

Both the 2N1495 and 2N1204 are available in studded versions for higher power applications. Typical characteristics are shown in the accompanying table. For complete application data, write Dept. EI-360.

*Reg. U. S. Pat. Off.

TYPICAL CHARACTERISTICS

TYPE	CASE	P_T @25°amb. (Max)	V_{CES} (Max)	V_{CE}(SAT) $I_C = -200$ma $I_B = -10$ma	V_{BE} $I_C = -200$ma $I_B = -10$ma	h_{FE} $V_{CE} = -1$v $I_C = -200$ma	f_T $V_{CE} = -10$v $I_E = 25$ma
2N1495	TO-9	250mw	−30v	0.35v	0.60v	60	320mc
2N1496	TO-31	*0.5w	−30v	0.35v	0.60v	60	320mc
2N1204	TO-9	250mw	−20v	0.35v	0.60v	60	320mc
2N1494	TO-31	*0.5w	−20v	0.35v	0.60v	60	320mc

*At 25°C case temp.

IMMEDIATELY AVAILABLE

In Design Quantities through your Philco Industrial Semiconductor Distributor

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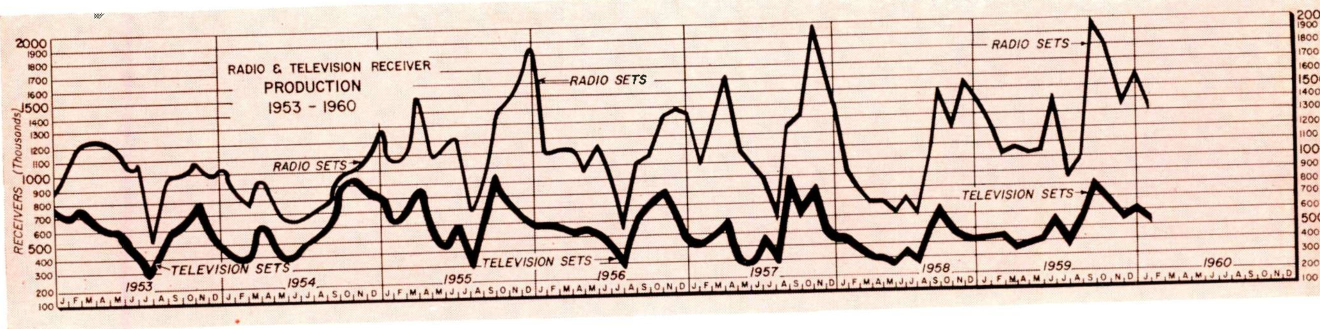
TRANSISTOR CENTER U.S.A.®

Facts and Figures Round-Up
March 1960

ELECTRONIC INDUSTRIES TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

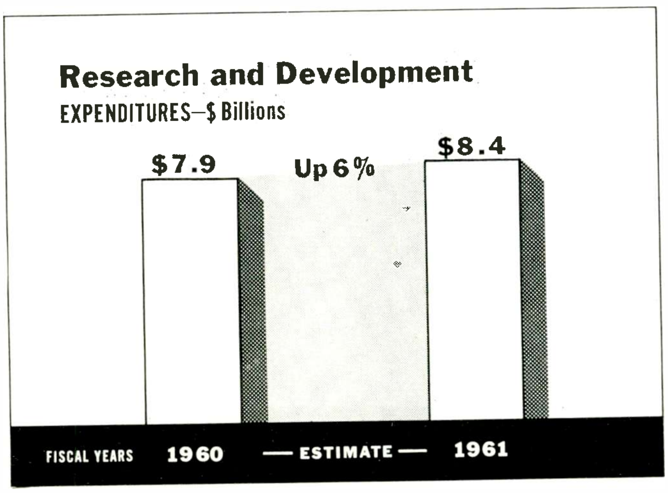
Amplifiers	268,430
Amplifiers, TWT	116,578
Analyzers, atmospheric	248,130
Analyzers, sound	132,843
Antenna, LORAN	61,781
Antennas, radio df	69,044
Antennas	179,600
Assemblies, gyro	26,613
Assemblies, waveguide	32,855
Batteries	1,950,346
Bridges, impedance	73,162
Cable	30,167
Cable assemblies	145,777
Cable, r-f	46,381
Cable, telephone	213,838
Chargers, battery	101,482
Coils	54,891
Campass sets, gyro-magnetic	267,747
Computers, analog	2,522,100
Computers, digital	1,450,000
Computer-indicators, radiac	57,503
Connectors	50,604
Couplers, antenna	67,590
Crystal units	49,471
Detectors, SONAR	126,868
Discriminators	42,642
Equipment, computer	70,126
Equipment, data reduction	64,000
Equipment, telemetry	42,166
Equipment, X-ray	134,450
Filters, band-pass	27,600
Generators, signal	33,325
Ground stations, communications	200,000
Gyroscopes	107,702
Handset-headsets	183,182
Headsets-microphone	50,681
Indicators, voltage	44,797
Insulators	130,193
Jacks, telephone	28,670
Lugs, terminal	39,273
Meters, frequency	35,335
Modules, serva	27,588
Oscilloscopes	25,000
Power supplies	251,814
Radar sets	11,649,538
Ranging equipment, electronic	79,850
Radio sets	2,275,148
Receivers, infrared	40,800
Receivers, radar	199,386
Receivers, radio	62,981
Receivers, telemetry	50,553
Receiver/transmitters, radio	625,455
Recorders, radiation pattern	256,925
Recorders, radiosonde	176,633
Recorders/reproducers magnetic tape	174,051
Rectifiers	131,875
Regulators, voltage	70,087
Resistors	34,040
Resistors, variable	46,941
Resolvers	86,507
Repeaters, telephone	148,518
Relays, armature	286,109
Relays, solenoid	49,946
Servos	261,672
Splices, electronic	32,396
Switches, pressure	43,754
Switches, rotary	56,850
Switches, thermostatic	30,256
Switches, toggle	25,607
Synthesizers, frequency	71,566
Systems, micrawave	296,617
Tape, magnetic	31,800
Teletypewriters	4,107,338
Terminals, telephone	2,616,305
Timing and recording equipment	56,250
Tawer, antenna	42,606
Transducers, pressure	40,600
Transformers, variable	47,862
Transistors, silican	50,103
Translatars	33,450
Transmitters/receivers, FM	209,595
Transmitters	87,719
Transmitters, rate gyro	44,208
Transmitters, synchro	38,476
Tubes, electron	2,949,254
Tubes, klystron	230,820
Tubes, magnetron	1,148,815
Turntables, gyro test	103,845

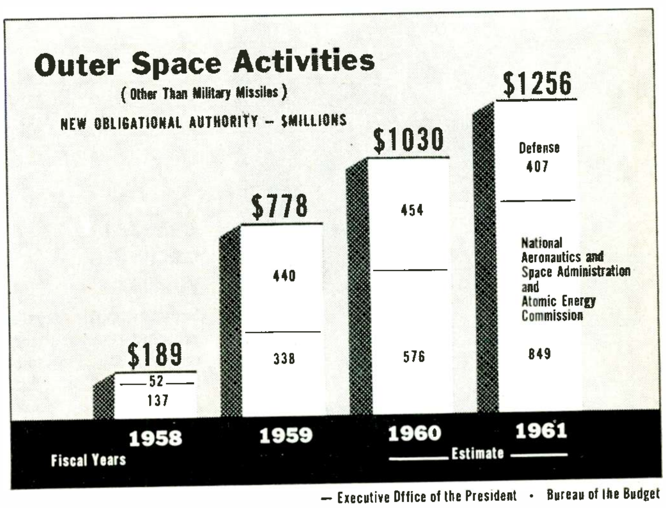
ENGINEERING DEGREES—1959

Official 1959 figures are expected to be published by the U. S. Office of Education in the near future. The following are for bachelor degrees, from colleges with ECPD accredited curricula.

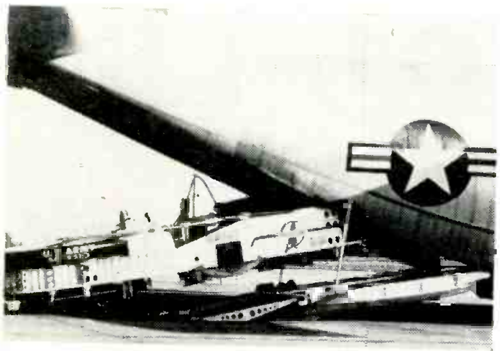
	1959 Estimated	1960 Projected
AERONAUTICAL	1300	1285
AGRICULTURAL	360	350
CHEMICAL	3025	2975
CIVIL	5050	4975
ELECTRICAL	9500	9400
GENERAL	710	685
INDUSTRIAL	1875	1825
MECHANICAL	8425	8350
METALLURGICAL	680	670
MINING	205	190
PETROLEUM	685	660
ALL OTHERS	1800	1750
TOTAL	33615	33115
From other Colleges	4350	4300
GRAND TOTAL	37965	37415

—Engineer's Joint Council



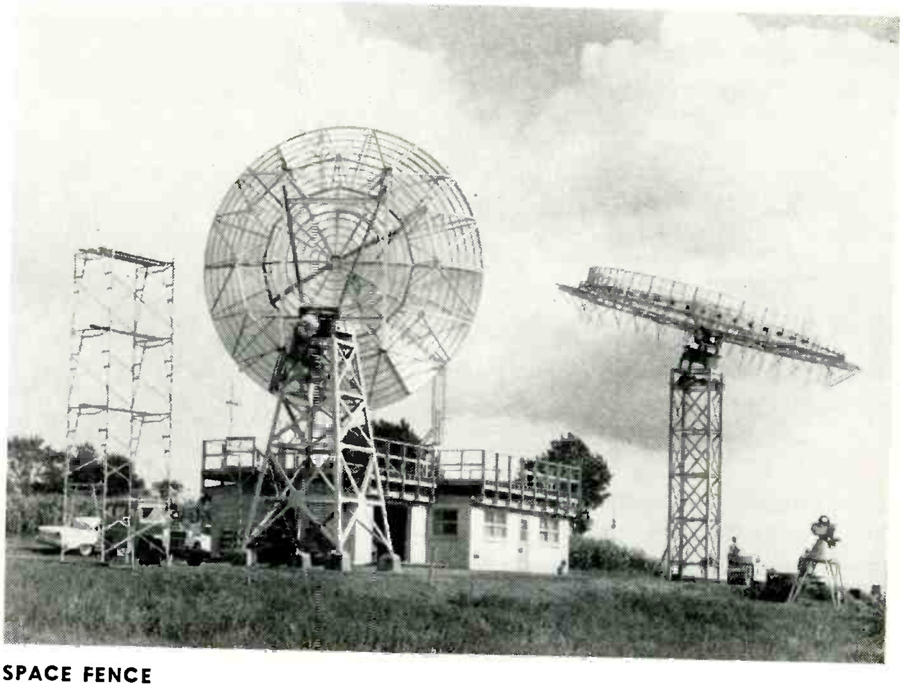


— Executive Office of the President • Bureau of the Budget



OPEN WIDE PLEASE!

Piasecki Aircraft Corp.'s "Aerial Jeep" disappears into the cargo department of an Air Force C-130. No folding was required and entire operation took four minutes.



SPACE FENCE

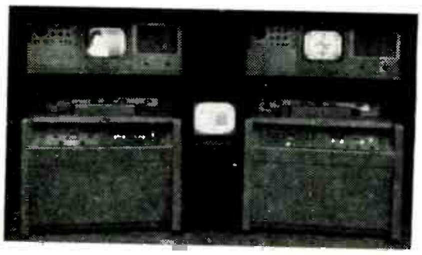
Electronic screens can spot objects as high as 1,000 mi. Shown here is antenna test range of Technical Appliance Corp., Sherburne, N.Y. Transmitter across the valley transmits controlled signals to the receiver location.

COMPUTER DESIGNS COMPUTER

Circuit designs for the IBM 7080 data processing system were prepared by its predecessor, the IBM 705 III, at Poughkeepsie, N. Y. Console of the 7080 is shown at left.

Snapshots . . .

of the

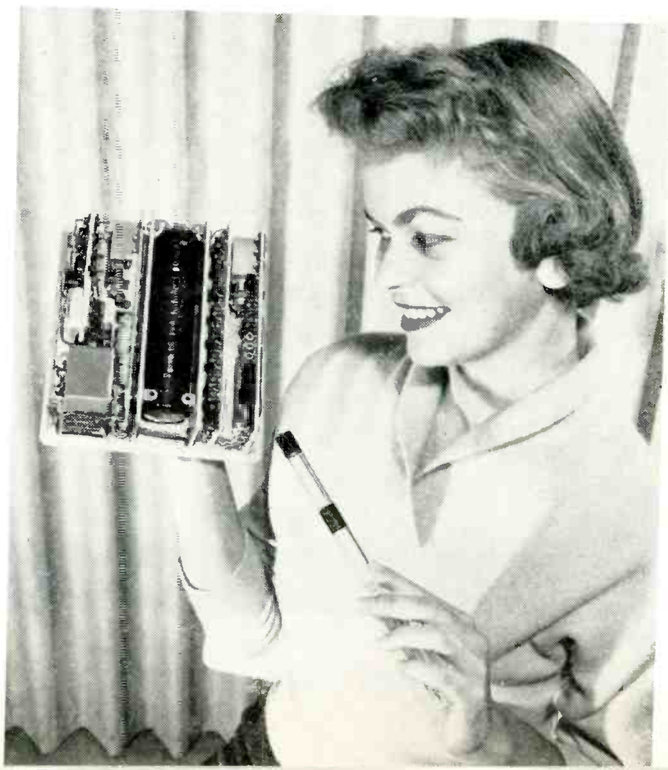


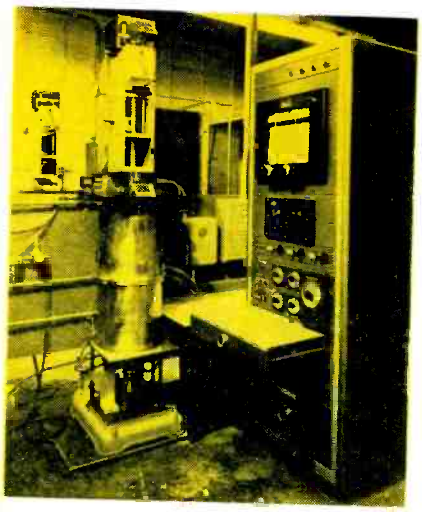
TV SPECIAL EFFECTS

"Inter-Sync" device developed by Ampex Corp., Redwood City, Calif., for its Videotape recorder synchronizes playback outputs of two VTRs for feed to a third monitor.

ATOMIC ENERGY MEASURES FUEL

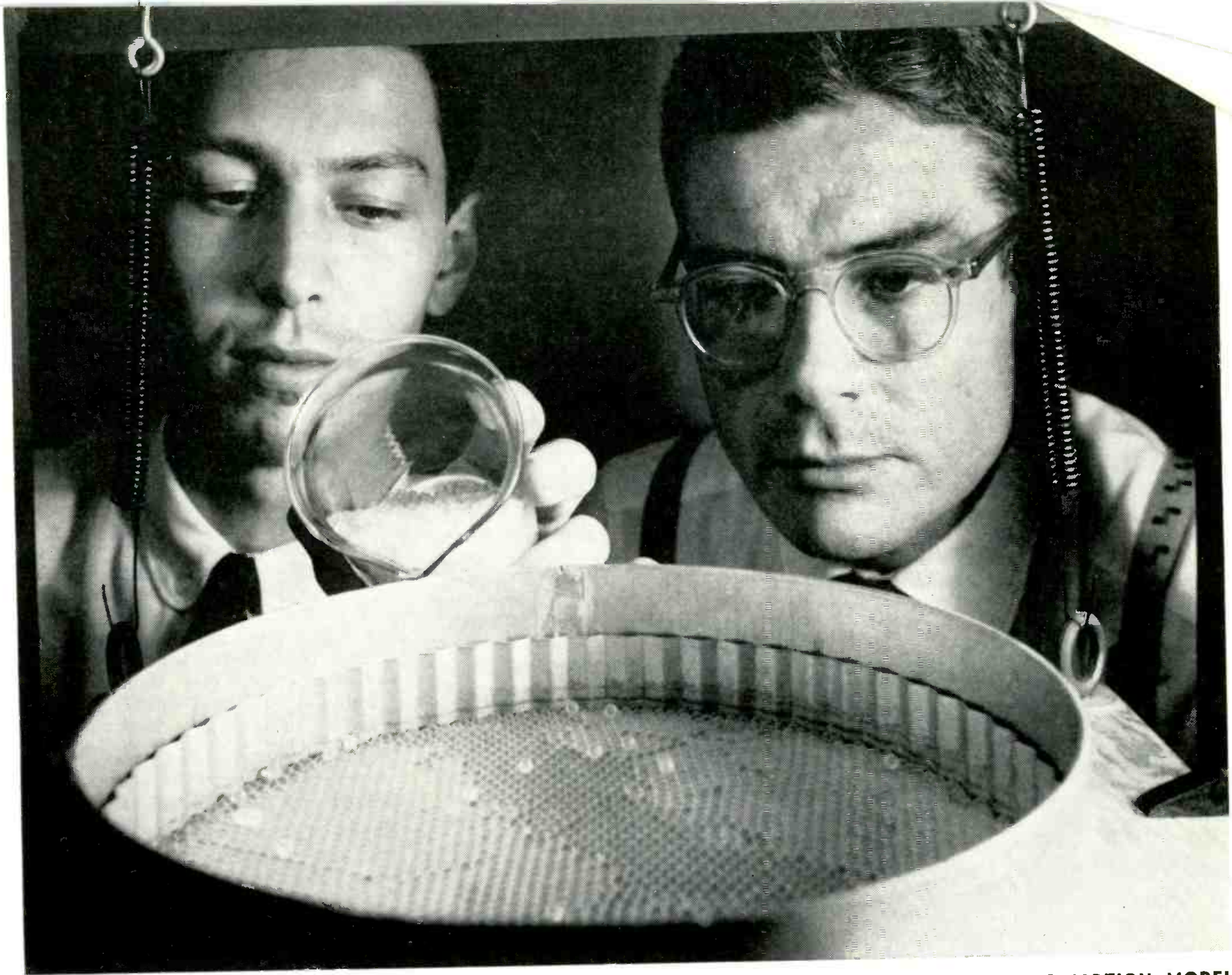
Atomic energy gage developed by Atomics International Div., North American Aviation, Inc., Canoga Park, Calif., measures the amount of fuel in airplanes and missiles during all flight attitudes.





CRYSTAL GROWING FURNACE

Semiautomatic crystal growing furnace developed by Hoffman Electronics Corp., Los Angeles, Calif., grows monocrystalline material three times faster than conventional furnaces.



ATOMIC MOTION MODEL

David Turnbull (r) and Robert Cormia of GE's Research Lab in Schenectady, N. Y., demonstrate apparatus which shows how atoms move in liquids. "Atoms" are glass beads jostling each other on a vibrating platform.

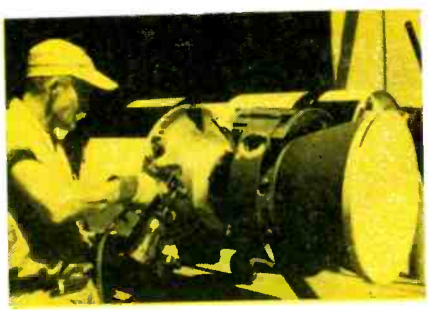
Electronic Industries

ROTARY ASSEMBLY LINE

Rotary wheel replaces standard assembly line work bench in assembling small missile electronic components at The Martin Co.'s Baltimore Div. Wheel has 24 positions and automatically rotates.

KEEPS MAN-IN-SPACE COOL

"Thermo-lag," from Emerson Electric, St. Louis, Mo., dissipates heat by sublimation. Material can be sprayed or brushed onto surface.



EI's International News

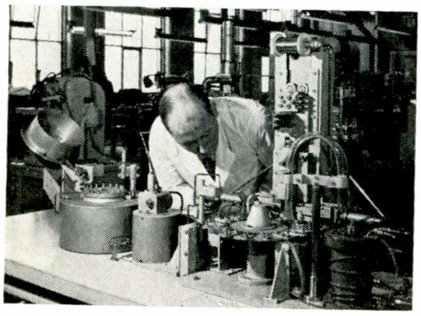
EUROPE

France Gets Cobalt 60

Paris—The Commissariat a l'Energie Atomique—the French Atomic Energy Commission—has bought 10,000 curies of cobalt 60 from the Budd Company, Phila. The isotopes will be used for studies at CEA's Nuclear Research Center at Saclay, near Paris.

Budd bought the isotopes from the AEC's Oak Ridge National Laboratory and encapsulated them in ten stainless steel "pencils." The pencils, supplied by the French, are 7 in. long and approx. ⅓ in. in dia. Each pencil has 50 wafers of cobalt 60. The pencils were capped by an AEC-approved technique to assure a completely hermetic seal.

AUTOMATED DIODE PLANT



Ferranti Ltd., Hollinwood, Lancs., England is turning out their ZS30 series, 500 ma. double-ended diffusion diodes in this new plant in Oldham, Lanc. (England). It can produce 43,000 diodes a week or 2½ million a year.

Global VHF System

Shannon Airport, Ireland — Pan American World Airways has installed the first unit of a VHF radio communications net at Ballybunion (about 38 miles from Shannon Airport). The net will eventually extend around the world.

The Ballybunion station makes possible radio contact by VHF up to 500 miles over the Atlantic. Other stations are planned for Gander, Newfoundland, and in Greenland and Iceland. These stations will cover the entire North Atlantic air route.

A second link, expected to be completed with the commissioning of an extended range VHF station in Beirut, Lebanon, will cover the Mediterranean routes. The Company is conducting tests on an extended range VHF station in San Francisco which will service the San Francisco—Honolulu route.

German Process Acquired

Oberkochen, West Germany — North American rights to an electron beam process developed by the Carl Zeiss Foundation for machining or welding hard materials has been acquired by Hamilton Standard Div. of United Aircraft Corp.

The process can cut holes finer than a human hair, surface-treat, melt or weld virtually every material known to man, including tungsten. The technique uses a controlled high density stream of electrons to change matter physically or chemically. There are six elements: an electron gun for developing the beam, a vacuum chamber within which the work is done, a high-vacuum pump capable of pumping down to about four-millionths of an inch of mercury, an electronic control system for manipulating the electronic deflectors and lenses, and a high-voltage power supply.

Form New Subsidiary

Munich — The Kollsman Instrument Corp., a subsidiary of Standard Coil Products Co., Inc., Elmhurst and Syosset, N. Y., has formed a new subsidiary in West Germany. The new company, Kollsman Luftfahrte Instrument G. m. b. H., has production and engineering space at the Munich Airport in Germany.

New PC Licensee

Florence, Italy—Rogers Corp., Rogers, Conn., has licensed Fratelli Marchi of Florence, Italy, to produce printed circuits by the Rogers molding process. The Italian firm will service customers in Italy, France, Luxembourg, Belgium, West Germany, and the Netherlands.

U.S.S.R.

Exchange Trade Fairs

Moscow—The British and Russians have agreed to hold reciprocal trade and industry fairs in London and Moscow in 1961. The Soviet exhibition will be held in Earls Court, London from July 7 to 29. The British exhibition will be held in Sokolniki Park, Moscow from May 19 to June 4. The Soviet exhibit will include both capital and consumer goods and will feature Soviet achievements in industry, science and technology. The British will use the Glass and Dome pavilions erected for the American Exhibition held last summer in Moscow.

UNITED KINGDOM

British TV for China

Hayes, Middlesex—E.M.I. Electronics, Ltd. has delivered the first British color TV camera to China. With the camera went control equipment and a Rank-Cintel, large screen, color-projector, which together form a complete CCTV installation.

The camera, designed for industrial, medical, and scientific applications, uses three vidicon tubes and a new optical system to give good quality under difficult lighting conditions. It can produce broadcast quality simultaneous color TV signals on either 405,525 or 625 line standards.

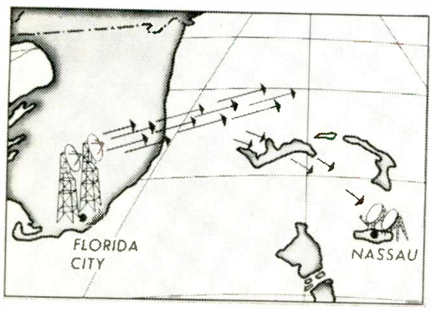
Propose Stereo System

London—G. D. Browne, of Mullard Research Labs., has proposed a time-multiplex system for stereophonic transmissions of sound broadcasts. The European Broadcasting Union is evaluating the system.

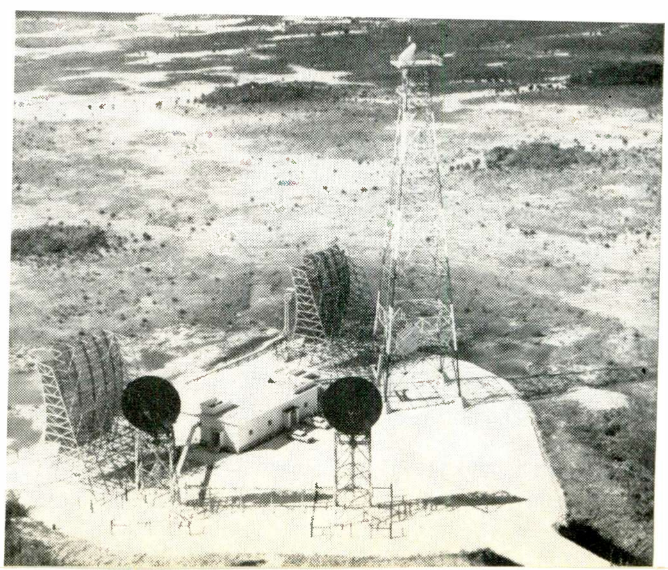
The system is claimed to have the advantage of enabling stereophonic receivers to be produced which need

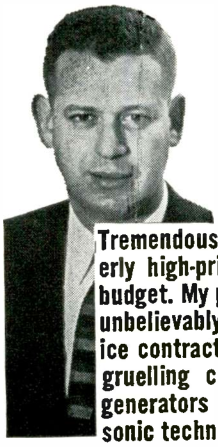
(*Continued on page 86*)

NEW TROPOSPHERIC SCATTER SYSTEM



Dish-like antennas at "over-the-horizon" site at Florida City, Fla., are aimed at Nassau in the Bahamas. New system will carry 24 simultaneous telephone conversations. New link is joint undertaking of Long Lines Dept. of American Telephone and Telegraph Co., and the Telecommunications Dept. of the Bahamas Government.





My name is Paul M. Platzman,

I pioneered the ultrasonic industry. Two well known ultrasonic companies were founded by me. Now, I have created a new organization, Ultrasonic Industries, Inc., based on a revolutionary approach to mass producing and selling ultrasonic equipment. No middleman's profit in this factory — direct-to-you deal.

Tremendous savings are passed on to you the customer bringing formerly high-priced ultrasonic cleaners within the range of everybody's budget. My products stand out because of their distinctive appearance, unbelievably low money-back-guaranteed prices—free five year service contract, and consistent trouble free performance under the most gruelling conditions. This is possible because my DiSONtegrator generators and transducers incorporate the latest advances in ultrasonic technology.

$ 99 95

Including tank, connecting cable and instruction manual (export model: 220V — 50 cycles $7.50 extra)

DiSONTEGRATOR®

SYSTEM FORTY

ULTRASONIC CLEANER

The lowest priced ultrasonic cleaner ever sold! **Buy ONE or 100 and Save!**

The DiSONtegrator System Forty ULTRASONIC CLEANER is attractively styled, ruggedly-built, and work-tested to give a lifetime of trouble-free service.

The DiSONtegrator Features:

Simplified one knob control for easy operation. High Frequency sound waves disintegrate harmful soils and contaminants in seconds. Saves time and labor, boosts production rate, improves product. You can replace hazardous chemicals with safe solvents and even water.

The DiSONtegrator works FAST

In **SECONDS** you can disintegrate soils on: radioactive lab apparatus; glassware; medical instruments; test tubes, syringes, hypodermic needles; dental instruments, drills, burrs, false teeth, bridges; fossils and fossil foraminifera; electronic components, semi-conductors, crystals, switches, precision potentiometers; optical parts, lenses, plastic contact lenses, eyeglasses; timing mechanisms; small gear trains; miniature printed circuit boards; and hundreds of other items.

In seconds you can remove:

rust, oxides, shop dirt, dust, lint, preservatives, finger prints, machining chips, extrusion lubricants, paraffin, wax, paint, varnish, lacquer, plastic residue, resists, silicones, greases, cooked food residue, blood, plaster of paris, lapping compounds, carbon, radioactive particles, polishing compounds, shale, diatomite, volcanic tuffs, clay and sand, graphite, starches, cutting oils, heat treat scale, color stains, foundry sand, abrasives, quenching oil, salts, pitch, asphalt, tar, inks, adhesives, jewelers rouge, tripoli, resin flux, acid flux, many others.

The DiSONtegrator is VERSATILE

In addition to super speed, surgical precision cleaning it can be used to: brighten, quench, degrease, impregnate, decontaminate, pickle, etch, dip coat, emulsify, degas liquids, anodize, dye, mix, accelerate reactions.

Ultrasonic cleaners are widely used

in production lines, maintenance departments and laboratories. You should have at least one DiSONtegrator if your field is Electronic, Optical, Glass, Clinical, Biological, Textile, Oil, Food, Paper, Dental, Plastic, Drug, Rubber, Wood, Chemical, Isotope, Geological, Agronomical, Metallurgical, Anthropological, Paleontological, Petrochemical, Ceramics, Dairy, Brewery, Beverage, Confectionery, Laboratories, Photographic, Paint, Bottling, Cosmetic, Pharmaceutical, Metal Working, Metal Finishing, Die-Casting, Foundry, Plating, Metal Treating, Automotive, Aircraft, Horological, Jewelry, Medical, Marine, Mining, Utilities, Power Plants, Instrumentation.

ultrasonic industries INC.
141 ALBERTSON AVENUE · ALBERTSON, L. I., N.Y.
Pioneer 1-4333

INTRODUCTORY OFFER

Money Refunded (less shipping charges) if not completely satisfied.

Guarantee

The DiSONtegrator you have just received
is the finest ultrasonic machine made. It
has passed a rigid inspection and found to
be in perfect condition. Read your instruc-
tion manual carefully. Properly handled,
this equipment wil exceed your expecta-
tions and render long service.
A free 5 year service policy is included
with this purchase. No charge for replace-
ment parts first two years. Tubes carry 90
day guarantee. Service and parts required
after the expiration of the guarantee will
be furnished at prevailing factory prices.

5-DAY TRIAL

We will pay all shipping charges to any point within the continental limits of the United States (not including Alaska and Hawaii), if you enclose check with order.

UNPRECEDENTED FREE 5 YEAR SERVICE CONTRACT

The **DiSONtegrator — System Forty** is available from stock for immediate delivery in unlimited quantities.

SPECIFICATIONS

GENERATOR INPUT: 117 V, 60 cycle—GENERATOR OUTPUT: 40 W, 90 KC
DIMENSIONS: GENERATOR: 10" L x 7" W x 5¾" H
Tank (overall): 6¼" L x 7" W x 6½" H
Tank (inside): 5¼" L x 5¾" W x 4" D
Tank (capacity): 0.5 gal.

FOR THE FIRST TIME — you have a choice of 6 beautiful decorator colors to harmonize with your office or laboratory decor: **Ivory, Wheat yellow, Turquoise, Desert sand, Pale green and Soft gray.** Please specify color when ordering.

ORDER NOW

TO: Ultrasonic Industries, Inc., Dept. 1-EI-3
141 Albertson Avenue, Albertson, L. I., N. Y.

Gentlemen: Please ship ________ DiSONtegrator® System Forty
Unit(s) @ $99.95 ea.: ☐ Ivory ☐ Wheat yellow ☐ Turquoise ☐ Desert sand ☐ Pale green ☐ Soft gray

to: ____________________________________

____

____

I understand that my money will be refunded if not completely satisfied after 5 day trial.

☐ check enclosed (freight prepaid) ☐ C.O.D.
☐ bill me (rated firms only) ☐ Please put us on your mailing list

Circle 15 on Inquiry Card


New "Beam-X"* switch
outperforms all

solid state, vacuum & magnetic devices

IN MULTIPOSITION SWITCHING, COUNTING AND DISTRIBUTING

A technological breakthrough in the design of Beam Switching Tubes eliminating external magnets and shields has resulted in a low cost revolutionary device. *BEAM-X** outperforms all existing solid state, magnetic and vacuum components for electronic switching applications. In aircraft, missile, commercial instrumentation, control systems and other industrial applications, *BEAM-X** offers far superior design flexibility and reliability than existing conventional components. *BEAM-X** type BX-1000 is the first of a new family of multiposition electronic switches.

THE *BEAM-X IS AN ALL-ELECTRONIC MULTIPOSITION SWITCH**

The *BEAM-X eliminates**

Multicomponent size

Multicomponent weight

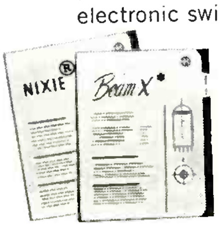
Multicomponent power

Multicomponent cost

and

Multicomponent unreliability

See us at I.R.E. Booth 1211-1213-1215



WRITE TODAY FOR TECHNICAL BROCHURE DESCRIBING THE OPERATION AND COMPLETE MECHANICAL AND ELECTRICAL APPLICATION DATA OF THIS NEW BURROUGHS *BEAM-X** SWITCH.

ANOTHER ELECTRONIC CONTRIBUTION BY

Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

Circle 16 on Inquiry Card

BEAM-X* APPLICATIONS:
COUNTING • CODING • DISTRIBUTING • CONVERTING • GATING • MULTIPLEXING • SWITCHING
TIMING • SAMPLING • MEMORY • MATRIXING • PRESETTING • DECODING • DIVIDING

*TRADEMARK OF BURROUGHS CORPORATION

Tele-Tips

DRUG STORE TUBE CHECKERS are taking a painful bite out of the income of the radio-tv servicing industry. The latest survey shows that only 54% of set owners are now turning to local service shops when they have trouble. More than 35% use drug store tube checkers. And more than 60% of those who use store checkers claim they are satisfied with the results.

SPEAKING OF "OBSOLESCENCE", Fermi's 200-ton atom smasher, originally installed at Chicago U., is for sale. It's only 10 years old.

MORE ENGINEERS come from the lower economic classes than any other group of college graduates—except education majors. Over 50% of the engineering students who won awards in the National Merit Scholarship Program have fathers in the manual and lower-middle class occupations.

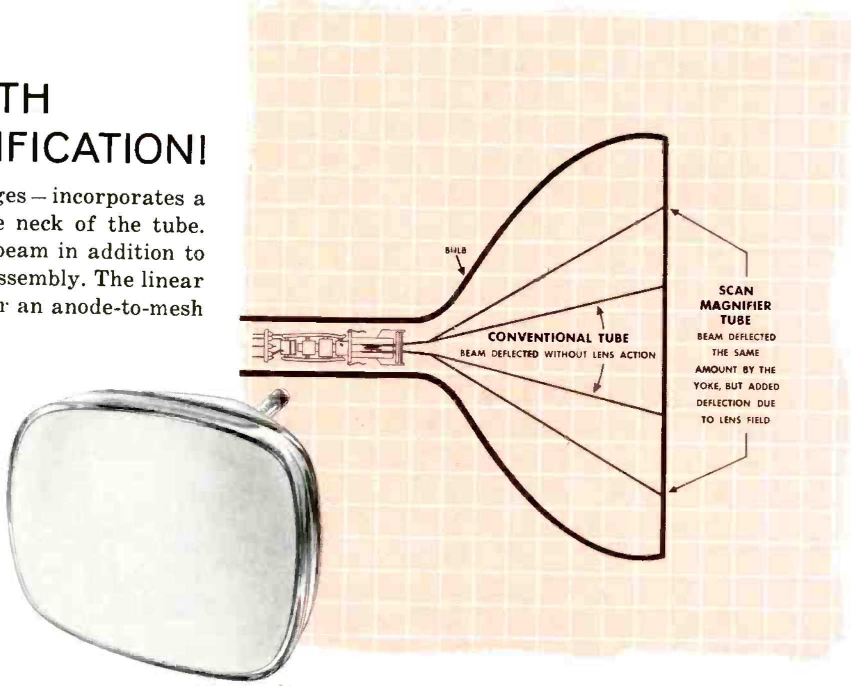
MOON FLIGHTS should concentrate on putting a man on the moon, and getting him back, says Dr. Pickering of Caltech's Jet Propulsion Lab. This step would be most effective, he says, in the "cold war" for men's minds. And the "cold war" is the most important factor in all this effort at space travel.

ELECTRONIC POOL table was set up by GE to demonstrate basic analog computer techniques. The equipment demonstrated to the Association of the U. S. Army how electronic equipment is used in solving intercept problems for the military. A portable pool table was redesigned so that a ball was fired down the length of the table in variable angles. Two photo cells relayed the time required for the ball to pass between them to the computer. The computer then calculated the velocity and position of the target ball and determined the proper time to automatically release and intercept the ball. The idea was to show how a computer can be used in missile defense or aircraft interception.

(*Continued on page* 46)

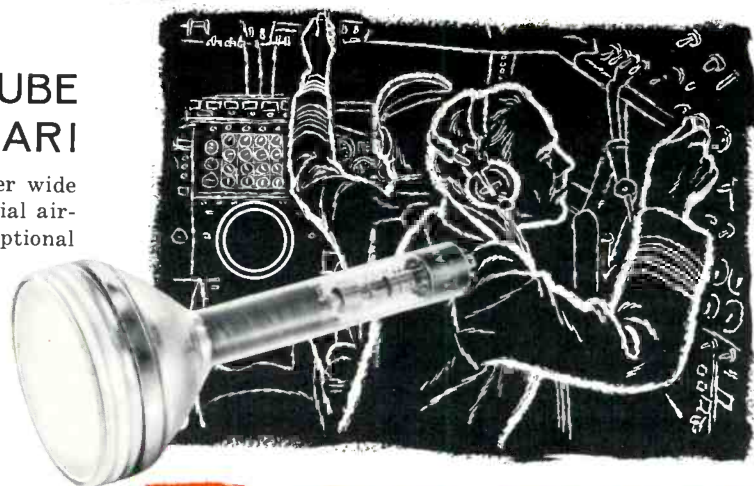
NEW—PICTURE TUBES WITH ELECTRONIC SCAN-MAGNIFICATION!

SYLVANIA ST-2836A—now in the developmental stages—incorporates a mesh-like diverging-lens assembly positioned in the neck of the tube. Its function is to provide deflection of the electron beam in addition to that accomplished by the magnetic field of the yoke assembly. The linear magnification of scan is in the order of two times for an anode-to-mesh voltage ratio of 2 to 1. The primary benefit of such a technique is in the reduction of horizontal-deflection power requirements. It is anticipated that this power requirement may be reduced in practice to as much as 60% of that required for conventional 110° picture tubes. Engineering samples with *low-power heaters* (1.5-volts @ 140 ma., or 12.6-volts @ 150 ma.) and/or low Eg_2 characteristics for a *complete* low-power picture tube are also available. For technical data and further information on SYLVANIA experimental-design SCAN-MAGNIFIED PICTURE TUBES, contact the Sylvania Field Office nearest you.



NEW—HIGH-VISIBILITY 'SCOPE TUBE FOR AIRBORNE WEATHER RADAR!

SYLVANIA SC-2854 provides improved image brilliance under wide ambient light conditions encountered in cockpits of commercial airliners. The color of the phosphor of this new tube gives exceptional image visibility to dark-adapted as well as to light-adapted eyes. Resolution, too, is exceptionally high. *Sylvania SC-2854* makes possible simplified equipment designs, improved volumetric efficiency and increased life-expectancy of the indicator tube, resulting in reduced costs of installation and maintenance of airborne weather-radar equipment. For details on price and delivery, contact your Sylvania Field Office.



NEW—C.R.T.'S FOR HIGH-ALTITUDE OPERATION TO 70,000 FEET!

Sylvania now makes available a group of direct-view cathode-ray tubes designed specifically for applications in airborne ECM, Radar, and Loran equipment intended for operation at high altitudes. All types feature high quality, nearly flat pressed-glass faceplates. This provides exceptionally clear display and excellent bulb strength. Connections to internal elements are made through insulated leads, encapsulated at points of entry to the bulb. This technique significantly reduces the possibility of corona and arc-over at high altitudes. See data below.

SYLVANIA 5CVP1, 5CVP7, 5CVP19 . . . feature 2¾" x 4¾" direct-view faces, magnetic deflection, electrostatic focus.

MAXIMUM RATINGS (Absolute Maximum Values)

Anode Voltage	4500 Volts dc
Anode Input	6 Watts
Grid No. 4 Voltage (Focusing Electrode)	—500 to +1100 Volts dc
Grid No. 2 Voltage	550 Volts dc
Grid No. 1 Voltage	
Negative Bias Value	165 Volts dc
Positive Bias Value	0 Volts dc
Positive Peak Value	2 Volts
Peak Heater-Cathode Voltage	
Heater Negative with Respect to Cathode	180 Volts
Heater Positive with Respect to Cathode	180 Volts
Altitude	70,000 Feet
Operating Temperature Range	—65 to +85°C

SYLVANIA 3BEP1, 3BEP-* . . . feature 1½" x 3" direct-view faces, electrostatic focus and electrostatic deflection. (-* can be supplied with several other screen phosphors.)

MAXIMUM RATINGS (Absolute Maximum Values)

Anode No. 2 Voltage	3000 Volts dc
Anode No. 1 Voltage (Focusing Electrode)	1200 Volts dc
Grid No. 1 Voltage	
Negative Bias Value	140 Volts dc
Positive Bias Value	0 Volts dc
Positive Peak Value	2 Volts
Peak Heater-Cathode Voltage	
Heater Negative with Respect to Cathode	140 Volts
Heater Positive with Respect to Cathode	140 Volts
Altitude	70,000 Feet
Operating Temperature Range	—65 to +85°C

SYLVANIA ANNOUNCES

3 NEW TUBE TYPES WITH 9-T9 OUTLINE!

New **17HC8, 6HC8** and **7695** offer important advantages inherent in the Sylvania unique 9-T9 design. Utilizing the straight-sided, 9-T9 bantam outline with its miniature 9-pin circle, these three types afford significant opportunities for compactness. The 9-T9 outline eliminates the octal base of the T9 and makes possible the use of tube structures capable of high plate dissipation in printed-circuit boards. This is accomplished with conventional 9-pin sockets widely used in printed circuits.

9-T9 increases volumetric efficiency of the chassis by eliminating the octal base of the T9 outline.

9-T9 enables the use of large tube-assemblies in those stages where higher power-dissipation capabilities of the tube are a design necessity to enhance reliability.

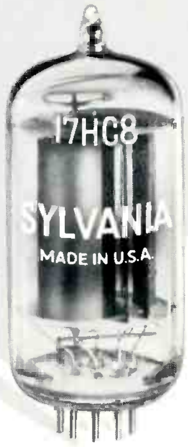
9-T9 maintains compactness of the equipment formerly afforded by tubes fitted with T6-½ header.

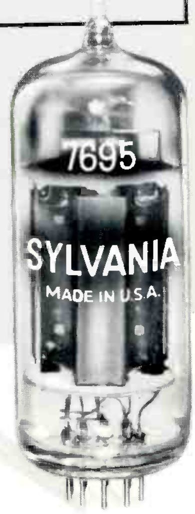
Sylvania 17HC8 is a triode-pentode designed for use as a vertical deflection oscillator and vertical deflection amplifier in 110° deflection circuits of TV receivers. Controlled for heater warm-up time, it is especially useful in 450mA series string operation. The pentode section has a plate dissipation of 11 watts. Structure of the 17HC8 includes an internal shield to reduce interaction of the elements. The 6HC8 is identical to the 17HC8 except for heater power requirements. In addition to normal 100% tests for shorts, continuity, plate current, gas, pentode screen current, heater cathode leakage, gm and triode cutoff, both types are tested 100% for peak plate and screen current, ratio of peak plate current to screen current, and microphonics.

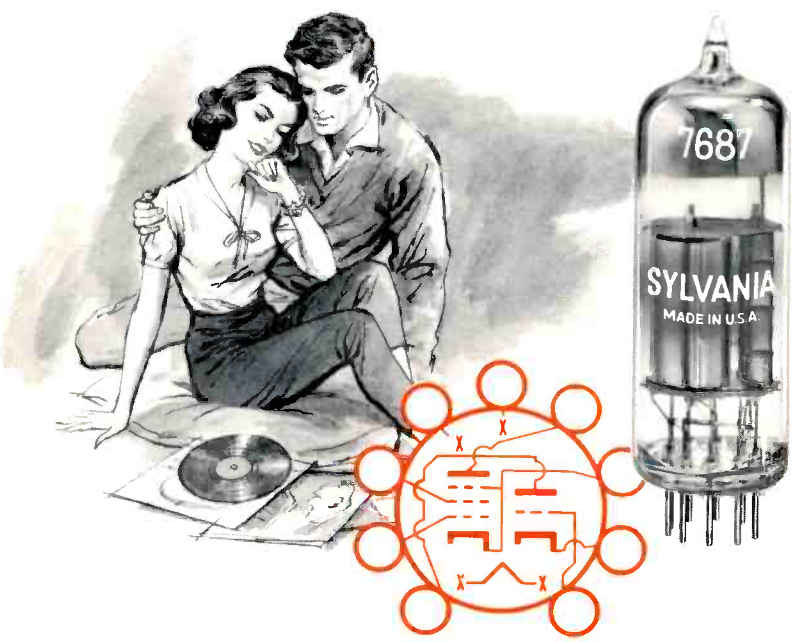
Sylvania 7695, beam power pentode, features remarkably high power sensitivity as an audio frequency amplifier. In Class A1 operation, it can deliver 4.5 watts of power with a B+ voltage of only 130 volts. As a result, the 7695 makes possible economies in power supply requirements.

SYLVANIA 7695 — Characteristics and Typical Operation

Class A1 Amplifier	Fixed Bias	Self Bias
Plate Voltage	130 Volts	140 Volts
Grid No. 2 Voltage	130 Volts	140 Volts
Grid No. 1 Voltage	—11 Volts	—
Cathode Resistor	—	100 Ohms
Peak AF Grid No. 1 Voltage (RMS)	11 Volts	8 Volts
Zero Signal Plate Current	95 mA	100 mA
Max. Signal Plate Current	100 mA	100 mA
Zero Signal Grid No. 2 Current	5 mA	5 mA
Max. Signal Grid No. 2 Current	13 mA	14 mA
Transconductance	11,000 μmhos	11,400 μmhos
Plate Resistance (approx.)	6,900 Ohms	6,800 Ohms
Load Resistance	1,100 Ohms	1,100 Ohms
Max. Signal Power Output	4.5	4.5
Total Harmonic Distortion (approx.)	11 Percent	11 Percent







NEW HI-FI TYPE

SYLVANIA 7687

CONTROLLED FOR LOW HUM

The new 7687 is a 9-pin miniature triode-pentode controlled for hum, noise and microphonics. It's a hard worker in tone-control amplifiers, phase splitter and high-gain voltage amplifier circuits, yet it does its job without even "breathing audibly." Sylvania 7687 structure is rigidly mounted to reduce noise and microphonic effects. It features a cooler-operating cathode to assure low hum. Further assurance of low hum is provided by the use of a coil heater made of specially developed materials. The triode section has an equivalent hum and noise level of 7.5 microvolts, the pentode only 10.5 microvolts. Investigate the possibilities of a cooler-operating tube with unusually low hum and long life expectancy for your compact high-fidelity design. The Sylvania 7687 merits your interest.

SYLVANIA "GLEAM" PROJECT COMBATS TUBE CONTAMINANTS, INCREASES TUBE RELIABILITY

Project "Gleam" further increases Sylvania tube reliability by eliminating lint and dust particles in factory operations. Fifteen years ago, Sylvania took its first air-purification measures to reduce contaminants that can result in early-hour tube failure. "Gleam" has gained impetus until it now includes the use of air conditioning in factories, lint-free clothing, individual hooded worktables, enclosed cloakrooms, methanol welding to eliminate splash particles, lint-free parts-containers, and specially processed getter material which resists flaking and spattering. Like many technological advancements, the "Gleam" Project will never be wholly complete. It is constantly undergoing change and improvement to maintain the Sylvania name for unsurpassed quality.

Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, New York.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

NEW!...FROM CONTINENTAL CONNECTOR

152 CONTACT

CENTER SCREWLOCK CONNECTOR WITH PROVEN RELIABILITY

MINIATURE POWER CONNECTORS FOR HEAVY DUTY APPLICATIONS—Again Continental Connector meets the challenge for reliability and high precision in critical electronic equipment with these new center screwlock plug and socket connectors. They are designed for heavy duty applications requiring high dielectric and mechanical strength, partially achieved by the use of a body material molded from glass filled Diallyl Phthalate (MIL-M-19833, Type GDI-30). The double lead thread action center screwlock and stainless steel channels are extra features that contribute to the rugged construction and performance-proven reliability.

Positive polarization is assured with reversed male and female guide pins and guide sockets. In addition to the wire wrap termination illustrated, solderless taper pin or solder cup terminals can also be supplied. Note: these connectors are also available in sizes of 104, 78 or 34 contacts.

CLOSED ENTRY CONTACTS provide increased reliability and maintain a low millivolt drop under constant and uniform insertion pressure.

For complete specifications on Continental Connector's new Series 1900, write to the Electronic Sales Division, DeJUR-AMSCO CORPORATION, 45-01 NORTHERN BOULEVARD, Long Island City 1, N. Y. (Exclusive Sales Agents)

CONTINENTAL CONNECTORS

MANUFACTURED BY CONTINENTAL CONNECTOR CORPORATION, AMERICA'S FASTEST GROWING LINE OF PRECISION CONNECTORS

"Wire-Wrap"—registered trademark of Gardner-Denver Company

SEE US AT THE IRE SHOW BOOTHS 2307-2309

← Circle 19 on Inquiry Card

Circle 20 on Inquiry Card

Tele-Tips

(*Continued from page 40*)

JAPANESE ENGINEERS indignantly denied reports that their new 1,091-ft. TV tower was leaning toward the south. But a number of cameramen who snapped the 10-month old structure just as adamantly claimed that their pictures show it definitely leaning tc one side. The chief engineer on the tower insists that it is an optical illusion, but promised to drop a plumb just to make sure.

A UNIQUE SCALE was demonstrated at the international industrial exposition in Brno, Czechoslovakia. It weighs minute portions of substances, reportedly with an accuracy of 1 and 10^{-6} gms.

"JUKE BOXES" are being designed at Univ. of Michigan that will help students learn French, Spanish and other modern languages. By simply dialing a telephone-like device the student will pick out any one of a wide variety of foreign language recordings. A first year French course, for instance, contains more than 800 different short lessons. Any one can be dialed by the student at any time.

NEW STANDARDS have been established by NBS for measuring the candlepower of electric lamps. They consist of 100-, 300-, and 500-watt lamps with inside-frosted T-20 bulbs, C-13 monoplane filaments and medium-bipost bases.

A RADIO TELESCOPE with an antenna from 1,000 to 2,000 ft. in diameter is something that astronomers must have in the next few years, says Prof. Harold Weaver, of the Univ. of California at Berkely.

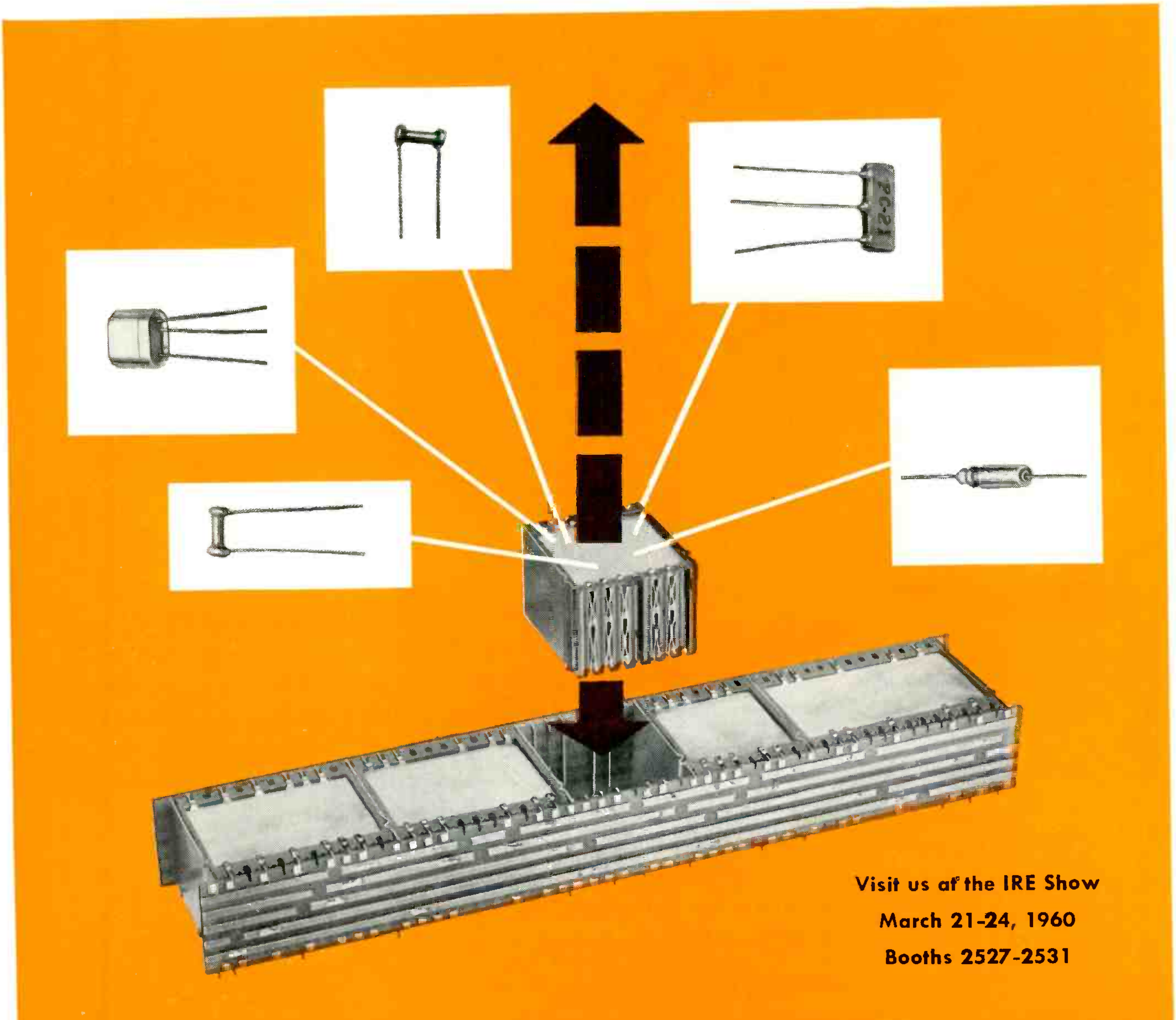
PROJECT VANGUARD is getting some belated recognition. Three Vanguard satellites are now out in space. Vanguard I is expected to remain in orbit about 2,000 years. Vanguard II's predicted life span is 200 years, while Vanguard III should be in orbit at least three decades.

NOW! 3-D PROGRAMED CIRCUITS!

with "Put 'N Take" servicing of individual functions

Here's a major new concept in interconnecting circuitry that offers the most advanced approach to reliability and maintainability—the AMP MECA (Maintainable Electronic Component Assembly). With MECA, you simply encapsulate your components in replaceable AMP-CELLS which are then plugged into AMP's 3-D Circuit Boards. Result: Instant servicing by substitution and throwaway.

The AMP-CELLS can grow or shrink in 3 dimensions on the 0.1 or 0.2 grid system. Hand, semi, or completely automatic tape programming produces these simple 3-D circuits. The AMP-CELL contacts do not protrude, cannot be damaged by abusive handling. All AMP-CELLS are wholly contained within the 3-D Circuits—totally secured to resist vibration and physical damage.



For a complete description of this important new product, send for our MECA brochure.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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

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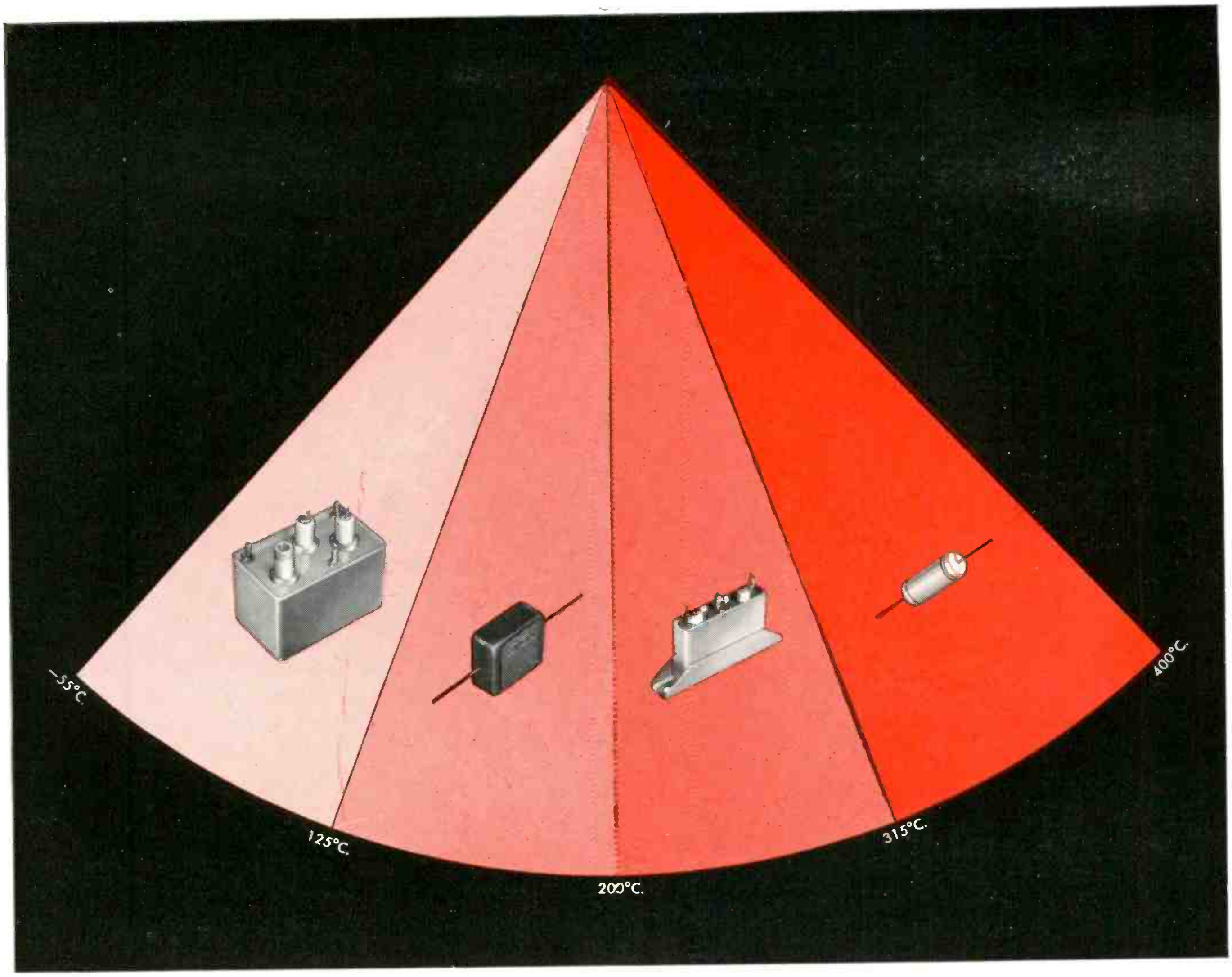


BENDIX CAPACITORS COVER A FULL TEMPERATURE SPECTRUM

ALL FEATURE THESE IMPORTANT ADVANTAGES:

Environmental resistance
No voltage derating

Wide voltage range
Solid impregnants

High I. R.
Wound mica papers

Radiation resistant
Exceptional stability

Under 125°C.—Specials
• Size and weight reductions at high voltages • Drift—.25% capacitance change typical from −55°C. to +125°C. • High I. R.—1500 megohm X microfarads typical at 125°C. • Solid impregnants—no liquid leakage.

125°C. to 200°C.—Available soon
• .001 to 6.0 mfd., 200 V to 3 KV, specials to 10 KV. • Molded and metal housed; tubular and rectangular • Size and weight reduction—over plastic film and stacked mica types, particularly at high voltages • Drift—1% capacitance change typical from −55°C. to +200°C. • High I. R.—50 megohm X microfarads typical at 200°C. • Proved in 4 years' usage.

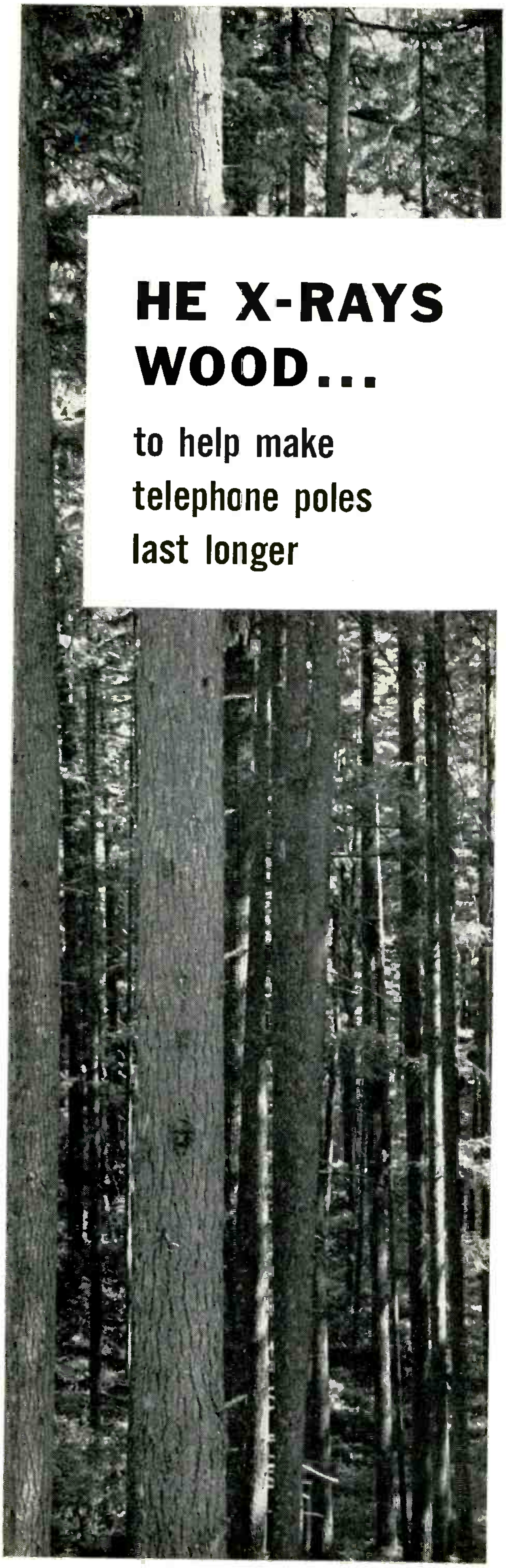
200°C. to 315°C.—In production
• .05 to 4.0 uf, 600 V and up • Drift—3% capacitance change typical from −55°C. to +315°C. • High I. R.—10 megohm X microfarads typical at 315°C. • Nothing smaller at 315°C.

315°C. to 400°C.—In development
• .001 to 6.0 uf, 150 V and 600 V • Drift—5% capacitance change typical from −55°C. to +426°C. • High I. R.—1 megohm X microfarad typical at 400°C. • Prototype availability • Only inorganic materials used.

For full details, write:
Scintilla Division
Sidney, New York

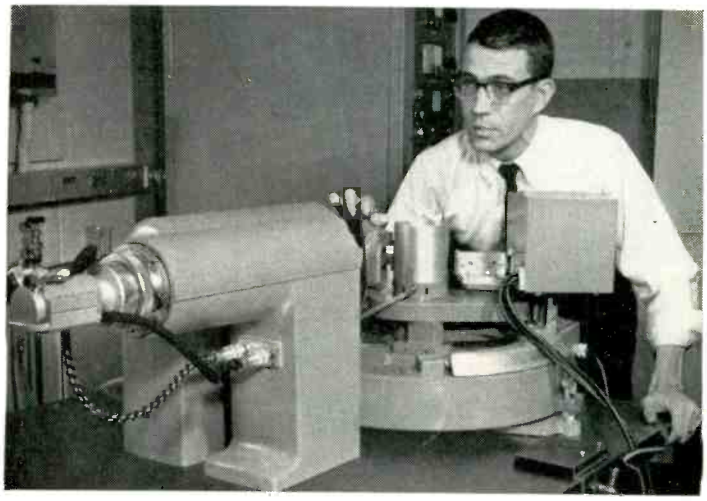
Bendix AVIATION CORPORATION

Circle 24 on Inquiry Card



HE X-RAYS WOOD...

to help make telephone poles last longer



Chemist Jack Wright developed the use of this X-ray fluorescence machine for testing the concentration of preservatives in wood. Here he bombards a boring from a test telephone pole with X-rays.

This Bell Labs chemist is using a fast, new technique for measuring the concentration of fungus-killing preservative in telephone poles.

A boring from a test pole is bombarded with X-rays. The preservative—pentachlorophenol—converts some of the incoming X-rays to new ones of different and characteristic wave length. These new rays are isolated and sent into a radiation counter which registers their intensity. The intensity in turn reveals the concentration of preservative.

Bell Laboratories chemists must test thousands of wood specimens annually in their research to make telephone poles last longer. Seeking a faster test, they explored the possibility of X-ray fluorescence—a technique developed originally for metallurgy. For the first time, this technique was applied to wood. Result: A wood specimen check in just two minutes—at least 15 times faster than before possible with the conventional microchemical analysis.

Bell Labs scientists must remain alert to *all* ways of improving telephone service. They must create radically new technology or improve what already exists. Here, they devised a way to speed research in one of telephony's oldest and most important arts—that of wood preservation.

Nature still grows the best telephone poles. There are over 21 million wooden poles in the Bell System. They require no painting, scraping or cleaning; can be nailed, drilled, cut, sawed and climbed like no other material. Scientific wood preservation cuts telephone costs, conserves valuable timber acres.

BELL TELEPHONE LABORATORIES

World Center of Communications Research and Development

AS MISSILES GO EVER HIGHER temperatures go down and down

Here's how the problem is met by
KEYSTONE THERMISTORS

Just as surely as missiles are going higher and higher, the demand is for Thermistors to operate at lower and lower temperatures. Sooner or later, such demands are being met by the research people at Keystone.

Ten years ago the low temperature range for Thermistors was approximately —50°C. Then a new area of interest was born—still lower temperature operation. By 1955 we had developed units that were useful down to —183°C. Today we are delivering units for applications operating at —260°C (below liquid hydrogen) for use in space as liquid level indicators or as flow control mechanisms. Our Thermistors are also working in gas liquefaction apparatus with fluorine, argon, oxygen, etc. and in the petrochemical industry with methane. New missiles, new products, and the whole new field of Cryotronics challenge us to even lower temperature response. Degree by degree we make progress toward lower temperatures and maximum reliability within the precision tolerances and wide selection of temperature coefficients in which we work.

There may be a low temperature indication or control problem in your present product, or, more likely, in a product you're thinking about for the future. Here at Keystone we're working on both today's and tomorrow's problems and we would like to hear about yours.
Glad to have you call us, anytime.

Keystone
CARBON COMPANY
Thermistor Division • St. Marys, Pa.

Circle 26 on Inquiry Card

Letters

to the Editor

"Strain Calibrator"

Editor, ELECTRONIC INDUSTRIES:

We have noted with considerable interest an article entitled "A Dynamic Strain Calibrator" in the issue for December, 1959.

We would like to point out that the Instruments Division of The Budd Company has been marketing Tatnall MetalFilm strain gages for about two years. These bonded resistance gages, manufactured from extremely thin special alloy foils, have received wide acceptance in the most critical applications. We are enclosing a recent catalog which describes about 125 gage types in one particular series. At the present time, our complete gage line consists of almost 300 types.

The foil strain gage is described in the article as a recent British development. While the British were among the first to experiment with this form of resistance gage, the United States is responsible for its present advanced state of development. The MetalFilm gage is now being distributed in Europe as well as the U. S., and will shortly be available in England.

J. E. Starr
Product Manager
Instruments Division of the Budd Co.
P. O. Box 245,
Phoenixville, Pa.

"Thanks . . ."

Editor, ELECTRONIC INDUSTRIES:

Enclosed is a U.S. Postal Money Order for $1.00 for a copy of "THE ELECTROMAGNETIC SPECTRUM —1960" which is desired for this office.

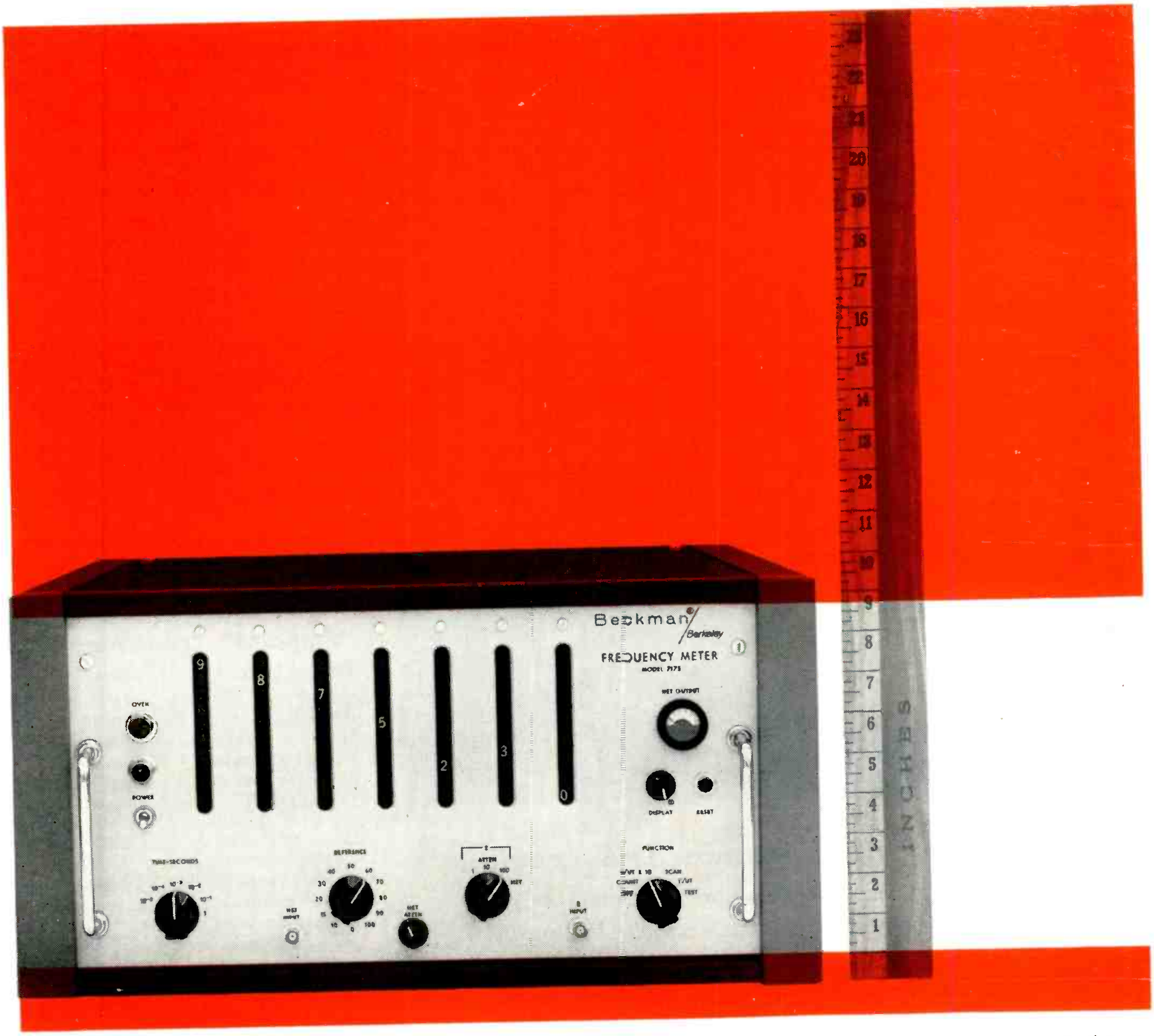
Also request that this office be furnished with the following copies of articles from back issues of ELECTRONIC INDUSTRIES.

(Writer lists 35 articles.)

Any consideration that you may show me in this matter will be extremely appreciated. It is only through your magazine that we are able to obtain writings of such high value to us which enables up to keep up to date within the electronics field in practical usage.

Gerald P. Germaine,
Technical Advisor,
Chief, Munich Office
U. S. Army Technical Information Office
Munich Field Office,
A.P.O. 407, New York

(*More "Letters" on page* 54)



Measure 10cps to 110Mc with one compact meter

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

Write for technical bulletin on Model 7175.

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

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

Beckman® | *Berkeley Division*
Richmond, California

T24

Circle 28 on Inquiry Card

Letters

to the Editor

"DC Restoration"

January 20, 1960

Editor, ELECTRONIC INDUSTRIES:

The article "The Case for D. C. Restoration" in the January issue is an excellent presentation of a little understood problem in TV transmission.

There is one slight error in the diagram: Figure 3 should be Figure 9 and vice versa.

Richard W. Crane,
Quality Control Operations Engineer

CBS Television Network,
485 Madison Ave.,
New York 22, N. Y.

Ed: Thanks for the bouquet, and for pointing out the error. And thanks, too, to the many, many other readers who also wrote in to point out the mistake.

"Pinpoint" Trademark

Editor, ELECTRONIC INDUSTRIES:

We note in your December, 1959 issue, page 5 of ELECTRONIC INDUSTRIES, a reference to a device "Pinpoint Pathfinder."

Please be advised that the term "PINPOINT" is a registered trademark of Goodyear Aircraft Corporation (registration No. 688,274), for "Automatic Guiding Systems for Aerial Vehicles and Parts Thereof."

We would appreciate the exercise of care on your part in not misusing our trademark.

J. G. Pere,
Patent Attorney

Goodyear Aircraft Corp.,
Akron 15, Ohio

Ed: Our sincere apologies!

"Coming Events Calendar"

Editor, ELECTRONIC INDUSTRIES:

The "1960 Coming Events Calendar" on pages 149-164 of the December issue of ELECTRONIC INDUSTRIES is an extremely handy and useful compilation. Various persons at ITTL will find it useful for planning our company's participation in these events.

On page 163 you make an offer to supply reprints. Could we have some—perhaps as many as one or two dozen? We would gladly pay any cost involved.

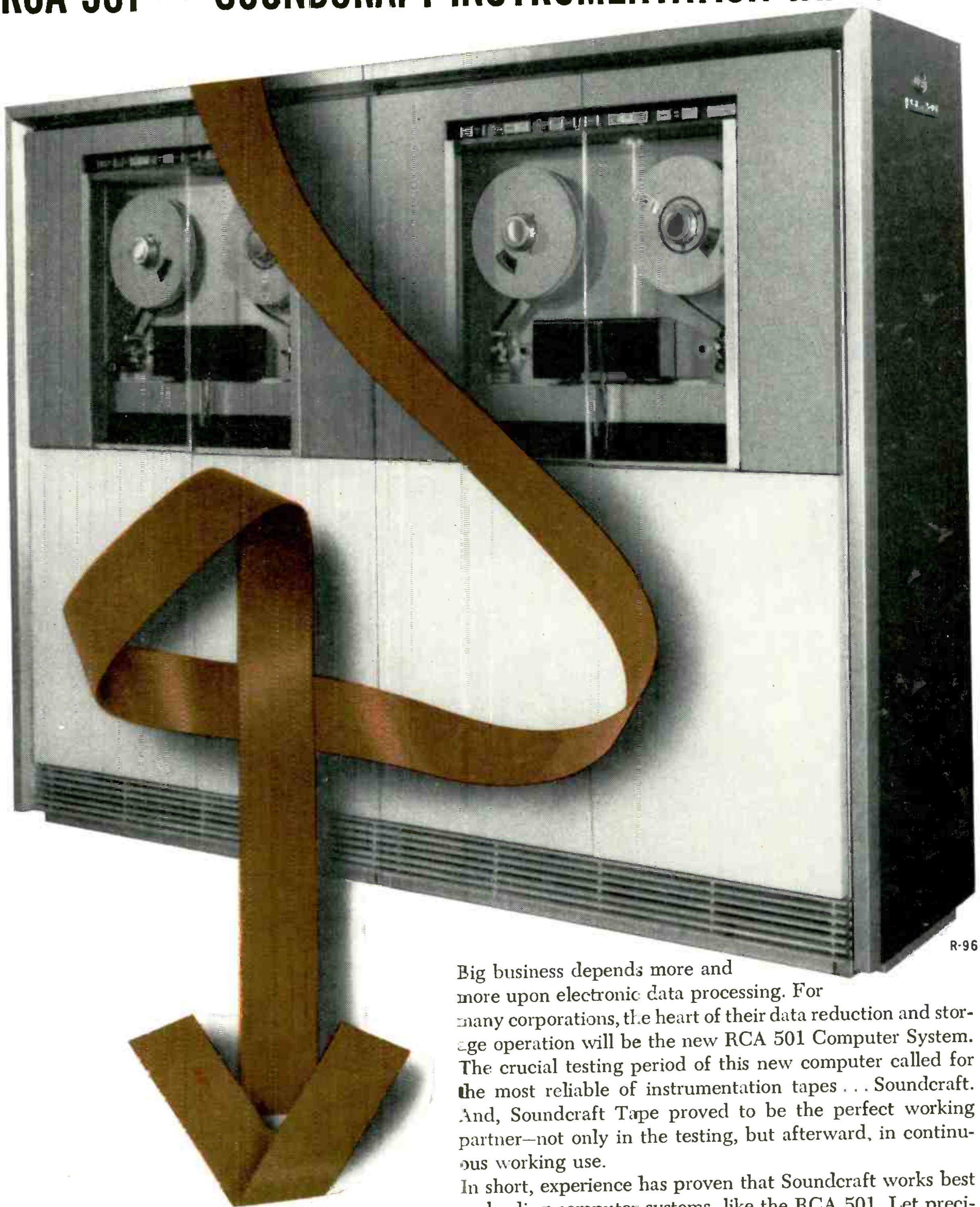
Robert I. Colin,
Administrative Assistant to the Vice-President

ITT Laboratories,
500 Washington Ave.,
Nutley 10, N. J.

Ed: We are happy to supply reprints of the "1960 Coming Events Calendar" in limited amounts.

WORKING PARTNERS

RCA 501 — SOUNDCRAFT INSTRUMENTATION TAPES



Big business depends more and more upon electronic data processing. For many corporations, the heart of their data reduction and storage operation will be the new RCA 501 Computer System. The crucial testing period of this new computer called for the most reliable of instrumentation tapes . . . Soundcraft. And, Soundcraft Tape proved to be the perfect working partner—not only in the testing, but afterward, in continuous working use.

In short, experience has proven that Soundcraft works best on leading computer systems, like the RCA 501. Let precision-made, trouble-free, error-free Soundcraft Instrumentation Tapes go to work for you. *Complete literature on request.*

REEVES SOUNDCRAFT CORP. Great Pasture Rd., Danbury, Conn. • Chicago: 28 E. Jackson Blvd. Los Angeles: 342 N. LaBrea • Toronto: 700 Weston Rd.

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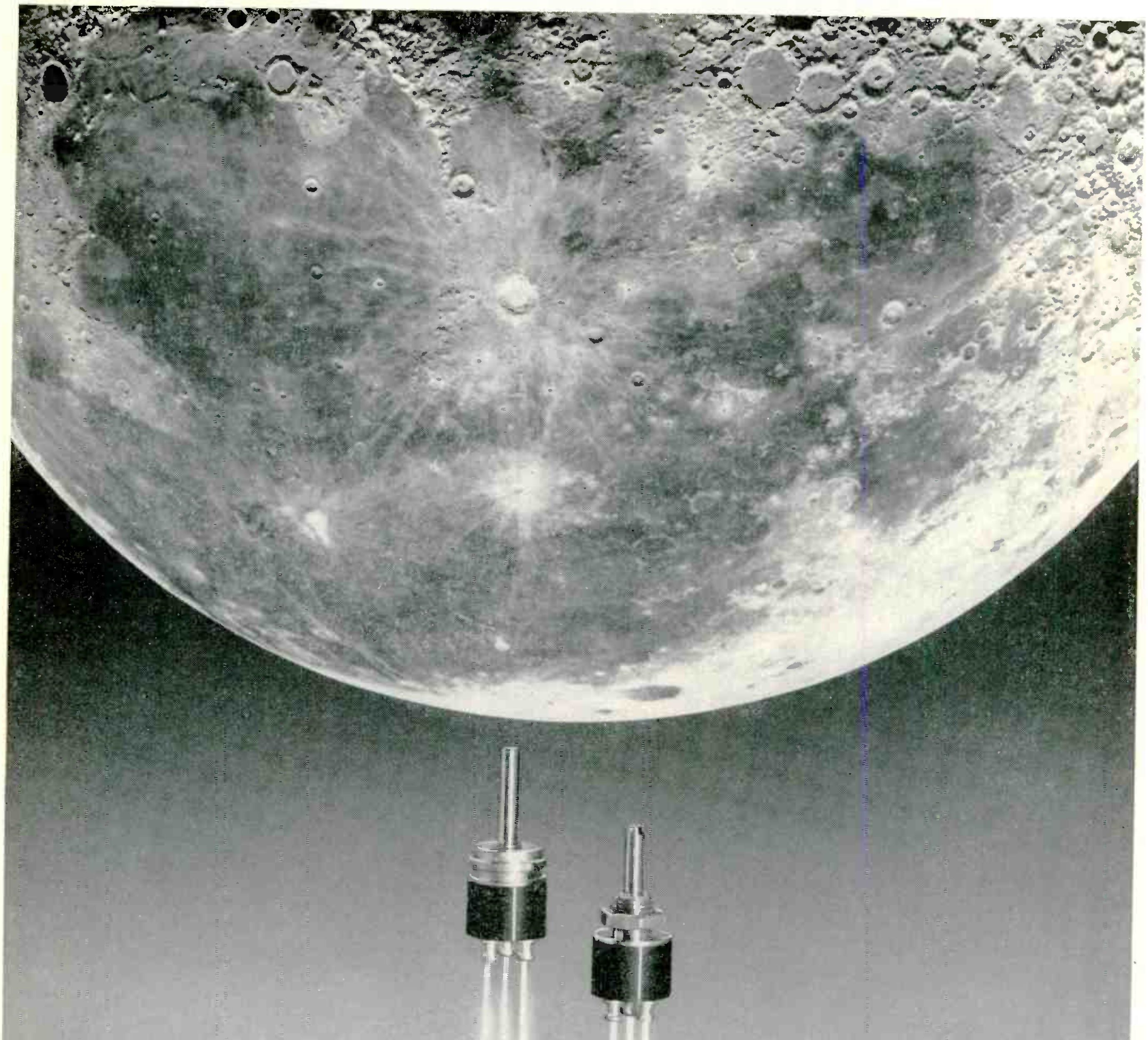


Waters new pots conquer space

Two new 1/2" Waters pots conquer a space problem for many a harassed space age engineer. Both require up to 25% less space behind the panel than pots having identical specifications. Available with terminals (shown), wire leads or printed circuit pins. Case lengths are only 3/8". The new APS 1/2 is designed for bushing-type mounting. The WPS 1/2, designed for servo mounting, is the smallest potentiometer available for general use in rugged servo applications. Both are capable of dissipating 2 watts continuously! Reliability test reports available. Write for Bulletin APS-160.

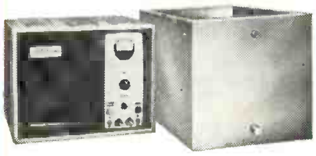
Waters
MANUFACTURING, INC.
WAYLAND, MASS.

POTENTIOMETERS • SLUG TUNED COIL FORMS • RF COILS • CHOKES • POT HOOK® PANEL MOUNTS • TORQUE WATCH® GAUGES • C'TROL METER/CONTROLLER • INSTRUMENTS

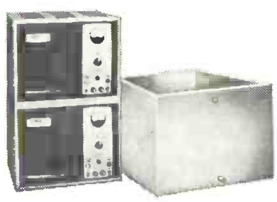
Model BC60
Capacity 1¼ gal. **$350**

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

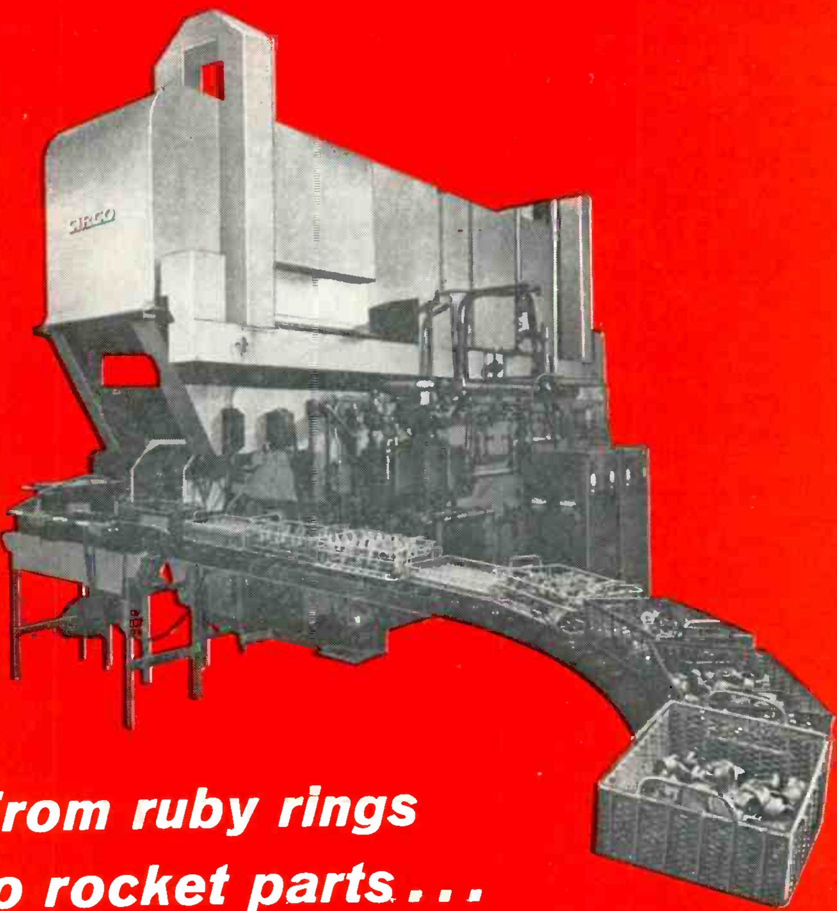
Model BC250
Capacity 5 gal. **$750**



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



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



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

. . . in seconds!

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

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

Whether you need a bench model or a huge custom-designed conveyerized system, CIRCO engineers can recommend the specific CIRCOSONIC unit to solve your problem. Write for your free copy of "Tips on Ultrasonic Cleaning".

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Specialists in Ultrasonic Energy

51 Terminal Ave., Clark, New Jersey • FUlton 8-8600

Circle 32 on Inquiry Card

Books

Progress in Dielectrics, Vol. I.

Edited by J. B. Birks and J. R. Schulman. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 312 pages. Price $11.00.

The aim of this series is to provide a common meeting point for all interested in dielectrics, to coordinate our current knowledge in dielectric phenomena, materials, and techniques, and to review recent progress in different aspects of this subject.

In the first four articles in this volume, the emphasis is on dielectric breakdown on the insulating properties of solid, liquid, and gaseous dielectrics. A comprehensive review of several mechanisms of dielectric breakdown in solid insulation is included, and the important practical question of insulation testing procedures is discussed. The intriguing and complex directional breakdown effects that occur in single crystals are described.

The book also considers the electric strength, breakdown time-lag, and high-field conductivity of dielectric liquids, with emphasis on recent systematic studies on pure hydrocarbons. The practical aspects of the use of gaseous insulation, with particular reference to the electronegative gases, are also reviewed.

Ferroelectricity is a type of dielectric behavior of particular scientific interest. The ferroelectric properties of barium-titanate crystals are classified, and the substantial progress that has been made towards a unified thermodynamic theory is described.

Introduction to Matrix Analysis

By Richard Bellman. Published 1960 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 331 pages. Price $10.00.

Three basic fields in the analysis of matrices are clearly covered in this book—symmetric matrices and quadratic forms, matrices and differential equations, and positive matrices and their use in probability theory and mathematical economics. Also presented is part of the theoretical treatment of the use of matrices in the computational solution of ordinary and partial differential equations by means of digital computers.

Each section includes discussions of the mathematical, physical, and economic backgrounds of the matrix theory introduced. Important chapters are included on dynamic programming and stochastic matrices. A large number of references to original papers containing further results are also given.

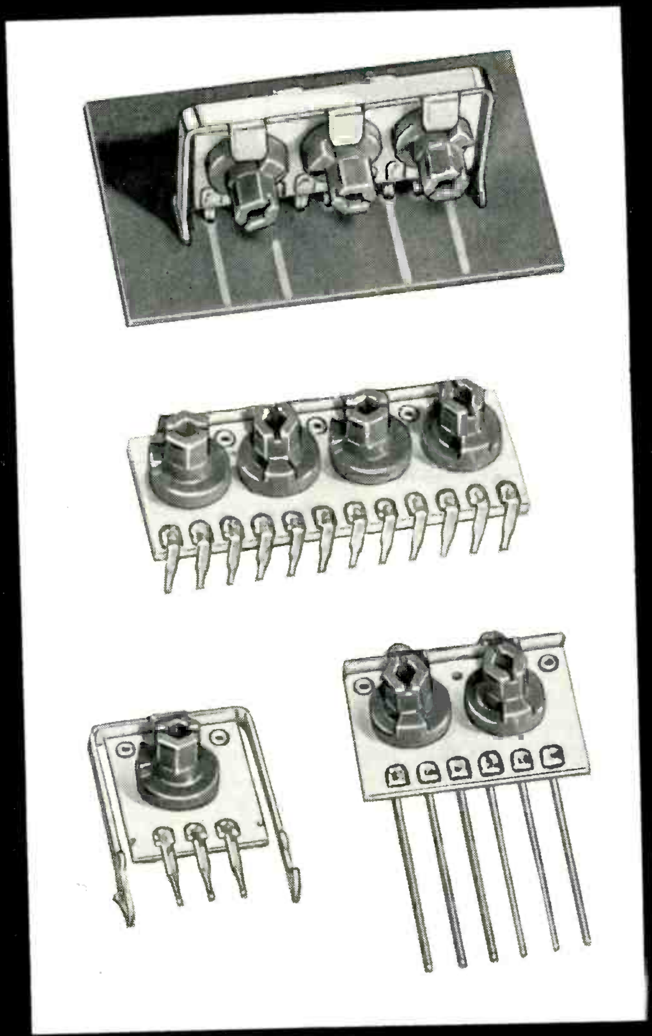
Emphasizing the parts of matrix theory that occur in analysis applications, the contents of this book are specifically slanted toward the needs of analysts, statisticians, mathematicians, mathematical physicists, engineers, and mathematical economists.

Originality in design concepts... your job...and Centralab's

Economical
Versatile
Reliable...

MODEL 5
RADIOHM®

1/4 WATT
MULTIPLE MINIATURE
VARIABLE RESISTOR
(Component Density: 16.2 per cu. in.)*



The Model 5 is a new proven design concept, not merely an improvement of an existing component. This is typical of CENTRALAB's approach to product design. It is available with up to 4 variable and 9 fixed resistors on a single steatite plate measuring 2¼" x ¾" x 15/32", including knobs . . . proportionally smaller when fewer variable resistors are required. This remarkable increase in component density is another CENTRALAB "first," setting the example for the electronics industry.

A WIDE RANGE OF MOUNTING STYLES AND TYPES

Model 5 Radiohms® are available with horizontal or vertical mounting brackets, plug-in terminals for printed circuit boards or wire leads for metal chassis.

SPECIFICATIONS

Resistance Range: 1000 ohms to 5 megohms, linear taper

Wattage Rating: ¼ watt at 70°C. ambient

Breakdown Voltage: 1250 volts RMS, between adjacent sections and to bracket

End Resistance: Less than 1% of total

Initial Torque: 2 inch ounces average

Complete specifications and design data are given in CENTRALAB Bulletin EP-539; write for your copy today.

*** Cubic inch, rather than cubic foot, is used to provide a more realistic and more readily visualized standard of comparision.**

Centralab ®
Y-5932

Electronics Division of Globe-Union Inc.
938C EAST KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: Ajax, Ontario

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

Circle 34 on Inquiry Card

FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

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

FREQUENCY STANDARD
TYPE 50L

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

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

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

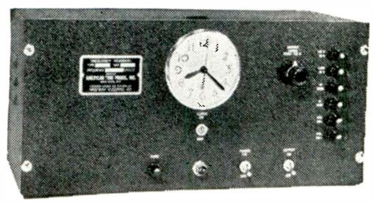
Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD — NEW
TYPE 2007-6
TRANSISTORIZED, Silicon Type

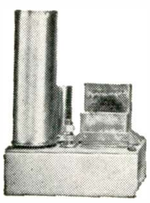
Size 1½" dia. x 3½" H. Wght. 7 ozs.

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)

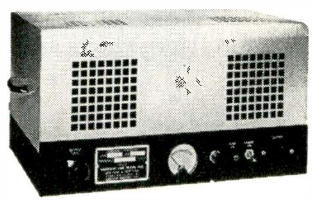


FREQUENCY STANDARD
TYPE 2001-2

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.

Circle 36 on Inquiry Card

Books

Millimicrosecond Pulse Techniques, 2nd Rev. Ed.

By I. A. D. Lewis and F. H. Wells. Published 1959 by Pergamon Press, Inc., 122 E. 55th St., New York 22. 417 pages. Price $8.50.

This work describes developments in the theory and design of electronic circuits and devices for operation in the range of time intervals which lie between the province of microsecond pulse circuits and the realm of microwave devices.

A brief theoretical introduction is included for the benefit of the non-electronic physicists and to clarify terminology. The bulk of the work is devoted to a consideration of basic circuit elements and pieces of equipment of universal application. Details of specific applications—mostly in the field of nuclear physics instrumentation—fill the last two chapters. A short bibliography and a comprehensive list of references complete the volume.

This book will be of use to the physicist who, with perhaps little experience in the electronic art, wishes to call the new techniques to his aid. For the electronic engineer, the volume aims at the collation of relevant material taken from known fields of electronic engineering, together with an account of special developments in the millimicrosecond range.

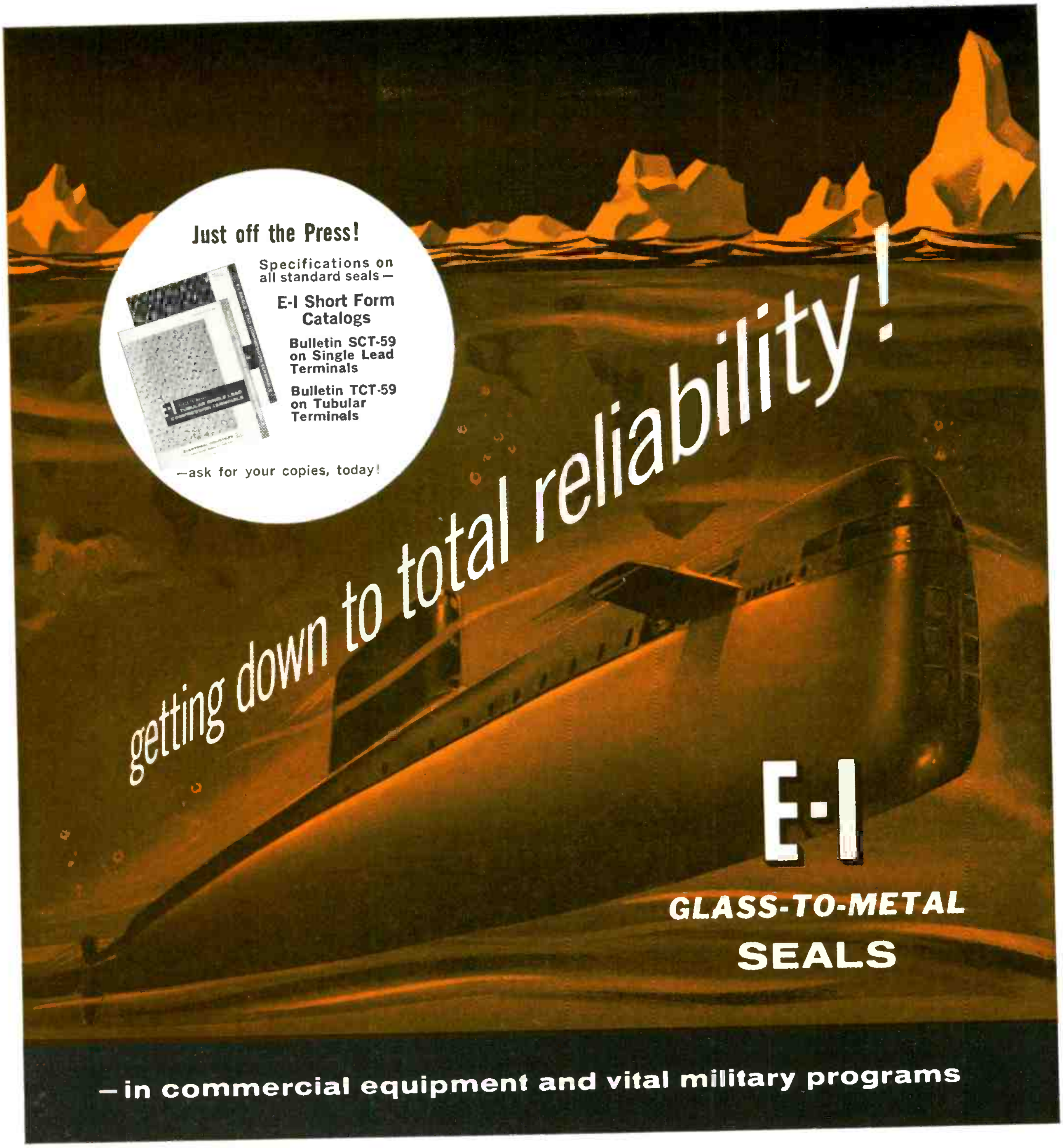
Industrial Electronics and Control, 2nd Ed.

By R. G. Kloeffler. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 540 pages. Price $10.00.

This book represents a modern approach to industrial electronics. Revised to include the latest information, it will be of interest not only to the electrical engineer, but to the mechanical and chemical engineer as well. In fact, anyone concerned with electronics and its commercial applications will find this book practical, thorough, and understandable, even if his technical background includes only physics.

This 2nd edition differs from its predecessor and from all previous texts in that it approaches the electronic theory of rectification, amplification, and oscillation through solid-state theory rather than by way of the vacuum and gaseous tubes. In addition, the author examines such recent developments as solid-state thyratrons, cryotrons, and cold cathode vacuum tubes.

Two new chapters on semiconductors have been included at the outset. The material on servomechanisms has been completely rewritten and information has been added on magnetic amplifiers, computers, and electronic measurement.



For proven reliability in severe environments, select your seals from the E-I standard line of application tested hermetic terminals. E-I offers designers the complete flexibility and economy of standardized production on all types of seals . . . from single lead terminals to sub-miniature closures. Proof of their reliability is the fact that leading manufacturers specify E-I for every type of seal application. Request catalog on standard types, or send drawings on seals for special requirements.

ELECTRICAL INDUSTRIES

A Division of Philips Electronics & Pharmaceutical Industries Corp.

MURRAY HILL, N.J.

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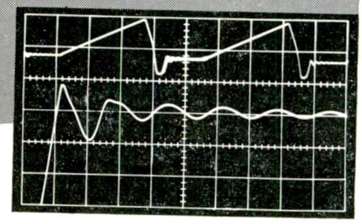
Visit Our Display at the Radio Engineering Show, Booths 2526-2528

Circle 38 on Inquiry Card

NEW DC-to-30 MC DUAL-BEAM

Tektronix Oscilloscope

with Independent X and Y Deflection



SWEEP DELAY

Same signal displayed simultaneously on slow sweep (upper beam) and fast sweep (lower beam) shows both coarse and fine structure of waveform.

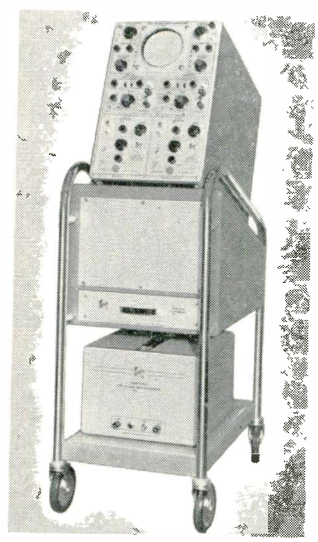
TYPE 555

Two electron beams, each with its own X and Y deflection systems, help make possible a highly versatile dual-beam oscilloscope.

Either of the two time-base generators in the Type 555 can deflect either beam for dual and single displays, and either can deflect both beams for a dual display on the same time base. Time-base units are the plug-in type to facilitate instrument maintenance.

With one time-base generator functioning as a delay generator, the start of any sweep generated by the other can be held off for a selected time interval with a high degree of accuracy. Both the original display and the delayed display can be observed at the same time. The "triggered" feature can be used to obtain a jitter-free delayed display of signals with inherent jitter.

Signal-handling versatility is provided by nine available types of plug-in preamplifiers, any combination of which can be used in the two fast-rise vertical channels. In addition to the many application areas opened with Tektronix plug-in preamplifiers, a three-channel or four-channel display is available through use of the time-sharing characteristics of Type C-A Dual-Trace Units in one or both channels.



Characteristics

INDEPENDENT ELECTRON BEAMS
Separate vertical and horizontal deflection of both beams.

FAST-RISE MAIN VERTICAL AMPLIFIERS
Passbands—dc-to-30 mc with Type K Units.
Risetimes—12 mμsec with Type K Units.
All Tektronix Plug-In Preamplifiers can be used in both vertical channels for signal-handling versatility.

WIDE-RANGE TIME-BASE GENERATORS
Either time-base generator can be used to deflect either or both beams.
Sweep ranges—0.1 μsec/cm to 12 sec/cm. 5 x magnifiers increase calibrated sweep rates to 0.02 μsec/cm.

SWEEP DELAY—Two modes of operation.
Triggered—Delayed sweep started after the delay period by the signal under observation.
Conventional—Delayed sweep started at the end of the delay period by the delayed trigger.
Delay range—0.5 μsec to 50 sec in 24 calibrated steps, with continuous calibrated adjustment between steps.

HIGH WRITING RATE
10-KV Accelerating potential provides bright traces at low repetition rates and in one-shot application.

REGULATED POWER SUPPLY
All dc voltages electronically regulated.
Heater voltages also regulated.

PRICE, Type 555 without plug-in preamplifiers **$2600**
Includes Indicator Unit, Power Supply Unit, 2 Time-Base Units, 4 Probes, Time-Base Extension.

Type 500A Scope-Mobile (as shown with Type 555) . . . **$100**

Type 500/53 Scope-Mobile
(with supporting cradles for plug-in preamplifiers) **$110**
Prices f.o.b. factory.

Tektronix, Inc.

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

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex • Atlanta, Ga. • Baltimore (Towson, Md.) • Boston (Lexington, Mass) • Buffalo, N Y. • Chicago (Park Ridge, Ill.) • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio • Denver, Colo • Detroit (Lathrup Village, Mich) • Endicott (Endwell, N Y) • Greensboro, N.C • Houston, Texas • Kansas City (Mission, Kan) • East Los Angeles, Calif • West Los Angeles, Calif • Minneapolis, Minn. • New York City Area (Albertson, L I., N Y • Stamford, Conn • Union N J) • Orlando, Fla. • Philadelphia Pa • Phoenix, (Scottsdale, Ariz) • San Diego, Calif • San Francisco (Palo Alto, Calif) • St Petersburg, Fla • Syracuse, N Y • Toronto (Willowdale, Ont) Canada • Washington, D C. (Annandale, Va)

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington Tektronix is represented in twenty overseas countries by qualified engineering organizations

SEE THE NEW TEKTRONIX KMC OSCILLOSCOPE AT THE IRE SHOW—BOOTHS 3027-3030


FORMICA®
Laminated Plastic
XXXP-36

Higher-Temperature Capacitors:

New Dielectric Materials Help Break the Heat Barrier

By Marc F. Warmuth, Staff Engineer, Airborne Accessories Corporation

Special Mylar*, Teflon† and mica constructions permit continuous operation up to 600°F

Three new types of special high-temperature motor-starting capacitors, utilizing Mylar, Teflon and mica dielectric respectively, have been developed recently by Airborne. The Mylar and Teflon types are wound of very thin metallized film for greatest possible miniaturization. The mica type is wound of a sandwich of aluminum foil and thin, pure mica ribbon, metallized mica not being procurable. All are encapsulated with thermoplastic polyamide or thermosetting epoxy resins (depending on temperature range) in sealed, cold-drawn steel cans with fused glass terminals. This construction provides low inductance units of exceptional mechanical sturdiness and environmental resistance.

As an alternate construction for less demanding applications, encapsulation in epoxy sleeves, with leads brought out through potted ends, is also available.

Mica for highest temperatures

The great advantage of mica as a dielectric is its ability to maintain its physical and electrical characteristics at temperatures up to 1000°F. All dielectric materials undergo severe reductions in insulation resistance at high temperatures, but with mica the critical value is reached around 600°F. Full voltage ratings up to this point are thus permitted. And with the right epoxy resin impregnant, mica capacitors are well able to withstand overtemperatures without damage . . . if not simultaneously subjected to full rated voltages.

Mica capacitors are three to four times larger than Mylar or Teflon units of comparable capacitance and voltage rating. This is because a greater thickness of dielectric must be used, as well as a separate layer of aluminum foil.

Mylar and Teflon for intermediate high temperatures and small size

Mylar can be worked continuously up to 300°F (derated to 250°F for a-c applications) and Teflon up to 400°F. For applications below these limits, but above the normal 185°F limit of more conventional insulating materials, metallized Mylar and Teflon offer high dielectric strength. They make possible wound capacitors of very small size with good voltage ratings and excellent capacitance-to-volume ratios.

A further advantage of metallized Mylar and Teflon capacitors is their self-healing characteristic. The short occurring when the dielectric is ruptured instantly burns the thin metallic coating back from the edges of the rupture, making further flashover impossible. Yet the amount of metallic coating burned away is so minute that hundreds of such self-healings have little effect on capacitance. Resistance to overvoltages can thus be considered excellent. Resistance to over*temperatures*, on the other hand, is not an outstanding characteristic of Mylar or Teflon—a design factor to keep in mind.

Summary

MYLAR: For intermediate high temperatures, high voltage and smallest size. Continuous operation at 300°F with ratings up to 1000 WVDC. Capacitance variation with temperature good, but not as good as that of Teflon or mica types.

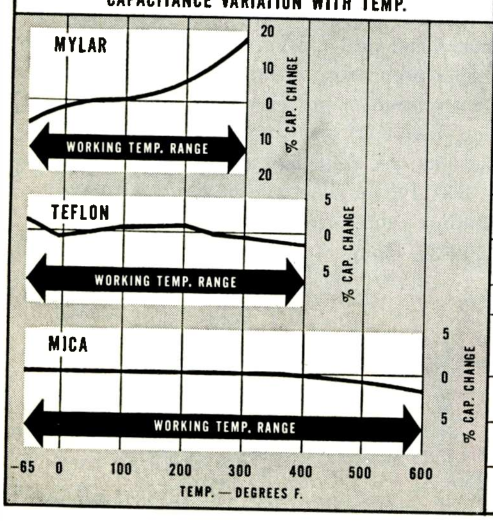
TEFLON: For intermediate high temperatures and small size. 600 WVDC up to 400°F without derating.

MICA: For highest temperatures. Continuous operation, 600 WVDC without derating up to 600°F. Higher temperatures possible with derating. Larger in size than equivalent Mylar or Teflon capacitors.

For further information, request Product Bulletin PS-6A from AIRBORNE ACCESSORIES CORPORATION, Marketing Dept., HILLSIDE 5, N.J.

*DuPont's tm for its polyester film
†DuPont's tm for its tetrafluoroethylene resin

CAPACITANCE VARIATION WITH TEMP.



TABULATED CHARACTERISTICS—AIRBORNE SPECIAL HIGH-TEMPERATURE CAPACITORS

TYPE	MYLAR Wound, Metallized Mylar Film	TEFLON Wound, Metallized Teflon Film	MICA Wound Alum. Foil with Mica Ribbon
Working temp. range	−65 to + 300°F (−55 to + 150°C)	−65 to + 400°F (−55 to + 205°C)	−65 to + 600°F (−55 to + 315°C)
Voltage ratings	200–1000 WVDC	200–600 WVDC	200–600 WVDC
Capacitance range	.01 mfd up	.01 mfd up	.01 mfd up
Capacitance variation with temp.	Very good to 150°F Good 150–300°F	Excellent to 250°F Very good 250–400°F	Excellent to 350°F Very good 350–600°F
Insulation resistance	50,000 meg x mfd at 78°F 10 meg x mfd at 257°F	500,000 meg x mfd at 78°F 75 meg x mfd at 300°F	10,000 meg x mfd at 78°F 4 meg x mfd at 600°F
Dielectric strength	4000 v/mil	1500 v/mil	1000 v/mil
Size	D, L	1.1 to 1.7 x D, 1.1 to 1.7 x L	3 to 4 x D, 3 to 4 x L
Capacitance change vs time at max. working temp.	−5% or less after 250 hr	−5% or less after 250 hr	−5% or less after 250 hr
Overvoltage resistance	Excellent (Self-healing)	Excellent (Self-healing)	Non-self-healing
Short-time exposure to overtemperature	Poor	Poor	Very good with derating

Circle 41 on Inquiry Card

Books

Encyclopedic Dictionary of Electronics and Nuclear Engineering

By Robert I. Sarbacher. Published 1959 by Prentice-Hall, Inc., 70 Fifth Ave., New York 11. 1417 pages. Price $35.00.

This massive new reference work covers all the modern terms and definitions, equipments, elements, components, and systems in the electronics and nuclear engineering fields, in alphabetical order.

Authorized armed forces definitions and abbreviations, and designations of all military establishments concerned with electronics and nuclear engineering, are included.

For fields related to electronics and nuclear engineering, additional definitions are provided wherever the terms are commonly associated with devices in these fields. Acoustical, chemical, electrical, physical and mathematical-physical terms and equipments, devices and systems, are given wherever application is made in the volume.

Sound in the Theatre

By Harold Burris-Meyer and Vincent Mallory. Published 1959 by Radio Magazines Inc., P. O. Box 629, Mineola, N. Y. 95 pages. Price $10.00.

By electronic control of sound, the speaker can be (though often he is not) heard in his own voice by the largest audience. The small orchestra in the great hall can have presence and balance.

This book is the first to set forth in authoritative detail what one can do with sound by electronic control and how to do it whenever the source and the audience are present together.

It develops the requirements for electronic sound control from the necessities of the performance, the characteristics of the audience, and the way sound is modified by environment, hall, and scenery. Sound sources are considered for there susceptibility of control and need for it, and the many techniques for applying electronic sound control are described and illustrated in 32 specific problems.

Magnetic and Electrical Fundamentals (Franklinian Approach)

By Dr. Alexander Efron. Published 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 132 pages, paper back. Price $2.50.

This book contains a complete version of all of the technical papers presented at the EIA Conference on Value Engineering held at the University of Pennsylvania, Oct. 6-7, 1959.

Books Received

RCA Semiconductor Products

Published 1959 by Semiconductor and Materiels Div., Radio Corp. of America, Somerville, N. J. 40 pages, paper bound. Price $.30.

(*Continued on page 68*)

Books

Master Receiving—Picture Tube Substitution Guide Book

By H. A. Middleton. Published 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 352 pages, paper back. Price $7.45.

Defense R & D Contracts Guide

Published 1959 by Vincent F Callahan, Publisher, Evans Building, Washington 5, D. C. 150 pages. Price $25.00 a copy.

Zener Handbook

Published 1959 by Motorola, Inc., Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz. 130 pages, spiro bound. Price $1.00.

EIA Membership List and Trade Directory (1959-60)

Published 1959 by EIA, 1721 DeSales St., N.W., Washington 6, D. C. 160 pages, paper bound. Price $2.50.

Fractional Horsepower Motor Handbook

Published 1959 by Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill. 66 pages, spiral bound. Price $1.00

R-F Amplifiers

Edited by A. Schure, PhD. Published 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 104 pages, paper bound. Price $2.40.

Short Wave Propagation

By Stanley Leinwoll. Publ'shed 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 160 pages, paper bound. Price $3.90.

Pin-Point Transistor Troubles in 12 Minutes

By Louis E. Garner, Jr. Published 1959 by Educational Book Publishing Div., Coyne Electrical School, 1501 W. Congress Highway, Chicago 7, Ill. 478 pages, spiral bound. Price $4.94.

Hi-Fi Made Easy

By Norman H. Crowhurst. Published 1959 by Gernsback Library, Inc., 154 W. 14th St., New York 11. 224 pages, paper bound. Price $2.90.

Doppler Shift Calculator

Published 1959 by Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y. 12 pages, paper bound. Price 50¢. Price covers instruction booklet and circular calculator.

Proceedings of the General Session on Powder Metallurgy.

Published 1959 by Metal Powder Industries Federation, 60 E. 42nd St., New York 17. Price $4.00.

Proceedings of the Special Session on Ceramic Permanent Magnets

Published 1959 by Metal Powder Industries Federation, 60 E. 42nd St., New York 17. Price $2.50.

Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment, NAVAER, 16-1-519, Supplement No. 2.

Published 1959 by U. S. Dept. of Commerce. 54 pages. Price 30¢. Copies may be obtained from Government Printing Office, Washington 25, D. C.

Understanding Transistors

By Milton S. Kiver. Published 1959 by Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. 64-page, paper bound. Price $.50.

Coming Events

(*Continued from page* 15)

Society; Hotel Biltmore, Los Angeles, Calif.

Apr. 26-28: Meeting, Fibre Box Assoc.; Edgewater Beach Hotel, Chicago, Ill.

Apr. 27-29: Great Lakes District Meeting, AIEE; Milwaukee, Wis.

Apr. 28-29: Seminar, Aids in Design Room Management, Univ. of Illinois; Urbana, Ill.

SOME HIGHLIGHTS OF 1960 .

March 21-24: IRE International Convention, IRE (All Professional Groups), Coliseum and Waldorf-Astoria Hotel, New York, N. Y. E. K. Gannett, IRE Hdqts., 1 East 79th St., New York 21, N. Y.; Gordon K. Teal, Chrmn., Tech. Prog. Comm., IRE Hdqts., 1 East 79th St., New York 21, N. Y.

April 3-7: Annual Convention, National Assoc. of Broadcasters; Conrad Hilton Hotel, Chicago, Ill.

May 3-5: Western Joint Computer Conf., IRE, AIEE, ACM; Jack Tar Hotel, San Francisco, Calif.

May 10-12: Electronic Components Conf., IRE, AIEE, EIA, WEMA; Hotel Washington, Washington, D. C.

Aug. 23-26: WESCON, IRE, WCEMA; Ambassador Hotel & Memorial Sports Arena, Los Angeles, Calif.

Oct. 10-12: National Electronics Conference, AIEE, IRE, Ill. Inst. of Tech., EIA, SMPTE; Hotel Sherman, Chicago, Ill. Arthur H. Streich, National Electronics Conf., 184 E. Randolf St., Chicago, Ill.

Nov. 14-16: Mid-America Electronic Convention (MAECON), IRE, Kansas City, Mo.

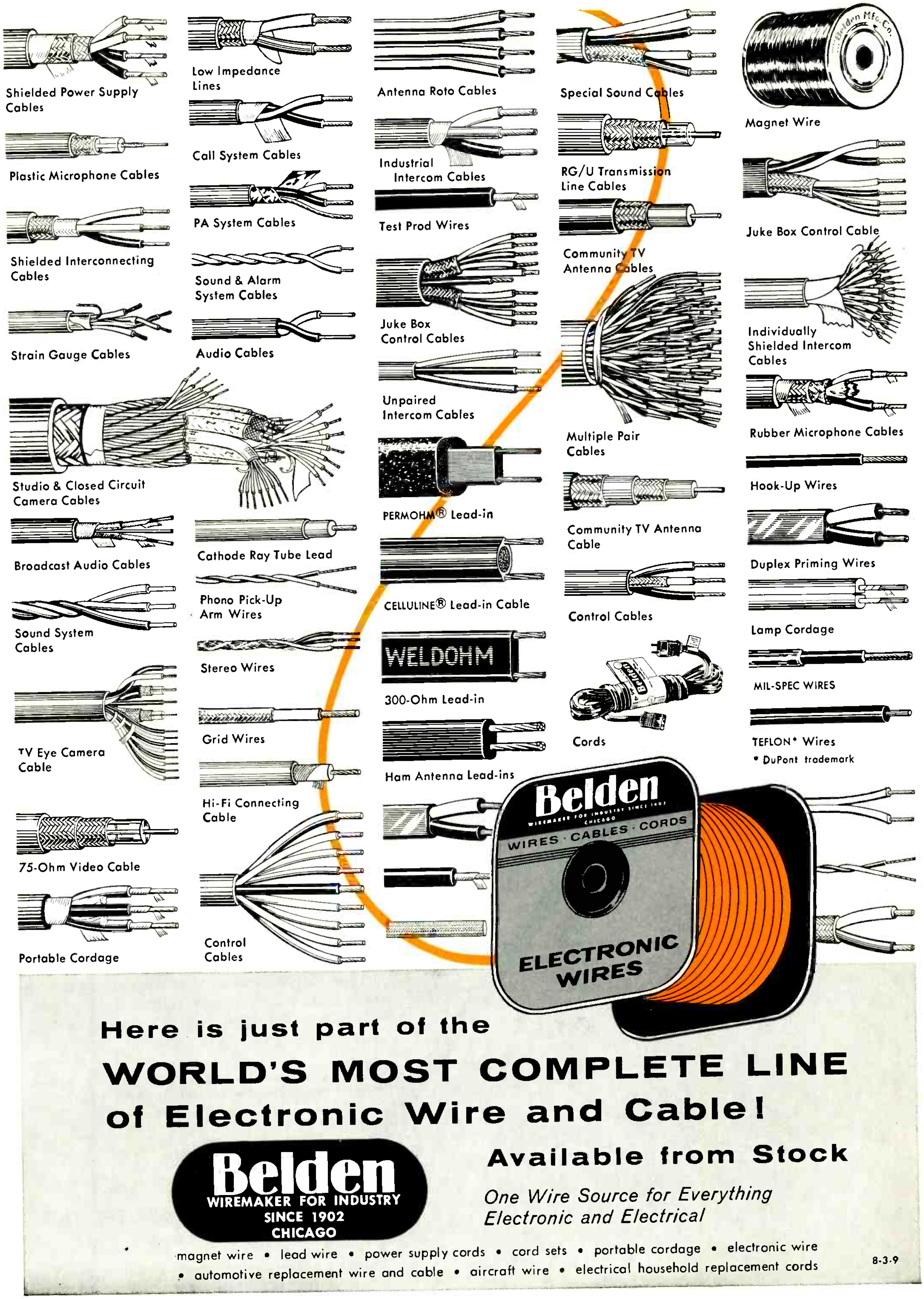
Nov. 15-17: Northeast Res & Eng. Meeting (NEREM), IRE, Boston, Mass.

Dec. 11-14: Eastern Joint Computer Conf., IRE, AIEE, ACM; Hotel New Yorker, New York, N. Y.

Apr. 20-22: South West IRE Regional Conf. and Electronics Show (SWIRCO), and National Medical Electronics Conference, IRE (Region 6); Shamrock Hilton Hotel, Houston, Texas.

Abbreviations

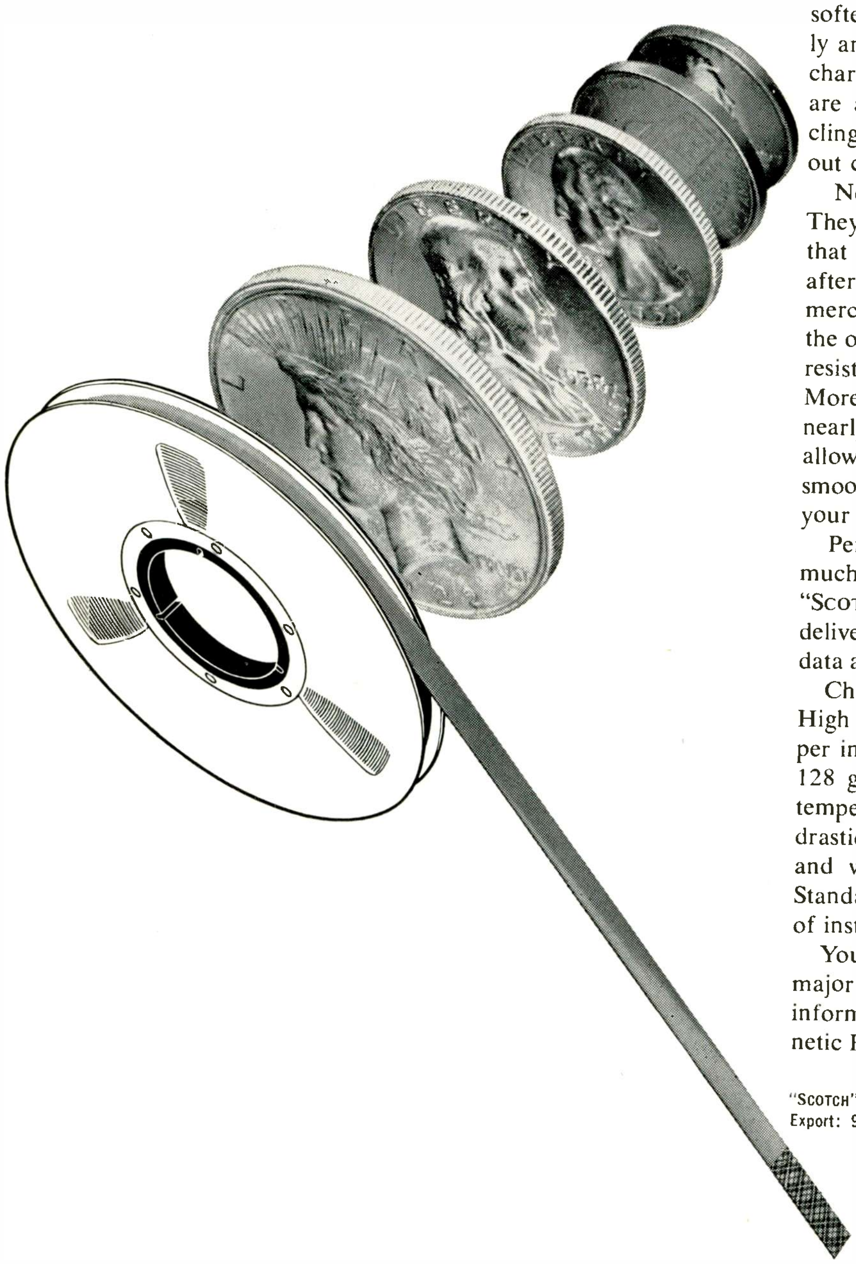
ACM: Assoc. for Computing Machinery
AIEE: American Institute of Electrical Engineers
AIME: American Institute of Metallurgical Engineers
ARS: American Rocket Society
ASME: American Society of Mechanical Engineers
ASTE: American Society of Tool Engineers
EIA: Electronic Industries Association
EJC: Engineers Joint Council
IAS: Institute of the Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
NAB: National Association of Broadcasters



Circle 47 on Inquiry Card

A GOOD RUN FOR YOUR MONEY—

New "SCOTCH" BRAND Heavy Duty Tapes offer exceptional life, low rub-off, good resolution



HAVE PROBLEMS OF TAPE-LIFE, rub-off and resolution? To cure your headaches in applications that subject magnetic tape to high speeds, pressures, temperatures and low humidity, "SCOTCH" BRAND now prescribes two new tapes—Heavy Duty Tapes 198 and 199. They offer plus-performance in a wide variety of temperature and humidity conditions.

Take the matter of wear, for instance. Field tests show that "SCOTCH" BRAND Heavy Duty Tapes wear five times longer than standard tapes—yet they maintain good resolution and freedom from drop-outs over this long haul. Two factors are decisive in this performance—resistance to rub-off and resistance to high temperatures.

Ordinary tapes age fast if the temperature climbs or the relative humidity drops sharply. The binder softens, allowing the oxides to rub off on those costly and sensitive heads.. Further, as an electrostatic charge builds with each pass, stray contaminants are attracted to the tape—and the tape starts to cling to the equipment. In each case—your drop-out count mounts.

Not so with "SCOTCH" BRAND Heavy Duty Tapes. They boast an extra tough binder system similar to that used in "SCOTCH" BRAND Video Tape, which after two years is still the only video tape in commercial use. The heavy duty binder system anchors the oxides firmly to the polyester base in a way that resists very high temperatures—minimizing rub-off. Moreover, Heavy Duty Tapes have a conductivity nearly 1000 times greater than conventional tapes, allowing static charge to drain off. Result? Clean, smooth runs with good resolution—a good run for your money.

Performance of this kind is easy to promise—much harder to deliver. And only experienced "SCOTCH" BRAND technology has such a record of delivering the right tape for every application in data acquisition, reduction or control programming.

Check all the tapes in the "SCOTCH" BRAND line. High Resolution Tapes 158 and 159 pack more bits per inch, offer extra play time. High Output Tape 128 gives top output in low frequencies, even in temperature extremes. Sandwich Tapes 188 and 189 drastically cut head-wear, eliminate oxide rub-off, and wear 10 times longer than ordinary tapes. Standard Tapes 108 and 109 remain the standard of instrumentation.

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

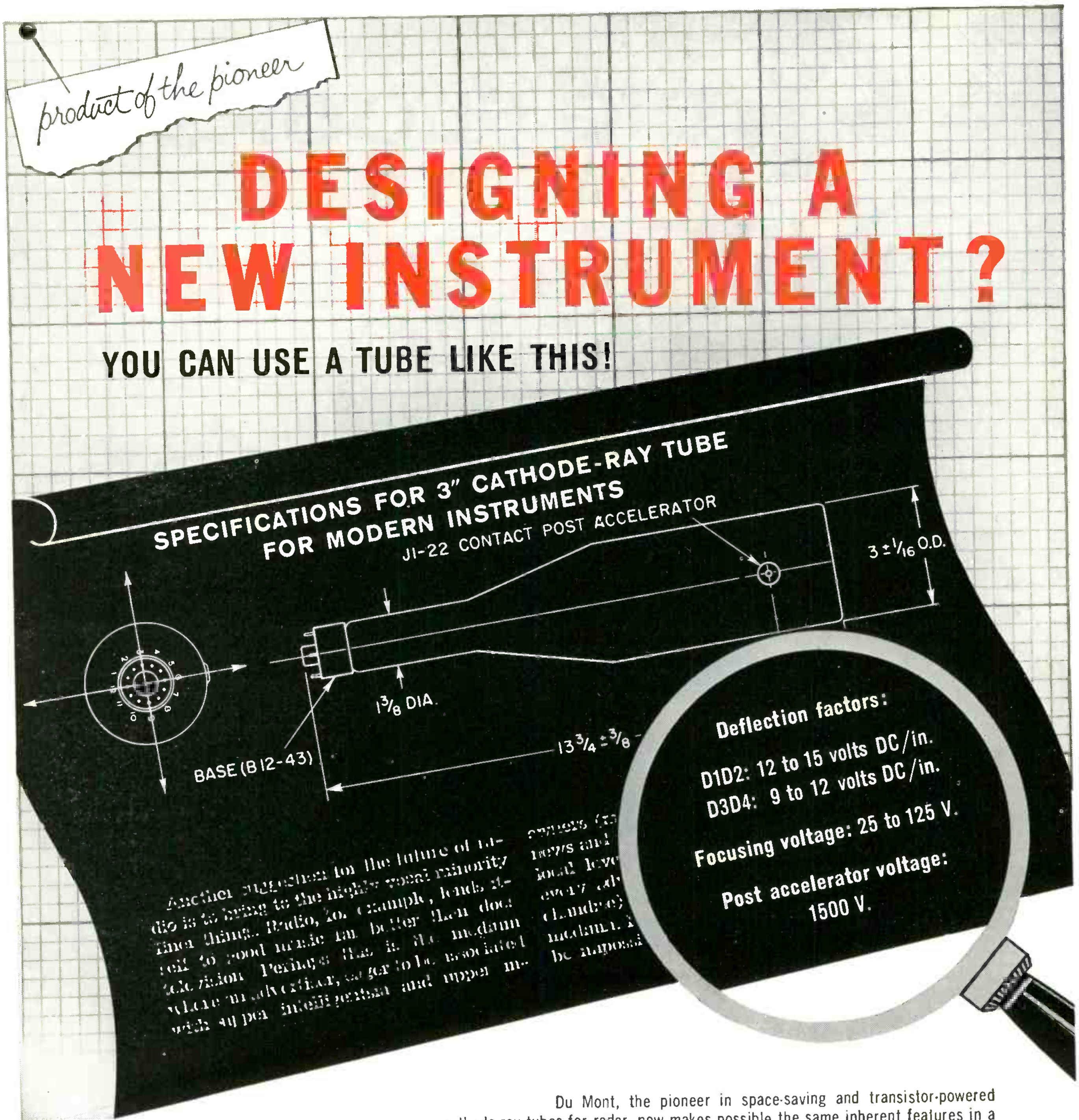
REG. U.S. PAT. OFF.

SCOTCH BRAND MAGNETIC TAPE

FOR INSTRUMENTATION

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

3M COMPANY



Du Mont, the pioneer in space-saving and transistor-powered cathode-ray tubes for radar, now makes possible the same inherent features in a fine instrument read-out tube. The Du Mont electrostatically deflected K1951 provides full scan with deflection voltages of 9-15 volts DC/in.

If your cathode-ray tube applications call for even greater compactness and power savings—consult the CRT Engineering Specialists at Du Mont. Daily advances in the state-of-the-art are being recorded for your benefit. A tube to fit your exacting requirements can be designed, developed and produced at Du Mont.

Whatever your CRT requirements, check with Du Mont first.

WRITE for complete details

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Cast Alnico • Sintered Alnico • Arnox • Vicalloy • Cunife

★ **MAGNETIC CORES**

Tape Wound Cores of Deltamax, Supermalloy, Permalloy, Supermendur, etc.

Type "C," "E" and "O" Cores of Silectron • Bobbin Cores

Mo-Permalloy Powder Cores • Iron Powder Cores • Sendust Cores

★ **SPECIAL MATERIALS**

Barium Titanates • Permendur • Vibralloy

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Circle 52 on Inquiry Card →

SYLVANIA NPN AND PNP SWITCHING TRANSISTORS

Reliable performers in military and computer applications

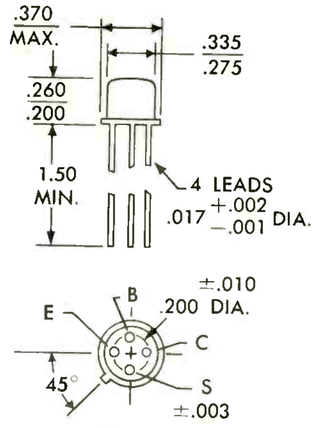
ELECTRICAL CHARACTERISTICS

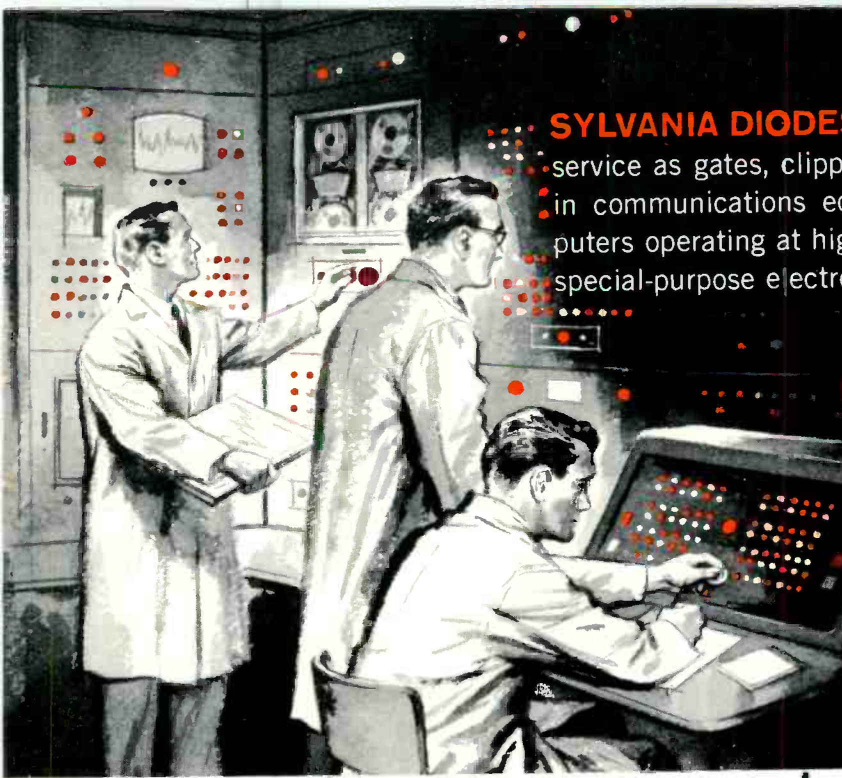
NPN Type	COLLECTOR TO BASE VOLTS (Min.)	EMITTER TO BASE VOLTS (Min.)	POWER DISS. AT 25°C (Max.)	FREQ. CUTOFF, FAB V_{CB}=6v. 1c=1ma (Min.)
2N312	15V	15V	100mW	3.0Mc
2N356	20V	20V	100mW	3.0Mc
2N357	20V	20V	100mW	6.0Mc
2N358	20V	20V	100mW	—
2N377	25V	15V	150mW	2.5Mc
2N377A	40V	15V	200mW	2.5Mc
2N385	25V	15V	150mW	4.0Mc
2N385A	40V	15V	200mW	4.0Mc
2N388	25V	15V	150mW	5.0Mc
2N388A	40V	15V	200mW	5.0Mc
2N438	30V	25V	100mW	2.5Mc
2N438A	30V	25V	150mW	2.5Mc
2N439	30V	25V	100mW	5.0Mc
2N439A	30V	25V	150mW	5.0Mc
2N440	30V	25V	100mW	10.0Mc
2N440A	30V	25V	150mW	10.0Mc
2N556	25V	10V	100mW	—
2N557	20V	10V	100mW	—
2N558	15V	5V	100mW	—
2N576	20V	15V	200mW	5.0Mc
2N576A	40V	15V	200mW	5.0Mc
2N585	25V	20V	120mW	3.0Mc
2N587	40V	40V	150mW	—
2N679	25V	15V	150mW	2.0Mc
2N1302	25V	25V	150mW	3.0Mc
2N1304	25V	25V	150mW	5.0Mc
2N1306	25V	25V	150mW	10.0Mc
2N1308	25V	25V	150mW	15.0Mc
2N1114	25V	15V	150mW	7.0Mc
2N1299	40V	15V	150mW	4.0Mc

PNP Type	COLLECTOR TO BASE VOLTS (Min.)	EMITTER TO BASE VOLTS (Max.)	POWER DISS. AT 25°C (Max.)	FREQ. CUTOFF, FAB V_{CB}=5 1e=1mA (Min.)
2N123	−20V	−10V	150mW	5.0Mc
2N404	−25V	−12V	150mW	4.0Mc
2N414	−30V	−12V	150mW	5.0Mc
2N425	−30V	−20V	150mW	2.5Mc
2N426	−30V	−20V	150mW	3.0Mc
2N427	−30V	−20V	150mW	5.0Mc
2N428	−30V	−20V	150mW	10.0Mc
2N519	−25V	−15V	150mW	0.5Mc
2N582	−25V	−12V	150mW	14.0Mc
2N1009	−10V	—	120mW	0.5Mc
2N1381	−25V	−15V	150mW	0.5Mc

SYLVANIA 2N624 "DRIFT" TRANSISTOR FOR TUNED-AMPLIFIER SERVICE TO 12.5 MC

Sylvania 2N624 is a hermetically sealed PNP diffused-base transistor. The package has JEDEC TO-12 dimensions and lead spacings. A fourth lead provides a connection to the metal case for improved shielding. Characteristic testing includes many environmental parameters to assure reliable operation under conditions which may be expected in military applications. Sylvania 2N624 conforms to the requirements for military electronics equipment.





SYLVANIA DIODES—Sylvania manufactures all types of diodes for service as gates, clippers, clampers, detectors; diodes for applications in communications equipment, switching circuits in electronic computers operating at high speeds in the order of millimicroseconds, and special-purpose electronic devices.

SYLVANIA facilities for life and environmental testing include salt spray, moisture, high altitude, vibration, shock, high and low temperatures. SYLVANIA manufacturing and testing facilities are highly automated and mechanized to assure extraordinary electrical uniformity. Many SYLVANIA diodes are available with specifications conforming to military requirements.

POINT-CONTACT DIODES

feature low cost, low capacitance, and exceptionally fast recovery time. Available in all-glass "min" package with power dissipation capabilities to 80mW. Available in solder-seal package for wire-in or clip-in use with power dissipation capabilities to 225mW.

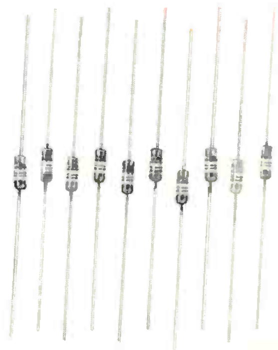
GOLD BOND DIODES

feature high forward-conduction and good recovery-time in units that are relatively low in cost. Available in all-glass "min" package with power dissipation capabilities averaging 80mW.

VLI (very low impedance) DIODES

feature very high conduction and relatively high voltage-breakdown. Available in all-glass "min" package with power dissipation capabilities averaging 80mW. Available in solder-seal package for wire-in or clip-in use with increased power dissipation capabilities to 225mW.

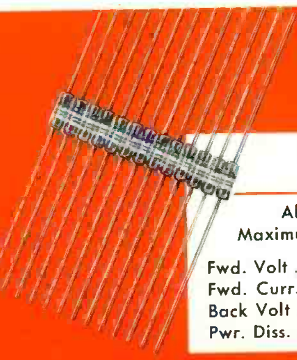
SILICON-JUNCTION DIODES



feature high conduction, good recovery time plus the environmental capabilities of silicon—the ability to withstand wide variations in ambient temperature. Available in all-glass "min" package with power dissipation capabilities to 200mW.

SYLVANIA D-1820 HIGH-SPEED SWITCHING DIODE

4 millimicroseconds guaranteed maximum recovery time!



ELECTRICAL CHARACTERISTICS—SYLVANIA D-1820

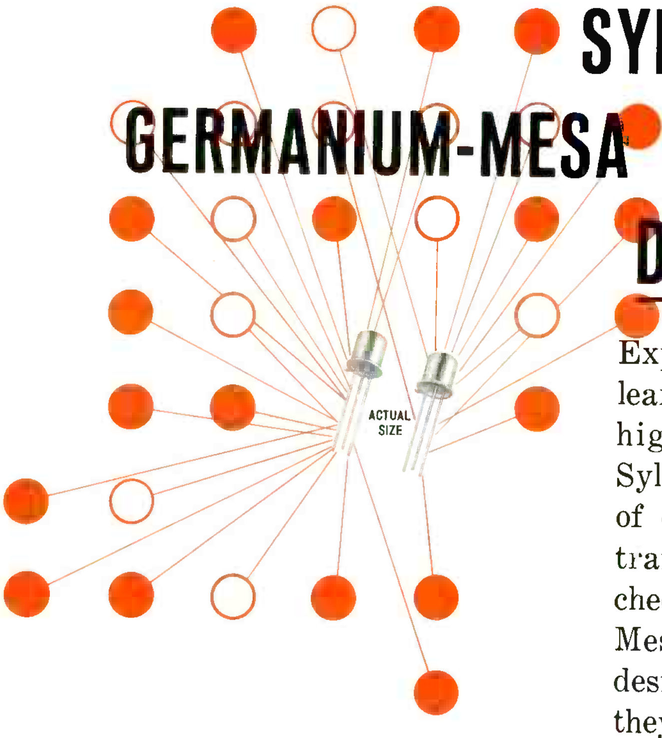
Absolute Maximum Ratings*		Typical Operating Conditions*	
Fwd. Volt	1.3 V †	Fwd. Volt	0.9 V
Fwd. Curr.	50 mA	Fwd. Curr.	2.0 μA
Back Volt	20 V	Rev. Recovery	2.5 mμs
Pwr. Diss.	80 mW		

†at 10 mA *at 20° C.

SYLVANIA D-1820—now available in commercial quantities—is designed, produced and controlled specifically for logic circuitry. The cost of this SYLVANIA diode is low enough to make it especially attractive for use in quantity-produced electronic computers. SYLVANIA D-1820 and circuits designed around it feature: high-speed operation • long-life performance • high reliability • exceptional uniformity • economy • simplicity • compactness.

SYLVANIA 2N705 and 2N710 GERMANIUM-MESA COMPUTER TRANSISTORS

DEPENDABLE! AVAILABLE!



Experienced designers of electronic computers have learned they can depend on the performance of high-speed switching circuits designed around Sylvania transistors. An exceptionally high degree of dependability is built into SYLVANIA Mesa transistors. There are 31 in-line quality control check-points for SYLVANIA 2N705 and 2N710 Mesa transistors. Another important reason for designing around SYLVANIA 2N705 and 2N710: they are available now.

A COMPREHENSIVE LINE OF SILICON RECTIFIERS

The latest in production equipment plus the most modern test procedures are devoted to the manufacture of SYLVANIA silicon rectifiers. Clinically controlled atmospheres on the production line minimize contaminants, result in units that feature low leakage and promise long-life operation.

SYLVANIA silicon rectifiers are quality-controlled for applications in *industrial power supplies* and *magnetic amplifiers*. SYLVANIA silicon rectifiers are available with peak-inverse-voltage ratings to 1000-Volts, and forward-current ratings to 750-mA.

SYLVANIA—RELIABLE SEMICONDUCTORS TO THE TELEPHONE INDUSTRY!

SYLVANIA semiconductor devices are available from your local franchised SYLVANIA SEMICONDUCTOR DISTRIBUTOR or through the FIELD OFFICE nearest you. For technical data, write: SYLVANIA SEMICONDUCTOR DIVISION, WOBURN, MASSACHUSETTS.

SYLVANIA

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

Insulation "Paints Out" Electric Arcs

A new insulation "paint" has been developed by Westinghouse engineers. The insulation can be painted or sprayed on. Paint is well suited for electrical equipment that is subjected to high-voltage discharges. These discharges cause the rapid breakdown of conventional insulating materials.

The new insulation dries to form a smooth and attractive painted surface and, at the same time, gives standard insulating materials as much as 300 times more resistance to breakdown by electrical arcing or "tracking."

SPACE EXPERIMENTS

General Electric missile re-entry vehicle is equipped with instruments for measuring meteor sizes and electrical energy in space. J. Frissora of Geo-Sciences, Inc., Alamagordo, N.M., points to his self-designed membrane detector. It measures size of meteors by escaping gas. Extended ears are for measuring ion densities and potential of vehicle.

NBS Obtains Radio Signal Strength Data

The effects of varying the heights of transmitting and receiving antennas on the strength of radio signals received beyond the radio horizon have been determined by National Bureau of Standards' physicists.

The data, said to be valuable in designing long-distance VHF-UHF communication systems and developing and testing theories of tropospheric scatter propagation, are contained in one of a series of NBS Technical Notes being published by the Office of Technical Services, U. S. Department of Commerce.

The report sets forth an analysis of measurements of transmission loss (signal strength) at 418 Mc over a 134-mile path. Continuous simultaneous recordings of signal level were made at receiving antenna heights ranging from 30 to 665 ft.

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Circle 54 on Inquiry Card

Buss and Fusetron Fuses

. . . help you safeguard your product's reputation for Quality and Reliability!

Undoubtedly, you take pride in the products your company manufacturers . . . and try to avoid using any components that could result in customer dissatisfaction . . . which in turn can affect your company's sales curve.

That's why it doesn't pay to gamble with fuses that could be faulty and create trouble for your customers — either by failing to protect and causing useless damage to equipment, or by blowing needlessly and causing unnecessary shutdowns.

With BUSS and FUSETRON fuses safe, dependable electrical protection is assured. Before one of these fuses ever leaves our plant, it is electronically tested to make sure it is right in every way . . . to make sure it will protect, not blow needlessly.

When you specify BUSS or FUSETRON fuses, you are safeguarding against customer complaints for you have equipped your product with the finest electrical protection possible. You are also helping to maintain the reputation of your product for service and reliability.

To meet all fuse requirements, there's a complete line of BUSS and FUSETRON fuses in all sizes and types . . . plus a companion line of fuse clips, blocks and holders.

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

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

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

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Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 9

NEW RAYTHEON MAGNETRONS FOR A WIDE RANGE OF APPLICATIONS

Designed for C-band systems requiring tunability, the RK-7156 magnetron has a minimum peak power output rating of 250 kilowatts over a frequency range of 5,450 to 5,825 megacycles. Applications include a flight-tested, revolutionary airborne weather radar system. The RK-7156 is in quantity production.

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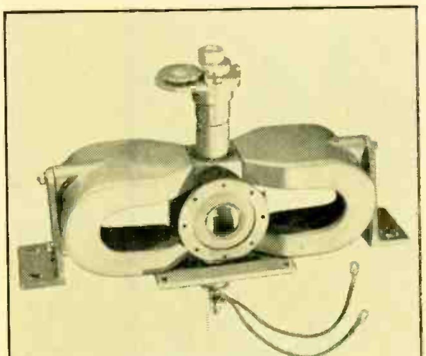
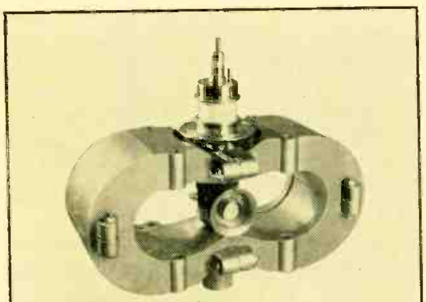

RK-7156

* * *

X-band magnetron for airborne search radar provides one megawatt minimum peak power and 875 watts average power within a frequency range of 9,340 to 9,440 Mc. Designated QK-624, this pulsed-type tube is liquid cooled and should give at least 1,000 hours of reliable service.

CIRCLE 57
Reader Service Card


QK-624

* * *

For ground-based and airborne radar systems, the RK-7529 magnetron provides a 2.0 microsecond pulse of 3.5 megawatts minimum peak power over 2,700 to 2,850 Mc. This liquid-cooled tube is interchangeable with other fixed-frequency S-band tubes operating at similar power levels.

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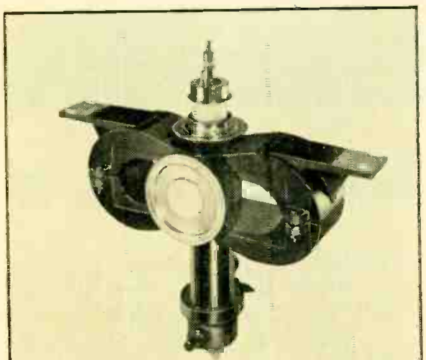
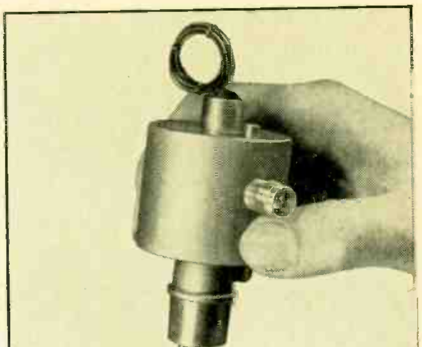

RK-7529

* * *

A one kilowatt beacon magnetron, the RK-7578 weighs only 14 ozs., yet will withstand vibrations of 15 G's at 20 to 2,000 cycles and shock up to 100 G's. It is mechanically tunable and covers the 5,400 to 5,900 Mc range.


RK-7578

CIRCLE 59
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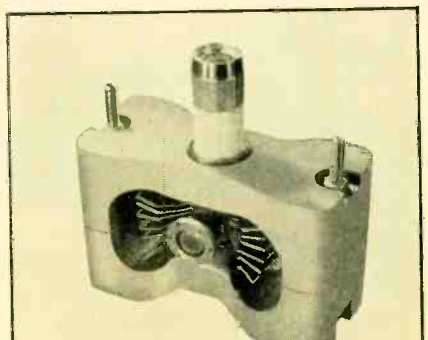
* * *

Developed to withstand extreme environmental conditions, the RK-7449 magnetron is a lightweight, compact tube with a minimum peak power output of 45 kilowatts at the operating frequency of 24 kmc. The RK-7449 is required to withstand repeated shocks of 50G. Stable operation is guaranteed at vibration frequencies up to 2,000 c.p.s. with 30G applied.


RK-7449

CIRCLE 60
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A Leader in Creative Microwave Technology

RAYTHEON

International News

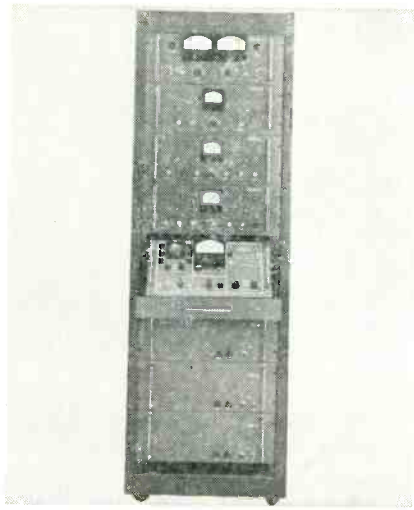
(*Continued from page 36*)

only a few parts (one transistor and two diodes) more than conventional sets. Of course the second loudspeaker and audio stage is still required. The proposed system is compatible and unconverted sets will be able to receive transmissions in the normal way.

Buy AM Stereo Equipment

Four foreign radio stations have bought AM Stereo Adapter Systems from Kahn Research Laboratories, Inc., Freeport, N. Y. Included are CJAD in Montreal, the major high power station in Mexico City, and two stations in Venezuela.

Programs broadcast using this system, the Model STR-59-IA Stereo Adapter System, can be received on two conventional AM receivers and balanced monaural reception is provided when only one receiver is used.

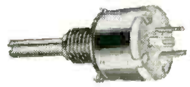


AM Stereo Adapter system develops two independent sidebands which are individually modulated by the two stereo inputs. Each sideband of the envelope wave can be demodulated by a standard AM receiver.

Using any standard AM transmitter, the Kahn Adapter develops a full carrier and two independent sidebands, each modulated by the two stereo channels. Total added harmonic distortion is approximately ½% and either sideband can be diode detected. Thus, true stereo is achieved by placing two standard AM receivers about six feet apart and tuning each set to the respective upper and lower sideband. Sideband rather than carrier tuning also makes AM fidelity comparable to FM. Balanced monaural reception is provided by tuning one receiver to the carrier.

Kahn Research Laboratories, recently filed a petition for rule change with the FCC to broadcast full-range stereo programs over a single AM transmitter.

New

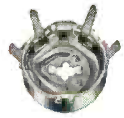


Circle 64 on Inquiry Card

Space Age Hi Temp Military Control, Series 600.
1/2" dia. variable resistor with infinite resolution and better stability and higher reliability than presently available in carbonaceous type units. Uses new CTS-developed hi temp metal-ceramic resistance element.

Burton browne advertising

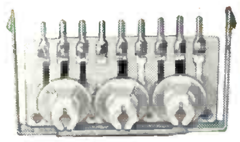
Low Cost Miniature Trimmer Pot, Series 110.
3/4" dia. preset wirewound 1/2-5,000 ohms resistance range variable resistor. Exceptional reliability due to several unique design features.



Circle 65 on Inquiry Card

New

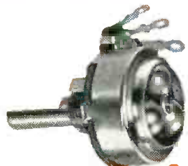
New



Circle 66 on Inquiry Card

67% Smaller Side-By-Side Printed Circuit Ceramic Base Control, Type X153.
Compact space-saving self-supporting snap-in 2 or 3-section variable and fixed resistor network 1/3 the size of previous units designed for printed circuit applications.

Compact Vernier Variable Resistor, Type VA-45.
12-1/2 to 1 reduction. For fine tuning applications. Ball bearing rotation.



Circle 67 on Inquiry Card

New

New

Circle 68 on Inquiry Card

Separately Mounted Simple Design Pull-Push and Push-Push Switches, Types SK-1 and SJ.
13/16" dia. In separately mounted styles for home appliances and other electrical and electronic applications.

Higher Reliability Micro-Miniature Composition Control, Series M250.
9/32" dia. For miniature transistor hearing aids, miniature radios, telephone equipment and industrial applications requiring tiny size and exceptional reliability.

Circle 69 on Inquiry Card

New

New

Circle 70 on Inquiry Card

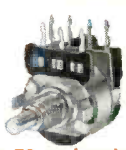
Highly Uniform Rugged Rotary Switches, TROLEX Series.
Exceptionally high uniform reliability is achieved by an entirely new manufacturing concept. For military and commercial applications.

Compact Motor Driven Control, Type MD 45.
For remote control functions.

Circle 71 on Inquiry Card

New

New



Circle 72 on Inquiry Card

Miniature Compact 5/8" Control, Series 200. (Illustrated with switch).
For limited space applications. Available with standard bushing mounting (illustrated) or economical ear mounting. Special thin ear-mounted model available for portable pocket transistorized radios.

CTS Specialists are willing to help solve your variable resistor and switch problems. Contact your nearest CTS office today.

Factories in Elkhart & Berne, Indiana; South Pasadena, California; Asheville, No. Carolina; McHenry, Illinois and Streetsville, Ontario. Sales Offices and Representatives conveniently located throughout the world.

Founded CTS 1896

CHICAGO TELEPHONE SUPPLY
Corporation

ELKHART • INDIANA

International News

JAPAN

Color TV in Japan

The Japan Broadcasting Corp. (NHK) has built a color TV camera made exclusively of domestically-produced parts. The camera is smaller than the RCA or GE color TV cameras now being used in Japan.

The firm is planning to mass produce 17-inch color TV receiving sets in the near future. Seven Japanese electric companies are turning out color receiving sets.

The Japan Broadcasting Corp. is telecasting 30-minute color shows five days each week and the Nihon Television Co. is broadcasting daily hour and a half color shows. NHK has installed color TV sets in various public locations in Tokyo to introduce color TV to the population.

MEASUREMENT SEMINAR

Technical reps from a dozen nations who attended an international 6-day measurement seminar in Amsterdam, Holland. Meeting, hosted by Groenpol Industrial Sales Co., rep in the Netherlands for General Radio Co., West Concord, Mass., featured 21 hrs of practical instruction in advanced measurement techniques.

International Computer Federation Formed

Eleven nations have ratified the statutes of the International Federation of Information Processing Societies. The new federation is a direct result of the first International Conference on Information Processing sponsored by UNESCO in Paris last June.

The first meeting of the IFIPS council is expected to plan a Second International Conference on Information Processing with an associated technical exhibit in 1963.

Countries now holding membership are: Canada, Denmark, Finland, France, West Germany, Netherlands, Spain, Sweden, Switzerland, United Kingdom, and the U. S. A. Belgium, Israel, and Japan are forming national computer societies to qualify for membership.

GENERAL INSTRUMENT CORPORATION

AUTOMATIC SUBMINIATURE silicon power diode/rectifiers

designed to meet USAF MIL-E-1/1143 specs

These fine silicon diode/rectifiers meet and exceed the USAF specs . . . and retain their outstanding characteristics and reliability at temperatures of 150° C. and more! Complete technical information on these and other General Instrument semiconductors is available upon request.

	MAXIMUM RATINGS			ELECTRICAL CHARACTERISTICS			
JEDEC TYPE NO.	PEAK INV. VOLT-AGE (V)	MAX. AVG. RECTIFIED CURRENT (mA)* @ 25° C.	MAX. AVG. RECTIFIED CURRENT (mA)* @ 150° C.	MINIMUM SATURA-TION VOLTAGE @ 100° C. (VOLTS)	MAXIMUM REVERSE CURRENT @ PIV (uA) @ 25° C.	MAXIMUM REVERSE CURRENT @ PIV (uA) @ 100° C.	MAXIMUM VOLTAGE DROP @ 400 ma DC @ 25° C. VOLTS DC
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

*Resistive or inductive load

Semiconductor Division
GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, N. J.
Midwest office: 5249 West Diversey Ave., Chicago 39
Western office: 11982 Wilshire Blvd., Los Angeles 25

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, SEMICONDUCTOR DIVISION, RADIO RECEPTOR COMPANY, INC., THE HARRIS TRANSDUCER CORPORATION, MICAMOLD ELECTRONICS MANUFACTURING CORPORATION AND GENERAL INSTRUMENT — F. W. SICKLES OF CANADA LTD. (SUBSIDIARIES)

Visit us at the IRE Show, Booths 1218-24

Circle 74 on Inquiry Card

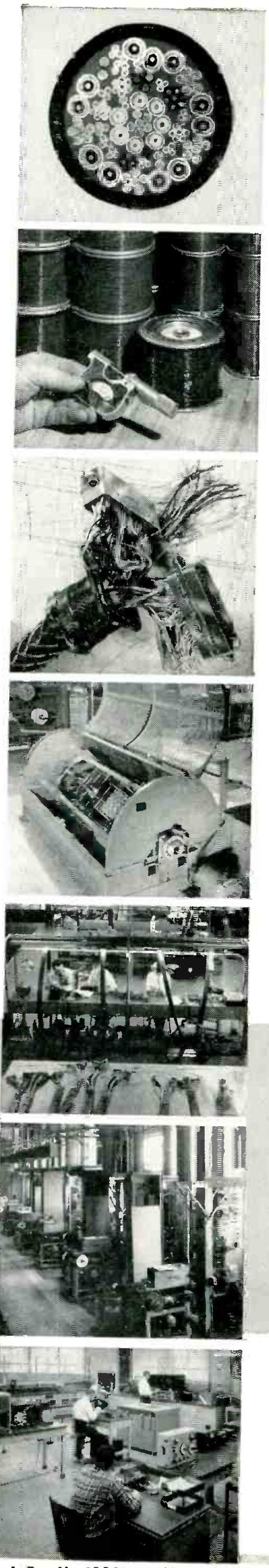
Tensolite

HIGH TEMPERATURE

CABLE CAPABILITIES

Our experienced Design Engineers specialize in cable and cable assemblies utilizing Teflon® insulated hook-up wire (large and small), solid core and air dielectric coaxial cable, shielded and jacketed multi-conductors—or any combination of these.

Many leading aircraft and electronic manufacturers are taking advantage of Tensolite's cable design and production facilities. Let us work with you in translating your requirements into highly reliable jumbo cables and cable assemblies.



Tensolite

HIGH TEMPERATURE

WIRE AND CABLE

HOOK-UP Wire—Mil Spec & Thin Wall

Teflon – Extruded, Spiral Wrapped, and FLEXOLON wire
Types E-EE to MIL-W-16878 and NAS-703 (−90° to +250°C)

Vinyl – Extruded, and parallel wrapped
Types B-C to MIL-W-16878 and NAS-702 (−55° to +105°C)
Types LW-MW to MIL-W-76A (−40° to +80°C)
Super-flexible wire (−40° to +60°C)

COAXIAL CABLE

Solid Core and Air Dielectric
Designed to MIL-C-17B
RG Specs. (−90° to +250°C)

MULTI-CONDUCTORS

Standard and Custom Designed to Military and Industrial Specs.

AIRFRAME WIRE

Designed to MIL-W-7139
(−90° to +250°C)

MAGNET WIRE

To Meet MIL-W-19583, Type III
16 thru 50 AWG, ST, HT, TT, & QT (−90° to +250°C)

ENAMELED PRODUCTS

High temperature magnet wire—and other enameled wire products—must be produced under exacting dust-free conditions. To assure this, Tensolite recently set up its *Mechtron Division* in a separate and specially designed plant. Tensolite is the only manufacturer to provide this assurance of reliability and high quality.

OTHER PRODUCTS

- Asbestos Wire to MIL-C-25038
- Antenna Wire
- Low Capacitance Cable
- Wire Coated with Teflon (100X) FEP Resin
- Tone Arm Wire
- Ribbon Cable Shielded and Unshielded
- Bondable Teflon Wire
- High Strength Conductors
- Nickel Plated Conductors
- Hearing Aid Cordage

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- ☐ Magnet wire catalog.
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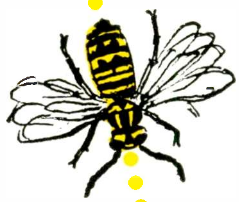
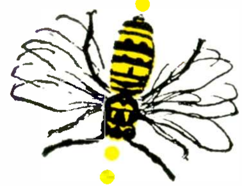
See us at Booth 4330 at the I.R.E. Show

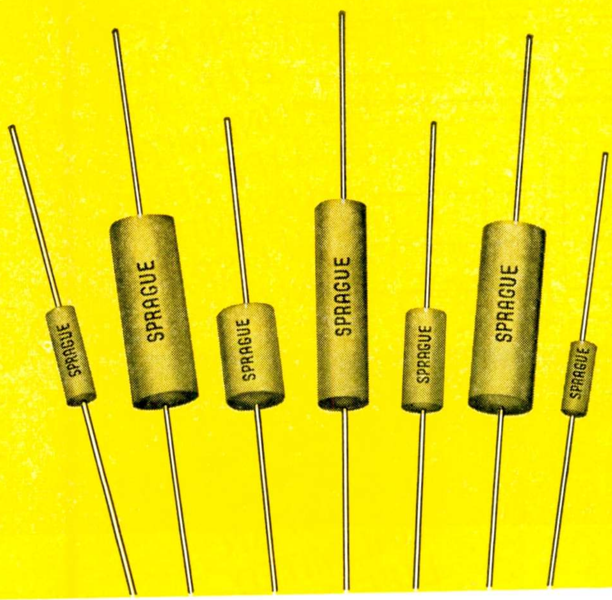
MOST RELIABLE "WRAP-AND-ENDFILL" FILM CAPACITORS—





Reliability in a "wrap-and-endfill" at last! . . . Sprague Yellow-Jacket Filmite "E" Capacitors. The design of these small, lightweight film capacitors is based on the most extensive life test data for polyester film dielectrics available at the present time. These capacitors will withstand a 250 hour accelerated life test of 150% of the 85 C rated voltage impressed or the equivalent derated 125 C voltage. *Not more than 1 failure is permitted in 25 samples tested.*

The "extended-foil" capacitor sections are fully protected against moisture by an outer wrap of yellow polyester-film tape. Only ultra-thin, specially selected polyester film and aluminum foil are used. The end seals are of a plastic resin which has been formulated to bond with the film wrap and the tinned leads so as to provide a secure seal.



TYPE 158P

YELLOW-JACKET® CAPACITORS

for military and industrial electronics

Because of their outstanding resistance to humidity, vibration, and shock, Type 158P Yellow-Jacket Capacitors are ideal for many military, computer, industrial control, and similar applications. They are particularly well-suited for potting or encapsulating in electronic sub-assemblies, filters, etc.

For complete engineering data on Military-Grade Yellow-Jacket Film Capacitors (Type 158P) write for Engineering Bulletin 2301. Data on Sprague's Commercial and Entertainment Grade Yellow-Jacket Capacitors (Types 148P and 149P) is given in Bulletin 2063A. Both bulletins are available from Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:
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HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

SEE US AT THE I.R.E. SHOW — BOOTHS 2416 — 2424

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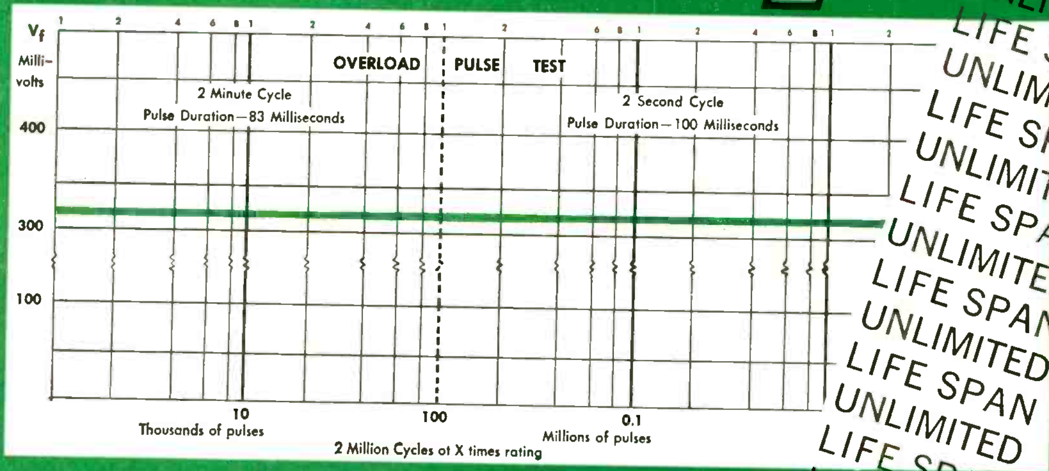
The only Selenium Rectifier Stack with no artificial barrier layer

ANOTHER ACHIEVEMENT OF GENERAL INSTRUMENT CORPORATION

RADIO RECEPTOR

Tri-Amp

UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN UNLIMITED LIFE SPAN



visible proof of Tri-Amp's unlimited life span

Day after day this life test continues in the Radio Receptor laboratories—with surge currents ten to fifteen times the rating of ordinary rectifiers! *Ordinary* cells deteriorate when run within rated limits, but Tri-Amp operates at these high current densities without detectable signs of deterioration due to age and usage.

And these results are not confined to tests—in actual performance Tri-Amp proves again and again it is one of the most effective forms of rectification available to modern industry! It has a true P-N junction formed by a closely controlled diffusion process involving the use of cadmium-selenide and tellurium. We'll be glad to send you more complete information on this important development. Write today to Section

CHECK LIST OF Tri-Amp SUPERIORITY

- Better overload characteristics.
- High current ratings.
- Lower forward voltage drop.
- No sudden failures.
- No special protective devices required.
- Smaller size.
- Operate in parallel or in series without special precautions.

REALLY R&R RELIABLE

AUTOMATIC MANUFACTURING

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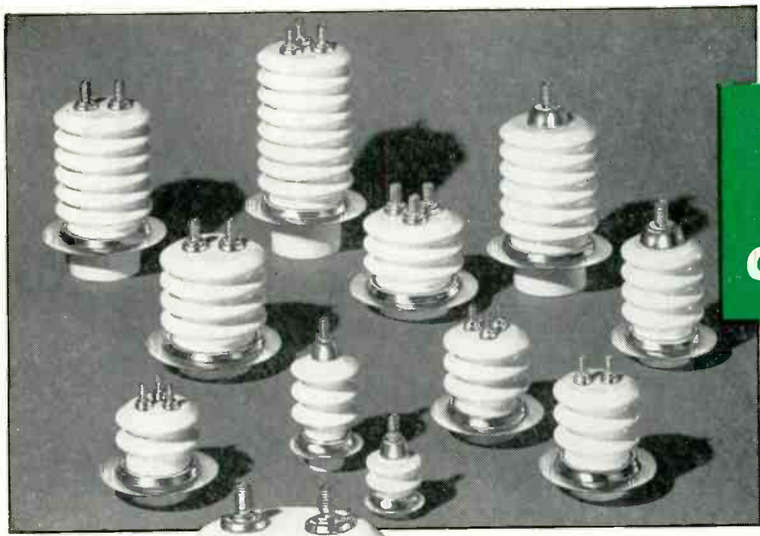

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CERAMIC-TO-METAL SEALS

Standard Bushings or Special Designs

FROM ONE COMPLETELY INTEGRATED SOURCE

ALITE — with its completely equipped facilities for producing high quality, vacuum-tight, ceramic-to-metal seals — is geared to meet all your requirements for high alumina ceramic-metal components. From design to finished assembly, every manufacturing step — including formulating, firing, metalizing and testing—is carefully supervised in our own plant. Result: effective quality control and utmost reliability.

Hermetic seals and bushings made of high alumina Alite are recommended for electromechanical applications where service conditions are extremely severe or critical. Alite has high mechanical strength and thermal shock resistance. It maintains low-loss characteristics through a wide frequency and temperature range. It resists corrosion, abrasion and nuclear radiation. Its extra-smooth, hard, high-fired glaze assures high surface resistivity.

To simplify design problems and speed delivery, Alite high voltage terminals, feed-throughs and cable end seals are available in over 100 standard sizes. However, when specifications call for special units for unusual applications, you can rely on expert assistance from Alite engineers to help you take full advantage of Alite's superior properties.

Write us about your specific requirements today.

WRITE FOR HELPFUL FREE BULLETINS

Bulletin A-7R gives useful comparative data. Bulletin A-40 describes Alite facilities and complete line of Alite Standard Bushings.

ALITE DIVISION

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102-G

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Personals

Vernon L. Grose has joined Litton Industries Electronic Equipment Div. as Head of the Reliability Staff, Guidance Systems Lab., Beverly Hills, Calif.

Robert B. Corby has been appointed to the position of Staff Engineer in the Program Planning Dept. of Motorola's Western Military Electronics Center, Phoenix, Ariz.

Dr. Choh-Yi Ang has been appointed Director of the Materials Labs. of P. R. Mallory & Co., Inc., Indianapolis, Ind.

Dr. Martin A. Edwards has taken charge of General Electric's New Advanced Planning Operation, Owensboro, Ky., to develop new electronic components. He had been Engineering Manager of the General Electric X-Ray Dept. in Milwaukee.

M. A. Edwards

F. A. Morris

Frank A. Morris is now Acting Director of Engineering in Stromberg-Carlson's Products Div., Rochester, N. Y.

Dr. John L. Grigsby has joined Applied Technology, Inc., Palo Alto, Calif., as Chief Engineer. He was formerly with the Stanford Univ., Applied Electronics Lab.

Neil A. Marshall has been appointed Chief Engineer of the Special Products Div., Leach Corp., Compton, Calif.

Quinn Gow has been appointed Chief Thermal Engineer for The Zippertubing Co., Los Angeles, Calif.

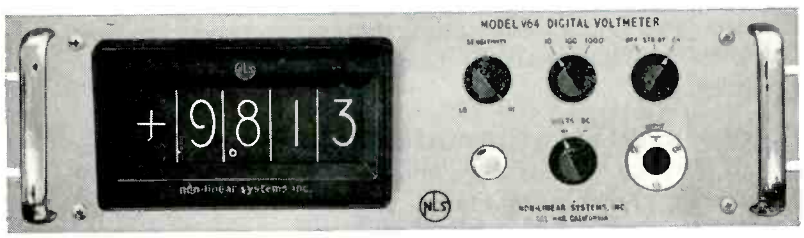
Francis L. Jackson has been named Assistant Director of the Franklin Institute Labs., Phila., Pa.

Eugene N. Torgow has joined the Engineering Div. of the Polytechnic Research & Development Co., Inc., Brooklyn, N. Y., as a Department Head of Special Products.

Howard T. Sterling is now Chief Engineer of the EPSCO, Worcester Div.

NOW $825

A Full Four-Digit Voltmeter at a Pointer Meter Price!



FOR THE FIRST TIME you can have the accuracy, speed and reliability of an NLS digital voltmeter with full four-digit resolution . . . for the price of a quality pointer meter. That's the dramatic story of the new NLS V64! Only NLS high-volume production techniques make it possible. Use the low-cost, versatile V64 for a wide range of measuring jobs. See the V64 in action...contact NLS today!

BRIEF SPECIFICATIONS: Accuracy ± (.02% of reading plus 1 digit) . . . full 4-digit resolution . . . measures DC voltages from one millivolt to 500 volts in steps of ±9.999/99.99/500.0 . . . one package design (5¼" high, 15¼" deep for 19" rack) . . . plug-in accessories permit measuring AC or low-level DC voltages . . . available from stock for immediate delivery.

NLS

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (SAN DIEGO), CALIFORNIA

NLS — The Digital Voltmeter That Works . . . And Works . . . and Works!

Microwave Component News from SYLVANIA

Lower relay equipment operating costs with new Sylvania Klystrons

Metallurgical and processing improvements mean superior life and performance

Sylvania's research and production capabilities have produced a series of klystrons that promise to surpass earlier types in performance.

Sylvania's klystrons have the following features:

Improved high-temperature glass seal — this permits higher bake-out temperatures and gives a lower gas level. The resulting tubes have a life expectancy of 10,000 hours, 2,000 hours longer than competitive types, and better shelf life. This means lower operating costs for relay link equipment.

Purer metals and materials — the premium quality metals used in these tubes, combined with new, exacting processing techniques permit higher bake-out temperatures and result in longer trouble-free operation with low gas levels.

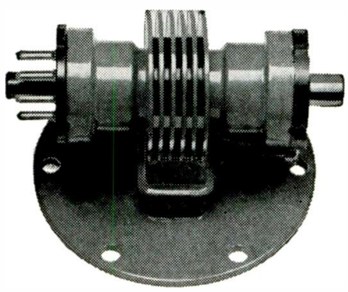
Superior performance — full coverage from 5925 to 8100 mc with 1 watt nominal output power. Most of these tubes have a minimum electronic bandwidth of 28 mc.

Sylvania klystrons will give you added cost savings because of their longer life and fewer early-life failures. Send for the data.

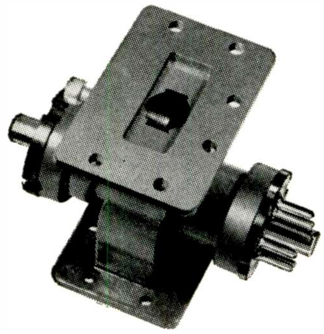
SYLVANIA

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

Sylvania Electric Products Inc.
Special Tube Operations
500 Evelyn Ave., Mountain View, Calif.



K-4160, shown approx. 1/3 actual size. Fins facilitate forced-air cooling.

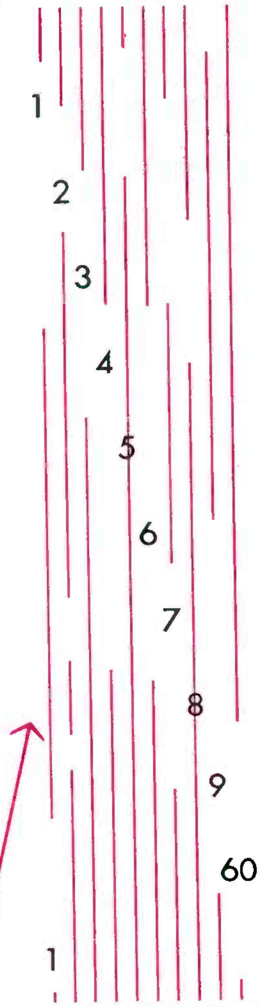


K-4186, shown approx. 1/2 actual size. Flange connects to heat sink.

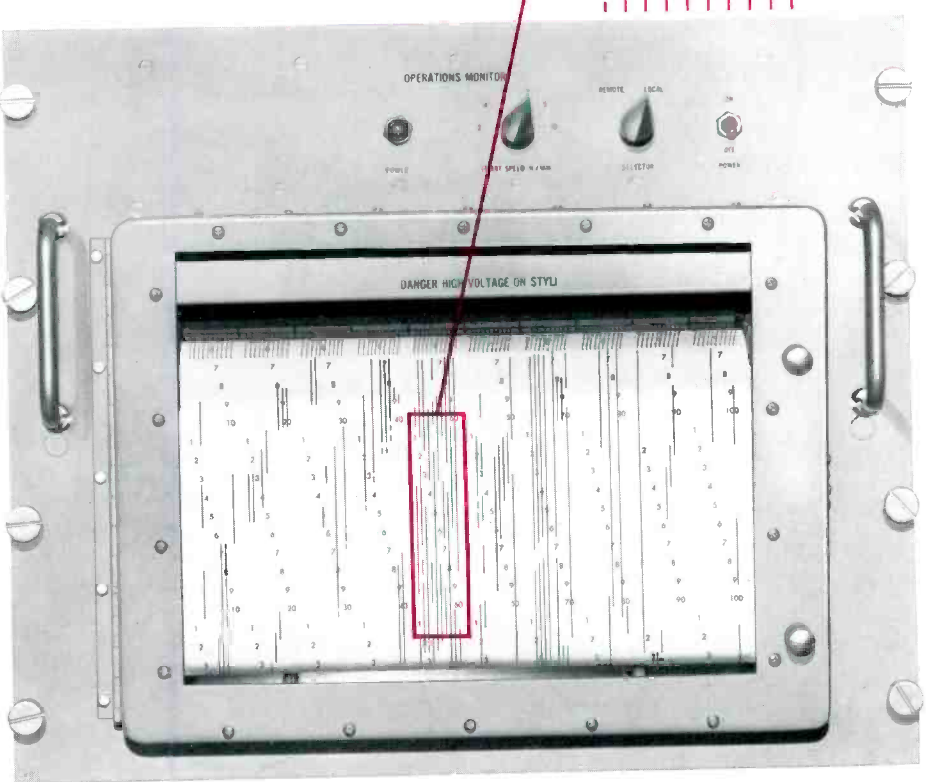
Forced air cooled	Conduction cooled	Frequency
K-4035	K-4189	5925-6225 mc
K-4162	K-4188	6125-6425 mc
K-4202	K-4187	6425-6575 mc
K-4161	K-4186	6575-6875 mc
K-4034	K-4185	6875-7125 mc
K-4160	K-4184	7125-7425 mc
K-4033	K-4183	7425-7750 mc
K-4036	K-4182	7750-8100 mc

Circle 81 on Inquiry Card

Circle 82 on Inquiry Card →



insight at 4 milliseconds



recorded with Brush operations monitors. Multiple high-speed events are reported in writing within 4 milliseconds of occurrence—to establish the basis for split-second, million dollar decisions necessary in today's complex control systems. Up to 120 separate "on-off" event signals are monitored and permanently recorded on a chart only 12″ wide. Fixed-stylus electric writing provides sharp, reproducible traces of uniform clarity. Chart speeds from one to 250 mm/sec permit a precise interpretation of all events, with resolution up to 500 signal changes per second. For military or industrial analysis and control, no direct writing recording system can match the capabilities of Brush Operations Monitors. Write today for complete specifications and application data.

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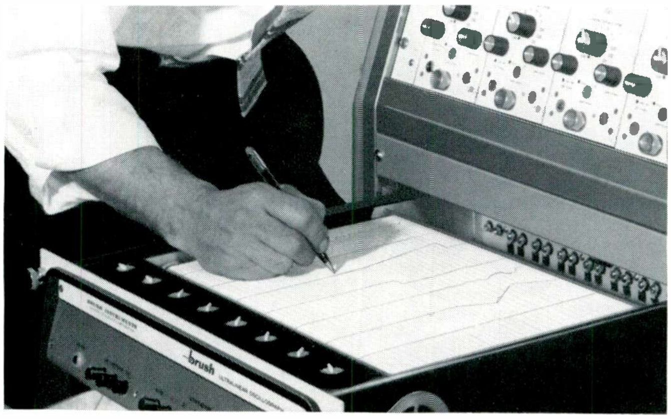
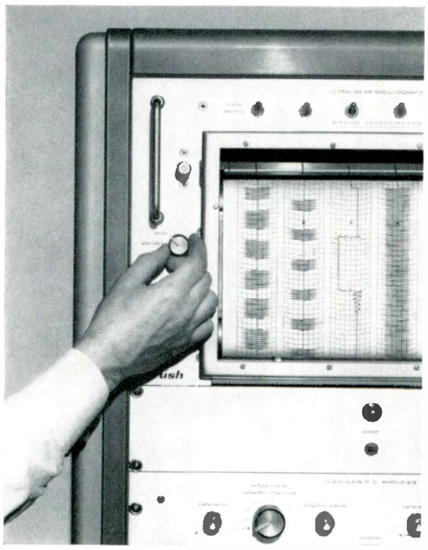
DIVISION OF CLEVITE CORPORATION

37TH AND PERKINS CLEVELAND 14, OHIO





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Avoid a "second best" choice. Get exactly what you need. Only Brush permits selection of . . . **Writing Method** . . . ink, electric or thermal . . . **Trace Presentation** . . . curvilinear or rectilinear . . . **Configuration** . . . vertical or horizontal, rack mounted or portable models. Also . . . chart speeds from 50″/sec to 10″/day . . . functionally designed control panels . . . readily accessible components for fast inspection, simple adjustment . . . complete, easy to understand operating manuals. Get the industry's most advanced design concepts. You never need compromise when you specify Brush. Complete information at your request.

brush INSTRUMENTS

DIVISION OF

37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

Next month

SPACE ELECTRONIC ISSUE

● THE CORIOLIS EFFECT

To the earth bound observer, a body having velocity does not travel in a straight line. It veers off to one side under the influence of an apparent force called Coriolis. This article assists in getting an intuitive grasp of this classic effect.

● SUPER POWER MICROWAVES AND SPACE PROBLEMS

Space platforms can be of great importance because they permit broad-band reliable communications of various kinds. They also provide an observation platform, means for a stable optical beacon, radar support structure and an optical observation post. Here are the results of calculations to the problems of space communications and radio transmission of power.

● STRUCTURAL FEEDBACK FILTER NETWORKS FOR ROCKET CONTROL

Structural feedback in a large rocket is a potentially disasterous situation. The conditions which produce it do not often come to light until the design is established and a dynamic analysis made. Under these circumstances the most practical corrective measure is the addition of an RC filter in the control system.

● SPECIAL EDITORIAL STAFF REPORT

The New Space Decade . . . as Viewed at Hughes Aircraft Company, Calif.

During the past ten years the electronic industries have developed systems and devices for the military that have been instrumental in making possible the most advanced tactical systems known. Scientific, engineering and production facilities within the industry have conceived, developed and produced technology and hardware which is now the basis for our military preparedness in manned aircraft and missile systems.

Today the electronic industries are experiencing a transition; the change of thinking from the requirement for more advanced manned aircraft and "ordinary" missiles, to the challenge of conquering space. The change of thought has not occurred within the industry, but among the industry's best customers. Our challenge in space thus becomes a responsibility for demonstrating that the electronic industries have within established facilities, the ability to advance successfully into the age of space.

Scientific and engineering capability within these facilities eliminates the necessity for establishing new and duplicating efforts for the purpose of extending what we already have gained in knowledge and experience.

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New concepts and capabilities in solid state devices. "Growing" radio receivers, amplifiers, from pools of molten semiconductor materials—termed possible.

Molecular Electronics

RECENTLY U. S. Air Force and Westinghouse Electric Corporation officials demonstrated how the startling new concept of "molecular electronics" may revolutionize the electronic industries and extend man's reach into space.

In taking the wraps off a status report, Westinghouse and Air Force representatives showed a variety of working sub-systems which are vastly more reliable and as much as 1000 times smaller than the most advanced electronic devices in use today.

Fig. 1: This molecular electronic audio amplifier has an output of 5 watts when a heat sink is used. Amplifier is the black device on the right; on left is a preamplifier. Frequency range is 0 to 20 KC.

New systems, employing these concepts, they said, could be operational in missiles or satellites in three to four years to perform such functions as telemetering light intensity or radiation levels back to earth, and providing infrared detection and reconnaissance information, flight guidance and communications.

Col. W. S. Heavner, USAF, chief of the Wright Air Development Division's Electronic Technology Laboratory, Dayton, O., said that "we expect Westinghouse will accelerate work on this program to prove the feasibility of a 'molecularized' radio receiver.

"The Air Force also hopes to find ways for molecular electronics to contribute to bio-electronics—this being the ability to simulate the superior biological capabilities found in the animal kingdom. For instance, we may be getting a step closer to duplicating the magnificent performance of the human brain."

To show the feasibility of a molecular electronic amplifier sub-system, Dr. S. W. Herwald, Westinghouse vice president in charge of research, demonstrated an amplifier used in a high fidelity phonograph in which the pre-amplifier was the size of a matchhead and the power amplifier was smaller than a dime.

"If this can be accomplished now, it isn't difficult to foresee development of a complete communications receiver the size of a pea within a few years," he said. Later he showed a "countdown switch," a sliver of germanium the thickness of a toothpick which would make it possible to monitor more effectively the pre-launch check-out of a missile.

"The concept of molecular electronics, in effect, 'leapfrogs' over current attempts to make electronic systems smaller and more reliable," Dr. Herwald said.

Col. Heavner pointed out that "it appears that the majority of present day military electronic equipment requirements can be satisfied with molecular electronics which will reduce size and weight and improve reliability."

"When this happens," he declared, "the use of many low-power conventional, standard component parts will greatly diminish and eventually disappear because

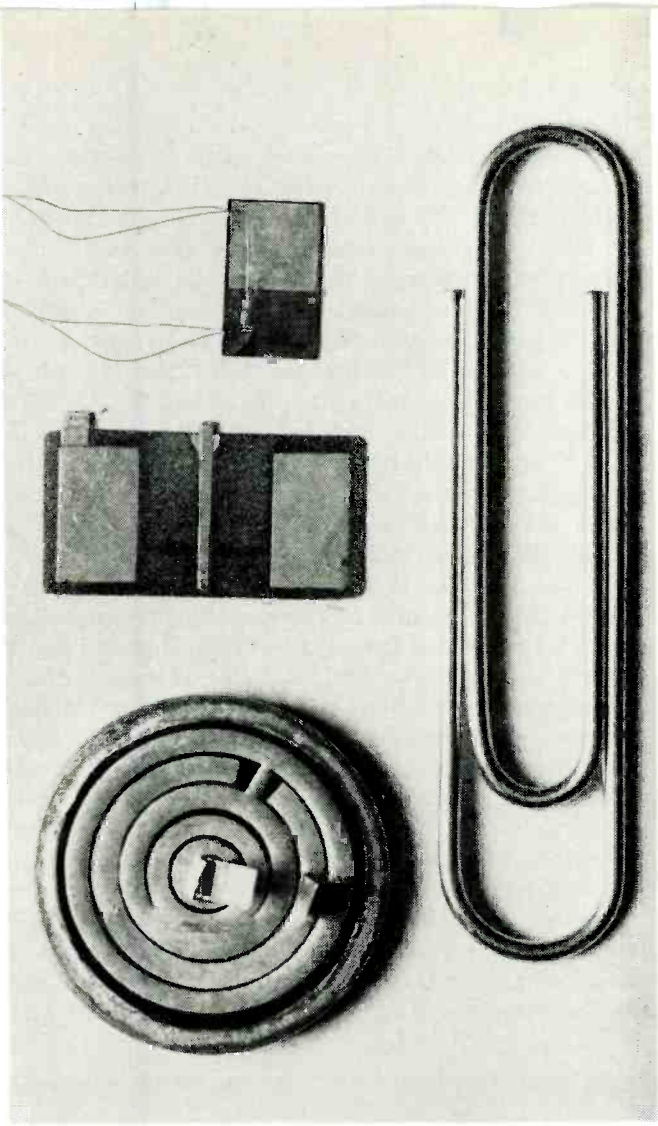

Fig. 2: Three function blocks representing subsystems: (top) a two-stage video amplifier; (center) a free running multivibrator; and, (bottom) the device with the concentric arcs, an audio amplifier.

molecular electronics demonstrated today has eliminated such components as resistors, capacitors, diodes and transistors."

Col. Heavner also said, however, that "as revolutionary and dynamic as this new technology seems to be, it probably will not replace all of the present conventional electronic component parts."

To construct molecular electronic sub-systems, Dr. Herwald said Westinghouse scientists first determine the desired electronic functions to be performed and then build these functions into a single piece of semiconductor material such as silicon or germanium. By such techniques as plating, etching, and alloying, the structure of the tiny solid piece is arranged to perform the identical functions that now require many individual components which have to be soldered together.

"For example, this phono-amplifying system has only eight soldered connections between the turntable and the speaker," Dr. Herwald explained. "A conventional phono-amplifier has perhaps eighty. Any one of these soldered connections can be a source of failure.

"Today, we are dealing with a technological paradox," he continued. "As we add electronic equipment to air and space craft to make these vehicles more versatile and intelligent, the risk of failure among their components and connections increases. Furthermore, it becomes more and more difficult for the designer to meet the weight and volume requirements for the necessary electronic gear."

The Air Research and Development Command awarded Westinghouse a $2 million contract last spring that made possible the rapid development of these sub-systems as a result of new basic knowledge of semiconductor materials. This knowledge has enabled Westinghouse scientists to develop a method of growing semiconductor crystals in which the basic material will be used. The new technique, a radical departure from existing methods, grows the crystals in the form of long, thin, near-perfect ribbons, or dendritic strips. The dendrites can be incorporated into finished semiconductor devices without intermediate material processing of any kind.

"By this new technique," Dr. Herwald declared, "our scientists have 'grown' multi-zone crystals, which provide the basic building blocks required in molecular electronic systems. We call such basic units 'functional electronic blocks,' each one of which is a complete functioning electronic sub-system. Eventually, we believe it will even be possible to automatically and continuously produce actual electronic equipment, such as radio receivers and amplifiers, starting from a pool of molten semiconductor materials."

As one accomplishment of the joint program, we are now producing a variety of molecular electronic "function blocks," three of which are shown in Fig. 1, as solid-state elements that achieve, entirely within themselves, electronic results such as have been gained

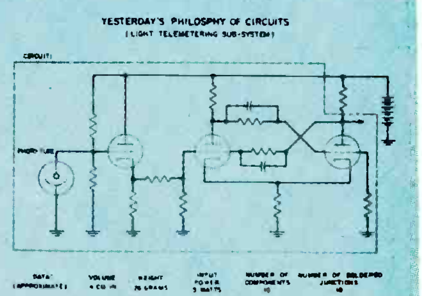

Fig. 3: A light telemetry subsystem showing extent of circuitry required when electronic tubes are used.

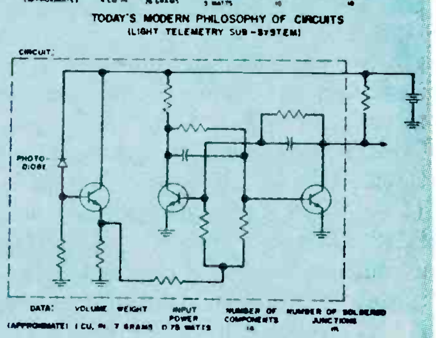

Fig. 4: Same subsystem as shown in Fig. 3 but using transistors instead of tubes.

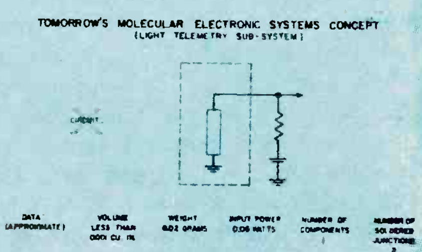

Fig. 5: The same system as shown in the preceding two illustrations, but this time the system uses a molecular electronic element.

Molecular Electronics *(Continued)*

only by assembling many, varied items of electronic hardware. Because of this, these elements are not intended as "components," as we think of transistors and tubes. This ability of molecular electronics to reduce the number of components and connections required is illustrated by a comparison of three designs for a light telemetering subsystem, Fig. 2. When designed to use electronic tubes, this subsystem required 16 components and 18 soldered connections; when designed to use transistors, it required 14 components and 15 connections. In contrast, a molecular electronic subsystem to achieve the same purposes, now needs but one component and two connections.

Also, because their internal functions involve distances of the order of a few atomic spacings, these function blocks are almost microscopically small and virtually weightless. For example, weight of the light telemetry subsystems was reduced from about one ounce to one quarter of an ounce, the weight of the monolithic element to about seven ten-thousandths of an ounce.

Eight classes of function blocks to demonstrate the feasibility of molecular electronics at frequencies ranging from infrared to direct current have been developed. These function blocks are: (1) 5-watt directly cascaded audio amplifier, (2) two-stage video amplifier, (3) frequency selective amplifier with notch filter in a feedback loop, (4) variety of multivibrators —bistable, monostable and astable. (5) variable potentiometer based on logarithmic addition of two inputs, (6) a variety of multiposition switches (including an "OR" switch, a multiple NPNP Dynistor switch, and a multiple NPNP Trinistor switch with firing electrode), (7) analog-to-digital converter employing an NPNP relaxation oscillator, (8) two-stage cooler, employing the Peltier effect, covering frequencies from 1 cps or less to 3 mc, for cooling infrared detectors to proper operating temperatures.

As the basis for these molecular electronic subsystems, there is a very substantial knowledge of solid state phenomena developed over the past 30 years. It is simple now to create materials having excessive positive or negative electrical charges and, by placing these materials in physical contact with related materials, to bring about such phenomena as rectification or amplification, as in diodes and transistors. Also, there is the ability of radiation to cause charge paths to occur in a semiconductor material along which current will flow when the material is irradiated.

Effects of this general type are used in molecular electronic blocks by creating—usually in single crystals—a number of distinct operative domains, which can be regarded as molecular "communities" having a common civic purpose, in that each domain will sustain a desired electronic occurrence. The domains border one another at boundaries called interfaces, which are like political frontiers in their ability to initiate phenomena different from those occurring inside the molecular domains.

As a simple example in the element diagrammed in Fig. 3 we see that it is composed of two domains which meet physically at one interface. One of these domains is composed of a resistive material selected and shaped to present a resistance R_1 to the passage of current; the other domain is also resistive, but is so planned that it has a resistance R_2. At the interface, the interaction between domains causes a capacitive effect. Thus, in one tiny element we have a subsystem equivalent to a time-delay circuit.

Another illustration of the uses of domains and interfaces is a function block designed as an ac-to-dc power supply for transistor circuits. It makes use of the Seebeck effect for the thermoelectric generation of electricity to convert 110-volt alternating current to 9-volt direct current power. In contrast, the conventional circuit, Fig. 4, requires five individual components—a transformer, a diode, and the inductive and capacitive elements making up the LC filter circuit. To accomplish this same purpose with molecular electronic methods, we have a function block comprised of the three separate domains. When a-c power is applied to the resistive domain, the heat that is generated passes through the domain at the center—this domain is an electrical but not a thermal insulator—and into the theroelectric domain where the energy is converted into electrical energy by the Seebeck effect. By proper control over the materials used, we provide the 9-volt d-c output we desire. An interesting aspect of the power supply is that elimination of ripple as an undesirable variation in voltage is inherent since heat flows from the resistive domain to the thermoelectric domain at practically a constant rate.

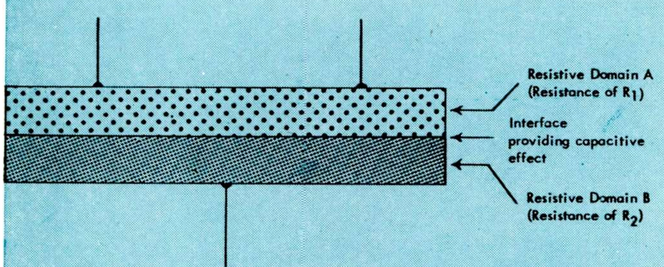

Fig. 6: Function block of two resistive domains and one capacitive interface, whose total effect is that of an RC or time-delay circuit.

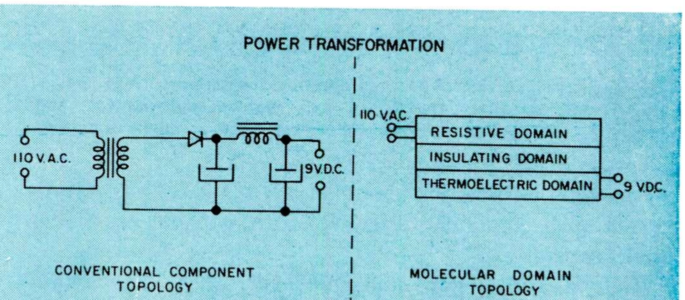

Fig. 7: AC to dc power supplies show (1) molecular element with its various domains, and (2) method using the conventional components.

As these two examples suggest, the concept of molecular electronics makes no use of the traditional circuit-and-component approach to electronics. Instead, the objective is to use our knowledge of the structure of matter to synthesize monolithic function blocks whose arrangement and composition permit each to serve as a substation to perform an electronic function in the control or transformation of energy.

To achieve function blocks with this capability, a number of effects and phenomena of the solid state are available. The only firm limitations on choice are that the effect must not react adversely on system reliability and must lend itself to consistent results when included in a function block. Methods typical of practice so far include: solid-state phenomena, such as Seebeck generation, Peltier cooling, and Hall-effect multiplication; the use of PN semiconductor junctions arranged to produce a result which would otherwise require numerous individual components; and when necessary, fabrication of circuit elements within a function block. Although such phenomena will be most often used for the control of electrical signals, they will also be suitable when quantities like electromagnetic radiation, heat, and mechanical displacement are inputs or outputs.

The design of a subsystem begins with the designer's analysis of the requirements of the system, to establish the functions to be performed by the function block. After logic processes are determined and suitable physical effects settled upon, a topologist—a mathematician who works with shapes—determines the structure of the block by designing, on paper, the arrangement of domains and interfaces that is to control the flow of energy in the block. The block is then produced by the materials engineers who use germanium and silicon as the basic semiconductor materials.

In producing these blocks we start with a basic semiconductor wafer and produce the necessary domains and interfaces by techniques used in the production of conventional semiconductor devices, including diffusion, plating, electron beam machining, etching, cutting, radiation, alloying, and photographic processes. Although the function block so produced can now perform its function, additional processing steps are required to encapsulate the block, protect it against shock and vibration, and make it stable under the conditions of temperature and radiation it will encounter.

As observed, the dominant theme, the essential philosophy of molecular electronics is that we can now create, modify, and process materials to endow them with the ability to accomplish electronic tasks through solid-state phenomena. The foundation of success has been our ability to develop new materials and to process available materials in new ways.

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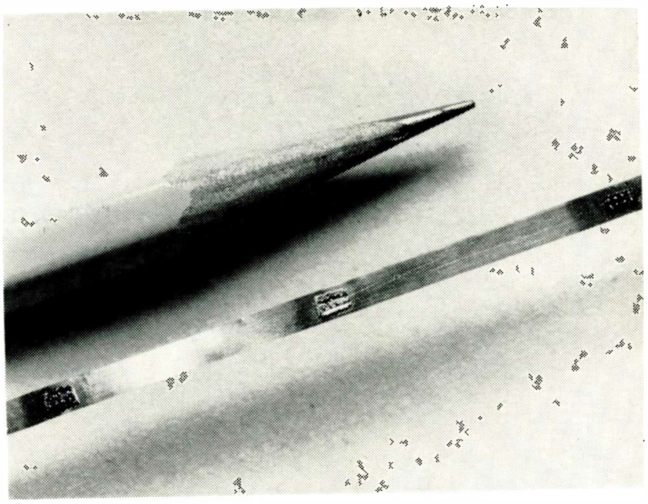


Fig. 8: Ribbon bearing multiple junction systems on germanium crystal produced by dendrite process. Three systems are shown on ribbon.

One important illustration of the contributions made by materials scientists is the development of a method for the rapid production of semiconductor crystals in a form that requires no removal of material to make them into suitable wafers for use as transistors or as the basic elements of molecular electronic elements. This is the dendrite process announced several months ago, in which germanium crystals in the form of ribbons about one-eighth of an inch wide and a few thousandths of an inch thick, are produced by drawing them from a molten mass. In contrast, in the conventional method, germanium crystals are grown as thick ingots, or boules, which require X-ray or crystallographic inspection before they can be sawed into precisely oriented wafers and then must be lapped, etched, and polished to obtain a satisfactory working surface. In addition to the waste of material and the cost of machining involved in the standard method, a serious disadvantage to its use for the production of molecular electronic blocks is the wide variation in characteristics frequently displayed by wafers, even by those cut from adjacent regions of a single ingot and processed identically. In the production of transistors, this difficulty can be circumvented by testing a production run to select those with proper values. In molecular electronics, however, it is necessary to build junctions in adjacent portions of the same crystal; thus it is essential to have materials whose characteristics are uniform if the yield is to be acceptable.

Other advantages of this dentritic method of importance to molecular electronics are these:

It is essentially a continuous process in which the germanium ribbon grows at a rate of 6 to 12 in./min. and in the precise direction of crystal growth we require for application. Thus, no X-ray or crystallographic examination is necessary, and the surfaces of the ribbon are always correctly oriented, optically flat, and immediately usable as working surfaces. An additional advantage is that if a contaminant enters the melt during the process, the resulting inclusion is "self-healing" so that when the process is completed,

(Continued on page 270)

Many pieces of airborne equipment depend for their accuracy on rigid control of the alternator power supply frequency. This new system holds the frequency within 0.4 cps at 400 cps by nulling a line frequency signal and a precise reference frequency through an electrical differential.

For Military Equipment . . .

Controlling Alternator

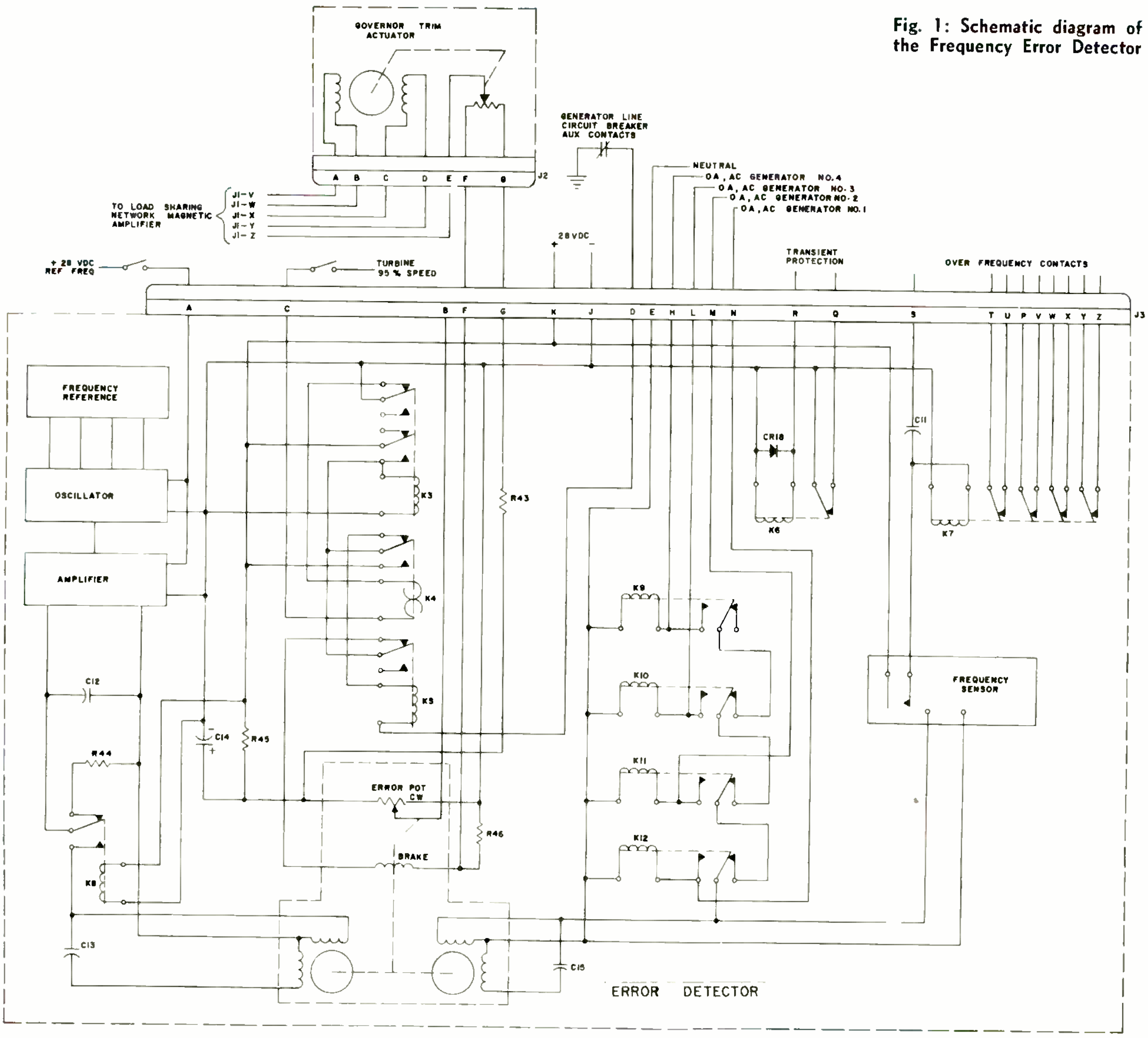
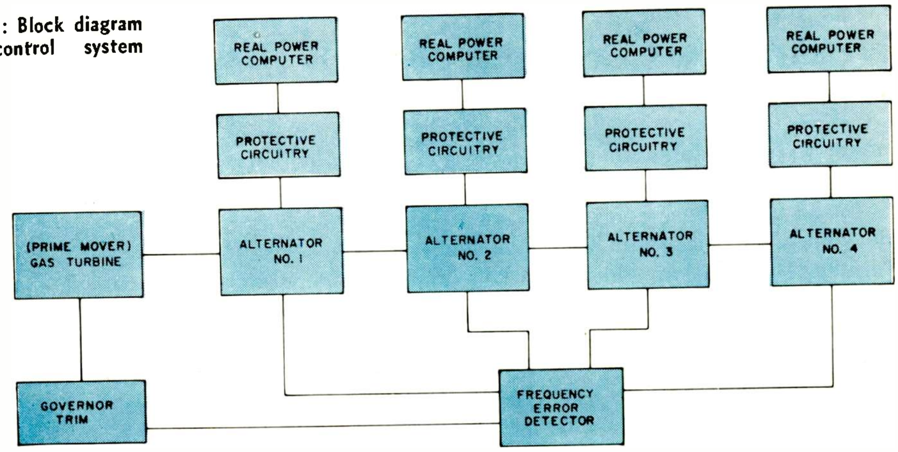


Fig. 1: Schematic diagram of the Frequency Error Detector

Fig. 2: Block diagram of control system



By **HARRY ETCHES,**
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Frequency

THE increasing military a-c power requirements, especially in aircraft, have created problems of frequency control, balancing of load between alternators, paralleling, etc. Similar problems are encountered at remote power plant installations; that is, with multiple alternator power sources that do not tie in to the large commercial power networks. With military power supplies, the problem of maintaining line frequency within rather close limits is becoming more important as an increasing amount of electronic equipment is used, some of which depends upon an accurate control of frequency for proper operation.

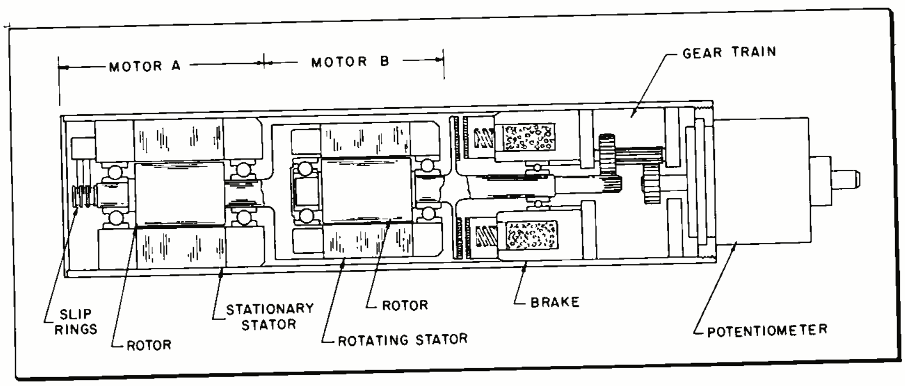
To illustrate, equipment incorporating various cathode ray displays rely upon line frequency to obtain timing traces. Synchronous motor types of equipment also depend upon frequency control for accuracy. In commercial operation accuracy is achieved by a time-average approach. That is, over a period of 24 hrs., for example, line frequency can be adjusted so that the average frequency for the period is 60-cycles. In addition, the vast mass and capacity (running to many hundreds of thousands of KVA) of the tied-in networks tend to maintain stable bus conditions. With military installations, the time-average frequency concept cannot be accepted because the instrumentation requirements are for short term steady state frequency accuracy and, again, the average installation may provide a matter of only a few KVA to a few hundred KVA. Thus, there is little system mass to provide stabilization.

Since multiple alternator power generating units are more frequently being used, the automatic paralleling and load sharing of these units is of importance. Paralleling can be accomplished only if accurate frequency can be maintained. Open loop mechanical and electrical control systems used for maintaining the speed of the prime mover allow too wide a frequency drift, and in turn unsatisfactory paralleling and load sharing.

Circuit Description

This Fine Speed and Load Sharing Control System provides an electrical and electronic means for precisely maintaining steady-state line frequency (Fig. 1). This is achieved by nulling a line frequency signal and a precise reference frequency through an electrical differential. Because the concept involves the use of an isochronous governor, provision is made for a temporary 1-cps droop as a paralleling aid. Load sharing is achieved through a load sensing element as a part of a real power computer rather than depending upon a drooping speed-load characteristic of the prime mover, since with fine speed control this type of characteristic does not exist. AiResearch approached the problem of prime mover failure protective devices by analyzing the types of failure and determining the effects upon the system. In general, it was assumed that failures could be grouped under two headings; the runaway type, and the seizure type. Positive and

Fig. 3: Error detector supplied G-M Laboratories, Chicago, Ill.



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Frequency Control *(Continued)*

negative power detection circuits were developed which provide system protection for both types of failure.

Based upon these concepts, a series of controls was developed to maintain line frequency within close limits. In addition, these controls can provide the means for automatic paralleling, load sharing, as well as providing failure protection under both runaway and stalling conditions.

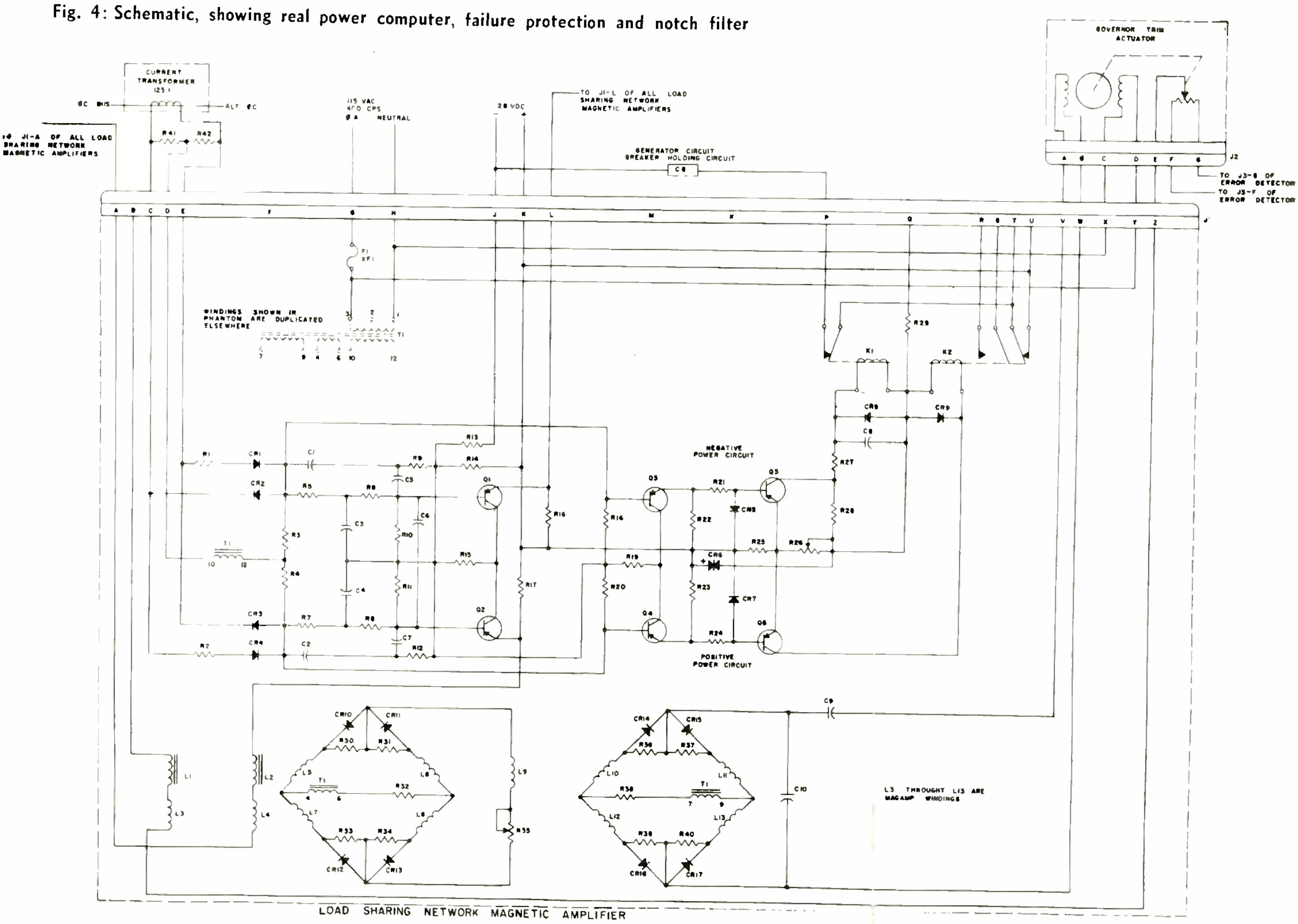
The specifications for one type control system provide that the average steady state frequency with a 60 KVA load be maintained at 400 ± 0.4 cps. This is equivalent to ± 0.1%. In addition, the alternator frequency is maintained at 400 ± 1.0 cps. within 0.8 secs after the application or removal of 60 KVA load. These tolerances are held under all environmental conditions listed under MIL-E-5272.

Frequency Error Detector

Fig. 1 shows schematically the Frequency Error Detector arrangement. Accuracy of control is achieved by the null method. A precise frequency reference signal is generated and amplified sufficiently to drive a small synchronous motor. Bus voltage is supplied to a second synchronous motor. Any difference in the frequencies to the two motors will result in a difference in movement of the two output shafts which is proportional to the difference in frequencies and is, therefore, a measure of the frequency error.

Commonly, such differential movement is conveniently coupled by gear type differentials to produce movement of a single output shaft which is a function of the error. Working with the G-M Laboratories of Chicago, Illinois, AiResearch came up with an Error Detector which has no differential gearing. Instead, an electrical differential approach has been used. Diagrammatically, this is shown in Figure 3. The two synchronous motors are still used. The stator of one motor is fixed to the housing. However, as can be seen, the rotor of this first motor is rigidly coupled to the "stator" of the second motor. The latter stator is ball bearing mounted and so is free to rotate with the rotor of the first motor. Electrical connections to this rotating stator are made through slip rings. The rotor of the second motor can rotate in the moving stator in a normal manner. If the frequency of the reference signal is identical with the line frequency, the movement of the rotating stator is equal and opposite to the movement of the rotor with the result that there is no movement of the output shaft. Any frequency difference between reference source and line will be reflected in output shaft movement. If the line frequency is higher than reference frequency, the rotor rotates faster than the stator, and

Fig. 4: Schematic, showing real power computer, failure protection and notch filter



the converse is true if the line frequency is less than reference frequency. Thus the output shaft velocity is a function of frequency difference and is proportional to that difference. If a potentiometer shaft is connected to this output shaft, an error signal is produced which is a rate of change of output voltage proportional to the difference in frequency.

Warm-Up Delay

To ensure immediate accuracy of the frequency reference, present units require somewhere between 20 and 30 secs warm-up. Consequently, prior to starting the prime mover, provision is made to switch on this component separately. Likewise, to ensure immediate operation of the error detector after release of the brake by the 95% speed switch, relay K8 applies power to the error detector. Time delay relay K4 is activated by the 95% speed switch to release the brake. Time delay is required to allow the prime mover to get from 95% speed to approximately 100% speed before switching to Fine Speed Control. This reduces transients in the control system. When relay K3 pulls in, the coil circuit for time delay relay K4 is opened permitting it to cool off and so maintain substantially constant delay time whenever it is used.

Relay K5 aids in paralleling. Assuming that the alternator frequency is 400 cycles, when K5 is energized by an external contactor, the error detector brake is applied and a resistor is put in the circuit of the follow-up and error potentiometers. In effect, this establishes an unbalance which is corrected by movement of the trim actuator. This movement produces a 1-cps droop for as long as the contactor holds. When the alternator parallels, the external contactor is opened, de-energizing K5 and 400-cycle control is resumed.

Several additional conditions must be considered. For example, if the control is allowed to be active when the prime mover is shut down, the error signal will increase to the maximum, asking for an increase in speed. Thus, when the prime mover is restarted, the control would be still at the maximum error position. The increase in prime mover speed being very rapid, the return of the error detector from maximum displacement would be slow in comparison resulting in overshoot and hunting. This is eliminated by the incorporation of an electro-magnetic brake which is applied to the output shaft simultaneously with shutdown. The error detector is therefore maintained at a setting near the correct frequency operating point.

In a typical installation, a "95% speed" switch acting through a time delay relay provides for the release of the brake automatically upon starting at a period in the speed events which is such that control is without significant overshoot or hunting.

Error Signal

The error signal is d-c. This was selected because it was readily used for the input of either magnetic or transistor amplifiers to drive the two-phase motor of the trim actuator. For this discussion, the magnetic amplifier will be considered.

In Fig. 4 it can be seen that this d-c input is obtained from the wipers on the error detector potentiometer and the follow-up potentiometer (which is part of the trim actuator assembly see Figure 5.

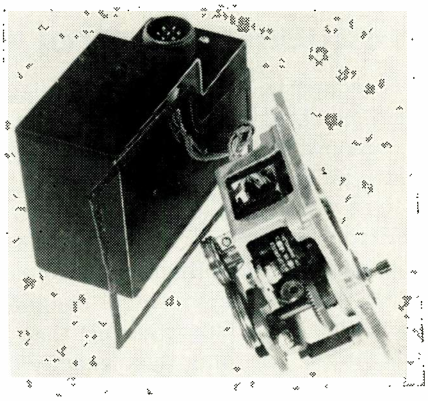


Fig. 5: Governor trim actuator assembly

This d-c signal (which can be plus or minus or zero) is fed into a 2-stage, half-wave magnetic amplifier. The output has both a-c and d-c components but the capacitor C-9 blocks the d-c. Therefore only a-c is supplied to the control winding of the trim motor. The reference winding of the motor is supplied from the 400-cycle bus. The change in phase relation of the control winding provides the necessary reversing rotation of the trim motor to maintain the precise governor adjustment to insure accurate speed control. If the input to the amplifier is zero, the trim motor receives no signal and there is no movement. Although the full voltage rating of the trim motor control winding is 57.5 volts, the design is such that a signal voltage of 8 to 10 volts will cause rotation. A signal of this magnitude will maintain line frequency control within the rated 0.1%.

Paralleling & Load Sharing

Generally, the load requirements are such that the operation of all alternators is not required. Assuming that the correct phase relationships between all alternators in the system have been established, the prime considerations when load demands call for paralleling an additional alternator are that the frequency of the added unit exactly match that of the line, the voltage equal that of the line, and that the added unit assume its share of the load. The mere placing of the alternator on the line does not assure load sharing as it could "float" on the line.

Commonly, the operation is controlled by a governor which gives the prime mover a drooping speed-load characteristic. Since paralleled alternators are essentially synchronous machines, any difference in the speed-voltage relationships between units on the line will produce circulating currents which tend to pull the machines into synchronization. The drooping characteristic of the governor, therefore, is used to assure load division between alternators. With an isochronous governor of the type used with the Fine Speed Control, there is no drooping characteristic.

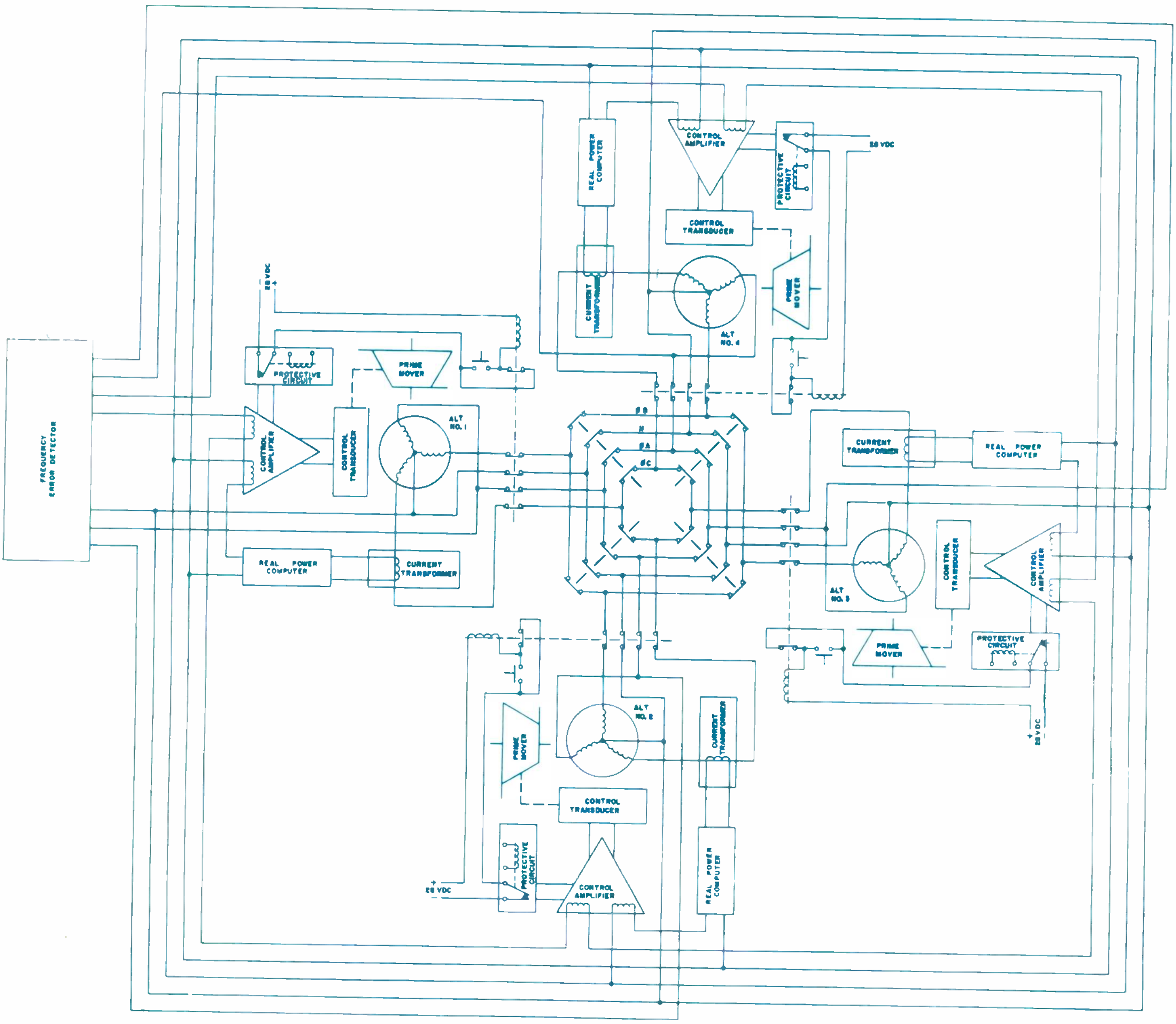
Frequency Control *(Continued)*

Consequently, other means must be provided to ensure load sharing. Figure 6 shows that each alternator has a current transformer sensing one phase. This provides an input for the Real Power Computer, the output of which is a separate input to the Governor trim actuator amplifier. Thus, the actual input signal to the magnetic amplifier is a composite of the signals from the frequency control channel and the load division channel. This assures that a newly paralleled alternator not only has exactly line frequency but also that it assumes its share of the load. To prevent circulating second harmonic components from the magnetic amplifier which could upset the control, filter chokes are incorporated in both amplifier inputs.

Alternator Speed Differences

The electrical coupling between paralleled alternators admits the possibility of there being slight differences in alternator speed, and introduces the possibility of the rotor of one machine tending to move away from what could be called its normal relationship with other rotors. This will result in a current circulating between the machines in such a direction as to pull the rotor back to its normal relationship. In other words, there is a tendency for electrical oscillation which is at a different frequency than the generated line frequency. This secondary frequency is usually very low. One system analysis indicated that 9-cycle signal would be present when generating the required 400-cycle potential if more than one alternator was operating. From a control standpoint, the presence of this 9-cycle signal is highly undesirable because it will upset the load division control. It was found that this could be eliminated by insertion of a specifically designed balanced notch filter in the Load Division channel between the Real Power Computer and the input to the Trim Actuator amplifier as shown in Fig. 4. Fig. 4 also shows the protective circuitry incorporated to protect against two types of equipment failure. The explanation of the

Fig. 6: Control system for four alternators, each of which is driven by a turbine prime mover



protective circuits starts with the establishment that a failure condition exists. It will be assumed that the failure is of a type which tends to drive one alternator overspeed (over frequency). The alternator of the faulty unit tends to assume all the line load and in addition drive the other alternators as motors. It is said, therefore, to be operating under "positive" power conditions. The alternators acting as motors are said to be running under "negative" power conditions.

Frequency Sensor

The frequency sensor is adjustable (within limits) and the actual setting is determined by the system requirements. A tolerance of ± 5 cps is usually established for the actual setting. Under the positive power, over-frequency type of failure, the contacts of the frequency sensor close providing power to open relay K7. The latter relay has normally closed contacts, individual pairs of which are in parallel with the normally closed contacts of relay K2 which is in the control package for individual alternators. K2 is in the positive power circuit so that for the alternator which is showing positive power of the magnitude determined as a failure, the normally closed contacts will have opened.

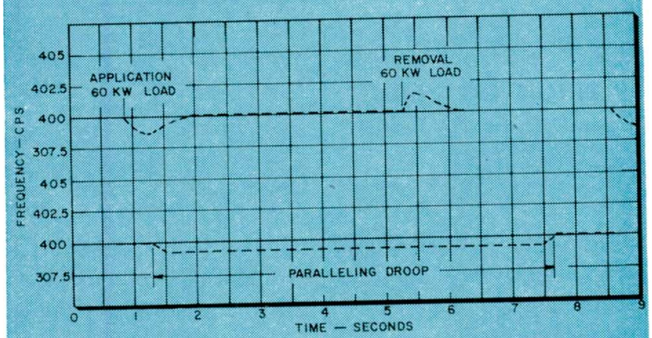


Fig. 7: Dynamic response of the fine speed control

Mechanical Seizure

A second type of failure can occur which tends to slow down the alternator. This can be caused by mechanical seizure in the prime mover or control failure.

In this situation, the other alternators tend to drive the defective unit which, in effect, is absorbing power and a "negative" power condition is said to exist.

If the failure condition is partial so that the alternator negative power is appreciable but not sufficient to trip the line circuit breaker, it is desirable to remove this alternator from the line. To perform this protective function, a negative power circuit has been incorporated which operates in a manner similar to the positive power protection circuit except that a frequency sensor is not employed. A time delay relay in the negative power circuit prevents transient conditions from opening the line circuit breaker and cutting the alternator off the line.

Representative of this series of control systems is one designed for four alternators each of which is

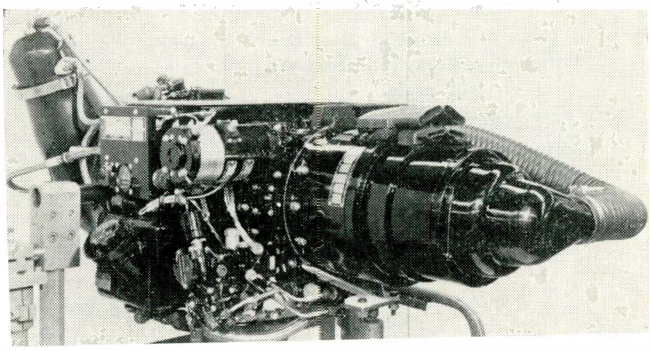


Fig. 8: Typical gas turbine generator application

driven by a turbine *prime mover.* This system is shown schematically in Fig. 6. For convenient reference, the alternators are designated Nos. 1, 2, 3, and 4. With all four alternators on the line, No. 1 is considered the "Master" alternator and the others are "slaves." The heart of the system is the Frequency Error Detector and Fine Speed Control. The assignment of the Frequency Error Detector to a particular alternator makes this unit the "Master" or controlling unit. This assignment is automatically accomplished by relays K9, K10, K11, and K12. If No. 1 alternator is shut down, alternator No. 2 automatically becomes the master, if it is operating. Otherwise the Master is No. 3 or No. 4 whichever is the lower number in operation. As other units are paralleled, control is automatically transferred to the lowest number alternator in operation.

For this particular system, a single frequency reference and error detector is used for control of all alternators. Another system requires that the individual alternators be operated and controlled independently of each other. Here, a single frequency reference is used with individual error detectors. Thus the components are flexible and the systems can be adapted to many different requirements.

The dynamic response of such an AiResearch system is shown in Fig. 7. Here the application of or removal of 60 KW loads is representative of a condition equivalent to instantaneously removing or applying the rated capacity on one alternator. The curve indicates that within 0.8 seconds, the frequency has been brought within 1 cps of the nominal 400 cps. Fig. 7 also shows the 1-cps droop which can be introduced as a paralleling aid.

* * *

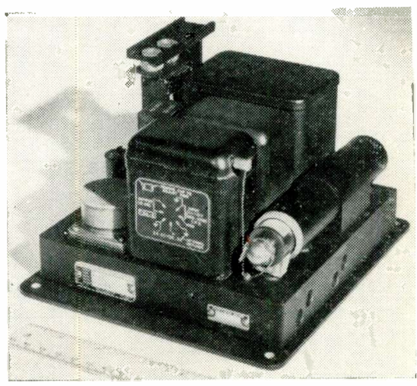


Fig. 9: Fine speed control assembly

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Little over a year has passed since the tunnel diode was first reported by Esaki. But, recognizing the tunnel diode's potential, the semiconductor industry has swung into serious application development. This article presents some general considerations on their use as amplifiers.

First of a new Design Series

Points to consider when . . .

Using the Tunnel Diode

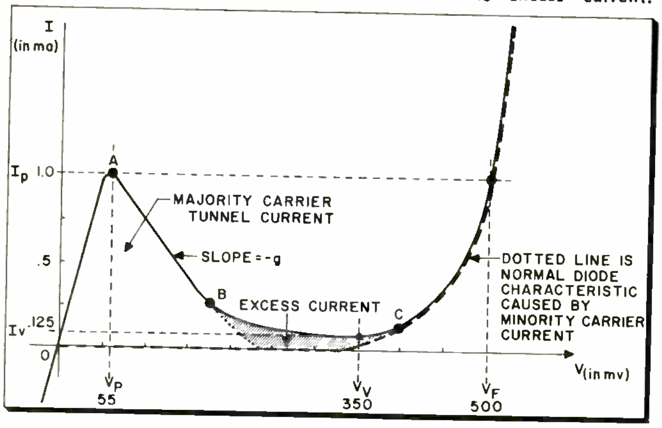
By **ERICH GOTTLIEB**
Semiconductor Products Dept.
General Electric Co.
Syracuse, New York

A GERMANIUM tunnel diode, the ZJ-56, is in development at General Electric. It uses the quantum mechanical tunneling phenomenon[1, 2] to attain a unique negative conductance "S" characteristic.

The tunnel diode[1, 2, 3, 4] is a single P-N junction diode with a negative conduction region when "forward" biased. It is highly conducting when "reverse" biased.

The negative conductance region results when the excessively high current at low forward voltages falls to somewhat above a normal P-N junction value at a higher forward voltage. The tunnel diode tends to be a high current, low voltage device. Further, it has a large negative conductance joining the two regions of large positive conductance. Fig. 1 shows a typical characteristic.

Fig. 1: The current at point C is greater than the sum of the minority and majority carrier currents and is called the excess current.

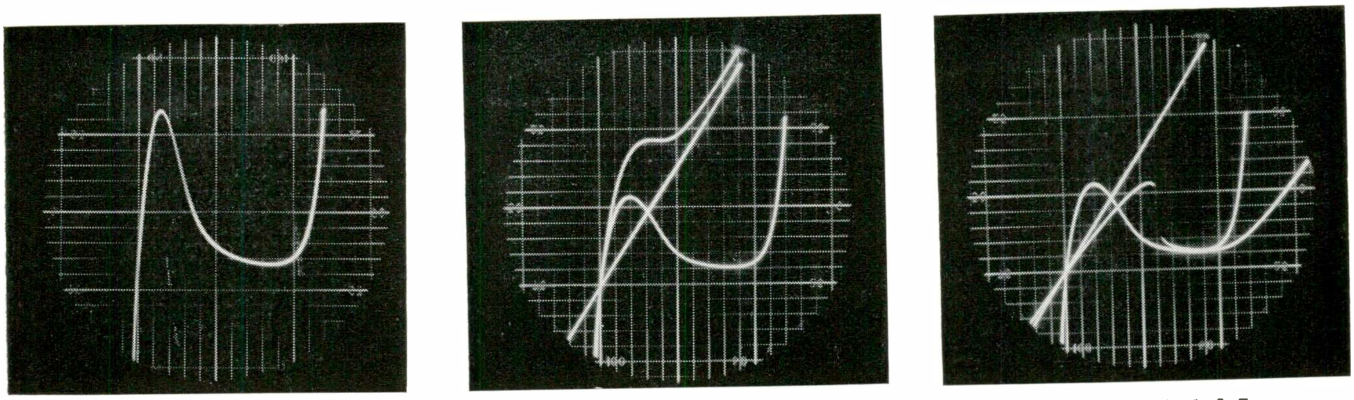


The tunnel current consists of majority carriers. The normally expected diode forward "injection" current, made up of minority carriers, becomes prevalent only towards the end of the negative conductance part of the curve, point C. A current greater than the sum of the minority and majority carrier currents at that point can not be fully explained. It is called the "excess current."

For a given fixed peak point current therefore, the highest I_p/I_V ratio would theoretically be most desirable. The ZJ-56 with a maximum peak current of 1.1 ma. has a minimum $I_p/I_V = 8$; therefore, a maximum excess current of approx. 138 μa.

The peak and valley point voltages are fixed by the semiconductor material used. For germanium these values would be about 50 mv and 350 mv; for silicon, 75 mv and 450 mv.

The magnitude of the negative conductance is equal to the slope di/dv, and for the ZJ-56 would be 0.01 typically (small signal). Being basically a forward biased diode, the equivalent circuit of a tunnel diode contains some capacitance. Its leads and internal structure present series resistance and inductance. The manufacturing process, package and structure, have been designed to minimize series resis-



Tracings of the tunnel diode characteristic curve and also its dynamic characteristics. Views are similar to Figs. 1, 6, & 7.

tance and inductance as well as distributed capacitance. Fig. 2 shows the simplified equivalent circuit of the tunnel diode.

The resistive cut-off frequency* of such a device is given by:

$$f_{go} = \frac{|G_d|}{2\pi C}\sqrt{\frac{1}{R_s\,|G_d|} - 1}$$

Therefore this device will remain "active" up to about 3.2 KMC for a 5 μμf unit, or up to approx. 1.6 KMC for a 10 μμf device.

Curve Tracing

When observing the *V-I* characteristics on a scope, part or all of the negative conductance exhibits an oscillatory condition. This latter is caused by the presence of excessive inductance in the test circuit resonating with the capacity of the diode at some very high frequency. If the total test circuit inductance were such that the circuit resonant frequency were higher than the resistive cut-off frequency, this oscillation would not exist. The inductive resonant frequency** of the device itself is given by:

$$f_o = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{g^2d}{C^2}}$$

for the ZJ-56,

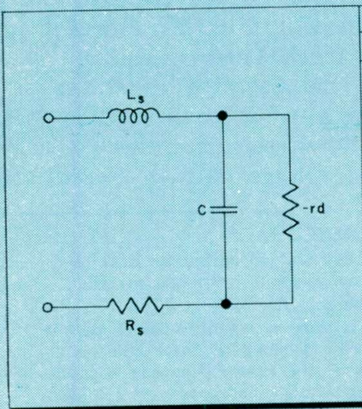
$$f_o = \frac{1}{2\pi}\sqrt{\frac{1}{6\times10^{-9}\times7\times10^{-12}} - \frac{10^{-4}}{49\times10^{-24}}}$$

$$\cong 750 \text{ Mc}$$

Although the self-resonant frequency of the device is lower than its inherent cut-off frequency, the latter is automatically reduced by any circuit resistance such as the load and generator resistances. Since external circuit resistance can be considered to be essentially in series with R_s, it would take only 50 ohms to reduce f_{go} by about 10:1, as the term under the radical becomes unity. Of course, care must be taken that the resultant additional circuit inductance does not drop f_o by the same order of magnitude.

Since most oscilloscopes have too much series resistance, they will not show the entire *V-I* characteristic as the device is caused to switch over the negative conductance region. A simple curve tracer circuit, Fig. 3, is capable of tracing the full characteristic. Even here one must be careful to avoid excessive distributed capacitance across the diode.

* The resistive cut-off frequency (f_{go}) is the frequency at which the real value of the negative conductance goes to zero.
** The self-resonant frequency (f_o) is the frequency at which the internal inductance and capacity will resonate if the device terminals were ac short-circuited.

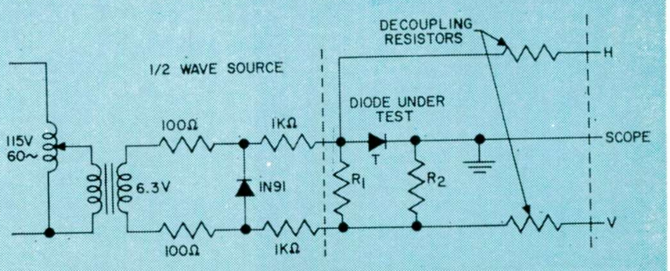


TYPICAL VALUES OF "ZJ56" PARAMETERS	
SERIES INDUCTANCE, Ls *	6mμh
TOTAL CAPACITANCE, C *	7μμfd
SERIES RESISTANCE, Rs	1ohm
NEGATIVE CONDUCTANCE, gd	.01mho
NEGATIVE RESISTANCE, rd	100ohm
PEAK POINT CURRENT, I_p	1ma
VALLEY POINT CURRENT, I_V	.1ma

* 1/8 INCH LEAD LENGTH

Fig. 2: Simplified equivalent circuit and parameters of a tunnel diode.

Fig. 3: This circuit permits full tracing of characteristic curve.



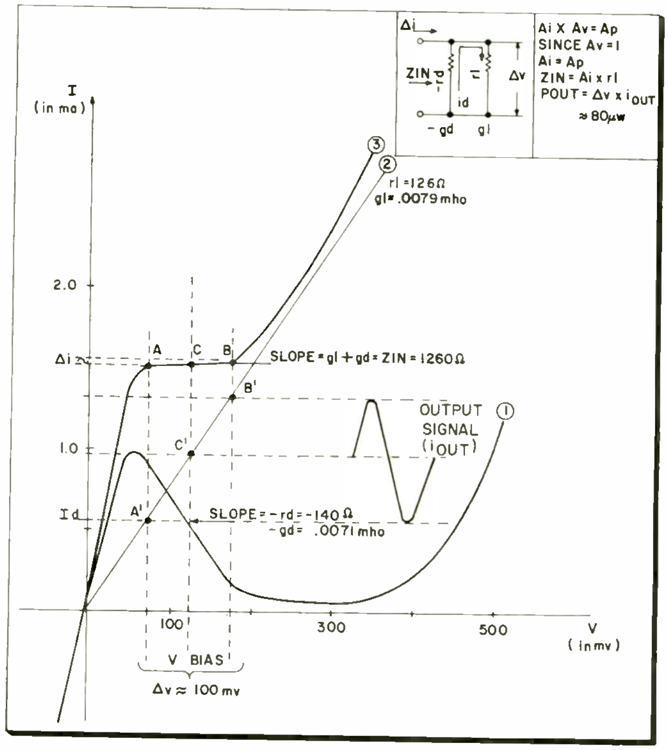


Fig. 6 (right): Performance is easily determined by using this graph for analysis of a parallel connection (short circuit stable) amplifier.

Tunnel Diodes *(Continued)*

Otherwise, the desired curve, Fig. 1, will be transformed into one, indicating the presence of oscillation, Fig. 4. The values of $(R_1 + R_2)$ in Fig. 3 are important and somewhat critical. When

$$R_1 + R_2 > 1 / |g|$$

the device can only switch and the "S" characteristic will not be seen in full, Fig. 5. Too small a value of $R_1 + R_2$, or R_s, can also lead to oscillation because some parasitic inductance, as well as capacitance, can not be avoided. As both the circuit Q and ω_c are increased with decreasing R_s, there exists a minimum R_s below which oscillations can not be be avoided.

Amplifiers

Having established some of the basic concepts of the device, one can now look at three types of amplifier circuits: parallel (short circuit stable), series (open circuit stable), and compound.

A graphical analysis of these circuits is helpful in determining performance.

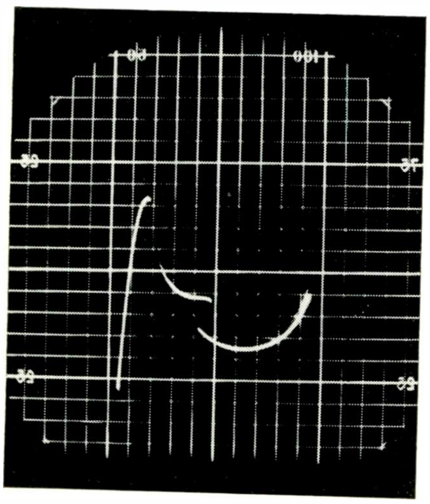


Fig. 4: Self oscillation with 10 uuf across the diode.

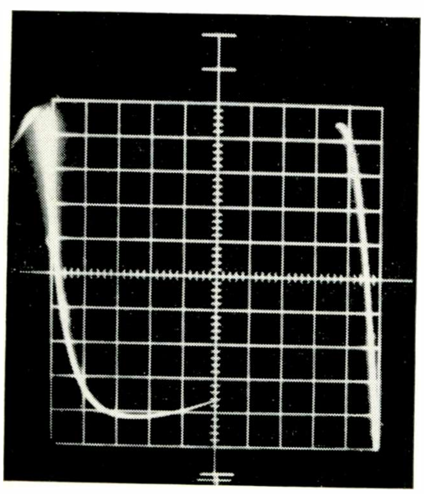


Fig. 5: Typical curve when the device can only switch.

Parallel Connection

Since the currents of the diode and the load add in the load resistance, Fig. 6, the composite, algebraic sum, of the currents, add and form curve 3. The slope of this curve, between points A and B, exhibits a much higher impedance than the slope of the load line (rl = curve 2) alone. Therefore, the composite impedance of rl and $-rd$ have now become a high input impedance while the actual load still remains 126 ohms.

By applying an input signal Δi to this high impedance, the output current swings greater than Δi. The ratio of output to input current is directly proportional to the power gain, since the voltage gain is unity. This value is also proportional to the ratio of

$$\frac{Gl}{Gl + (-Gd)}$$

in other words, to the ratio of the transformed impedance to the load impedance.

Series Connection

The voltages across the diode and the load add to form the composite curve 3, Fig. 7. The slope of this curve exhibits a much lower resistance value $(= -rd + rl)$ since the negative resistance subtracts from the positive one. A small signal voltage applied across this low total resistance yields a larger voltage across R_L. The voltage gain is proportional

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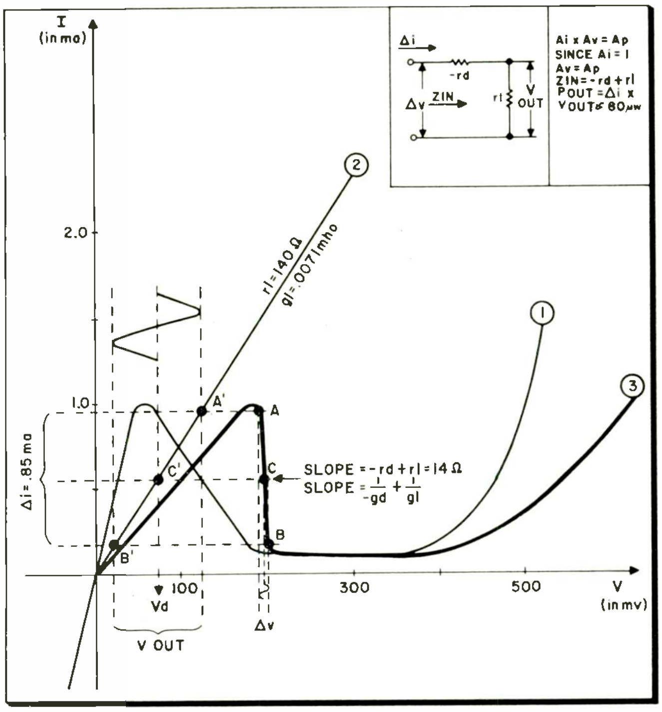


Fig. 7: This convenient graph should be used in studying the performance of series connection (open circuit stable) amplifier circuits.

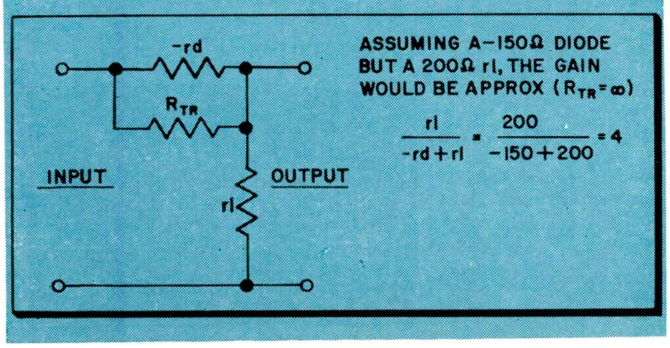
to power gain since the current gain is unity. Again this gain is also proportional to the impedance transformation ratio of $rl/(-rd + rl)$ or

$$= \frac{\frac{1}{Gl}}{\frac{1}{-Gd} + \frac{1}{Gl}}$$

Compound Connections

To achieve relatively high gain, the resultant negative conductance slopes have to be close to horizontal (very high Z_{in}, limit ∞) in the parallel case; and, close to vertical (very low Z_{in}, limit 0) in the series case. Under those conditions, the input currents or voltages are very small as compared to their outputs. To achieve this, it becomes apparent that the load conductance must be very near equal to the negative conductance of the diode. For a ZJ-56 with a negative resistance of 100-150 ohms, this would restrict the choice of load resistance to this magnitude unless a transformer is used. It is possible, however, to change the negative resistance by various schemes achieving virtual impedance match.

Fig. 8: Circuit and assumptions for increasing negative resistance.



Negative Resistance

The circuit of Fig. 8 gives a very small gain, but if a resistance were placed in parallel with $-rd$ such that the resultant negative resistance is increased, for example, to -198 ohms, then

$$G_{AV} = \frac{200}{-198 + 200} = 100 = 20\ db.$$

Similarly a resistor could be used to parallel the the load such that rl becomes 151.1 ohms in which case

$$G_{AV} = \frac{151.5}{-150 + 151.5} \approx 100 \approx 20\ db.$$

Although such a resistor will introduce losses, the overall transducer gain can be in excess of the low gain available without impedance match.

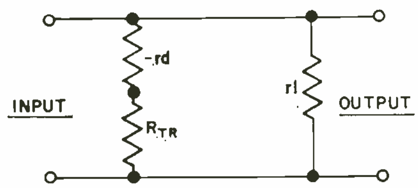
Assuming the case of the parallel connection when $-rd = 200$ ohms and $rl = 150$ ohms,

$$(R_{TR} = 0)$$

Here the

$$G_{AV} = \frac{\frac{-rd \times rl}{-rd + rl}}{rl} = 4.$$

Fig. 9: To lower negative resistance, this circuit is considered.



Adding 48.5 ohms (R_{tr}) in series with $-rd$ yields a total negative resistance of $48.5 + (-200) = -151.5$. The resulting gain is now approximately equal to

$$G_{AV} = \frac{\frac{-151.5 \times 150}{-151.5 + 150}}{150} \approx 20\ db.$$

Similarly, if the transformation resistance R_{tr} is put in series with the load and adds with it to 198 ohms, the resultant gain will be 20 db. Since some of the power is lost in the series resistance, only 150/198 part of this power is recuperated in the load resistance, yet the overall gain still is 150/198 x 100 = 75.6 ≈ 18.8 db.

References

1. Esaki, Leo, "New Phenomenon in Narrow Ge P-N Junctions," *Phys. Rev.*, Vol. 109, p. 603, 1958.
2. Lesk, I. A., Holonyak, N., Davidsohn, U. S., Aarons, M. W., "Germanium and Silicon Tunnel Diodes—Design, Operation and Application," *I.R.E. WESCON Convention Record*, Aug. 1959, pp. 9-31.
3. Yajima, T., Esaki, L. J., *Phys. Soc.*, Japan, Vol. 13, p. 1281, 1958.
4. The following papers, presented at the 1959 IRE-AIEE Solid State Devices Research Conference, Cornell University, June 17, 1959.
   a. R. L. Batdorf, "An Esaki Type Diode in InSb"
   b. H. S. Sommers, Jr., H. Nelson, "Tunnel Diodes as High Frequency Devices"
   c. R. N. Hall, J. H. Racette, "Tunnel Diodes in III-V Semiconductors"
   d. J. J. Tiemann, R. L. Watters, "Noise Considerations of Tunnel Diode Amplifiers"
   e. N. Holonyak, Jr., I. A. Lesk, "Anomalous Behavior of Silicon Tunnel Diodes at Low Temperatures"

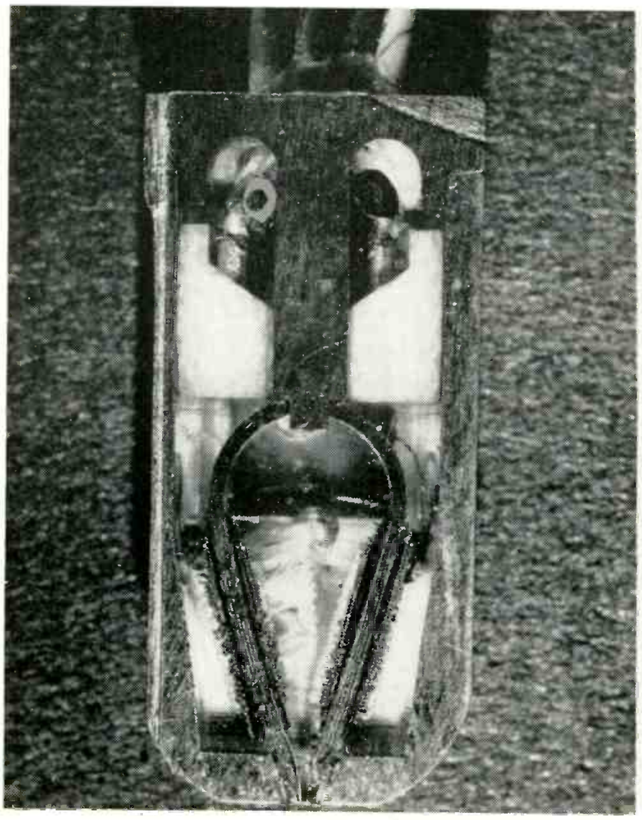


Fig. 1a: Cut-away view of the high resolution magnetic head.

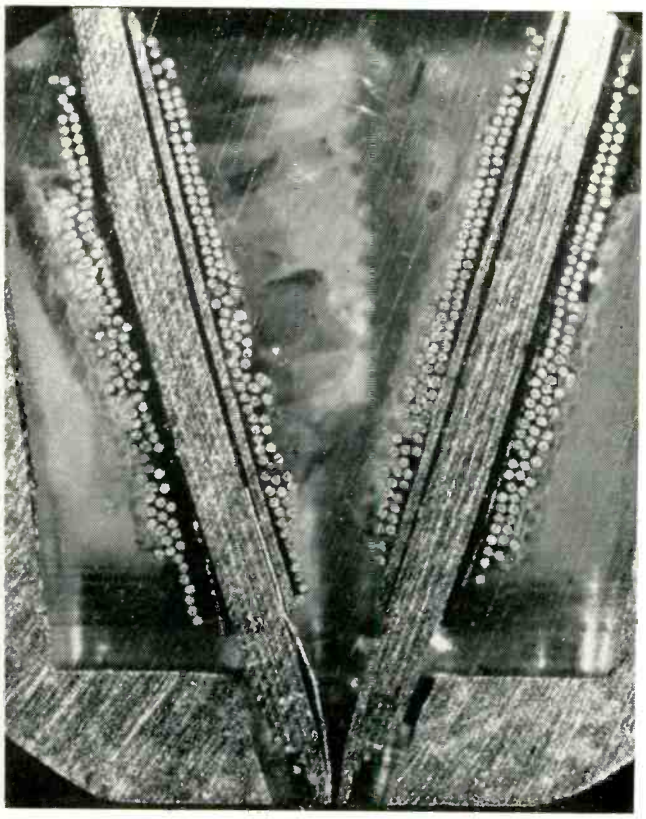


Fig. 1b: Close-up view of the head shown in Fig. 1a.

A Magnetic Drum Memory with

A One Megabit Storage

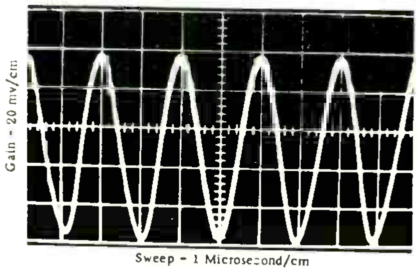
A SURVEY of advanced development work in the medium computer field was made. Survey indicated a need for larger capacity memories in the access time range of the 650 drum. It was immediately evident that if access times were to be retained and bit densities increased, higher frequency circuitry would be required. To realize this performance in our future memories, to the groundwork was laid for high frequency transistorized memory circuits. To demonstrate the feasibility of these techniques, a prototype memory was developed in which advanced transistor circuits and magnetic heads of high resolution were adapted to a standard 650 drum assembly. This resulted in an 8 times increase in capacity. The work was directed toward satisfying an immediate need in this area and does not represent "state of the art" or what may be accomplished with present goals.

Design Objectives

Starting with the production 650 discrete pulse system (operating at 125KC, 50 bits per inch, and 20 tracks per inch), the performance of the memory was aimed at 500KC, 200 bits per inch, and 40 tracks per inch. This performance would result in a capacity of one million bits on the 650 drum. The prototype of the one megabit memory was developed with the following design features:

1. The drum used was a production 650 rotor and base assembly with a 0.0006 inch thickness of Co-Ni magnetic coating and a rotational speed of 12,600 RPM.
2. A head mounting shell was located around the rotor and bored to accept 430 fixed type high resolution magnetic heads.
3. The recording technique used was the return-to-zero or "discrete pulse" made at 500KC and 200 bits per inch. This results in 2500 information bits per track on the 650 drum. The track spacing of 0.035 in. on centers allows for 400 information tracks of 2500 bits each, or a total capacity of one million bits.
4. Electronic switching was provided for the data heads so that they can be used in a serial manner or in a parallel by character mode. The access time for this memory is dependent primarily on a revolution time of 4.8 msecs.

Fig. 2: Readback voltage waveform at 500KC



A survey indicated the need for larger capacity memories in the medium computer field.
Design engineers took an existing magnetic drum memory and increased its capabilities 8 times.
Their ideas and innovations, given here, will prove useful to other design engineers.

By ROBERT R. SCHAFFER
Product Development Labs.
International Business Machines Corp.
Endicott, N. Y.

5. The drum was divided into several addressable sectors by means of recorded timing tracks.
6. The transistorized write driver, sense amplifier and track select matrix components were fixed to circuit board mounted directly above the associated magnetic heads.
7. Logic control circuits were developed for simulation and testing on a working model of the system.

Drum & Head Description

The high density recording and resultant expanded capacity were made possible by the development of a high resolution magnetic drum head.* In addition to improving the resolution capabilities, the stability of the headcoating spacing was improved, and the cost reduced below the existing magnetic drum heads. These features not only result in a decrease in the cost per bit on a track, but coupled with improved circuit techniques make a greater number of tracks economically feasible. In order to retain the access time within the range of memory capacity under consideration in our program, a fixed head per track concept was used with electronic track selection.

The magnetic head, shown in cross section in Fig. 1, consists of a laminated metal core formed into a ring structure with one 100 turn coil on each leg of the core. The core structure is encapsulated in a metal housing. The recording is done through one coil, with both coils in series for the readback process. The heads are 0.0003 to 0.0005 inch from the drum surface and are held by spring forces in holes bored in a head mounting shell. An adjusting tool, used for all the heads, moves the head toward and away from the drum. An indication of the resolution of the head, under the conditions in this system, may be obtained by observing the readback voltage waveform in Fig. 2. Waveform resulted from recording a string of discrete pulse "ones" at 500KC. There is no observable attenuation in these pulses from the amplitude of the single bit shown in Fig. 3.

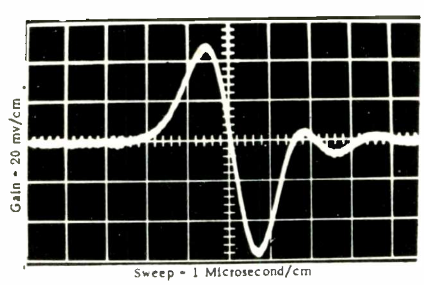


Fig. 3: Oscillogram of readback single bit

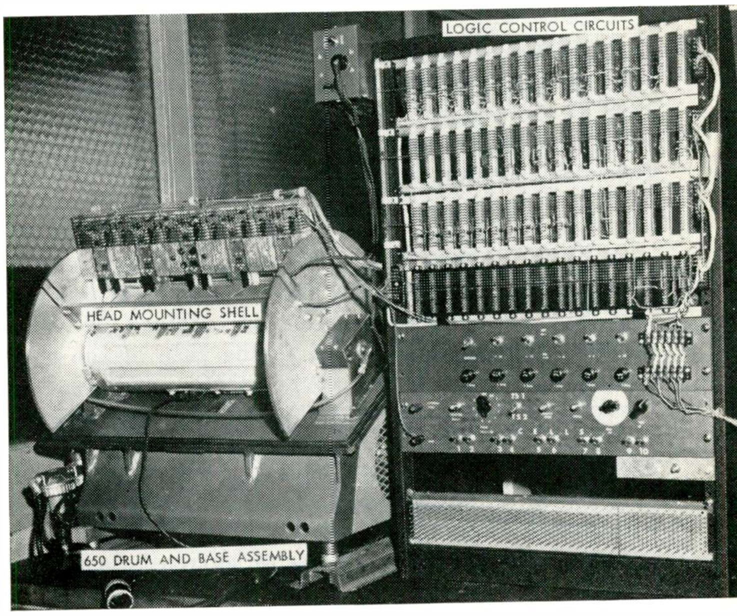


Fig. 4: Photograph of one megabit drum memory prototype

* Background information on the recording problem is contained in a report by L. J. Poch and R. R. Schaffer entitled: "Preliminary Report on Investigation of Magnetic Drum Recording of Digital Data," *IBM TR 103. 042. 463; May 7, 1957.*

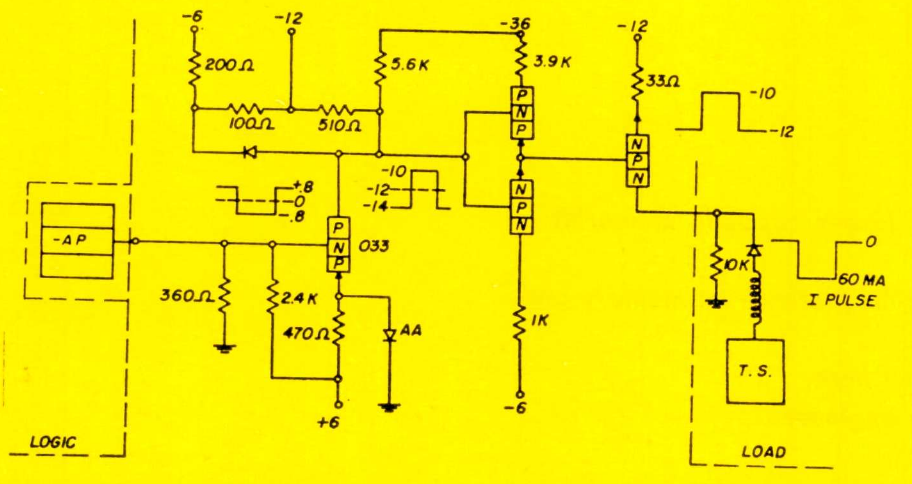


Fig. 5: Schematic diagram shows the write driver circuit with transistors

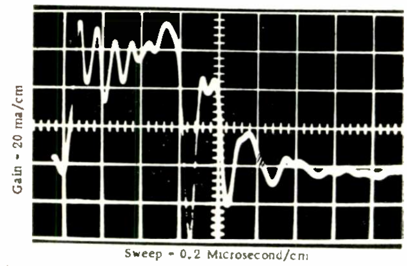


Fig. 6 (above): Oscillogram of the write current waveform

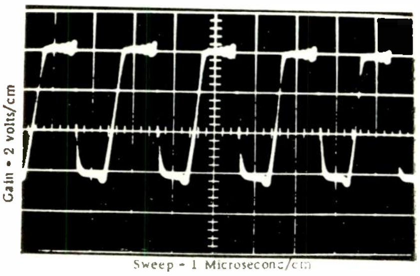


Fig. 7 (right): Waveform is the output of the sense amplifier

Megabit Storage *(Continued)*

A further comparison shows that the "spread" of the readback voltage pulse is 3-4 times less than that of the present 650 System. Other experimental work has shown the feasibility of recording up to twice the density and frequency used here.

Circuit Description

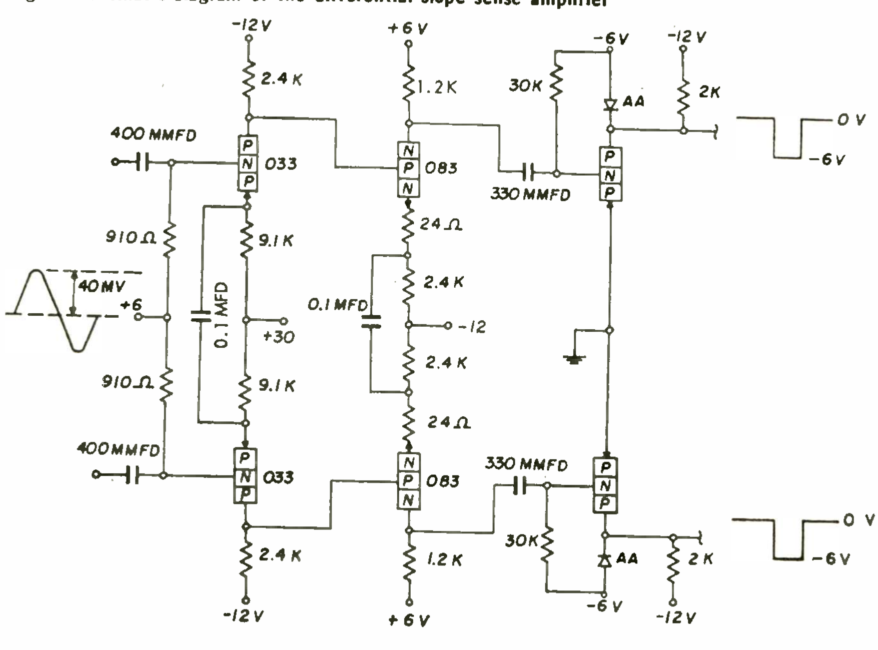
A. WRITE DRIVER: The write current output transistor is an IBM NPN Class C power drift (see Fig. 5). The constant current is obtained by well-defined voltage levels applied to the base of the output transistor from the complemented emitter followers (fixed voltage drop across a 33 ohm emitter resistor). This circuit is analyzed as a grounded base configuration. A constant emitter current is caused to flow in a variable impedance collector load by adjustment of the base reference potential.

Fig. 6 shows a typical write current waveform from the circuit in Fig. 5 as seen across a 1 ohm resistor in series with the coil. A nominal write current amplitude of 60 ma. and a pulse width of 0.8 μsec. was used for the magnetic recording process. A typical readback voltage waveform of 100 mv. peak—peak amplitude resulting from recording with this pulse is shown in Fig. 3. For recording above the 500KC rate used here, the upper limit was established by the deterioration of the pulse waveform at 0.6 μsec. pulse width.

B. SENSE AMPLIFIER: A differential slope sense amplifier shown in Fig. 8 was used to convert the readback voltage into a 0 to −6 volt output. The upper clipping level of the amplifier was set at 30-40 mv, permitting a variation of approximately 3/1 from the nominal 100 mv. readback voltage. A common mode noise rejection in the order of 300 mv. was achieved as a result of the differential amplifier approach. DC isolation and stabilization is obtained by using capacitors in the input and output stages.

The waveform shown in Fig. 7 is the output of the sense amplifier to the input readback waveform shown in Fig. 2. The sense amplifier recovery time from the write current waveform is 1.8 μsec. For frequency of operation higher than 500KC, the sense amplifier requires increased amplitude input signal with an upper limit of 90 mv. or 1.2 MC.

Fig. 8: Schematic diagram of the differential slope sense amplifier



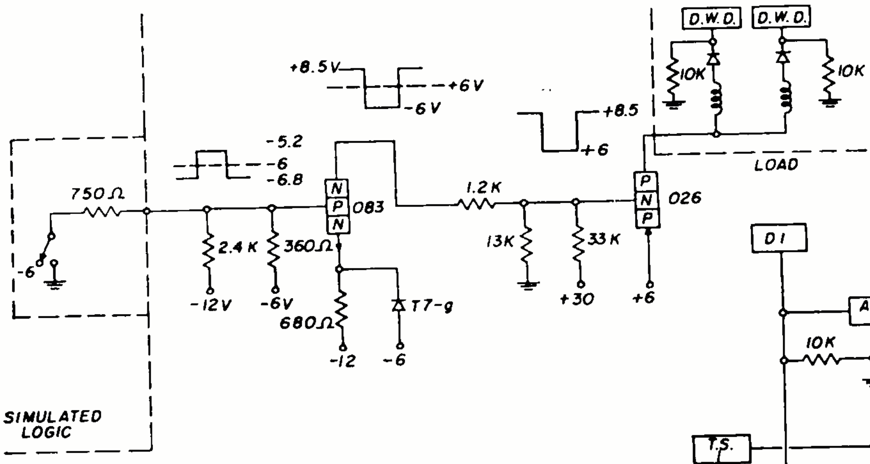


Fig. 9 (left): Switch matrix provides for head selection during recording and reading

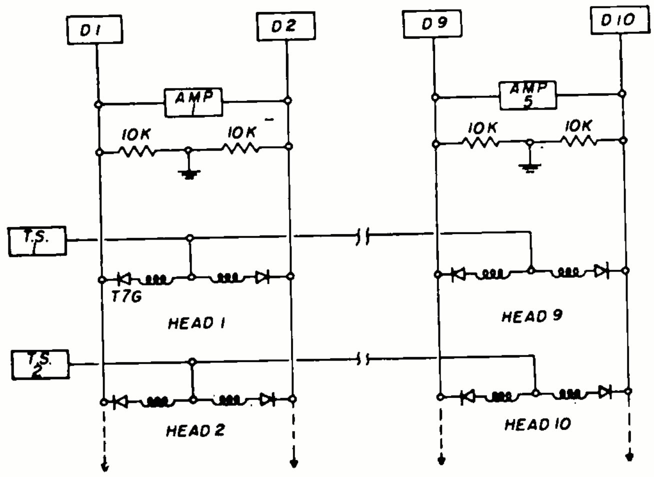


Fig. 10 (below): Schematic diagram shows the track select circuit

C. TRACK SELECT: The switch matrix shown in Fig. 9 provides for head selection during recording and reading. During both of these functions, the track select circuit (Fig. 10) provides a +6 v. potential to a common end of both coils of a selected head. This potential forward biases the isolation diodes through the 10K resistors to ground. With the diodes forward biased, the two 100 turn coils are in series with the sense amplifier during readback. During recording, a "one" or a "zero" is written by the associated write driver.

D. PACKAGING: Since line loss, capacitance and noise become major factors in the design of high frequency memory circuits, an effort was made in the packaging to minimize their effect by reducing lead length and cabling. This was accomplished by plugging each row of heads directly into a 3½ x 16 in. printed circuit board which spanned the drum. As a result of this approach, in addition to the common mode rejection differential sense amplifier, the signal-to-ambient noise level in the sense amplifier was improved by a factor of two. This board contained the write drivers, sense amplifiers, and track select circuits for 2 rows of heads. In Fig. 4, a photograph of the memory system, the circuit board is shown mounted in slots in the end plates directly above the head mounting shell.

Conclusion

The prototype of a one megabit drum memory was developed to determine the feasibility of applying the basic concepts used in the design of the magnetic head, write driver, select matrix and sense amplifier to a type 650 drum. Although the system described is not proposed as a final design, the interaction of these components was found to function satisfactorily in a working memory at 500KC, 200BPI discrete pulse recording. The limitations of the components were determined wherever possible, both as an aid to their application in other systems and to guide future work in this area.

The author wishes to acknowledge the contributions of the Circuit Technology Department and especially the work of Messrs. D. W. Gill and D. R. Franck. The drum and head work was under the direction of Mr. L. J. Poch with design assistance of Messrs. E. Haire, G. Wiederhold, and A. de Roos.

NEW PREFIXES FOR UNITS

The National Bureau of Standards will follow the recommendations of the International Committee on Weights and Measures. They will use the new prefixes for denoting multiples and sub-multiples of units. The Committee adopted the prefixes at its meeting in Paris in the fall of 1958. In addition to the eight numerical prefixes in common use, which are given in the table below, the Committee expanded the list by adding the four prefixes marked with an asterisk. Thus, for example, 10^{-12} farad is called 1 picofarad, and is abbreviated 1 pf.

Multiples and Sub-multiples	*Prefixes*	*Symbols*
1 000 000 000 000 = 10^{12}	tera*	T
1 000 000 000 = 10^{9}	giga*	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10	deka	dk
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano*	n
0.000 000 000 001 = 10^{-12}	pico*	p

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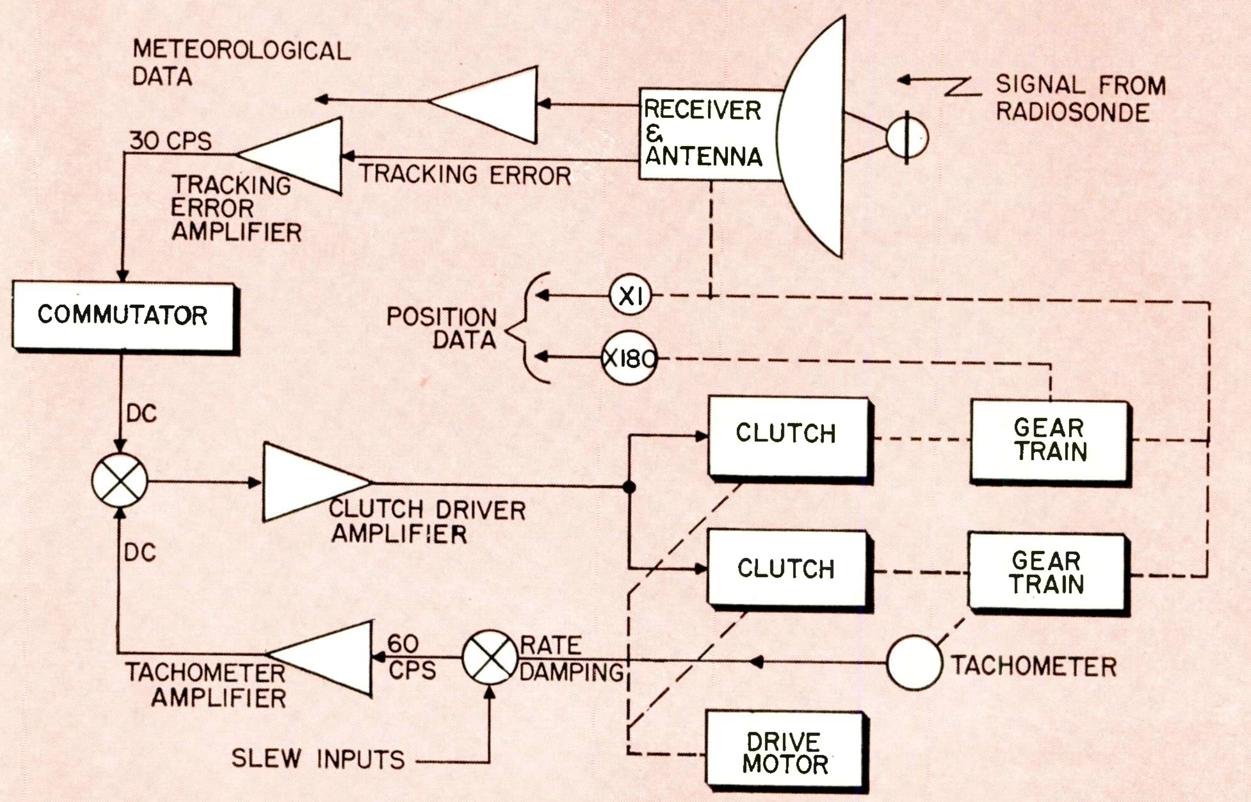
Chestnut & 56th Sts., Phila. 39, Pa.

High accuracy is attained by a push-pull arrangement of hysteresis clutches which smoothly transfers torque through dual gear trains from the drive motor to the antenna.

Accurate Tracking for

Fig. 1: A bock diagram shows one of two identical radiotheodolite servo drive units.



By FRED ELLIS
Servo Corp. of America
New Hyde Park, L.I., N.Y.

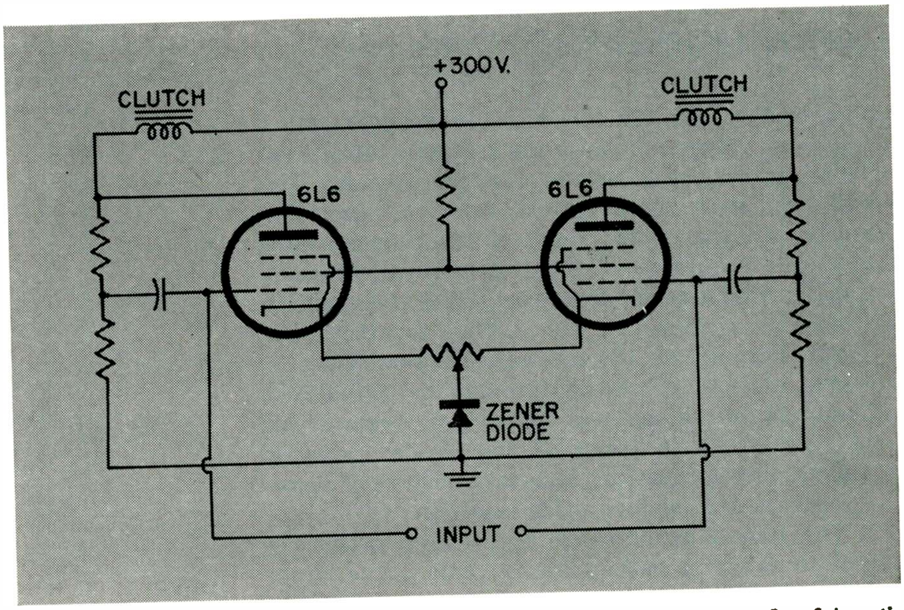


Fig. 2: Schematic shows the hysteresis clutch field coil amplifier.

Radiotheodolites

AZIMUTH and elevation of the ten-foot diameter antenna system of a weather sonde tracking radiotheodolite is accomplished to a system static accuracy of 0.01° and a dynamic accuracy of less than 0.03° RMS.

In the system we will describe here this tracking accuracy is attained by a push-pull arrangement of hysteresis clutches. These clutches smoothly transfer torque through dual gear trains from the drive motor to the antenna.

Some of the features that contribute to the ease and smoothness of control over a wide range of tracking and slewing speeds are shown in Fig. 1, where one of the two identical servo drives is depicted.

The system operates as follows. Conical scanning is accomplished by spinning a secondary reflector in the antenna system. A 30 CPS modulation is obtained from the received signal, the amplitude and phase of which correspond respectively to the amplitude and direction of the tracking error. The amplified tracking error (30 CPS) signal is passed through a commutator, essentially a synchronous phase sensitive rectifier, and applied to the push-pull grids of the clutch driver amplifier. The clutches are thereby energized to position the antenna system in a manner that decreases the tracking error, thus closing the major servo loop.

A secondary loop provides velocity damping which can be manually varied over two ranges to obtain system velocity constants from approximately 0 to 15° per second per degree error on the low-speed range and 10 to 50° per second per degree error on the high-speed range.

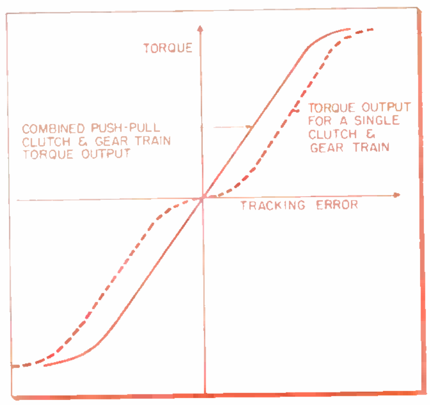
Other details not shown although essential to proper system functioning are:

1. Stabilizing networks.
2. Separate gain controls for azimuth and elevation channels.
3. Two independent damping controls for each channel.
4. Switching for selecting one of three modes of operation, to wit:
   a. Highly damped automatic tracking.
   b. Critically damped automatic tracking.
   c. Manual control.

Several desirable performance characteristics are available in this design:

1. A smooth transmission of torque from the drive motor to the load by a pair of hysteresis clutches used in push-pull, and driving the load through independent gear trains is employed to linearize the current torque characteristic of the clutches

Fig. 3: Graph shows the restoring torque vs. tracking error characteristics for the system.



Radiotheodolites *(Continued)*

per se. At the same time, backlash in the gear trains is taken up. Figure 3 shows the restoring torque vs. tracking error characteristic for the system. The dotted lines show the departure from this desirable characteristic that would result if the clutches were used singly. The clutches are driven by a pair of push-pull 6L6's with a zener diode regulating the common cathode bias as shown in Fig. 2. This together with a slight amount of bleeder current establishes a quiescent amount of current through the clutch field coils to maintain a tautness in the gear train at all times. Advantage is taken of the bleeder network to tap-off, with a capacitor, a certain amount of negative feedback for common mode rejection.

2. The wide dynamic range of tracking speeds required to follow a balloon borne radio sonde, from the ground up to altitudes of 100,000 feet and slant ranges of 150 miles, make it desirable to provide large amounts of rate damping for the far tracking conditions and a small amount for the near tracking. This is accomplished by using a drag cup tachometer generator suitably geared-up from the load. The output of the tachometer is amplified and applied to a phase sensitive demodulator shown in Fig. 4. From there it is mixed with the error signal into the clutch field driver amplifier.

The input to the tachometer amplifier provides a convenient place to insert slewing inputs. In this manner, slewing rates from a maximum, determined by the servo drive motor speed and gearing, to very slow rates are obtained. The total range in this application is from 540° per minute to less than 0.5° per minute.

The rate damping controls are individually set and then selected at will by push button control, either locally or remotely, to obtain the best overall performance during a sounding. However, the design permits the inclusion of automatic switch-over from one mode to the other or continuous automatic control of rate damping as some arbitrary function of tracking error.

The equipment provides complete remote control of the system as well as indication and recording of azimuth and elevation angles and time. Other equipment is used to record and process the meteorological data received by the radiotheodolite.

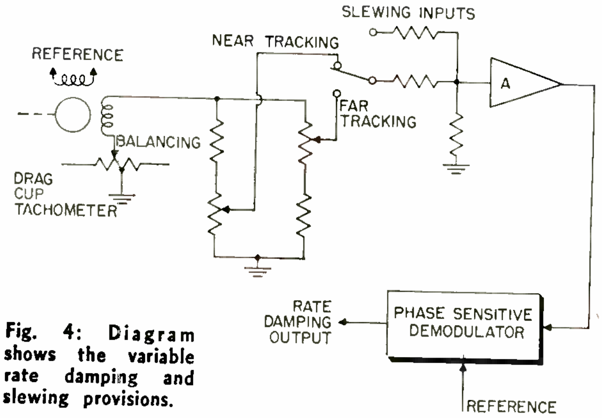


Fig. 4: Diagram shows the variable rate damping and slewing provisions.

By LIONEL ROBBINS

Chief Applications Engineer
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Norwalk, Connecticut

The AC

AUTOTRANSFORMERS possess a number of very desirable characteristics, among them precise voltage ratios, high input impedance, low output impedance, and low phase shift. Coincidentally, it happens that these characteristics are quite desirable in a precision potentiometer. This has led to a union of the autotransformer and the potentiometer to produce a hybrid—the AC potentiometer—of great interest to electrical engineers.

The tape-wound, toroidal cores of today permit the construction of autotransformers having extremely low leakage inductance. Furthermore, they permit the construction of autotransformers of moderate size with high impedance, yet low winding resistance; i.e., a high Q. The effect of these characteristics will be pointed out.

Characteristics

To illustrate a basic characteristic of the autotransformer, assume that you need a precise voltage divider, say 2:1. Wind on a toroidal core a number of turns of wire. Pull out a loop of wire (later to be bared and tinned) and then wind on another series of turns equal in number to the first group. You now have a very precisely center-tapped autotransformer.

"How do you know the center turn is tapped at the proper place?" Herein lies one of the beauties of the autotransformer, for it is impossible to have a fractional turn. We either link the flux in the core or we do not. There is no partial linkage of flux except for minute amounts of leakage flux which can result in errors of as little as 0.001% of the input voltage.

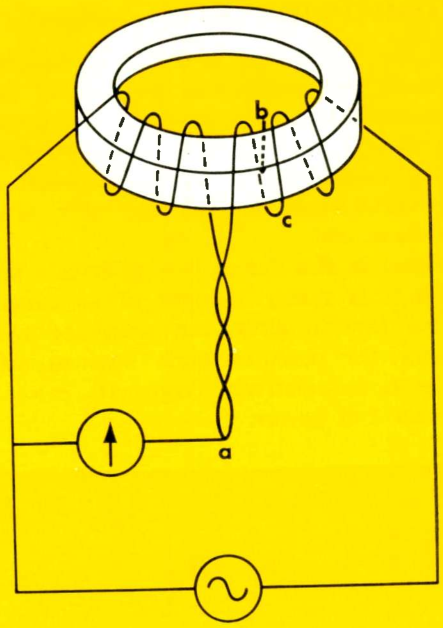


Fig. 1: The Autotransformer is a source of very accurate voltage increments.

Autotransformers have a number of very desirable characteristics. These characteristics are also desirable in a precision potentiometer. The union of the two produces an extremely useful new component.

Potentiometer— A New Circuit Component

Imagine that the voltmeter is of extreme sensitivity. If we move the meter lead along the turn of wire, we would detect no change in voltage even though it were moved from "a" far into the center of the toroid to "b". However, if we should connect the meter lead to "c" without passing it through the center of the toroid, we would detect a voltage increment equal to the input voltage divided by the total number of turns. The meter lead may now be moved along that turn back to "b" with no further change in voltage. This is because the meter lead is taking part in the process of linking flux. Hence, the autotransformer is a source of very accurate voltage increments.

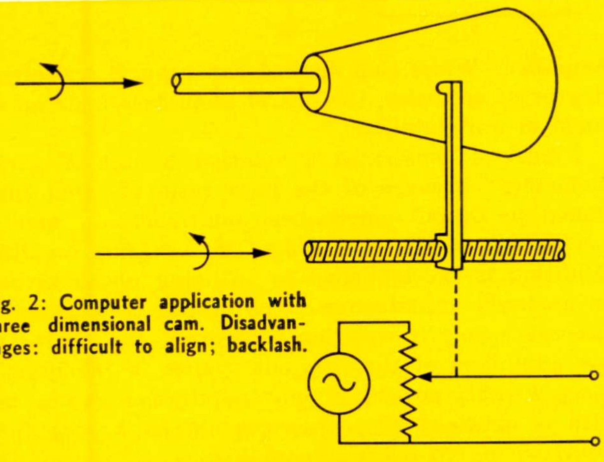


Fig. 2: Computer application with three dimensional cam. Disadvantages: difficult to align; backlash.

Other Properties

Let us look at some of the other properties. It appears to its source of excitation primarily as a very high inductive impedance (many turns of wire on a high permeability core). Core and copper losses may be disregarded generally in electronics work. Of course, if a lead is connected to a tap, it will be reflected to the input terminals by the square of the turns ratio.

Now, if the autotransformer is driven by a zero impedance source, the output impedance at a tap will be quite low since it is primarily due to the winding resistance itself.

This high ratio of input impedance to output impedance represents another major advantage because autotransformers may be cascaded or otherwise loaded without appreciable loading error; i.e., tap voltages will remain accurate.

Two other advantages remain. The first is low phase shift. Since the leakage inductance and winding resistance are low, the tapped autotransformer acts almost as a perfect voltage divider; i.e., tap voltages are almost exactly in phase with the input voltage.

A useful corollary to this property is that toroidal autotransformers may be used over a wide range of frequencies. Military equipment designers tend to use the power frequencies as high as 2 KC to reduce the size of motors and power transformers. This feature of the autotransformer is important since many voltage dividers develop excessive phase shift at higher frequencies.

Potentiometer *(Continued)*

The last advantage is that the autotransformer is essentially non-dissipative. Because of this the autotransformer found its way into the laboratory many years ago. I am referring to the Variac* which is nothing more than an autotransformer that has all of its turns bared so that they may be contacted by a carbon brush.

In essence, the Variac is similar to a potentiometer, though it is rarely thought of as such. The turns are too few to afford an adequate resolution and linearity for potentiometric applications; and also, the device is relatively large. Its prime function is the control of power.

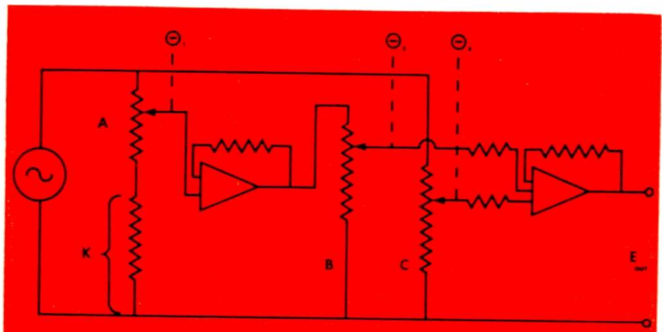


Fig. 3: Computer application with resistance potentiometers. Advantages: easy to align. Disadvantages: amplifiers decrease reliability; amplifiers and potentiometers are dissipative.

In summation, characteristics of the autotransformer are:

(1) Precise voltage division,
(2) High input impedance,
(3) Low output impedance,
(4) Low phase shift over a wide frequency range, and
(5) Low power dissipation.

It is not surprising that designers have made use of these characteristics in AC potentiometers. In general, the technique consists of locating a series of precise, equally spaced taps along an autotransformer. A precision resistance potentiometer is used to interpolate linearly between the adjacent taps to obtain high resolution. Some AC potentiometers use several tapped autotransformers which are cascaded. Interpolation is performed between the taps of the last transformer. The output resistance of the interpolating potentiometer is low enough to permit a favorable ratio of input impedance to output inpedance.

Types of AC Potentiometers

There are two general types of AC potentiometers. In one type, rotary switches are used to select a combination of transformer taps. This provides coarse voltage adjustment. A separate shaft controls the interpolating potentiometer for fine voltage selection. These types are necessarily manually operated and may be used to provide accurate ac voltages or voltage ratios.

The other type is designed so that both switching and interpolation are accomplished with a single shaft.

All commercially available models are multi-turn units. These are precision potentiometers in the generally understood sense and are of particular interest to designers of such analog equipment as servos, computers, and control equipment. These components can be instrumental in achieving a high order of system simplicity, accuracy, and reliability.

An application

The next three figures show how an equation may be solved in three different ways. The equation, $E_{out} = [K + A(\Theta_1)] [B(\Theta_2)] + C(\Theta_3)$, is frequently solved with a three-dimensional cam.

In operation, the cam is rotated about its axis and a feeler arm is made to move parallel to that axis so that it may contact any point on the cam's surface. The feeler arm is coupled to a potentiometer whose output voltage is proportional to the distance from the point of contact to the axis of rotation of the cam. This computing system is very reliable. However, certain restrictions must be applied to the maximum slope of the cam's surface so that the feeler may easily ride over it without requiring excessive torque. Occasionally the nature of the cam's contour may result in an exceedingly lengthy indexing procedure which would represent a major drawback to this method.

Figure 3 illustrates a solution using resistance potentiometers. Notice that this system can handle three independent variables. Indexing of this system is quite simple. However, due to the high output impedance of the potentiometers, they would normally be used with an isolation amplifier in the multiplication portion of the circuit. The addition would be accomplished with summing resistors and a feedback amplifier. While this method can provide a desirable degree of accuracy, the use of amplifiers adds an element of unreliability.

Fig. 4: Solution using AC potentiometer. By eliminating amplifiers a reduction in size, weight, power supply requirements and heat rise is obtained—reliability increased.

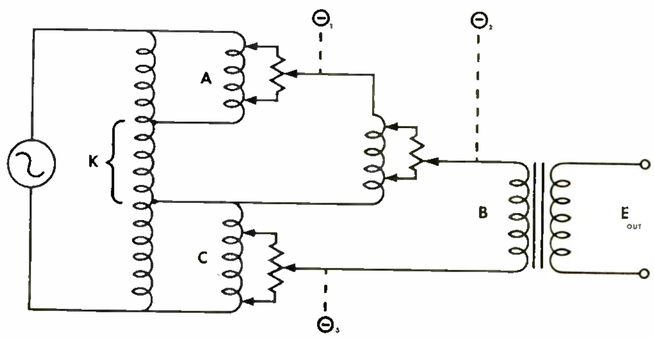


Figure 4 illustrates a solution using AC potentiometers. Because of the high ratio of input impedance to output impedance, multiplication may be performed without the aid of an isolation amplifier. Addition is accomplished by utilizing phase reversal in an input transformer. The output transformer is necessary only if isolation is desired. By eliminating the amplifiers of the previous system, a reduction in size, weight, powers supply requirements and heat rise is obtained also, there should be a substantial contribution to overall reliability.

* Registered trademark of the General Radio Company.

Other uses

The ability of AC potentiometers to work directly into other components, such as resolvers, makes this kind of circuitry even more interesting. Application to other problems may be realized by the use of nonlinear AC potentiometers. These space the taps unequally along the autotransformer in accordance with the nonlinear function to be generated. The function is then generated as a series of straight line interpolations, or in other words, a series of chords.

Even greater versatility is provided by adjustable AC potentiometers which are constructed so that the user may make his own selection of transformer taps and hence set in the shape of the nonlinear function to be generated. These devices can be very useful as computing elements, but in addition, their extreme ease of operation makes them especially suitable as control elements and as design tools where nonlinear functions must be determined experimentally.

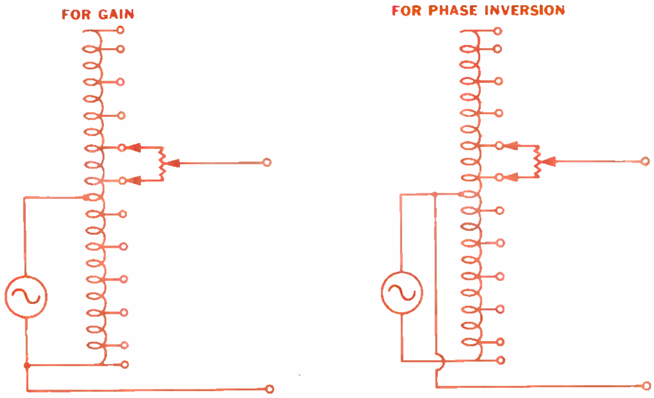
A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

Voltage step-up feature

Many unique applications result from using the voltage step-up feature of the autotransformer as illustrated in Figure 5. The left hand schematic shows how a portion of the transformer may be energized to derive an output voltage greater than the input voltage. This technique may be used to obtain a small amount of gain which might otherwise require another component. By relocating the fixed output lead, the right hand circuit shows how an AC potentiometer can provide voltages of opposite phase when it is excited by a single ended source of voltage. The output voltage reverses phase when the wiper passes the fixed output lead. This eliminates a separate transformer to perform the same function.

An extension of this technique is used to generate the secant function as shown in Figure 6. In this case, the taps are located only in the unexcited portion of the transformer so that the output voltage ratio

Fig. 5: The voltage step-up feature may be used to obtain a small amount of gain (left) or provide voltages of opposite phase (right).



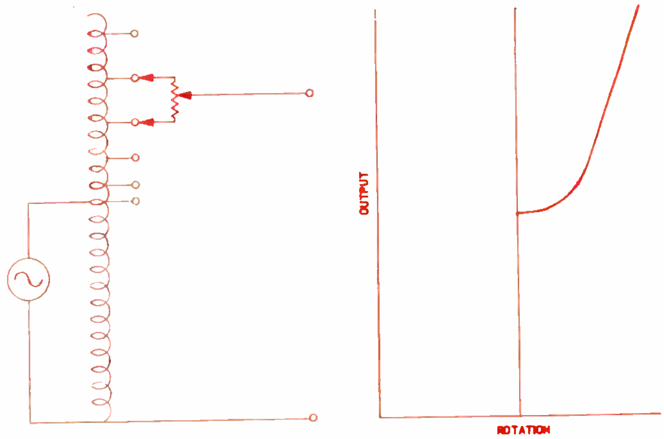


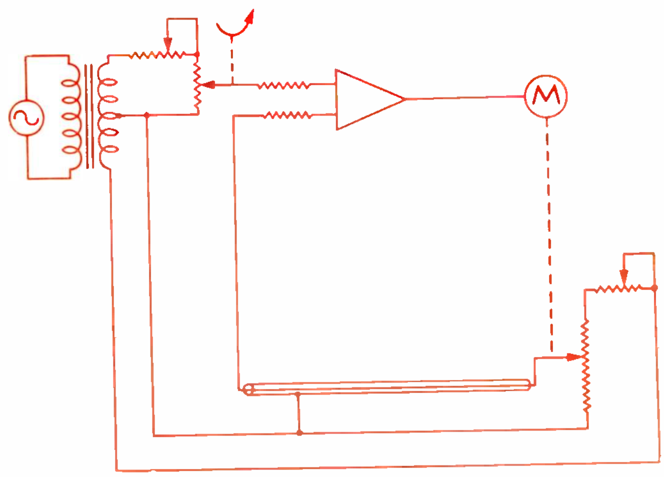
Fig. 6: The voltage step-up feature is used to generate the secant function. The taps are located in the unexcited portion of the transformer so the output voltage ratio will always be greater than one.

will always be greater than one, as it must be for the secant. This application was the result of an attempt to simplify a secant generator consisting of a servo amplifier, a servo motor, and a resolver. The cosine winding of the resolver provided the feedback signal so that the transfer function of the servo was the reciprocal of the cosine, i.e., the secant. In this case the entire servo was replaced with a single AC potentiometer.

Applied to servos

A final application is an example in servomechanisms. A simple feedback servo will illustrate the

Fig. 7: Conventional follow-up servo uses two potentiometers as command and feedback elements with summing resistors as a null detector. Gain loss of one-half must be made up in the amplifier.



circuit principles involved, first using resistance potentiometers, and then using AC potentiometers.

In Figure 7, two precision potentiometers are used as the command and feedback elements with summing resistors as a null detector. This circuit requires a source of accurately center tapped voltage so that the two potentiometers will be excited by equal voltages of opposite phase. The voltage at the input to the amplifier will be zero when the shafts of the two potentiometers correspond. Several disadvantages can be pointed out. First, consider the effect of the summing resistors. If we start with the servo balanced and displace the shift of one potentiometer to get an error voltage, half of that error voltage appears

Potentiometer *(Continued)*

across each summing resistor and so only half of the error voltage appears at the amplifier input. This represents a gain loss of one-half which must be made up in the amplifier.

In many systems, pick-up might be a problem due to the relatively high potentiometer output impedance. If this necessitates shielding of the remote signal lead, the combination of high output impedance and capacitance of the shield could result in excessive phase shift.

Another possible complication is that many systems require potentiometers which exhibit terminal linearity rather than independent linearity. This means that the best straight line which can be laid down through a plot of output voltage versus shaft position will also pass through the potentiometer's terminal points. This is a stringent requirement for resistance potentiometers since the output voltage gradient is controlled only at the two end terminals. An AC

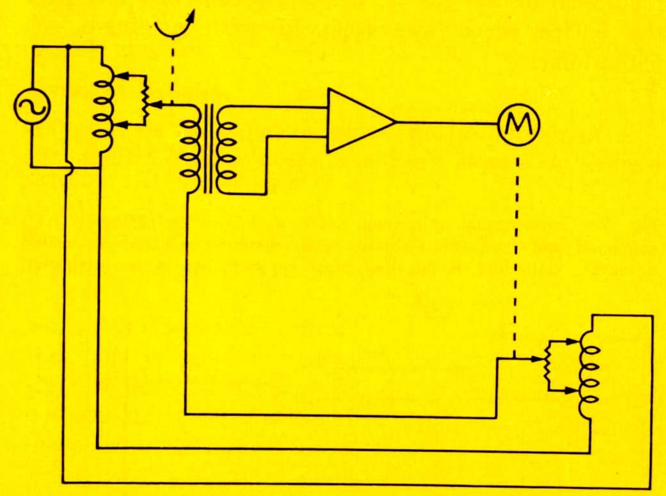


Fig. 8: Circuit performs same function as fig. 7. Two AC Potentiometers are connected in a bridge circuit. Voltage step-up may be achieved in the null transformer. This and elimination of the summing resistors reduces gain which must be provided by the amplifier.

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

potentiometer, on the other hand, has a series of accurate voltage reference points throughout the range of output voltage. Hence they permit terminal linearity to be an easily controlled characteristic.

Figure 8 shows a circuit which can perform the same function as the previous one. Here, two AC potentiometers are shown connected in a bridge circuit. A null transformer transmits the error signal to the amplifier. When the two potentiometer shafts correspond, the error signal is zero. Resistance potentiometers are not suitable because their high output impedance would result in a voltage dividing action with the input impedance of the null transformer. This would correspond to a loss of gain which would have to be provided by the amplifier.

Low output impedance gives this circuit two major advantages. Voltage step-up may be achieved in the null transformer up to the point where the impedance reflected to the amplifier input begins to be excessive. This effect, and the elimination of the summing resistors, reduced the gain which must be provided by the amplifier.

In addition, pick-up due to stray fields is greatly reduced. This is desirable in almost all applications. But it achieves special significance in inertial guidance systems where the persistence of small noise voltages over long periods of time can cause significant navigational errors. Low impedance devices are particularly helpful in reducing these errors.

This paper illustrates typical applications of AC potentiometers for significant design improvements. But, AC potentiometers should not be considered simply as a new type of potentiometer. To use them to their fullest advantage, they should be considered as a new type of component with their own body of application techniques.

PROBLEM CLINIC—Long Life, Low Speed Tape Printer

The General Electric Co. is interested in *manufacturers of tape printers* that meet the following general requirements:

1. Print four quantities side by side on approx. a 3½″ wide paper tape. Two quantities are of 5 digit magnitude, one is of 4 digits and the fourth is of 3 digit magnitude.
2. The maximum counter pulse rate is 1 per sec.
3. There is to be a predetermined automatic point-out every ½, 1, 8 or 24 hours, as well as manual print-out at random. One of the 5 digit quantities is to automatically reset to zero at each print-out.
4. The unit is to ultimately operate from a 120V —60 cycles power source. If the basic unit operates on dc, it will be necessary to provide a conversion from 120 v —60 cycle to the required dc power.
5. The unit must operate satisfactorily over an ambient range of —20°F to +125°F.
6. The unit must be compact—not to exceed a volume 6″ wide x 12″ high x 12″ deep.
7. We expect a minimum 10-year life.

Essentially, what is required is a long life, low speed tape printer of high reliability that when properly packaged can be used out-of-doors or indoors and operates from a standard power source.

Firms or individuals offering solutions to this problem please contact Editor, ELECTRONIC INDUSTRIES, 56th & Chestnut Sts., Phila. 39, Pa. Correspondence will be forwarded to the manufacturer.

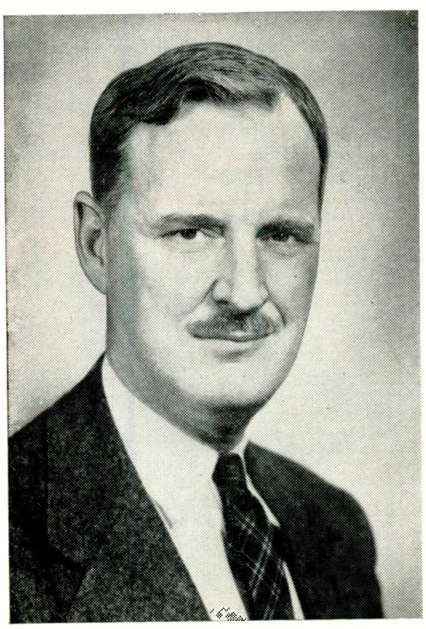
Over 60,000 engineers and scientists will attend the 1960 IRE International Convention. A highlight of the 4-day show will be a symposium, "Electronics—Out of this World" conducted by Ernst Weber. Over 850 exhibitors will display the latest in electronic developments and a comprehensive program of 275 papers will be presented.

Aerial view of New York's Coliseum where over 850 exhibitors will display the latest in electronic wares at the 1960 IRE International Convention.

IRE Show is Now "International"

THIS year's IRE Convention will be called the IRE International Convention emphasizing the fact that the IRE now has 22 Sections and over 6,000 members outside of the United States.

Ronald L. McFarlan: President, IRE



The annual event, the world's largest technical meeting and exhibition, will be held March 21 through 24 at the Waldorf-Astoria Hotel and the New York Coliseum. Over 60,000 engineers and scientists are expected to attend.

A comprehensive program of 275 technical papers will be presented in 54 sessions at the Waldorf-Astoria and the Coliseum. (See the complete program listing beginning on page 126 of this issue). A high point of the program will be a special symposium on "Electronics—Out of this World" to be held Tuesday evening, March 22. The symposium will be conducted by Ernst Weber, President of the IRE for 1959, and a panel of leading space electronics experts.

All 28 IRE Professional Groups will participate in the technical program. Important sessions will be held in: Control Theory, The Engineer Writes and Speaks, Radio Frequency Interference, The Human Factor in Electronics, Engineering Management, Aerospace Subsystems, Production Techniques, Electronic Devices, Reliability, Ultrasonics, Computers, Network Theory, etc. All electronic/electrical engineers will find sessions of particular and general interest.

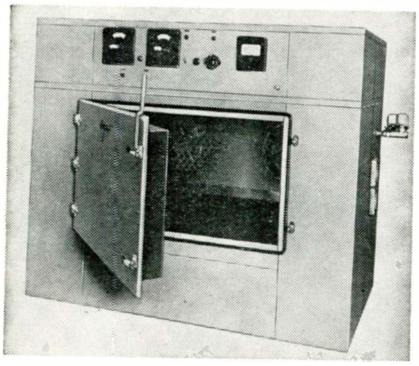
The Radio Engineering Show will fill all four floors of the Coliseum. There will be over 850 exhibitors displaying over $15,000,000 worth of the latest electronic equipment.

The convention will get under way with the Annual Meeting of the IRE on Monday morning, March 21. Dr. Lloyd V. Berkner, President of Associated Universities, Inc., will be the featured speaker.

The social events will include a "get-together" cocktail party Monday evening and the annual IRE banquet Wednesday evening, both in the Grand Ballroom of the Waldorf. The banquet will feature the presentation of IRE awards for 1960, including the Medal of Honor to Harry B. Nyquist, former Bell Telephone Laboratories engineer, and the Founders Award to Haraden Pratt, Secretary of the IRE.

As in the past, an entertaining program of tours, fashion shows, and matinees has been arranged for wives of visitors.

(Continued on following Page)



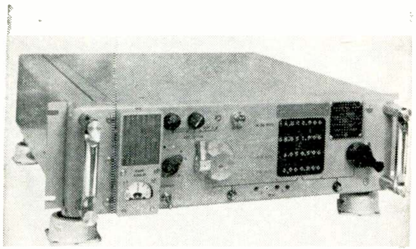
Test Chamber

High-low temperature test chambers with ranges from −100°F to +400°F for production testing of electronic parts. Using liquid CO_2 it provides rapid temp. drop for thermal shock studies. Electric Hotpack Co. Booth 3931.

Circle 162 on Inquiry Card

Frequency Synthesizer

Crystal frequency synthesizer can produce over 64,000 discrete frequencies with a stability of better than



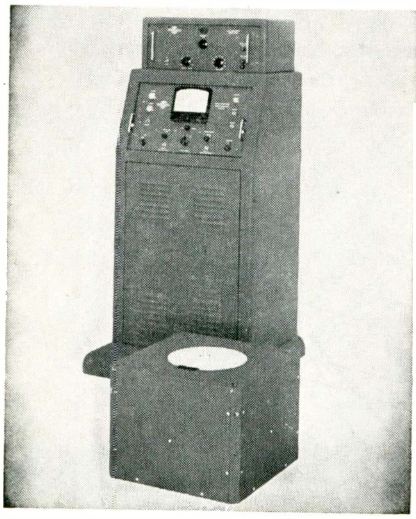
1 x 10^{-8} per day. Characteristics include zero-error readability. Manson Laboratories. Booth 3213.

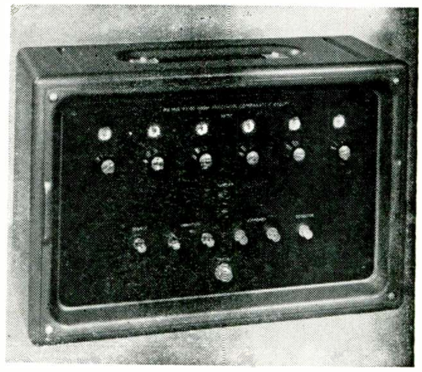
Circle 163 on Inquiry Card

Rate Table

Model 60A, angular oscillating table for rapid frequency response testing of rate gyros and angular accelerometers. Frequency: 0.1 to 150 CPS. Takes loads to 100 lb. Low distortion. Micro Gee Products. Booth 3846.

Circle 164 on Inquiry Card





Comparator

Precision High Impedance Comparator, Type B-921, a 3-terminal bridge compares impedances of the order of megohms against a known standard. Accurate to 0.001%. Frequency: 400 CPS to 10 KC. Wayne Kerr Corp. Booth 3827-29.

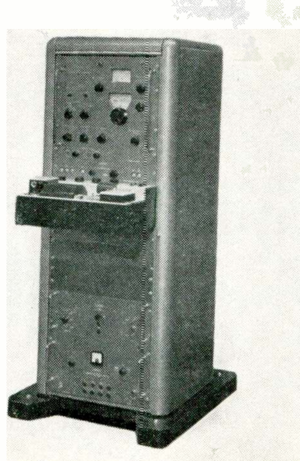
Circle 165 on Inquiry Card

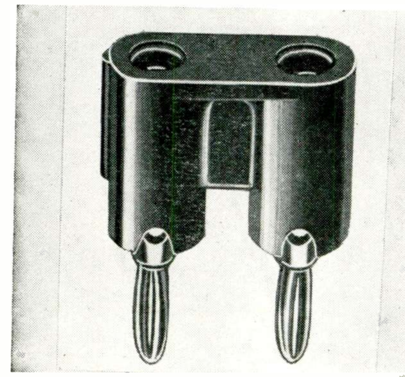
See these Products at IRE

Automatic Analyzer

Automatic analyzer equipment for large scale vibration and noise testing programs. The D-940-A analyzes all types of complex wave-forms. Frequency range is 10 CPS to 19 KC. Muirhead Instruments. Booth 3230.

Circle 166 on Inquiry Card





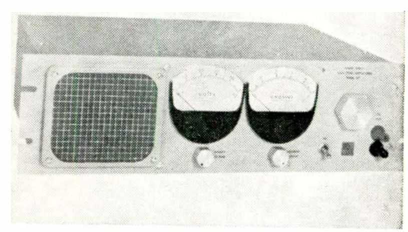
Banana Plug

Molded black polystyrene dual banana plug mates with standard dual binding post ¾ in. centers. Can be stacked for multiple connections. Wire held with set screw. Polarity indicated top and side. Herman H. Smith, Inc. Booth 2325.

Circle 167 on Inquiry Card

Power Supplies

The 120 series, transistorized power supplies, features highly regulated, low ripple output. Regulation is



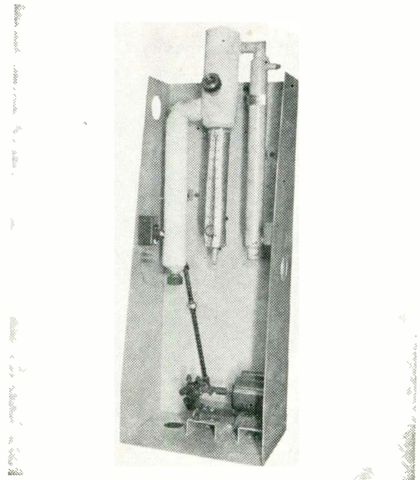
±0.01% or ±3 mv from no load to full load or from 105 v to 125 v line. Quan-Tek Tabs. Booth 3034.

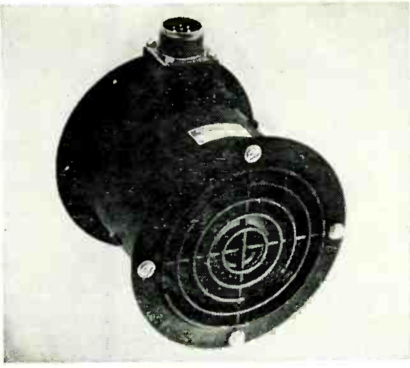
Circle 168 on Inquiry Card

Evaporator-Stripper

Artisan Evaporator-Stripper is for reclaiming chlorinated hydrocarbon solvents. It recovers 98% of the solvent while maintaining the inhibitor balance. Metal Fabricators Corp. Booth 4528.

Circle 169 on Inquiry Card





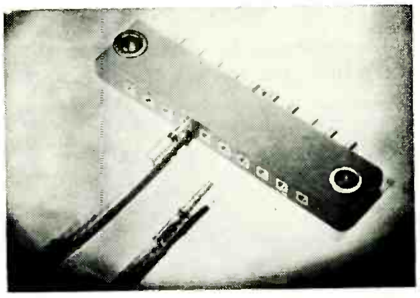
Vane Axial Blower

Vane axial blower exceeds environmental tests of MIL-E-5422D. Model E2543-200 delivers 200 CFM at ¾ in. Wg and 10,500 RPM. It operates on a 200 v, 3 phase, 400 CPS source. Air Marine Motors, Inc. Booth 2601.

Circle 170 on Inquiry Card

Terminal Blocks

Miniature taper-in terminal blocks in 6-terminal (Type 399-6) and 10-terminal (Type 399-10) sizes. They



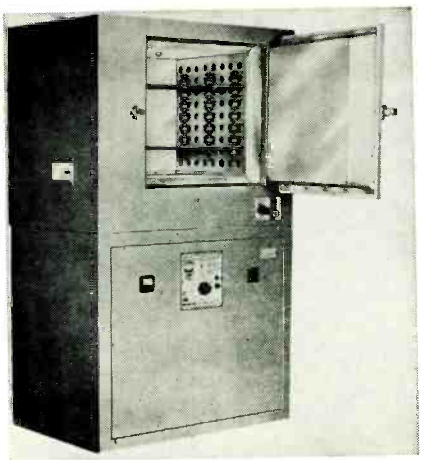
mount upright on printed wiring boards-solder studs slipped through holes. Kulka Electric Corp. Booth 2900.

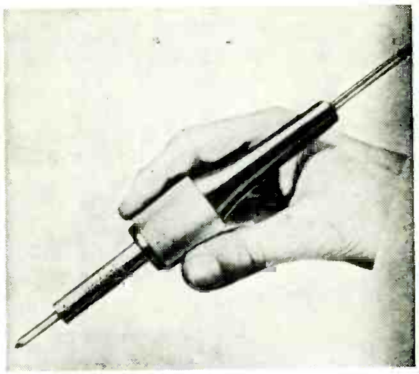
Circle 171 on Inquiry Card

Convection Ovens

Power-O-Matic 60 mechanical convection ovens with saturable power reactor control system. Temperature ranges to 350° and 650°F. Control system is stepless, switchless, and infinitely proportional. Blue M Electric Co. Booth 3008.

Circle 172 on Inquiry Card





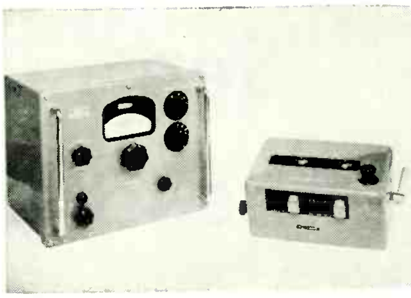
Soldering Iron

No. 24S 60 Pencil Soldering Iron has a long-life ¼ in. tip, rated at 60 w, weighs 2 oz. Tip and element are separate parts and are replaceable independently. AC or DC. Hexacon Electric Co. Booth 4012.

Circle 173 on Inquiry Card

Electrolytic Bridge

Model 543 provides a compact, direct reading bridge for precision checking of capacitors up to 100,000 μf. It



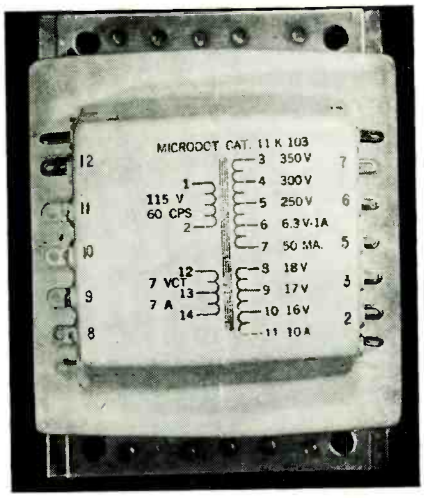
measures capacity and loss factor—is calibrated for 60 and 120 CPS. Electronic Applications, Inc. Booth 3929.

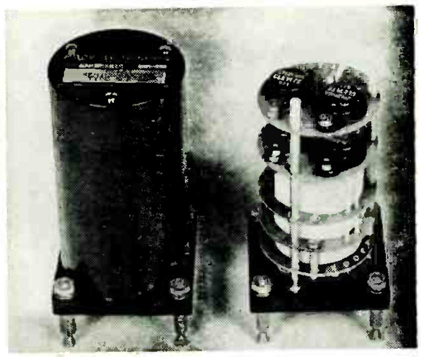
Circle 174 on Inquiry Card

Transformers

Line of specialty transformers ranging from miniature to standard sizes. Includes pulse transformers, charging chokes, blocking oscillators, and rectifier, filament, and power transformers. Microdot, Inc. Booth 2101.

Circle 175 on Inquiry Card





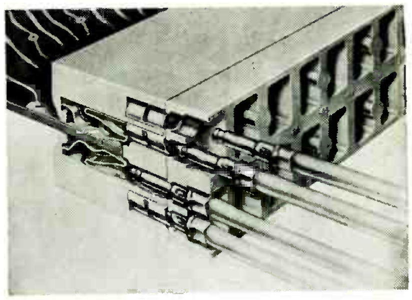
Relays

Transistorized relay with keying speeds up to 2500 baud (bits/sec.) for telegraphic or teletypewriter applications. Relays are interchangeable with WE 255A or similar types. Rixon Electronics, Inc. Booth 3411.

Circle 176 on Inquiry Card

PC Connector

Edge-type printed circuit connector, the Edge-On, features a bifurcated, undulating spring design which as-



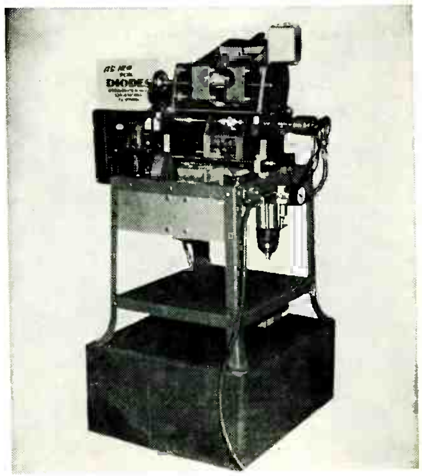
sures multipoint contact. Another feature is a closed entry face on the board side. Burndy Corp. Booth 1329.

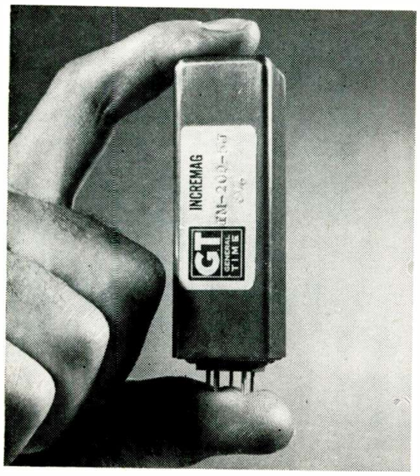
Circle 177 on Inquiry Card

Testing Unit

Universal Orienting and Testing Unit electrically tests diodes, capacitors, and resistors. Average rate is 3500 pieces per hour. Rejects sub-standard parts. Orients parts in direction of polarity. Universal Instruments Corp. Booth 4019.

Circle 178 on Inquiry Card

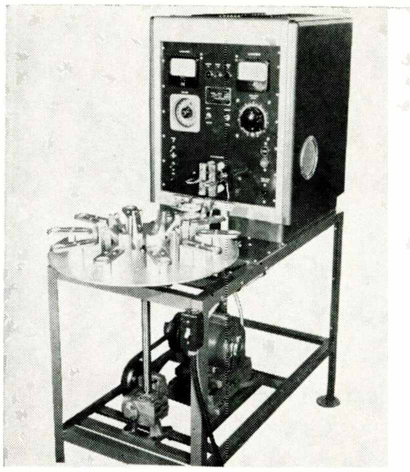




Precision Counter

Digital component, INCREMAG, can perform counting-dividing functions otherwise requiring a battery of binary type units. Variable counting rate is up to 100,000 pps. General Time Corp. **Booth 1726A.**

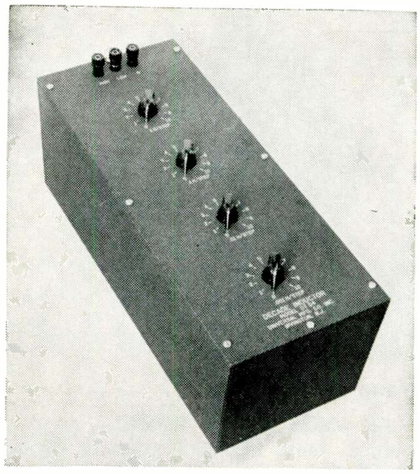
Circle 187 on Inquiry Card



Turntable

For use with Induction Heating Generators, continuously moving turntable has adjustable speed. There is no direct connection for r-f current or cooling water. McDowell Electronics, Inc. **Booth 4128.**

Circle 190 on Inquiry Card



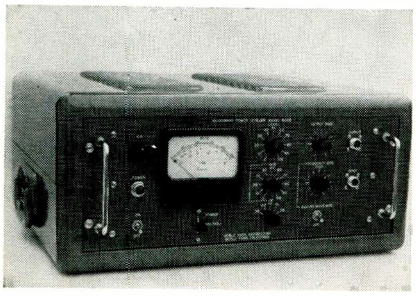
Decade Inductor

Decade inductors useful for substitution in the design of equalizers and filters at audio and ultrasonic frequencies. At 1 KC the accuracy of total inductance is ±1.0%. Universal Manufacturing Co. **Booth 4415.**

Circle 192 on Inquiry Card

Power Levelers

Microwave power leveler, the series 500, is used to control output variations from a traveling wave amplifier or a backward wave oscillator. Menlo Park Engineering. **Booth 3836.**

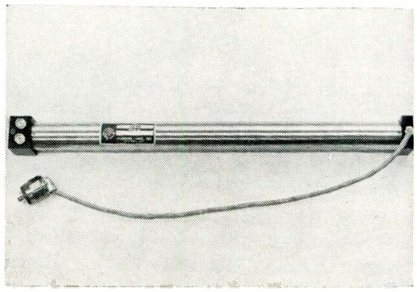


Circle 188 on Inquiry Card

See these Products at IRE

Traveling Wave Tube

Electrostatic focused 1 w traveling wave tube, the HA 58, operates on 500 to 1000 MC with a small signal gain of 30 db min. and a saturation gain of 28 db min. Huggins Labs. **Booth 2917.**

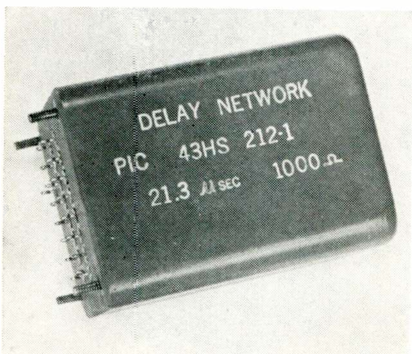


Circle 193 on Inquiry Card

Delay Lines

Standard Lumped Constant Delay Networks offer a wide range of specifications to meet the increasing demand for precision delay networks. Polyphase Instruments Co. **Booth 2839.**

Circle 189 on Inquiry Card



Circuit Breakers

Series 500-I electro-magnetic circuit breakers provide tripping action within 25 msec on overloads of 150% of rated current. Current ratings are from 50 ma to 10 a. For dc and ac use. Airpax Electronics. **Booth 2306.**

Circle 191 on Inquiry Card

Transistor Transformers

Miniature Molded Transistor Transformers are ½ in. in dia., ½ in. high. They are designed to meet MIL-T-27A, Grade 5, Class R, 10,000 hr. reliable life. Microtran Co., Inc. **Booth 2315.**

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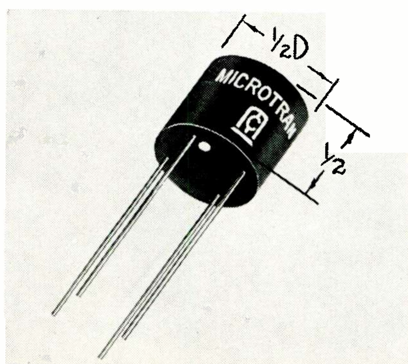
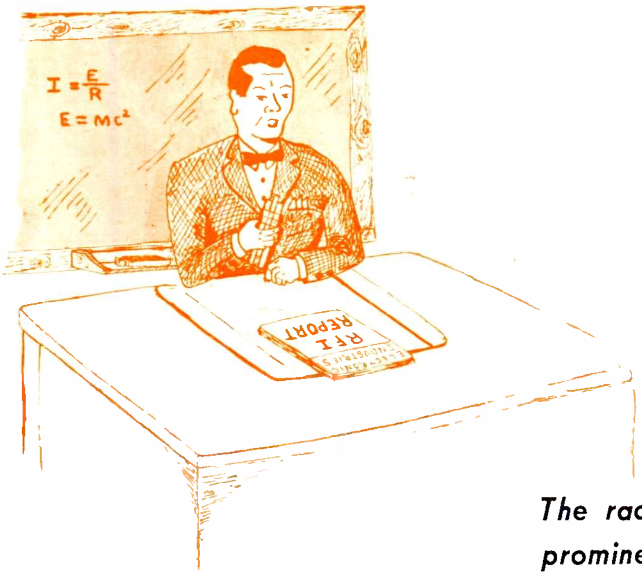




By JOHN E. HICKEY, Jr.
Associate Editor
"Electronic Industries"

The radio frequency interference problem is gaining the prominence it justly deserves. Up to now engineers "let George do it" when the RFI problem came up. Now the responsibility is being placed on all electronic engineers.

RFI is Everybody's Business

THE electronic spectrum is now accommodating millions of pieces of transmitting and receiving gear. Added to this are a few million other pieces of test and control equipment, each of them generating small local fields in the course of their operation. What this amounts to is a king-sized problem of Radio Frequency Interference.

In the past, engineers working on a black box for a system have been able to pass-the-buck when it came to interference. This is no longer being permitted. New Government specs are being written which spell-out the contractor's responsibility and these new specs will soon be written into every contract.

Aside from the fact that contracts will and do call for interference-free equipment, we should remember that interference affects all of us. It may appear in our radio or TV set at home, in communications and radar equipment, it can foul-up telemetering information, or send a missile crashing to earth prematurely.

Interference is any electrical disturbance or electromagnetic radiation that interferes with the reception of desired electromagnetic radiations. This interference may appear in many forms, some border on the ridiculous. Anything that carries electrical current or sends out electromagnetic radiations is a potential source of trouble. Natural phenomena such as electrical storms and sunspots create interference also.

No matter what creates RFI, you the electronic engineer have the headaches of overcoming it. After all it is your equipment that is being interfered with. This means you should always design your equipment with this problem uppermost in your mind.

We have no control over interference created by natural phenomena, and very little control over RFI generated by non-electronic equipment such as motors, signs, power lines, etc. In specific cases of man-made noise, we can track down the source and request that the cause be corrected. Generally this takes time, effort and money. Also, we have no assurance that the next day another source will not crop-up. There are many ways that our own electronic equipment can create interference. Some of the ways are quite sophisticated. However, we do have a weapon to combat these problems—Good Design.

To accomplish good design, you must know about interference, its causes and cures. This information must be learned, it cannot be obtained by osmosis. There has been a large amount of work done in the field of RFI. Unfortunately, this information is of interest to only a small segment of engineers who are specialists in this area.

With the growing concern about RFI, the editors of *Electronic Industries* decided to present as much material as space would permit. To do the best job, we discussed this problem with engineers active in RFI work. From our discussions, and the help of O. M. Salati, Associate Professor, Moore School of Electrical Engineering, University of Pennsylvania, we outlined the various areas to be covered.

Armed with this outline, we contacted the people best qualified to write specific articles for this series. In this issue we are starting this series and each month thereafter we will publish at least one article until our series is completed. (See the box on this page for the main areas to be covered and the selected authors.)

This is the first in a planned series of editorial features on Radio Frequency Interference arranged for by the editors of ELECTRONIC INDUSTRIES

Future articles covering RFI will be in these areas. The authors and their affiliations appear with the subjects they are writing about.

Interference in Transmitters
C. E. Blakely
R. N. Bailey
Georgia Tech.

RFI in Systems Design
Rocco Ficcki
RCA Service Co.

Interference in Receivers
H. M. Sachs
J. J. Krstansky
Armour Research

Interference to Satellites
O. M. Salati
University of Penna.

Transmission Lines (& Filters)
D. C. Ports
Jansky & Bailey

Interference in Propagation
R. B. Schulz
L. Valcik
Armour Research

Graphical presentation of Filters
M. H. First
Filtron Company

Antennas
E. Jacobs
University of Pennsylvania

Man-made RFI & FCC Enforcement
FCC, Washington, D. C.

Instrumentation
Dr. R. M. Showers
F. Haber
University of Penna.

PRACTICALLY all interference in communications equipments is caused by energy generated at certain frequencies inside a transmitter. This energy is eventually transmitted to the receiver through such routes as the antenna system, transmitter case, and power leads.

There are other sources of interference not associated with transmitters. These include receiver emissions, power systems, appliances, machinery, vehicle motors, and the various processes of nature. But we will not discuss those here.

The interference generated in a transmitter is usually considered in the categories of spurious and harmonic radiations from the case, leads and antennas, carrier noise, sideband splatter, cross-modulation, and intermodulation. The interference effects such as desensitization, spurious responses, and co-channel, which are produced in receivers by the carrier, will not be discussed here. It is more appropriate to discuss them when considering receivers and frequency selection schemes.

A few general remarks can be made concerning the interference generated and radiated from a transmitter.

(1) The frequencies at which the interference will appear can be calculated by means of linear equations. Thus, if all of the signal sources inside a transmitter are known, it is easy to predict the frequencies of the outputs.

(2) The amplitudes of the outputs depend on nonlinearities, which are present in all active devices. Therefore they cannot be calculated with any degree of accuracy unless all of the nonlinearities are known to a high degree of accuracy.

(3) If one transmitter's interference measurements are going to be applied to other transmitters of the same type, then a high degree of accuracy may

If all the signal sources inside the transmitter are known then the frequencies at which the interference will appear can be calculated by rather simple linear equations. It is somewhat more difficult to calculate amplitudes, because these depend on non-linearities. Other methods must be used.

Making Transmitters RFI-Free

By C. E. BLAKELY
and R. N. BAILEY

Research Engineers
Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia

not be warranted. This is true because of the set-to-set variations in the level of interference.

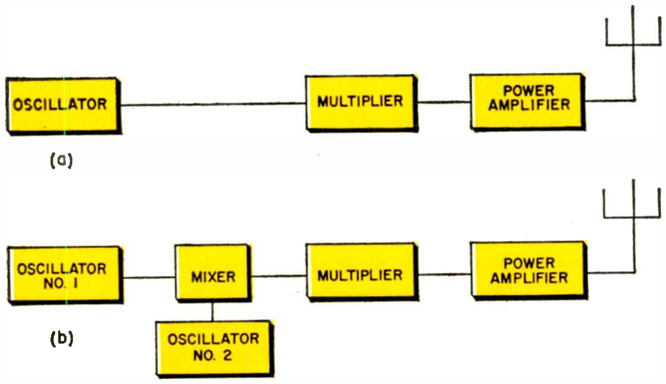
(4) The relative importance of the various types of interference changes with transmitter type. For example, case radiation may not be important for a transmitter that has very little filtering in the output stage. Therefore, it is difficult to assign relative values to the various types of interference.

The measurement of most transmitter-generated interference is relatively easy and straightforward. Suitable measuring equipment has already been developed for most of the tests. The procedure for each test is to select a piece of measuring equipment and a suitable sampling point and record all outputs that are present.

The suppression of transmitter interference covers a very large range but the principles are basically simple. If for a particular application a certain frequency is causing trouble in adjacent equipments, it can be eliminated by means of traps or stubs. However if the transmitter is a production type that must be used in many different installations, suitable filters must be designed to suppress all the outputs to a negligible level. These filters must be placed in the power leads, antenna leads and control leads. Also, with respect to case leakage, the case must be made as tight as necessary by means of gaskets and screens.

There are cases in which it is not necessary to suppress the outputs of a transmitter to a lower level until the state of the art of receiver design has progressed further. For example, as shown later, receiver intermodulation is usually more serious than transmitter intermodulation, and carrier noise is not as serious as the desensitization caused by the strong carrier. Of course, as receiver design improves, it will become necessary to suppress these quantities further. With the frequency spectrum becoming more and more crowded it becomes important that all forms of transmitter interference be considered in initial equipment design and in channel assignment. This becomes necessary in cases where a large number of channels will be used in a confined area. Disruption of communications by interference can have serious consequences.

Fig. 1: Block diagrams of frequency conversion systems. The two oscillator system (b) complicates the RFI problem with the inclusion of sum and differences of the two oscillators.



Spurous and Harmonic Emissions

Transmitter circuitry may assume a variety of forms. For the purpose of this article, the two block diagrams shown in Fig. 1 will illustrate the principles involved. The transmitter characterized by Fig. 1a is the ordinary frequency multiplication communications type. It has a low frequency master oscillator and a chain of frequency multipliers to obtain the operating frequency. The frequency multipliers are by necessity quite nonlinear; therefore, the output of each is rich in harmonics. Thus the output

Transmitter RFI *(Continued)*

of the first multiplier will contain a large number of master oscillator harmonics. One of these is selected by the plate tuned circuitry and passed on to the next stage. One particular harmonic will be accentuated, but several additional harmonics of significant amplitude will also arrive at the grid of the next stage. The levels of these unwanted harmonics, with respect to the selected frequency, can be calculated approximately by the following expression, which relates the voltage output of any master oscillator harmonic to the desired or selected harmonic.

$$E_n = \frac{E_o}{\sqrt{1 + S_n^2}} \doteq \frac{E_o}{S_n} \qquad (1)$$

where

$$\text{Selectivity} = S_n = Q_e\left(\frac{f}{f_o} - \frac{f_o}{f}\right)$$
$$= Q_e\left(\frac{k+n}{n} - \frac{k}{k+n}\right)$$
$$= Q_e\left(\frac{n}{k}\right)\left(\frac{2k+n}{k+n}\right) \qquad (2)$$

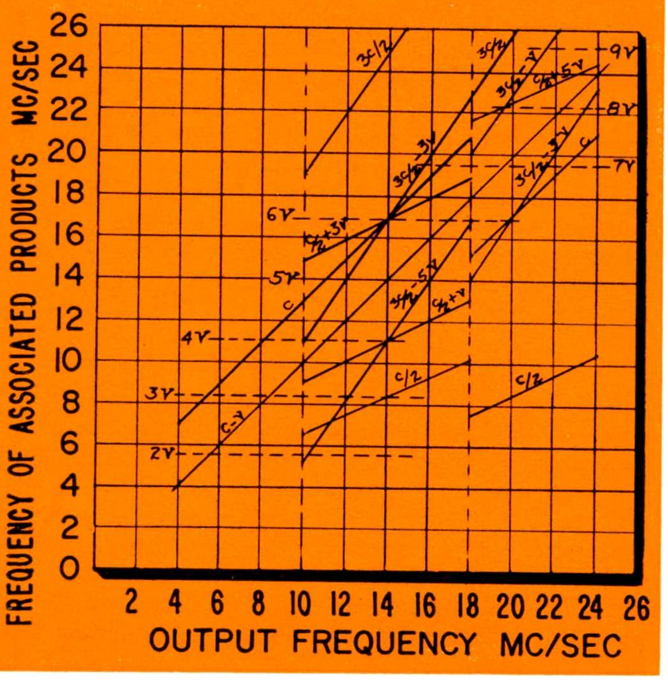
where

Q_e = effective Q of the tuned circuit
$= Q(1 - \eta)$
k = multiplication factor of the stage
n = positive or negative integer, $|n| < k$.

For $k = 2$, $Q_e = 50$ and $n = \pm 1$, i.e., a frequency doubler, the fundamental will be attenuated approximately 37 db and the 3rd harmonic 32 db.

Thus it is apparent that in addition to the desired harmonic, harmonics of the master oscillator will arrive at the final amplifiers at appreciable level unless extremely high Q circuits are used. Practical limits on tuning and efficiency usually require that Q_e be approximately 40 or 50. Also, any spurious resonance[1] of the circuitry will tend to raise the level of certain bands of harmonics at frequencies widely separated from the desired frequency. This is because at each spurious resonance the same formula will apply with a different Q_e. The same analysis will also apply to the harmonics of the output stage of the transmitter. Thus, there will be two distinct sets of harmonic emissions, one related to the master oscillator and the other related to harmonics of the carrier.

Fig. 2: Spurious and desired frequencies in the output of a high-frequency modulator



The circuit of Fig. 1b will perform in the same manner as 1a with one exception—the output is now complicated by the addition of several frequencies due to sums and differences of all the oscillator frequencies. If two or three frequency translations are used, a very large number of harmonic outputs can be anticipated. This has been discussed by J. J. Hupert[10, 11] in detail and summarized by the following statement:

> "Frequency composition has one inherent disadvantage, namely that of producing frequencies other than that of the wanted channel. It should be remembered, however, that ordinary frequency-multiplication also produces unwanted frequencies as a result of the modulation of the selected harmonic by the adjacent one. The number of channels on which the possible disturbance can occur increases with the total multiplication factor applied in the set."

Fig. 2, taken from A. E. Kerwien's[16] paper which discusses the design of modulation equipment for SSB transmitters, is a chart of the spurious and desired outputs in the tuning range of an actual transmitter. If the chart were extended to include the 2nd harmonic of the carrier, then this spectrum would be repeated with all the lines spread by twice the frequency shown, and the amplitudes would be reduced. The same is true for 3 times the carrier frequency, etc. Measurements show that the interference created by a transmitter extends for a considerable range above its basic tuning range. In all the preceding discussion only the harmonic output of the various oscillators has been mentioned, while the words "spurious and harmonic emissions" are used to describe the output of a transmitter. Actually, in all measurements made to date and in all literature seen by the authors, no outputs were found that could not be related to some frequency or combinations of frequencies that were present in normal transmitter operation. While it is possible for a stage to operate on two unrelated frequencies simultaneously, this does not seem to occur in transmitters operating up to a few hundred MCS.

Spurious emissions are usually measured by means of a field intensity meter, dummy load, signal generator and attenuators. This is shown by the solid lines in Fig. 3. If the radiated field strength is to be measured, a calibrated dipole antenna is used as the signal source for the field intensity meter. The usual precautions to prevent errors due to overload and desensitization, spurious responses, and harmonic generation in the front end of the meter must be observed. Some experimenters use a selective circuit in place of the attenuator. This is done to reduce the level of the transmitter fundamental in order to reduce the aforementioned effects. However, this refinement is unnecessary if the spurious outputs have been suppressed by less than 80-100 db. This figure is based on the NF-105 field intensity meter available from Empire Devices, Inc. If a selective network is used, care must be exercised to avoid errors due to spurious resonances and impedance changes of the network with respect to frequency.

Fig. 4 is the combined results of the measured spurious outputs for 14 transmitters representing 7 types. The length of each line represents the range of values and the circle is the mean value for each particular harmonic order. Since there may be more than a hundred measurable responses for a l-f transmitter, only a few of the harmonics are shown. On the average for several transmitters, the level ultimately decreases to approximately 100 db with respect to the carrier in the vicinity of the 15th harmonic. It remains at about this value until they drop out at several hundred megacycles for the typical communications transmitter. A ripple of approximately ±20 db is usually superimposed on this level so that the envelope undulates from −80 to −120 db below the carrier. The envelopes for two transmitters of the same type but different serial number are usually shifted in frequency so that individual harmonics will show considerable variation in magnitude from one serial number to the next.

Fig. 3: Block diagram of spurious emissions measurements setup.

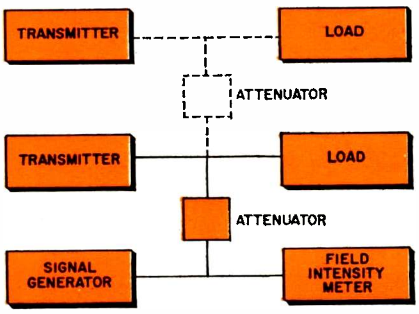


Fig. 5 shows the measured spurious and harmonic output for a transmitter which uses two frequency doublers. An examination of the frequency scale shows that outputs which are related to the master oscillator and carrier are present; and the master oscillator pair adjacent to the carrier follow Eq. 2. The transmitter from which these data were obtained uses a broadband frequency multiplier. Therefore, the master oscillator fundamental is also present at the output with an amplitude sufficient to cause serious interference. In the preceding discussion all levels were referred to the carrier. However, the absolute levels will vary according to the absolute power output of the transmitter. The levels shown in Figs. 4 and 5 were measured with the transmitter terminated in a resistive load. From this one might expect them to be considerably different if a complex load were used. But, tests conducted with various load magnitudes and phase angles indicate that the harmonics are reduced in roughly the same proportion as the fundamental. In almost every case the output was lowered as the phase angle was varied. This was expected because of the finite Q of the tuning components.

In general, 4 techniques may be used to reduce or to suppress the harmonic output of a transmitter. They are:

a. better filtering,
b. better shielding between circuits,
c. stubs and traps for particular harmonics, and
d. more linear operation.

For a general purpose transmitter the first two are the most practical. Linear operation of amplifiers reduces efficiency, and traps and stubs must be readjusted for each tuned frequency. Also, since traps or stubs usually work well for only one particular harmonic, a large number would be required for complete suppression.

A study of the data collected for several transmitter types shows some general trends in the harmonic outputs as a function of the components and circuitry. Transmitters that use the newer, more modern tube types and components tend to have more harmonic output than the older types. There are probably two reasons for this:

1. The older components are more lossy and thus the conversion gain decreases very rapidly with frequency;
2. More tuning adjustments are usually provided on the older models.

The example shown in Fig. 5 illustrates the tendency to use untuned or very low Q circuits in the multipliers, which, according to Eq. 1, will increase the harmonic outputs. Measurements show that the harmonic output is weaker for master oscillator controlled transmitters than for other types. This has also been reported by F. T. Wilson.[36]

Intermodulation

R-f intermodulation is defined as the mixing of two or more carrier frequencies in a nonlinearity to produce new frequencies which are then radiated. In recent years, considerable attention has been devoted to this form of interference as the result of occurrences of serious interference. However, a great deal of the attention has been devoted strictly to mathematical analysis and theoretical discussions.

Very little data has been published with respect to intermodulation levels and the necessary frequency separation between transmitters to reduce transmitter intermodulation to an acceptable level. Because of the limited amount of intermodulation data available, very little effort could be made to include intermodulation in system planning except to omit all intermodulation frequencies from consideration. A simple method of predicting these levels from a small amount of measured data is given in another paper by the authors.[2] There are two types of transmitter intermodulation, audio and radio frequency. The audio intermodulation occurs in the modulator and r-f stages but produces extraneous components only in the passband and the adjacent channels. R-f intermodulation requires the presence of a 2nd transmitter and produces radiations at the carrier frequency plus and minus multiples of the frequency spacing between the two transmitters. The r-f type will be discussed here and the audio type under Sideband Splatter.

A discussion of intermodulation, for completeness, should include an analysis of the mechanism of generation. But, due to the nature of this article, a few statements will be made and the reader may refer to references 8, 10 and 19 for a complete discussion. Intermodulation products generated in an r-f amplifier are related to the plate current, which can be represented by a power series of the form

$$i = a_o + a_1 e + a_2 e^2 + a_3 e^3 \cdots \quad (3)$$

The constants in Eq. 3 are determined by the tube characteristics and the operating point, which in turn is dependent on the circuit parameters. In theory it is possible to evaluate these constants. But in practice, due to variation in tube characteristics and circuit parameters, those constants which apply in one specific case may not be sufficiently accurate for another case. For our purpose here we will assume that it is possible to evaluate the constants with sufficient accuracy. It should be noted, that if the device were perfectly linear, the 3rd, 4th, etc. coefficients would be zero; however, almost all vacuum tubes have higher order coefficients of significant magnitude.

If we assume an input voltage to the r-f stage of the form

$$e = E_1 \sin \omega_1 t + E_2 \sin \omega_2 t \quad (4)$$

we can expand the power series to obtain the intermodulation products generated. The actual substitution of Eq. 4 into the 2nd, 3rd, etc. terms of Eq. 3 and simplification becomes quite tedious and long and will not be given. However, the results will be discussed below and those interested may find a complete analysis in the referenced literature. The output resulting from the linear term of the power series is of the same form and frequency as the input, while the squared term results in a dc component, components at twice the input frequencies, and at the sum and difference of the input frequencies. These products will not usually be of importance when considering the r-f intermodulation in the output stage of a transmitter. The output circuit is usually selective enough that the frequencies far removed from the transmitter tuned frequency will be greatly attenuated. The squared term, though not important in the generation of transmitter intermodulation, may produce serious interference in a receiver.[25]

The expansion of the cubic term produces a large number of terms with components at the input frequencies f_1 and f_2, and also at frequencies $3f_1$, $3f_2$, $2f_1 \pm f_2$, $2f_2 \pm f_1$.

The intermodulation products of interest are those which fall in the transmitter output passband. In general, they are the difference products $mf_1 - nf_2$, where m and n *are* integers. As mentioned above, the sum frequencies are not of importance because they produce components which are considerably removed from the transmitter passband. The sum of m and n is usually referred to as the intermodulation product order. It is the same as the exponent of the *lowest* power term in the power series that will produce this particular frequency term. The amplitudes of these signals are proportional to $E_1^m E_2^n$. It should be noted that the harmonics of the carrier necessary for the production of these intermodulation products usually already exist in the transmitter final amplifier at relatively high levels. If the amplitudes of these harmonics are considered as constants of harmonic order m, then the amplitude of the intermodulation products will be proportional to the *nth* power of the amplitude of the signal coupled into the transmitter which generates the intermodulation products, i.e.,

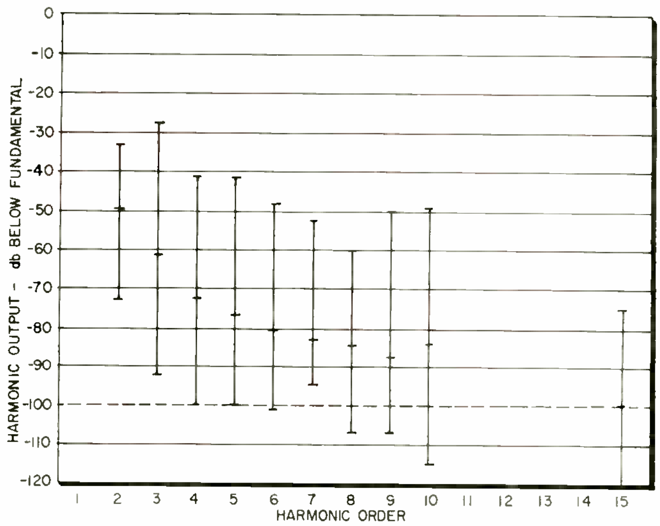


Fig. 4: Normalized harmonic emissions. Line length represents range of values and mark near line center is the mean value.

$$E_I \propto E_i^n$$

where

E_I = intermodulation product amplitude,

E_i = interfering signal amplitude, and

n = order of the interfering signal required to generate intermodulation product of order $m + n$.

Transmitter intermodulation measurements may be made after installation of the transmitter, but a better approach would be to have intermodulation product data at hand for use in the initial planning. Of course, initial planning of a system for freedom from intermodulation interference requires a knowledge of the frequency and approximate signal levels at the proposed transmitter site. These can usually be obtained or estimated.

The test arrangement shown in Fig. 3, where the dotted portion represents the interfering signal, is a convenient one to use for making intermodulation measurements. Tests performed on equipment using this arrangement showed that essentially no errors were introduced in the intermodulation measurements when the interfering signal, coupled into the transmitter output, was 40 db or less below the desired signal. Greater attenuation, however, resulted in intermodulation product levels so low that too little attenuation was used at the receiver input. This resulted in some error due to receiver desensitization and/or intermodulation. This effect is worst, with receivers which have bad intermodulation and desensitization characteristics.

Intermodulation measurements by Blake[4] show an example of intermodulation interference which it is not always possible to eliminate in initial planning. He found that two signals were being intermodulated in a nonlinearity due to corrosion between two plates in a metal structure. Transmitter intermodulation has also been attributed to corroded bolts or joints in the transmitter tower or circuitry and nonlinear monitor circuits. These types are most severe when the device that generates the intermodulation has a combined length of ½ λ or multiples thereof.

Another case of intermodulation in which 3 programs were heard simultaneously was reported by Brinkley.[5] The particular case was three BBC VHF FM transmitters using the same antenna with a frequency spacing between carriers of approximately 2%. The relative level of each transmitter carrier at the antenna terminals of the other transmitters was −65 db. However, the products were strong enough to produce a field strength of 5μv/meter at 31 miles from the transmitting site. One characteristic was that the deviations added so that the intermodulation products occupied 3 times as much spectrum as the original signals. He found that the 3rd order products were the most serious, with the higher products considerably weaker.

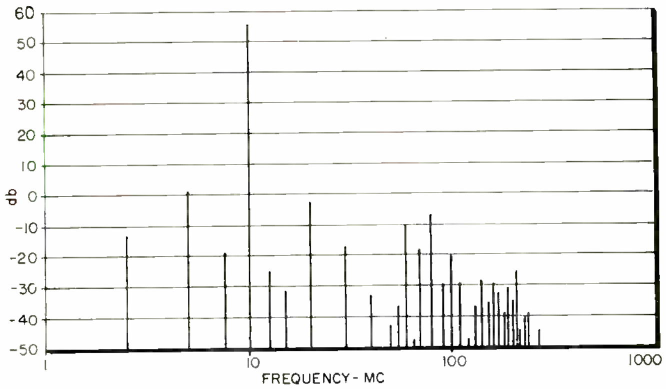


Fig. 5: Measured spurious and harmonic output for a transmitter which uses two frequency doublers is plotted

Beauchamp[3] reported that with 33 db attenuation between two transmitting antennas, and 62 db attenuation between the transmitting and the receiving site, it was not possible to eliminate 3rd order intermodulation with 70 MC separation between the transmitter frequencies. Our observations have been that for transmitter frequency separations of greater than 5% of the desired tuned frequency and antenna separation of 70 db, there will be no measurable intermodulation products. However, 3rd order intermodulation in a receiver[25] can be serious to about 10% separation in signals; and 2nd order intermodulation can be serious for practically any separation when one strong local signal is present.

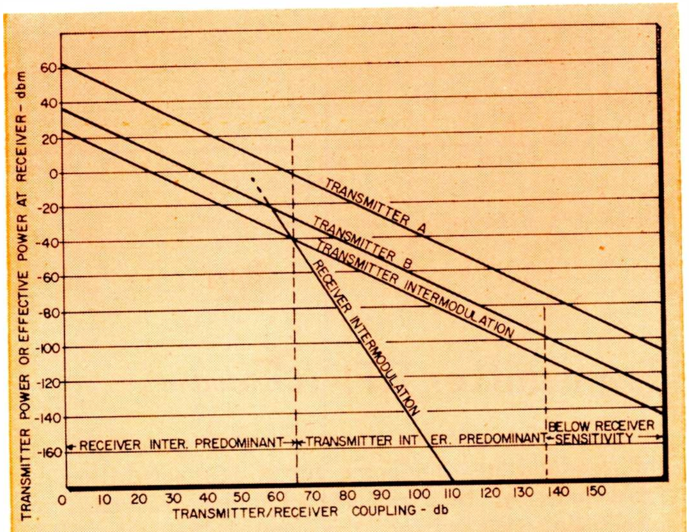


Fig. 6: Comparison of transmitter and receiver intermodulation effect is shown. Transmitters have 100 kc frequency separation.

Fig. 3 of Beauchamp's paper seems to be a combination of transmitter and receiver intermodulation. Data obtained for 15 different transmitters and 14 different receivers show that the slope of the 3rd order transmitter intermodulation curve vs the interfering signal level for the product nearest the frequency of the transmitter producing the products, when plotted on a log-log scale, is unity;[2] and the slope of the receiver intermodulation curve is two.[25]

It can be further shown that for small attenuation between the transmitter and receiver site, receiver 3rd order intermodulation will be more serious than transmitter 3rd order intermodulation. But, as the attenuation is increased, the transmitter intermodulation becomes more serious. Fig. 6 is a plot of the data from a typical transmitter and receiver, where the 2 transmitters are assumed to be located at the same site and have a frequency separation of 100 KCS. For attenuation of less than 66 db between the transmitting and receiving site, graph shows receiver intermodulation is the more serious. Whereas, for greater attenuation, the transmitter intermodulation is the worst.

A decrease in the signal level of the transmitters tends to cause the transmitter intermodulation to become more serious at a smaller attenuation than previously. And, for a change in attenuation between the transmitter antennas, the coupling between the transmitting and receiving site at which transmitter intermodulation is the most serious tends to remain constant. Of course, at some coupling value, depending on the transmitter intermodulation characteristics, the transmitter intermodulation products will be below the ambient noise level and will not be detected.

Fig. 7 shows the results of comparing the same

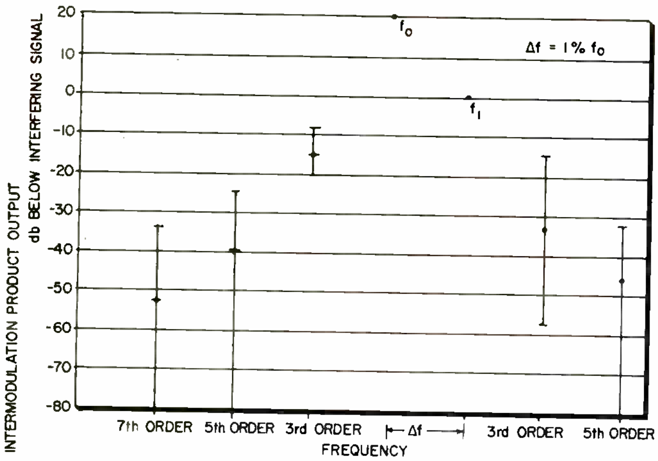


Fig. 7: Plot of normalized transmitter intermodulation

Transmitter RFI *(Concluded)*

group of transmitters, as shown in Fig. 4, from an intermodulation standpoint for a 1% separation in frequencies of the transmitter under test and the interfering transmitter. The symbols have the same meaning as those used in Fig. 4.

Typical intermodulation curves are shown in Fig. 8 for an h-f transmitter. The slopes of these curves correspond very closely with theory, in that the intermodulation curve for the 3rd order products on the desired signal side (when the desired signal is assumed to be the tuned frequency of the transmitter which produces intermodulation) is unity. The slope for the 3rd order products on the interfering signal side is two. Higher order products were also found to agree relatively closely with the theoretical slopes; however, there was less agreement for higher order products. This effect is at least partially due to measurement difficulties as the intermodulation level becomes small.

It will be noted that increasing the transmitter frequency spacing decreases the intermodulation on the interfering signal side more rapidly than that on the desired signal side. This effect is the result of the mechanism of generation. That is, the product on the interfering signal side is proportional to the square of the interfering signal. Now, increasing the spacing will move the interfering signal farther out on the skirt of the bandpass characteristic curve. This effectively reduces the amplitude products more on the interfering signal side. Since these curves correspond so closely with theory, intermodulation levels can be predicted from the data obtained by a few measurements.[2]

As stated by Brinkley[5], transmitter intermodulation can be avoided if separate suitably spaced antennas, or suitably oriented directional antennas, are used to reduce the mutual coupling sufficiently. Additional means for suppressing transmitter intermodulation are to improve the output circuit selectivity and/or the output stage linearity. When these precautions are taken, receiver intermodulation then becomes the important consideration.

Intermodulation resulting from nonlinearities in the audio circuits and in the modulating process are discussed with Sideband Splatter.

Case Radiation & Susceptibility

Almost all electronic equipment can emit spurious radiation from its case or can be susceptible to case-penetrating radiation generated by other nearby equipment. The radiation fields which are present around a transmitter case are at the same frequency as those calculated by the procedure outlined in the section on Spurious and Harmonic Emissions. However, the amplitudes do not have the same relationships as those at the antenna terminals because the path attenuations are different.

Case radiation consists of both low impedance and high impedance fields. The former is most important up to 20 or 30 MC and the latter from 30 MC up. To make measurements of these fields in the vicinity of a particular equipment, the electric field intensity and magnetic field intensity must be measured separately. These fields are not simply related as in the case of the far, or radiated field. A calibrated loop for the low frequencies and a calibrated dipoie for the high frequencies may be used to sample the field. A field intensity meter may be used to determine the magnitude.

Since these fields decay rapidly as the distance from the radiator approaches a small fraction of a wavelength, it is generally necessary to sample the field near the case. The distance for sampling should, however, be dictated by the normal juxtaposition of the radiating case and susceptible equipment. There are two basic procedures for measuring case radiation: the open field method[23] and the screen room method[20]. Each method has certain advantages and disadvantages which are discussed in the references.[13,20,23] The most important advantage of the open field method is the unlimited frequency range, while the screen room method is limited to 20 or 30 MC and to small equipments.

Generally case radiation is not a serious problem because the harmonic output at the antenna terminals is usually always at a higher level. Fig. 9 is the result of case radiation measurements for the same transmitter as Fig. 5 by the open field method. This spectrum is typical of that found in other transmitters. Examples have been found in which the antenna filtering was better than the case shielding. Thus the case radiation would constitute interference.

The suppression of case radiation consists of preventing current flow on the case and leads, the grounding of all potential radiators such as knobs, shafts, etc., the shielding of meters, inspection windows, etc., and proper grounding of the equipment.

Case susceptibility to interfering signals is almost negligible in transmitters; however, there are serious examples of this type interference. If modulated r-f energy from a nearby source should leak into low level modulator stages and be detected it can modulate the carrier in the same manner as the desired audio. The suppression of this type of interference is the same as for the case radiation. Case susceptibility can be determined by means of a signal generator and a small loop. The loop is energized and moved about over the case surface while a modulation monitor or the modulation meter of the transmitter under test is observed.

Power Leads

R-f, as well as audio voltage from a transmitter, may be radiated from the power lines at an amplitude sufficient to constitute interference. In general, the levels from low and medium power transmitters are such that they will not interfere with receiving equipments through the power system directly. But, according to S. F. Pearce[22] the coupling between supply wiring and the antennas on five merchant ships was −70 db with a standard deviation (σ) of 13 db. These values for steel ships are much better than those for wooden ships. For wooden ships the range of measured values were −50 to −90 db. He also states that these values are much lower than for domestic installations. Using these values as a guide, couplings of −40 db might be expected for installations with above-the-ground power systems and no shielding.

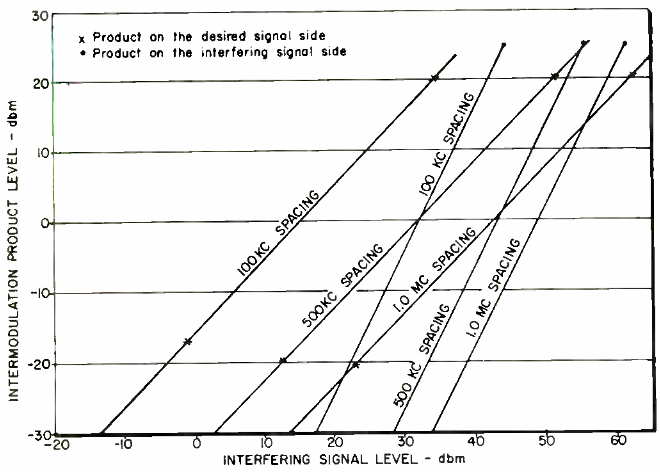


Fig. 8: Typical h-f transmitter intermodulation curves —third order product on the interfering signal side.

The average level of interference at the power terminals is 100 db below the carrier for a typical transmitter. This interference shows much the same frequency composition and amplitude distribution as the harmonic emissions at the antenna terminals (see Fig. 10). Thus, unless the filtering at the antenna terminals is much better than the power line filtering, no new interference will be created due to power line interference. In general, measurements show that transmitters are not susceptible to signals entering through the power line. Most of the transmitters that were found to be susceptible were vehicular types that were not usually used where other transmitters were connected to the same power systems.

Cross-Modulation

Cross-modulation is usually defined as the transfer of modulation from one carrier to another in a nonlinear circuit. It is produced by the same mechanism as intermodulation. Thus all the components of the intermodulation spectrum, including the carrier radiated by a transmitter will contain the modulation from both transmitters. However, the depth of modulation on the desired carrier, due to the interfering transmitter, is usually negligible in practice.[33] One particular case of cross-modulation for a 150 kw transmitter and a 100 kw transmitter separated by 9 km was reported by Schellmann and Vogt.[28]

The type of interference, discussed under Case Radiation and Susceptibility, caused by leakage of a carrier into the modulator of another transmitter, is sometimes referred to as cross-modulation, which is probably a misnomer although the definition is satisfied.

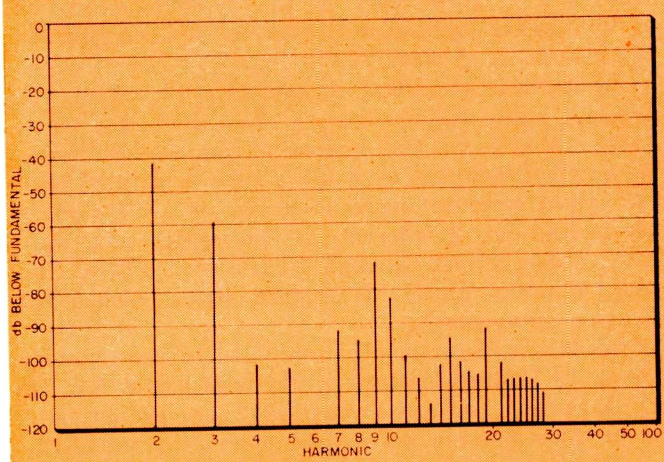
Sideband Splatter

Sideband splatter is a by-product of the modulation process. It exists in all types of transmitters with varying degrees of severity. A careful survey of the literature will reveal varied definitions of the term which will now be defined for use here. "Sideband splatter consists of all those outputs of a transmitter that are a result of nonlinearities in the audio circuits, and the modulation characteristic which produce undesired components in the desired band or adjacent channels." This definition does not include those out-of-channel radiations that are due to excessive bandwidth in the modulator.

Sideband splatter is generated in several ways. The most common causes are modulation limiters, overdriven modulators, poor regulation on the power supply, and nonlinearities in the audio amplifiers and r-f modulating characteristic.

All of these factors tend to broaden the audio spectrum considerably if the circuits generating the side band splatter are not followed by suitable filters. They also tend to degrade the desired signal, since the first few harmonics of the low audio frequencies, and all the difference frequencies, will be in the passband of the desired signal. Rather extensive analyses of sideband splatter have been made by Price,[24] Smith,[29] Firestone,[8, 9] Villard[35] and others. The paper by Price is highly mathematical and investigates the output of a transmitter for several different types of modulation characteristics. The conclusions are that if the mathematics represent the actual transmitters, then the spectrum is not too

Fig. 9: Normalized electric field due to case radiation. This is the result of measurements for same transmitter as Fig. 5.



Transmitter RFI *(Continued)*

sensitive to the actual modulating characteristic. He states that the spectrum near the passband falls off as $(1/\Delta f)^2$ for AM and $(1/\Delta f)^3$ for SSBSC, with a greater rate at large separations in frequency. These results tend to be supported by experimental data.

Firestone presented a theoretical analysis and some measured data to support his analysis, it consisted of assuming a power series representation of the modulating characteristic and then evaluating the coefficients by using experimental data. Actual calculations show a very good fit with experimental results.

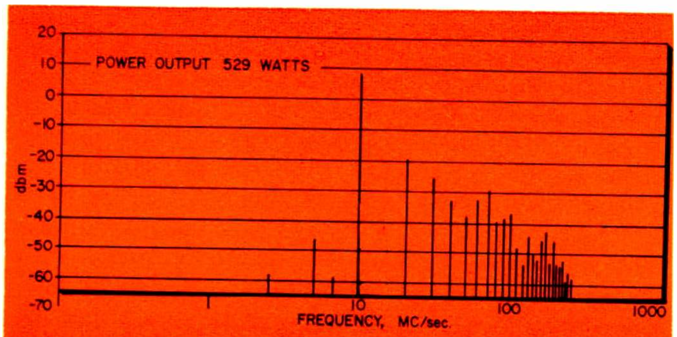


Fig. 10: Output conducted interference, fo = 10 mc/sec.

His theoretical analysis shows that, surprisingly, the output of a poor AM transmitter will occupy more spectrum space than the average FM transmitter. Experimental results seem to show that the splatter is proportional to the carrier. Thus the full carrier transmitter is at one end of the scale and the suppressed carrier transmitter at the other. The reduced and controlled carrier fit somewhere between. Experimental results, published by Firestone,[8] for a typical SSB suppressed carrier transmitter show that the splatter components are approximately 40 db below the band signal in the adjacent channels. The initial slope is $(1/\Delta f)^3$ and changes to $(1/\Delta f)$ at some intermediate frequency separation.

Overmodulation has the effect of making the modulation characteristic more nonlinear by operating the tube over a larger part of the dynamic range on positive peaks, and actually cutting the stage off on negative peaks. A circuit is described by Villard which is designed to eliminate the splatter caused by the negative audio voltage cutting the stage off. But it does nothing to prevent splatter on the positive peaks. He accomplishes this by using a tube in parallel with the output stage to supply a carrier of reverse phase during the cut-off interval. If the output tube were rated conservatively enough to perform well on the positive peaks, then this method would reduce the splatter significantly.

Sideband splatter may be evaluated by the two-tone test or by loading the transmitter with noise. For the two-tone test, two equal amplitude tones are adjusted to produce a given percentage modulation or deviation, or peak envelope power, and the distortion-to-tone ratio is then measured. This ratio is −40 to −50 db for a typical SSB transmitter. It can be reduced to −60 db for a well designed transmitter. One fault of the two-tone test is the inclination to exaggerate the splatter spectrum and make the transmitter appear worse than it actually is under normal operating conditions.

The noise-loaded test is attractive because it does not exaggerate the true splatter spectrum, but it is more difficult to evaluate. This test is performed in the following manner. The transmitter is loaded with band-limited noise and the output spectrum is displayed on a spectrum analyzer and photographed. If the filter characteristic of the noise generator is then superimposed on this photograph, all those components outside the filter characteristic are the result of transmitter splatter. Lund[17] has shown that there is a very close correlation (within 1 db) in the spectrums obtained for noise and voice loading of a SSB transmitter. If the transmitter is of the baseband multi-channel type, the standard test for cross-talk is to load two channels with noise and then observe the output of the other channels, in particular those at the intermodulation frequencies. Any increase in the output of these channels indicates intermodulation and/or splatter in the baseband modulators and the modulating characteristic.

The suppression of sideband splatter is done in much the same manner as that of all other types of interference, i.e., by increased filtering, improved linearity, r-f feedback and regulation of the power supply. It is essential that any nonlinear modulation limiter be followed by filtering to avoid severe adjacent channel components.

Carrier Noise

The output of any oscillator consists of a discrete and a continuous spectrum. The discrete spectrum consists of the desired frequency and harmonics of this frequency which were discussed under Spurious and Harmonic Emissions. The continuous spectrum is usually referred to as noise and is due to oscillator frequency jitter, power supply noise, tube noise, etc. Interference due to this continuous noise spectrum is primarily adjacent-channel in nature but may extend for a considerable number of channels for a high power transmitter. In general this noise does not degrade the desired signal appreciably. This is because the depth of modulation or deviation due to noise is quite small compared to the desired modulation. Smith and Shepherd[32] have stated that,

> "Among the various methods of modulation it has been shown that one of the prime cases of interference, modulation sidebands, can be reduced by attention to deviation, modulator audio bandpass, and amplifier linearity. By way of mention, and usually as a side issue, the presence of transmitter noise has been mentioned. . . . In many cases transmitter noise, rather than any other difficulty, has been the thing which reduced the range of reliable communication."

Transmitter noise, in some cases, has been obscured by modulation splatter, and in some cases it has been mistaken for modulation splatter. Smith[31] shows in his paper that FM "transmitter noise" represents interference in the range 80 to 90 db below the carrier. But, below the 90 db level the evaluation of the noise is difficult since it depends on the selectivity of the receiver which is used as the measuring device. It should be stated at this point that, in general, receiver characteristics are usually measured with signal generators which have worse noise characteristics than transmitters.[30]

Analytical studies show that for a low index of modulation, the power density falls off at a rate of $1/\Delta f$ for amplitude modulation, where Δf is the separation from carrier frequency, and is flat for phase modulation. Curves published by Smith & Shepherd for transmitters tuned to 30, 45, 160 and 450 MC tend to verify these conclusions for the power amplifier alone. However if the complete transmitter is included in the measurment, the output is higher in level and the slope changes at some intermediate separation such that the power density changes at the rate of $(1/\Delta f)^2$. The worst case of transmitter noise reported was that of a SSB transmitter tuned to 450 MC whose noise level was 63 db/KC below the carrier at a frequency separation of 10 KC. The average noise level for Most FM and AM transmitters seems to be 80 to 90 db/KC below the carrier. Generally speaking, FM transmitters are better than AM.

Measurement of transmitter noise with sufficient accuracy at the level of interest—below 80 db below the carrier—is difficult. The measurements are influenced by the dynamic range and selectivity of the receiver which is used as the measuring device. Reduction of transmitter noise can best be accomplished in the design stage by providing suitable filters following the audio stages, mixers, modulators, and oscillators. An optimum design including these filters will have a noise output which is determined, in a major part, by the characteristics of the final amplifier stage.

Smith has stated that Class C amplifiers tend to have less noise output than do linear amplifiers. Published data[32] also tend to show that transmitter noise becomes worse as the transmitter tuned frequency increases.

Acknowledgment

Due to space limitations, all the current literature concerned with transmitter interference was not discussed. The bibliography is a listing of those papers that in our opinion represents a good cross section of the literature. It is not intended to be complete.

We wish to thank Mr. W. B. Wrigley, Mr. H. H. Jenkins and Mr. W. M. Rogers for their suggestions regarding the form and content of this paper.

Bibliography

1. "An Investigation of Fundamental Circuit Factors which Influence Spurious Response and the Generation of Spurious Radiations," Final Report, Contract No. AF-33(600)-27091, 6 Dec. 55, (ASTIA AD No. 81 923), The Electro-Mechanics Company, Austin, Texas.
2. Bailey, R. N., et al, "The Prediction of Transmitter Intermodulation from Simple Measurements," *Electronic Design,* Feb. 60.
3. Beauchamp, A. J., "A Technique of Intermodulation Interference Determination," *IRE Convention Record,* Part 8, 1953, p. 26.
4. Blake, K. W., "External Cross-Modulation in the 100 Mc/S Band," *JIEE,* Vol. 94, 1947, pp. 659-662.
5. Brinkley, J. R., "Spurious Radiations from Wrotham," *Wireless World,* Vol. 61, July 55, p. 325.
6. Bruene, W. B., "Distortion Reducing Means for SSB Transmitter," *Proc. IRE,* Vol. 44, Dec. 56, pp. 1760-1765.
7. Bruene, W. B., "Linear Power Amplifier Design," *Proc. IRE,* Vol. 44, Dec. 56, pp. 1754-1759.
8. Firestone, W. M., "SSB Performance as a Function of Carrier Strength," *Proc. IRE,* Vol. 44, Dec. 56, pp. 1839-1848.
9. Firestone, W. M., et al, "Modulation Sideband Splatter in VHF and UHF Transmitters," *Tele-Tech and Electronic Industries,* May 55, p. 82.
10. Hupert, J. J., "Frequency Composition in Naval Communication Transmitters," *JIEE (London),* Vol. 94, Part IIA IIIA, 1947, pp. 405-417.
11. Hupert, J. J., "Spurious Responses and Spurious Frequency Generation Arising from Frequency Translation and Multiplication," *Proc. of the Unclassified Sessions of Symposium on Electromagnetic Interference,* U. S. Army Research & Development Laboratories, Ft. Monmouth, N. J., Nov. 57, pp. 92-136.
12. "Intermodulation Testing Using the Marconi White Noise Test Set Type OA 1249A," *Marconi Instrumentation,* Vol. 7, No. 1, March 59, pp. 17-21.
13. Jarva, W., "Technical Note: Problems of Radio Interference Measurement," Aeronautical Electronic and Electrical Laboratory, U. S. Naval Air Development Center, Johnsville, Pa., Report #NADC-EL-N54199, Feb. 11, 55.
14. Jarva, W., "Techniques for the Measurement of Spurious Radiations and Harmonics from Transmitters," *Proc. of the First Armour Conference on Radio Frequency Interference,* Armour Research Foundation, Ill. Inst. of Tech., Chicago, Ill., Dec. 54, p. 282.
15. Joffee, I., "Harmonic & Spurious Energy Measurements in High Power Transmitters," *Proc. of the First Armour Conference on Radio Frequency Interference,* Armour Research Foundation, Ill. Inst. of Tech., Chicago, Ill., Dec. 54, p. 251.
16. Kerwien, A. E., "Design of Modulation Equipment for Modern Single-Sideband Transmitters," *Proc. IRE,* Vol. 40, No. 7, July 52, pp. 797-803.
17. Lund, N., "Methods of Measuring Adjacent Band Radiation from Radio Transmitters," *Proc. IRE,* Vol. 39, No. 6, June 51, pp. 653-656.
18. Lund, N., et al, "Amplifiers for Multichannel Single-Sideband Radio Transmitters," *Proc. IRE,* Vol. 70, July 52, pp. 790-796.
19. Meek, R. E., et al, "Investigation and Study of Communication Interference Reduction Techniques," Engineering Experiment Station, Ga. Inst. of Tech., Contract #AF-30 (602)-1638, 31 Jan. 58.
20. Mortenson, K. E., & Truax, C. J., "A Method of Making Screen Room Interference Measurements," *Proc. of the Third Armour Conference on Radio Frequency Interference,* Armour Research Foundation, Ill. Inst. of Tech., Chicago, Ill., Feb. 57.
21. "Nontactical Radio Equipment System Study," Final Report, AF Contract #AF-30(602)-1251, Motorola, Inc., Nov. 1, 57.
22. Pearce, S. F., "Radio Interference in Ships," *Engineer,* (London), Vol. 185, No. 4807, March 13, 48, pp. 251-263.
23. Peterson, W. G., "Local Oscillator Radiation from AM and FM Sets," *IRE Transactions on Broadcast & Television Receivers,* Vol. BTR-4, No. 2, Mar. 58.
24. Price, Robert, "Analysis of the Spectral Shape of Modulation Splatter," *IRE Conv. Record,* Vol. 6, Part 8, 1958, pp. 119-127.
25. Rogers, W. M., et al, "The Prediction of Receiver Intermodulation from Simple Measurements," *Electronic Design,* Feb. 60.
26. Rowles, A. L., "Out-of-Channel Radiation from Mobile FM, VHF Transmitters," *Electronic Engineering,* March 57, p. 102.
27. Royden, G. T., "Suppression of Harmonics in Radio Transmitters," *Elec. Commun.,* (London), Vol. 28, June 51, pp. 112-120.
28. Schellmann, G., & Vogt, K., "A Particular Case of Cross-Modulation in the Field of High Power Transmitters," *Fernmeldetech Z.,* Vol. 7, May 54.
29. Seybold, A. M., "Filters for Television Interference," *IRE Nat'l. Conv. Record,* 1950.
30. "Signal Generator Design Occasioned by Mobile Radio Services Expansion," *Marconi Instrumentation,* Vol. 6, No. 8, Dec. 58, pp. 228-232.
31. Smith, J. S., "Adjacent Channels and the Fourier Curse," *IRE-PGVC Trans.,* June 1957, pp. 3-11.
32. Smith, J. S., & Shepherd, N. H., "The Gaussian Curse-Transmitter Noise Limits Spectrum Utilization," *Proc. of the Unclassified Session of the Symposium on Electromagnetic Interference,* U. S. Army Research and Development Laboratories, Ft. Monmouth, N. J., Nov. 57.
33. Tirrell, C. W., "The Influence of Antenna System and Equipment Characteristics on Frequency Allocations for UHF Communication Systems," U. S. Navy Electronics Laboratory, San Diego, Calif., (ASTIA AD No. 104, 709), Jan. 8, 57.
34. Valley, E. E., Jr., & Wallman, H., *Vacuum Tube Amplifier,* Vol. 18, M.I.T., Radiation Lab. Series, McGraw-Hill, 1948.
35. Villard, O. G., "Overmodulation Splatter Suppression," *QST,* June 47, p. 13.
36. Wilson, F. T., "Suppression of TVI," *Short-Wave Magazine,* Vol. 7, Dec. 49 & Jan. 50, pp. 740-745.

Interference to, and from, electronic equipment should be considered from a systems viewpoint. The interference problem should be checked at every stage—design, development, production—right through to equipment delivery. Measures taken to combat interference after the equipment is built are on a "crisis" basis. These types of solutions are not desirable because a system compromise must be made.

Consider Interference in Systems Design

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INTERFERENCE should be a primary concern in the design of any electronic system. From two viewpoints. The system should, first of all, not generate an interfering signal, and second, it should be able to reject unwanted "signals."

Interference may be defined here as the undesirable effects of one part's functions on the operation of another part. Sometimes this carry-over is so slight as to be of no consequence. In this case no interference problem exists. But, on the other hand, the problem can be so severe that the affected system will be inoperative. This is the problem that must be considered and guarded against.

One approach to this problem is to supply the designer with a general specification of noise requirements, treat the problem as one of seconeary importance, and remedy any troublesome interference after the equipment has been built. This is the "crisis" approach; nothing much is done until the problem arises in the testing stages. Then an extremely urgent effort is made to find a solution. The solution is usually highly complex, expensive, and almost certainly detracts from the overall system performance in its original conception.

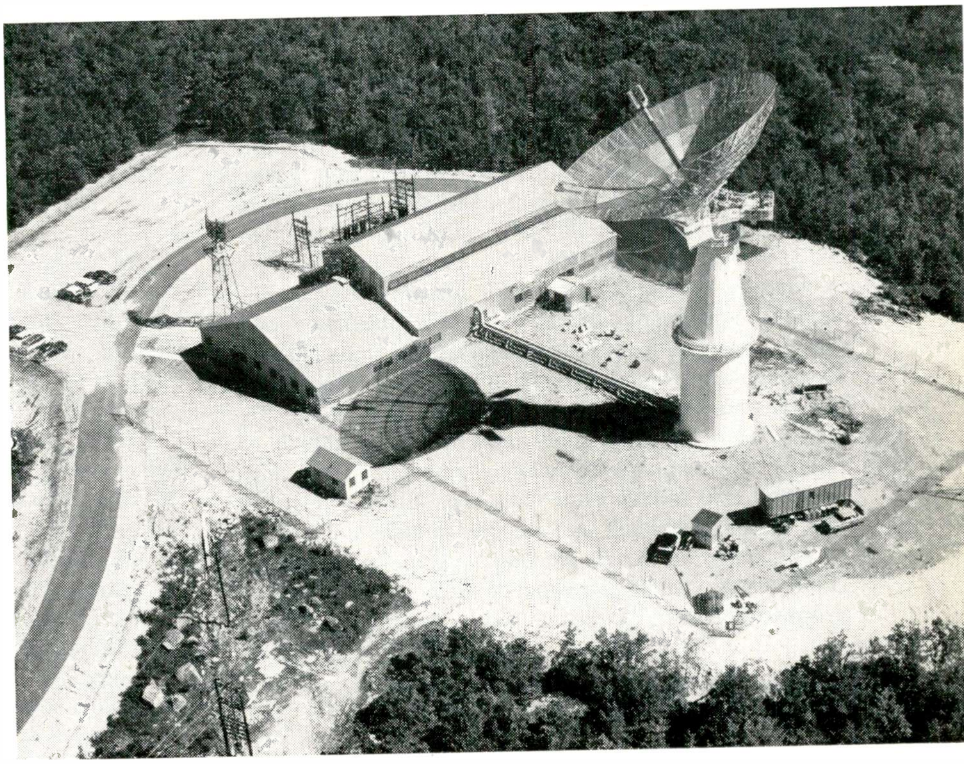
The system approach is to establish and maintain a well integrated effort from the orginal concept, through the production of all the parts to the completed system. Minimizing the interference problem and obtaining the most practical and economically feasible solution is the only way that optimum system performance may be obtained. The function of a designated engineering group* would be to take the responsibility of producing an electronic system, the performance of which would not be lowered or made less reliable because of interference problems. The group could monitor these problems as encountered by the design engineers. (See Editor's note at the end of article.)

The application of the system approach to the problem of interference control in a large electronic system requires a continuous program from the system planning stage, through fabrication, to final installation. This program can be divided into four phases, roughly corresponding to the following stages in the development of a system:

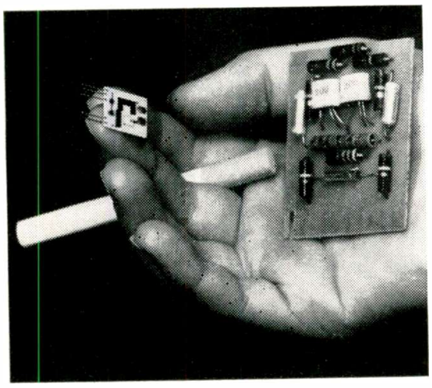
System Planning Stage
Subsystem Planning Stage
Design Stage
Fabrication & Installation

This is the second in a planned series of editorial features on Radio Frequency Interference arranged for by the editors of ELECTRONIC INDUSTRIES

* The RCA Service Company is a division of the Radio Corporation of America. This division is subdivided into four groups—Consumer Products, Technical Products, Government Products and Electronic Data Processing. The Service Company employs 14,000 engineers and technicians and is responsible for the installation and servicing of RCA equipment, technical publishing, teaching, and field engineering.



Radio frequency interference should always be considered from a systems viewpoint. This is just as true for a module (below) as it is for a high-powered radar (right) such as the one developed by MIT.



During all four phases, however, the economic feasibility of what effect the interference reduction in a subsystem has on the entire system must be constantly given important consideration. The value of any effect of a subsystem interference reduction program must be measured against its effect on the whole system.

System Planning Stage

Phase 1 of the interference control program is initiated during the system planning stage. The objectives of this phase of the program are:

1. Determination of the effects of external environment on system, and effects of system on external environment;
2. Determination of the compatability of subsystem;
3. Estimation of the ambient noise levels and recommendation of tolerable noise levels;
4. Establishment of the basic scheme for signal transmission;
5. Specifications for architectural grounding system;
6. Suggestion for possible improvements to system by modification of basic parameters.

One of the first tasks of Phase 1 should be to investigate the systems capability to co-exist with the external environment. The system must not be susceptable to disturbances from the external environment. It must not act as an unnecessary source of disturbances to other electronic systems. Often this requires a detailed survey of the environment.

Another problem is the intra-compatibility of subsystems themselves. One subsystem must not disturb another. For example, an anti-aircraft missile system, which utilizes both a tracking radar and a guidance radar, must have both radar systems operating simultaneously to fulfill its mission. Any interaction between the radar system could not be tolerated. The susceptibility and noise generating potential of each subsystem must be fully investigated to predict any possible trouble areas and to suggest a means of removing the cause. From this investigation, the ambient noise levels of the various areas of the system can be determined. At this time a basic grounding philosophy should be established and a specification prepared for the architectural ground system to provide for satisfactory operation of the system. Also a specification covering the general interference design parameters should be prepared.

Subsystem Planning Stage

Phase 2 of the interference program is carried out simultaneously with the subsystem planning stage. As the detailed subsystem design specifications are developed, the interference program should use this information to accomplish:

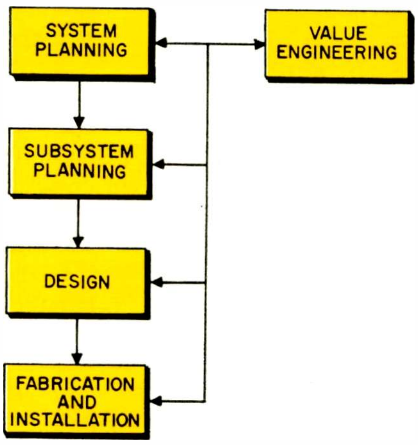
1. A detailed specification for signal transmission circuits. This should include a preliminary tabulation of the various types of signals to be used. An effort should be made to standardize these. Also signal transfer methods should be selected, such as balanced lines, coax, twisted pair, etc. This should be carried out down to the module level.
2. The utilization and distribution of power supplies should be considered and preliminary design work started. This should provide most of the required decoupling in the most economical manner.
3. A detailed grounding specification for all compo-

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

Systems Interference *(Concluded)*

nents of the system can now be prepared. This specification should contain all information necessary for the electrical and mechanical design of cabinet grounding, module grounding, connections to building grounds, etc.

4. A further investigation of the compatibility of the various equipments of the system should be made. This should be a more detailed study than that of Phase 1, and would greatly aid in the integration of the components into subsystems and then into the system. This would also have the effect of having the same design engineer cognizant of both the load and source ends of a transmission circuit, and thereby greatly reduce the problems that so often arise, such as mismatch due to improper cable termination, improper signal levels and improper allocation of coaxial cable, twisted pair, etc.



Application of an interference program to system planning

Design Stage

Phase 3 of the interference program is related to the actual equipment design stages. At this time, all equipment designs should be reviewed with respect to noise generating and noise susceptibility characteristics and any other problems. Recommendations can be made for solutions. All cabling design should be reviewed and bad practices pointed out. The effects of the power distribution system on the signal transmission cabling should also be considered. Also, the initiation of a program to assist the design engineers with filtering and shielding problems.

As detailed design information becomes available, the preparation of specifications for interference testing is made. These tests should be designed to insure proper operation of the system under all required conditions, and to minimize the effect of the system on the external environment. They should be made at component, subsystem and system levels.

Final Phase

The final phase of the interference control program, is mainly the correlation of test data on interference control with the original system concepts to insure that the system will meet all basic operations and interference generation requirements. All interference problems found during testing must be studied to find the basic cause, and recommendations made as how to remove this cause. Also, any modifications to the system should be studied to determine effects the modifications will have on interference control.

Conclusions

In every interference control program a case history should be prepared to use as a guide in designing future systems. When preparing such a history, careful attention should be given to the inclusion of all pertinent test measurements and design details.

If the program just outlined is followed, together with sound engineering judgment, many advantages of this preventative design approach will become apparent, viz:

1. One basic system parameter—interference will be minimized.
2. Overall costs will be reduced due to a minimum number of changes in the final stages of development.
3. Production of specific items will often be less costly.
4. Shipment delays will be avoided.
5. The customer will be satisfied.

The author wishes to thank Edward E. Smith, Systems Engineer, RCA Service Company, for his assistance in preparing this article.

* * * * *

Editor's Note

The author mentions a point that we feel should be emphasized. He suggests that a group be designated specifically to handle the interference problem from the systems angle.

We have discussed this idea with people in the field. From these discussions one point came to light. Management must designate this group of engineers. At least one of the group should be of management level, and their duties and scope of authority must be spelled-out.

This group would make sure that the proper approach to interference is always taken. They should also monitor interference problems as they arise, and are solved by the design engineers. This is to be done with the view that such solutions do not in any way compromise the overall system performance.

The group would have to outline a well defined program, and see that it is followed. They should have the authority to prohibit any production line or field changes that may circumvent the interference program. Production line or field changes can be a particularly touchy problem. That's why the group must have at least one member at a management level or with management authority.

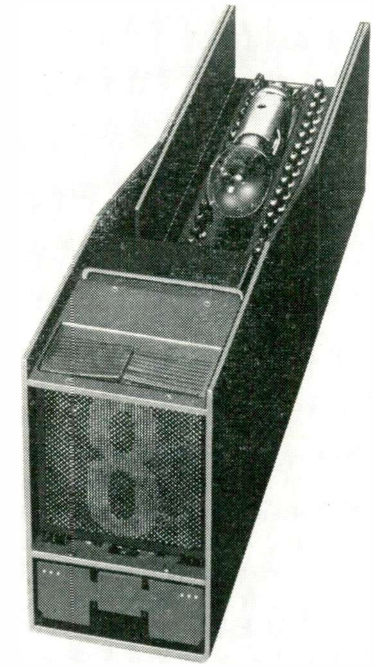
REFERENCE PAGES
The pages in this section are perforated for easy removal and retention as valuable reference material.
SOMETHING NEW HAS BEEN ADDED
An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed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

What's New . . .

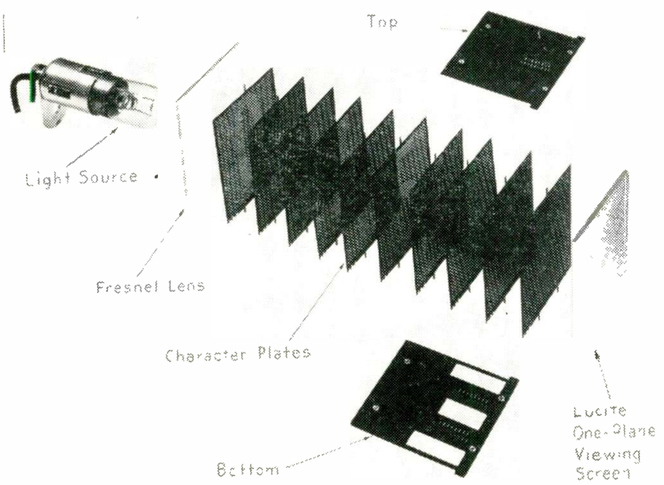
Slide Plate for Visual Display

A NEW development in the field of in-line digital displays is the Slide Plate. It is manufactured by Industrial Electronic Engineers Inc., 5527 Vineland Ave., North Hollywood, Calif.

The Slide Plate accepts binary coded decimal (BCD) input and displays alpha-numeric characters. This means that the unit does its own translating and does not need auxiliary translaters, relays, or diodes. It will accept any BCD or teletype code up to 6 bits, do its own translating, and display the proper character.



(Right) Top view of the Slide Plate readout display indicates compactness.



(Left) The various components of the readout display are shown in this exploded view.

The device works on such low signal power input that it can be connected directly to transistor or vacuum tube flip-flops without intermediate buffers or amplifiers and without overloading the flip-flop. This means that it can be connected directly into computers and other electronic equipment. The prototype unit is very sensitive indeed. It operates on less

(Continued on page 268)

A Variable Limit Circuit Breaker

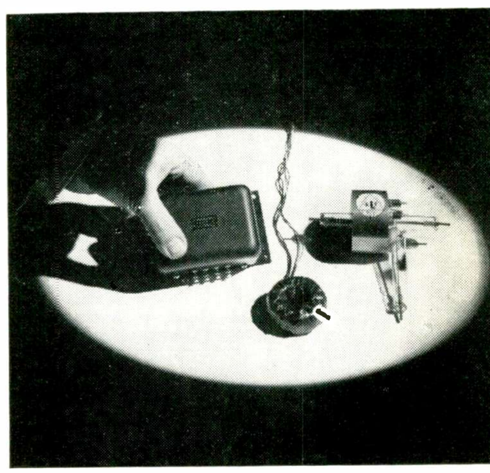
OFTEN the protection of high voltage and high current circuits is not adequate because the protecting element is too slow or not sufficiently accurate. A new circuit breaker, using solid state components, that will open circuits in less than ½ cycle is now available. The breaker threshold is variable from .5 to 100 amperes with sensitivity accurate to 1%. This allows presetting the overload point to the exact requirements of the circuit or equipment to be protected.

The unit is manufactured by Resitron Laboratories, Inc., 2910 Nebraska Ave., Santa Monica, Calif.

In installation, the overload sensing element, a toroidal transformer, is inductively coupled to the primary circuit, eliminating the need for inserting resistors in the line. When the load current is increased sufficiently to overcome the bias applied to the toroid through a variable resistor, the breaker is actuated, opening the circuit. When overload conditions are eliminated, the protective device returns to normal with the protected circuit returned to operation.

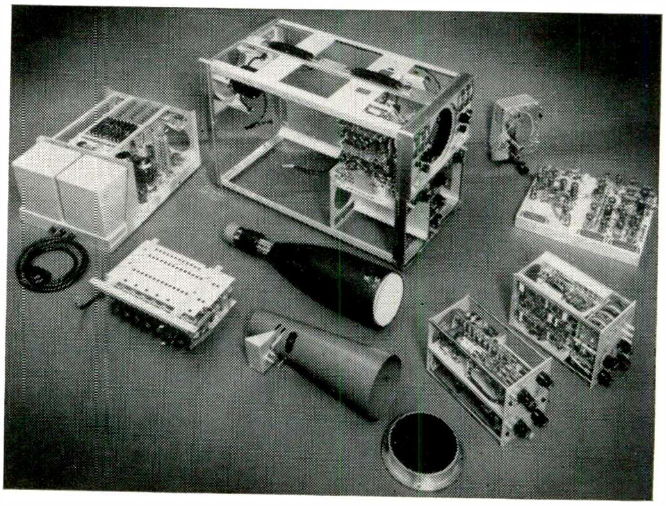
Circuit voltages of from 50 volts to 100,000 volts can be protected. The high vacuum relay shown is one of many types supplied with the unit which allow protection at either primary or high voltage levels.

Applications include radar systems, high voltage test equipment, x-ray equipment, and transistor test equipment power supplies.



This illustration shows packaged solid-state current sensor, toroidal transformer which monitors input current and high vacuum relay for rapid disconnect.

Scope Reads-Out In Numbers



The DuMont model 425 is completely modularized for easy servicing.

DU MONT'S new high performance oscilloscope, designed to "human engineering" principles, provides an unusual combination of interesting features. The Model 425 scope offers direct digital readout of wave form measurements, modular plug-in construction with a variety of interchangeable amplifiers and exceptional high frequency response.

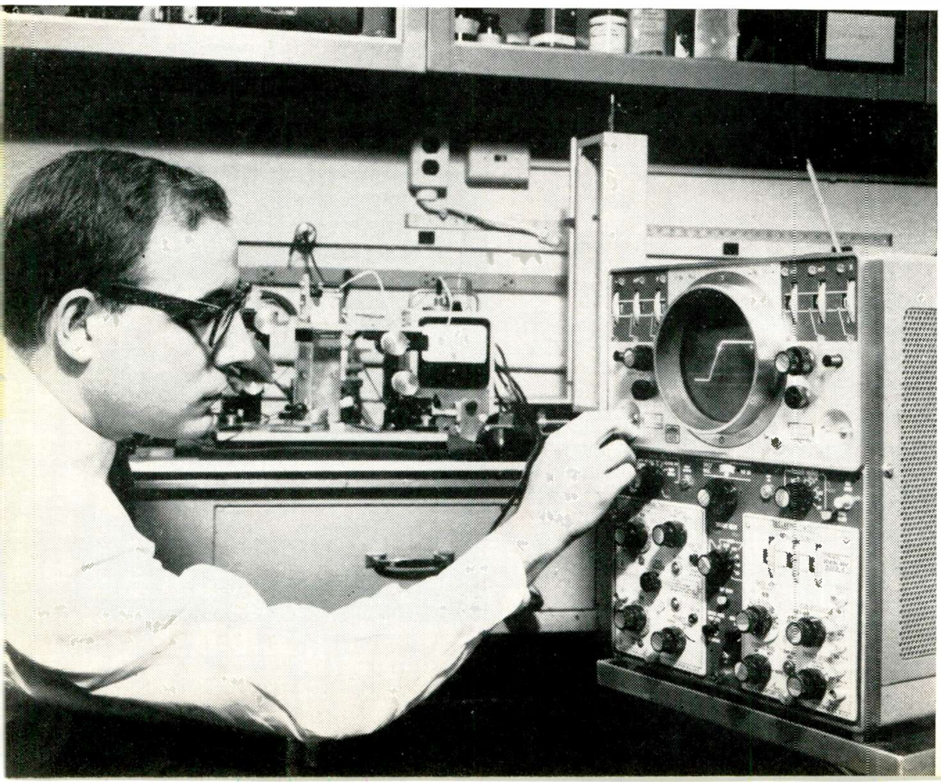
The scope has a digital readout system that permits accurate readings every time on the production line or in the lab. After an original set-up by an engineer, the operator can read the amplitude and time measurements as actual digits on the scope panel. Further, the scope can be tied directly, by a connector, into data processing or punch-card equipment for automatic recording and data analysis.

In operation, the digital system is relatively simple. On the face of the instrument, six thumb wheels and a joy stick positioner control are employed to traverse two display dots across the face of the cathode-ray screen. The two dots are moved in unison by the joy stick or index positioning control. When one dot—the indexing dot—is positioned on a reference part of the waveform, the two thumb wheel sets (horizontal and vertical) are then used to move the second (scaling) dot to the other position on the trace where the measurement is to be taken. The thumb wheels, while moving the scaling dot, also control the digital display, and when the two dots are positioned, the exact time and amplitude are read directly in volts, seconds, milliseconds or microseconds. The reading eliminates the need for any dial multiplication, interpolation and parallax adjustment, and is reputed to be more accurate than any human measurement because the possibility of error is eliminated.

The oscilloscope also features modular construction. It contains five separate chassis, all separately interchangeable. This feature reduces the average maintenance problem to 20 minutes compared to several hours for other oscilloscopes. Breakdowns can be corrected immediately by inserting a spare, plug-in circuit. To accomplish this construction feature,

MORE
What's New
on page 272

Dr. D. J. Shombert, research scientist at Merck, Sharp & Dohme Research Labs. uses new DuMont scope to analyze the structure of silicon crystals.



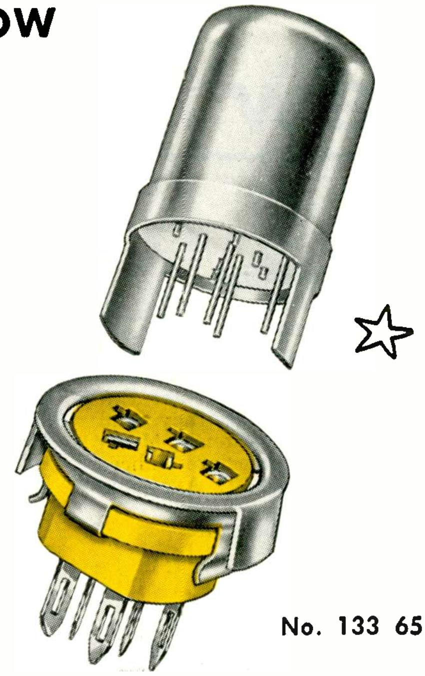
Du Mont engineers designed the 425 to include five separate modules. As a result, the distributed amplifier, one of the plug-in modules, was designed with a canted tube alignment to minimize coupling. Equipment does not require selected tubes for replacements.

Previously instruments of this nature contained no more than one plug-in. The 425 scope provides two plug-in facilities. A wide variety of interchangeable amplifiers offers versatility and insurance against obsolescence. The interchangeable units for X functions include delaying sweep, dual-trace capabilities, and X-amplification. The Y plug-ins presently range from a 50 mv/cm, 33 MC amplifier to a 500 uv/cm, 3-5 MC unit of high stability and balanced input. Signal generators, passive

(*Continued on page* 269)

VISIT BOOTH NO. 2535 AT THE I.R.E. SHOW

CINCH SOCKET FOR THE RCA NUVISTOR TUBE



No. 133 65 10 001

Low insertion force and contact protection . . . require minimum space . . . fullfilling every requirement for miniaturized equipment

No. 133 65 10 001

The socket provides two slots of different widths mating with two corresponding legs depending from the metal envelope of the tube to index the tube and socket contacts. As a result the tube can be inserted by feel only and it is impossible to insert the tube incorrectly or damage the contacts. The socket saddle provides spring elements that engage with the depending legs of the tube envelope thus grounding the envelope to the panel.

The socket body is of low loss phenolic insulation, Type MFE. The saddle is of cold rolled steel, cadmium plated. The contacts are of copper alloy with cadmium plating.

Although the contact tails are of sub-miniature size, an ample slot is provided for ease of soldering connecting leads.

ELECTRICAL RATINGS:

	VOLTS AC RMS	VOLTS DC
VOLTAGE BREAKDOWN:		
Sea level (adj. terminals)	1600	2600
Sea level (to ground)	1800	3000
Altitude 3.4 in. hg. (adj. terminals) 50,000 ft.	500	800
Altitude 3.4 in. hg. (to ground)	600	900
VOLTAGE RATINGS:		
Seal level (adj. terminals)	550	850
Sea level (to ground)	600	1000
Altitude 3.4 in. hg. (adj. terminals) 50,000 ft.	160	250
Altitude 3.4 in. hg. (to ground)	200	300
RECOMMENDED WITHSTANDING VOLTAGE:		
Seal level (adj. terminals)	1200	1500
Sea level (to ground)	1300	1600
Altitude 3.4 in. hg. (adj. terminals) 50,000 ft.	350	600
Altitude 3.4 in. hg. (to ground)	450	700

Current Rating: 1 ampere

Contact Resistance: 0.05 ohms Maximum

Insulation Resistance: 50,000 Megohms Minimum

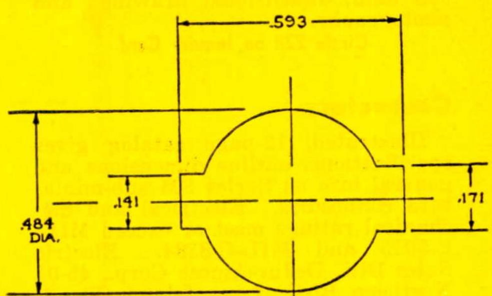
Capacitance:
Between one contact and all other conducting parts. .25 mmf Maximum

Electrical tests performed in accordance with EIA Standard RS-167.

ACTUAL SIZE

RCA NUVISTOR TUBE

The socket fits into a .484 diameter hole with two slots as shown below, and the two legs of the socket that fit into these slots fold over on the under side of the panel, this holds the socket securely in place.



Cinch ELECTRONIC COMPONENTS ®

CINCH MANUFACTURING COMPANY

1026 South Homan Ave., Chicago 24, Illinois
Division of United-Carr Fastener Corporation, Boston, Mass.

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri

Circle 84 on Inquiry Card

New Tech Data for Engineers

Digital Instrumentation

Technical paper from Beckman/Berkeley Div., 2200 Wright Ave., Richmond 3, Calif., describes "Digital Instrumentation for Jet Engine Testing." Included are: Typical Jet Engine Test Systems; Accuracy and Speed of Digital Test Systems; Methods of Obtaining Appropriate Indications, and Summary of Available Equipment.

Circle 225 on Inquiry Card

Rotary Solenoids

"Engineering Data Sheets" give tech. details on "F" size, 300 in.-lb.-degree Rotary Solenoid and, "C" size, 70 in.-lb.-degree Rotary Solenoid. Information is given on solenoid torque characteristics, direction of travel, voltage requirements, duty cycles, stroke in degrees, and ambient temp. Pacsol Div., Illinois Tool Works, 3155 El Segundo Blvd., Hawthorne, Calif.

Circle 226 on Inquiry Card

Power Supplies

Bulletin describes SIE Airborne Transistorized Power Supplies, Models TPC-18A and 19A. It includes applications, schematic drawings and specs. Products are for direct, plug-in replacement of D-10A dynamotors. Southwestern Industrial Electronics Co., 10201 Westheimer Rd., P.O. Box 22187, Houston 27, Tex.

Circle 227 on Inquiry Card

Potentiometers

Data sheet from Helipot Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif., describes series of ⅞ in. dia., 10-turn precision potentiometers for servo mounting. Included are preliminary specs, environmental characteristics, coil data, dimensional drawings and photographs.

Circle 228 on Inquiry Card

Connectors

Illustrated, 12-page catalog gives specifications, outline dimensions and general info on Series SM sub-miniature connectors. Electrical and mechanical ratings meet or exceed MIL-C-5015 and MIL-C-8384. Electric Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 229 on Inquiry Card

Telemetering Systems

Specs of airborne telemetering systems using standard telemetry hardware are featured in a systems spec sheet from Dorsett Laboratories, Inc., P.O. Box 862, Norman, Okla.

Circle 230 on Inquiry Card

Peak Symmetrizer

Four-page illustrated brochure from Kahn Research Laboratories, Inc., 81 South Bergen Pl., Freeport, N. Y., describes Symmetra-Peak, a passive network used by AM, FM, and TV broadcasters to increase effective power and coverage range of voice transmissions and to improve limiter and AGC amplifier performance.

Circle 231 on Inquiry Card

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or Circle No. 161 on Inquiry Card.

Teaching Servo Systems

Method for teaching servo systems, using a Servolab (TM) Servo System Simulator, that bridges gap between theory and practice is described in report SR-3 from Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y. Students can build and test their own servo systems.

Circle 232 on Inquiry Card

Technical Journal

Airpax Technical Journal is devoted to the study and theory of electronic components and systems. Volume 1, No. 1 features articles titled "The Duel Between Vacuum Tubes and Magnetic Amplifiers" and "The Magnetic Amplifier as an Integrating Device." Airpax Electronics Inc., Seminole Div., Ft. Lauderdale, Fla.

Circle 233 on Inquiry Card

Base Tab Stampings

Bulletin Z-102 describes solder clad base tab stampings used in making ohmic junctions to germanium or silicon junction transistors. It lists specs on availability of base tab stampings. Accurate Specialties Co., Inc., 37-11 57th St., Woodside 77, N. Y.

Circle 234 on Inquiry Card

Electrolytic Capacitors

Four-page QE Bulletin NPJ-110, describing computer grade electrolytic capacitors, is available from Aerovox Corp., New Bedford, Mass. Tech. information includes dimensional drawings, performance characteristics and table of stock values.

Circle 235 on Inquiry Card

Rectifier Analyzer

Data sheet 106 contains description of Wallson 20 Ampere Dynamic Rectifier Analyzer, Model 141A. Forward current and reverse voltage are independently adjustable. No auxiliary equipment needed. Wallson Associates, Inc., 912-914 Westfield Ave., Elizabeth, N. J.

Circle 236 on Inquiry Card

Converter

Data sheet describes Voltage-to-Time Converter Model 1230. It features 10 msec. conversion, 0.05% accuracy and connects directly to Systron Models 1010, 1040, 1043, and 1031 to provide an in-line readout (± 10,000) of dc voltages. Systron Corp., 950 Galindo St., Concord, Calif.

Circle 237 on Inquiry Card

X-Ray Chart

An 11½ by 22 in. wall chart, shows 10 basic X-ray techniques used for industrial quality control and scientific research. Chart includes simplified diagrams, explanatory notes, and a brief discussion of application. Philips Electronic Instruments, 750 So. Fulton Ave., Mt. Vernon, N. Y.

Circle 238 on Inquiry Card

Variable Resistor

Data Sheet contains dimensional drawings, electrical specs and description of Series M250 9/32 in. dia. micro-miniature composition variable resistor. Resistor is for miniaturized equipment. CTS of Asheville, Inc., Skyland, N. C.

Circle 239 on Inquiry Card

Bandpass Filters

Data sheet No. 701 lists 6 models of Audio Bandpass Filters. It deals with bandpass filters designed for alternate-band-separation use which have high off-pass band impedances permitting inputs to be paralleled with no adverse effects on other circuitry. Control Electronics Co., Inc., 10 Stepar Place, Huntington Station, L. I., N. Y.

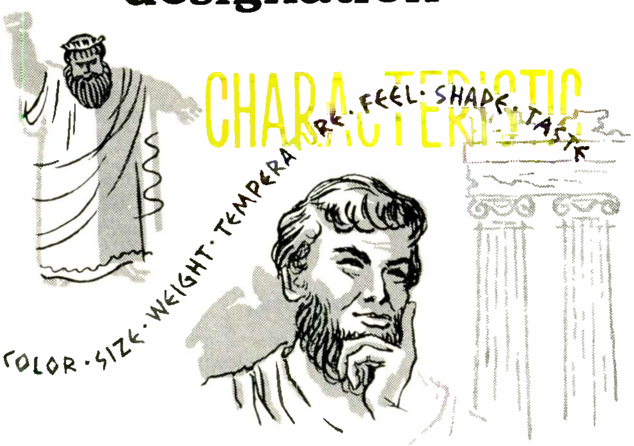
Circle 240 on Inquiry Card

after routing, clip and save

a continuing series on technical topics of specific interest to engineers

Folio 60-9 **REFERENCE DATA FILE** SANGAMO

capacitor characteristic designation



. . . . . . and the story is told that Pelops was the son of Tantalus and the grandson of Jupiter. He was slain and served up before the gods by his own father, who wished to test the omniscience of the Olympians. They were not deceived, however, and would not touch the cannibal feast. But Demeter (Ceres), absorbed in grief for the loss of her daughter, Proserpina, tasted of the shoulder before she discoverd what it was. Jupiter restored Pelops to life, and replaced his shoulder with one of ivory, whence the ivory shoulder of the sons of Pelops became a proverbial phrase for the distinguishing or distinctive mark of anyone, since all the descendants of Pelops bore this characteristic. — Greek Mythology

The word "Characteristic" can mean many things in the description of capacitors. This article is aimed at removing some of the jargon associated with the term and clarifying its meaning and application to various capacitor types.

An indicator for "characteristic" is found in the nomenclature of many types of capacitors. It does not mean the same "distinguishing or distinctive mark" for all types. This is sometimes a source of confusion for equipment design engineers.

Typical examples of product nomenclatures including a "characteristic" identifier are:

1. SBA1 **H** 04104
2. CB11N **D** 101K
3. SMDA1 **K** 04104K
4. CE34 **C** 101E
5. CM15 **E** 101K03

Items 1 and 3 are Sangamo nomenclatures for impregnated kraft tissue dielectric capacitors. Item 2 is a MIL type designation for a button style mica capacitor. Item 4 is a MIL type designation for an electrolytic capacitor. Item 5 is a MIL type designation for a plastic encased, axial wire lead mica capacitor.

The important information meant to be conveyed by the characteristic letter is shown below for Paper, Electrolytic and Mica capacitors.

PAPER CAPACITORS In the case of Sangamo products, this letter tells us:

1. The specific impregnant used in the dielectric. "H" is Sangwax, and "K" is Etherm. Detailed information on these impregnants is set forth in Sangamo Reference Data File—Folio 59-2.
2. High and low ambient test temperatures.
3. Minimum insulation resistance at 25°C., and at the high ambient test temperature.
4. Maximum capacitance change (in per cent of the initial value) from 25°C. to the low ambient test temperature.
5. Voltage (in per cent of rated) that can be applied to establish accelerated life performance capability.
6. Maximum and minimum allowable service operating temperatures consistent with normal life expectancy.

ELECTROLYTIC CAPACITORS The identifier letter spells out the working temperature range of the product as maximum and minimum values in degrees Centigrade. The inherent capability to perform is adjusted by:

a. Selection of insulating separators.
b. Formulation and control of the conductive electrolyte.
c. Selected processing techniques.

The performance parameters affected are:

I. At reduced temperature:
  a. DC leakage current.
  b. Capacitance change (in per cent of the initial room temperature value).
  c. Equivalent series resistance.
  d. Impedance.
II. At high temperature:
  a. Capacitance change (in per cent of the initial value).
  b. Equivalent series resistance.

MICA CAPACITORS The characteristic letter defines the capacitance stability of the unit during one "round trip" excursion from room temperature to minimum and maximum temperatures specified for the capacitor, although it does not specify the operating temperature range. It further defines the maximum temperature coefficient of capacitance. In the case of transmitting types, certain characteristic letters will also be associated with a required fifty per cent derating of radio-frequency current specified for that type.

The design factors affecting the "characteristic" performance of mica capacitors are:

a. The physical configuration (style) of the product. Button style capacitors are most stable in the family of mica dielectric units.
b. The relative nominal capacitance value in the design range. High capacitance values are inherently more stable than low values.
c. The electrode design. Styles using electrodes of deposited metal bonded to the dielectric plates (silvered) are more stable than styles using independent metallic foil electrodes.
d. Selection of mica quality.
e. Processing techniques.

It has been the purpose of this article to explore the meaning of the word "characteristic" as it applies to describing capacitor differences. While the term is used in a specific rather than a general sense, it serves its purpose to describe the "Ivory Shoulder" of the capacitor industry.

SC60-1

New Tech Data for Engineers

Resistors—Capacitors

Stock catalog No. 30A, 32 pages, 2 colors, from Ohmite Manufacturing Co., 3695 Howard St., Skokie, Ill., lists an increased selection in the company's product line as well as newer products. Included are: a line of power rheostats, resistors, molded composition resistors, and tantalum capacitors.

Circle 212 on Inquiry Card

Non-Destructive Testing

Catalog sheet No. 570, on the Company's line of Megpot high potential test sets for non-destructive testing from General Hermetic Sealing Corp., 99 E. Hawthorne Ave., Valley Stream, Long Island, N. Y. The Model 570 Series has variable voltage ranges to 0-5000 v.

Circle 213 on Inquiry Card

Coating Compounds

A brochure describes method of applying coating compounds to electrical and electronic components at a rate of 4000 per hr. Conforming Matrix Corp., 474 Toledo Factories Bldg., Toledo 2, Ohio. Bulletin tells how compositions like epoxy compounds can be used to form a tight seal for selenium diodes.

Circle 214 on Inquiry Card

Capacitors

Data sheet, Reference File CE-1.01, describes fusion sealed glass capacitors, guaranteed to be 4 times better than military specs for moisture resistance. Electronic Components Dept., Corning Glass Works, Bradford, Pa. Capacitors are in two sizes from 1 to 1200 μμf, working voltages are 300 v. and 500 v. from −55 to 125°C.

Circle 215 on Inquiry Card

Power Supply

Static Inverter - Converter supply designed to operate off 28 vdc and provide 3 phase 3200 CPS power at 1 kva, with additional outputs at 300 vdc for a total of 1300 va is described in color brochure. Bulletin S-1057, Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.

Circle 216 on Inquiry Card

Conversion Table

Conversion table for Rd/L values for the convenience of those who report the magnitude of color-difference in terms of N.B.S. units. Values are in accord with governing ASTM Specs, and avoid intercalibration difficulties, as well as instrumental errors, in reading L values from dials. Gardner Laboratory Inc., P.O. Box 5728, Bethesda 14, Md.

Circle 217 on Inquiry Card

Rotameter Selector

Functional bulletin #110 shows a line of rotameters. It states advantages of variable area flow meters and displays meters in specific areas of application. Brooks Rotameter Co., P.O. Box 432, Lansdale, Pa.

Circle 218 on Inquiry Card

Tape Reels

Four - page brochure on "Ampex Precision Reels" contains outline drawings, specifications, and general information. Ampex Corporation, 934 Charter St., Redwood City, Calif.

Circle 219 on Inquiry Card

Theodolites

Brochure, 8-pages, describing a Series of Azimuth Alignment Theodolites used to obtain azimuth accuracy of inertially guided ballistic missiles, has been published by the Electro-Optical Div., Perkin-Elmer Corp., Norwalk, Conn.

Circle 220 on Inquiry Card

Power Supplies

Single page bulletin PS2013 describes PI series of Plug-in Solid State Power Supplies. Includes specs and electrical characteristics. Deltron, Inc., 2905 N. Leithgow St., Phila., Pa.

Circle 221 on Inquiry Card

Coaxial Connectors

Radio frequency connector guide and tech manual contains connector illustrations, diagrams, and numerical designations. It contains sections on the use of connectors, coaxial cables, and complete cable assemblies. Automatic Metal Products Corp., 315-323 Berry St., Brooklyn 11, N. Y.

Circle 222 on Inquiry Card

Pulse Generator

Single catalog bulletin contains specs for Model 4120B pulse generator. Instrument is compact source of medium power, fast rise time pulses. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Circle 223 on Inquiry Card

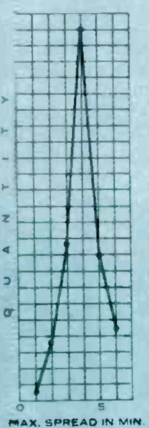
Resistors

Bulletin LC1066 from Cinema Engineering Div., 1100 Chestnut St., Burbank, Calif., describes wire-wound micro-miniature and printed circuit resistors. Wire-wound resistors are the axial type and the PC resistors replace the cinema PW series.

Circle 224 on Inquiry Card

SYNCHROS *for* GYRO PLATFORMS by cppc

VISIT US IN STUDIO K
Barbizon-Plaza Hotel
during the National IRE Show
New York City, March 21-24



6′ max. error spread Synchro for Gyro Pick-Off

The SG-17- and ST-17- type pancake synchros (SG-18- and ST-18- with housings) are our most standard line for gyro pick-off applications.

These units have been manufactured in large quantity and are readily available for prototype breadboarding. The high accuracies shown on the left are obtainable in standard 26v or 115v units.

Pancake Resolver for Gimbal Mounting

Clifton Precision produces special pancake resolvers for direct gimbal mounting. They were developed for use in cascaded amplifier-less resolver systems and have been trimmed for 10K input impedance, 0° phase shift and a constant transformation ratio, with temperature, at 900cy. Accuracies of 4′, perpendicularities of 3′ and nulls of 1mv/v of output or less can be held.

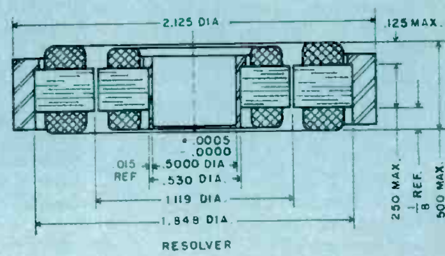
Special techniques maintain concentricity between rotor and stator — thus reducing difficulties commonly encountered in gimbal mountings.

Custom Designed Pancakes

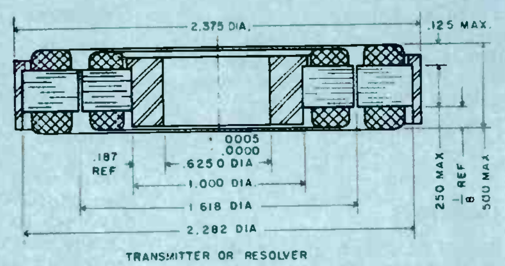
CPPC has developed a number of special pancakes (drawings below) with relatively large bores and narrow stack heights.

Means have been devised to minimize error due to clamping pressures on these thin units.

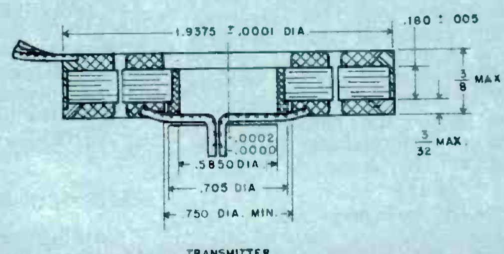
Special accuracies have been maintained where required. Let us know your needs.



RESOLVER



TRANSMITTER OR RESOLVER



TRANSMITTER

ENGINEERS — Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. J7

cppc CLIFTON PRECISION PRODUCTS Co., INC.

CLIFTON HEIGHTS, PENNSYLVANIA

Sales Office: 9014 W. Chester Pike, Upper Darby, Pa., Hilltop 9-1200 • TWX Flanders, Pa. 1122—or our Representatives

Circle 87 on Inquiry Card

New Tech Data for Engineers

Microwave Tubes

Short Form catalog on microwave and special purpose tubes list principal characteristics for more than 150 tubes. Microwave components include: traveling-wave tubes, ferrite devices, magnetrons, and microwave diodes. Special purpose devices include: decade counter tubes and trigger tubes. High power devices include: X-band tunable magnetrons at 250 kw. The top frequency shown is 75 KMC for a BWO. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y.

Circle 241 on Inquiry Card

Hi-Fi Components

A 20-page catalog featuring their Stereomaster High Fidelity Components for 1960 is available from H. H. Scott, Inc., Dept. P, 111 Powdermill Rd., Maynard, Mass. It includes an explanation of stereo, what it is and how it works, typical installations, and tech. specs.

Circle 242 on Inquiry Card

Relays

Series 100 and Series 150 Relay Technical Bulletins, 4 pages, illustrates and describes sensitive relays. Relays described range upward from 1 mw with contact arrangements from 1 Form C through 4 Form C. Input powers, contact ratings, and coil resistance are included. General Automatic Corp., 12 Carton Ave., Mountain View, Wayne, N. J.

Circle 243 on Inquiry Card

Ferrite Isolators

Latest issue of "New from PRD," describes PRD 1203-1209 ferrite isolators which are designed for max. isolation and min. insertion loss over a frequency range of 3.95 to 26.5 KMC. The 2-page bulletin gives typical performance curves which show VSWR, isolation, and insertion loss plotted over the isolators frequency range. Polytechnic Research & Development Co., Inc., 202 Tillary St., Bklyn. 1, N. Y.

Circle 244 on Inquiry Card

Transformer Kit

Bulletin No. R-51 from Automatic Timing & Controls, Inc., King of Prussia, Penna., describes the Atcotran Differential Transformer Experimental Kit. Seven complete differential transformers are supplied for covering a linear range of ± 0.01 to ± 2.5 inches.

Circle 245 on Inquiry Card

Plastics Table

Table shows significant physical, electrical, chemical and optical properties of 9 thermoplastic materials. Materials covered are acrylics, acetate, butyrate, Taflon and Kel-F fluorocarbons, nylon, polyethylene and vinyls. Cadillac Plastic & Chemical Co., 15111 Second St., Detroit 3, Mich.

Circle 246 on Inquiry Card

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or Circle No. 161 on Inquiry Card.

Duplexer Tubes

Handbook from Microwave Associates, Burlington, Mass., describes the company's services and products. The first section outlines the latest techniques in duplexing circuits, including both gas tube and ferrite techniques. The second section explains some of the more fundamental aspects of duplexer gas tube design. Special attention is given to crystal protection, switching at high power, problems of high temp. operation, recovery time, and min. degradation of noise figure. The third section explains the design of a new rotary shutter. Included are abbreviations and symbols and a chart of the company's duplexer tubes with data in tabular form.

Circle 247 on Inquiry Card

Electrical Resins

Catalog covers the entire line of commercially available "Scotchcast" brand electrical resins. The 28-page illustrated booklet discusses "Scotchcast" brand resins as an insulation system, tells how to select the best resin system for a job and lists more than 20 flexible, semi-flexible, rigid and special resins, with examples of their applications. Dept. WO-10, Minnesota Mining and Mfg. Co. (3M), 900 Bush Ave., St. Paul 6, Minn.

Circle 248 on Inquiry Card

Wall Chart

Reference table includes such common conversions as inches to centimenters, watts to horsepower, atmospheres to Kgs/cm^2, cm/sec to mi./hr., ft.^{3} to liters, microns to meters, quintal to lbs. Precision Equipment Co., 4411 E Ravenswood Ave., Chicago 40, Ill.

Circle 249 on Inquiry Card

Communications System

Brochure from Adler Electronics, Inc., One Le Fevre Lane, New Rochelle, N. Y., has technical descriptions and strategic applications of a ground-air transportable; long range; multichannel voice; teletypewriter and facsimile communications system —the AN/TSC—16.

Circle 250 on Inquiry Card

Frame Grid Tubes

"Amperex Frame Grid Tubes for TV," 13-pages, describes how frame grid tubes for TV applications are manufactured and lists the specs of these tubes. Amperex Electronic Corp., Semiconductor and Special Purpose Tube Div., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 251 on Inquiry Card

R-F Chokes

Data sheet on r-f chokes with subminiature characteristics is available from Essex Electronics, Div. of Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J. Two thousand of these r-f chokes can be packed in a cu. ft. Included is a description of the electrical parameters for the complete line.

Circle 252 on Inquiry Card

Directional Couplers

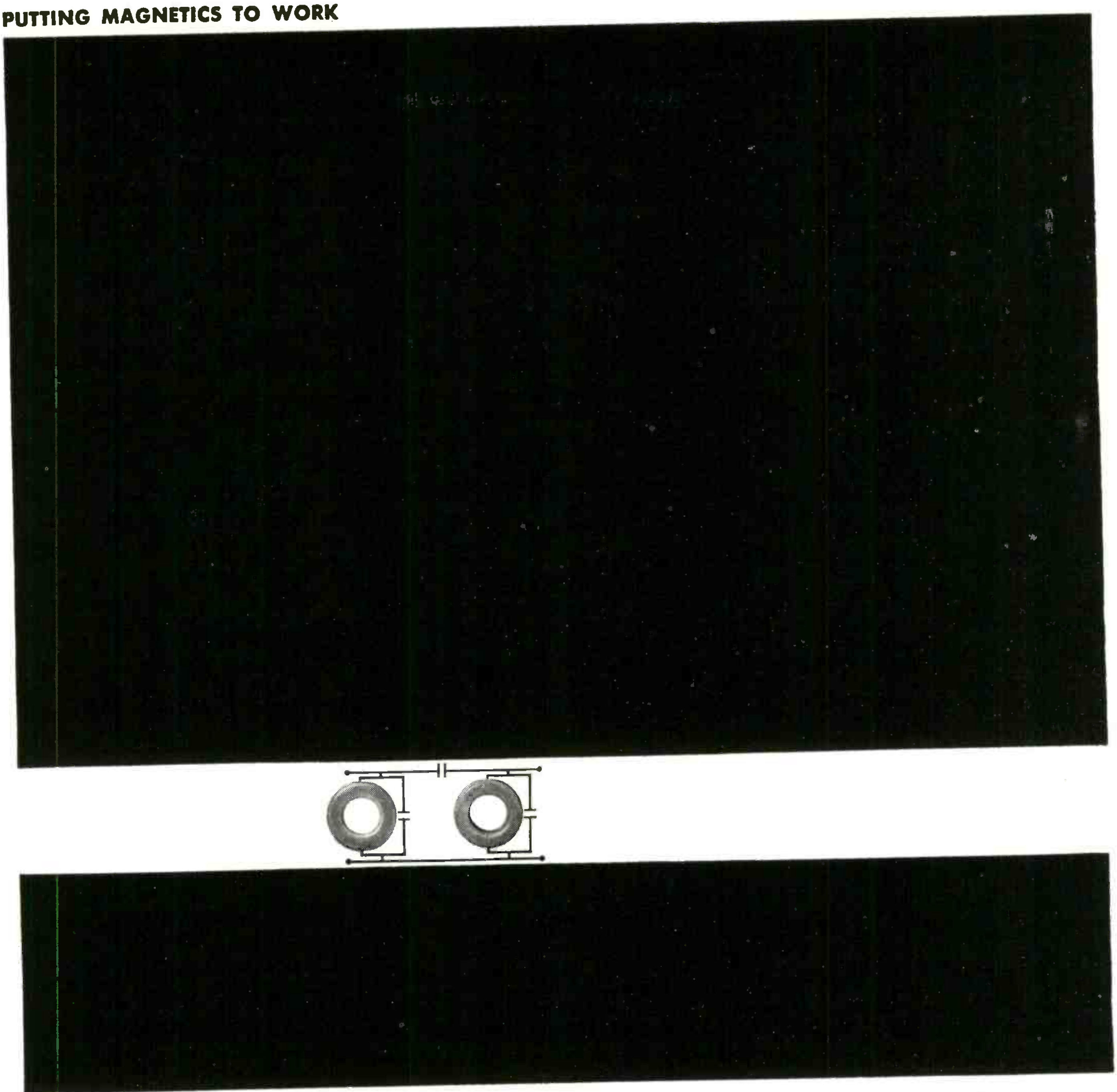
An eight-page brochure describes directional coupler design and shows types and models now available. Graphs and charts as well as complete electrical performance data are included. Waveline Inc., Passaic Ave., Caldwell, N. J.

Circle 253 on Inquiry Card

Aluminum Foil Capacitors

Specs and performance characteristics of their miniature and subminiature aluminum foil capacitors are described in bulletin 81558 from International Electronic Industries, Inc., Box R 19, Nashville, Tenn. Standard rating and selection charts for the aluminum encased and ceramic encased capacitors are listed.

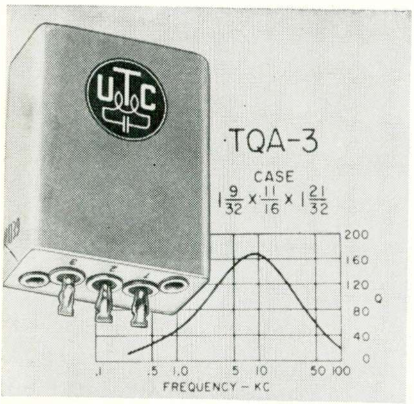
Circle 254 on Inquiry Card



New Products ... for the Electronic Industries

CENTER TAPPED INDUCTORS

Type TQA toroid inductors are center tapped for oscillator circuits and have a stabilized core for max. temp. stability. Available in 19 inductance values from 7 mhy to 22 h, adjusted

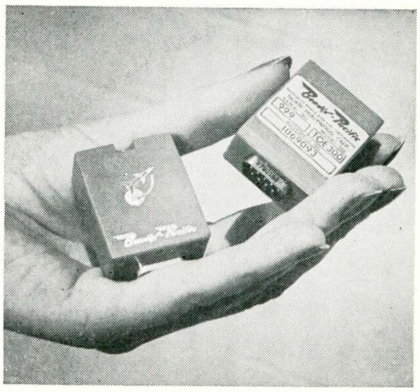


to 1% accuracy. Max. Q is approx. 160 at 7.5 KC down to 20 at 400 CPS and to approx. 30 at 75 KC for low inductance values. Hum pickup is low due to uniform toroid winding plus a high permeability outer case, providing 80 db at coupling attenuation. Units meet MIL-T-27A and carry MIL identification TF4RX20YY. United Transformer Corp., 150 Varick St., New York 13, N. Y.

Circle 195 on Inquiry Card

TELEMETER OSCILLATOR

Transistorized, voltage-controlled subcarrier oscillator, Model TOE-300, the 1.5 cubic unit is applicable to FM/FM telemetering systems for missiles, space vehicles and aircraft.

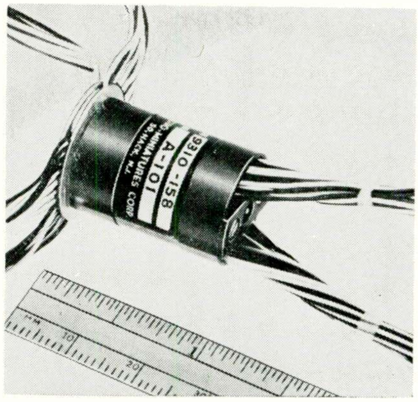


Total requirement is 20 vdc at 5 ma. Other characteristics include: input ranges — 1 v. total (min.) — 5 v. total (max.); input impedance — 100,000 ohms per v.; linearity — 0.5%; stability — 1%; temperature range — 25° to 85°C; operating environment — ± 25g. Bendix-Pacific Division, Bendix Aviation Corp., 11600 Sherman Way, North Hollywood, Calif.

Circle 197 on Inquiry Card

BRUSH ASSEMBLY

Capsule slip ring and brush assembly has 56 isolated circuits and the rotor is bearing-mounted at both ends. Total length is 0.982 in. with O.D. of 0.624 in., with the exception

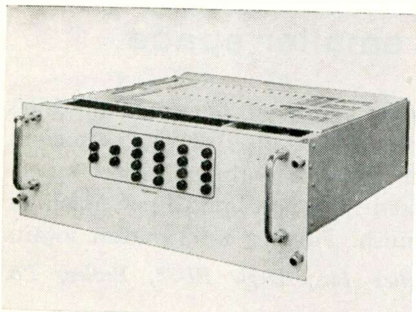


of the drive flange which is 0.750 in. in dia. Leakage resistance is more than 20,000 megohms at 500 vdc. between all circuits and between each circuit and ground. Current ratings are 0.5 a on 12 circuits and 0.25 a on the remaining 44 circuits. Torque required is 65 gram-centimeters for reliability at 25 g between 0 and 2,000 CPS. Electro-Miniatures Corp., 600 Huyler St., So. Hackensack, N. J.

Circle 198 on Inquiry Card

CONVERTER

Decimal digit voltage-to-digital high-speed converter, the MTD-704, translates input analog voltages into 4 binary-coded decimal digits, plus sign and overflow digits. Input full-scale voltage range is ±10 vdc, with provision for an extended range of ±12 vdc. Max. conversion rate is 5000 independent conversions a sec-



ond. Linearity and accuracy are rated at 0.01%. Meets MIL-E-4158B. Featured is plug-in modular design. Equipment Division, Epsco, Inc., 275 Massachusetts Ave., Cambridge, Mass.

Circle 196 on Inquiry Card

! MORE !

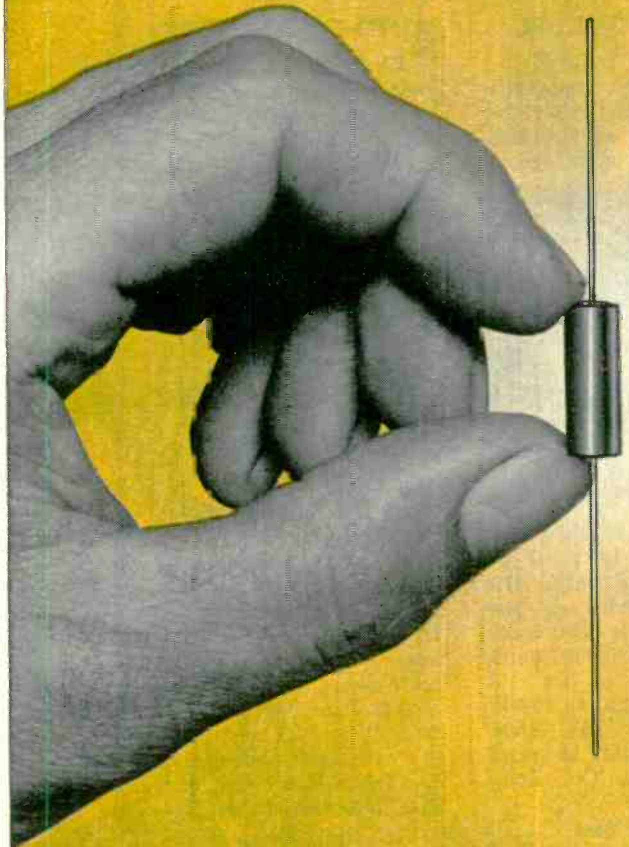
The New Products mentioned here have been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred new product releases received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or Circle No. 161 on Inquiry Card.

AMPLIFIER

Model 603, a broad-band dc amplifier, has 10^{14} ohms input impedance, high voltage and current gain, and a remote differential input. Input head may be operated up to 24 ft. from the amplifier or plugged directly onto the panel. Other features: 9 ranges from 2.5 to 1000 mv, with precise gains up to 4000 and a 10 v. output at 10 ma

for full scale meter deflections. Bandwidth is dc to 10 KC on the 2.5 mv range, rising to 50 KC on the 1000 mv range. Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.

Circle 199 on Inquiry Card



OUT-PERFORMS WIRE WOUND... YET SMALLER IN SIZE, LOWER IN COST

New Electra Precision Metal Film Resistor

Here's an entirely new achievement in electronic components; one of the biggest steps forward in years. This precision metal film resistor offers you precision and stability that formerly was available only in a wire wound resistor, yet it is much smaller in size, much lower in cost, also has far superior high frequency characteristics. Available in five sizes from 1/8 to 2 watts, the new Electra Precision Metal Film Resistor meets or exceeds Mil-R-10509C Characteristic C, and can be supplied in any of eight standard temperature coefficient tolerances. Why not let us supply you full details by return mail. Write today

CHECK THESE OUTSTANDING TEST RESULTS

MIL-R-10509C (TYPICAL DATA) 237K MF1/2

TEMPERATURE CYCLE

Initial	Final	% Change
236.9	236.9	0
237.5	237.5	0
238.1	238.[illegible]	0
237.1	237.1	0
237.9	237.[illegible]	0
236.6	23[illegible]	—.04
236.9	23[illegible]	—.04
237.4	23[illegible]	0
237.2	23[illegible]	0
237.7	23[illegible]	0

MOISTURE

Initial	% Change Wet	% Change Dry
236.9	—.21	—.04
237.4	0	0
238.1	0	0
237.1	0	0
237.9	0	0
236.5	.04	.04
236.8	.04	.04
237.4	.04	.04
237.2	—.08	.04
237.7	.04	.04

LOAD LIFE 125°C

Initial	Final	% Change
137.4	237.5	04
237.5	238.0	21
238.0	238.8	34
237 0	237.0	0
237.5	238.0	.21
237.3	237.8	.21
237.6	238.1	.21
236.9	237.4	.21
237.8	238.2	.14
237.0	237.3	.13

SHORT TIME OVER-LOAD

Initial	Final	% Change
237.2	2[illegible]7.[illegible]	0
237.0	2[illegible]6.[illegible]	.04
237.3	2[illegible]7.[illegible]	0
237.2	2[illegible]7.[illegible]	0
237.7	2[illegible]7.[illegible]	.08
237.2	2[illegible]7.[illegible]	0
237.0	2[illegible]6.3	.04
238.0	2[illegible]8.[illegible]	0
237.6	2[illegible]7.3	0
237.8	2[illegible]7.[illegible]	0

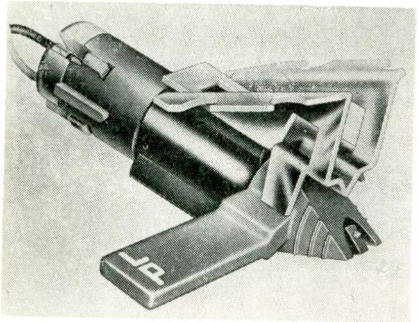
Electra MANUFACTURING COMPANY
4051 Broadway Kansas City, Mo.

Circle 89 on Inquiry Card

New Products . . . for the Electronic Industries

PHONO CARTRIDGE

Mono ceramic phono cartridge, Model "11T," a one-channel turnover "pickup" which plays stereo records without damage to the complex grooves. Cartridge incorporates 2

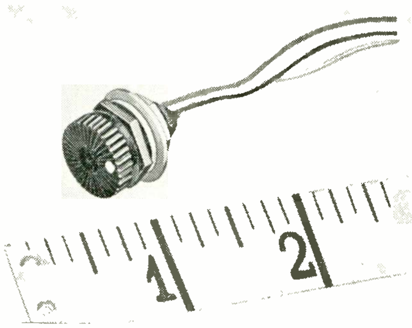


basic stereo features which assure safe mono reproduction of stereo records. Equal compliance in all directions eliminates the problem of groove breakdown. The other stereo feature is a 0.7-mil jewel tip instead of the usual 1-mil tip used in mono cartridges. Smooth from 20 to 20,000 cycles, the frequency response is flat out to 15,000 cycles with a gradual rolloff beyond. Sonotone Corp., Elmsford, N. Y.

Circle 200 on Inquiry Card

NO-SHAFT POTENTIOMETER

Cap-Pot, for portable transmitting and receiving equipment, and trimmer applications, is nylon, the knob being an integral part of the unit. It is 0.500 in. in dia.; behind panel

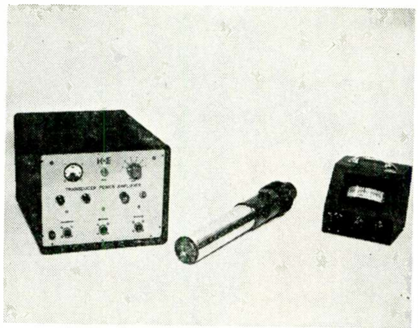


depth is 5/16 in. Power rating 0.5 w at 40°C, derated linearly to 0 at 105°C. Linear functions only. Dielectric strength is 900 VRMS at sea level for 1 min. Type A to 5000 ohms max.—tolerance ± 5% (25,000 cycles min. at 10 cycles/min. at rated power.) Type B (Trimmer) to 10,000 ohms max.—tolerance ± 10% (500 cycles min. at 2 cycles/min. at rated power.) Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 202 on Inquiry Card

AUTO-COLLIMATOR

Electronic Auto-Collimator can measure the tilt of a reflective surface with respect to the Auto-Collimator axis. It reads angles directly to sensitivity of 1/50 sec. Sensing unit has

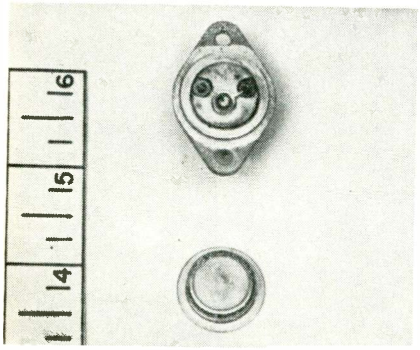


indicating range of 50 sec. ± 25 sec., and working distance to 30 ft. between sensing unit and reflecting surface. Other features: Response—20 msec; drift less than 1% in 24 hrs. Output voltage ± 15 v. (full scale range). Sensitivity selection has a 3-position switch with ranges of ± 1, 10 and 25 sec. Electronic damping with 2-sec. time constant provided. Keuffel & Esser Co., 3rd and Adams Sts., Hoboken, N. J.

Circle 204 on Inquiry Card

SWITCHING TRANSISTOR

Military-type 2N1011 germanium pnp power transistor meets MIL-T-19500/67(SigC). It has a 5 a max. current rating, a current gain range of 30-75 at I_c = 3 adc, and a max. collector-base voltage rating of 80 v. The 2N1011 will dissipate 35 w at 25°C mounting base temp. For power switching and power control circuits, it is useful in aircraft power supplies, missiles, and communications power

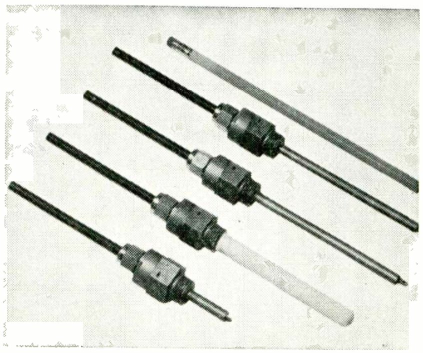


supplies. Other applications are high current switching and audio amplification. Marketing Dept., Bendix Semiconductor Products, 201 Westwood Ave., Long Branch, N. J.

Circle 201 on Inquiry Card

THERMOCOUPLE PROBE

Thermocouple probe measures liquid and gas temp. in the 1800°F range at pressures in excess of 2000 psig. Models include those with stainless steel sheaths and either covered or exposed probes for use with hot gases, and ceramic sheaths for use with liquid metals and acids. Helium and nitrogen tested for leakage at 1800°F and 2000 psig. Units are suitable for connection to low temp. Tef-

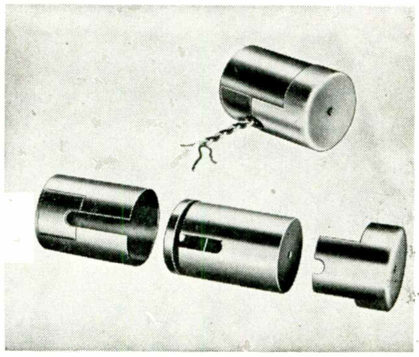


lon or high temp. MgO cable. Constructed of chromel-alumel or chromel-constantan. Technical Industries Corp., 389 North Fair Oaks Ave., Pasadena, Calif.

Circle 203 on Inquiry Card

MAGNETIC SHIELDS

Alternately inverted nesting Netic Co-Netic cylindrical enclosures provide low level shielding for magnetically sensitive devices in electronic circuits. Slots permit simple assembly and facilitate bringing out leads. Max. low level shielding from a min. number of layers is obtained by overlapping the cylinder walls and butting joint covers. A contour formed tab section completely encloses the slot-



ted section of the outer cylinder, assuring a virtually complete magnetic shielded enclosure. Magnetic Shield Div., Perfection Micro Co., 1322 N. Elston Ave., Chicago 22, Ill.

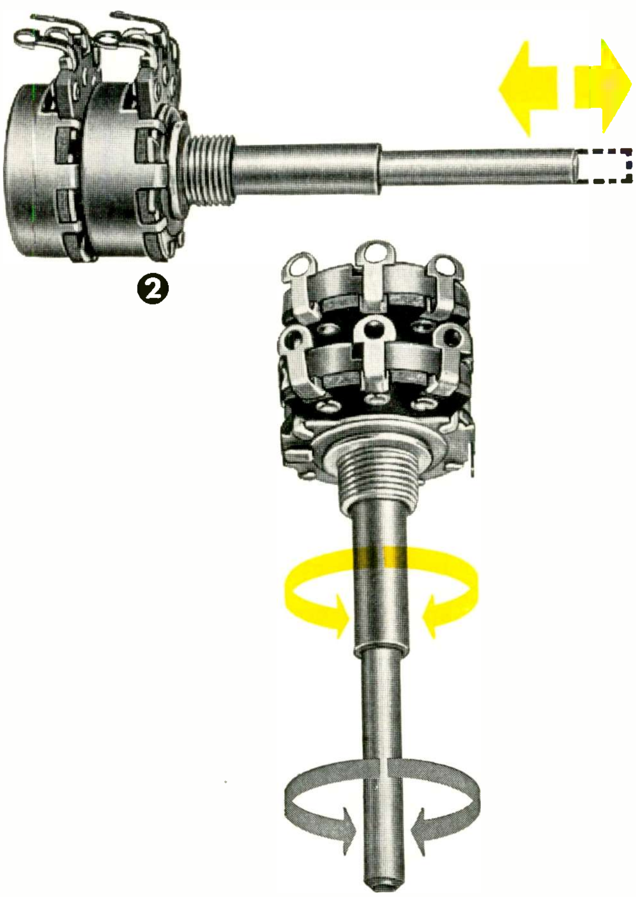
Circle 205 on Inquiry Card

NEW CONTROLS FOR STEREO

Flexibility without Complexity

Even a wife can appreciate the major points of these special dual-element controls for 2-channel stereo equipment! No longer is it necessary to fiddle with 2 bass controls, 2 treble controls, and 2 volume controls to obtain proper stereo balance—then re-adjust everything when listening to monophonic material. No longer, that is, unless you're an ardent audiophile who would have it no other way.

For these new Stackpole controls "clean-up" the panels of stereo equipment, make them easier to operate and understand . . . yet retain all the flexibility of individual adjustments required on the most elaborate equipment.



1. **FRICTION SHAFT DUAL**—Type LS3: A friction fit between shafts causes both elements of this dual concentric shaft control to operate in tandem when either shaft is turned. Either element can also be adjusted independently by holding one shaft while rotating the other. Once set, either knob can be turned while maintaining stereo balance through a wide range of adjustment.

2. **CLUTCH SHAFT DUAL**—Type LS1: This wonderfully convenient control allows either simultaneous or individual adjustment of its two elements. A push on the inner shaft engages a clutch which connects both elements together for tandem operation by either shaft. Pulling the inner shaft permits each element to be individually adjusted without disturbing the other.

3. **MATCHED ELEMENT TANDEM**—Type L-Tandem: Through precise electrical matching and careful mechanical alignment, this stereo tandem control allows convenient, single-knob adjustment of both channels. It's ideal for adjustment of master volume or of bass or treble in systems where an absolute minimum of panel complexity is desired.

Mechanical and electrical specifications on these dependable 0.75-watt variable composition resistors are available on request. *Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.*

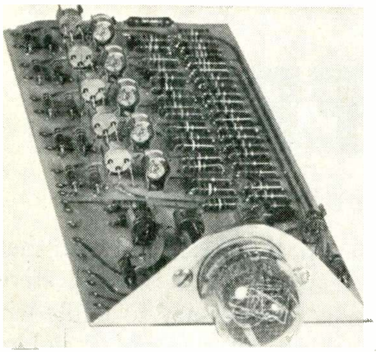
STACKPOLE

Coldite 70+® fixed composition Resistors • Slide & Snap Switches • Ceramag® Ferrite Cores • Fixed composition Capacitors • Ceramagnet® Ceramic Magnets • Electrical Contacts • Brushes for all rotating electrical equipment • Hundreds of related carbon, graphite, and metal powder products.

New Products . . . for the Electronic Industries

CONVERTER

Solid state Binary to Decimal Converter, Model 260, designed as companion equipment for computers which require decimal display readout for any number of 4 bit code in-

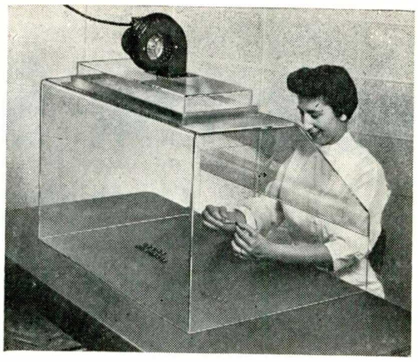


puts. Relays and tubes are eliminated. No preventive maintenance required. It activates a cold-cathode decimal display equivalent to a "Nixie" tube. Filamentary projected readout equivalent to IEE Alpha-Numberic unit available. A variety of 4 bit codes can be converted. Hermes Electronics Co., 75 Cambridge Pkwy., Cambridge 42, Mass.

Circle 206 on Inquiry Card

DUST HOOD

New dust hood, the Microvoid, allows full visibility and unimpeded movement of arms and hands. A quiet blower at the top forces room air into the dust hood through a large-

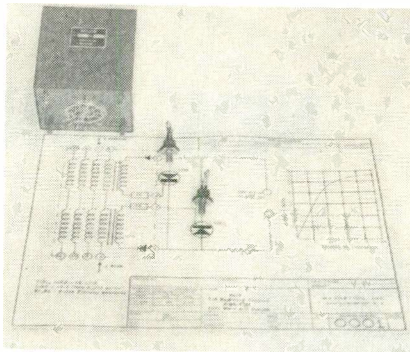


area filter. The filter removes airborne dust particles down to 0.5 micron in dia. and provides an internal "positive" pressure which prevents unfiltered room air from entering the open front. Working area measures 34 x 24 x 19¼ in. It is constructed of optically-clear, ¼ in. "Plexiglas." Air-Shields Inc., Industrial Division, Hatboro, Penna.

Circle 208 on Inquiry Card

CONTROL AMPLIFIER

Type MA 1 magnetic amplifier provides phase angle firing control for the General Electric C35, or equivalent, silicon controlled rectifier (SCR). Designed for 120 v., 50 to



400 CPS, the MA 1 supplies gate signal to SCRs to give full wave ac or dc output. Some features: response, ½ cycle (max.) of the supply frequency; complete isolation between power and control circuits; and multiple control windings; full-off to full-on control with 1.5 a turns. Magnetico, Inc., T. A. Div., 6 Richter Court, E. Northport, N. Y.

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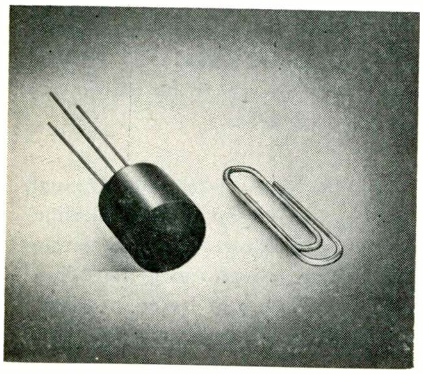
Line of standard transistor transformers is designed for circuits in the audio range. For audio and servo amplifiers, signalling equipment, etc., they measure ½ in. dia., ½ in. height. A choice of 4 standard lead terminations provides lead spacing on 0.10 in. grid, for mounting on circuit board without bulky clamps. Min. lead length is 1 in. Built to meet MIL-



T-27A, class R, grade 5 requirements, units may be used reversed, input to secondary. Hermetic Seal Transformer Co., 555 N. 5th St., P.O. Box 978, Garland, Tex.

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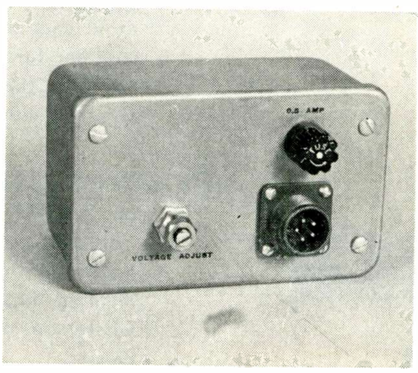
VOLTAGE REGULATORS

Regulated dc from unregulated dc sources obtained with a transistorized voltage regulator. Output voltages range from 6 to 35 vdc from inputs from 24 to 45 vdc. Outputs can be varied over a 15 v. range with a screw driver adjust. Specs: Ripple reduction 500: 1 typical; line regulation ±0.1% or 10 mv whichever greater; load regulation 50 mv for 0-0.5 a load



change; residual noise 1 mv typical; output impedance 0.10 ohm max., dc-5 KC; size 3 x 3 x 5 in.; weight 16 oz. Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

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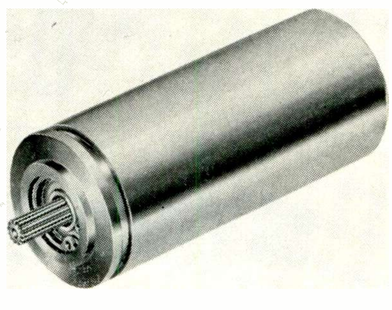
MOTOR-TACH GENERATOR

A size 8 precision —55°C +125°C motor-tach generator, Type 6204-01 rotor moment of inertia is 0.65. Motor has 0.2 oz.-in. min. stall torque with approx. 5 w. total input, 6,000 RPM speed at no load, 26 v (fixed phase) and 40 v (control phase) rated voltage and 179 + J132 = 222 ohms (fixed phase) and 382 + j321 = 500 ohms (control phase) impedance at



stall. Tachometer generator has 26 v RMS, 400 CPS rated input voltage and 0.26 v RMS output voltage at 1,000 RPM. John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.

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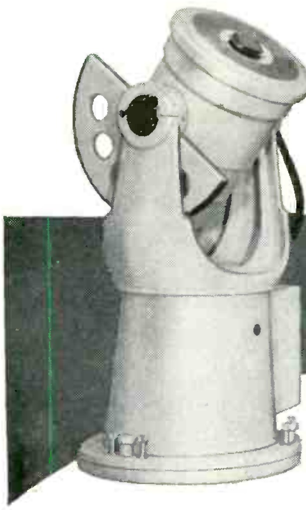

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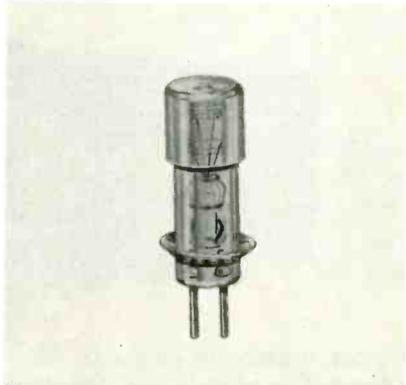

legends. Connectors are 0.040 in. plated terminals. It is for use in instruments and small equipment and on computers and data processors. Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn.

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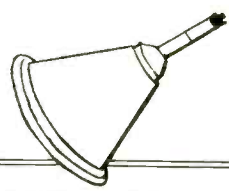

TYPICAL CHARACTERISTICS

Type	Focusing Method	Deflection Method	Deflection Angle	Collector Voltage	Grid #2 Voltage	Grid #1 Voltage	Focus Current (JETEC Coil #109)	Overall Length	Overall Diameter	Screen Diameter
16ADP	magnetic	magnetic	53°	12,000 Vdc	300 Vdc	−33 to −77 Vdc	95 ma.	21½″	15⅞″	14⅜″
CK1352	high-voltage (3300 to 4300 Vdc)									
CK1353	low-voltage (−135 to +400 Vdc)									

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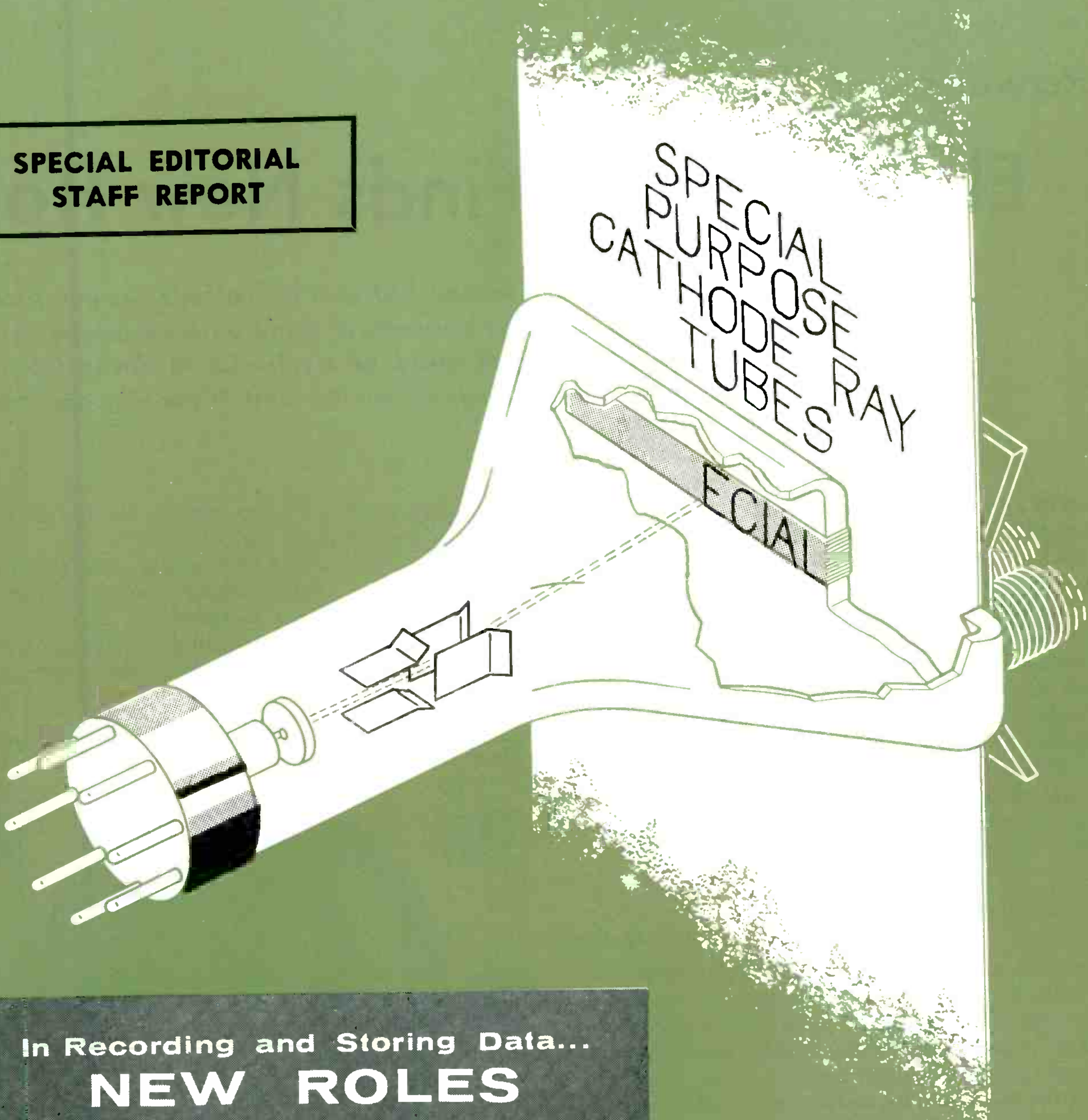
ELECTRONIC INDUSTRIES

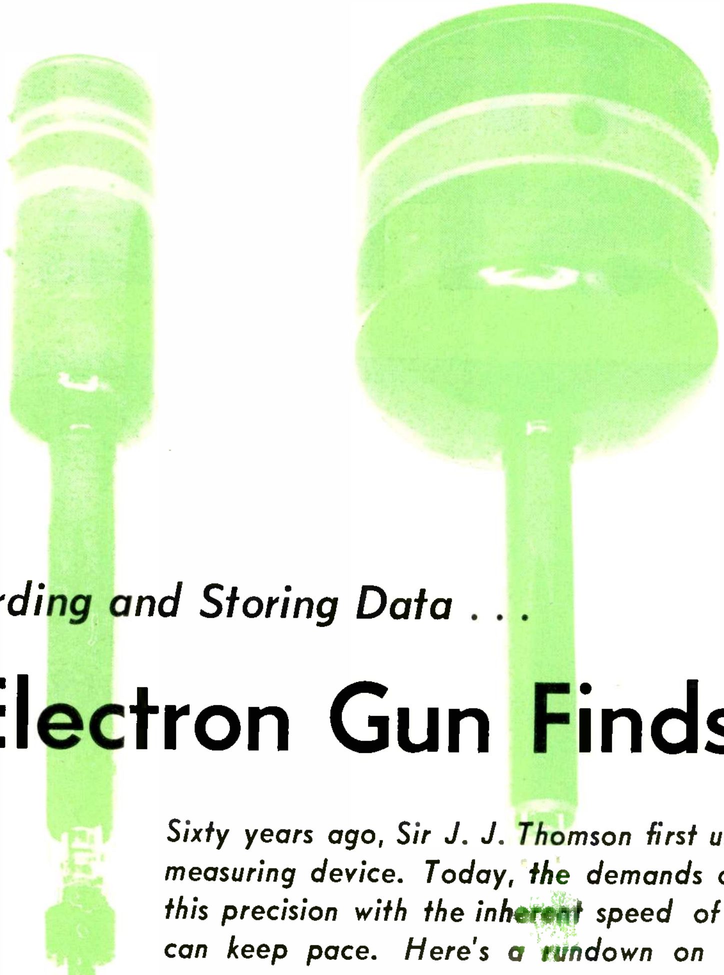
SPECIAL EDITORIAL STAFF REPORT



In Recording and Storing Data...

NEW ROLES for the ELECTRON GUN

March 1960



Quartz-faced tubes provide ultraviolet light source for cancer tissue analysis.

By **RICHARD G. STRANIX**
Associate Editor
Electronic Industries

In Recording and Storing Data . . .

Electron Gun Finds New Role

Sixty years ago, Sir J. J. Thomson first used the cathode ray as a precision measuring device. Today, the demands of rapid data processing combine this precision with the inherent speed of electronics to devise tubes that can keep pace. Here's a rundown on the most interesting applications.

CROOKES[1], Perrin[2], and Thomson[3, 4] proved in the late 1800's that the "cathode ray" was actually a stream of electrons. It seems a little late in the game to start arguing semantics, so we won't stress this point. Engineers should know what we mean, when we say "cathode ray."

Some manufacturers in the electronic industry do not call their electron beam products "special purpose" cathode ray tube. But, as far as we are concerned here, "special purpose" cathode-ray tubes include practically every tube that uses an electron gun. We are excluding only TV picture tubes, and oscilloscope tubes. These are the "general" category of CRT's, as opposed to "special purpose."

Electron Optics

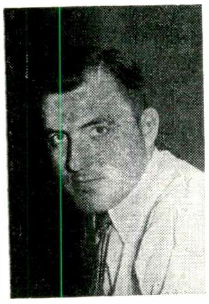
Let's take a quick look at the CRT construction (Fig. 3). The electron-gun assembly is comprised mechanically of four major parts: the cathode-grid assembly; the preaccelerator anode assembly; the focussing electrode, or first anode assembly; and the accelerating electrode, or second anode assembly. The assemblies are mounted by means of ceramic supports which run the entire length of the electron gun assembly.

This electron gun provides a source of electrons, directs them towards the face of the tube, focuses them into a narrow beam, and accelerates this beam towards the front of the tube.

There are two kinds of focusing—electrostatic and electromagnetic. Tubes usually use one or the other but some can use both methods.

One other system of focusing—using an inert gas in the tube—has long since been discarded.

Fig. 1: Scope presentation of a hot plate, 125° C, as detected by the Philco electronic infrared imaging system. Details in Fig. 26.



R. G. Stranix

In electrostatic focusing, the lines of force in the field created by the difference of potential between (1) the preaccelerating and focusing electrodes and (2) the focusing and accelerating electrodes may be considered as a thick concave lens. As the beam enters the first field, the force lines produce a diverging action on the beam. As it enters the second field, the force lines reconverge it into a narrow, clearly defined beam.

The alternative method of focusing uses the principle of electromagnetic control. A current is passed through a solenoid placed around the neck of a CRT. This establishes an electromagnetic field within the tube. Electrons passing through the edge of the field, along the axis of the tube, experience no deflecting force. Those traveling at an angle to the axis will be acted on in such a way by the field as to place it in a spiral. The electron continues this motion as long as it is under the influence of the field. When it emerges, the resultant inertia keeps it moving toward the focal point on the screen.

Both systems have their own merits and place.

For deflecting the beam there are also two methods —electrostatic and electromagnetic. In the former, two pairs of plates are placed at right angles to each other. Since like electrostatic charges repel and unlike charges attract, the electron, a negatively charged particle, is attracted to the positively charged plate and vice versa.

A magnetic field can also deflect a cathode-ray because the beam of electrons acts the same as a conductor carrying a current. When a current is passed through a pair of solenoids mounted in the close proximity to the neck of the tube, an electromagnetic field is formed. The electron beam is deflected at right angles to the electromagnetic field. Two pairs of solenoids, at right angles to each other, can control vertical and horizontal deflection.

The parts we have covered so far are common to virtually all special purpose CRT's. We are coming now to the part of the tube where most of the novel features enter into play. Depending on its use, the CRT may have screens, other targets, or wire matrices.

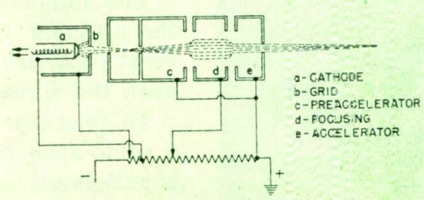
Storage Tubes

Storage tubes have found application in computers, radar display, and frequency-bandwidth conversion. They are tubes into which information can be introduced and then extracted at a later time. The output may be an electrical signal and/or a visual image corresponding to the stored information.

Principle of Operation

Cathode ray charge storage tubes are usually divided into 2 groups: Electronic input with electronic output; and, electronic input with

Fig. 3: Principal parts of an electron gun.



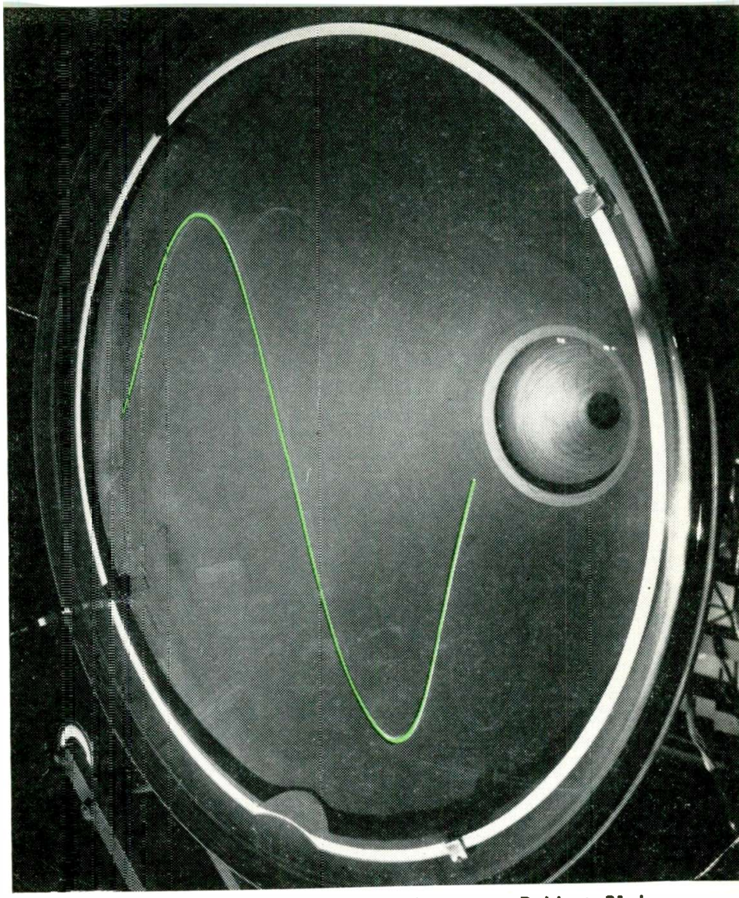


Fig. 2: Trace apparently suspended in mid-air on a DuMont 21 in. tube using a transparent phosphor. Used when ambient light is high.

visual output. Under electronic output, we have a subdivision into single gun tubes and dual, or multi-gun tubes. In single gun tubes the one gun is used for both writing and reading. In dual gun tubes the second gun may be located either at the same end of the bulb as the writing gun or on the same axis at the other side of the storage surface.

Following the deflection system, there is a storage assembly.[6] This is an assembly of electrodes, including meshes, which contains the target together with the electrodes used for control of the storage process, or which receive an output signal, and other members used for structural support.

The target is the storage surface and its immediate supporting electrodes. The storage surface is that surface upon which the information is stored.

Another important design feature of the storage tube is the collimating lens system composed of the anode coating, lens shield, and decelerator screen. This lens is designed to correct for the angle of the electron beam generated during scanning so that the beam strikes the storage screen at right angles to that screen, regardless of initial scanning angle. In other words, it is an electron-optical lens with one focal plane at the center of deflection of the beam and the other at infinity.

Basically, there are two kinds of storage tubes—recording and barrier grid.

Recording Storage Tube

In the recording storge tube[7], the element which provides the time storage of information is usually a fine-mesh metal screen—up to 1000 lines per linear inch—coated on one side with a dielectric material.

Electron Gun *(Concluded)*

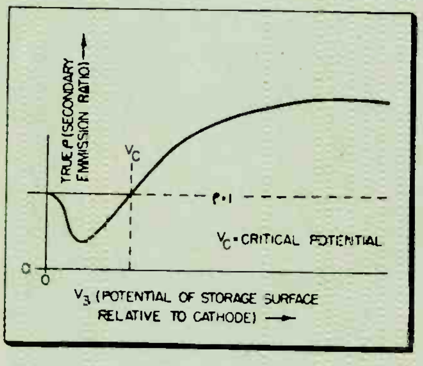


Fig. 4: Operation of storage tubes is based on the secondary-emission curve.

MODE	STORAGE SCREEN	DIELECTRIC SURFACE
PRIME (ERASE)	[illegible]	[illegible] 0V
WRITE (INPUT SIGNAL)	[illegible]	[illegible]
READ ([illegible])	[illegible]	[illegible]

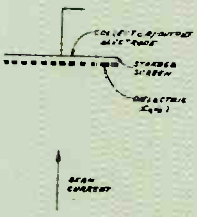


Fig. 5: Typical applied voltages for operating models; also, direction of storage surface charge during priming and writing.

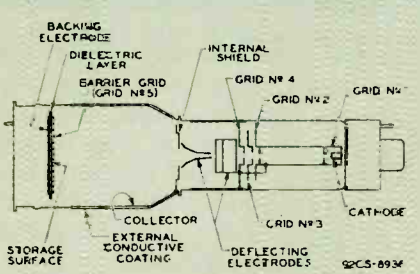


Fig. 6: Arrangement of elements in a barrier grid storage tube.

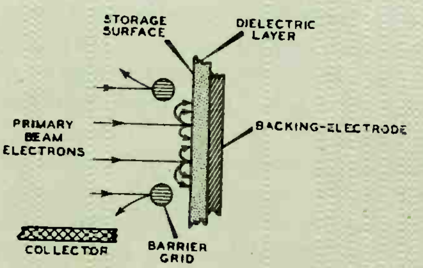


Fig. 7a: Storage surface instantaneously positive with respect to barrier grid.

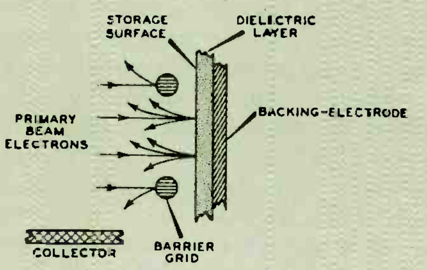


Fig. 7b: Storage surface instantaneously negative with respect to barrier grid.

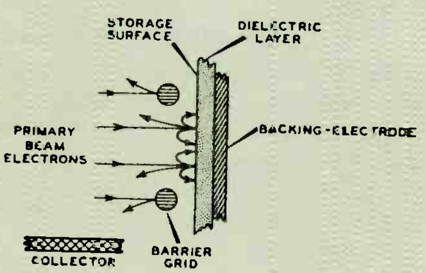


Fig. 7c: Storage surface at equilibrium potential.

It should be noted that the recording storage tube does not merely allow the stored information to be played back once, but can play back the stored information thousands of times without substantial deterioration. Moreover, the stored information can be held for hours prior to retransmittal.

Three or four steps are usually used in operating this type tube. The four-step cycle consists of erase, prime, write, and read. Erase and prime are combined for circuit simplicity in the three-step cycle. However, in the latter case, there is a slight loss in the degree of erasure which can be obtained.

During the erase, prime, and write modes, an electron beam is used to vary the charge level on the storage surface. During read, the charge pattern previously written amplitude-modulates a constant beam from the gun. Naturally, the electron beam is being scanned during these operations.

The secondary-emission curve, Fig. 4, helps clarify the situation. The horizontal axis represents the velocity of electrons striking the surface. By simple conversion, this gives the voltage of that surface. The ratio of the number of electrons that bounce off the dielectric surface to those that strike it is plotted along the vertical axis.

Below the critical potential V_c, each electron striking drives off less than one secondary electron. Therefore, the surface being struck would be charged negatively.

If the dielectric surface is above V_c, each electron drives off more than one secondary electron. The surface will then charge in a positive direction as long as the voltage field directly before the surface is sufficiently positive to draw off the secondary electrons thus emitted.

Using this ability to charge either positively or negatively depending on the dc voltage of the storage surface, we can now cycle the tube through its various modes.

The table in Fig. 5, shows the applied voltages for each mode of operation as well as the direction that the storage surface will charge during the priming and writing modes. In priming, the storage screen is set below V_c of the dielectric material. When the surface is scanned with a dc beam, it charges negatively to cathode potential. Any previously written signals are erased. The surface is made ready for subsequent writing.

In writing, the storage screen voltage is elevated substantially above the V_c. If sufficient dc current were scanned across the surface, it would charge to a value equivalent to the storage screen voltage. Actually, a video-modulated beam is used of such an amplitude that even peak currents charge the dielectric only part way toward the equilibrium value.

The numbers in the table are typical and show that the different regions of the dielectric surface would be at potentials between 270 and 285 volts, depending upon the signal written amplitude in each region.

To read, the storage screen voltage is switched to a value such that the front surface of the dielectric is sufficiently negative to prevent electrons from passing through the storage screen toward the collector or output electrode. Where the dielectric surface is

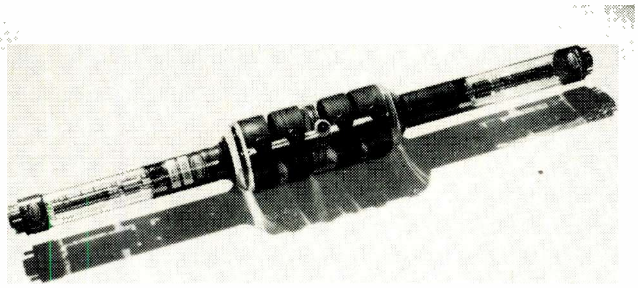


Fig. 8: The Raytheon dual-gun scan converter recording storage tube.

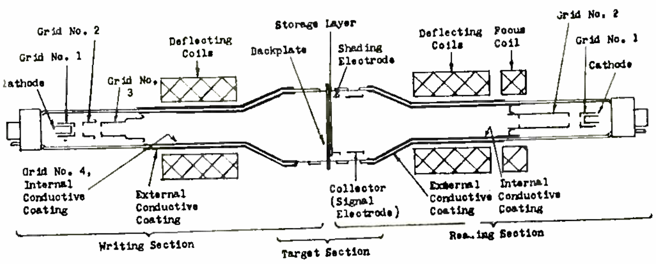


Fig. 9: Arrangement of elements in the RCA scan converter tube.

less negative than the cut-off value of voltage, a portion of the electron beam that is a function of the voltage of that surface, will be allowed to pass through the storage screen and produce an output signal at the collector.

Barrier Grid

The barrier grid[8] tube has a grid-like structure superimposed on the storage surface that prevents redistribution of electrons. The barrier grid itself consists of a fine mesh screen, which is very close to or in contact with, the gun side of the dielectric layer. On the opposite side of the layer and in contact with it is the backing-electrode, Fig. 6. The dielectric layer has high insulating qualities at a maximum secondary-emission ratio greater than unity. The barrier grid, the dielectric layer, and the backing-electrode, are collectively referred to as the "target" for convenience in explaining the operating principles. The collector is a conductive coating on the inside wall of the large part of the tube.

The barrier grid also provides an electrostatic shielding of adjacent areas. These functions prevent loss of resolution and signal level. The functions mentioned refer to both the shielding of the barrier grid and also the redistribution of electrons mentioned earlier. Many references are possible without regeneration of the stored information.

The area of the storage surface bombarded by the electron beam is determined for any specific application by the magnitude of the voltages applied to the defecting electrodes.

The storage-surface potential effects the action of the target as shown in Fig. 7. In Fig. 7a, the storage surface is instantaneously some tens of volts positive with respect to the barrier grid. When the primary-beam electrons, produced by the electron gun, go through the barrier grid and hit the storage surface, they dislodge secondary electrons from the storage surface. The number released depends on the velocity of the electrons, Fig. 4. The energy of the secondary electrons is not sufficient to overcome the negative gradient existing between the barrier-grid plane and the storage surface. Consequently, after a transit time of a small fraction of a microsecond, the secondary electrons return to the vicinity from which they were released.

Under these conditions, a net electron current flows into the target from the beam. This current has a value equal to that of the beam current multiplied by the transmission of the barrier grid. Because the barrier grid is treated so that it has a secondary-emission ratio of very nearly unity it contributes nothing to the net electron current flowing into the target.

In Fig. 7b, the storage surface polarity has been reversed so that it is now some tens of volts negative with respect to the barrier grid. When the primary electrons go through the barrier grid and impinge on the storage surface, they dislodge secondary electrons from the storage surface as in Fig. 7a. These secondary electrons, however, are accelerated from the storage surface, pass through the plane of the barrier grid and go into the space beyond it. These secondaries, plus those released from the barrier grid, are then accelerated to the collector which is operated at a positive dc potential. Some secondaries are collected by the barrier grid but these may be neglected in considering first order effects without introducing appreciable inaccuracy. The net electron current flows away from the target. This current has a value equal to that of the beam current multiplied by both the effective transmission ratio of the barrier grid, and by the difference between the secondary-emission ratio of the storage surface and unity.

In Fig. 7c, the storage surface is several volts positive with respect to the barrier grid. Now, the escaping secondaries exactly balance those primary-beam electrons arriving at the storage surface. Under these conditions, the net target current is zero and the potential of the storage surface in known as the equilibrium potential.

The condition shown in Fig. 7a, is unstable because charge neutrality cannot be maintained within the dielectric layer. To maintain charge neutrality within the dielectric as the beam deposits electrons in the storage surface, it is necessary that the displacement current flow in the storage-surface backing-electrode. As a result of this flow, a voltage gradient is built up across the dielectric. The potential of the storage surface on which the electrons land, becomes more and more negative until the condition shown in Fig. 7c is shown. Similarly, the condition of Fig. 7b is unstable. Here, the process of charging to the equilibrium potential is in a positive direction.

It is by this process of charging, called writing, that the storage of information is effected.

Electron Gun *(Continued)*

Writing

Here is how we write. With the storage surface at equilibrium potential, zero potential exists between the backing electrode and the barrier grid. A step-function voltage of +50 v. with respect to the barrier grid, is applied to the backing-electrode. Because of the relatively high capacitance between the backing-electrode and the barrier grid, practically all of the step function voltage appears between the storage surface and the barrier grid. The undeflected beam is now turned on, and that part of the storage surface bombarded by it commences to charge negatively toward equilibrium. Assume that bombarding continues until the storage-surface potential, in relation to equilibrium potential, has changed from the +50 v. to +40 v., and here the beam is turned off. A charge sufficent to develop a gradient of 10 v. has now been stored in a dielectric layer. With these conditions the discharge factor is $(50-40)/50+0.2$. If the step function voltage is now removed the storage surface becomes 10 v. more negative than the equilibrium value.

Reading

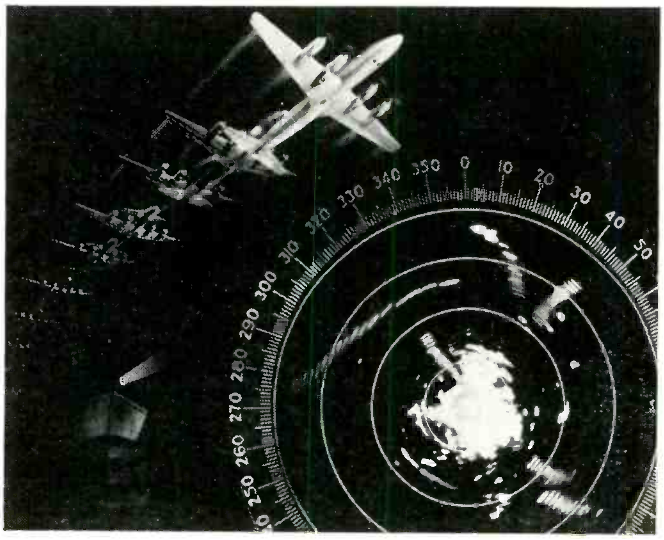
This stored information may now be extracted by a discharging process known as reading. During reading, the backing-electrode is held at the same potential as the barrier grid. When the beam is turned on, the resulting target-current flow is that for the storage surface at −10 v. with respect to the equilibrium potential.

Because reading is accomplished by the removal of electrons from the storage surface and its consequent discharge toward equilibrium potential, it is likewise an erasing process. If the discharge factor during reading is sufficiently high, further erasing is unnecessary.

Fig. 10: Sperry's Daylight Indicator uses a display storage tube.

Scan Converters

Scan converters are usually examples of multi-gun doubled ended tubes. As can be seen in Fig. 8 one half of the Raytheon dual-gun recording tube looks identical to the single gun version. That is, we have an electron gun, a collimating lens system, a decelerator screen, and a storage screen. The collector or output electrode is, in this case, a third screen rather than a solid plate. This screen acts not only as a collector for the reading operation, but also as the decelerator electrode for the writing gun and therefore a part of the writing-gun lens systems.



Aircraft at upper left, symbolizing the memory function, appears as target trail on Raytheon's Flight Tracker. System uses a Recording Storage Tube; presentation is on a high resolution picture tube.

This charge storage tube is designed for use in data processing applications where signal information must be transformed continuously from one time base to another. It is particularly useful in systems in which it is desired to display PPI information generated by conventional radar systems on direct-viewing and projection television receivers.

In the RCA version[10], the target section in the center contains the target, a shading electrode and a collector or output signal electrode, Fig. 9. The target consists of a thin layer, known as the storage layer of a high resistivity material deposited on the reading gun side of a metallic back plate. This high resistivity material, which has a maxmum secondary emission ratio greater than unity, serves as the dielectric for the capacitor formed between the back plate and the reading gun beam incident on the front surface of the storage layer.

When the front surface of the storage layer, that surface facing the reading gun, is bombarded by the medium velocity electron beam of the reading gun, secondary electrons are emitted. Since the secondary-electron emission ratio of the front surface is greater than unity, the surface tends to charge in the positive direction. Under continued bombardment, the surface becomes increasingly positive with respect to the

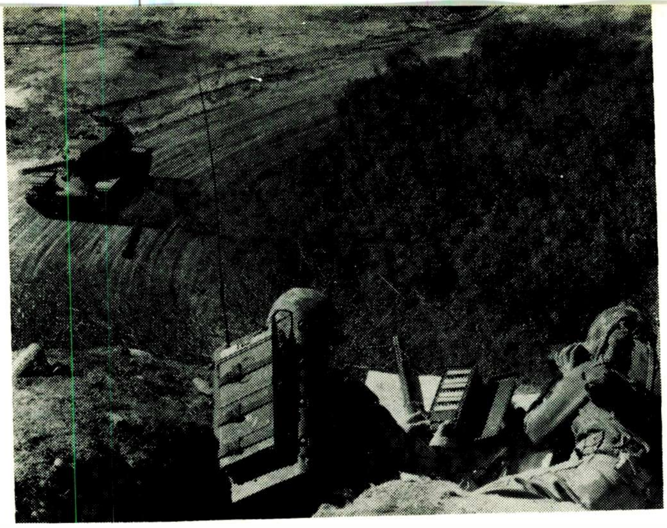


Fig. 11 (left): Marines set up and transmit battle information which instantly appears on rear line command post tactical map.

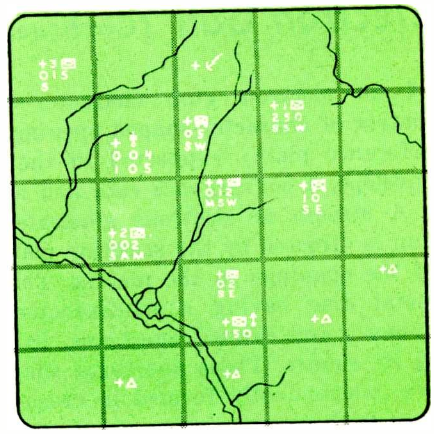


Fig. 12 (right): Typical display of battle information on Charactron. Each grouping identifies observer and indicates situation. This BASIC system is made by Stromberg-Carlson for the USMC.

collector until a retarding potential of a few volts is built up and equilibrium is established.

The opposite side of the insulating layer is in mechanical and electrical contact with the back plate which is maintained at a negative potential with respect to the collector. Thus, in the equilibrium condition, a difference of potential exists between the two surfaces of the storage layer.

When the high velocity electron beam of the writing gun bombards the target, it goes through the back plate and penetrates the storage layer. The resulting induced conductivity produced in the storage layer lowers the potentials of the front surface element by varying degrees toward that of the negative back plate. The front surface of the storage layer thus acquires a pattern of potential variations corresponding to the input signal applied to the writing gun grid. When the writing beam is removed, the storage layer gradually regains normal conductivity.

The discharging or writing characteristic is a function of the writing-beam current, the writing-beam velocity, the scanning speed, and the width as well as the repetition rate of the pulse signal applied to the grid of the writing gun.

The change in potential of the storage surface elements caused by the writing-beam bombardment upsets the equilibrium condition established by the reading beam. Secondary electrons produced by reading-beam bombardment of those areas of the storage surface driven negative (toward back plate potential) by writing are now accelerated to the collector and constitute the output signal current. As already described, the reading process erases the stored potential pattern by driving the storage surface potential back to the equilibrium value. Because of the relatively large capacitance between front and back surfaces of the storage layer, a large number of reading scans are required before equilibrium is reestablished. Thus the output signal persists for some time after the writing beam has bombarded a particular area of the storage layer.

The charging or reading characteristic is a function of the back plate potential and the reading-beam current. Increasing the back plate potential and decreasing the reading-beam current, result in increased charging time. By suitably adjusting these operating values, the reading time can be varied from a few seconds to over a minute.

The maximum number of scanning frames obtainable during the reading process depends on the magnitude of the potential variations produced on the insulating-surface elements during the writing process, and the minimum value of reading-beam time can be used in relation to the noise level of the associated amplifier.

Display Tubes

Character display tubes are a form of cathode ray tubes in which the cathode ray beam can be shaped by either (1) electrostatic or electromagnetic deflection, or (2) passing the beam through a mask, into symbols or letters.

Shaped beam display tubes are cathode ray tubes in which the beam is first deflected through a matrix then repositioned along the axis of the tube and deflected finally into their desired position on the faceplate. Typical of this type of tube is the Charactron.[12] Through the use of a P-14 phosphor, these tubes can retain the display on the faceplate for a considerable period of time.

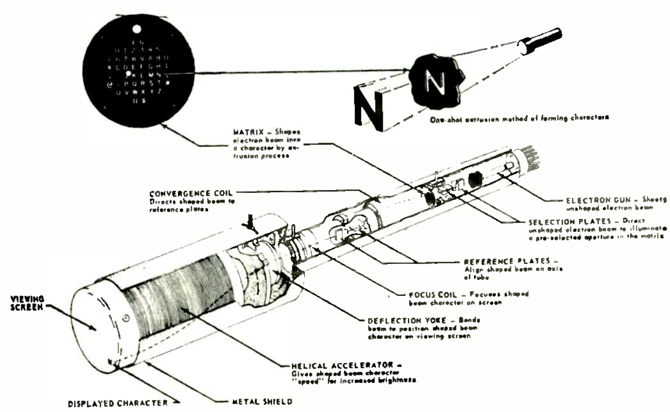
Referring to Table 1, Phosphors, it is seen that the P-14 is a 2-layer phosphor with a purple fluorescence and an orange phosphorescence. It is considered a long persistence phosphor.

An important use of this tube is the display of coded information that provides target data for an air-surveillance system.

The charactron generates characters by forming the cross-sections of electron beams in the shape of the characters. In brief, the manner in which this is accomplished is as follows:

The essentials of the charactron, Fig. 13, are: a character-forming electron gun assembly (consisting

Fig. 13: Elements of Stromberg-Carlson's shaped beam Charactron.



of an electron gun, character-selection plates, a matrix of character-shaped openings, and beam axial-reference plate) supported in the neck of the tube envelope, a convergence coil, and a deflection yoke.

A stream of electrons generated by the electron gun is directed by the selection plates toward any one of the openings in the matrix. The matrix is a thin metal disc having a 64-character array of alpha-numeric and symbol apertures, in an area less than ¼ in. square. These apertures shape the beams, that are independently formed in cross-section, in accordance with corresponding openings.

The magnetic field of the convergence coil redirects the beams toward the optical axis of the tube. These beams cross the axis at points that coincide with the deflection of the beams which redirects them along the axis of the tube, and into the field of the deflection yoke. The electromagnetic fields established by the yoke allow these beams to be deflected to any position on the screen of the tube. A helical accelerator supported in the funnel portion of this envelope between the deflection yoke and the screen, increases the velocity of the character-shaped beam with a minimum distortion of the characters displayed near the edges of the screen.

Display & Storage

A tube, known as the Typotron[13], is actually a combination of a storage tube and a character display tube, Fig. 16. In addition to the gun, character matrix, convergence coil, and deflection plates in the character display tubes, already described, this tube incorporates a storage target and an additional flood gun placed beside the last set of deflection plates closest to the viewing screen. As one might guess, this tube does not depend upon the persistence of the phosphor for lengthy display, but upon an operation similar to a storage tube in which the display will remain until it is erased from the storage target.

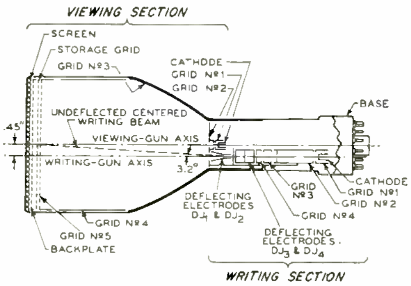


Fig. 14: Arrangement of elements in a display storage tube.

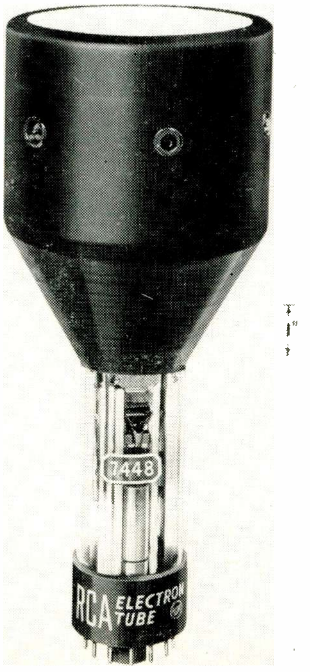


Fig. 15: RCA's direct view display storage tube. Like those of other manufacturers, it is used where a bright, non-flickering display of stored information is desired after writing has ceased.

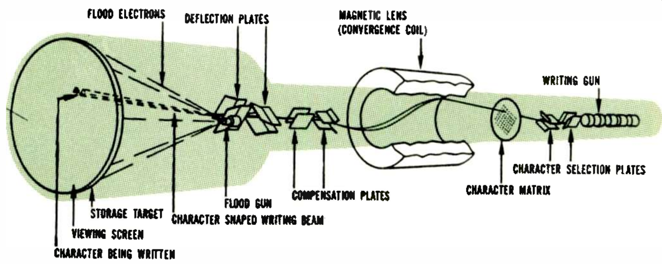


Fig. 16: Arrangement of elements in the Typotron, a display storage tube manufactured by Vacuum Tube Prods. Div., Hughes Aircraft Co.

It should be pointed out before going any further that besides displaying characters, the tube can also display patterns that are normally generated by the cathode-ray spot. Here basically is how the typotron operates.

A character-shaped beam is formed and directed toward the screen in a manner similar to that already described.

The flood gun, mounted alongside the last deflection plates, covers the entire storage target with a barrage of low-velocity electrons. The high velocity character-shaped beam bombards the dielectric material on the storage mesh, charging it positive by secondary emission. The low velocity electrons from the flood gun penerate the storage mesh in the area of the storage target that have been written positive. These electrons are then accelerated to the viewing screen, thus displaying the written information. The areas of the storage target not charged positive, remain at the flood-gun cathode potential, and the electrons from the flood beam are unable to penetrate to the viewing screen.

In addition to providing a display of the stored pattern, the low velocity electrons serve to regenerate the pattern. By means of secondary emission, they hold the written areas positive and the unwritten areas negative. This holding function must be disabled to erase a written pattern. This can be done by momentarily lowering the secondary, collector mesh potential below its normal value.

Direct view display storage tubes provide a bright, non-flickering display of stored information for as long as 40 seconds after writing has ceased. Applications include fire-control radar; airplane-cockpit radar display; airport surveillance; transient studies; data transmission, including halftones; and visual communications requiring steady, non-flickering, narrow bandwidth transmission over telephone lines.

This type tube usually has 2 guns—a writing gun and a viewing gun.[11] The writing gun uses electrostatic focus and produces an electron beam which is electrostatically deflected by 2 sets of deflecting electrodes. The viewing gun produces an electron stream which floods the electrodes controlling the storage function and the brightness of the display.

The tube is usually divided into two sections—a writing section and a viewing section, Fig. 14. The writing section contains a gun which produces an electron beam, electrostatically deflected by two sets of deflecting electrodes. The viewing section contains an aluminized screen on the inside surface of a flat faceplate, a backplate capacitively coupled to a storage grid, and a viewing gun having 5 grids.

Viewing Operation

In addition to the viewing gun with its grids, 1 and 2, the viewing section contains grids No. 3, 4, and 5. A storage grid, a backplate capacitively coupled to the storage grid, and a screen having excellent visual efficiency.

The viewing gun provides a low-velocity electron stream which continuously floods the electrodes (grid No. 5, storage grid, and backplate) controlling the storage function and the brightness of the display. A display with high brightness is possible because the very efficient phosphor is continuously excited, rather than intermittently as in conventional cathode-ray tubes, by the high-current viewing beam. The high current can be used because the viewing beam is not controlled by methods ordinarily employed in guns and is consequently not limited by focusing, deflection, and modulation requirements.

Writing Operation

The writing gun is similar to that used in electrostatically focused and electrostatically deflected oscillograph tubes, and produces a well-defined focused beam. This beam may be deflected and modulated in the same manner as for oscillograph tubes. It has a control function and contributes little to the total light output from the tube.

The cathode of the writing gun is generally operated at −2000 volts with respect to the viewing-gun cathode.

The writing-beam electrons landing on the storage grid have sufficient velocity to produce a secondary-electron emission ratio greater than unity.

Erasing Operation

In most applications, writing should be followed by a gradual decay of the stored information. This kind of performance is obtained by applying a continuous series of pulses to the backplate at a rate no lower than the phosphor flicker frequency. The technique of erasing by applying a series of pulses to the backplate is known as dynamic erasure.

The amount of charge erased during each erasing pulse is dependent on the duration, amplitude, and shape of the pulse. These factors, together with the erasing-pulse repetition frequency, determine the observed rate of decay of stored information.

With a rectangular type of erasing pulse, all storage elements are erased at nearly the same rate regardless of the charge on any storage element. The brightest elements of the viewed pattern, therefore, are visible for longer periods than half-tones.

When the pulse used for erasing is of the positive-going sawtooth type, the most positive storage elements are erased more rapidly than the others, because electrons in the viewing-beam land on these elements for a longer period. With this kind of erasure, half-tones persist as long as bright elements.

In applications where half-tone display is involved, the amplitude of the rectangular erasing pulse should

Table 1

Phosphor Ratings

NO.	FLUORESCENCE	PHOSPHORESCENCE	PERSISTENCE
P1	Green	Green	Medium
P2	Blue-Green	Green	Medium-Short
P4 Sulfide	White	White	Short
P4 Silicate-sulfide	White	Yellow	Medium
P4 Silicate	White	Blue	Medium
P5	Blue	Blue	Medium-short
P7	Blue-white	Yellow	Very long
P10	Dark trace—color depends on absorption characteristics and type of illumination		Very, very long, few seconds, to few months
P11	Blue	Blue	Medium-short
P12	Orange	Orange	Long
P14	Purple	Orange	Medium
P15	Blue-Green and ultra-violet	Blue-Green	Very short
P16	Violet and near-ultra violet	Violet and near-ultra violet	Very short
P17	Greenish-Yellow	Yellow	One component extremely short, other component long
P19	Yellow-Orange	—	Long
P21	Orange	Orange	Very long
P22	Tri-Color	—	3 components: one short; two medium
P23	White	White	Short
P24	Green	Green	Short
P25	Orange	Orange	Medium
P26	Orange	—	Very, very long
P27	Red	Red	Medium
P28	Orange	—	Very long

P3, P6, P8, P9, P13, P18, and P20 are obsolete.

Fig. 17: Reproduction of a character display tube presentation. In this tube, the beam was shaped into symbols by deflection, not by passage through a matrix.

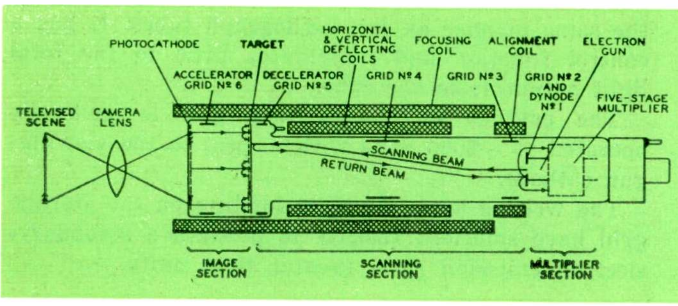
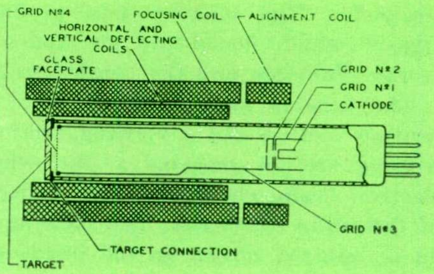


Fig. 18 (left): Arrangement of elements in a typical image orthicon.

Fig. 19 (right): Arrangement of elements for operating a typical vidicon.



Electron Gun *(Continued)*

be adjusted so that the storage surface is charged to exactly cutoff potential by the erasing operation.

In applications, such as radar, where it is desired to suppress noise in the display, a higher-amplitude erasing pulse may be used to lower the potential of the unwritten storage elements several volts below cutoff. A number of addresses by the writing beam is then required to charge the storage elements less negative than cutoff. Ideally, the erasing-pulse amplitude should be adjusted so that the noise component in the modulated writing beam charges the storage surface to just cutoff. Then, the signal superimposed on the noise signal charges the storage elements to a potential less negative than cutoff and thus is effectively displayed on the screen devoid of noise background.

Camera Tubes

One of the early developments in the field of television camera tubes was the Iconoscope. Developed and manufactured by RCA, this tube is now obsolete even for replacement purposes. Because of this status, space will not be used here to describe its operation.

Image Orthicon

The camera tube most widely used in the TV studio today is the image orthicon[14]. Until recently there were two principal types—one for regular studio and outdoor pickup work, and one for color TV work. Recently, improvements and new designs have made possible remote indoor color pickups such as sporting events.

The image orthicon Fig. 18, is best separated into three sections—image, scanning, and multiplier—for easier study.

Image Section

This section contains a semitransparent photocathode on the inside of the faceplate, a grid to provide an electrostatic accelerating field, and a target which consists of a thin glass disc with a fine mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a magnetic field produced by an external coil, and by varying the photocathode voltage.

Light from the scene being televised is picked up by an optical lens system and focused on the photocathode which emits electrons from each illuminated area in proportion to the intensity of the light striking the area. The streams of electrons are focused on the target by the magnetic and accelerating fields.

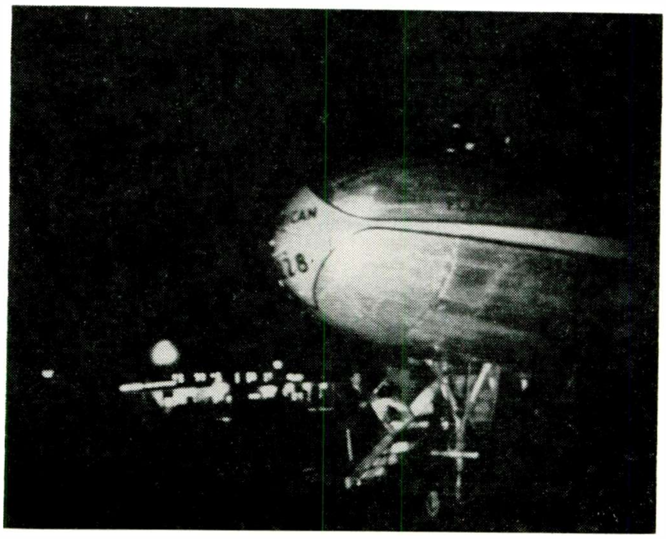
On striking the target, the electrons cause secondary electrons to be emitted by the glass. The secondaries thus emitted are collected by the adjacent mesh screen which is held at a definite potential of about 2 v. with respect to target-voltage cutoff. Therefore, the potential of the glass disc is limited for all values of light and stable operation is achieved. Emission of the secondaries leaves, on the photocathode side of the glass, a pattern of positive charges which corresponds with the pattern of light from the scene being televised. Because of the thinness of the glass, the charges set up a similar potential pattern on the opposite of scanned side of the glass.

Scanning Section

The opposite side of the glass is scanned by a low-velocity electron beam produced by the electron gun in the scanning section. This gun contains a thermionic cathode, a control grid (grid No. 1), and an accelerating grid (grid No. 2). The beam is focused at the target by the magnetic field of an external focusing coil and the electrostatic field of grid No. 4.

Grid No. 5 serves to adjust the shape of the decelerating field between grid No. 4 and the target to obtain uniform landing of electrons over the entire target area. The electrons stop their forward motion at the surface of the glass and are turned back and focused into a 5-stage signal multiplier, except when they approach the positively charged portions of the pattern on the glass. When this condition occurs,

Fig. 20: Monitor presentation from a camera equipped with a typical black-and-white image orthicon pickup tube. Note lack of sensitivity.



they are deposited from the scanning beam in quantities sufficient to neutralize the potential pattern on the glass. Such deposition leaves the glass with a negative charge on the scanned side and a positive charge on the photocathode side. These charges will neutralize each other by conductivity through the glass in less than the time of one frame.

Alignment of the beam from the gun is accomplished by a transverse magnetic field. This field is produced by an external coil located at the gun end of the focusing coil.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflecting coils.

The electrons turned back at the target form the return beam which has been amplitude modulated by absorption of electrons at the target in accord with the charge pattern whose more positive areas correspond to the highlights of the televised scene.

Multiplier Section

The return beam is directed to the first dynode of a 5-stage electrostatically focused multiplier. This uses the phenomenon of secondary emission to amplify signals composed of electron beams.

The electrons in the beam impinging on the first dynode surface produce many other electrons, the number depending on the energy of the impinging electrons. These secondary electrons are then directed to the second dynode and knock out more new electrons. Grid No. 3 facilitates a more complete collection by dynode No. 2 of the secondaries from dynode No. 1.

The multiplying process is repeated in each successive stage, with an ever-increasing stream of electrons until those emitted from dynode No. 5 are collected by the anode and constitute the current used in the output circuit.

The multiplier section amplifies the modulated beam about 500 times. The multiplication so obtained maintains a high signal-to-noise ratio, and also permits the use of an amplifier with fewer stages.

The color image orthicon operates in a similar manner. It should be remembered that three color image orthicons are required for proper use. One to pick up each of the three primary colors, red, green and blue.

Fig. 21: Same scene looks much different when the camera is equipped with GE's new tube. Lens setting, light were equal.

Fig. 22: A new extended-life, 1000-hour warranty, image orthicon which uses a new target material is interchangeable with the 5820.

Low Light Level Orthicon

Very recently a new, highly sensitive camera tube, an image orthicon[15], has been introduced that promises to widen the scope of black and white TV and radically extend the general application of color TV.

This new tube, Fig. 24, is physically and electrically interchangeable with standard camera tubes. Its big contribution is that it requires from 1/10 to 1/20 the light required by standard orthicons, either black and white or color.

It can produce pictures of usable black-and-white quality at one foot candle of scene illumination or less, compared to the 10 ft. candles required by standard black-and-white image orthicons at the same camera lens setting, Figs. 20 & 21.

The sensitivity of the new image orthicon tube permits origination of studio colorcasts under normal black-and-white lighting levels. The extremely high lighting requirements (400 ft. candles and higher) of standard color image orthicons have been one of the barriers to the wide-spread application of color programming. Removal of this barrier will also make possible colorcasts from sports arenas, auditoriums and light-equipped ballparks without the addition of special lighting, since the new tube produces quality color pictures with light levels as low as 40 ft. candles. Color television, now in its fifth year, has been chained to specially equipped studios—except for outdoor events in bright sunlight—because of the economic obstacle of properly lighting night and indoor sports events and other "remotes." It now gives color television most of the programming flexibility of black-and-white television.

Color-equipped stations should be able to sharply reduce operating costs. Many of the nation's more than 1000 black-and-white studios can convert to color without significant investment for additional lighting and air-conditioning equipment, or electric power. In addition, performers will no longer be subjected to the "bake-out" temperature of a set illuminated by 400 ft. candles and higher.

The extreme sensitivity results mainly from a high-gain, thin-film target of magnesium oxide approximately two millionths of an inch thick. It is approximately 1/100 of the thickness of the targets used in conventional camera tubes. If 1,500 of the thin-film targets were stacked, they would equal the thickness of a single human hair.

For many years, scientists have endeavored to improve the targets of conventional image orthicon tubes. All such targets ultimately become "sticky"—that is, they retain the image for longer and longer periods of time, Fig. 25. When this "stickiness" becomes noticeable by causing images of a previous scene to smear over the new scene, the tube must be retired. "Stickiness" has been a major reason for tube replacement.

Unlike conventional targets, targets in the new tube use a different principle of conduction. Conventional targets rely on ion conduction. Because this conduction is irreversible, the ions are ultimately exhausted and the useful life of the tube is ended.

The new target, however, uses electron conduction. This is a reversible process, and the life of a tube is not limited by the exhaustion of charged carriers. Thus, the problems of "stickiness" and "burn-in" are virtually eliminated so that expected tube life is appreciably extended.

The extreme thinness of the new target inhibits sideways leakage, thus preventing loss of resolution. Moreover, its sensitivity allows improved depth of focus, since the lens opening at normal light levels may to stopped down. While the normal network transmission bandwidth of 325-350 lines limits use of this extra resolution in daily television fare, it can be used to advantage with special-purpose camera chains for military and industrial applications Fig. 23.

Vidicon

Principle of Operation

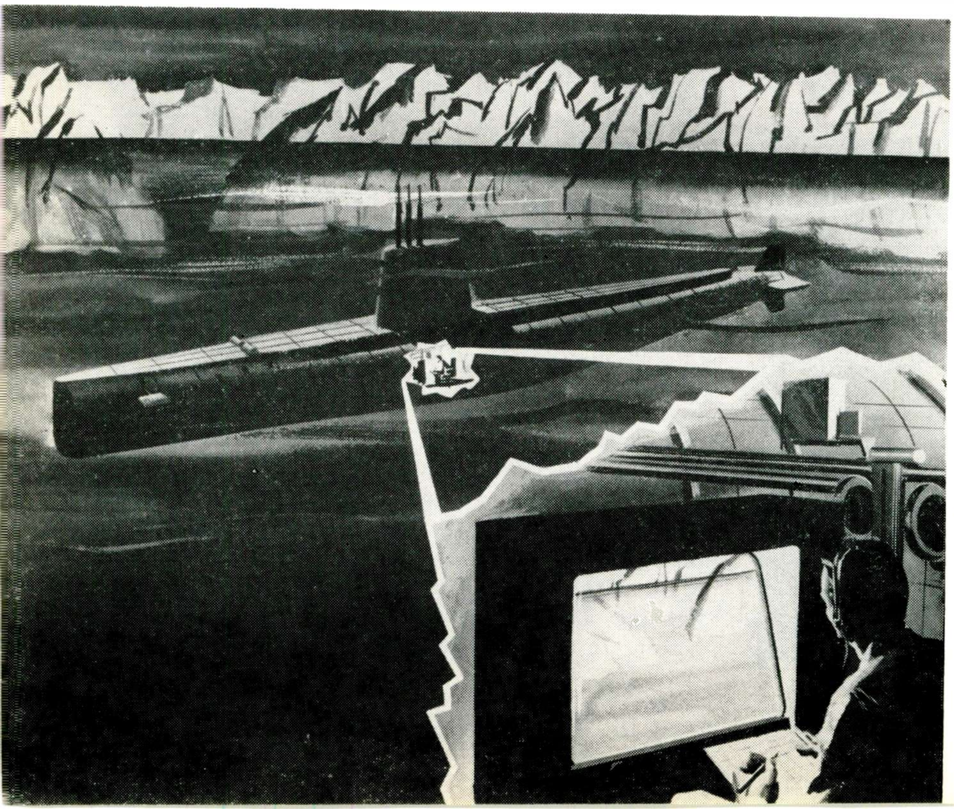
The structural arrangement of the vidicon[16], Fig. 19, consists of a target composed of a transparent conducting film (the signal electrode) on the inner surface of the faceplate and a thin photoconductive layer deposited on the film; a fine mesh screen (grid No. 4) located adjacent to the photoconductive layer; a beam-focusing electrode (grid No. 3) connected to a grid No. 4; and an electron gun for producing a beam of electrons.

Each element of the photoconductive layer is an insulator in the dark but becomes slightly conductive when it is illuminated and acts like a leaky capacitor having one plate at the positive potential of the signal electrode and the other floating.

When light from the scene or film being televised is focused on the photoconductive-layer surface next to the faceplate, each illuminated layer element conducts slightly depending on the amount of illumination on the element and thus causes the potential of its opposite surface (on the gun side) to rise in less than the time of one frame toward that of the signal-electrode potential. Hence, there appears on the gun side of the entire layer surface a positive potential pattern, composed of the various element potentials, corresponding to the pattern of light imaged on the layer.

The gun side of the photoconductive layer is scanned by a low-velocity electron beam produced by the electron gun. This gun contains a thermionic cathode, a control grid (grid No. 1), and an accelerating grid (grid No. 2). The beam is focused at the surface of the photoconductive layer by the combined action of the uniform magnetic field of an external coil and the electrostatic field of grid No. 3.

Grid No. 4 serves to provide a uniform decelerating field between itself and the photoconductive layer so that the electron beam will tend to approach the layer in a direction perpendicular to it—a condition necessary for driving the surface to cathode potential. The



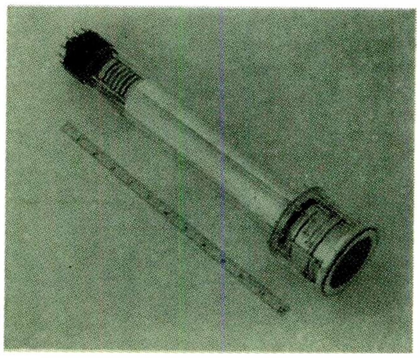


Fig. 23 (left): A military version of GE's low light level image orthicon was used on the Skate when it probed a path under the ice to the North Pole in April, 1959.

Fig. 24 (right): Here is an image orthicon similar to that used on the Skate.

Fig. 25: If the new type image orthicons had been used, this newscaster would not be a victim of "stickiness." This effect is caused by the target holding the former show, the weathercast, for several seconds after the camera has been focused on the present show, the newscast.

beam electrons approach the layer at low velocity because of the low operating potential of the signal electrode.

When the gun side of the photoconductive layer with its positive potential pattern is scanned by the electron beam, electrons are deposited from the beam until the surface potential is reduced to that of the cathode, and thereafter are turned back to form a return beam which is not used.

Deposition of electrons on the scanned surface of any particular element of the layer causes a change in the difference of potential between the two surfaces of the element. When the two surfaces of the element, which in effect is a charged capacitor, are connected through the external target (signal-electrode) circuit and the scanning beam, a capacitive current is produced and constitutes the video signal. The magnitude of the current is proportional to the surface potential of the element being scanned and to the rate of scan. The video-signal current is then used to develop a signal-output voltage across a load resistor. The signal polarity is such that for highlights in the image, the grid of the first video-amplifier tube swings in a negative direction.

Alignment of the beam is accomplished by a transverse magnetic field produced by external coils located at the base end of the focusing coil.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflecting coils.

The Monoscope

While not actually a camera tube, it is probably well to consider the monoscope[17] in this general field. This tube is designed to produce a video signal of a test picture or pattern which is enclosed in the tube. In other words it gives an output similar to a camera tube but does not have the facility to actually pick up a picture.

The tube consists of a gun, a signal plate, and a collector closed in a highly evacuated envelope. The electron beam is scanned over the signal plate by an electro-magnetic deflection system.

The signal plate is made of aluminum foil on which the desired picture or pattern is printed with a black foil ink. Before sealing, the signal plate is fired in hydrogen removing the volatile matter from the ink and leaving it almost pure carbon. The surface of the aluminum has a natural coating of aluminum oxide that has a reasonably high secondary emission ratio, while the carbon has a relatively low ratio. Thus as the electron beam scans the signal plate, the amplitude of the current pulses from those parts of the plate on which printing appears, is lower than from that on which there is no printing. These current pulses are fed to a series of video amplifiers. An odd number of video amplifier stages are normally used and thus the picture on the signal plate should bave blacks and whites reversed, but should not have printed matter reversed. This reversal is necessary because the aluminum oxide produces a signal that corresponds to black.

Miscellaneous Tubes

Electron printing cathode-ray tubes have a reproducing face made up of a precision matrix of wires imbedded directly in the faceplate of the tube, Fig. 32. The beam is scanned over the ends of the wires on the inside of the tube inducing a current in each wire.

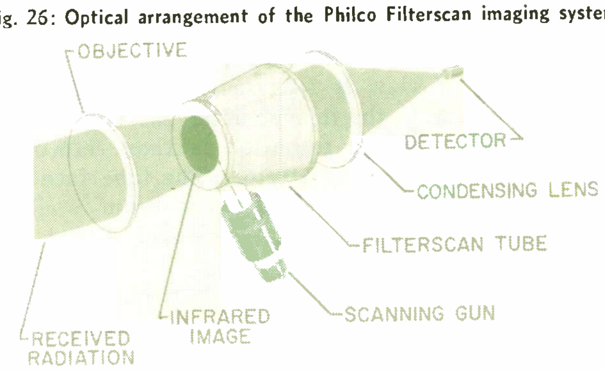
One such tube, the "Printapix"[19], prints on non-sensitized dielectric material.

This device is being used in facsimile, high speed computer readout, oscillography, address labeling[20] and television type image reproduction. Planned applications include controlled information storage and erase, projection transparency generation, multiple copy reproduction, and simultaneous recording at any number of dispersed stations.

Electrons in the beam of the writing tube produce a charge pattern on a dielectric surface, such as ordinary paper or plastic, through the mosaic printing head. The charge image, either line or continuous tone, is rendered instantaneously visible by adherence of a pigmented powder or flox, which may be permanently fixed by a rapid heat process, or erased for reuse of the base material.

Light source tubes are designed to take advantage of the color and decay properties of phosphor screens. A flood beam of electrons bathes the phosphor which emits a characteristic light which can be used as a standard in reproduction processes and in color comparison. A second use of these tubes depends on the fast decay time of certain phosphors to provide a stroboscopic light source.

Fig. 26: Optical arrangement of the Philco Filterscan imaging system.



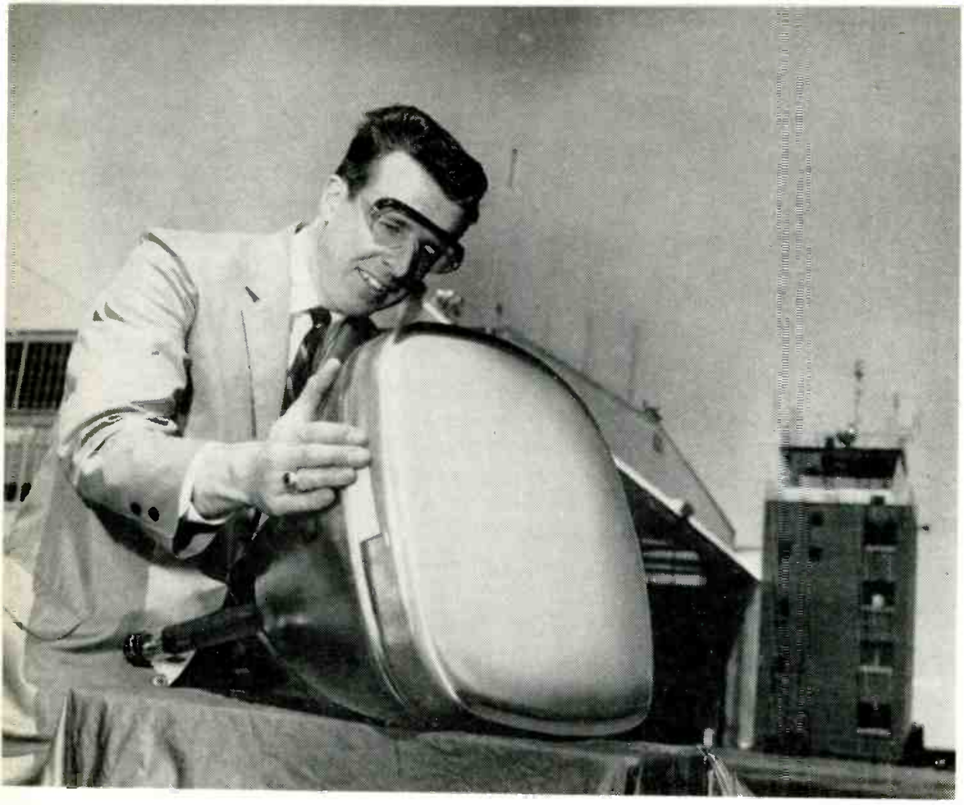


Fig. 27: A high resolution, high brightness monitor tube, made by GE, can be used with scan converters in aircraft control systems.

Electron Gun *(Continued)*

Traveling wave cathode-ray tubes, Fig. 29, are used to display signals that occur so fast that, in the time required by the electrons used to display them to pass through conventional deflection systems, there would be several phase reversals. The use of a helical deflection system insures that the electrons will always be in proper phase with the signal to present its true amplitude.

Dark trace tubes are cathode-ray tubes which depend on the use of scotophors for their display. Scotophors differ from phosphor by not producing light emission under electron bombardment. However, the path of the beam across this material is apparent when viewed by reflected light. The advantage of this type of tube lies in its ability to retain a trace for days.

Flying spots scanners, Fig. 28, are a specialized use of a cathode-ray tube in which the flying spot of the cathode-ray beam is followed by a multplier photo tube or other recording device which produces a signal. This signal is used to modulate the beam and a second cathode-ray tube swept with same raster of the flying spot tube to reproduce the original picture.

A new scanning tube is now being used in an all electronic imaging system[21]. The infrared image of a given field of view is focussed onto the scanning tube which dissects the image; after passing through the scanning tube, the radiation is then refocussed onto a separate infrared detector. The tube face is a semiconducting window. An electron beam, striking the window, generates free carriers and reduces the transmission of the window locally. As the electron beam is swept across the scanning tube face, the moving opaque spot produces a video signal at the detector, Fig. 26.

New Developments

Because this article did not concern itself with the ordinary cathode ray tubes—oscilloscope and picture tubes, it seems only fair to mention a few of the more important developments in this display area.

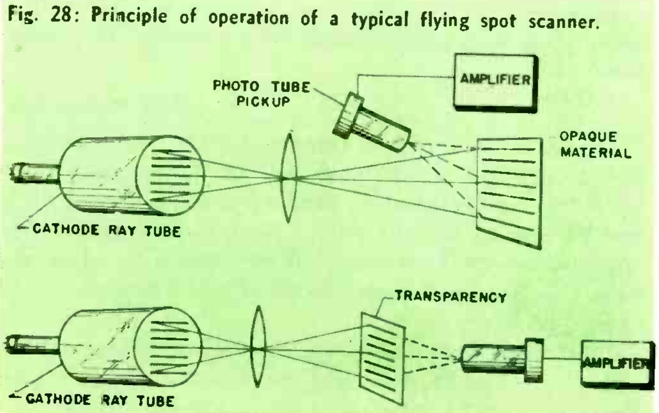
One of the first is a low-heater power CRT by Sylvania. It offers a high efficiency 1.5v-140 ma heater and will operate on an ordinary flashlight battery, Fig. 30. It employs a light-weight design and requires only 1/16 of the power necessary to operate a conventional 6.3v-600 ma heater. It is ideally suited for portable oscilloscope, radar and monitor applications.

High Deflection Sensitivity

A very practical limitation in present large size CRT displays is the peak-to-peak deflection voltage required in electrostatic tubes. The electrostatic types are preferred in random access displays because of low deflection plate capacities, but the peak-to-peak potentials can reach 1500 volts or higher.

New developments of electron guns will produce deflection factor improvements of the order of 5 to 10:1 depending on certain other display parameters. These improvements will be available at high brightnesses where final anode voltages are 15 to 20KV.

Fig. 28: Principle of operation of a typical flying spot scanner.



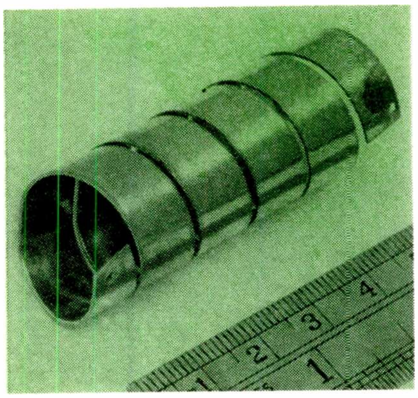


Fig. 29: Deflection plate used in the DuMont travelling wave deflection cathode ray tube.

High Accuracy Displays

As the military systems have become more sophisticated, the complexity of display requirements has increased. No longer is raw video information displayed. but in almost all cases there is readout from a computer or other information processing device.

To use this information effectively, the display tubes are becoming high accuracy measuring devices similar to meters. Current display accuracy measurements of deflection factor uniformity trace parallelism and perpendicularism and pattern distortion average two percent/one degree. Future developments will see these present tolerances divided by four or more.

Environment and Reliability

There is a small revolution under way in the physical environment all tubes are being expected to meet. No longer is MIL-E-1D the sole specification for a successful tube, rather a complex series of system specifications are being imposed. These far exceed usual tests and require additional shock, vibration, altitude, life, moisture resistance, salt spray, etc.

These new requirements will see cathode ray tubes designed for five to 2,000 cycle vibration tests, 10,000 hour life tests, altitude of 100,000 ft. and higher. In ultra-high resolution radar systems, spot movements of less than 0.0005 inch during shock and vibration tests will be required. The increased reliability requirements of certain complex systems will see considerable effort to insure failure free operation of display tubes.

Ultra-High Resolution

New reconnaissance radar techniques demand resolution unobtainable at the present time from available, high resolution cathode ray tubes.

Present production devices have about 1000 lines per inch capability. The tubes that will be used in systems three to five years hence will be capable of electron beam resolution of 10,000 to 15,000 lines per inch. This substantial improvement will be based on new approaches to electron beam formation. Accompanying this increased resolution capability will be the need for a broader spectrum of "transparent" film-like phosphors exhibiting the advantageous signal-to-noise improvements. These developments will include higher efficiencies and spectral outputs to match optimized photographic film and pick-up devices with the phosphors exhibiting decay rates in the 0.01 to 0.1 μsec. region.

High Brightness

Many present-day military applications call for displays which must be visible under extreme ambient light conditions ranging up to direct sunlight on the tube face. Monitor tubes which will provide reasonable resolution under such extreme conditions have been developed by a combination of optimized electron optics and high efficiency phosphors. Work is continuing on this problem to develop much higher resolution and contrast through the use of evaporated phosphor screens and such tubes should be available in 1960.

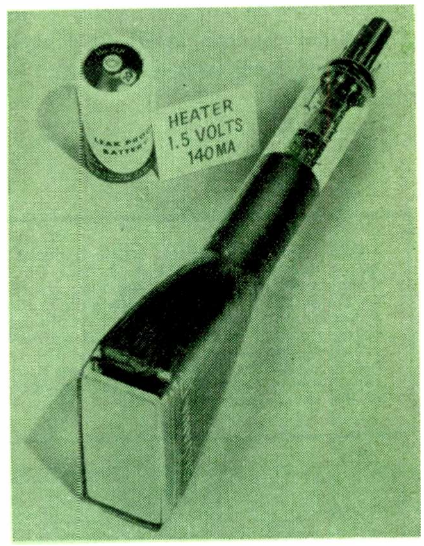
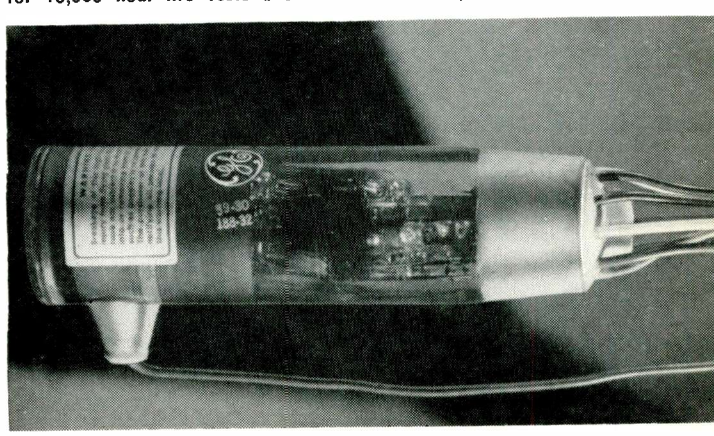


Fig. 30: First of a series of new developments will be lowering of the heater power.

Color

An ever-increasing demand for more and more information is being imposed on military displays and it is inevitable that color must be employed to differentiate between different classes of information in the same display, e.g., target identification, terrain clearance radar. General Electric has developed the industry's only color tube capable of high resolution two and three color displays with no inside masks or any other extra hardware besides the normal electron gun or guns. This developmental tube type can be demonstrated and produced today.

Fig. 31: A compact 1½ inch diameter electrostatic tube for severe environmental applications. New requirements will see tubes designed for 10,000 hour life tests and altitudes of 100,000 ft. and higher.



Electron Gun (Concluded)

High Transconductance

Present CRT's cannot reliably be driven with transistorized circuits. Tubes have been produced which are useful in many applications with exceedingly low drive requirements. Laboratory measurements on such tubes have shown beam currents as high as 1000 microamperes for ten volts video drive. Tubes like this open up completely new areas in possible miniaturization and improved reliability for display engineers.

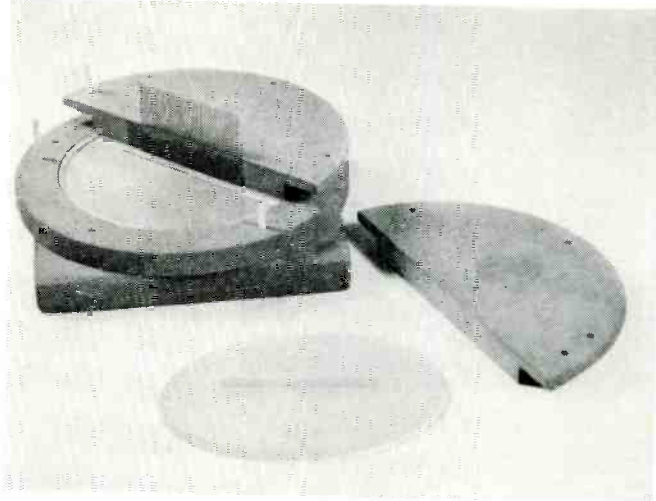


Fig. 32: Faceplate construction of an electron printing tube. Tubes similar to this are used in addressing applications such as that depicted on page 163. Note how the wire passes through faceplate.

COVER: The cover for this article is based on the Videograph Process, a development of the A. B. Dick Co., 5700 West Toughy Ave., Chicago 48. In this system, the tube creates an electrostatic image on the printing medium—usually paper. Next, a mixture comprising a carrier and a toner powder is applied to the paper. The toner, a pigmented thermoplastic resin, is statically charged to a positive potential; the carrier to a negative. The toner is then attracted to the latent image and the carrier repelled. By applying heat, the resin forming the toner is set to a permanent image in the shape of the charge pattern.

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References

1. Crookes, W. "On the Illumination of Lines of Molecular Pressure and the Trajectory of Molecules." *Phil. Trans. Roy. Soc.*, Vol. 170, Pt. 1, pp. 135-164, 1879.
2. Perrin, J. "Nouvelles Proprietes des Rayons Cathodiques." *Comptes rendus*, Vol. 121, pp. 1130-1134, 1895.
3. Thomson, J. J. "Cathode Rays," *Proc. Royal Institution*, Vol. 15, pp. 419-432, 1897.
4. Parr, G., and Davie, O. H. *The Cathode Ray Tube and its Applications, 3d Rev. Ed.*, Reinhold, New York, 1959.
5. Du Mont Labs, Inc., *The Cathode-Ray Tube and Typical Applications*, Clifton, N. J., 1953.
6. IRE Standards on Electron Tubes: Definition of Storage Tube Terms, 1959 (59 IRE 7.10 PS1) (Advance copy).
7. Luftman, A. S. "A Survey of Recording Storage Tube Types," *Proc. 7th Weather Radar Conf.*, Miami Beach, 17-20 Nov. 1958.
8. RCA, Bul. 6499, Radechon, 1956.
9. Luftman, A. S. "The Dual-Gun Recording Tube," *Electronic Progress*, Vol. 3, No. 4, pp. 8-12, 1959.
10. RCA, Bul. 7539 (Tent), Scan Converter, 1959.
11. RCA, Bul. 7448, Display Storage Tube, 1959.
12. Stromberg-Carlson, San Diego, B-105, Charactron.
13. Hughes Aircraft Co.—Typotron.
14. RCA, Bul. 5820, Image Orthicon.
15. General Electric, GL-7629 and 7-5294, Low Light Level Image Orthicon.
16. RCA, Bul. 7038, Vidicon.
17. Rider, J. F., and Uslan, S. D., *Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses, 2d Ed.*, John F. Rider Publisher, Inc., New York, 1959.
18. Williamson, N., Private Communication.
19. Litton Industries, Buls. L-4013, L-4016, Printapix.
20. A. B. Dick Co., *Videograph Process*, Chicago, 1959.
21. Lasser, M. E., Cholet, P. H., and Emmons, R. B., "Electronic Scanning System for Infrared Imaging." *Proc. IRE*, Vol. 47, No. 12, pp. 2069-2075, 1959.

Bibliography

Bacon, R. C., and Pollard, J. R., "The Dekatron," *Electronic Engng.*, Vol. 22, pp. 173-7, 1950.

Barstow, J. M., "The ABC's of Color Television," *Proc. I.R.E.*, Vol. 43, No. 11, p. 1574, Nov., 1955.

Bliss, W. H., and Young, C. J., "Facsimile Scanning by Cathode-Ray Tube," *RCA Rev.*, Vol. 15, pp. 275-290, Sept., 1954.

Brangaccio, D. J., "New Broadband Oscilloscope Tube," *Bell Lab. Rec.*, Vol. 36, pp. 450-452, Dec., 1958.

Burnett, C. E., "The Monoscope," *RCA Rev.*, Vol. 2 pp. 414-420, Apr., 1938.

Chenoweth, J., "Television Camera Tubes," *Service*, Vol 16, p. 14, Feb. 1947.

Florey, L. W., Dilley, J. E., Pike, W. S., and Smith, R. W., "A Storage Oscilloscope," *RCA Rev.*, Vol. 12, pp. 220-229, June, 1951.

Hazeltine Corp., Laboratories Staff, *Color Television Receiver Practices*, New York, John F. Rider Publisher, Inc., 1955.

Hubby, A. G., and Watson, R. B., "Scriptoscope Shows Messages on CR Tube." *Electronics*, Vol. 25, pp. 144-145, July, 1952.

Iams, H., Morton, G. A., and Zworykin, V. K., "The Image Iconoscope," *Proc. I.R.E.*, Vol. 27, pp. 541-547, Sept., 1939.

Jackson, H. F., "Four-Gun Oscilloscopes for Use in Nuclear Research," *Rev. Sci. Instr.*, Vol. 29, p 527, June, 1958.

Jones, R. B., Johnson, R. E., and Moore, R. S., "Development and Performance of Television Camera Tubes," *RCA Rev.*, Vol. 10, No. 2, June 1949.

Kates, Joseph, "A Method for Improving the Read-Around-Ratio in Cathode-Ray Storage Tubes," *Proc. I.R.E.*, Vol. 41, pp. 1017-1023, Aug. 1953.

Kaufman, M., and Thomas, H., *Introduction to Color TV*, New York, John F. Rider Publisher, Inc., 1954.

Lafferty, J. M., "Beam Deflection Color Television Picture Tubes," *Proc. I.R.E.*, Vol. 42, pp. 1478-1494, Oct. 1954.

Laposky, B. F. "Oscilloscope Art," *Electronics*, Vol. 30, pp. 198-199, Nov. 1957.

Larson, C. E., and Gardner, B. C., "The Image Dissector," *Electronics*, Vol. 12, pp. 24-27, Oct. 1939.

Lytel, A., *TV Projection and Enlargement, 1st Ed.*, pp. 158-161, New York, John F. Rider Publisher, Inc., 1949.

Norwood, C. W., "A Symbol Generator for Cathode-Ray Tubes," *Bell Lab. Rec.*, Vol. 31, pp. 41-47, Feb., 1953.

Olden, R., "A Thin-Window Cathode-Ray Tube for High-Speed Printing with 'Electrofax'," *RCA Rev.*, Vol. 18, pp. 343-350, Sept., 1957.

Owaki, K., Terahata, S., Hada, T., and Nakamura, T., "The Traveling-Wave Cathode-Ray Tube," *Proc. I.R.E.*, Vol. 38, pp. 1172-1179, Oct., 1950.

Pensak, L., "The Graphecon—A Picture Storage Tube," *RCA Rev.*, Vol. 10, pp. 59-73, Mar., 1949.

Pensak, L., "The Metrechon—A Halftone Picture Storage Tube," *RCA Rev.*, Vol. 15, pp. 145-162, June, 1954.

Sterzer, F., and Siekanowicz, W. W., "The Design of Periodic Permanent Magnets for Focusing of Electron Beams," *RCA Rev.*, Vol. 18 pp. 39-59, Mar., 1957.

Weimer, P. K., "The Image Isocon—An Experimental Television Pickup Tube Based on the Scattering of Low Velocity Electrons," *RCA Rev.*, Vol. 10, pp. 366-386, Sept., 1949.

Winkler, S., and Nozick, S., "Operation of CRT Storage Devices," *Electronics*, Vol. 27, pp. 184-187, Oct., 1954.

Withey, E. L., "Cathode-Ray Adds Third Dimension," *Electronics*, Vol. 31, pp. 81-83, May, 1958.

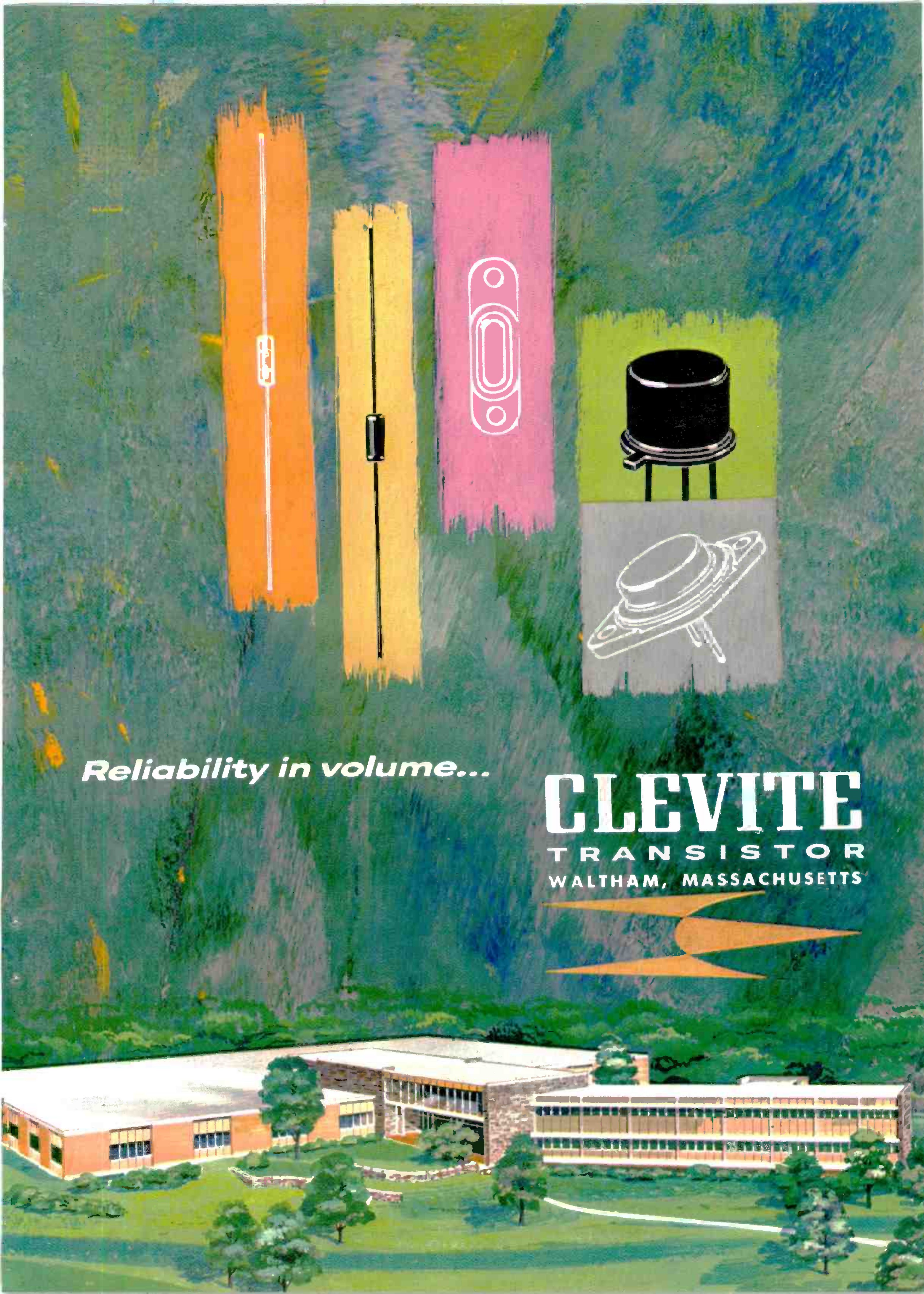
Zworykin, V. K., "The Iconoscope—A Modern Version of the Electric Eye," *Proc. I.R.E.*, Vol. 22, pp. 16-32, Jan., 1934.

Zworykin, V. K., "Iconoscopes and Kinescopes in Television," *RCA Rev.*, Vol. 1, pp. 68-84, July, 1936.

Zworykin, V. K., Morton, G. A., and Flory, L. E., "Theory and Performance of the Iconoscope," *Proc. I.R.E.*, Vol. 25, pp. 1071-1092, Aug. 1937.

"Television Receiver Uses One-Gun Color CRT," *Electronics*, Vol. 29, pp. 150-153, June, 1956.

"The Orthicon," *Electronics*, Vol. 12, p. 11, July, 1939.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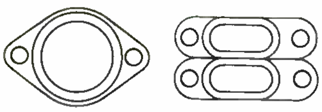

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THREE AMPERE SWITCHING TYPES

TEST	UNITS	CTP 1728	CTP 1735	CTP 1729	CTP 1730	CTP 1731	CTP 1736	CTP 1732	CTP 1733
Min BVcbo @ 2 ma	volts	40	60	80	100	40	60	80	100
Min BVceo @ 500 ma	volts	25	40	55	65	25	40	55	65
Min BVces @ 300 ma	volts	35	50	65	75	35	50	65	75
Max Icbo @ 85°C @ Max Vcb	ma	7	7	7	7	7	7	7	7
Typ. Icbo @ 2 V	μa	20	20	30	30	20	20	30	30
D. C. Current Gain @ 0.5A		30-75	30-75	30-75	30-75	60-150	60-150	60-150	60-150
Max Veb @ 3.0 A	volts	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Max Vce (sat) @ 3.0A, 300 ma	volts	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Min fae @ 1.0 A	kc	15	15	8	8	10	10	6	6
Max Thermal Resistance	°c/w	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

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1960 Transistor Interchangeability Chart

THIS 1960 Transistor Interchangeability Guide is a composite presentation of the interchangeability data supplied by the major transistor manufacturers. It is another in the series of special staff studies prepared by editors of ELECTRONIC INDUSTRIES.

The addition of hundreds of new transistors has produced a chart which is nearly twice the size of our 1959 edition. It differs in another way, too, in that we have attempted to list all the types of transistors currently registered with EIA (Electronic Industries Association) and the names of manufacturers who sponsor them. More specific information about the transistors and their applications has also been included to increase the usefulness of the guide in selecting possible replacements. Diagrams giving the physical specifications are presented at the end.

Manufacturers who furnished this information point out that cross-referenced types should not be assumed to be exact equivalents, except where specifically stated that types are direct replacements. To determine the degree of similarity, reference should always be made to published electrical and physical specifications. For exact comparison of electrical characteristics, the reader is referred to the ELECTRONIC INDUSTRIES' June 1959 Directory of Transistor Manufacturers and Types.

The manufacturers included in this guide are identified after the interchangeability listings together, with the abbreviation used for them throughout the listings.

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N21	GC	S	WE	2N21		
2N21A	GC	AF	WE	2N21A		
2N22	GC	S	WE	2N22		
2N23	GC	S	WE	2N23		
2N24	GC	AF	WE	2N24		
2N25	GC	AF	WE	2N25		
2N26	GC	S	WE	2N26		
2N27[1]	GNPNG	AF	WE			
			CBS		2N444	1
			AMP		2N280	
			GEM		2N35	
			SYL		2N35	
			WE	2N29		
2N28	GNPNG	AF	WE	2N28		
			CBS		2N444	1
			AMP		2N280	
			GEM		2N35	
			SYL		2N35	
2N29	GNPNG	S	WE	2N29		
			CBS	.	2N438	1
2N30[1]	GC	AF	GE	2N30		
2N31	GC	OSC	GE	2N31		
2N32[3]	GC	S	RCA			
2N32A[3]	GC	S	RCA			
2N33[3]	GC	OSC	RCA			
2N34[3]	GPNPA	AF	RCA		2N407	
			GE		2N190	
			GT		GT20	
			SYL	2N34		
			IND		2N465	
			TS		2N461	1
			MOT		2N1191	
			RAY		2N465	
			AMP		2N281	
			GEM	2N34		
			TR	2N34		
			W		2N612	
2N34A[3]	GPNPA	AF	RCA		2N407	
			RAY		2N465	
			MOT		2N1191	
			SYL		2N34	
			AMP		2N281	
			GEM		2N34	
			NUC		NPC153	
			GE		2N190	
			W		2N403	
2N35[3]	GNPNA	AF	RCA		2N647	
			SYL	2N35		
			GT		GT35	
			CBS		2N438A	1
			AMP		2N281	
			GEM	2N35		
			GE		2N169	
2N36	GPNPA	GP	CBS	2N36		2
			RCA		2N217	
			IND		2N465	
			MOT		2N1191	
			GT		GT20	
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			GE		2N191	
			SYL		2N34	
2N37	GPNPA	GP	CBS	2N37		2
			RCA		2N408	
			IND		2N465	
			MOT		2N1191	
			GT		GT14	
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			GE		2N190	
			SYL		2N34	
2N38	GPNPA	AF	CBS	2N38		2
			RCA		2N408	
			IND		2N464	
			MOT		2N1191	
			GT		GT34	
			TS		2N63	3
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			GE		2N189	
			SYL		2N34	
2N38A	GPNPA	AF	CBS	2N38A		
			RCA		2N408	
			MOT		2N1191	
			AMP		2N281	
			GEM		2N34	
			W		2N402	
			GE		2N189	
			SYL		2N34	
2N39	GPNPA	GP	GT	2N39		
			RCA		2N217	
2N40	GPNPA	GP	GT	2N40		
			IND		2N464	
2N41[3]	GPNPA	AF	RCA		2N105	
			BEN		2N1008A	
			AMP		2N280	
			W		2N402	
			GE		2N190	
2N42	GPNPA	GP	GT			
			RCA		2N217	
2N43	GPNPA	AF	GE	2N43		3
			RCA		2N109	
			IND		TR43	
			MOT		2N1191	
			GT	2N43		
			BEN		2N1008B	
			TS		2N461	1
			AMP		2N284A	
			GEM		2N34	
			W		2N60	
			NUC		NPC141	
			PHL		2N597	
			SYL		2N34	
2N43A	GPNPA	AF	GE	2N43A		4
			RCA		2N331	
			GT	2N43A		
			MOT		2N1191	
			BEN		2N1008B	
			TS		2N461	
			GEM		2N34	
			W		2N60	
			NUC		NPC152	
			PHL		2N597	
			SYL		2N34	
2N44	GPNPA	AF	GE	2N44		4
			RCA		2N109	
			IND		TR44	
			MOT		2N1191	
			GT	2N44		
			BEN		2N1008B	
			TS		2N460	1
			AMP		OC74	
			GEM		2N34	
			W		2N61	
			NUC		NPC142	
			PHL		2N1125	
			SYL		2N34	
2N44A	GPNPA	AF	GE	2N44A		
			RCA	2N109		
			TS		2N460	
			MOT		2N1191	
			AMP		OC74	
			GEM		2N34	
			W		2N61	
			NUC		NPC151	
			PHL		2N1125	
			SYL		2N34	
2N45[4]	GPNPA	AF	GE	2N45		4
			RCA	2N109		
			IND		TR45	
			MOT		2N1191	
			GT	2N45		
			AMP		OC72	
			GEM		2N34	
			W		2N403	
			PHL		2N1124	
			SYL		2N34	

PHILCO TRANSISTORS

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
2N344	22	50	General purpose; narrow beta spread (11-33)
2N345	35	50	General purpose; similar to 2N344 with higher beta
2N346	20	75	General purpose; like 2N344 and 2N345 but higher frequency

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	75	60	High voltage, high speed switch
2N1122A	75	60	Higher voltage version of 2N1122
2N1411	75	f_T 60	High frequency switch MIL specs
2N1427	75	f_T 100	High frequency switch

MICRO ALLOY DIFFUSED-BASE TRANSISTORS (MADT*)

TYPE	GAIN	FREQUENCY f_{max} in mc	APPLICATIONS
2N499	10 db @ 100 mc	320	VHF amplifier; MIL specifications
2N501	h_{FE} 35	Switching rates 40mc	Ultra-fast switch; typical t_r 9 $m\mu$sec; t_s 9 $m\mu$sec; t_f 7 $m\mu$sec.
2N501A	h_{FE} 35	Switching rates 40mc	Rated at 100°C; MIL specifications
2N502	10db @ 200 mc	700	VHF amplifier
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
2N1158	25mw PO	at 200 mc	UHF power oscillator
2N1204	h_{FE} 60	f_T 400	High current switch & core driver
2N1494	h_{FE} 60	f_T 400	High current, high power switch & core driver
2N1495	h_{FE} 60	f_T 400	Higher voltage version of 2N1204
2N1496	h_{FE} 60	f_T 400	Higher voltage version of 2N1494
2N1499	h_{FE} 35	5 mc switching rates	MADT saturated switch
2N1500	h_{FE} 35	Switching rates 40 mc	50 mw equivalent of 2N501 in TO-9 case

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
2N535A	100	2	General purpose; 85°C max temperature rating
2N535B	100	2	General purpose; 85°C max temperature rating
2N536	h_{FE} 100	2	Low level switch at pulse rates up to 150kc

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

SILICON SURFACE ALLOY DIFFUSED-BASE TRANSISTORS (SADT*)

TYPE	GAIN h_{fe}	FREQUENCY	APPLICATIONS
2N1199	h_{FE} 25	f_T125mc	NPN high-speed silicon switch; max t_r 70 $m\mu$sec, t_s 20 $m\mu$sec, t_f 40 $m\mu$sec
2N1267	11	24db at 4.3mc	NPN silicon amplifiers and oscillators; TO-9 case
2N1268	20	25db at 4.3mc	NPN silicon amplifiers and oscillators; TO-9 case
2N1269	50	26db at 4.3mc	NPN silicon amplifiers and oscillators; TO-9 case
2N1270	11	24db at 12.5mc	NPN silicon amplifiers and oscillators; TO-9 case
2N1271	20	25db at 12.5mc	NPN silicon amplifiers and oscillators; TO-9 case
2N1272	50	26db at 12.5mc	NPN silicon amplifiers and oscillators; TO-9 case
2N1472	h_{FE} 35	Switching rates 5mc	NPN high frequency silicon switch

SILICON SURFACE ALLOY TRANSISTORS (SAT*)

TYPE	GAIN h_{fe}	FREQUENCY	APPLICATIONS
2N495	20	f_{max}21mc	General purpose; MIL specs
2N496	h_{FE} 16	f_T20mc**	High-speed switching; MIL specs
2N1118	20	f_{max}21mc	Electrical equivalent of 2N495 in TO-5 case
2N1118A	25	f_{max} 21 mc	General purpose, amplifier, high beta (15-35)
2N1119	h_{FE} 16	f_T20mc**	Electrical equivalent of 2N496 in TO-5 case
2N1428	h_{FE} 30	f_T24mc	General purpose, low cost silicon high frequency amplifier and switch; TO-1 case
2N1429	h_{FE} 30	f_T24mc	Electrical equivalent of 2N1428 in TO-5 case

**Frequency for Beta=1

MEDIUM FREQUENCY TRANSISTORS

TYPE	GAIN h_{FE}	FREQUENCY $f_{\alpha b}$ in mc	APPLICATIONS
2N597	70	5	High-voltage general purpose amplifier and switch; TO-9 case
2N598	125	10	500kc logic switching; TO-9 case
2N599	175	18	Logic switching rates up to 1mc; core driver; TO-9 case; MIL specifications
2N600	125	10	500kc switching; 1 watt peak power dissipation for 0.1 sec; stud mount
2N601	175	18	High-power core driver; typical rise time 0.1 μsec; stud mount
2N1123	70	5	High-voltage power amplifier and switch; stud mount
2N1478	70	5	300kc switching applications

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 store times
2N673	20(Sat.)	0.5 μsec max t_r	High power version of 2N672; stud mount
2N674	h_{fe} 100	$f_{\alpha b}$500kc	75-volt version of 2N670
2N675	100	$f_{\alpha b}$500kc	75-volt version of 2N671

MEDIUM POWER TRANSISTORS

TYPE	GAIN h_{FE}	FREQUENCY $f_{\alpha b}$ in mc	APPLICATIONS
2N223	h_{fe} 110	0.6	Audio driver; exceptional beta lin.
2N1416	h_{fe} 110	0.6	Matched pair of 2N223
2N224	90	0.51	Audio output; exceptional beta linearity
2N225	90	0.51	Matched pair of 2N224
2N226	60	0.4	Audio output; exceptional beta linearity
2N227	60	0.4	Matched pair of 2N226
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
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

*Trademarks Reg. U.S. Pat. Off. †Noise Factor at 1 μv reference level across 1,000 ohms

Write for Handy Reference Chart

PHILCO®

TRANSISTOR CENTER U.S.A.

LANSDALE DIVISION / 507 CHURCH ROAD, LANSDALE, PA.

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N46[3]	GPNPA	AF	RCA	2N46	2N105	
			BEN		2N1008A	
			W		2N402	
			PHL		2N223	
			GE		2N322	
2N47	GPNPA	AF	PHL	2N47		5
			RCA		2N105	
			BEN		2N1008A	
			AMP		2N281	
			GE		2N322	
2N48	GPNPA	AF	PHL	2N48		5
			RCA		2N105	
			BEN		2N1008A	
			GE		2N321	
2N49	GPNPA	AF	PHL	2N49		5
			RCA		2N105	
			GE		2N322	
2N50	GC	S	CTP	2N50		
2N51	GC	S	CTP	2N51		
2N52	GC	OSC	CTP	2N52		
2N53	GC	S	CTP	2N53		
2N54	GPNPA	AF	W	2N54		
			RCA		2N109	
			BEN		2N1008B	
			MOT		2N1191	
			AMP		OC72	
			GEM		2N34	
			GE		2N1098	
			SYL		2N34	
2N55	GPNPA	AF	W	2N55		
			RCA		2N109	
			BEN		2N1008B	
			MOT		2N1191	
			AMP		OC72	
			GEM		2N34	
			GE		2N1047	
			SYL		2N34	
2N56	GPNPA	AF	W	2N56		
			RCA		2N109	
			BEN		2N1008B	
			MOT		2N1191	
			AMP		2N281	
			GEM		2N34	
			GE		2N322	
			SYL		2N34	
2N57	GPNPA	AFO	MH	2N57		
			CBS		2N156	6
			W	2N57		
2N59	GPNPA	AF	W	2N59		
			RCA		2N270	
			IND		TR466	
			GT		GT109	
			BEN		2N1008A	
			TS		2N383	1
			MOT		2N1192	
			AMP		OC74	
			GEM		2N241A	
			NUC		NPC123	
			GE		2N321	
2N59A	GPNPA	AF	W	2N59A		5
			BEN		2N1008A	
			PHL		2N1125	
			GE		2N321	
2N59B	GPNPA	AF	W	2N59B		5
			BEN		2N1008B	
2N59C	GPNPA	AF	W	2N59C		5
			BEN		2N1008B	
2N60	GPNPA	AF	W	2N60		5
			RCA		2N270	
			IND		TR320	
			GT		GT109	
			BEN		2N1008A	
			TS		2N382	1
			MOT		2N1193	
			NUC		NPC123	
			PHL		2N1128	
			GE		2N321	
2N60A	GPNPA	AF	W	2N60A		
			BEN		2N1008A	
			GE		2N321	
2N60B	GPNPA	AF	W	2N60B		5
			BEN		2N1008B	
2N60C	GPNPA	AF	W	2N60C		5
			BEN		2N1008B	
2N61	GPNPA	AFO	W	2N61		5
			RCA		2N270	
			IND		2N464	
			GT		GT109	
			BEN		2N1008A	
			TS		2N381	1
			MOT		2N1192	
			NUC		NPC122	
			GE		2N320	
2N61A	GPNPA	AFO	W	2N61A		5
			BEN		2N1008A	
			GE		2N320	
2N61B	GPNPA	AFO	W	2N61B		5
			BEN		2N1008B	
2N61C	GPNPA	AFO	W	2N61C		5
			BEN		2N1008B	
2N62[4]	GPNPA	GP	PHL	2N62		
			RCA		2N109	
			GT		GT109	
			MOT		2N1191	
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			PHL		2N535B	
			SYL		2N34	
2N63	GPNPA	AF	RAY	2N63		
			RCA		2N217	
			IND		2N464	
			GT		GT14	
			BEN		2N1008	
			TS	2N63		3
			MOT		2N1191	
			AMP		2N281	
			GEM		2N217	
			W		2N402	
			PHL		2N226	
			GE		2N107	
			SYL		2N217	
2N64	GPNPA	AF	RAY	2N64		
			RCA		2N217	
			GT		GT20	
			BEN		2N1008	
			TS	2N64		3
			MOT		2N1191	
			AMP		2N281	
			GEM		2N217	
			W		2N402	
			PHL		2N224	
			GE		2N322	
			SYL		2N217	
2N65	GPNPA	AF	RAY	2N65		
			RCA		2N217	
			IND		2N465	
			GT		GT81	
			BEN		2N1008	
			TS	2N65		3
			MOT		2N1193	
			AMP		2N281	
			GEM		2N217	
			W		2N402	
			PHL		2N223	
			GE		2N323	
			SYL		2N217	
2N66[4]	GPNPA	AF	WE			
2N67	GC	S	WE	2N67		
2N68	GPNPA	AFO	SYL			
			CBS		2N156	6
			GEM	2N68		
			PYE		V30/20IP	
2N69	GPNPA	AF	WE			
2N71	GPNPA	AF	W			
			CBS		2N158	6
2N72[4]	GC	S	RCA			
2N73	GPNPA	S	W			
			BEN		2N1008B	
			GE		2N1056	
2N74	GPNPA	S	W			
			BEN		2N1008B	
			GE		2N1056	
2N75	GPNPA	S	W			
			BEN		2N1008	
			GE		2N1056	
2N76[4]	GPNPA	AF	GE	2N76		1
			RCA		2N104	
			GT		GT14	
			BEN		2N1008	
			MOT		2N1192	
			AMP		OC71	
			W		2N402	
			GE		2N188	
2N77[3]	GPNPA	AF	RCA		2N105[5]	
			IND		2N465	
			GT		2N565	
			BEN		2N1008A	
			MOT		2N1191	
			W		2N402	
			NUC		NPC152	
			PYE		V1050A	
			GE		2N324	
2N78	GNPNG	RF, IF	GE	2N78		7
			GT		2N445	
			CBS		2N439	1
			AMP		OC45	
			GEM		2N139	
			W		2N615	
			SYL		2N139	
2N79[3]	GPNPA	AF	RCA		2N331	
			GT		GT20	
			BEN		2N1008A	
			MOT		2N1191	
			AMP		OC71	
			W		2N403	
			GE		2N191	
2N80	GPNPA	AF	CBS	2N80		2
			GT		GT81	
			GE		2N508	
2N81	GPNP	AF	GE	2N81[4]		8
			GT		GT14	
			BEN		2N1008	
			MOT		2N1191	
			GE		2N1098	
2N82	GPNPA	AF	CBS	2N82		
			GT		GT14	
			BEN		2N1008	
			MOT		2N1191	
			GE		2N1098	
2N83	GPNPA	AFO	TR	2N83		
			CBS		LT5036	9
2N83A	GPNPA	AFO	TR	2N83A		
2N84	GPNPA	AFO	TR	2N84		
2N84A	GPNPA	AFO	TR	2N84A		
2N85	GPNPA	AF	TR	2N85		
			RCA		2N109	
			GT		GT81	
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			SYL		2N34	
			TI	2N85		
2N86	GPNPA	AF	TR	2N86		
			RCA		2N109	
			GT		GT81	
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			SYL		2N34	
2N87	GPNPA	AF	TR	2N87		
			RCA		2N109	
			GT		GT81	
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			SYL		2N34	
2N88	GPNPA	AF	TR	2N88		
			RCA		2N105	
			GT		GT20	
			GEM		2N34	
			W		2N402	
			SYL		2N34	
2N89	GPNPA	AF	TR	2N89		
			RCA		2N105	
			GT		GT20	
			W		2N402	
2N90	GPNPA	AF	TR	2N90		
			RCA		2N105	
			GT		GT20	
			W		2N402	
2N91	GPNPA	S	TR	2N91		
2N92	GPNPA	S	TR	2N92		
2N94	NPN	HF	SYL	2N94		
			RCA		2N585	
			GT		GT948R	
			CBS		2N377	1
			AMP		OC140	
			GEM	2N94		
			GE		2N634	
2N94A	NPN	HF	SYL	2N94A		
			GT		GT792R	
			CBS		2N377	1
			AMP		OC140	
			GEM		2N94	
			GE		2N634	
2N95			CBS		LT5210	10
			GEM	2N95		
2N96[3]	GPNPA	AF	RCA		2N331	
			GT		GT14	
			AMP		OC71	
			W		2N403	
2N97	GNPNG	AF	GP	2N97		
			GT		2N444	
			CBS		2N444	1
			GEM		2N169A	
			GE		2N169	
			BOG	2N97		
2N97A	GNPNG	S	GP	2N97A		
			CBS		2N438	1
			GEM		2N169A	
			GE		2N169A	
			BOG	2N97A		
2N98	GNPNG	AF	GP	2N98		
			GT		2N445	
			CBS		2N444	1
			GEM		2N169A	
			GE		2N169A	
			BOG	2N98		
2N98A	GNPNG	S	GP	2N98A		
			CBS		2N444	1
			GEM		2N169A	
			GE		2N169A	
			BOG	2N98A		
2N99	GNPNG	S	GP	2N99		
			GT		2N445	
			CBS		2N438	1
			GEM		2N169A	
			GE		2N169A	
			BOG	2N99		
2N100	GNPNG	AF	GP	2N100		
			GT		2N446	
			CBS		2N439	1
			GE		2N170	
			BOG	2N100		
2N101	PNP	AF	SYL			
			CBS		LT5209	10
			GEM	2N101		
			PYE		V30/20IP	
2N102	NPN	AF	SYL			
			CBS		LT5210	10
			GEM	2N102		
2N103	NPN	AF	GP	2N103		
			GT		GT35	
			GE		2N170	
			BOG	2N103		
2N104	GPNPA	AF	RCA	2N104		
			IND		TRC44	
			GT		2N565	
			BEN		2N1008A	
			TS		2N381	3
			MOT		2N1191	
			AMP		OC71	
			GEM		2N109	
			W		2N402	
			NUC		NPC152	
			PHL		2N207A	
			GE		2N190	

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Bendix Bulletin

Up-to-the-minute news about transistors

NEW DRIVER TRANSISTORS SWEEPING THE FIELD

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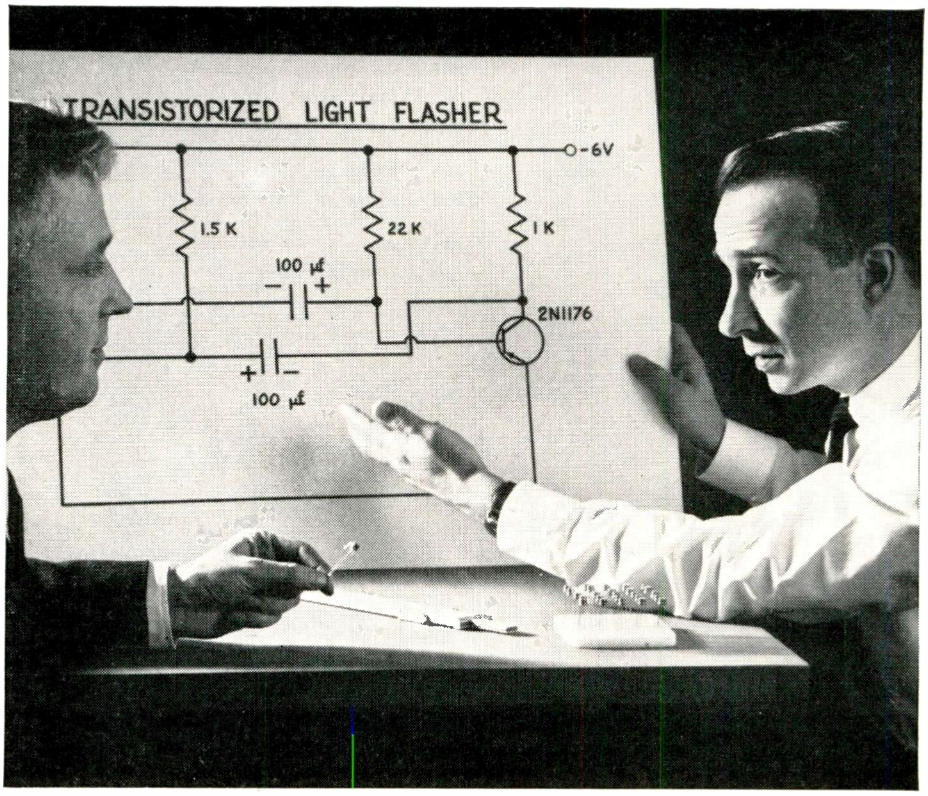

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APPLICATION, PERFORMANCE DATA INDICATE BROAD USAGE

TYPE NUMBERS	MAXIMUM RATINGS					TYPICAL OPERATION		
	Vce Vdc	Ic mAdc	Pc mW	Tj °C	T storage °C	hfe	fαb	Vce(Sat)
						Ic = 10 mAdc		Ic = 100 mAdc, Ib = 10 mAdc
2N1008	−20	300	400	85	−65 to +85	90	1.2 mc	0.15 Vdc
2N1008A	−40	300	400	85	−65 to +85	90	1.2 mc	0.15 Vdc
2N1008B	−60	300	400	85	−65 to +85	90	1.2 mc	0.15 Vdc
2N1176	−15	300	300	85	−65 to +85	65	1.2 mc	0.15 Vdc
2N1176A	−40	300	300	85	−65 to +85	65	1.2 mc	0.15 Vdc
2N1176B	−60	300	300	85	−65 to +85	65	1.2 mc	0.15 Vdc

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EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N105	GPNPA	AF	RCA	2N105		
			IND		2N465	
			GT		GT81	
			BEN		2N1008A	
			TS		2N64	3
			MOT		2N1192	
			GEM		2N109	
			W		2N403	
			NUC		NPC152	
			PYE		V10/50A	
			PHL		2N535	
			GE		2N191	
2N106	PNP	AF	RAY	2N106		
			GEM		2N109	
			W		2N402	
			PHL		2N223	
			GE		2N1097	
2N107	GPNP	AF	GE	2N107		
			RCA		2N218	
			IND		TR722	
			GT		GT222	
			BEN		2N1008	
			TS		2N63	3
			MOT		2N1191	
			AMP		2N279	
			GEM		2N34	
			W		2N402	
			PYE		V6/2R	
			PHL		2N223	
			SYL		2N34	
2N108	GPPA	AF	CBS	2N108		
			PHL		2N226	
			GE		2N322	
2N109	GPNPA	AF	RCA	2N109		
			IND		2N632	
			GT		GT109	
			BEN		2N1008A	
			TS		2N382	1
			MOT		2N1192	
			AMP		2N281	
			GEM	2N109		
			W		2N403	
			NUC		NPC153	
			PHL		2N1130	
			GE		2N1097	
			SYL	2N109		
2N110	GPNPC	S	WE	2N110		
2N111	GPNPA	IF	RAY	2N111		
			RCA		2N218	
			IND		2N413	
			GT		2N519	
			BEN		2N1008A	
			TS		2N413	1
			GEM		2N139	
			W		2N614	
			GE		2N450	
2N111A	GPNPA	IF	RAY	2N111A		
			RCA		2N218	
			IND		2N413A	
			BEN		2N1008A	
			TS		2N413	
			GEM		2N139	
			W		2N614	
			GE		2N450	
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			IND		2N414	
			GT		2N520	
			TS		2N414	1
			GEM		2N139	
			W		2N615	
			GE		2N450	
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			IND		2N483	
			TS		2N414	
			GEM		2N139	
			W		2N615	
			GE		2N450	
2N113	GPNPA	IF	RAY	2N113		
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			IND		2N416	
			GT		2N521	
			AMP		OC45	
			GEM		2N139	
			W		2N617	
			GE		2N450	
			SYL		2N139	
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			IND		2N417	
			GT		2N522	
			AMP		OC44	
			GEM		2N139	
			W		2N617	
			GE		2N450	
2N115	PNP		AMP	2N115		
			RCA		2N270	
			BEN		2N234A	
			MOT		2N176	
2N116	GPNPA	AF	CBS	2N116		
			RCA		2N175	
			GT		GT81	
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			GE		2N332	
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			TR	2N118	2N474	
			GE		2N333	
2N118A	SNPNG	AF	TI	2N118A		
			TR	2N118A	2N474	
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			TR	2N119		
2N120	SNPNG	GP	TI	2N120		
			TR	2N120	2N335	
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			TS		2N426	1
			TR	2N123	2N425	
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			GEM	2N123		
			PHL		2N598	
			SYL		2N404	
2N124	GNPNA	S	TI	2N124		
			CBS		2N445	1
			GE		2N293	
2N125	GNPNG	S	TI	2N125		
			RCA		2N585	
			CBS		2N446	1
			GE		2N167	
2N126	GNPNG	S	TI	2N126		
			RCA		2N585	
			CBS		2N439	1
			GE		2N167	
2N127	GNPNG	S	TI	2N127		
			CBS		2N440	1
			GE		2N167	
2N128	GPNPS	HG	PHL	2N128		
			RCA		2N247	
			GT		2N604	
			SPR	2N128[7]		
			AMP		2N1516	
			GEM		2N247	
			SYL		2N247	
2N129	GPNPS	IF	PHL	2N129		
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			GT		2N603	
			AMP		2N1516	
			GEM		2N247	
			PYE		V15/20R	
			SYL		2N247	
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			BEN		2N1008	
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			W		2N402	
			PHL		2N1128	
			GE		2N1098	
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			RCA		2N105	
			IND		2N464	
			GT		GT14	
			BEN		2N1008B	
			TS		2N381	1
			MOT		2N650	
			W		2N402	
			PYE		V10/30AC	
			PHL		2N1124	
			GE		2N1098	
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			RCA		2N105	
			IND		2N465	
			BEN		2N1008	
			TS		2N64	3
			MOT		2N1191	
			GEM		2N241A	
			W		2N402	
			PHL		2N1124	
			GE		2N1098	
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			GT		GT20	
			BEN		2N1008B	
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			MOT		2N650	
			GEM			
			W		2N402	
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			PHL		2N1124	
			GE		2N1098	
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			IND		2N362	
			BEN		2N1008	
			TS		2N65	3
			MOT		2N1192	
			W		2N403	
			PHL		2N535	
			GE		2N321	
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			IND		2N466	
			GT		GT81	
			BEN		2N1008A	
			TS		2N383	1
			MOT		2N1192	
			GEM		2N241A	
			W		2N403	
			PYE		V10/50A	
			PHL		2N1125	
			GE		2N321	
2N133	GPNPA	AF	RAY	2N133		
			RCA		2N175	
			BEN		2N1008	
			TS		2N64	3
			MOT		2N1191	
			PHL		2N207B	
			GE		2N1097	
2N133A	GPNPA	AF	RAY	2N133A		
			RCA		2N175	
			IND		2N465	
			GT		GT74	
			BEN		2N1008A	
			TS		2N382	1
			MOT			
			PYE		V10/50AC	
			PHL		2N535	
			GE		2N1097	
2N135	GPNPA	RF	GE	2N135		
			RCA		2N139	
			IND		2N482	
			GT		2N520	
			TS		2N425	1
			AMP		OC45	
			GEM		2N139	
			W		2N614	
			PYE		V6/4RC	
			SYL		2N139	
2N136	GPNPA	RF	GE	2N136		
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			IND		2N482	
			GT		2N520	
			TS		2N414	1
			AMP		OC45	
			GEM		2N139	
			W		2N615	
			PYE		V6/4R	
			SYL		2N139	
2N137	GPNPA	RF	GE	2N137		
			RCA		2N140[5]	
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			GT		2N521	
			TS		2N416	
			AMP		OC44	
			W		2N615	
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2N138	GPNPA	AF	RAY	2N138		
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			BEN		2N1008	
			MOT		2N1193	
			AMP		2N281	
			GEM		2N406	
			W		2N61	
			PHL		2N226	
			GE		2N508	
			SYL		2N406	
2N138A	GPNPA	AF	RAY	2N138A		
			RCA		2N406	
			BEN		2N1008B	
			AMP		2N281	
			GEM		2N406	
			W		2N60	
			PHL		2N1130	
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2N138B			BEN		2N1008B	
2N139	GPNPA	IF	RCA	2N139		
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			GT		GT160R	
			TS		2N414	1
			AMP		OC46	
			GEM	2N139		
			W		2N615	
			PYE		V6/4R	
			PHL		2N344	
			GE		2N450	
			SYL	2N139		
2N140	GPNPA	CNV	RCA	2N140		
			IND		2N485	
			GT		GT761R	
			BEN		2N1008	
			TS		2N416	1
			AMP		OC46	
			GEM	2N140		
			W		2N617	
			PYE		V618R	
			PHL		2N345	
			GE		2N450	
			SYL	2N140		
2N141	GPNPA	AFO	SYL	2N141		
			CBS		LT5201	10
			GEM	2N141		
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			PHL		2N386	
2N142	GNPNA	AFO	RAY	2N142		
			CBS		LT5202	10
			GEM	2N142		
2N143	GPNPA	AFO	RAY	2N143		
			CBS		LT5201	10
			GEM	2N143		
			PYE		V60/20IP	
			PHL		2N675	
2N144	GNPNA	AFO	RAY	2N144		
			CBS		LT5202	10
			GEM	2N144		
2N145	GNPNG	IF	TI	2N145		
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			GEM		2N169	
			GE		2N448	
			SYL		2N94A	
2N146	GNPNG	IF	TI	2N146		
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			CBS		2N444	1
			AMP		OC45	
			GEM		2N169	
			GE		2N292	
			SYL		2N94A	
2N147	GNPNG	IF	TI	2N147		
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			GEM		2N168A	
			GE		2N293	
			SYL		2N94A	
2N148	GNPNG	IF	TI	2N148		
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			CBS		2N377	1
			AMP		OC45	
			GEM		2N169A	
			GE		2N448	
2N148A	GNPNG	IF	TI	2N148A		
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			AMP		OC44	
			GEM		2N169A	
			GE		2N448	

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N149	GNPNG	IF	TI	2N149		
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			CBS		2N377	1
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2N149A	GNPNG	IF	TI	2N149A		
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			GEM		2N169A	
			GE		2N292	
2N150	GNPNG	IF	TI	2N150		
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			CBS		2N377	1
			GEM		2N169A	
			GE		2N293	
2N150A	GNPNG	IF	TI	2N150A		
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			GEM		2N169A	
			GE		2N293	
2N151	GPNPA	AF	MAL	2N151		
2N152	GPNPA	AFO	MAL	2N152		
2N153	GPNPA	AFO	MAL	2N153		
2N154	GPNPA	AFO	MAL	2N154		
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			AMP		OC30	
			GEM	2N155		
			PYE		V30/20P	
			PHL		2N386	
			SYL	2N155		
			CTP	2N155		
2N156	GPNPA	AFO	CBS	2N156		6
			RCA		2N301	
			BEN	2N156	2N235A	
			TS		2N242	12
			MOT		2N178	
			AMP		OC30	
			GEM	2N156		
			PYE		V30/20P	
			PHL		2N386	
			SYL		2N242	
2N157	GPNPA	AFO	CBS	2N157		11
			RCA		2N561	
			BEN		2N638A	
			TS		2N379	
			MOT		2N375	
			PYE		V60/20P	
			PHL		2N386	
2N157A	GPNPA	AFO	CBS	2N157A		11
			RCA		2N1014	
			BEN		2N638B	
			TS		2N459	12
			MOT		2N1362	
			PHL		2N387	
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			BEN		2N639A	
			TS		2N379	12
			MOT		2N375	
			AMP		OC30	
			GEM		2N242	
			PYE		V60/30P	
			SYL		2N242	
2N158A	GPNPA	AFO	CBS	2N158A		6
			BEN		2N639A	
			TS		2N459	12
			MOT		2N375	
			GEM		2N242	
			PHL		2N387	
2N159	GC	S	SPR	2N159		
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2N160A	SNPNG	RF	GP	2N160A		
			GE		2N332	
			BOG	2N160A		
2N161	SNPNG	RF	GP	2N161		
			GE		2N333	
			BOG	2N161		
2N161A	SNPNG	RF	GP	2N161A		
			GE		2N333	
			BOG	2N161A		
2N162	SNPNG	RF	GP	2N162		
			GE		2N335	
			BOG	2N162		
2N162A	SNPNG	RF	GP	2N162A		
			GE		2N335	
			BOG	2N162A		
2N163	SNPNG	RF	GP	2N163		
			GE		2N335	
			BOG	2N163		
2N163A	SNPNG	RF	GP	2N163A		
			GE		2N335	
			BOG	2N163A		
2N164A	GNPN	IF	GE	2N164A		
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			GEM		2N169A	
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			GEM		2N169A	
2N166	GNPN	IF	GE	2N166		
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			CBS		2N446	1
			GEM		2N94A	
2N167	GNPN	S	GE	2N167		
			RCA		2N1090	
			GT		GT167	
			CBS		2N446	1
			AMP		OC140	
			GEM		2N94A	
2N167A	GNPN	S	GE	2N167A		7
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			CBS		2N445	1
			AMP		OC45	
			GEM		2N292	
			GE		2N293[4]	7
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			AMP		OC44	
			GEM	2N168A		
			GE		2N1086[4]	7
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			CBS		2N445	1
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			GEM		2N169A	
			SYL		2N94A	
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			AMP		OC45	
			GEM	2N169A		
			SYL	2N169A		
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			GT		GT948R	
			CBS		2N377	1
			AMP		OC45	
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			SYL		2N94A	
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			AMP		OC44	
			GEM		2N212	
			GE		2N1086	
			SYL		2N212	
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			BEN		2N1031A	
			TS	2N173		14
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			AMP		OC29	
			GEM		2N677B	
			PHL		2N386	
			SYL	2N173		
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			BEN		2N1031B	
			TS	2N174		14
			MOT		2N630	
			GEM		2N677C	
			PHL		2N387	
			SYL	2N174		
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			BEN		2N1031B	6
			GEM		2N677C	
			PHL		2N387	
2N175	GPNPA	AF	RCA	2N175		
			IND		2N633	
			GT		GT74	
			TS		2N65	3
			MOT		2N1192	
			W		2N403	
			PYE		V10/50A	
			PHL		2N207B	
2N176	GPNPA	AFO	MOT	2N176		
			RCA	2N176		
			CBS		2N301	11
			BEN		2N235A	
			TS		2N242	12
			AMP		OC27	
			GEM	2N176		
			SYL	2N176		
			NUC	2N176		
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			BEN		2N234A	
			TS		2N307	12
			GEM		2N235A	
			PHL		2N386	
2N179	GPNPA	AFO	MOT	2N179		
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			BEN		2N1008	
			PHL		2N386	
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			IND		2N466	
			GT		2N565	
			BEN		2N1008A	
			MOT		2N651	
			AMP		2N281	
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			W		2N60	
			PHL		2N1130	
			GE		2N1097	
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			RCA		2N270	
			IND		2N382	
			BEN		2N1008A	
			MOT		2N651	
			AMP		OC74	
			GEM		2N270	
			W		2N60	
			PHL		2N1124	
			GE		2N188A	
			SYL		2N270	
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			GT		2N445	
			AMP		OC140	
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			GE		2N634	
2N183	GNPNA	S	CBS	2N183	2N439	1
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			AMP		OC140	
			GE		2N634	
2N184	GPNPS	S	CBS	2N184	2N440	
			GT		2N447	
			AMP		OC140	
			GE		2N635	
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			RCA		2N270	
			IND		2N361	
			GT		GT81	
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			MOT		2N1191	
			AMP		2N281	
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			W	2N61		
			PHL		2N223	
			GE		2N188	
			SYL		2N34	
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			GT		GT20	
			BEN		2N1008A	
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			MOT		2N1191	
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			W		2N61	
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			PHL		2N226	
			SYL		2N34	
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			IND		2N464	
			BEN		2N1008A	
			TS		2N381	1
			MOT		2N1191	
			AMP		OC74	
			GEM		2N270	
			W		2N61	
			PHL		2N1130	
			SYL		2N270	
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			IND		2N361	
			GT		GT81	
			BEN		2N1008A	
			TS		2N381	1
			MOT		2N1191	
			AMP		2N281	
			GEM		2N34	
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			PHL		2N224	
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			IND		2N632	
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			MOT		2N1191	
			AMP		OC74	
			GEM		2N270	
			W		2N61	
			NUC		NPC121	
			PHL		2N1129	
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			GT		GT109	
			BEN		2N1008A	
			TS		2N382	1
			MOT		2N1192	
			AMP		2N281	
			GEM		2N34	
			W		2N60	
			PYE		V10/50AC	
			PHL		2N223	
			SYL		2N34	
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			IND		2N465	
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			AMP		OC74	
			GEM		2N270	
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			NUC		NPC122	
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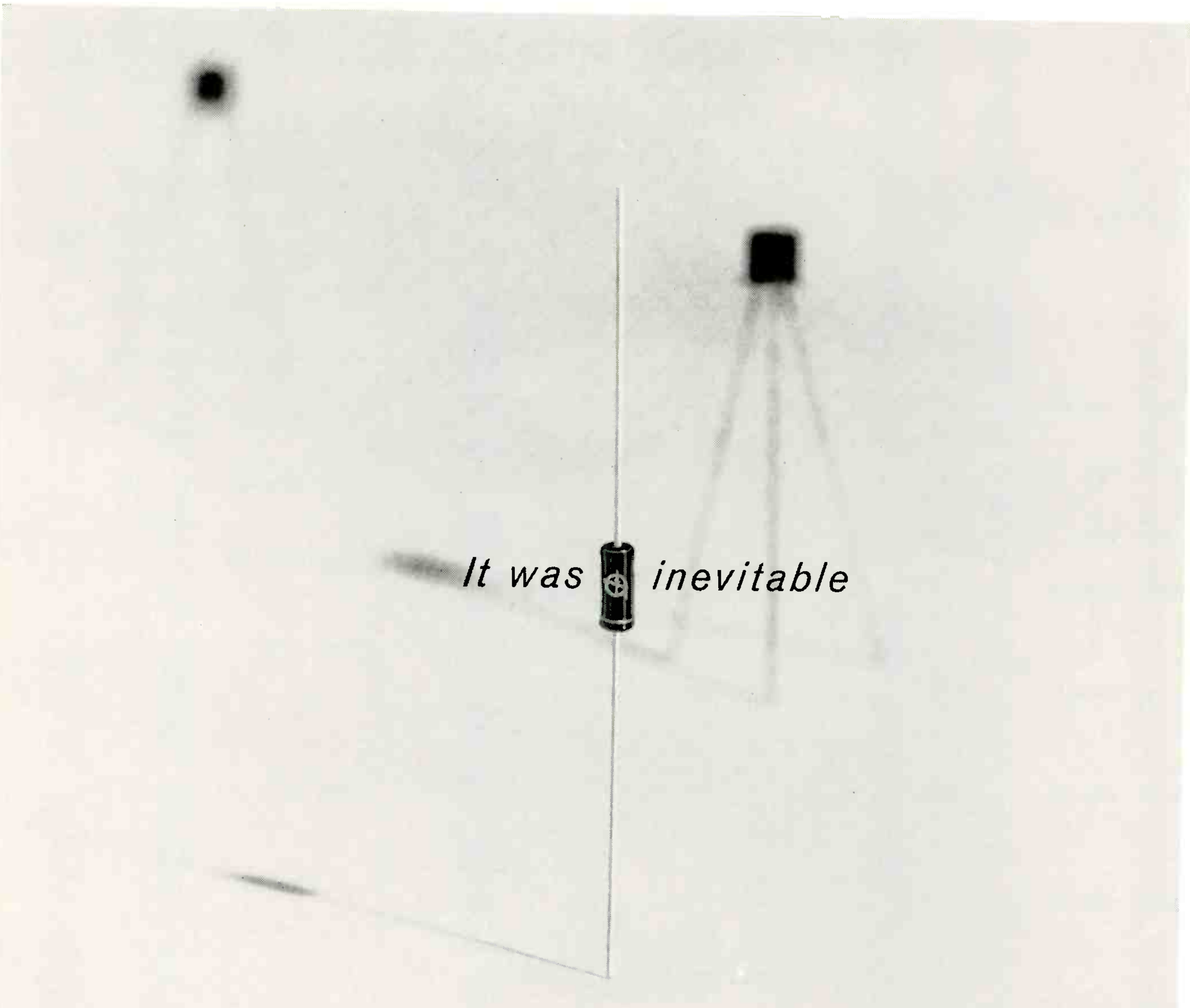
			IND		2N465	
			GT		GT14	
			BEN		2N1008A	
			TS		2N381	1
			MOT		2N1191	
			AMP		OC71	
			GEM		2N34	
			W		2N402	
			NUC		NPC151	
			PYE		V10/15AC	
			PHL		2N1130	
			SYL		2N34	
2N190	GPNP	AF	GE	2N190		13
			RCA		2N408	
			IND		2N465	
			GT		GT20	
			BEN		2N1008A	
			TS		2N381	
			MOT		2N1191	
			AMP		OC71	
			GEM		2N109	
			W		2N403	
			NUC		NPC151	
			PYE		V10/30A	
			PHL		2N1128	
			SYL		2N34	

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N191	GPNP	AF	GE	2N191		13
			RCA		2N270	
			IND		2N465	
			GT		GT81	
			BEN		2N1008A	
			TS		2N382	
			MOT		2N1191	
			AMP		OC75	
			GEM		2N109	
			W		2N403	
			NUC		NPC152	
			PYE		V10/50A	
			PHL		2N1128	
			SYL		2N34	
2N192	GPNP	AF	GE	2N192		13
			RCA		2N270	
			IND		2N466	
			GT		GT81	
			TS		2N383	1
			MOT		2N1192	
			AMP		OC75	
			GEM		2N34	
			W		2N61	
			NUC		NPC153	
			PYE		V10/50AC	
			PHL		2N1128	
			SYL		2N34	
2N193	GNPN	OSC	SYL	2N193		
			GT		GT948R	
			GEM	2N193		
			GE		2N1086	
2N194	GNPN	CNV	SYL	2N194		
			GT		GT948R	
			GEM	2N194		
			GE		2N1086	
2N194A	NPN		SYL	2N194A		
			GEM	2N194A		
			GE		2N1087	
2N195	GPNPA	AF	TR	2N195		
			RCA		2N217	
			GT		GT82	
			AMP		2N281	
			GEM		2N217	
			W		2N403	
			SYL		2N217	
2N196	GPNPA	AF	TR	2N196		
			RCA		2N217	
			GT		GT81	
			AMP		2N281	
			GEM		2N217	
			W		2N403	
			SYL		2N217	
2N197	GPNPA	AF	TR	2N197		
			RCA		2N217	
			GT		GT81	
			AMP		2N281	
			GEM		2N217	
			W		2N403	
			SYL		2N217	
2N198	GPNPA	AF	TR	2N198		
			RCA		2N217	
			GT		GT20	
			AMP		2N281	
			GEM		2N217	
			W		2N403	
			SYL		2N217	
2N199	GPNPA	AF	TR	2N199		
			RCA		2N109	
			GT		GT14	
			AMP		2N281	
			GEM		2N34	
			W		2N403	
			SYL		2N34	
2N200	GPNPA	AF	TR	2N200		
			RCA		2N331	
			GT		2N566	
			AMP		OC71	
			W		2N403	
2N204	GPNPA	GP	TR	2N204		
			RCA		2N331	
			GT		2N564	
			AMP		OC71	
			W		2N403	
2N205	GPNPA	GP	TR	2N205		
			RCA		2N331	
			GT		2N566	
			AMP		OC71	
			W		2N402	
2N206	GPNPA	AF	RCA	2N206	2N331[5]	
			IND		2N362	
			GT		2N567	
			BEN		2N1008A	
			TS		2N381	1
			MOT		2N1191	
			AMP		OC71	
			W		2N403	
			NUC		NPC152	
			PYE		V10/30AC	
			PHL		2N1125	
			GE		2N1097	
2N207	PNP	AF	PHL	2N207		
			RCA		2N105	
			IND		2N362	
			GT		GT81	
			TS		2N65	3
			GE		2N324	
2N207A	PNP	AF	PHL	2N207A		
			RCA		2N105	
			TS		2N65	
			GEM		2N241A	
			GE		2N324	
2N207B	PNP	AF	PHL	2N207B		
			RCA		2N105	
			TS		2N65	3
			GEM		2N241A	
			GE		2N324	
2N211	NPN	OSC	SYL	2N211		
			GT		GT948R	
			GEM	2N211		
			GE		2N293	
2N212	GNPN	CNV	SYL	2N212		
			GT		GT792R	
			GEM	2N212		
			GE		2N1086	
2N213	GNPN	AF	SYL	2N213		
			CBS		2N439	1
			GEM	2N213		
			GE		2N169A	
2N213A	GNPN	AF	SYL	2N213A		
2N214	GNPN	AF	SYL	2N214		
			CBS		2N438	
			GEM	2N214		
2N215	GPNP	AF	RCA	2N215		
			IND		2N362	
			GT		2N565	
			BEN		2N1008A	
			MOT		2N1191	
			AMP		OC75	
			GEM		2N34	
			W		2N402	
			PHL		2N207	
			GE		2N1097	
2N216	GNPN	IF	SYL	2N216		
			GT		GT948R	
			GEM	2N216		
			GE		2N292	
2N217	GPNPA	AF	RCA	2N217		
			IND		2N632	
			GT		GT109	
			BEN		2N1008A	
			TS		2N382	1
			MOT		2N1192	
			AMP		OC72	
			GEM	2N217		
			W		2N403	
			NUC		NPC153	
			PHL		2N1128	
			GE		2N321	
			SYL	2N217		
2N218	GPNPA	IF	RCA	2N218		
			IND		2N482	
			GT		GT760R	
			TS		2N414	1
			AMP		OC45	
			GEM		2N139	
			W		2N615	
			PYE		V6/4RC	
			PHL		2N344	
			GE		2N136	
2N219	GPNPA	CNV.	RCA	2N219		
			IND		2N485	
			GT		GT761R	
			TS		2N416	1
			AMP		OC44	
			GEM		2N140	
			W		2N617	
			PYE		V6/8R	
			PHL		2N344	
			GE		2N137	
2N220	GPNPA	AF	RCA	2N220		
			IND		2N632	
			GT		GT74	
			TS		2N65	3
			MOT		2N1192	
			W		2N403	
			PYE		V10/50AC	
			PHL		2N207	
			GE		2N323	
2N222	PNP	AF	GT	2N222		
			IND		2N464	
			GEM		2N34	
			W		2N402	
			SYL		2N34	
2N223	PNP	AF	PHL	2N223		
			RCA		2N270	
			IND		2N360	
			GT		GT81	
			BEN		2N1008	
			TS		2N383	1
			MOT		2N1193	
			AMP		OC74	
			GEM		2N270	
			PYE		V15/20IP	
			GE		2N323	
			SYL		2N270	
2N224	PNP	AF	PHL	2N224		
			RCA		2N270	
			IND		2N466	
			BEN		2N1008A	
			MOT	2N224	2N1192	
			AMP		OC74	
			GEM		2N270	
			W		2N60	
			PYE		V30/20IP	
			GE		2N321	
			SYL		2N270	
2N225	PNP	AF	PHL	2N225		
			IND		2N466	
			BEN		2N1008A	
			AMP		2N282	
			GEM		2N270	
			W		2N60	
			PYE		V30/20IP	
			GE		2N321	
			SYL		2N270	
2N226	PNP	AF	PHL	2N226		
			RCA		2N270	
			IND		2N465	
			GT		GT109	
			BEN		2N1008A	
			TS		2N382	
			MOT		2N1192	
			AMP		OC74	
			GEM		2N270	
			W		2N60	
			PYE		V30/20IP	
			GE		2N321	
			SYL		2N270	
2N227	PNP	AF	PHL	2N227		
			IND		2N466	
			GT		GT109	
			BEN		2N1008A	
			AMP		2N282	
			GEM		2N270	
			W		2N60	
			PYE		V30/201P	
			GE		2N321	
			SYL		2N270	
2N228	GNPN	AF	SYL	2N228		
			CBS		2N377	1
			GEM	2N228		
			GE		2N169	
2N229	GNPN	GP	SYL	2N229		
			GT		GT229	
			CBS		2N377	1
			GEM	2N229		
			GE		2N169	
2N230	GPNP	AFO	MAL			
			MOT		2N669	
			PHL		2N386	
2N231	GPNPS	HF	PHL	2N231		15
			RCA		2N218	
			AMP		OC45	
			W		2N615	
2N232	GPNPS	HF	PHL	2N232		15
			RCA		2N218	
			AMP		OC45	
			W		2N615	
2N233	GNPN	RF	SYL	2N233		
			GT		GT948R	
			AMP		OC45	
			GEM	2N233		
			GE		2N448	
2N233A	NPN	RF	SYL	2N233A		
			GT		GT948R	
			AMP		OC45	
			GEM	2N233A		
			GE		2N448	
2N234	GPNPA	AFO	BEN	2N234		
			RCA		2N301[5]	
			CBS		2N256A	11
			BEN		2N234A	
			TS		2N307A	12
			MOT		2N555	
			AMP		OC26	
			GEM		2N242	
			PHL		2N386	
			SYL		2N242	
2N234A	GNPNA	AFO	BEN	2N234A		
			RCA		2N301[5]	
			CBS		2N256A	11
			TS		2N307A	12
			MOT		2N555	
			AMP		OC26	
			GEM		2N242	
			PYE		V30/20P	
			PHL		2N386	
			SYL		2N242	
2N235	GPNPA	AFO	BEN	2N235		
			RCA		2N301[5]	
			CBS		2N235A	11
			TS		2N242	12
			MOT		2N350A	
			AMP		OC26	
			GEM		2N235A	
			PHL		2N386	
			SYL		2N235A	
2N235A	GPNPA	AFO	BEN	2N235A		
			RCA		2N301[5]	
			CBS	2N235A		11
			TS		2N242	12
			MOT		2N350A	
			AMP		OC26	
			GEM		2N235B	
			PYE		V60/30P	
			PHL		2N386	
			SYL	2N235A		
			CTP	2N235A		
2N235B	PNP	AFO	BEN	2N235B		
			CBS	2N235B		11
			TS		2N242	12
			MOT		2N351A	
			PYE		V60/30P	
2N236	PNP	AFO	BEN	2N236		
			CBS		2N236A	11
			TS		2N242	
			MOT		2N350A	
			AMP		OC26	
			GEM		2N236B	
			SYL		2N242	
2N236A	PNP	AFO	BEN	2N236A		
			RCA		2N301	
			CBS	2N236A		11
			TS		2N242	
			MOT		2N350A	
			AMP		OC26	
			GEM		2N236B	
			PYE		V60/30P	
			PHL		2N386	
			SYL		2N242	
2N236B	PNP	AFO	BEN	2N236B		
			CBS	2N236B		11
			TS		2N242	12
			MOT		2N351A	
			AMP		OC26	
			GEM	2N236B		
			SYL	2N236B		
2N237	GPNPA	AF	NA	2N237		
			RCA		2N220	
			GT		GT81	
			PHL		2N1124	
			GE		2N192	
			SYL		2N242	



DIFFUSED SILICON DIODES FROM FAIRCHILD

THE FIRST — An ultra-fast computer diode: Four millimicrosecond maximum reverse recovery time of this new FD 100 overcomes the diode-caused speed limitations in computer circuits. Capacitance is only 2μμf at zero volts bias.

THE REASON — A need and the technology to serve it: Fairchild's diffused silicon transistors have achieved heretofore unattainable performance. Application of these transistors has in turn created the need for silicon diodes of similarly outstanding performance.

THE FOLLOW UP — A broad line of high reliability diodes: This Fairchild FD 100 diode is being followed by others providing industry-leading standards in reliability and uniformity — backed by a continuing accumulation of statistical data on a large scale.

TENTATIVE SPECIFICATIONS — FAIRCHILD FD 100
25°C Except As Noted

Symbol	Characteristic	Min.	Max.	Conditions
BV	Breakdown Voltage	40 volts		@ I_R = 100 μA
I_R	Reverse Current		.100 μA	@ V_R = 30v, 25°C
V_F	Forward Voltage Drop		1 v	@ I_F = 10 mA
C	Capacitance		2 μμf	@ V_R = 0v
t_{rr}	Reverse Recovery Time To Ir = 1 ma		4 mμs	@ $I_f = I_r$ = 10 ma
	Maximum Power Dissipation		200 mw.	
	Temp. Range Operating	−65°C to 175°C		
	Storage	−65°C to 200°C		

For full specifications, write Dept. J-3
See us at Booth #2701-3-5-7 on the second floor at I.R.E.

FAIRCHILD SEMICONDUCTOR CORPORATION

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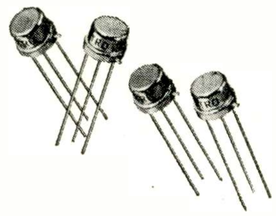
EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N238	GPNP	AFO	TI	2N238		
			RCA		2N217	
			IND		2N465	
			GT		GT81	
			MOT		2N1192	
			AMP		OC72	
			GEM		2N217	
			W	2N402		
			PHL		2N226	
			GE		2N191	
			SYL		2N217	
2N240	GPNPS	S	PHL	2N240		
			RCA		2N582	
			GT		2N604	
			SPR	2N240[7]		
			AMP		OC46	
			GEM		2N217	
			PYE		V15/20R	
			SYL		2N217	
2N241	GPNPA	AF	GE	2N241		
			RCA		2N217	
			IND		2N383	
			GT		GT109	
			BEN		2N1008A	
			TS		2N383	1
			MOT		2N1192	
			AMP		2N281	
			GEM		2N241A	
			W		2N59	
			PYE		V10/50A	
			PHL		2N1128	
			SYL		2N241A	
2N241A	GPNP	AFO	GE	2N241A		13
			RCA		2N270	
			IND		2N466	
			BEN		2N1008A	
			TS		2N383	1
			MOT		2N1193	
			AMP		OC74	
			GEM	2N241A		
			W		2N59	
			NUC		NPC123	
			PHL		2N1128	
			SYL	2N241A		
2N242	PNP	AFO	SYL	2N242		
			RCA		2N301A[5]	
			CBS		2N235A	11
			BEN	2N242	2N235A	
			TS	2N242		12
			MOT		2N176	
			AMP		OC28	
			GEM	2N242		
			PYE		V60/20P	
			PHL		2N1124	
			CTP	2N242		
2N243	SNPNG	AF	TI	2N243		
			TR	2N243	2N342	
2N244	SNPNG	AF	TI	2N244		
			TR		2N343	
2N245	SNPNG	AF	TI	2N245		
2N246	SNPNG	AF	TI	2N246		
2N247	GPNPD	RF	RCA	2N247		
			GT		2N606	
			AMP		2N1516	
			GEM	2N247		
			PYE		V15/20R	
			PHL		2N393	
			SYL	2N247		
2N248	GPNPG	RF	TI	2N248		
			RCA		2N247	
			GT		2N608	
			AMP		2N1518	
			GEM		2N247	
			PHL		2N504	
			SYL		2N247	
2N249	GPNPA	AF	TI	2N249		
			RCA		2N270	
			BEN		2N1176A	
			AMP		OC74	
			GEM		2N270	
			W		2N59	
			GE		2N320	
			SYL		2N270	
2N250	GPNPA	AFO	TI	2N250		
			RCA		2N301[5]	
			CBS		2N301	11
			BEN		2N235A	
			TS		2N242	12
			MOT		2N555	
			AMP		OC26	
			GEM	2N250		
			PHL		2N386	
			SYL	2N250		
			CTP	2N250		
2N251	GPNPA	AFO	TI	2N251		
			RCA		2N301A[5]	
			CBS		2N301A	11
			BEN		2N639A	
			MOT		2N375	
			AMP		OC28	
			GEM		2N296	
			PHL		2N386	
			SYL		2N296	
2N252	GPNPG	CNV	TI	2N252		
			RCA		2N374	
			IND		2N485	
			GT		2N606	
			AMP		OC44	
			GEM		2N140	
			W		2N617	
			PYE		V15/20R	
			PHL		2N344	
2N253	GNPNG	IF	TI	2N253		
			GT		GT948R	
			AMP		OC45	
			GEM		2N94A	
			GE		2N292	
			SYL		2N94A	
2N254	GNPNG	IF	TI	2N254		
			GT		GT948R	
			AMP		OC45	
			GEM		2N94A	
			GE		2N293	
			SYL		2N94A	
2N255	GPNPA	AFO	CBS	2N255	2N255A	11
			RCA		2N301[5]	
			BEN	2N255		
			TS		2N307	12
			MOT		2N554	
			AMP		OC26	
			GEM	2N255		
			PYE		V15/30P	
			PHL		2N386	
			SYL	2N255		
			CTP	2N255		
2N255A	GPNP	AFO	CBS	2N255A		11
			TS		2N307	12
			PYE		V15/30P	
			BEN	2N255		
2N256	GPNPA	AFO	CBS	2N256	2N256A	11
			RCA		2N301[5]	
			BEN	2N256		
			TS		2N307A	
			MOT		2N555	
			AMP		OC26	
			GEM	2N256		
			PYE		V30/30P	
			PHL		2N386	
			SYL	2N256		
			CTP	2N256		
2N256A	GPNP	AFO	CBS	2N256A		
			TS		2N307A	12
			PYE		V30/30P	
2N257	GPNPA	AFO	CTP	2N257		
			RCA		2N301[5]	
			CBS	2N257		11
			BEN		2N235A	
			TS		2N242	12
			MOT		2N176	
			AMP		OC26	
			GEM	2N257		
			PHL		2N386	
			SYL	2N257		
2N260	SPNPA	GP	CTP	2N260		
			PHL		2N496	
			GE		2N332	
2N260A	SPNPA	GP	CTP	2N260A		
			PHL		2N495	
			GE		2N332	
2N261	SPNPA	GP	CTP	2N261		
			PHL		2N495	
			GE		2N332	
2N262	SPNPA	GP	CTP	2N262		
			PHL		2N496	
			GE		2N333	
2N262A	SPNPA	GP	CTP	2N262A		
			PHL		2N495	
			GE		2N333	
2N263	SNPNG	S	TI	2N263		
2N265	GPNP	AF	GE	2N265		
			RCA		2N408	
			IND		2N465	
			GT		GT81	
			BEN		2N1008A	
			TS		2N383	
			MOT		2N1193	
			GEM		2N406	
			W		2N403	
			PHL		2N1128	
			SYL		2N406	
2N266	GPNPA	AF	GE	2N266		
			IND		2N381	
			BEN		2N1008	
			AMP		2N281	
			W		2N61	
			PHL		2N226	
2N267	GPNPD	RF	RCA	2N267[3]	2N247	
			GT		2N606	
			AMP		2N1516	
			GEM		2N247	
			PHL		2N593	
			SYL		2N247	
2N268	GPNPA	HS	CTP	2N268		
			RCA		2N301A	
			CBS		LT5072	11
			BEN	2N268	2N639A	
			TS		2N379	12
			MOT		2N375	
			AMP		OC26	
			GEM	2N268		
			PHL		2N675	
			SYL	2N268		
2N268A	PNP	AFO	CTP			
			CBS		LT5075	11
			BEN	2N268A	2N639A	
			TS		2N379	
			MOT		2N375	
			AMP		OC28	
			GEM		2N268	
			PHL		2N675	
2N269	GPNPA	S	RCA	2N269		
			GT		GT269	
			TS		2N404	
			TR	2N269		
			MOT		2N404	
			AMP		OC47	
			PYE		V6/8RC	
			PHL		2N598	
			GE		2N404	
2N270	GPNPA	AF	RCA	2N270		
			IND		2N631	
			BEN		2N1008A	
			TS		2N383	1
			MOT		2N1193	
			AMP		OC74	
			GEM	2N270		
			W		2N59	
			PHL		2N1124	
			GE		2N321	
			SYL	2N270		
2N271	GPNPA	S	RAY	2N271		
			RCA		2N404	
			IND		2N486	
			TS		2N416	
			AMP		OC44	
			GEM		2N411	
			PHL		2N393	
			SYL		2N411	
2N271A	GPNPA	S	RAY	2N271A		
			RCA		2N404	
			IND		2N484	
			TS		2N416	
			GEM		2N139	
			PHL		2N393	
			SYL		2N139	
2N272	GPNPA		RAY	2N272		
			GT		GT75	
			BEN		2N1008	
			PHL		2N1128	
			GE		2N323	
2N273	GPNPA	AF	RAY	2N273		
			RCA		2N109	
			IND		2N361	
			BEN		2N1008	
			PHL		2N226	
			GE		2N1098	
2N274	GPNPD	RF	RCA	2N274		
			GT		2N606	
			AMP		2N1516	
			PYE		V15/20R	
			PHL		2N504	
2N277	GPNPA	AFO	DEL	2N277		
			BEN		2N1031[6]	
			TS	2N277		14
			MOT		2N628	
			GEM		2N677A	
			PHL		2N386	
			SYL		2N278	
			CTP		CTP1508	
2N278	GPNPA	AFO	DEL	2N278		
			BEN		2N1031[6]	
			TS	2N278		14
			MOT		2N628	
			GEM		2N677	
			PHL		2N386	
			SYL	2N278		
			CTP		CTP1506	
2N279	GPNPA	AF	AMP	2N279		
			RCA		2N217	
			IND		TR320	
			GT		GT214	
			TS		2N64	3
			MOT		2N1191	
			GEM		2N34	
			W		2N402	
			PYE		V10/30A	
			PHL		2N223	
			GE		2N319	
2N280	GPNPA	AF	AMP	2N280		
			RCA		2N215	
			IND		2N1352	
			GT		GT20	
			TS		2N64	
			MOT		2N1191	
			GEM		2N34	
			W		2N403	
			PYE		V10/50A	
			PHL		2N207	
			GE		2N320	
2N281	GPNPA	AF	AMP	2N281		
			RCA		2N217	
			GT		GT81	
			MOT		2N651	
			GEM		2N241A	
			W		2N403	
			PHL		2N224	
			GE		2N321	
2N282	GPNPA	AF	AMP	2N282		
			GT		GT109	
			GEM		2N241A	
			PHL		2N225	
			GE		2N321	
2N283	GPNPA	AF	AMP	2N283		
			RCA		2N215	
			GT		2N563	
			TS		2N64	3
			MOT		2N1191	
			PYE		V10/50A	
			PHL		2N1124	
			GE		2N320	
2N284	GPNPA	AF	AMP	2N284		
			IND		TR722	
			GT		GT87	
			TS		2N381	1
			PYE		V6/2RC	
			PHL		2N1124	
			GE		2N1056	
2N284A	GPNPA	AF	AMP	2N284A		
			PYE		V6/2R	
			PHL		2N674	
			GE		2N1056	



specify with assurance when you specify

INDUSTRO

pnp alloy junction germanium COMPUTER transistors to MIL-T-19500A

- Medium to high speed switching
- Medium gain
- Tight parameters
- Very linear current amplification factor

TYPE	V_{CER} R_{BE}=5K volts	f_{ab} typ mc	h_{FE} typ I_C=−1 ma V_{CE}=−0.25V	h_{FE} typ I_B=−10 ma V_{CE}=−0.35V	Rsat (typ) I_B=−10 ma I_C=−100 to −200 ma ohms
2N425	−30	4	30	20	2.2
2N426	−25	6	40	25	2.2
2N427	−20	11	55	25	1.3
2N428	−15	17	80	35	1.1

- Medium gain, fast switching
- High reliability at maximum ratings
- Tight parameters
- Low leakage current at high temperatures

TYPE	V_{CER} R_{BE}=1K volts	f_{ab} typ mc	h_{FE} typ I_C=−10 ma V_{CE}=−1V	I_{CBO} max V_{CBO}=−20V μa	I_{EBO} max V_{EBO}=−10V μa	V_{CE}sat typ I_C=−10 ma volts @ I_B
2N1284	−20	8	90	−6	−6	−1.5 −.5 ma

Floating base replacement for 2N123

- General purpose HF switching
- Low leakage current at high temperatures
- Tight parameters
- High reliability at maximum ratings

TYPE	V_{CEX} V_{BE}=0.1V volts	f_{ab} typ mc	h_{fe} typ —	I_{CBO} max V_{CBO}=−12V μa	I_{EBO} max V_{EBO}=−12V μa	C_{ob} typ μμf
2N413	−25	2.5	30	−5	−5	12
2N414	−20	7	60	−5	−5	12
2N414B	−24*	7	60	−6 @ −20V	−5	12
2N416	−15	10	80	−5	−5	12
2N417	−12	20	140	−5	−5	12

*V_{BE}=0.2V

- High gain
- HF fast switching
- Low leakage current at high temperatures
- High reliability at maximum ratings

TYPE	V_{CEX} V_{BE}=0.25V volts	f_{ab} typ mc	h_{FE} typ I_C=−20 ma V_{CE}=−1V	I_{CBO} max V_{CBO}=−15V μa	I_{EBO} max V_{EBO}=−5V μa	V_{BE} max I_C=−20 ma V_{CE}=−1V
2N1344	−15	12	90	−10	−10	−.6V

- Medium to high gain
- HF switching
- Low leakage current at high temperatures
- Tight parameters
- Very linear current amplification factor

TYPE	V_{CER} R_{BE}=1K volts	f_{ab} typ mc	h_{FE} typ I_C=−10 ma V_{CE}=−1V	h_{FE} min I_C=−200 ma V_{CE}=−0.35V	V_{CE}sat typ I_C=−50 ma volts @ I_B
2N1353	−16	3.5	70	10	−0.1 −5 ma
2N1354	−20	4.5	70	10	−0.1 −5 ma
2N1355	−25	8	80	15	−0.08 −3.3 ma
2N1357	−20	12	85	20	−0.07 −2.5 ma

Floating base replacement for 2N394, 2N395, 2N396, 2N397

• Special selection to customer parameters • 100% test to all parameters • For critical military and industrial applications • JEDEC 30 (TO-5 case) packaged for automatic assembly

INDUSTRO

TRANSISTOR CORPORATION
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EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N285	GPNPA	AFO	BEN	2N285		
			RCA		2N301	
			TS		2N242	12
			MOT		2N669	
			AMP		OC28	
			GEM		2N285A	
			PHL		2N386	
			CTP		CTP1117	
2N285A	GPNPA	AFO	BEN	2N285A		
			RCA		2N301	
			TS		2N242	
			MOT		2N669	
			AMP		OC28	
			GEM	2N285A		
			PHL		2N386	
			SYL	2N285A		
			CTP		CTP1117	
2N290	GPNPA	AFO	DEL	2N290		
			BEN		2N1031B[6]	
			MOT		2N630	
			PHL		2N387	
2N291	GPNPA	AFO	TI	2N291		
			IND		2N363	
			GT		GT81	
			BEN		2N1176A	
			TS		2N382	1
			MOT		2N1192	
			AMP		OC74	
			GEM		2N270	
			W		2N59	
			PHL		2N1129	
			GE		2N188A	
			SYL		2N270	
2N292	GNPN	IF	GE	2N292		7
			GT		GT948R	
			AMP		OC45	
			GEM	2N292		
			SYL		2N216	
2N293	GNPN	IF	GE	2N293		7
			GT		GT792R	
			AMP		OC44	
			GEM		2N216	
			SYL		2N216	
2N296	GPNPA	AFO	SYL	2N296		
			RCA		2N301A	
			CBS		2N157	11
			BEN		2N639A	
			TS		2N459	12
			MOT		2N375	
			AMP		OC28	
			GEM	2N296		
			PYE		V60/30P	
			PHL		2N386	
			CTP		2N268A	
2N297	PNP	AFO	CTP	2N297		
			CBS	2N297		11
			BEN	2N297		
			TS	2N379		12
			MOT		2N297A	
			AMP		OC28	
			GEM		2N296	
			PHL		2N386	
2N297A	GPNP	GP,P	CTP	2N297A		12
			RCA		2N457	
			CBS	2N297A		11
			BEN	2N297A		
			TS		2N379	12
			MOT	2N297A		
			PHL		2N386	
2N299	GPNPS	RF	PHL	2N299		16
2N300	GPNPS	RF	PHL	2N300		16
			AMP		2N1517	
2N301	GPNPA	AFO	RCA	2N301		
			CBS	2N301		11
			BEN	2N301	2N235A	
			TS		2N242	
			MOT		2N176	
			AMP		OC29	
			GEM	2N301		
			PHL		2N386	
			SYL	2N301		
			CTP	2N301	2N257	
2N301A	GPNPA	AFO	RCA	2N301A		
			CBS	2N301A		11
			BEN	2N301A	2N638A	
			TS		2N242	12
			MOT		2N375	
			AMP		OC28	
			GEM	2N301A		
			PHL		2N386	
			SYL	2N301A		
			CTP	2N301A	2N268A	
2N302	GPNPA	S	RAY	2N302		
			RCA		2N269	
			GT		GT269	
			TR	2N302		
			AMP		OC47	
			PHL		2N598	
			GE		2N186A	
2N303	GPNPA	S	RAY	2N303		
			RCA		2N269	
			GT		GT269	
			AMP		OC47	
			PHL		2N598	
			GE		2N186A	
2N306	NPN	AF	SYL	2N306		
			GT		GT35	
			CBS	2N306		1
			GEM	2N306		
			GE		2N292	
2N307	PNP	AFO	SYL	2N307		
			RCA		2N301[5]	
			CBS		2N256A	11
			BEN	2N307		
			TS	2N307		12
			MOT		2N350A	
			AMP		OC26	
			GEM	2N307		
			PYE		V30/20IP	
			PHL		2N386	
			CTP		CTP1104	
2N307A	GPNPA	AFO	SYL	2N307A		
			RCA		2N301[5]	
			CBS		2N256A	11
			BEN	2N307A		
			TS	2N307A		
			MOT		2N350A	
			GEM	2N307A		
			PYE		V30/30P	
			PHL		2N386	
			CTP		2N257	
2N308	GPNPG	IF	TI	2N308		
			RCA		2N373	
			IND		2N417	
			GT		2N606	
			AMP		OC45	
			GEM		2N247	
			PYE		V15/20R	
			PHL		2N386	
			SYL		2N247	
2N309	GPNPG	IF	TI	2N309		
			RCA		2N373	
			IND		2N417	
			GT		2N606	
			AMP		OC45	
			GEM		2N247	
			PYE		V15/20R	
			PHL		2N588	
			SYL		2N247	
2N310	GPNPG	IF	TI	2N310		
			RCA		2N373	
			IND		2N465	
			GT		2N606	
			AMP		OC44	
			GEM		2N247	
			PYE		V15/20R	
			PHL		2N504	
			SYL		2N247	
2N311	GPNPA	S	MOT			
			RCA		2N404	
			GT	2N311		
			BEN		2N1176	
			TR	2N311	2N404	
			AMP		OC47	
			GEM		2N404	
			PHL		2N536	
			GE		2N123	
2N312	GPNPA	S	MOT			
			RCA		2N585	
			GT	2N312		
			CBS	2N312		1
			AMP		OC140	
			GEM	2N312		
			GE		2N167	
			SYL	2N312		
2N313[4]	GNPNA	AF	GE		2N292	7
			GT		GT948R	
			AMP		OC45	
			GEM		2N292	
2N314[4]	GNPNA	AF	GE		2N293	7
			GT		GT792R	
			AMP		2N1516	
			GEM		2N292	
2N315	GPNPA	S	GT	2N315		
			RCA		2N578	
			IND	2N315	2N426	1
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			TR	2N315		
			AMP		OC47	
			GEM		2N404	
			PYE		V10/1SC	
			PHL		2N597	
			GE		2N396	
			SYL		2N404	
2N315A	PNP	S	IND	2N315A		1
			TS		2N426	1
2N316	GPNPA	S	GT	2N316		
			RCA		2N579	
			IND	2N316	2N427	1
			TS		2N427	1
			TR	2N316		
			AMP		OC47	
			GEM		2N404	
			PYE		V10/1S	
			PHL		2N598	
			GE		2N397	
			SYL		2N404	
2N316A	PNP	S	IND	2N316A		1
			TS		2N427	
2N317	PNP	S	GT	2N317		
			RCA		2N582	
			IND	2N317	2N428	1
			TS		2N428	
			TR	2N317		
			AMP		OC47	
			GEM		2N404	
			PHL		2N599	
			SYL		2N404	
2N317A	PNP	S	IND	2N317A		1
			TS		2N428	
2N318	PNP	PH	GT	2N318		
2N319	GPNP	RF	GE	2N319		
			RCA		2N270	
			IND		TR319	
			GT		GT81	
			BEN		2N1008A	
			TS		2N381	
			MOT		2N1191	
			AMP		OC74	
			GEM		2N270	
			W		2N61	
			NUC		NPC122	
			PHL		2N1125	
			SYL		2N270	
2N320	GPNP	RF	GE	2N320		
			RCA		2N270	
			IND		TR320	
			GT		GT81	
			TS		2N382	
			MOT		2N1191	
			AMP		OC74	
			GEM		2N270	
			W		2N60	
			NUC		NPC122	
			PHL		2N1125	
			SYL		2N270	
2N321	GPNP	RF	GE	2N321		17
			RCA		2N270	
			IND		TR321	
			GT		GT81	
			TS		2N383	
			MOT		2N1193	
			AMP		OC74	
			GEM	2N321		
			W		2N59	
			NUC		NPC123	
			PHL		2N1125	
			SYL	2N321		
2N322	GPNP	RF	GE	2N322		17
			RCA		2N406	
			IND		TR322	
			GT		GT20	
			BEN		2N1008	
			TS		2N381	
			MOT		2N1191	
			AMP		2N281	
			GEM		2N406	
			W		2N403	
			PYE		V10/50AC	
			PHL		2N1128	
			SYL		2N406	
2N323	GPNP	RF	GE	2N323		17
			RCA		2N270	
			IND		TR323	
			GT		GT81	
			TS		2N382	1
			MOT		2N1192	
			AMP		OC74	
			GEM		2N270	
			W		2N403	
			PHL		2N1129	
			SYL		2N270	
2N324	GPNP	RF	GE	2N324		17
			RCA		2N407	
			IND		TR324	
			TS		2N383	
			MOT		2N1192	
			AMP		OC74	
			GEM		2N270	
			W		2N61	
			PHL		2N1129	
2N325	GPNPA	AFO	SYL	2N325		
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			TS		2N242	
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			GEM	2N325		
			PYE		V30/30P	
			PHL		2N386	
2N326	GNPNA	AFO	SYL	2N326		
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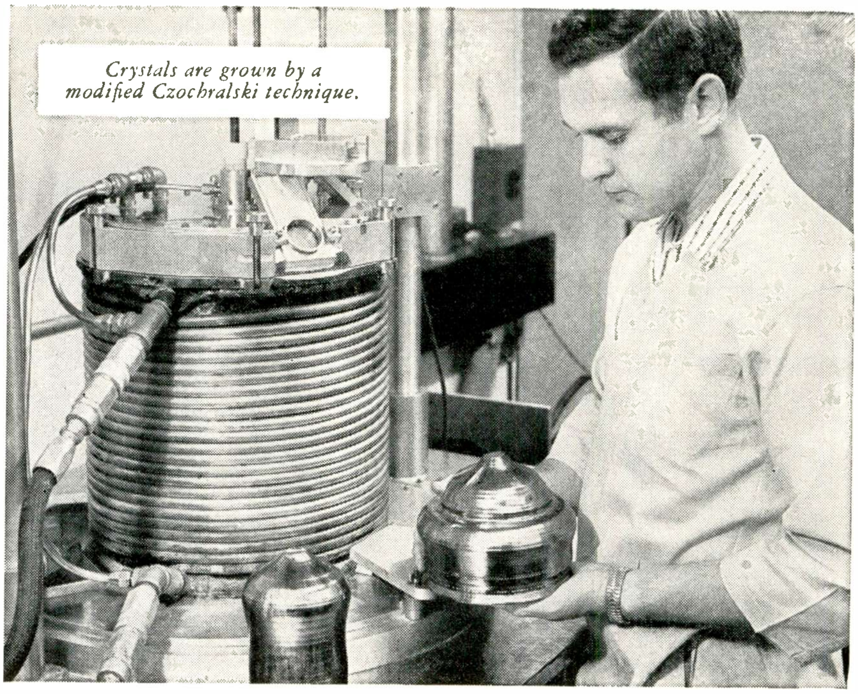
			GEM	2N326		
2N327	PNP	AFO	RAY	2N327		
			FCH		2N1131	
			PYE		V60/20IP	
			PHL		2N495	
2N327A	SPNPA	AF,S	RAY	2N327A		
			SRC	2N327A		
			HU		2N1232[7]	
			NSC	2N327A		1
			CRI	2N327A		
			PYE		V60/20IP	
			PHL		2N495	
2N328	SPNP	S	RAY	2N328		
			PHL		2N495	
2N328A	SPNPA	AF,S	RAY	2N328A		
			SRC	2N328A		
			HU		2N1233[7]	
			FCH		2N1131	
			NSC	2N328A		1
			CRI	2N328A		8
			PHL		2N495	
2N329	SPNP	S	RAY	2N329		
			PHL		2N495	
2N329A	SPNPA	AF,S	RAY	2N329A		
			SRC	2N329A		
			NSC	2N329A		1
			CRI	2N329A		8
			PHL		2N495	
2N330	PNP		RAY	2N330		
			PHL		2N495	
2N330A	SPNPA	S	RAY	2N330A		
			SRC	2N330A		
			PHL		2N495	
2N331	GPNPA	AF	RCA	2N331		
			IND	2N331		1
			GT		2N565	
			BEN	2N331		
			TS		2N382	
			MOT	2N331		
			AMP		OC74	
			GEM		2N270	
			PHL		2N224	
			GE		2N188A	

Let KNAPIC *grow your* SILICON CRYSTALS *for you!*



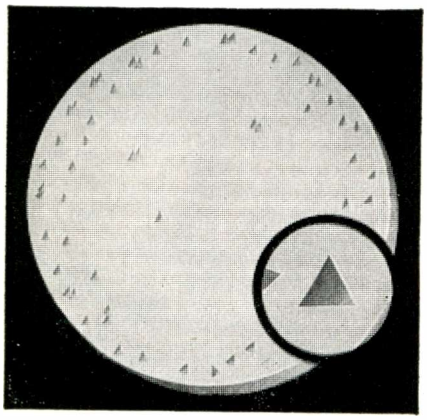
Crystals are grown by a modified Czochralski technique.

SILICON AND GERMANIUM MONOCRYSTALS

For Semiconductor, Solar Cell and Infrared Devices

Major manufacturers of semiconductor devices have found that Knapic Electro-Physics, Inc. can provide production quantities of highest quality silicon and germanium monocrystals far quicker, more economically, and to much tighter specifications than they can produce themselves. Knapic Electro-Physics has specialized in the custom growing of silicon and germanium monocrystals. We have extensive experience in the growing of new materials to specification. Why not let us grow your crystals too?

Knapic monocrystalline silicon and germanium is available in evaluation and production quantities in all five of the following general grade categories —Zener, solar cell, transistor, diode and rectifier, and high voltage rectifier.



Dislocation density, Knapic silicon monocrystals: Crystal diameters to 3/8"—None; 3/8" to 3/4"—less than 10 per sq. cm.; 3/4" to 1 1/4"—less than 100 per sq. cm.; 1 1/2" to 2"—less than 1000 per sq. cm.

Check these advantages . . .

Extremely low dislocation densities.

Tight horizontal and vertical resistivity tolerances.

Diameters from 1/4" to 2". Wt. to 250 grams per crystal. Individual crystal lengths to 10".

Low Oxygen content 1 x 10^{17} per cc., 1 x 10^{16} for special Knapic small diameter material.

Doping subject to customer specification, usually boron for P type, phosphorous for N type.

Lifetimes: 1 to 15 ohm cm.—over 50 microseconds; 15 to 100 ohm cm.—over 100 microseconds; 100 to 1000 ohm cm.—over 300 microseconds. Special Knapic small diameter material over 1000 microseconds.

Specification Sheets Available.

TUNNEL (ESAKI) DIODE MATERIALS
RECOMMENDED SPECIFICATIONS

Material	Phosphorous Concentration x 10^{19} cm^{-3}	Specific Resitivity in ohm cm	Electron Mobility cm^2 $volt^{-1}$ sec^{-1}
SILICON	6.8	.00105	85
SILICON	11.0	.00078	81
SILICON	16.0	.00065	78
GERMANIUM	1.6	.00091	426
GERMANIUM	3.4	.00067	268

. . . Also manufacturer of large diameter silicon and germanium lenses and cut domes for infrared use

Knapic Electro-Physics, Inc.

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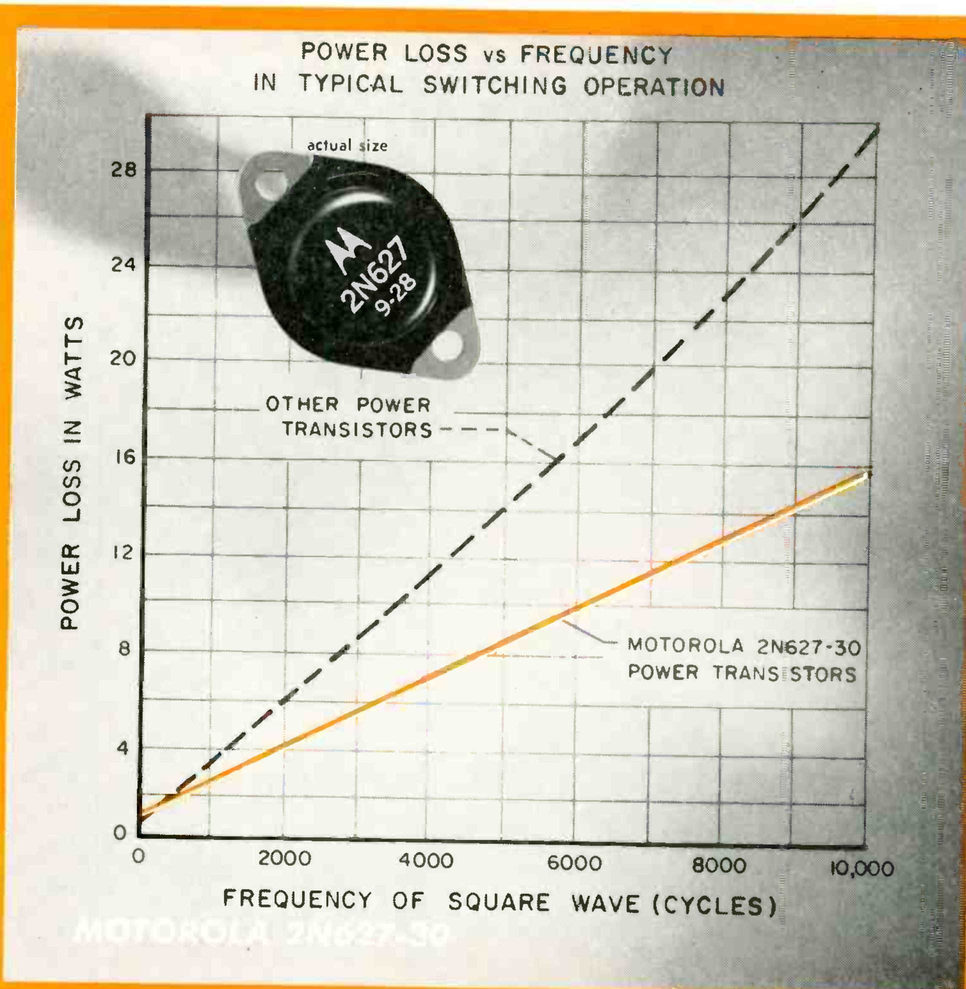
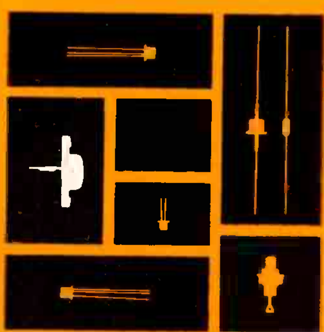
EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N332	SNPNG	GP	TI	2N332		
			TR	2N332	2N472	
			GEM		2N332	
			PHL		2N1267	
			GE	2N332		17
			BOG	2N332		
2N332A	SNPN	RF,S	GE	2N332A		17
			PHL		2N1267	
2N333	SNPNG	GP	TI	2N333		
			TR	2N333	2N475	
			GEM	2N333		
			PHL		2N1268	
			GE	2N333		17
			BOG	2N333		
2N333A	SNPN	RF,S	GE	2N333A		17
			PHL		2N1268	
2N334	SNPNG	GP	TI	2N334		
			TR	2N334	2N475	
			GEM	2N334		
			PHL		2N1268	
			GE	2N334		17
			BOG	2N334		
2N334A	SNPN	RF,S	GE	2N334A		17
			PHL		2N1268	
2N335	SNPNG	GP	TI	2N335		
			TR	2N335	2N480	
			GEM	2N335		
			PHL		2N1269	
			GE	2N335		17
			BOG	2N335		
2N335A	SNPN	RF,S	GE	2N335A		17
			PHL		2N1269	
2N335B	SNPN	RF,S	GE	2N335B		17
2N336	SNPNG	GP	TI	2N336		
			TR	2N336	2N543	
			GEM	2N336		
			PHL		2N1269	
			GE	2N336		17
			BOG	2N336		
2N336A	SNPN	RF,S	GE	2N336A		17
			PHL		2N1269	
2N337	SNPNA	S	TI	2N337		
			GEM	2N337		
			PHL		2N1199	
			GE	2N337		17
			TR	2N337		
2N338	SNPNA	S	TI	2N338		
			GEM	2N338		
			PHL		2N1199	
			GE	2N338		17
			TR	2N338		
2N339	SNPNG	AFO	TI	2N339		
			FCH		2N696	
			TR	2N339		
2N340	SNPNG	AFO	TI	2N340		
			TR	2N340		
2N341	SNPNG	AFO	TI	2N341		
			FCH		2N698	
			TR	2N341		
2N342	SNPNG	AFO	TI	2N342		
			FCH		2N696	
			TR	2N342		
2N342A	SNPN	AFO	TI	2N342A		
			TR	2N342A		
2N343	SNPNA	AFO	TI	2N343		
			TR	2N343		
2N344	GPNPS	HF	PHL	2N344		
			RCA		2N274	
			GT		2N607	
			SPR	2N344[7]		
			PYE		V15/20R	
2N345	GPNPS	HF	PHL	2N345		
			RCA		2N274	
			GT		2N608	
			SPR	2N345[7]		
			PYE		V15/20R	
2N346	GPNPS	HF	PHL	2N346		
			RCA		2N384	
			GT		2N608	
			SPR	2N346[7]		
2N347	SNPNA	AFO	BOG	2N347		
2N348	SNPNA	AFO	BOG	2N348		
2N348A			BOG	2N348A		
2N349	SNPNA	AFO	BOG	2N349		
2N350	GPNPA	AFO	MOT	2N350		
			RCA		2N301	
			CBS		2N236A	11
			BEN		2N235A	
			TS		2N242	12
			AMP		OC26	
			GEM	2N350		
			PHL		2N386	
			CTP		CTP1117	
			SYL	2N350		
2N350A	GPNPA	AFO	MOT	2N350A		
			TS		2N242	
2N351	GPNPA	AFO	MOT	2N351		
			RCA		2N351[5]	
			CBS		2N236A	11
			BEN		2N236A	
			TS		2N242	12
			AMP		OC27	
			GEM	2N351		
			PHL		2N386	
			SYL	2N351		
			CTP		CTP1117	
2N351A	GPNPA	AFO	MOT	2N351A		
			TS		2N242	
2N352	GPNP	AFO	PHL	2N352		
			RCA		2N301[5]	
			CBS		2N301	11
			BEN		2N235A	
			TS		2N242	12
			MOT		2N351A	
			AMP		OC27	
			GEM		2N242	
			SYL		2N242	
			CTP		CTP1117	
2N353	GPNP	AFO	PHL	2N353		
			RCA		2N301[5]	
			CBS		LT5099	11
			BEN		2N236A	
			TS		2N242	12
			MOT		2N376	
			AMP		OC27	
			GEM		2N242	
			SYL		2N242	
			CTP		CTP1117	
2N354	SPNP	AF	PHL	2N354		
2N355	SPNP	AF	PHL	2N355		
2N356	GNPNA	S	GT	2N356		
			RCA	2N356		
			CBS	2N356		11
			AMP		OC139	
			GEM	2N356		
			GE		2N634	
			SYL	2N356		
			HU	2N356		
2N356A	GNPNA	S	GT	2N356A		
			CBS	2N356A		11
2N357	GNPNA	S	GT	2N357		
			RCA	2N357		
			CBS	2N357		11
			AMP		OC140	
			GEM	2N357		
			PYE		V10/15C	
			GE		2N634	
			SYL	2N357		
			HU	2N357		
2N357A	NPN	S	GT	2N357A		
			CBS	2N357A		11
2N358	GNPNA	S	GT	2N358		
			RCA	2N358		
			CBS	2N358		11
			AMP		OC141	
			GEM	2N358		
			GE		2N635	
			SYL	2N358		
			HU	2N358		
2N358A	GNPN	S	GT	2N358A		
			CBS	2N358A		11
2N359	GPNPA	AF	RAY	2N359		
			IND	2N359	2N631	1
			GT		GT109	
			MOT		2N652	
			AMP		OC72	
			W		2N59	
2N360	GPNPA	AF	RAY	2N360		
			IND	2N360	2N632	1
			GT		GT109	
			MOT		2N652	
			AMP		OC72	
			W		2N60	
2N361	GPNPA	AF	RAY	2N361		
			IND	2N361	2N633	1
			GT		GT109	
			MOT		2N651	
			AMP		OC72	
			W		2N61	
2N362	GPNPA	AF	RAY	2N362		
			IND	2N362		1
			GT		GT81	
			TS		2N283	1
			MOT		2N1193	
			W		2N403	
2N363	GPNPA	AF	RAY	2N363		
			IND	2N363		1
			GT		GT81	
			TS		2N382	1
			MOT		2N1192	
			AMP		OC70	
			W		2N403	
2N364	GNPN	GP	TI	2N364		
			GT		2N444	
2N365	GNPN	GP	TI	2N365		
			GT		2N445	
2N366	GNPN	GP	TI	2N366		
			GT		2N446	
2N367	GNPN	GP	TI	2N367		
			RCA		2N406	
			IND		TR34	
			GT		GT34	
			BEN		2N1176A	
			TS		2N381	
			MOT		2N1191	
			AMP		2N279	
			W		2N612	
			PHL		2N226	
			GE		2N189	
2N368	GPNP	GP	TI	2N368		
			RCA		2N213	
			IND		TR722	
			GT		GT20	
			BEN		2N1176A	
			TS		2N382	1
			MOT		2N1191	
			AMP		2N279	
			GEM		2N109	
			W		2N403	
			PHL		2N1130	
			GE		2N189	
			SYL		2N109	
2N369	GPNP	GP	TI	2N369		
			RCA		2N215	
			GT		GT81	
			BEN		2N1176A	
			TS		2N383	
			MOT		2N1192	
			AMP		2N280	
			GEM		2N109	
			W		2N403	
			PHL		2N1130	
			GE		2N190	
			SYL		2N109	
2N370	GPNPD	RF	RCA	2N370		
			GT		2N608	
			AMP		2N1516	
			GEM	2N370		
			PYE		V15/20R	
			PHL		2N588	
			SYL	2N370		
2N371	GPNPD	OSC	RCA	2N371		
			GT		2N608	
			AMP		2N1516	
			GEM	2N371		
			PYE		V15/20R	
			PHL		2N499	
			SYL	2N371		
2N372	GPNPD	M	RCA	2N372		
			AMP		OC140	
			GEM	2N372		
			PYE		V15/20R	
			PHL		2N588	
			SYL	2N372		
2N373	GPNPD	IF	RCA	2N373		
			AMP		2N1515	
			GEM	2N373		
			PYE		V15/20R	
			PHL		2N588	
			SYL	2N373		
2N374	GPNPD	CNV	RCA	2N374		
			AMP		2N1515	
			GEM	2N374		
			PYE		V15/20R	
			PHL		2N588	
			SYL	2N374		
2N375	GPNPA	P	MOT	2N375		
			RCA		2N561	
			CBS		LT5108	11
			BEN		2N639B	
			TS		2N459	12
			GEM		2N296	
			PHL		2N387	
2N376	GPNPA	AFO	MOT	2N376		
			RCA	2N376		
			CBS		2N236B	11
			BEN		2N236B	
			TS		2N242	
			GEM		2N236B	
			PHL		2N386	
			CTP		CTP1117	
2N376A			BEN		2N236B	
			TS		2N242	
2N377	GNPNA	S	SYL	2N377		
			RCA		2N357	
			GT		2N357	
			CBS		2N377	1
			AMP		OC140	
			GEM	2N377		
			GE		2N634	
2N378	GPNPA	P	TS	2N378		12
			RCA		2N561	
			CBS		2N301	11
			BEN		2N639	
			MOT		2N176	
			GEM		2N242	
			PHL		2N386	
			SYL		2N242	
			CTP		2N257	
2N379	GPNPA	P	TS	2N379		12
			RCA		2N561	
			CBS		2N297A	11
			BEN		2N638	
			MOT		2N375	
			GEM		2N296	
			PHL		2N387	
			CTP		2N268A	
2N380	GPNPA	P	TS	2N380		12
			RCA		2N561	
			CBS		2N297A	11
			BEN		2N637	
			MOT		2N1359	
			AMP		OC28	
			GEM		2N296	
			PHL		2N386	
			CTP		2N268A	
2N381	GPNPA	AF	TS	2N381		1
			RCA		2N270	
			IND	2N381	TR722	1
			BEN		2N1008A	
			AMP		OC74	
			GEM	2N381		
			W		2N61	
			PHL		2N1128	
			GE		2N320	
			SYL	2N381		
2N382	GPNPA	AF	TS	2N382		1
			RCA		2N270	
			IND	2N382	2N363	1
			BEN		2N1008A	
			AMP		OC74	
			GEM	2N382		
			W		2N60	
			PHL		2N1128	
			GE		2N321	
			SYL	2N382		

Faster switching speeds combined with low saturation resistance make Motorola 2N627-30 power transistors ideal for industrial power-switching applications. Their low power loss results in greater circuit efficiency especially for applications operating above 400 cps. In addition, these 10 amp power transistors offer: High voltage breakdown . . . flat gain vs current curve . . . and low I_{CBO}. Their high reliability is proven in more than 20 million hours of life-test data.

Motorola 2N627-30 power transistors are IMMEDIATELY AVAILABLE, in engineering quantities, from your nearest Motorola Semiconductor Distributor, who also carries a full line of Motorola mounting hardware. Call him, today!

FOR MILITARY APPLICATIONS . . . Motorola offers the 2N1120, a 10 amp power transistor designed to meet MIL-T-19500A/68 (Sig. Corps) specifications. These units are available, in quantity, through your Motorola Semiconductor district office.

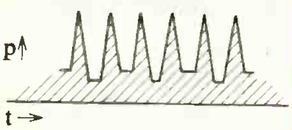




FOR MORE EFFICIENT SWITCHING

Less power loss . . . improved circuit performance

HIGH FREQUENCY POWER LOSS



HOW TO DETERMINE AVERAGE POWER LOSS

$$P_{loss} = \frac{I_p}{6T}(V_p + 2V_{CS})(t_r + t_f) \quad \text{switching loss}$$

$$+ \frac{I_p V_{CS}}{T}\left(\frac{T}{2} - t_r\right) \quad \text{"on" loss}$$

$$+ \frac{I_{CO} V_p}{T}\left(\frac{T}{2} - t_f\right) \quad \text{"off" loss}$$

Where I_p is maximum collector current.
V_p is maximum collector voltage.
V_{CS} is minimum collector voltage.
I_{CO} is collector cutoff current.
T is period of square wave.
t_r is rise time.
t_f is fall time.

NOTE: In push pull converter operations, wave shapes are generally symmetrical because of feedback, and "storage" time can be considered as part of the "on" time.

DESIGN CHARACTERISTICS at 25° ± 3°C

		2N627	2N628	2N629	2N630	2N1120	Units
BV_{CBO}	max	40	60	80	100	80	volts
BV_{CES}	max	30	45	60	75	70	volts
I_C	max	10	10	10	10	15	amps
T_J	max	100	100	100	100	100	°C
$V_{CE(SAT)}$	max(I_C=10A, I_B=1A)	1.0	1.0	1.0	1.0	1.0	Vdc
$f_{\alpha e}$ (typical)		8	8	8	8	8	Kc

SWITCHING TIME (based upon average of a typical production lot) @ 10A

t_r	rise time	4.1	μsec
t_f	fall time	13.2	μsec
t_s	Storage time	2.5	μsec
Total switching time		19.8	μsec

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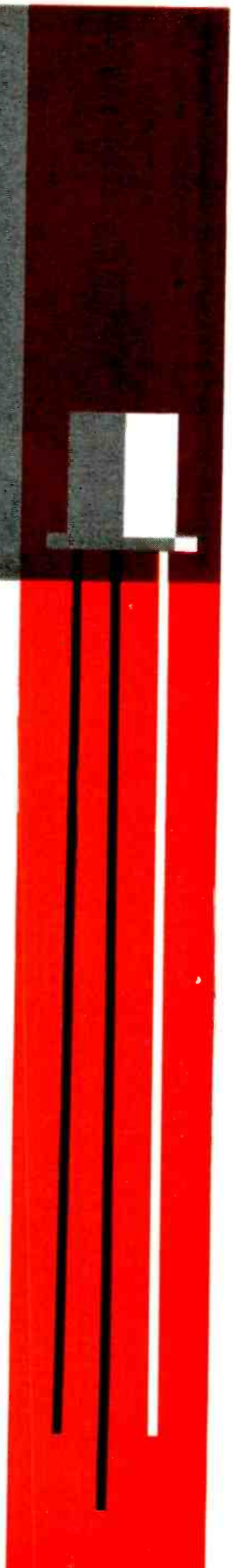
MOTOROLA
Semiconductor Products Division

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N383	GPNPA	AF	TS	2N383		1
			RCA		2N270	
			IND	2N383	2N466	1
			BEN		2N1008A	
			AMP		OC74	
			GEM	2N383		
			W		2N59	
			PHL		2N1128	
			GE		2N321	
			SYL	2N383		
2N384	GPNPA	HF	RCA	2N384		
			AMP		2N1517	
			GEM	2N384		
			PHL		2N502	
			SYL	2N384		
2N385	GPNPA	S	SYL	2N385		
			RCA		2N357	
			GT		2N357	
			CBS	2N385		
			GEM	2N385		
			GE		2N634	
2N386	GPNPA	AFO	PHL	2N386		
			RCA		2N301A	
			CBS		LT5066	11
			BEN		2N638A	
			TS		2N380	12
			MOT		2N375	
			AMP		OC28	
			GEM		2N296	
			PYE		V60/30P	
			SYL		2N296	
			CTP		2N268A	
2N387	GPNPA	AFO	PHL	2N387		
			CBS		LT5075	11
			BEN		2N638B	
			TS		2N379	12
			MOT		2N375	
			AMP		OC29	
			CTP		CTP1112	
2N388	GNPNA	S	SYL	2N388		
			RCA		2N357	
			GT		2N358	
			CBS	2N388		1
			AMP		OC141	
			GEM	2N388		
			GE	2N388		
			HU	2N388		
2N389	SNPNG	AFO	TI	2N389		
			TR	2N389		
2N392	GPNP	P	DEL	2N392		12
			CBS		2N297A	11
			BEN		2N1137	
			MOT		2N628	
			PHL		2N386	
2N393	GPNPA	RF	PHL	2N393		
			SPR	2N3937		
			AMP		2N1516	
2N394	GPNPA	S	GE	2N394		8
			RCA		2N404	
			IND		2N1353	
			GT		2N520	
			TS		2N425	
			AMP		2N284	
			GEM		2N404	
			W		2N615	
			PHL		2N1125	
			SYL		2N404	
2N395	GPNPA	S	GE	2N395		8
			RCA		2N581	
			IND		2N1354	
			GT		2N521	
			TS		2N426	1
			TR	2N395		
			AMP		OC46	
			GEM		2N404	
			W		2N615	
			PHL		2N597	
			TI	2N395		
			SYL		2N404	
2N396	GPNPA	S	GE	2N396		8
			RCA		2N404	
			IND		2N1355	
			GT		2N315	
			TS		2N426	
			AMP		OC46	
			GEM		2N404	
			W		2N617	
			PHL		2N598	
			TI	2N396		
			SYL		2N404	
2N396A			IND		2N1356	
2N397	GPNPA	S	GE	2N397		8
			RCA		2N582	
			IND		2N1357	
			GT		2N316	
			TS		2N427	1
			TR	2N397		
			AMP		OC47	
			GEM		2N404	
			W		2N617	
			PHL		2N599	
			TI	2N397		
			SYL		2N404	
2N398	GPNPA	S	RCA	2N398		
			GT		GT34N	
			PHL		2N674	
2N399	GPNPA	AFO	BEN	2N399		
			RCA		2N456	
			CBS		2N301	11
			TS		2N242	
			MOT		2N351	
			GEM	2N399		
			PYE		V60/30P	
			PHL		2N386	
			SYL	2N399		
			CTP		CTP1137	
2N400	GPNPA	AFO	BEN	2N400		
			RCA		2N456	
			CBS		2N236B	11
			TS		2N242	
			MOT		2N376A	
			GEM		2N350	
			PYE		V60/30P	
			SYL		2N350	
			CTP		CTP1137	
2N401	GPNPA	AFO	BEN	2N400		
			RCA		2N456	
			CBS		2N301	11
			TS		2N242	
			MOT		2N350	
			GEM	2N401		
			PYE		V60/30P	
			PHL		2N386	
			SYL	2N401		
			CTP		2N257	
2N402	GPNP	AF	W	2N402		
			RCA		2N406	
			IND		TR722	
			GT		GT20	
			BEN		2N1008A	
			TS		2N381	
			MOT		2N1191	
			AMP		OC71	
			NUC		NPC121	
			PHL		2N223	
			GE		2N188A	
2N403	GPNP	AF	W	2N403		
			RCA		2N215	
			IND		2N465	
			GT		GT81	
			BEN		2N1008A	
			TS		2N381	12
			MOT		2N1191	
			AMP		OC74	
			GEM		2N139	
			NUC		NPC121	
			PHL		2N223	
			GE		2N187A	
2N404	GPNPA	S	RCA	2N404		
			GT	2N404		
			TS			1
			MOT	2N404		
			AMP		OC47	
			GEM	2N404		
			RAY	2N404		
			PYE		V6/8R	
			PHL		2N598	
			GE	2N404		
			SYL	2N404		
			TR	2N404		
			HU	2N404		
2N405	GPNPA	AFD	RCA	2N405		
			IND		2N362	
			GT		GT20	
			BEN		2N1008	
			TS		2N382	
			MOT		2N1191	
			AMP		2N281	
			GEM	2N405		
			W		2N403	
			PHL		2N1128	
			GE		2N1145	
			SYL	2N405		
2N406	GPNPA	AFD	RCA	2N406		
			IND		2N362	
			GT		GT20	
			BEN		2N1008	
			TS		2N382	
			MOT		2N1191	
			AMP		2N281	
			GEM	2N406		
			W		2N403	
			PHL		2N1130	
			GE		2N1145	
			SYL	2N406		
2N407	GPNPA	AF	RCA	2N406		
			IND		2N633	
			GT		GT109	
			BEN		2N1008	
			TS		2N383	
			MOT		2N1192	
			AMP		2N281	
			GEM	2N407		
			W		2N60	
			PHL		2N1129	
			GE		2N241A	
			SYL	2N407		
2N408	GPNPA	AF	RCA	2N408		
			IND		2N633	
			GT		GT109	
			BEN		2N1008	
			TS		2N383	1
			MOT		2N1192	
			AMP		2N281	
			GEM	2N408		
			W		2N60	
			PHL		2N1129	
			GE		2N241A	
			SYL	2N408		
2N409	GPNPA	IF	RCA	2N409		
			IND		2N633	
			GT		GT760R	
			TS		2N414	1
			AMP	2N409	OC45	
			GEM			
			W		2N615	
			PYE		V6/4RC	
			PHL		2N344	
			GE		2N450	
			SYL	2N409		
2N410	GPNPA	IF	RCA	2N410		
			IND		2N482	
			GT		GT760R	
			TS		2N414	
			AMP		OC45	
			GEM	2N410		
			W		2N615	
			PYE		V6/8RC	
			PHL		2N344	
			GE		2N450	
			SYL	2N410		
2N411	GPNPA	CNV	RCA	2N411		
			IND		2N485	
			GT		GT761R	
			TS		2N416	
			AMP		OC44	
			GEM	2N411		
			W		2N617	
			PHL		2N588	
			GE		2N450	
			SYL	2N411		
2N412	GPNPA	CNV	RCA	2N412		
			IND		2N485	
			GT		GT761R	
			TS		2N416	1
			AMP		OC44	
			GEM	2N412		
			W		2N617	
			PHL		2N588	
			GE		2N450	
			SYL	2N412		
2N413	GPNPA	IF	RAY	2N413		
			RCA		2N218	
			IND	2N413		1
			GT		2N519	
			TS	2N413		1
			PHL		2N504	
			GE		2N450	
2N413A	GPNPA	IF	RAY	2N413A		
			RCA		2N218	
			GT		GT760R	
			AMP		OC45	
			GEM	2N413A		
			W		2N615	
			PHL		2N1122A	
			GE		2N450	
			SYL	2N413A		
2N414	GPNPA	IF	RAY	2N414		
			RCA		2N218	
			IND	2N414		1
			GT		2N520	
			TS	2N414		
			GEM		2N414A	
			PHL		2N504	
			GE		2N450	
2N414A	GPNPA	IF	RAY	2N414A		
			RCA		2N218	
			GT		GT761R	
			AMP		OC45	
			GEM	2N414A		
			W		2N615	
			PHL		2N504	
			GE		2N450	
			SYL	2N414A		
2N414B	PNP	RF	IND	2N414B		1
2N415	GPNPA	CNV	RAY	2N415		
			RCA		2N374	
			IND		2N521	
			GT		2N521	
			AMP		OC44	
			GEM		2N247	
			PHL		2N1122A	
			GE		2N450	
2N415A	GPNPA	CNV	RAY	2N415A		
			RCA		2N374	
			IND		2N416	
			AMP		OC45	
			GEM		2N247	
			W		2N617	
			PHL		2N599	
			GE		2N450	
			SYL	2N415A		
2N416	GPNPA	IF	RAY	2N416		
			RCA		2N247	
			IND	2N416		
			GT		2N521	
			TS	2N416		
			AMP		OC44	
			GEM		2N247	
			W		2N617	
			PHL		2N599	
			GE		2N450	
			SYL		2N247	
2N417	GPNPA	IF	RAY	2N417		
			RCA		2N247	
			IND	2N417		1
			GT		2N522	
			TS	2N417		1
			AMP		OC44	
			PHL		2N599	
			GE		2N450	
2N418	GPNPA	AFO	BEN	2N418		
			RCA		2N301	
			MOT		2N1363	
			GEM		2N296	
2N419	GPNPA	PS	BEN	2N419		
			RCA		2N561	
			CBS		LT5063	11
			TS		2N380	
			MOT		2N1360	
			GEM	2N419		
			PYE		V60/30P	
			SYL	2N419	2N296	
2N420	GPNPA	PS	BEN	2N420		
			RCA		2N561	
			CBS		2N301A	11
			MOT		2N1360	
			GEM	2N420		
			PYE		V60/30NP	
			SYL	2N420		
2N420A			BEN	2N420A		
2N421	GPNPA	PS	BEN	2N421		
			RCA		2N561	
2N422	GPNPA	AF	RAY	2N422		
			RCA		2N215	
			GT		GT81	
			BEN		2N1008A	
			TS		2N461	1
			MOT		2N1191	
			PHL		2N1128	
			GE		2N320	

NOW SPERRY QUALITY IN SILICON MESA TRANSISTORS



2N696 2N697 2N699 2N706

DIVERSE APPLICATION in all areas of high-speed switching, broad-band video amplification and RF oscillation. New Sperry line of mesa transistors permits unsurpassed design flexibility with unique combinations of frequency, gain, voltage and power dissipation.

IMPROVED CONSTRUCTION means greater reliability. More rugged short-post design guarantees better mechanical strength; concentric base-emitter configuration provides optimum efficiency. And of course, all units undergo thorough bakeout at 300°C to insure stability.

HIGHER POWER 2N706 provides sophisticated logic device of even greater value for reliable high-speed operation in the saturated region.

For unsurpassed stability, performance, reliability and long life in silicon mesa transistors — SPECIFY SPERRY.

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ELECTRICAL CHARACTERISTICS (25°C)

Type	2N696	2N697	2N699	2N706
V_{CBO}	60v.	60v.	120v.	25v.
h_{FE} (Min.) (I_C = 150ma, V_{CE} = 10V)	20	40	40	15
h_{fe} (Min.) (I_C = 50ma, V_{CE} = 10V, f = 20mc.*) *for 2N706: f = 100mc.	2.0	2.5	2.5	2.0
P at 25°C case temp.	2w.	2w.	2w.	1w.

SPERRY

SPERRY SEMICONDUCTOR DIVISION, *SPERRY RAND CORPORATION, SOUTH NORWALK, CONNECTICUT*
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Circle 103 on Inquiry Card

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N424	SNPNA	P	TI	2N424		
			GT		GT269	
			TR	2N424		
2N425	GPNPA	S	RAY	2N425		
			RCA		2N404	
			IND	2N425		1
			GT		2N315	
			TS	2N425		1
			MOT	2N425		
			AMP		OC47	
			GEM	2N425		
			PHL		2N597	
			GE		2N394	
			SYL	2N425		
			TR	2N425		
			HU	2N425		
2N426	GPNPA	S	RAY	2N426		
			RCA		2N578	
			IND	2N426		1
			GT		2N315	
			TS	2N426		
			MOT	2N426		
			AMP		OC47	
			GEM	2N426		
			PHL		2N598	
			GE		2N395	
			SYL	2N426		
			TR	2N426		
			HU	2N426		
2N427	GPNPA	S	RAY	2N427		
			RCA		2N579	
			IND	2N427		1
			GT		2N316	
			TS	2N427		
			MOT	2N427		
			AMP		OC47	
			GEM	2N427		
			PHL		2N599	
			GE		2N396	
			SYL	2N427		
			TR	2N427		
			HU	2N427		
2N428	GPNPA	S	RAY	2N428		
			RCA		2N580	
			IND	2N428		1
			GT		2N317	
			TS	2N428		
			MOT	2N428		
			AMP		OC47	
			GEM	2N428		
			PHL		2N1478	
			GE		2N397	
			SYL	2N428		
			TR	2N428		
2N430	SNPNA	S	GE	2N430		
2N431	SNPNA	RF	GE	2N431		
2N432	SNPNA	RF	GE	2N432		
2N433	SNPNA	RF	GE	2N433		
2N434	SNPNA	RF	GE	2N434		
2N438	NPN	S	CBS	2N438		1
			RAY	2N438		
			GE		2N634	
2N438A	NPN	S	CBS			1
			RCA		2N356	
			GE		2N634	
2N439	NPN	S	CBS			1
			GT		2N446	
			GEM	2N439		
			RAY	2N439		
			GE		2N634	
			SYL	2N439		
2N439A	NPN	S	CBS	2N439A		1
			RCA		2N357	
			GE		2N634	
2N440	NPN	S	CBS	2N440		1
			GT		2N447	
			RAY	2N440		
			GE		2N635	
2N440A	NPN	S	CBS	2N440A		1
			RCA		2N358	
			GE		2N635	
2N441	GPNPA	AFO	DEL	2N441		
			BEN		2N1031[6]	
			TS	2N441		14
			MOT		2N628	
			GEM		2N677	
			PHL		2N386	
			CTP		CTP1509	
2N442	GPNPA	AFO	DEL	2N442		
			BEN		2N1031[6]	
			TS	2N442		14
			MOT		2N628	
			GEM		2N677	
			PHL		2N386	
			CTP		CTP1507	
2N443	GPNPA	AFO	DEL	2N443		
			BEN		2N1031A[6]	
			TS	2N443		
			MOT		2N629	
			AMP		OC29	
			GEM		2N677B	
			PHL		2N386	
			CTP		CTP1505	
2N444	NPN	S	GT	2N444		
			RCA		2N356	
			CBS		2N444	1
			PYE		V10/15A	
2N444A	NPN	S	GT	2N444A		
			CBS		2N377	1
2N445	NPN	S	GT	2N445		
			RCA		2N356	
			CBS	2N445		1
2N445A	NPN	S	GT	2N445A		
			CBS		2N377	1
2N446	NPN	S	GT	2N446		
			RCA		2N357	
			CBS	2N446		1
			GE		2N634	
2N446A	NPN	S	GT	2N446A		
			CBS		2N385	1
2N447	GNPNA	S	GT	2N447		
			CBS	2N447		1
			RCA		2N358	
			GE		2N635	
2N447A	NPN	S	GT	2N447A		
			CBS		2N388	1
2N448	GNPN	IF	GE	2N448		7
2N449	GNPN	IF	GE	2N449		7
2N450	GNPNA	RF	GE	2N450		13
			IND		2N1347	
			GT		2N520	
			TS		2N426	1
			W		2N615	
			PHL		2N598	
2N451	SNPND	AFO	GE	2N451		
2N452	SNPND	S	GE	2N452		
2N453	SNPND	AFO	GE	2N453		
2N454	SNPND	AFO	GE	2N454		
2N456	GPNPA	PS	TI	2N456		
			RCA	2N456		
			CBS		2N301	1
			BEN		2N1136	
			MOT		2N376A	
			GEM		2N296	
			PHL		2N386	
			CTP		CTP1137	
2N457	GPNPA	P	RCA	2N457		
			CBS		2N443	2
			BEN		2N1136	
			MOT		2N618	
			GEM		2N296	
			PHL		2N386	
			CTP		2N268A	
2N458	GPNPA	HS	TI	2N458		
			RCA		2N561	
			CBS		2N174	2
			BEN		2N1136A	
			MOT		2N1363	
			PHL		2N387	
2N459	GPNPA	P	TS	2N459		12
			CBS		LT5117	11
			BEN		2N1136B	
			PHL		2N386	
			CTP		CTP1104	
			DEL	2N459		
2N460	GPNPA	AF	TS	2N460		1
			RCA		2N331	
			IND		2N1451	
			BEN		2N1008B	
			MOT		2N650	
			W		2N61	
			PHL		2N1125	
			GE		2N319	
			DEL	2N460		
2N461	GPNPA	AF	TS	2N461		1
			RCA		2N331	
			IND		2N1452	
			BEN		2N1008B	
			MOT		2N650	
			AMP		OC80	
			W		2N60	
			PHL		2N1125	
			GE		2N320	
			DEL	2N461		
2N462	GPNP	S	PHL	2N462		
			GT		2N593	
2N463	GPNPA	PA	WE	2N436		
			CBS		2N297A	11
			MOT		2N629	
			PYE		V60/30NP	
			PHL		2N674	
2N464	GPNPA	AF	RAY	2N464		
			RCA		2N270	
			IND	2N464		19
			GT		GT14	
			BEN		2N1008B	
			TS		2N460	
			MOT	2N464		
			AMP		OC71	
			W		2N402	
			NUC		NPC141	
			PHL		2N1124	
			GE		2N187A	
2N465	GPNPA	AF	RAY	2N465		
			RCA		2N270	
			IND	2N465		19
			GT		GT20	
			BEN		2N1008B	
			TS		2N461	
			MOT	2N465		
			W		2N402	
			NUC		NPC152	
			PHL		2N1124	
			GE		2N320	
2N466	GPNPA	AF	RAY	2N466		
			RCA		2N270	
			IND	2N466		19
			GT		GT81	
			BEN		2N1008A	
			TS		2N383	
			MOT	2N466		
			GEM		2N241A	
			W		2N403	
			NUC		NPC123	
			PHL		2N1130	
			GE		2N321	
2N467	GPNPA	AF	RAY	2N467		
			IND	2N467		19
			GT		GT82	
			BEN		2N1008A	
			MOT	2N467		
			AMP		OC75	
			W		2N403	
			PHL		2N1128	
			GE		2N508	
2N468	NPN	P	CBS	2N468		6
2N469	GPNPA	PH	GT	2N469		
2N470	SNPND	RF	TR	2N470		
2N471	SNPND	RF	TR	2N471		
2N472	SNPND	RF	TR	2N471		
2N472	SNPND	RF	TR	2N473		
2N474	SNPND	RF	TR	2N474		
2N475	SNPND	RF	TR	2N475		
2N476	SNPND	RF	TR	2N476		
2N477	SNPND	RF	TR	2N477		
2N478	SNPND	RF	TR	2N478		
2N479	SNPND	RF	TR	2N479		
2N480	SNPND	RF	TR	2N480		
2N481	GPNPA	RF	RAY	2N481		
			RCA		2N371	
			GT		GT761R	
			TS		2N413	1
			MOT		2N1191	
			W		2N617	
			PHL		2N1125	
2N482	GPNPA	IF	RAY	2N482		
			RCA		2N373	
			IND	2N482		19
			GT		GT760R	
			TS		2N414	
			W		2N614	
			PHL		2N1125	
2N483	GPNPA	IF	RAY	2N483		
			RCA		2N373	
			IND	2N483		19
			GT		GT760R	
			W		2N615	
			PHL		2N598	
2N484	GPNPA	IF	RAY	2N484		
			RCA		2N373	
			IND	2N484		19
			GT		GT760R	
			TS		2N416	
			W		2N615	
			PHL		2N599	
2N485	GPNPA	IF	RAY	2N485		
			RCA		2N374	
			IND	2N485		19
			GT		GT761R	
			TS		2N414	1
			W		2N617	
			PHL		2N598	
2N486	GPNPA	IF	RAY	2N486		
			RCA		2N374	
			IND	2N486		19
			GT		GT761R	
			W		2N617	
			PHL		2N599	
2N487	GPNPA	RF	RAY	2N487		
2N489	Diode	Si Unij.	GE	2N489		18
2N490	Diode	Si Uni	GE	2N490		18
2N491	Diode	Si Unij.	GE	2N491		18
2N492	Diode	Si Unij.	GE	2N492		18
2N493	Diode	Si Unij.	GE	2N493		18
2N494	Diode	Si Unij.	GE	2N494		18
2N495	SPNPA	S	PHL	2N495	2N1118	
			SRC		S500	
			HU		2N1254[7]	
			FCH		2N1131	
2N496	SPNPA	S	PHL	2N496		
			HU		2N1254[7]	
			FCH		2N696	
2N497	S	P	TI	2N497		
			RHE	2N497		
			FCH		2N497	
			TR	2N497		
2N498	S	P	TI	2N498		
			RHE	2N498		
			TR	2N498		
2N499	GPNPD	HF	PHL	2N499		16
			RCA		2N371	
			SPR	2N499[7]		
			AMP		2N1517	
2N500	GPNPD	HF, OSC	PHL	2N500		16
			SPR	2N500		
2N501	GPNPD	S	PHL	2N501[7]		16
			SPR	2N501[7]		
2N501A	GPNPD	S	PHL	2N501A[7]		16
			SPR	2N501A[7]		
2N502	GPNPD	HF	PHL	2N502		5
			SPR	2N502		
2N502A	GPNPD	HF	PHL	2N502A		5

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N503	GNPND	HF	PHL	2N503		5
			SPR	2N503		
2N504	GPNPD	IF	PHL	2N504		
			RCA		2N373	
			GT		2N606	
			SPR	2N504[7]		
2N505	GPNPA	RF	MOT	2N505		
			PYE		V10/15C	
2N506	PNP		SYL	2N506		
			GEM	2N506		
			PHL		2N1124	
			GE		2N1098	
2N507	NPN		SYL	2N507		
			GEM	2N507		
2N508	GPNP	RF	GE	2N508		8
			IND		TR508	
			TS		2N383	1
			MOT		2N1193	
			W		2N403	
			PHL		2N1129	
2N509	GPNPD	GP	WE	2N509		
			PHL		2N502	
2N511	GPNPA	HS	TI	2N511		
			CBS		2N441	2
			TS		2N441	14
			MOT		2N628	
2N511A	PNP	P	TI	2N511A		
			CBS		2N443	2
			MOT		2N629	
2N511B	PNP	P	TI	2N511B		
			CBS		2N174	2
			MOT		2N630	
2N512	PNP	P	TI	2N512		
			CBS		2N277	2
			TS		2N443	
			MOT		2N628	
2N512A	PNP	P	TI	2N512A		
			CBS		2N278	2
			MOT		2N629	
2N512B	PNP	P	TI	2N512B		
			CBS		2N1099	2
			MOT		2N630	
2N513	PNP	P	TI	2N513		
			MOT		2N1163	
2N514	GPNPA	AFO, HS	TI	2N514		
			MOT		2N1163	
2N514A			PHL		2N386	
2N514B			PHL		2N387	
2N515	GNPNA	RF	SYL	2N515		
			GT		GT948R	
			CBS		2N445	1
			GEM	2N515		
2N516	GNPNA	RF	SYL	2N516		
			GT		GT948R	
			CBS		2N445	1
			GEM	2N516		
2N517	GNPNA	RF	SYL	2N517		
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			PHL		2N1472	
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			IND	2N568		
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			TS		2N173	14
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			TS		2N174	14
			MOT		2N629	
			GEM		2N677C	
			PHL		2N387	
2N575	GPNPA	GP	MH	2N575		
			CBS		2N1099	2
			TS		2N173	
			MOT		2N1163	
			GEM		2N677B	
			PHL		2N386	

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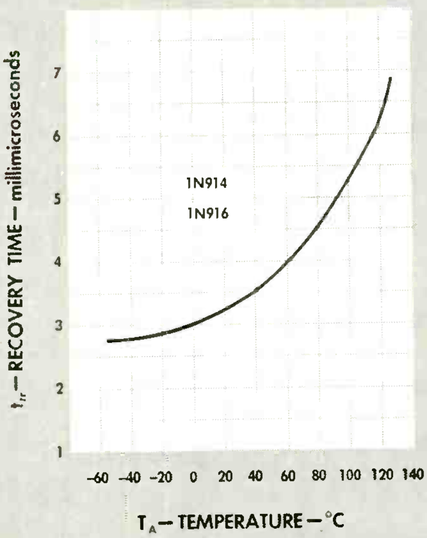
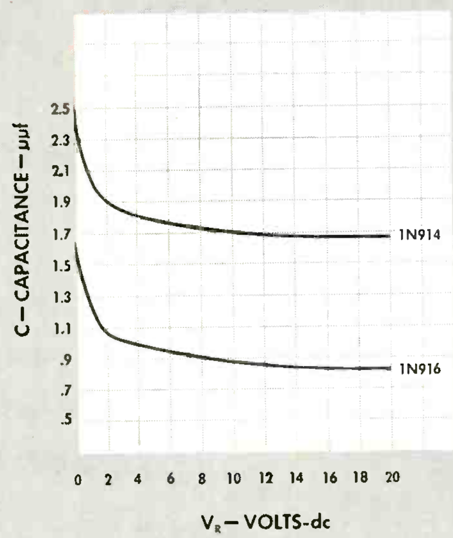
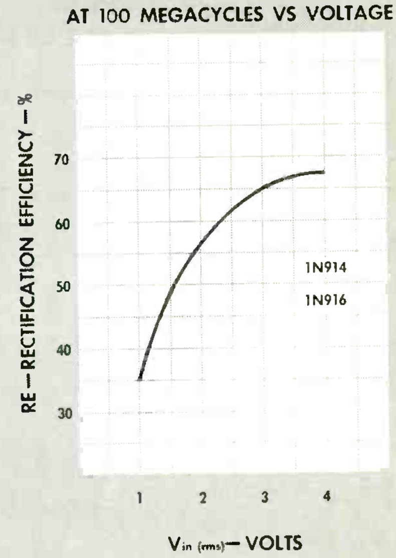
TYPICAL REVERSE RECOVERY TIME VS TEMPERATURE



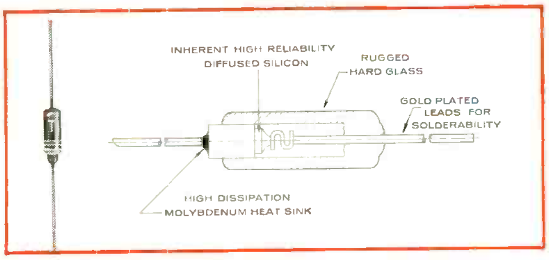
TYPICAL CAPACITANCE VS VOLTAGE

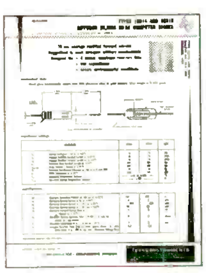


TYPICAL RECTIFICATION EFFICIENCY AT 100 MEGACYCLES VS VOLTAGE



- High maximum average rectified forward current (75 ma)
- Low maximum capacitance (2 μμf or 4 μμf at zero volts bias)
- High minimum forward conductance (10 ma at 1 v)
- Maximum reliability (TI mesa process, TI hard-glass case)





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Circle 104 on Inquiry Card

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EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N575A	GPNPA	GP	MH	2N575A		
			CBS		2N1099	2
			TS		2N174	
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2N577	PNP	PH	MU	2N577		
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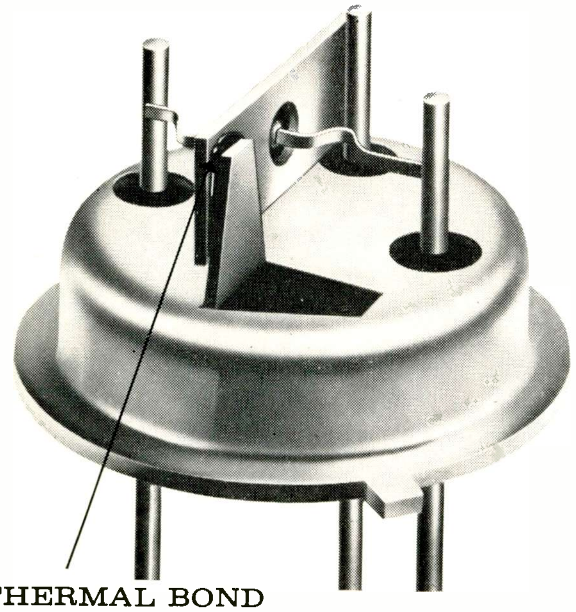
			BEN		2N1176A	
			TS		2N383	
			MOT		2N1192	
			PHL		2N1130	
			GE		2N324	
2N633	GPNPA	AF	RAY	2N633		
			RCA		2N270	
			IND	2N633		
			BEN		2N1176A	
			TS		2N382	
			MOT		2N1191	
			PHL		2N1124	
			GE		2N323	
2N634	GPNP	S	GE	2N634		8
			CBS	2N634		1
2N635	GPNP	S	GE	2N635		8
			RCA		2N1091	
			CBS	2N635		1
2N636	GPNP	S	GE	2N636		8
			RCA		2N1091	
			CBS	2N636		1
2N637	GPNPA	PS	BEN	2N637		
			RCA		2N561	
			CBS		2N301	11
			MOT		2N1360	
			PYE		V60/30NP	
			PHL		2N386	
2N637A	GPNPA	PS	BEN	2N637A		
			RCA		2N561	
			CBS		LT5099	11
			MOT		2N618	
			PHL		2N387	
2N637B	GPNPA	PS	BEN	2N637B		
			RCA		2N561	
			CBS		LT5108	11
			MOT		2N1363	
			PHL		2N387	
2N638	GPNPA	PS	BEN	2N638		
			RCA		2N561	
			CBS		2N301	11
			TS		2N379	
			MOT		2N1359	
			PYE		V60/15NP	
			PHL		2N386	
2N638A	GPNPA	PS	BEN	2N638A		
			RCA		2N561	
			CBS		LT5099	11
			TS		2N459	12
			MOT		2N375	
			PHL		2N387	
2N638B	GPNPA	PS	BEN	2N638B		
			RCA		2N561	
			CBS		LT5108	11
			MOT		2N1362	
			PHL		2N387	
2N639	GPNPA	PS	BEN	2N639		
			RCA		2N561	
			CBS		2N301	11
			TS		2N379	
			MOT		2N1359	
			PHL		2N386	
2N639A	GPNPA	PS	BEN	2N639A		
			RCA		2N561	
			CBS		LT5063	11
			TS		2N459	
			MOT		2N385	
			PYE		V60/15NP	
			PHL		2N387	
2N639B	GPNPA	PS	BEN	2N639B		
			CBS		LT5072	11
			MOT		2N1362	
			PHL		2N387	
2N640	GPNPD	RF	RCA	2N640		
			PHL		2N588	

5 GUARANTEES

for Tung-Sol 2N1313 Computer Transistor mean new freedom for designers



THERMAL BOND

- GUARANTEED DESIGN CENTER VALUES OF ALL MAJOR PARAMETERS
- GUARANTEED MIN-MAX LIMITS FOR ALL MAJOR PARAMETERS
- GUARANTEED DISTRIBUTION OF ELECTRICAL DESIGN CHARACTERISTICS
- GUARANTEED DISTRIBUTION OF SWITCHING TIMES
- GUARANTEED UNIFORMITY OF EVERY LOT

And there's still another. For a nominal additional charge any specific electrical design characteristic will be 100% guaranteed not to exceed its distribution limits. These guarantees add up to a marked upgrade in circuit design accuracy . . . high reliability in operation . . . and consistent repeat performance. In specifying the Tung-Sol 2N1313 high speed switching transistor, you're selecting a transistor which features an ideal balance of the most wanted characteristics as revealed by a survey of computer designers. You're also choosing a transistor which offers improved performance at lower cost over most of today's popular computer types.

The 2N1313 is designed to meet vigorous military environmental standards. It features "Thermal Bond" construction, exclusive with Tung-Sol. The transistor junction tab is securely joined to the base of the transistor. The bonding material provides high heat dissipation while maintaining complete base-to-case electrical isolation.

Tung-Sol Electric Inc., Newark 4, N. J. SALES OFFICES: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Philadelphia, Pa.; Seattle, Wash.; Montreal, Canada.

Absolute Maximum Ratings (@ 25°C)

BV_{CBO} . . . . −30 Volts
BV_{EBO} . . . . −20 Volts
BV_{CEX} (V_{BE}=0.1V) . . . . . −20 Volts
BV_{CEO} . . . . −15 Volts
I_C (continuous) 400mA
I_B (continuous) 50mA
T_j . . . . −65°C to +100°C
P_C 180mW

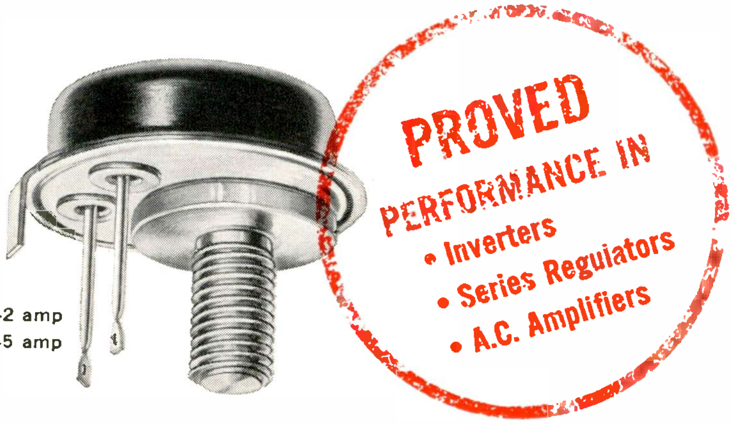
Typical Characteristics (@ 25°C)

Parameter	Conditions	Min.	Design Center	Max.	Units
I_{CBO}	$V_{CB} = -0.5V$	—	1.5	2.5	μA
I_{CBO}	$V_{CB} = -15V$	—	2	3.5	μA
h_{FE}	$I_B = 1mA$, $V_{CE} = -0.25V$	40	70	125	
h_{FE}	$V_{CE} = -0.35V$, $I_C = 400mA$	20	30	50	
$f_{\alpha b}$	$V_{cb} = -6V$, $I_c = 1mA$	6	12	—	Mc
C_{OB}	$V_{CB} = -6V$, $I_E = 1mA$, $f = 1Mc$	9	14	20	μμf
$(t_r + t_d)$ (rise plus delay time)	I_{B1} (turn on current to base) = 1mA; I_{B2} (turn off current) = 1mA; $I_C = 10mA$; $R_L = 1K$	—	0.45	0.70	μsec
t_s (storage)		—	0.30	0.60	μsec
t_f (fall)		—	0.25	0.40	μsec

TUNG-SOL

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N641	GPNPD	IF	RCA	2N641		
			PHL		2N588	
2N642	GPNPD	CNV	RCA	2N642		
			PHL		2N588	
2N643	GPNPD	S	RCA	2N643		5
			PHL		2N504	
2N644	GPNPD	S	RCA	2N644		5
			PHL		2N240	
2N645	GPNPD	S	RCA	2N645		5
			PHL		2N501	
2N646			FCH		2N696	
2N647	GNPNA	AF	RCA	2N647		
2N649	GNPN	AF	RCA	2N649		22
			PYE		V10/50AC	
2N650	GPNPA	AF	MOT	2N650		
			IND		TR650	
			TS		2N460	1
			PHL		2N1124	
2N651	GPNPA	AF	MOT	2N651		
			TS		2N461	
			PHL		2N1124	
2N652	GPNPA	AF	MOT	2N652		
			PHL		2N1124	
2N653	GPNPA	AF	MOT	2N653		
			IND		TR653	
			TS		2N382	
			PHL		2N1130	
2N654	GPNPA	AF	MOT	2N654		
			TS		2N383	
			PHL		2N1130	
2N655	GPNPA	AF	MOT	2N655		
			PHL		2N1130	
2N656	SNPND	P	TI	2N656		
			RHE	2N656		
			TR	2N656		
2N657	SNPND	P	TI	2N656		
			RHE	2N657		
			TR	2N657		
2N658	GPNPA	S	RAY	2N658		
			PHL		2N598	
			GE		2N394	
2N659	GPNPA	S	RAY	2N659		
			RCA		2N578	
			PHL		2N599	
			GE		2N396	
2N660	GPNPA	S	RAY	2N660		
			RCA		2N643	
			PHL		2N1478	
			GE		2N397	
2N661	GPNPA	S	RAY	2N661		
			RCA		2N643	
			PHL		2N1478	
2N662	GPNPA	S	RAY	2N662		
			RCA		2N579	
			PHL		2N598	
			GE		2N396	
2N665	GPNP	P	DEL	2N665		12
			CBS		LT5066	11
			BEN		2N639B	
			PHL		2N387	
2N669	GPNP	AFO	MOT	2N669		
			CBS		2N301	11
			TS		2N242	12
2N670	GPNPA	S	PHL	2N670		5
			BEN		2N285A	
			PYE		V60/20IP	
2N671	GPNPA	S	PHL	2N671		23
			BEN		2N285A	
2N672	GPNPA	S	PHL	2N672		5[2]
			BEN		2N1031[6]	
2N673	GPNPA	S	PHL	2N673		23
2N674	GPNPA	S	PHL	2N674		
			PYE		V60/20IP	
2N675	GPNPA	S	PHL	2N675		
			PYE		V60/20IP	
2N677	GPNPA	AFO	BEN	2N677		
			CBS		2N441	2
			BEN		2N1031[6]	
			TS		2N278	14
			MOT		2N1162	
			GEM	2N677		
			SYL	2N677		
2N677A	GPNPA	AFO	BEN	2N677A		
			CBS		2N441	
			BEN		2N1031A[6]	
			TS		2N173	
			MOT		2N1162	
			GEM	2N677A		
			SYL	2N677A		
2N677B	GPNPA	AFO	BEN	2N677B		
			CBS		2N174	2
			BEN		2N1031B[6]	
			MOT		2N1164	
			GEM	2N677B		
			SYL	2N677B		
2N677C	GPNPA	AFO	BEN	2N677C		
			CBS		2N174	
			BEN		2N1031C[6]	
			MOT		2N1166	
			GEM	2N677C		
			SYL	2N677C		
2N678	GPNPA	AFO	BEN	2N678		
			CBS		2N277	2
			BEN		2N1032[6]	
			MOT		2N1162	
2N678A	GPNPA	AFO	BEN	2N678A		
			CBS		2N277	2
			BEN		2N1032A[6]	
			MOT		2N1162	
2N678B	GPNPA	AFO	BEN	2N678B		
			CBS		2N173	
			BEN		2N1032B[6]	2
			MOT		2N1164	
2N678C	GPNPA	AFO	BEN	2N678C		
			CBS		2N1099	2
			BEN		2N1032C[6]	
			MOT		2N1166	
2N679	GNPNA	S	SYL	2N679		
			CBS		2N385	1
			GEM	2N679		
2N680	GPNP	AFO	TI	2N680		
			MOT		2N1191	
			PHL		2N1129	
2N694	GPNPD	IF	WE	2N694		
2N695	GPNPD	S	MOT	2N695		
			PHL		2N501	
2N696	SNPND	AFO,S	FCH	2N696		5
			IND	2N696		1
			RHE	2N696		
			TI	2N696		
			HE	2N696[7]		8
			PSI	2N696		
2N697	SNPND	AFO,S	FCH	2N697		5
			IND	2N697		19
			RHE	2N697		
			TI	2N697		
			HE	2N697[7]		8
			PSI	2N697		
2N698			FCH	2N698		
2N699	NPN	S	FCH	2N699		
			IND	2N699		19
2N700	GPNPD	HF	MOT	2N700		
			PHL		2N502	
2N702	S	S	TI	2N702		
			IND	2N702		24
			TR	2N702		
			FCH		2N706	
2N703	S	S	TI	2N703		
2N705	GPNP	S	TI	2N705		
			PHL		2N503	
2N706	SNPND	S	FCH	2N706		24
			IND	2N706		24
			PHL		2N1199	
2N710	GPNP	S	TI	2N710		
			PHL		2N1204	
2N715	S	HF	TI	2N715		
2N716	S	HF	TI	2N716		
2N1000	GNPNA	S	GT	2N1000		
			CBS	2N1000		1
2N1007	PNP	P	BEN	2N1007		
			CBS		2N236A	11
2N1008	GPNPA	AF	BEN	2N1008		
			MOT		2N1192	
			PHL		2N1125	
2N1008A	GPNPA	AF	BEN	2N1008A		
			MOT		2N651	
			PHL		2N1125	
2N1008B	GPNPA	AF	BEN	2N1008B		
			MOT		2N651	
			PHL		2N1125	
2N1009			PHL		2N1129	
2N1010	GNPNA	AF	RCA	2N1010		
2N1011	GPNPA	AFO	BEN	2N1011		
			MOT	2N1011		
2N1012	NPN	S	GT	2N1012		
			CBS	2N1012		1
2N1013			PYE		V60/20IP	
			PHL		2N675	
2N1014	GPNPA	AFO	RCA	2N1014		
			CBS		LT5120	11
			TS		2N459	
			MOT		2N630	
			PHL		2N387	
2N1015	SNPN	PA	W		WX1015	
2N1015A	SNPN	PA	W		WX1015A	
			TR		2N1212A	
2N1015B	SNPN	PA	W		WX1015B	
			TR		2N1212B	
2N1015C	SNPN	PA	W		WX1015C	
			TR		2N1212C	
2N1016	SNPN	PA	W		WX1016	
2N1016A	SNPN	AF,P	W		WX1016A	
			TR		2N1208A	
2N1016B	SNPN	AF,P	W			
					2N1208B	
2N1016C	SNPN	AF,P	W			
			TR		2N1208C	
2N1017	GPNPA	S	RAY	2N1017		
			RCA		2N582	
			IND	2N1017		
			PHL		2N599	
2N1018	GPNPA	S	RAY	2N1018		
2N1021	GPNPA	P	TI	2N1021		
			RCA		2N1014	
			CBS		LT5123	11
			BEN		2N1136B	
			MOT		2N1363	
			PHL		2N387	
2N1022	GPNPA	P	TI	2N1022		
			RCA		2N1014	
			CBS		LT5123	11
			BEN		2N1136B	
			MOT		2N1365	
			PHL		2N387	
2N1023	GPNPD	RF	RCA	2N1023		
			PHL		2N504	
2N1024	SPNPA	S	SRC	2N1024		
			HU		2N1228	
2N1025	SPNPA	S	SRC	2N1025		
			HU		2N1230	
2N1026	SPNPA	S	SRC	2N1026		
			HU		2N1230	
2N1027	SPNPA	S	SRC	2N1027		
2N1028	SPNPA	S	SRC	2N1028		
2N1029	PNP	P	BEN	2N1029		
			CBS		2N441	2
			TS		2N278	
			MOT		2N1163	
2N1029A	PNP	P	BEN	2N1029A		
			CBS		2N441	2
			TS		2N173	14
			MOT		2N1163	
2N1029B	GPNPA	AF,P	BEN	2N1029B		11
			CBS		2N174	2
			MOT		2N1165	
2N1029C	GPNPA	AF,P	BEN	2N1029C		11
			CBS		2N174	2
			MOT		2N1167	
2N1030	GPNPA	AF,P	BEN	2N1030		11
			CBS		2N277	2
			MOT		2N1163	
2N1030A	GPNPA	AF,P	BEN	2N1030A		
			CBS		2N277	
			MOT		2N1163	
2N1030B	GPNPA	AF,P	BEN	2N1030B		
			CBS		2N173	2
			MOT		2N1165	
2N1030C	GPNPA	AF,P	BEN	2N1030C		
			CBS		2N1099	
			MOT		2N1167	
2N1031	GPNPA	AF,P	BEN	2N1031		11
			CBS		2N441	2
			TS		2N278	14
			MOT		2N1163	
			PHL		2N386	
2N1031A	GPNPA	AF,P	BEN	2N1031A		
			CBS		2N441	
			TS		2N173	
			MOT		2N1163	
			PHL		2N386	
2N1031B	GPNPA	AF,P	BEN	2N1031B		
			CBS		2N441	
			MOT		2N1165	
			PHL		2N387	
2N1031C	GPNPA	AF,P	BEN	2N1031C		
			CBS		2N441	
			MOT		2N1167	
			PHL		2N387	
2N1032	GPNPA	AF,P	BEN	2N1032		11
			CBS		2N277	2
			MOT		2N1163	
			PHL		2N386	
2N1032A	GPNPA	AF,P	BEN	2N1032A		
			CBS		2N173	
			MOT		2N1163	
			PHL		2N386	
2N1032B	GPNPA	AF,P	BEN	2N1032B		
			CBS		2N173	
			MOT		2N1165	
			PHL		2N387	
2N1032C	GPNPA	AF,P	BEN	2N1032C		
			CBS		2N1099	
			MOT		2N1167	
			PHL		2N387	
2N1033			PHL		2N226	
2N1034	SPNPA	AF	RAY	2N1034		
			SRC	2N1034		
			HU		2N1232[7]	
			RAY	2N1034		
			PHL		2N495	
2N1035	SPNPA	AF	RAY	2N1035		
			SRC	2N1035		
			HU		2N1233[7]	
			RAY	2N1035		
			PYE		V30/20IP	
			PHL		2N495	

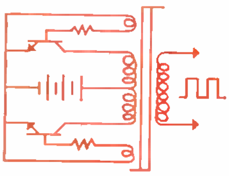
INCREASED RELIABILITY PLUS HIGHER OPERATING TEMPERATURES with Westinghouse Silicon POWER Transistors*



2N1015—2 amp
2N1016—5 amp

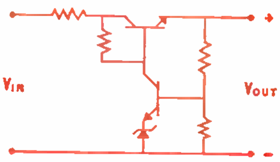
Westinghouse 2N1015 and 2N1016 Silicon Power Transistors offer positive, *proved* benefits to designers of inverters, series regulators, and A.C. Amplifiers.

INVERTERS...



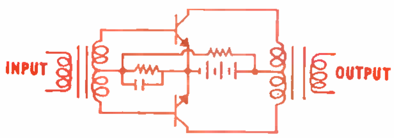
Extremely low saturation resistance (typical .3 ohms) minimizes power losses in the transistor. High temperature (150°C T_j max.) operation permits compact inverter designs for missiles, aircraft, and other military equipment.

SERIES REGULATORS



High voltage ratings and high temperature operation, plus internal power dissipation of 150 watts made possible by low thermal resistance of .7°C/watt make the 2N1015 and 2N1016 an ideal choice for constant voltage and constant current regulators.

A.C. AMPLIFIERS...

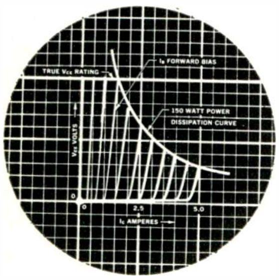


Perfect choice for high power audio and A.C. Amplifier applications, thanks to their high power dissipation capabilities and common emitter frequency response to 20KC.

PLUS TRUE VOLTAGE RATINGS...

guaranteed by 100% power testing. Means you can operate these transistors continuously at the V_{CE} listed for each rating without the risk of transistor failure.

Production quantities of Westinghouse Silicon Power Transistors are available in 2 and 5 ampere collector ratings. Both are available in 30, 60, 100, 150, and 200 volt ratings for immediate applications. Contact your local Westinghouse Apparatus Sales Office, or write directly to Westinghouse Electric Corp., Semiconductor Department, Youngwood, Penna.



*Designed to meet or exceed military specifications and currently being used in many military, industrial, and commercial applications.

Type	V_{CE}*	B (min)	R_S (max)	I_C A (max)	T_j max. operating	Thermal drop to case (max)
2N1015	30	10 @ I_C=2 amp	.75 ohms @ I_C=2 amp I_B=300 ma	7.5	150°C	.7°C/W
2N1015A	60					
2N1015B	100					
2N1015C	150					
2N1015D	200					
2N1016	30	10 @ I_C=5 amp	.50 ohms @ I_C=5 amp I_B=750 ma	7.5	150°C	.7°C/W
2N1016A	60					
2N1016B	100					
2N1016C	150					
2N1016D	200					

*TRUE voltage rating (The transistors can be operated continuously at the V_{CE} listed for each rating.)

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

Circle 107 on Inquiry Card

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1036	SPNPA	AF	RAY	2N1036		
			SRC	2N1036		
			HU		2N1233[7]	
			RAY	2N1036		
			PYE		V30/20IP	
			PHL		2N495	
2N1037	SPNPA	AF	RAY	2N1037		
			SRC	2N1037		
			RAY	2N1037		
			PYE	V30/20IP		
			PHL		2N495	
2N1038	GPNPA	AF, HS	TI	2N1038		
			RCA		2N586	
			PYE		V60/30P	
			PHL		2N671	
2N1039	CPNPA	AF, HS	TI	2N1039		
			PYE		V60/30P	
			PHL		2N674	
2N1040	GPNPA	AF, HS	TI	2N1040		
			PYE		V60/30P	
			PHL		2N674	
2N1041	GPNPA	AF, HS	TI	2N1041		
			PHL		2N674	
2N1042	GPNPA	P	TI	2N1042		
			CBS		2N156	6
			MOT		2N350A	
			PYE		V30/20P	
			PHL		2N386	
2N1043	GPNPA	P	TI	2N1043		
			RCA		2N561	
			CBS		2N158	6
			MOT		2N375	
			PYE		V60/20P	
			PHL		2N386	
2N1044	GPNPA	P	TI	2N1044		
			RCA		2N561	
			CBS		2N158A	6
			MOT		2N1362	
			PHL		2N387	
2N1045	GPNPA	P	TI	2N1045		
			RCA		2N1014	
			CBS		LT5035	10
			MOT		2N1364	
			PHL		2N387	
2N1046	GPNPD	CD, D	TI	2N1046		
			PHL		2N387	
2N1047	S	P	TI	2N1047		
2N1048	S	P	TI	2N1048		
2N1049	S	P	TI	2N1049		
2N1050	S	P	TI	2N1050		
2N1051	SNPND	AF	WE	2N1051		
2N1056	GPNP	S	GE	2N1056		4
2N1057	GPNP	S	GE	2N1057		4
2N1058	GPNPA	M	SYL	2N1058		
			RCA		2N412	
			CBS		2N377	1
			GEM	2N1058		
2N1059	GPNPA	AF	SYL	2N1059		
			RCA		2N270	
			CBS		2N444	1
			GEM	2N1059		
2N1060	SNPND	S	WE	2N1060		
2N1065	GPNPD	S	GT	2N1065		
			PHL		2N588	
2N1066	GPNPD	RF	RCA	2N1066		
			PHL		2N504	
2N1067	SNPND	P	RCA	2N1067		
2N1068	SNPND	P	RCA	2N1068		
2N1069	SNPND	P	RCA	2N1069		
			STC	2N1069	2N389	
			TR	2N1069	2N1212A	
2N1070	SNPND	P	RCA	2N1070		
			STC	2N1070	2N389	
			TR	2N1070	2N1208A	
2N1072	SNPND	CD, S	WE	2N1072		
2N1073			BEN	2N1073[6]		
			TS		2N277	14
			PYE		V60/30NP	
2N1073A			BEN	2N1073A[6]		
2N1073B			BEN	2N1073B[6]		
2N1074	SNPNA	AF	RAY	2N1074		
2N1075	SNPNA	AF	RAY	2N1075		
2N1076	SNPNA	AF	RAY	2N1076		
2N1077	SNPNA	AF	RAY	2N1077		
2N1078	PNP	P	CBS	2N1078		10
			PHL		2N386	
2N1086	GNPN	OSC	GE	2N1086		7
2N1086A	GNPN	OSC	GE	2N1086A		7
2N1087	GNPN	OSC	GE	2N1087		7
2N1090	GNPNA	S	RCA	2N1090		
			GE		2N634	
2N1091	GNPNA	S	RCA	2N1091		
			GE		2N635	

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1092	SNPND	P	RCA	2N1092		
			FCH		2N696	
2N1093	GPNP	CD	TI	2N1093		
2N1094	GPNPD	IF	WE	2N1094		
2N1095	SNPNG	RF	BOG	2N1095		
2N1096	SNPNG	RF	BOG	2N1096		
2N1097	GPNP	AFO	GE	2N1097		8
			IND		2N363	
			MOT		2N1191	
2N1098	GPNP	AFO	GE	2N1098		8
			IND		2N465	
			MOT		2N1191	
2N1099	GPNP	GP	DEL	2N1099		
			MOT		2N630	
			PHL		2N387	
2N1100	GPNP	GP	DEL	2N1100		
			MOT		2N630	
2N1101	GNPN	AFO	SYL	2N1101		
			RCA		2N647	
			CBS		2N306	1
			GEM	2N1101		
2N1102	GNPN	AFO	SYL	2N1102		
			RCA		2N647	
			CBS		2N438A	1
			GEM	2N1102		
2N1107	GPNP	RF	TI	2N1107		
2N1108	GPNP	RF	TI	2N1108		
			PYE		V15/20R	
2N1109	GPNP	RF	TI	2N1109		
			PYE		V15/20R	
2N1110	GPNP	RF	TI	2N1110		
			PYE		V15/20R	
2N1111	GPNP	RF	TI	2N1111		
			PYE		V15/20R	
2N1111A	GPNP	RF	TI	2N1111A		
			PYE		V15/20R	
2N1111B	GPNP	RF	TI	2N1111B		
			PYE		V15/20R	
2N1114	GNPN	CD	SYL	2N1114		
			CBS		2N440A	1
			GEM	2N1114		
2N1115			IND		2N1284	
2N1116	SNPN	P	TR	2N1116		
2N1117	SNPN	P	TR	2N1117		
2N1118	SPNPA	OSC	PHL	2N1118		8
			FCH		2N1131	
2N1118A	SNPNA	HF	PHL	2N1118A		
2N1119	SPNPA	S	PHL	2N1119		8
2N1120	GPNPA	AFO	BEN	2N1120		
			CBS		2N1099	2
			MOT		2N1120	
2N1121	GNPN	IF	GE	2N1121		
2N1122	GNPNA	HS	PHL	2N1122		15
			SPR	2N1122[7]		
			PYE		V15/20R	
2N1122A	GNPNA	HS	PHL	2N1122A		15
			SPR	2N1122A[7]		
			PYE		V15/20R	
2N1123	GPNP	S	PHL	2N1123		21
2N1124	GPNP	S	PHL	2N1124		
			BEN		2N1176B	
			PYE		V60/20IP	
2N1125	GPNP	S	PHL	2N1125		
			BEN		2N1176B	
2N1126	GPNP	S	PHL	2N1126		
2N1127	GPNP	S	PHL	2N1127		
2N1128	GPNP	S	PHL	2N1128		
			IND		2N1284	
			BEN		2N1008A	
			TS		2N383	1
2N1129	GPNP	S	PHL	2N1129		
			BEN		2N1176A	
			MOT		2N1193	
2N1130	GPNP	S	PHL	2N1130		
			IND		2N359	
			BEN		2N1008A	
			MOT		2N1193	
2N1131			FCH	2N1131		
			HU		2N1256	
2N1132			FCH	2N1132		
			HU		2N1257	
2N1136	GPNPA	AF, P	BEN	2N1136		
			CBS		LT5102	11
			TS		2N277	14
			MOT		2N628	
2N1136A	GPNPA	AF, P	BEN	2N1136A		
			CBS		LT5111	
			MOT		2N629	
2N1136B	GPNPA	AF, P	BEN	2N1136B		
			CBS		LT5120	
			MOT		2N630	

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1137	GPNPA	AF, P	BEN	2N1137		
			CBS		LT5102	11
			MOT		2N1162	
2N1137A	GPNPA	AF, P	BEN	2N1137A		
			CBS		LT5111	
			MOT		2N1164	
2N1137B	GPNPA	AF, P	BEN	2N1137B		
			CBS		LT5120	
			MOT		2N1166	
2N1138	GPNPA	AF, P	BEN	2N1138		
2N1138A	GPNPA	AF, P	BEN	2N1138A		
2N1138B	GPNPA	AF, P	BEN	2N1138B		
2N1139	SNPN	RF	TR	2N1139		
2N1140	SNPN	S	TR	2N1140		
2N1141	GPNP	HF	TI	2N1141		
2N1142	GPNP	HF	TI	2N1142		
2N1143	GPNP	HF	TI	2N1143		
2N1144	GPNP	AFO	GE	2N1144		4
			IND		2N363	
			MOT		2N1191	
2N1145	GPNP	AFO	GE	2N1145		4
			IND		2N465	
			MOT		2N1191	
2N1146	PNP	P	CTP	2N1146		2
			CBS		2N277	
			MOT		2N1162	
2N1146A	PNP	P	CTP	2N1147		
			CBS		2N278	
			MOT		2N1164	
2N1146B	PNP	P	CTP	2N1146B		
			CBS		2N173	
			MOT		2N1166	
2N1146C	PNP	P	CTP	2N1146C		
			CBS		2N1099	
			MOT		2N1166	
2N1147	PNP	P	CTP	2N1147		
			CBS		2N277	2
			MOT		2N1163	
2N1147A	PNP	P	CTP	2N1147A		
			CBS		2N278	
			MOT		2N1165	
2N1147B	PNP	P	CTP	2N1147B		
			CBS		2N173	
			MOT		2N1167	
2N1147C	PNP	P	CTP	2N1147C		
			CBS		2N1099	
			MOT		2N1167	
2N1149	SNPN	HG	TI			
2N1150	SNPN	HG	TI	2N1150		
2N1151	SNPN	HG	TI	2N1151		
2N1152	SNPN	HG	TI	2N1152		
2N1153	SNPN	HG	TI	2N1153		
2N1154	SNPN	AF	TI	2N1154		
2N1155	SNPN	AF	TI	2N1155		
2N1156	SNPN	AF	TI	2N1156		
2N1157	GPNPA	GP	MH	2N1157		
			MOT		2N1163	
			PHL		2N387	
2N1157A	GPNPA	GP	MH	2N1157A		
			MOT		2N1165	
			PHL		2N387	
2N1158			PHL	2N1158		
2N1159	GPNP	S	DEL	2N1159		
			CBS		LT5102	1
			MOT		2N628	
2N1160	GPNP	S	DEL	2N1160		
			TS		2N174	14
			MOT		2N628	
			PHL		2N387	
2N1162			MOT	2N1162		
2N1163			MOT	2N1163		
2N1164			MOT	2N1164		
2N1165			MOT	2N1165		
2N1166			MOT	2N1166		
2N1167			MOT	2N1167		
2N1168	GPNP	P	DEL	2N1168		
			CBS		LT5099	11
			BEN		2N1136	
			MOT		2N669	
			PHL		2N386	
2N1171			RAY	2N1171		
2N1172	GPNP	GP	DEL	2N1172		
			PYE		V60/20IP	
			PHL		2N386	

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1173	GNPNA	AF	WE	2N1173		
2N1174	GNPNA	AF	WE	2N1174		
2N1176	GPNPA	AF	BEN			
			PYE		V15/20IP	
2N1176A	GPNPA	AF	BEN			
			PYE		V30/20IP	
2N1176B	GPNPA	AF	BEN			
			PYE		V60/20IP	
2N1190			TS		2N460	
2N1192			TS		2N461	
2N1195	GPNPD	HF	WE	2N1195		
			TI	2N1195		
			PHL		2N502	
2N1198	GNPN	S	GE	2N1198		7
2N1199	SNPND	S	PHL	2N1199		
			FCH		2N706	
2N1202	GPNPA	P	MH	2N1202		
			CBS		LT5074	9
			BEN		2N637B	
			MOT		2N618	
			PHL		2N387	
2N1203	GPNPA	HV	MH	2N1203		
			CBS		LT5087	9
			MOT		2N1362	
			PHL		2N387	
2N1204	SNPND	HF	PHL	2N1204		
2N1205	SNPN	IF	TR	2N1205		
2N1206	SNPN	P	TR	2N1206		
2N1207	SNPN	P	TR	2N1207		
2N1208	SNPN	P	TR	2N1208		
2N1209	SNPN	P	TR	2N1209		
2N1212	SNPN	P	TR	2N1212		
2N1219	SPNPA	S	GT	2N1219		
			PHL		2N495	
			SRC	2N1219		
2N1220	SPNPA	S	GT	2N1220		
			SRC	2N1220		
			NSC	2N1220		
			PHL		2N495	
2N1221	SPNPA	AF	GT	2N1221		
			SRC	2N1221		
			PHL		2N495	
2N1222	SPNPA	AF	GT	2N1222		
			SRC	2N1222		
			NSC	2N1222		
			PHL		2N495	
2N1223	SPNPA	AF,S	GT	2N1223		
			SRC	2N1223		
2N1224	GPNPD	RF	RCA	2N1224		
			PHL		2N504	
2N1225	GPNPD	RF	RCA	2N1225		
			PHL		2N504	
2N1226	GPNPD	RF	RCA	2N1226		
			PHL		2N504	
2N1228	SPNPA	AF	HU	2N1228		
			SRC		2N1024	
			NSC	2N1228		
2N1229	SPNPA	AF	HU	2N1229		
			SRC		2N1024	
			NSC	2N1229		19
2N1230	SPNPA	AF	HU	2N1230		
			SRC		2N1025	
			NSC	2N1230		19
2N1231	SPNPA	AF	HU	2N1231		
			SRC		2N1469	
			NSC	2N1231		19
2N1232	SPNPA	AF	HU	2N1232		
			SRC		2N1474	
			NSC	2N1232		19
2N1233	SPNPA	AF	HU	2N1233		
			SRC		2N1475	
			NSC	2N1233		19
2N1245	GPNP	P	CBS		2N1245	11
			TS		2N242	
			PYE		V30/30P	
2N1246	GPNP	P	CBS	2N1246		11
			TS		2N242	
2N1250	SNPN	P	TR	2N1250		
2N1251	GNPN	AF	SYL	2N1251		
2N1252	SNPND	S	FCH	2N1252		
			IND	2N1252		19
2N1253	SNPND	S	FCH	2N1252		
			IND	2N1253		19
2N1254	SPNPD	S	HU	2N1254		
2N1256	SPNPD	S	HU	2N1256		
2N1257	SPNPD	S	HU	2N1257		
2N1258	SPNPD	S	HU	2N1258		
2N1259	SPNPD	S	HU	2N1259		

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1261	GPNPA	GP	MH	2N1261		
			CBS		LT5131	4
			MOT		2N375	
			PYE		V60/30NP	
2N1262	GPNPA	GP	MH	2N1262		
			CBS		LT5126	9
			MOT		2N375	
			PYE		V60/30NP	
2N1263	GPNPA	GP	MH	2N1263		
			CBS		LT5134	9
			MOT		2N618	
			PYE		V60/30P	
2N1264	GPNP	GP	SYL	2N1264		
			MOT		2N1191	
			PYE		V6/2RC	
			PHL		2N232	
2N1265	GPNP	RF,OSC	SYL	2N1265		
			MOT		2N1192	
			PYE		V10/50A	
			PHL		2N207	
2N1266	GPNP	IF	SYL	2N1266		
			PYE		V10/30A	
			PHL		2N232	
2N1267	SNPND	RF	PHL	2N1267		5
2N1268	SNPND	RF	PHL	2N1268		
2N1269	SNPND	RF	PHL	2N1268		
2N1270	SNPND	RF	PHL	2N1270		
2N1271	SNPND	RF	PHL	2N1271		
2N1272	SNPND	RF	PHL	2N1272		
2N1273	GPNP	AFO	TI	2N1273		
			IND		TRC71	
			MOT		2N1191	
2N1274	GPNP	AFO	TI	2N1274		
			IND		2N363	
			MOT		2N1191	
2N1275			RAY	2N1275		
			SRC	2N1275		
2N1276	SNPN	GP	GE	2N1276		
			PHL		2N1267	
2N1277	SNPN	GP	GE	2N1277		
			PHL		2N1268	
2N1278	SNPN	GP	GE	2N1278		
			PHL		2N119	
2N1279	SNPN	GP	GE	2N1279		
			PHL		2N1472	
2N1280	PNP	S	IND	2N1280		
2N1281	PNP	S	IND	2N1281		19
2N1282	PNP	S	IND	2N1282		19
2N1284	PNP	S	IND	2N1284		19
2N1296	GNPN	P	CBS	2N1296		11
2N1297	GPNP	P	CBS	2N1297		11
2N1298	GNPN	P	CBS	2N1298		11
2N1299	GNPN	S	SYL	2N1299		
2N1300	GPNPD	S	RCA	2N1300		
			PHL		2N1204	
2N1301	GPNPD	S	RCA	2N1301		
			PHL		2N1204	
2N1302	GNPNA		TI	2N1302		
2N1291	GPNP	P	CBS	2N1291		11
			PYE		V30/30P	
2N1292	GNPN	P	CBS	2N1292		11
			PYE		V60/30P	
2N1293	GPNP	P	CBS	2N1293		11
			PHL		2N386	
2N1294	GNPN	P	CBS	2N1294		11
2N1295	GPNP	P	CBS	2N1295		11
			PHL		2N387	
2N1303	GPNPA	CD	TI	2N1303		
			IND		2N363	
			TS		2N425	1
2N1304	GNPNA	CD	TI	2N1304		
2N1305	GPNPA	CD	TI	2N1305		
			IND		2N466	
			TS		2N426	
2N1306	GNPNA	CD	TI	2N1306		
2N1307	GPNPA	CD	TI	2N1307		
			IND		2N428	
			TS		2N427	
2N1308	GNPNA	CD	TI	2N1308		
2N1309	GPNPA	CD	TI	2N1309		
			IND		2N428	
			TS		2N428	
2N1310	GNPNA	HV	GT	2N1310		
2N1313		S	TS			1
			IND	2N1313		
2N1316	PNP	S	IND	2N1316		19
2N1317	PNP	S	IND	2N1317		19
2N1318	PNP	S	IND	2N1318		19

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1320	GPNP	P	CBS	2N1320		9
2N1321	GNPN	P	CBS	2N1321		9
2N1322	GPNP	P	CBS	2N1322		9
			PHL		2N386	
2N1323	GNPN	P	CBS	2N1323		9
2N1324	GPNP	P	CBS	2N1324		9
			PHL		2N387	
2N1325	GNPN	P	CBS	2N1325		9
2N1326	GPNP	P	CBS	2N1326		9
2N1327	GNPN	P	CBS	2N1327		9
2N1328	GPNP	P	CBS	2N1328		10
2N1329	GNPN	P	CBS	2N1329		10
2N1330	GNPN	P	CBS	2N1330		10
2N1331	GPNP	P	CBS	2N1331		10
					2N387	
2N1332	GNPN	P	CBS	2N1332		10
2N1333	GPNP	P	CBS	2N1333		10
2N1334	GNPN	P	CBS	2N1334		10
2N1335	SNPND	HF,S	PSI	2N1335		25
			FCH		2N698	
2N1336	SNPND	HF,S	PSI	2N1336		25
			FCH		2N698	
2N1337	SNPND	HF,S	PSI	2N1337		25
			FCH		2N698	
2N1339	SNPND	HF,S	PSI	2N1339		25
2N1340	SNPND	HF,S	PSI	2N1340		25
2N1341	SNPND	HF,S	PSI	2N1341		25
2N1343	PNP	S	IND	2N1343		19
2N1344	PNP	S	IND	2N1344		19
2N1345	PNP	S	IND	2N1345		19
2N1346	PNP	S	IND	2N1346		19
2N1347	PNP	S	IND	2N1347		19
2N1348	PNP	S	IND	2N1348		19
2N1349	PNP	S	IND	2N1349		19
2N1350	PNP	S	IND	2N1350		19
2N1351	PNP	S	IND	2N1351		19
2N1352	PNP	S	IND	2N1352		19
2N1353	PNP	S	IND	2N1353		19
2N1354	PNP	S	IND	2N1354		19
2N1355	PNP	S	IND	2N1355		19
2N1356	PNP	S	IND	2N1356		19
2N1357	PNP	S	IND	2N1357		19
2N1358	G	GP	DEL			
			MOT		2N630	
			PHL		2N387	
2N1359			MOT	2N1359		
			CBS		LT5099	11
2N1360			MOT	2N1360		
			CBS		LT5102	11
2N1362			MOT	2N1362		
			CBS		LT5117	11
2N1363			MOT	2N1363		
			CBS		LT5117	11
2N1364			MOT	2N1364		
2N1365			MOT	2N1365		
2N1370	GPNP	AFO	TI	2N1370		
			IND		2N361	
			MOT		2N1192	
2N1371	GPNP	AFO	TI	2N1370		
			MOT		2N651	
2N1372	GPNP	GP	TI	2N1372		
			MOT		2N1191	
2N1373	GPNP	GP	TI	2N1373		
			MOT		2N650	
2N1374	GPNP	GP	TI	2N1374		
			IND		TR721	
			MOT		2N1192	
2N1375	GPNP	GP	TI	2N1375		
			MOT		2N651	
2N1376	GPNP	GP	TI	2N1376		
			IND		2N360	
			MOT		2N1192	
2N1377	GPNP	GP	TI	2N1377		
			MOT		2N651	
2N1378	GPNP	GP	TI	2N1378		
			MOT		2N1193	
2N1379	GPNP	GP	TI	2N1379		
			MOT		2N1193	
2N1380	GPNP	GP	TI	2N1380		
			MOT		2N1192	

1960 TRANSISTOR INTERCHANGEABILITY CHART

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1381	GPNP	GP	TI MOT	2N1381	2N1192	
2N1382			IND MOT		2N466 2N1192	
2N1383			IND MOT		2N465 2N1191	
2N1385	GPNP	S	TI	2N1385		
2N1386			RAY	2N1386		
2N1387			RAY	2N1387		
2N1388			RAY	2N1388		
2N1389			RAY	2N1389		
2N1390			RAY	2N1390		
2N1395	GPNPD	RF	RCA PHL	2N1395	2N504	
2N1396	GPNPD	RF	RCA PHL	2N1396	2N504	
2N1397	GPNPD	RF	RCA PHL	2N1397	2N504	
2N1409	SNPND	HF,S	PSI FCH	2N1409	2N696	5
2N1410	SNPND	HF,S	PSI FCH	2N1410	2N696	5
2N1411			PHL PYE	2N1411	V6/8RC	
2N1412			PYE		V6/8RC	
2N1416	GPPA	HF	PHL PYE	2N1416	V15/20IP	
2N1420	NPN	S	IND	2N1420		19
2N1427			PHL	2N1427		

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
2N1428	SPNPA	GP	PHL SRC	2N1428	2N1429 S565	8
2N1429	SPNPA	GP	PHL	2N1429		8
2N1431	GNPN	AF	SYL	2N1431		
2N1432	GNPND	LRF	SYL PHL	2N1432	2N588	
2N1440	SPNPA	S	NSC	2N1440		19
2N1441	SPNPA	S	NSC	2N1441		19
2N1442	SPNPA	S	NSC	2N1442		19
2N1444	SNPND	S	WE	2N1444		
2N1446	PNP	AF	IND	2N1446		19
2N1447	PNP	AF	IND	2N1447		19
2N1448	PNP	AF	IND	2N1448		19
2N1449	PNP	AF	IND	2N1449		19
2N1450	GPNPD	S	GT PHL	2N1450	2N1204	
2N1451	PNP	AF	IND	2N1451		19
2N1452	PNP	AF	IND	2N1452		19
2N1467			PHL	2N1467		
2N1468			RAY	2N1468		
2N1469	SPNPA	S	SRC HU	2N1469	2N1231	
2N1471	PNP	AF	IND	2N1471		19
2N1472	SNPND	S	PHL	2N1472		
2N1474	SPNPA	S	SRC HU	2N1474	2N1232	
2N1474A	SPNPA	S	SRC HU	2N1474A	2N1232	
2N1475	SPNPA	S	SRC HU	2N1475	2N1233	
3N23	GNPNG	RF	BOG	3N23		

EIA NO.	TYPE	APPL.	MFR.	MFR. NO.	NEAREST TYPE	FIG.
3N23A	GNPNG	RF	BOG	3N23A		
3N23B	GNPNG	RF	BOG	3N23B		
3N23C	GNPNG	RF	BOG	3N23C		
3N29[4]	GNPN		GE			
3N30[4]	GNPN		GE			
3N25	GPNP	IF	TI	3N25		
3N31[4]	GNPN		GE			
3N32	SNPN	IF	TI	3N32		
3N33	SNPN	IF	TI	3N33		
3N34	SNPN	RF	TI	3N34		
3N35	SNPN	RF	TI	3N35		
3N36	GNPN	RF	GE	3N36		26
3N36	GNPN	RF	GE	3N37		26
3N45	PNPA	P	MH	3N45		
3N46	PNPA	P	MH	3N46		
2N1476	SPNPA	S	SRC HU	2N1476	2N1234	
2N1477	SPNPA	S	SRC HU	2N1477	2N1234	
2N1478		RF	PHL	2N1478		
2N1494		HF	PHL	2N1494		
2N1495		HF	PHL	2N1495		
2N1496		HF	PHL	2N1496		
2N1499		HF	PHL	2N1499		
2N1500		HF	PHL	2N1500		
2N1505	SNPND	HF	PSI	2N1505		25
2N1506	SNPND	HF	PSI	2N1506		25
3N21	GC	S	SYL	3N21		
3N22	GNPN	RF	WE	3N22		

1960 TRANSISTOR INTERCHANGEABILITY ABBREVIATIONS

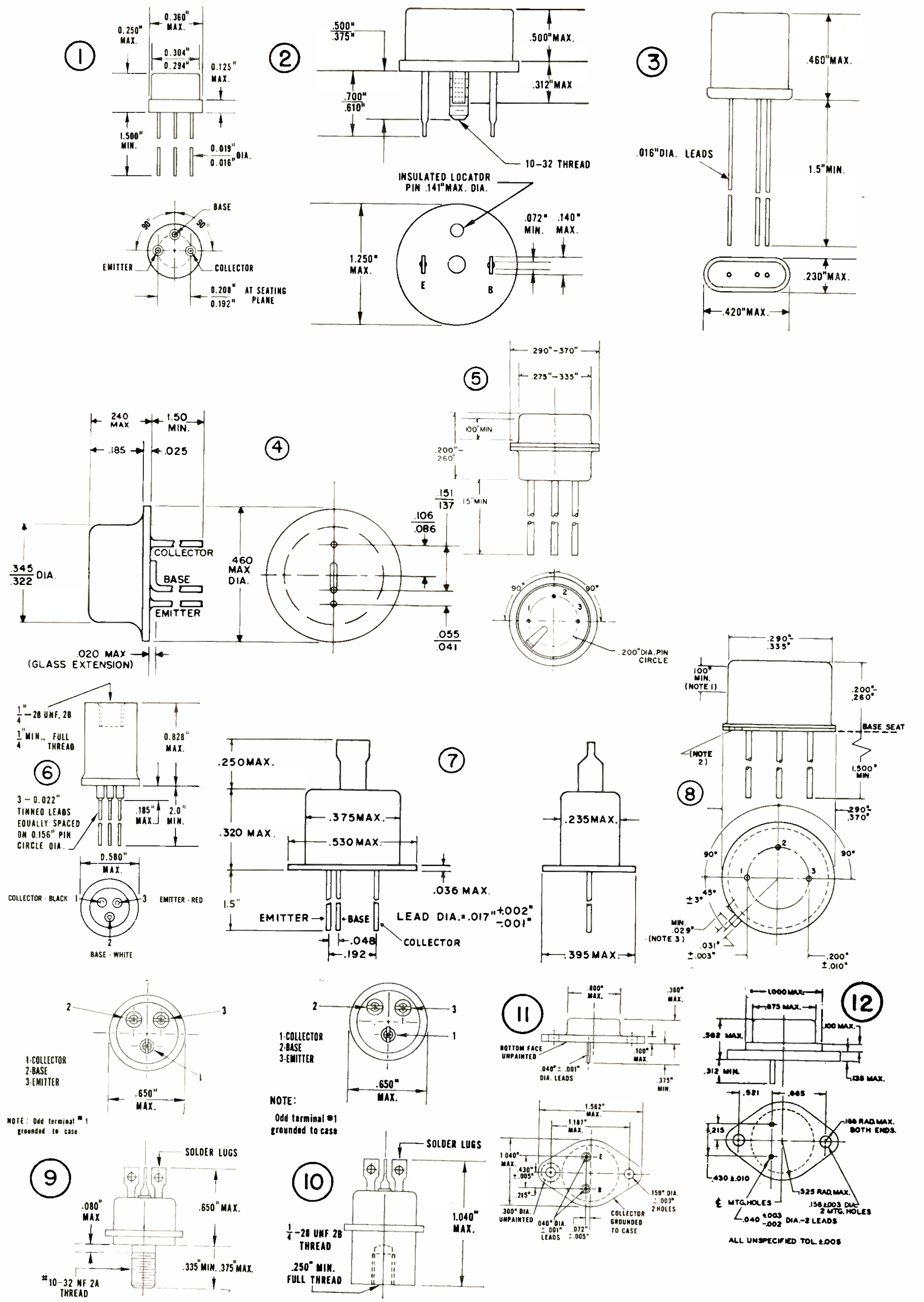
Manufacturers
In This Chart

ARA—Advanced Research Assoc.
AMP—Amperex
BEN—Bendix
BOG—Bogue
CBS—CBS-Hytron
CRI—Crystalonics, Inc.
CTP—Clevite
DEL—Delco
FCH—Fairchild
GE—General Electric
GEM—Great Eastern
GP—Germanium Products
GT—General Transistor
HU—Hughes
IND—Industro
MAL—Mallory
MH—Minneapolis-Honeywell
MOT—Motorola
MU—Mullard
NA—National Aircraft
NSC—National Semiconductor
NUC—Nucleonic Products
PHL—Philco
PSI—Pacific Semiconductors
PYE—Pye Electronics
RAY—Raytheon
RCA—Radio Corp. of America
RHE—Rheem
SPR—Sprague
SRC—Sperry
SYL—Sylvania
STC—Silicon Transistor
TI—Texas Instruments
TR—Transitron
TS—Tung-Sol
WE—Western Electric
W—Westinghouse

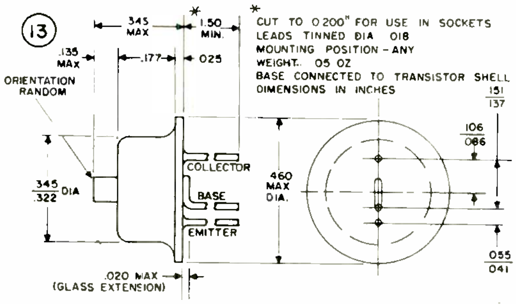
DESCRIPTIONS AND FOOTNOTES

AF—Audio Amplifier
AFD—Af Driver
AFO—Af Power Amplifier
CD—Core Driver
D—CRT Deflection
CNV—Converter
GC—Germanium Point Contact
GP—General Purpose
GNPNA—Germanium, NPN, Alloy
GNPNB—Germanium, NPN, Bilateral
GNPND—Germanium, NPN, Diffused
GNPNG—Germanium, NPN, Grown
GPNPA—Germanium, PNP, Alloy
GPNPB—Germanium, PNP, Bilateral
GPNPD—Germanium, PNP, Diffused
GPNPS—Germanium, PNP, Surface Barrier
GPPA—Germanium, Matched Pair, Alloy
HF—High Frequency Amplifier
HG—High Gain
HS—High Current Switch
HV—High Voltage Applications
IF—If Amplifier
LRF—Low Frequency Amplifier
M—Mixer
OSC—Oscillator
P—Power Switch, Power Conversion
PH—Phototransistor
RF—Rf Amplifier
S—High Speed Switching
SNPNA—Silicon, NPN, Alloy
SNPND—Silicon, NPN, Diffused, drift
SNPNG—Silicon, NPN, Grown
SPNPA—Silicon, PNP, Alloy
SPNPD—Silicon, PNP, Diffused, Drift
SPNPG—Silicon, PNP, Grown

1. Spade Lugs
2. .004" Length
3. Discontinued
4. Obsolete
5. Replacement
6. Lug Type Leads
7. Directly Interchangeable


1
0.360" MAX.
0.250" MAX.
0.304" 0.294"
0.125" MAX.
1.500" MIN.
0.019" 0.016" DIA.
BASE
EMITTER
COLLECTOR
0.208" 0.192" AT SEATING PLANE
2
.500" .375"
.500"MAX.
.312"MAX
.700" .610"
10-32 THREAD
INSULATED LOCATOR PIN .141"MAX. DIA.
.072" MIN.
.140" MAX.
1.250" MAX.
E
B
3
.460"MAX.
.016"DIA. LEADS
1.5"MIN.
.230"MAX.
.420"MAX.
4
240 MAX
1.50 MIN.
.185
.025
COLLECTOR
BASE
EMITTER
.345 .322 DIA.
.460 MAX DIA.
.106 .086
.151 .137
.055 .041
.020 MAX (GLASS EXTENSION)
5
.290"-.370"
.275"-.335"
.100"MIN
.200"-.260"
1.5"MIN
.200"DIA. PIN CIRCLE
6
1/4"-28 UNF, 2B
1/4"MIN., FULL THREAD
0.828" MAX.
3 - 0.022" TINNED LEADS EQUALLY SPACED ON 0.156" PIN CIRCLE DIA.
.185" MAX.
2.0" MIN.
0.580" MAX.
COLLECTOR - BLACK
EMITTER - RED
BASE - WHITE
7
.250MAX.
.320 MAX.
.375MAX.
.530MAX.
.036 MAX.
1.5"
EMITTER
BASE
COLLECTOR
LEAD DIA.=.017" +.002" -.001"
.048
.192
.235MAX.
.395MAX.
8
.290"-.335"
.100" MIN. (NOTE 1)
.200"-.260"
BASE SEAT
(NOTE 2)
1.500" MIN.
.290"-.370"
45° ±3°
MIN. .029" (NOTE 3)
.031" ±.003"
.200" ±.010"
1-COLLECTOR
2-BASE
3-EMITTER
.650" MAX.
NOTE: Odd terminal #1 grounded to case
9
SOLDER LUGS
.080" MAX
.650" MAX.
#10-32 NF 2A THREAD
.335" MIN. .375" MAX.
1-COLLECTOR
2-BASE
3-EMITTER
.650" MAX.
NOTE:
Odd terminal #1 grounded to case
10
SOLDER LUGS
1/4-28 UNF 2B THREAD
1.040" MAX.
.250" MIN. FULL THREAD
11
.800" MAX.
.380" MAX.
BOTTOM FACE UNPAINTED
.100" MAX.
.040" ± .001" DIA. LEADS
.375" MIN.
1.562" MAX.
1.187" MAX.
1.040" MAX.
.430" ±.005"
.215"
.300" DIA. UNPAINTED
.040" DIA. ±.001" LEADS
.072" ±.005"
.159" DIA. ±.003" 2 HOLES
COLLECTOR GROUNDED TO CASE
12
1.000 MAX.
.875 MAX.
.562 MAX.
.100 MAX.
.312 MIN.
.135 MAX.
.921
.665
.188 RAD.MAX. BOTH ENDS.
.215
.430 ±.010
.525 RAD.MAX.
℄ MTG.HOLES
.156 ±.003 DIA. 2 MTG. HOLES
.040 +.003 -.002 DIA.-2 LEADS
ALL UNSPECIFIED TOL. ±.005

13



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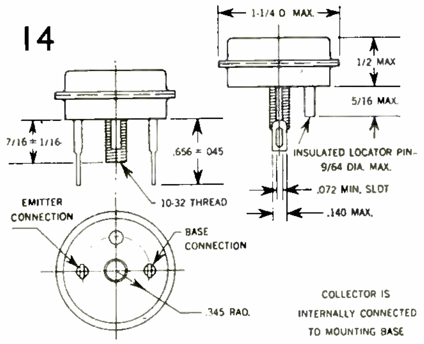

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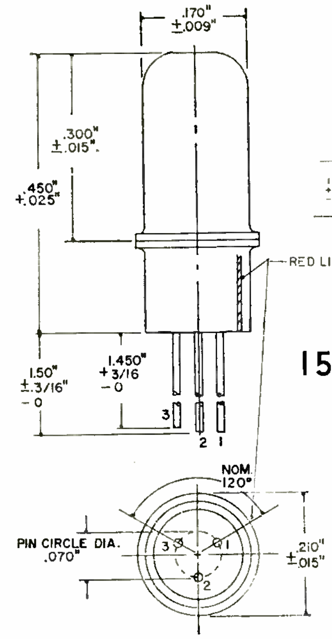

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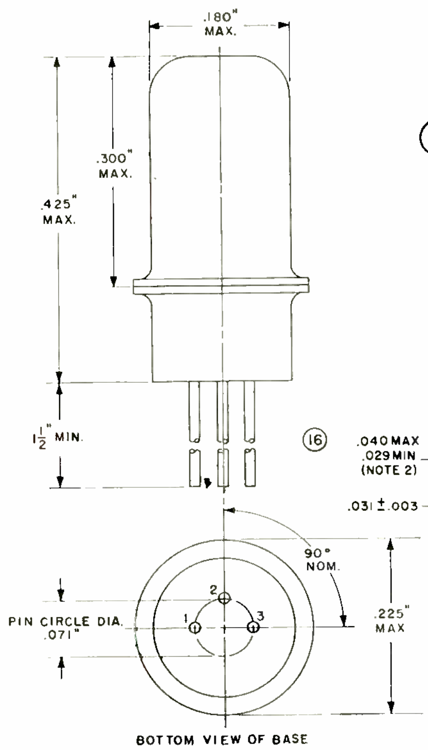

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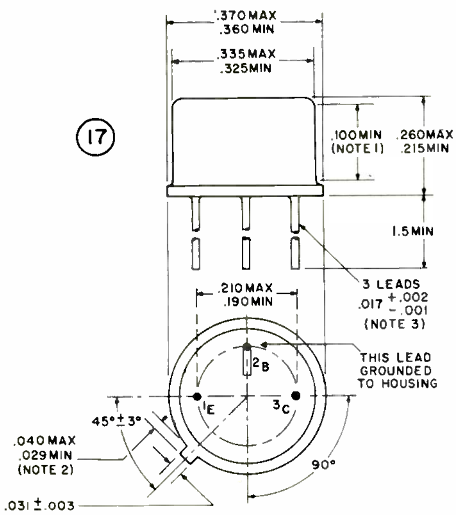

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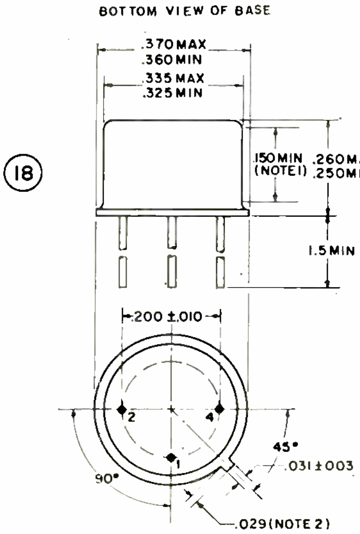

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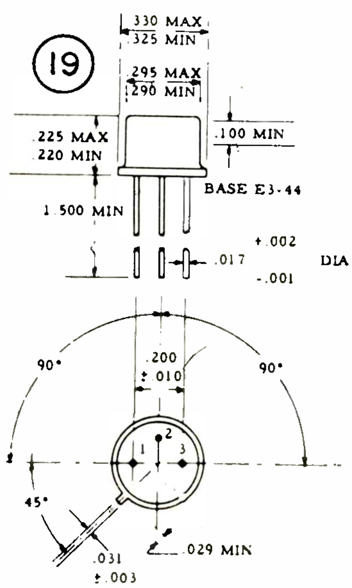

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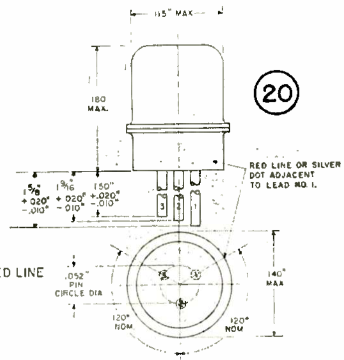

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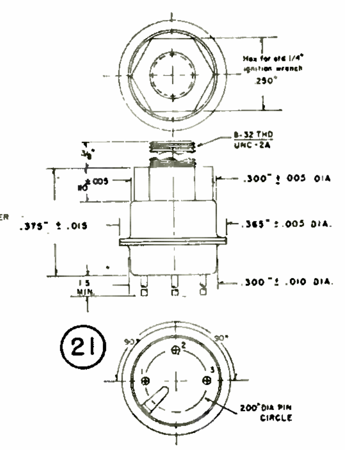

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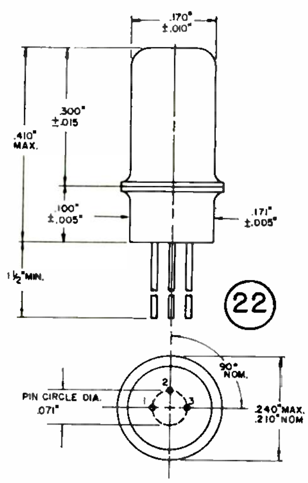

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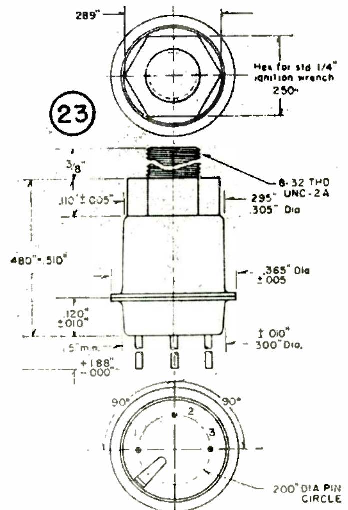

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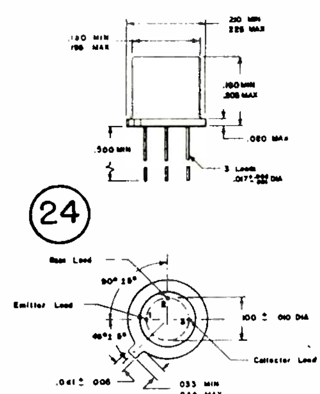

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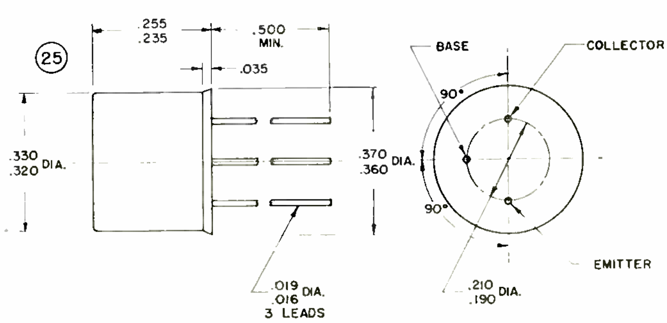
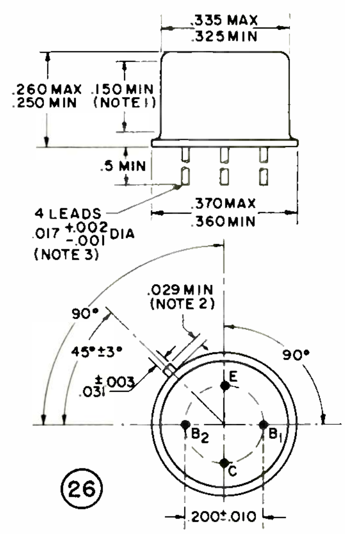
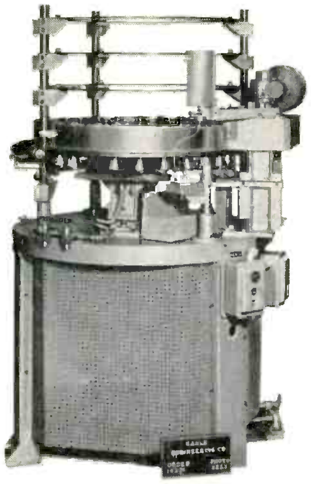




26

1 HIGH SPEED GLASS TUBING CUTTER
2 AUTOMATIC DIODE BEAD MACHINE
3 AUTOMATIC CRYSTAL GROWER
4 TRANSISTOR STEM (HEADER) MACHINE
5 AUTOMATIC CAT WHISKER WELDER



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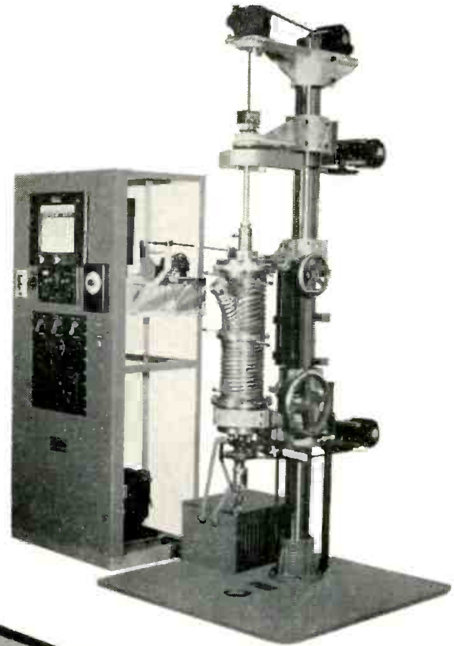
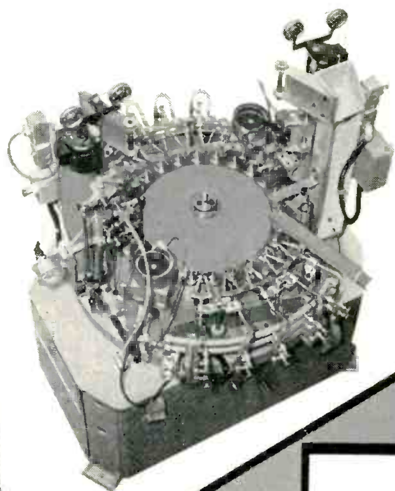


3

AUTOMATIC MACHINES

FOR **SEMICONDUCTOR PRODUCTION**

Higher output at lower cost
for every operation
from crystal growing to final test



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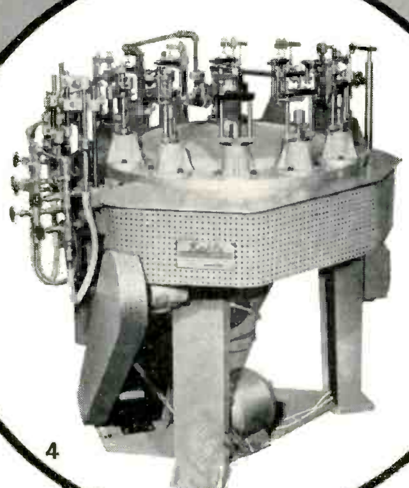

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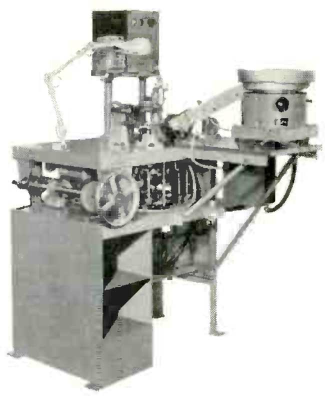


5

KAHLE
ENGINEERING COMPANY
3322 Hudson Avenue
Union City, New Jersey

Designers and Manufacturers of Automatic Machines

from

DALOHM

better things in smaller packages

ENLARGED CUTAWAY ILLUSTRATION
Four Times Average Size

SEE THESE NEW RESISTORS AT BOOTHS 2627-2629 AT IRE SHOW

NOW...

TWO MAJOR BREAK-THROUGHS IN ENCAPSULATED BOBBIN RESISTOR DESIGN

Here's How **DALOHM** *Achieved New, Long Lasting Stability*

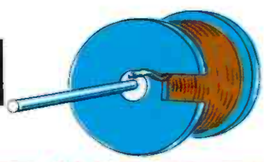
1 NEW TERMINATION*

New TERMINAL DISC prevents breakage of terminating wire and changes in resistance value due to strain when leads are bent or subjected to outside mechanical forces.

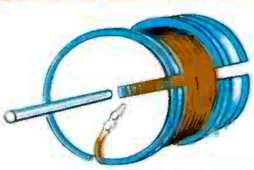
TERMINAL DISC is welded to lead and firmly bonded to end of bobbin. Termination of last pi winding can be made at any point on periphery of TERMINAL DISC, allowing more accurate calibrating. This large TERMINAL DISC provides more welding area, thus insuring dependable welds.

*(patent applied for)

OLD METHOD



NEW METHOD



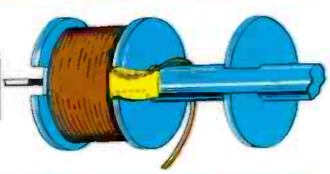
2 NEW WINDING METHOD*

New TWIN-DISC winding separators remove need for insulating tape to prevent shorting between pi's.

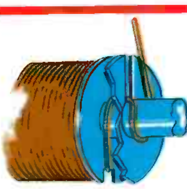
TWIN-DISC separators make shorting physically impossible.

*(patent applied for)

OLD METHOD



NEW METHOD



WW HW WIREWOUND PRECISION RESISTORS

Built to surpass MIL-R-93B and MIL-R-9444

TWO TYPES: WW prefix meets requirements of Characteristic A; HW prefix meets requirements of Characteristic C. Available with axial, radial or parallel leads or lug terminals.

- RESISTANCE RANGE: 0.1 ohm to 6 megohms, depending on type
- TOLERANCES: 0.02%, 0.05%, 0.1%, 0.25% 0.5%, 1%
- TEMPERATURE COEFFICIENT: .00002 per degree C.
- OPERATING TEMPERATURE:
  Type WW -55° C. to 125° C.
  Type HW -55° C. to 145° C.
- WIDE SIZE RANGE: Sub-miniature, 5/16" x 5/64" up to MIL size 2⅛" x ⅞"

REQUEST BULLETIN R-26D

DALOHM Ω ®

DALE PRODUCTS INC.

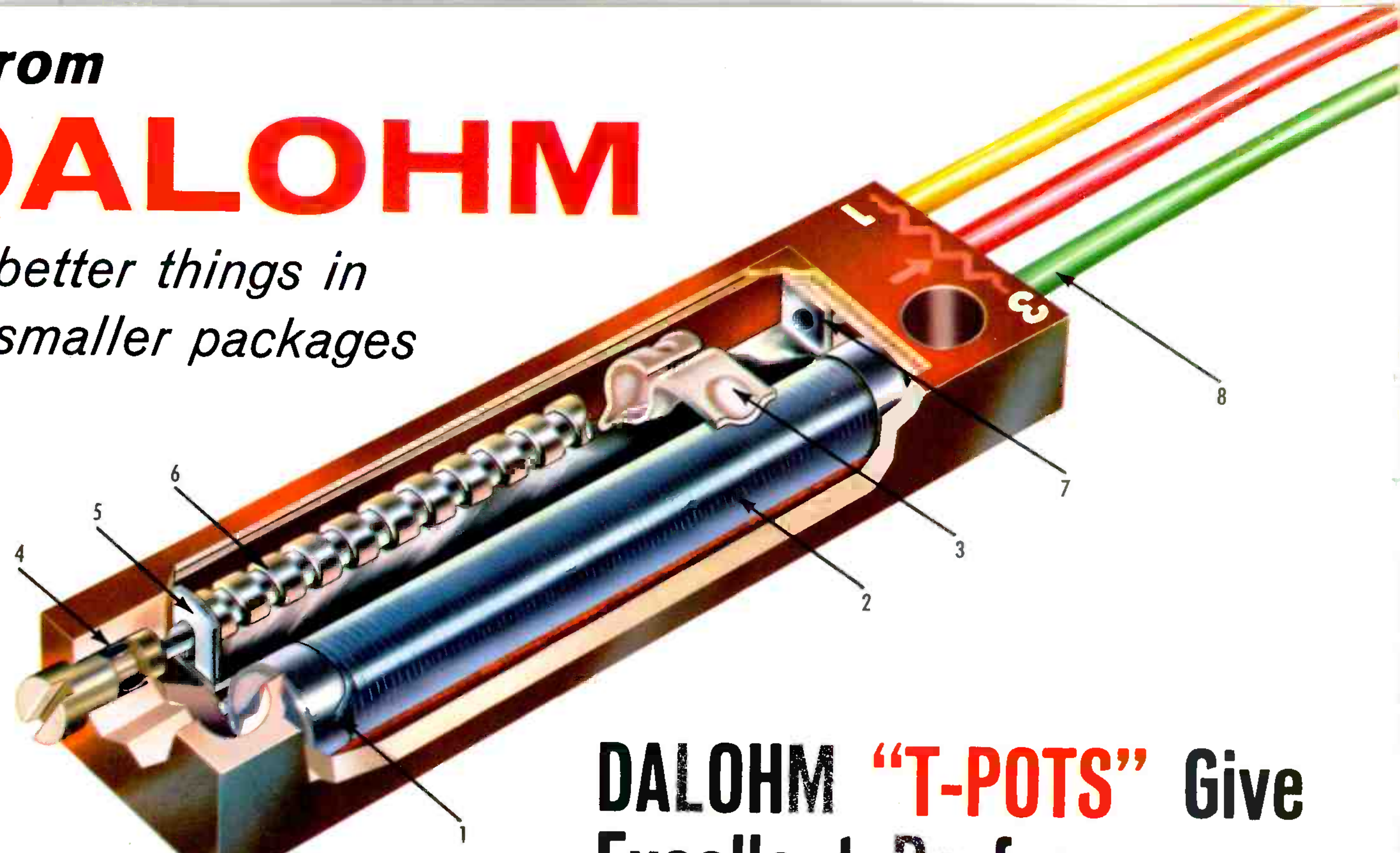
1304 28th Ave.
COLUMBUS,
NEBRASKA

Circle 149 on Inquiry Card

from

DALOHM

better things in smaller packages



ENLARGED CUTAWAY ILLUSTRATION
Four Times Average Size

DALOHM "T-POTS" Give Excellent Performances

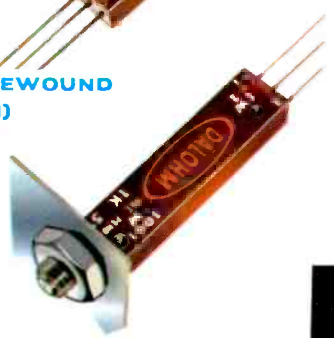
1. Welded termination
2. Longer winding mandrel (ceramic) giving better resolution, better heat dissipation, higher values and allows use of larger wire diameter
3. Lightweight precious metal wiper with low weight-pressure ratio provides best performance under vibration and shock
4. "O" ring seal provides protection against humidity, dust and salt spray
5. Thrust spring maintains constant position of lead screw eliminating lead screw backlash
6. Polished stainless steel lead screw is ultrasonically polished for smooth operation and long rotational life
7. Collector provides dual current path for improved reliability and low rotational noise level
8. Wide selection of external terminal configurations is available to meet any requirements

ALL MODELS MEET FUNCTIONAL REQUIREMENTS OF MIL-R-27208 and MIL-R-22097

TYPE 1000 WIREWOUND (Completely Sealed)

Rated at 2.5 watts
Resistance Range 10 ohms to 50K ohms
Standard Tolerance 5%

TYPE 1001 WIREWOUND (Panel Mounted)



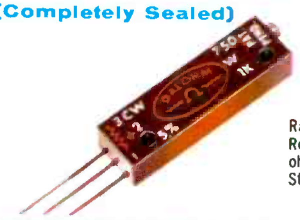
Rated at 1.25 watts
Resistance Range 10 ohms to 50K ohms
Standard Tolerance 5%

Some Models are smaller than MIL. Spec. sizes

These T-Pots are miniature precision trimmer potentiometers, resistant to stringent environmental conditions. They are ruggedly constructed with completely sealed cases. A wide selection of terminal configurations provide solutions for demanding miniaturization design problems.

SEE THE NEW 1200 SERIES AT BOOTHS 2627-2629 AT IRE SHOW

TYPE 750 WIREWOUND (Completely Sealed)



Rated at 2 watts
Resistance Range 10 ohms to 30K ohms
Standard Tolerance 5%

TYPE 751 WIREWOUND (Panel Mounted)

Rated at 1 watt
Resistance Range 10 ohms to 30K ohms
Standard Tolerance 5%

DALOHM TYPE A10-W WIREWOUND

Ruggedly constructed miniature precision trimmer potentiometer. Fully reliable under severe environmental conditions. Four designs adaptable to demanding space requirements of precision circuits. Rated at 1 watt; Resistance Range from 10 ohms to 50K ohms; Standard Tolerance 5%.

DALOHM TYPE B11-W WIREWOUND

This miniature trimmer potentiometer is designed to give excellent performance, for normal circuit problems where economy is of prime importance, yet dependable performance is a necessity. It retains many of the advantages of the precision grade A10-W trimmer. Rated at 1 watt; Resistance Range from 10 ohms to 100K ohms; Standard Tolerance 10%.

DALOHM TYPE C12-W WIREWOUND

A low cost miniature commercial trimmer potentiometer that will give good performance for many applications where trimmer potentiometers are specified. It is reliable under environmental conditions found in most commercial and industrial equipment. Rated at ½ watt; Resistance Range from 10 ohms to 20K ohms; Standard Resistance 15%.

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

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IRE New Products

Computer Components

Line of subminiature computer and control system components includes: Ac Summing Amplifiers, Ac Isolation Amplifiers, Servo Pre-amplifiers,

Power Amplifiers, Pulse Amplifiers, etc. Reeves Instrument Corp. **Booth 1305.**

Circle 266 on Inquiry Card

Zener Diode Handbook

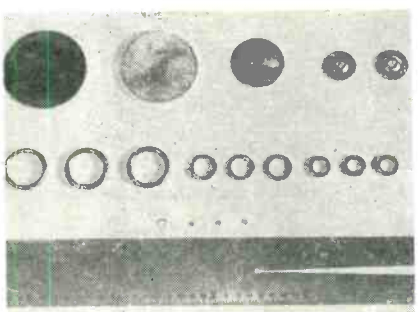
Chapters in handbook include: Semiconductor Theory and Reverse Breakdown; Silicon Reference Ele-

ments; Zener Diode Thermal Considerations; Zener Diode ac and dc applications, and Zener Diode Audio and r-f Applications. International Rectifier Corp. **Booth 2901.**

Circle 465 on Inquiry Card

Semiconductors

Microforms include common elements used as emitters and collectors such as indium, aluminum, gallium, lead,



tin, gold, silver, arsenic, antimony, pure binary or ternary alloys and composites. Anchor Alloys, Inc. Booth 4042.

Circle 267 on Inquiry Card

Circle 155 on Inquiry Card


FXR's ENGINEERING KNOW-HOW!
Control room of a 50 million watt transmitter created to better man's understanding of the atmosphere and ionosphere—The complete transmitter developed and manufactured by FXR.
IRE BOOTH
3713, 15, 17
FXR's precision microwave equipment, high-power pulse modulators and high-voltage power supplies have prominent roles in such leading scientific programs as this 50 million watt transmitter, thermonuclear control research, communication and ballistic missiles systems and similar astronautical, aeronautical and electronic developments.
50 MILLION WATTS!
FXR
FXR, Inc.
Design • Manufacture • Development
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Woodside 77, N. Y.
RA. 1-9000
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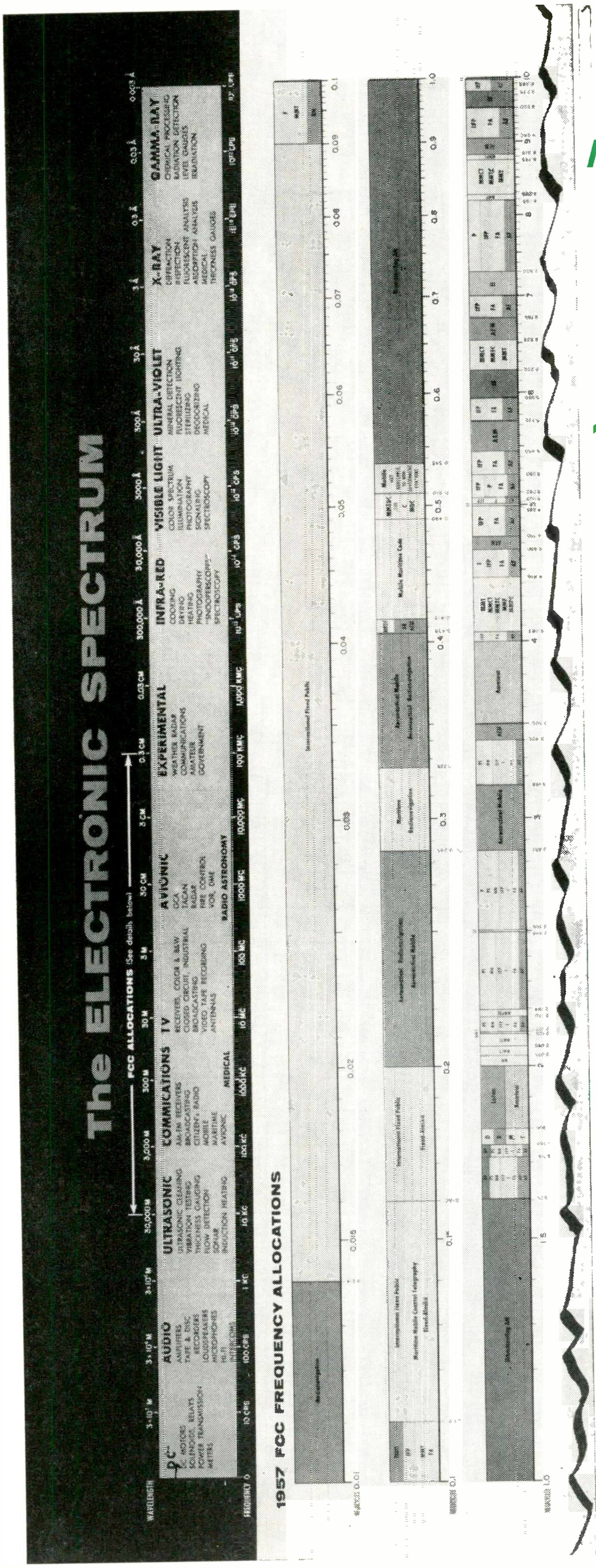
PRECISION MICROWAVE EQUIPMENT • HIGH-POWER PULSE MODULATORS • HIGH-VOLTAGE POWER SUPPLIES • ELECTRONIC TEST EQUIPMENT



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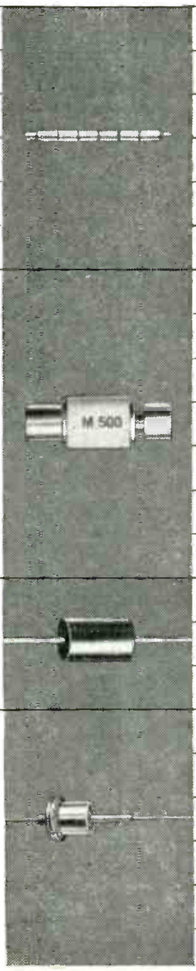
← Sample of 1957 Edition

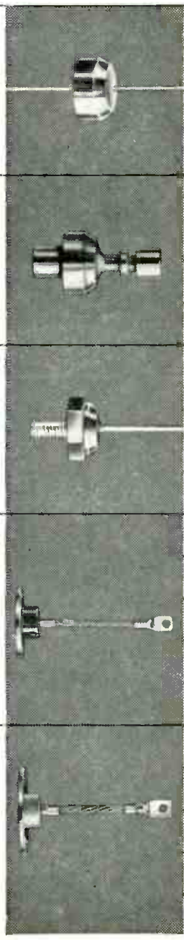
← Circle 159 on Inquiry Card

TARZIAN *designer's line*

silicon rectifiers include 84 high efficiency types



amps. DC (100° C)	peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	Tarzian Type	Jedec No.
0.325	2800	1960	3.25	19.5	280SM	1N1113
0.35	2400	1680	3.5	21	240SM	1N1112
0.375	2000	1400	3.75	22.5	200SM	1N1111
0.4	1600	1120	4	24	160SM	1N1110
0.425	1200	840	4.25	25.5	120SM	1N1109
0.45	800	560	4.5	27	80SM	1N1108
0.5	100	70	5	30	10M	1N1081
	200	140	5	30	20M	1N1082
	300	210	5	30	30M	1N1083
	400	280	5	30	40M	1N1084
	400	280	5	30	M-500	1N1084
	500	350	5	30	50M	—
	600	420	5	30	60M	—
	200	140	7.5	75	F-2	1N2482
	400	280	7.5	75	F-4	1N2483
	600	420	7.5	75	F-6	1N2484
0.75	100	70	7.5	75	10H	—
	200	140	7.5	75	20H	1N2485
	300	210	7.5	75	30H	1N2486
	400	280	7.5	75	40H	1N2487
	500	350	7.5	75	50H	1N2488
	600	420	7.5	75	60H	1N2489



amps. DC (100° C)	peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
1.5	100	70	10	100	—	—	10J1	1N1617
	200	140	10	100	—	—	20J1	1N1618
	300	210	10	100	—	—	30J1	1N1619
	400	280	10	100	—	—	40J1	1N1620
2	100	70	30	100	—	—	10LA	1N1085
	200	140	30	100	—	—	20LA	1N1086
	300	210	30	100	—	—	30LA	1N1087
	400	280	30	100	—	—	40LA	1N1088
10	100	70	50	150	—	—	10J2	1N1621
	200	140	50	150	—	—	20J2	1N1622
	300	210	50	150	—	—	30J2	1N1623
	400	280	50	150	—	—	40J2	1N1624
20	50	35	120	200	5RAN	1N1157	5RAP	1N1171
	100	70	120	200	10RAN	1N1158	10RAP	1N1172
	200	140	120	200	20RAN	1N1159	20RAP	1N1173
	300	210	120	200	30RAN	1N1160	30RAP	1N1174
	400	280	120	200	40RAN	—	40RAP	—
35	50	35	210	350	5SAN	1N1161	5SAP	1N1175
	100	70	210	350	10SAN	1N1162	10SAP	1N1176
	200	140	210	350	20SAN	1N1163	20SAP	1N1177
	300	210	210	350	30SAN	1N1164	30SAP	1N1178
	400	280	210	350	40SAN	—	40SAP	—

Rated at from 0.325 to 250 amps,
in complete variety of case designs and terminals

Proved performance, low cost, prompt shipment from stock

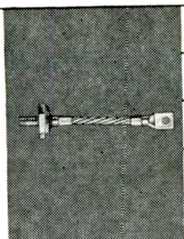
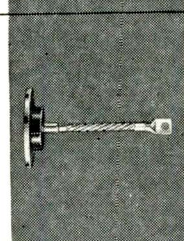
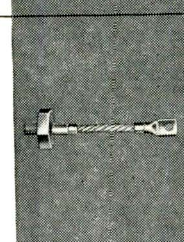
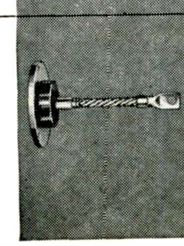
Sarkes Tarzian's "Designers' Line" silicon rectifiers offer the small size, high efficiency, mounting versatility, and wide range of ratings that can help solve many of your power conversion circuitry problems. Tarzian's realistic prices make these high quality components practical for almost all commercial and military applications.

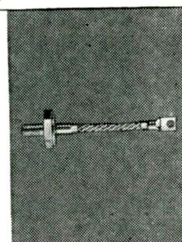
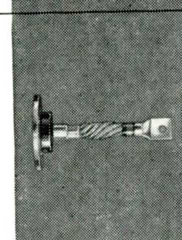
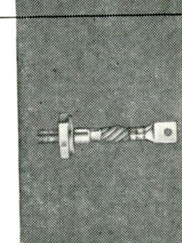
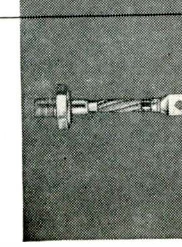
The 84 types of Tarzian "Designers' Line" rectifiers feature extremely low junction current density to provide maximum reliability and operating life. Their −55°C to +125°C temperature range makes Tarzian silicon rectifiers ideal for circuits where ambient temperatures are high and small size is desired. Ratings range from 0.325 to 250 amperes.

Tarzian types are available for immediate delivery in production quantities from factory or warehouse stocks. Complete power conversion engineering service on your rectifier requirements is available at no charge or obligation.

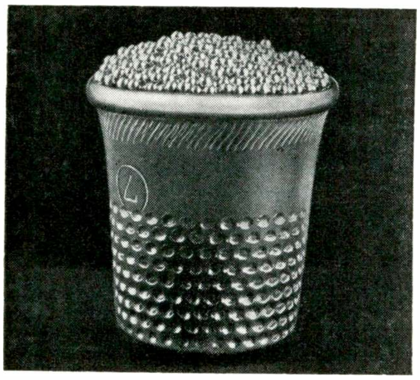
For further information contact your nearest Tarzian sales representative or write to Section 4394A, Semiconductor Division, Sarkes Tarzian, Inc., Bloomington, Indiana.

SARKES TARZIAN, INC.
SEMICONDUCTOR DIVISION
BLOOMINGTON, INDIANA
In Canada: 700 Weston Rd., Toronto 9, Ontario
Export: Ad Auriema, Inc., New York City

amps. DC (100° C)		peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
35		50	35	210	350	5S3N	–	5S3P	–
		100	70	210	350	10S3N	–	10S3P	–
		200	140	210	350	20S3N	–	20S3P	–
		300	210	210	350	30S3N	–	30S3P	–
		400	280	210	350	40S3N	–	40S3P	–
100		50	35	600	1000	5VAN	1N1165	5VAP	1N1179
		100	70	600	1000	10VAN	1N1166	10VAP	1N1180
		200	140	600	1000	20VAN	1N1167	20VAP	1N1181
		300	210	600	1000	30VAN	1N1168	30VAP	1N1182
		400	280	600	1000	40VAN	–	40VAP	–
		50	35	600	1000	5V3N	–	5V3P	–
		100	70	600	1000	10V3N	–	10V3P	–
		200	140	600	1000	20V3N	–	20V3P	–
		300	210	600	1000	30V3N	–	30V3P	–
		400	280	600	1000	40V3N	–	40V3P	–
150		50	35	900	1500	5WAN	1N1263	5WAP	1N1267
		100	70	900	1500	10WAN	1N1264	10WAP	1N1268
		200	140	900	1500	20WAN	1N1265	20WAP	1N1269
		300	210	900	1500	30WAN	1N1266	30WAP	1N1270
		400	280	900	1500	40WAN	–	40WAP	–

amps. DC (100° C)		peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
150		50	35	900	1500	5W3N	–	5W3P	–
		100	70	900	1500	10W3N	–	10W3P	–
		200	140	900	1500	20W3N	–	20W3P	–
		300	210	900	1500	30W3N	–	30W3P	–
		400	280	900	1500	40W3N	–	40W3P	–
200		50	35	1200	2000	5XAN	1N1263A	5XAP	1N1267A
		100	70	1200	2000	10XAN	1N1264A	10XAP	1N1268A
		200	140	1200	2000	20XAN	1N1265A	20XAP	1N1269A
		300	210	1200	2000	30XAN	1N1266A	30XAP	1N1270A
		400	280	1200	2000	40XAN	–	40XAP	–
		50	35	1200	2000	5X3N	–	5X3P	–
		100	70	1200	2000	10X3N	–	10X3P	–
		200	140	1200	2000	20X3N	–	20X3P	–
		300	210	1200	2000	30X3N	–	30X3P	–
		400	280	1200	2000	40X3N	–	40X3P	–
250		50	35	1500	2500	5Y3N	–	5Y3P	–
		100	70	1500	2500	10Y3N	–	10Y3P	–
		200	140	1500	2500	20Y3N	–	20Y3P	–
		300	210	1500	2500	30Y3N	–	30Y3P	–
		400	280	1500	2500	40Y3N	–	40Y3P	–

Circle 114 on Inquiry Card



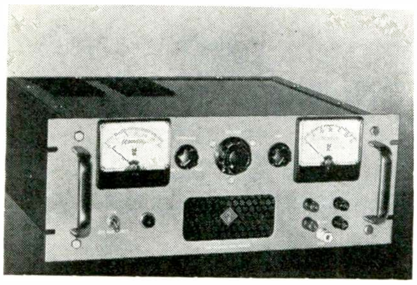
Gold Preforms

Miniature gold preforms used in semiconductor devices. They are used as a high-temp. solder for attaching the wafer to base tab or for making electrical contact. Alpha Metals, Inc. **Booth 4328.**

Circle 257 on Inquiry Card

Power Supplies

ST Series input: 100-135 vac, single phase. Output continuously variable



down to approx. 100 mv. Duty cycle: continuous duty at full load. Ripple: Less than 500 μv, RMS. Mid-Eastern Electronics, Inc. **Booth 3009.**

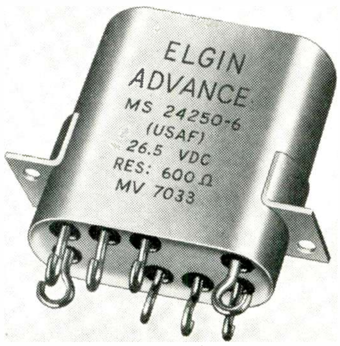
Circle 258 on Inquiry Card

Wiring Designs

Twisted pairs simulated in Flexprint flexible printed circuitry by conductors crossing over on two layers. Cable can be bent, folded, and twisted to conform to equipment geometry. Sanders Assoc. Inc. **Booth 1723.**

Circle 259 on Inquiry Card

IRE New Products



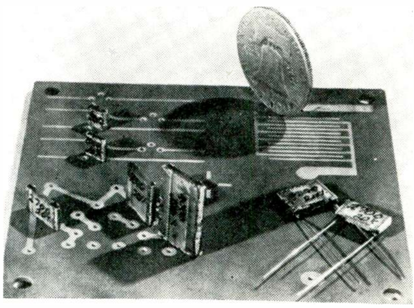
Crystal Can Relay

MV 7033 Crystal Can Relay operates from −65 to +125°C. Nominal operating voltage is 26.5 vdc; coil resistance, 600 ohms. Sensitivity is 250 mw. Contact rating: 2 a. Elgin National Watch Co. **Booth 2233.**

Circle 260 on Inquiry Card

Wafer Capacitors

Wafer capacitors have high temp. solder wire leads for use on printed



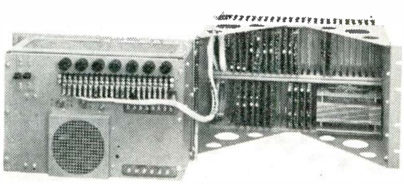
circuit boards. Capacitance range is one to 10,000 μμf.; electrical properties same as caps without leads. Corning Glass Works. **Booth 2334.**

Circle 261 on Inquiry Card

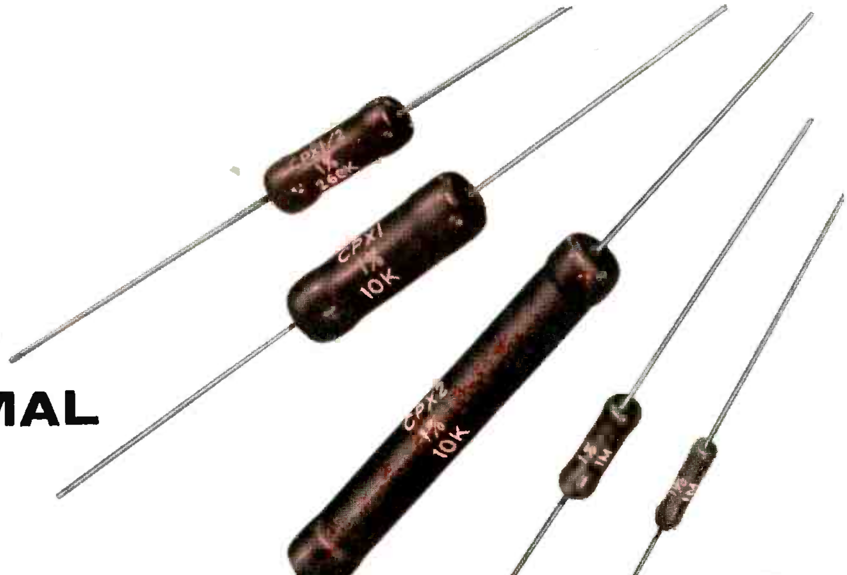
General Purpose Memories

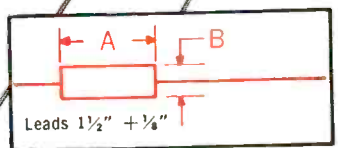
Type RB General Purpose Memory capacity from 128 to 1024 words of from 4 to 24 bits per word. Operating rates to 125 KC. Sequential and Random Access Operation. Telemeter Magnetics, Inc. **Booth 1900.**

Circel 262 on Inquiry Card



NEW AEROGLAZE® CONFORMAL COATING ON HI-Q® *Carbofilm®* RESISTORS





Exceed Painted Resistor Performance at NO Increase in Price!

Now . . . deposited carbon resistors with exclusive Aeroglaze conformal coating offer superior performance and greater mechanical protection over conventional painted units at NO increase in price.

Aeroglaze coating applied as a 100% solid eliminates weakened coatings through use of solvents and provides uniform sizes and appearance. Aeroglaze coating will meet all moisture requirements of MIL-R-10509B. Mechanical protection is superior to any other method and special tubes, sleeves and jackets are eliminated.

Aeroglaze resistors are available for immediate delivery in production quantities in the following ratings and sizes:

TYPE CPX—AEROGLAZE CARBOFILM RESISTORS

Type	A±1/16	B Max.	Watts	Res. Range	Mil Designations	Max. Volts
CPX ¼	15/32	.125	¼	5 ohms to 1 meg.	RN10	300
CPEX ½	½	.203	½	10 ohms to 2 meg.		350
CPSX ½	⅝	.203	½	10 ohms to 2.5 meg.	RN20	350
CPX ½	23/32	.250	½	10 ohms to 5 meg.		350
CPLX ½	1	.250	½	5 meg. to 7.5 meg.		500
CPX 1	15/16	.328	1	10 ohms to 15 meg.	RN25	500
CPX 2	2 1/16	.328	2	15 ohms to 50 meg.	RN30	1000

CPM CARBOMOLD RESISTORS

Encapsulated resistors in a strong reinforced moisture and heat resistant plastic for stability, precision and reliability. Available in ⅛, ¼, ½, 1 and 2 watt sizes in MIL designations RN60B, RN65B, RN70B, RN75B and RN80B.

CPC CERAMIC-CASED CARBOFILM RESISTORS

Extra-rugged construction to meet all requirements of critical circuitry. Especially suitable for applications demanding maximum protection against exposure and extreme environmental conditions. Available in ⅛, ¼, 1 and 2 watt sizes.

HI-Q® DIVISION

Write for new descriptive literature to . . .

AEROVOX CORPORATION

OLEAN, NEW YORK

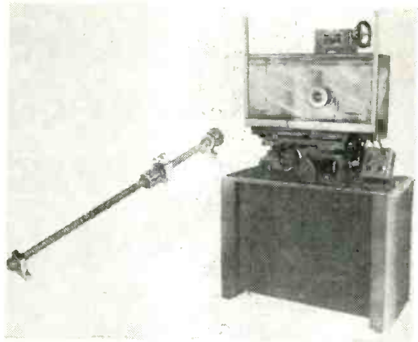
SEE US AT IRE SHOW BOOTHS 2603, 2605, 2607

Circle 116 on Inquiry Card

IRE New Products

Wafering Machine

Roton Table Drive for cutting germanium, silicon, and other materials. It provides a rolling rather than a sliding fit between screw and nut, and

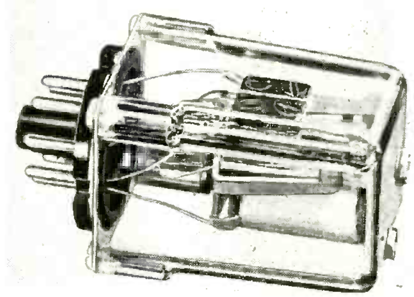


gves a frictionless drive. Micromech Manufacturing Corp. Booth 4038.

Circle 268 on Inquiry Card

Miniature Relay

Magnecraft Class 33 plug-in-mounted relays has a cover made of transparent, high-impact strength styrene

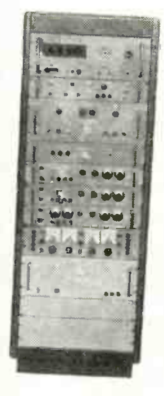


which also insulates the relay electrical interference with other components. Magnecraft Electric Co. Booth 2525.

Circle 269 on Inquiry Card

Semiconductor Test Set

Model 1500, Automatic Transistor Test Set, measures a variety of semi-

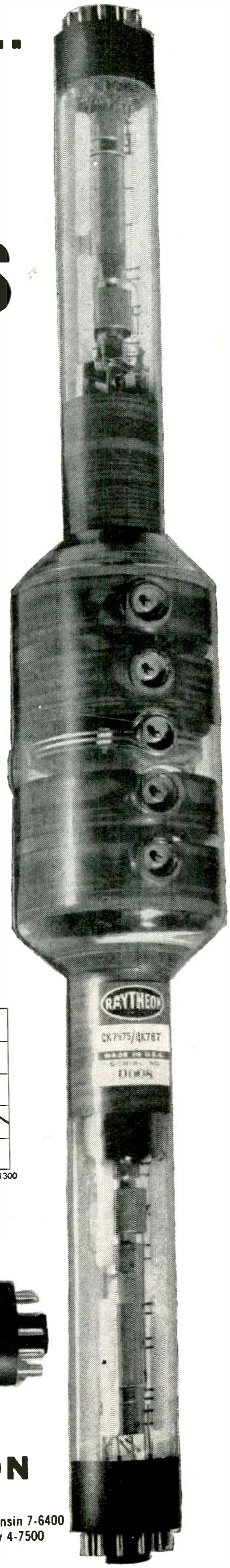


conductor parameters on a Go, No-G basis. Test modes and limits are grammed in advance. Optimiz vices, Inc.

Circle 270 on Inquiry Ca

Sharper Definition . . . Improved Gray Scale . . . with

RAYTHEON "KILOLINE" RECORDING STORAGE TUBES



A Raytheon-designed tetrode gun insures higher resolution — 1,000 TV lines at 50% modulation — and improved control over beam cut-off in Raytheon's new CK7571/QK685 and CK7575/QK787 recording storage tubes. A new multiple collimating lens improves background uniformity and results in a signal-to-shading ratio of ten.

These advanced design features, plus low noise and stable operating characteristics, make Raytheon recording storage tubes ideal for frequency and scan conversion. Among the applications where these tubes play an important role are:

- Scan conversion for bright display and target trails.
- Slow-down video for transmission of still pictures over telephone lines.
- Stop motion to permit analysis of production machinery or to stop action in a sporting event.
- Signal-to-noise improvement of radar or other still pictures by integration.
- Conversion of television pictures from one transmission standard to another.
- Indication of moving targets by electrical comparison of pictures taken at different times.

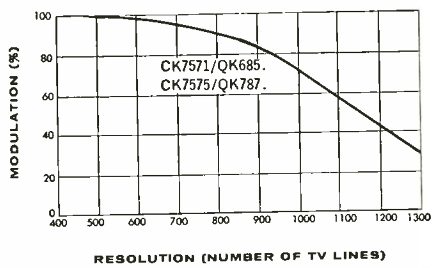
For scan conversion applications, both r.f. read-out and video cancellation techniques have proved equally effective with Raytheon single- and dual-gun storage tubes.

Raytheon's single-gun CK7571/QK685 and dual-gun CK7575/QK787 recording storage tubes are available from stock in sample quantities. Detailed technical data bulletins are yours for the asking — write direct to Dept. 2527.

TYPICAL OPERATING CHARACTERISTICS
CK7571/QK685 and CK7575/QK787

Anode Voltage	4,000 Vdc
Magnetic Focus Resolution	1,000 Lines (nominal)
Electrostatic Resolution	700 Lines (nominal)
Output capacitances:	
CK7571/QK685	12 μμf (nominal)
CK7575/QK787	27 μμf (nominal)
Maximum Deflection Angle	30 Degrees

TYPICAL RESOLUTION CURVE



RAYTHEON

INDUSTRIAL COMPONENTS DIVISION

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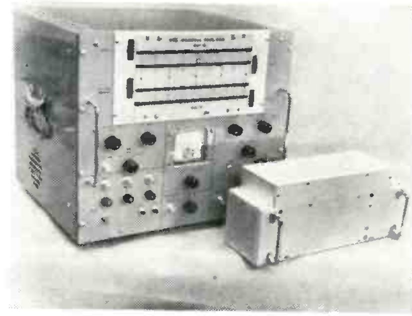
GOVERNMENT SALES: Boston — Bigelow 4-7500 • **Washington, D.C.** — Metropolitan 8-5205 • **Dayton** — Baldwin 3-8128

Circle 118 on Inquiry Card

IRE New Products

Microwave Oscillator

Microwave oscillators, models 621 to 626 feature electronic sweep or CW operation, 1 to 18 KMC (6 models),

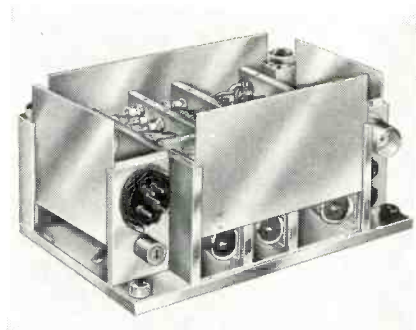


quick look read-out, 0.5 μsecs AM response, 0.01 to 100 sweeps per sec. Alfred Electronics. Booth 1633.

Circle 285 on Inquiry Card

Telemetering Transmitter

Model 1483-A1, a true FM Telemetering Transmitter, is a completely modularized missile transmitter. Output is 2 to 6 w at 215 to 260 MC. Carrier stability is 0.005%. Telechrome Manufacturing Corp. Booth 3612.

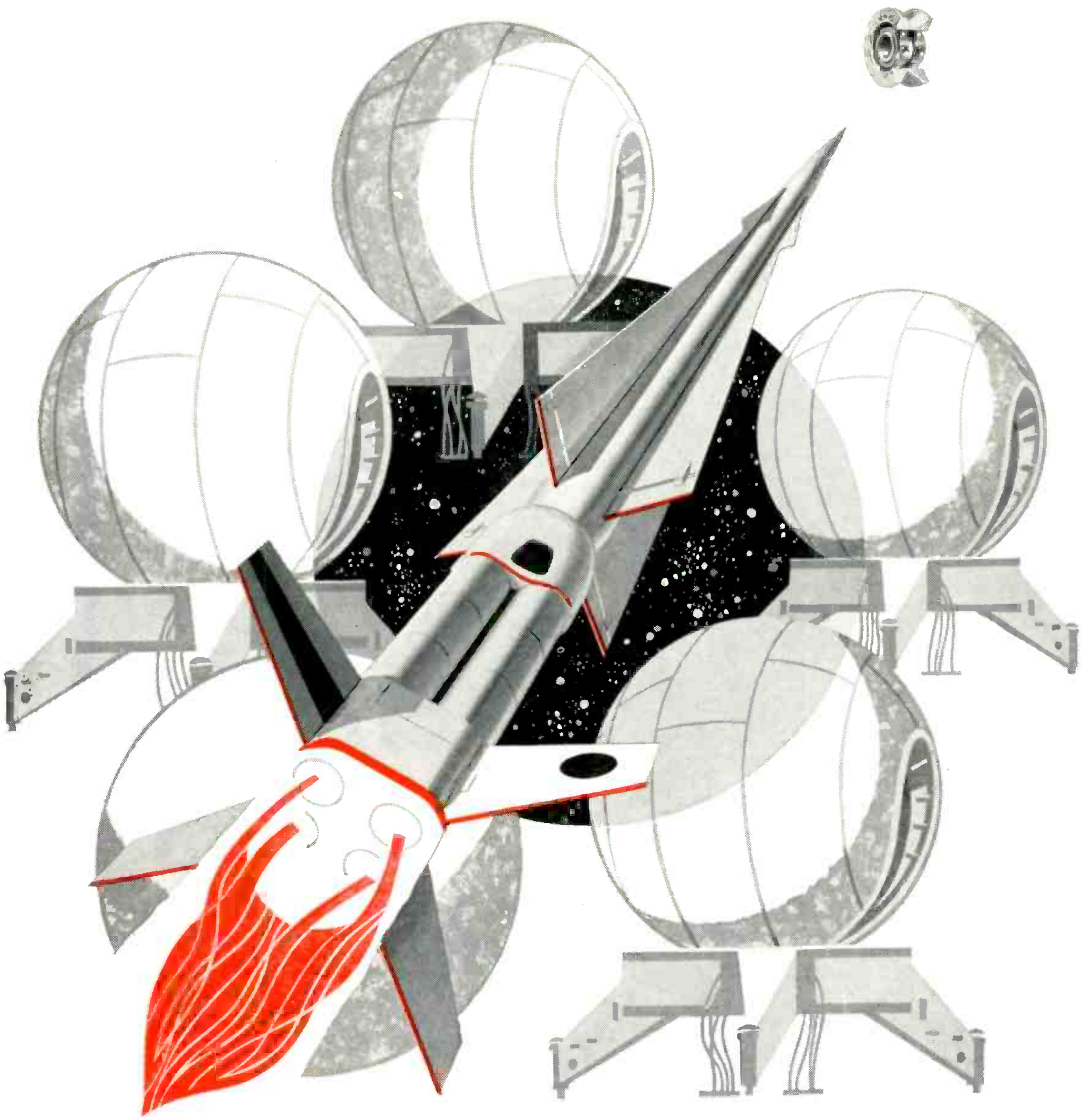


Circle 286 on Inquiry Card

Transistor Tester

Dynamic Beta Transistor tester, Model 870, measures large signal dc Beta on power transistors as well as small signal ac Beta on low and medium power transistors. Collector test current variable up to 2 a. Hickok Electrical Instrument Co. Booth 3616.

Circle 287 on Inquiry Card



THOR
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Helping customers *simplify* instrument assembly is a specialty of the N/D engineering group. How? Through *creative* Miniature/Instrument ball bearing application and design. Often, a new ball bearing design will produce assembly savings in excess of its additional costs. Integral ball bearings, too, very often cut down difficult and costly hand assembly of shaft and parts.

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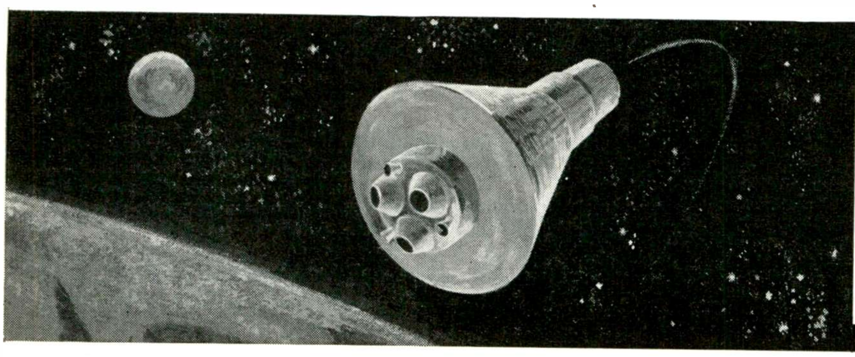
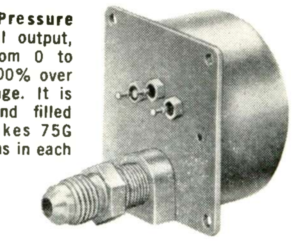
FAIRCHILD PRESSURE TRANSDUCERS



Fairchild TPH-175 Pressure Transducer has a dual output, can take pressure from 0 to 10,000 psi and up to 100% over pressure without damage. It is hermetically sealed and filled with silicone oil. Takes 75G shocks and accelerations in each of three axes without damage. Twin spring design eliminates all linkages and pivots.



At the heart of the Capsule Pressurization System, built by Garrett Corporation's AiResearch Division for the McDonnell Aircraft Corporation — as part of NASA'S Project Mercury Space Vehicle — is a miniature (1.75" Diameter) FAIRCHILD TPH-175 PRESSURE TRANSDUCER. It monitors the pressure of oxygen remaining in the storage tank under the most severe environmental conditions.

A dual output transducer: One output goes to the astronaut's control panel, reassures him that plenty of oxygen is still available. The second output goes to the telemetering system for relay to ground control stations.

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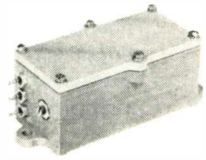

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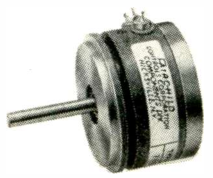

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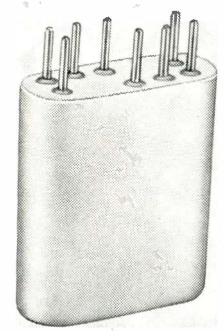
IRE New Products

Crystal Case Relay

Sub-miniature, 2-pole relay has a double throw bifurcated contact structure. One in. long and ½ oz., it is for continuous operation in the −65 to



+125°C. range. Union Switch & Signal. Booth 2122.

Circle 271 on Inquiry Card

Dielectric Lens

The Bistatic Ecco Reflector, a spherically symmetrical dielectric lens with an associated spherical reflecting

surface, provides a reflectivity pattern sharply peaked in the direction of the transmitter. Emerson & Cuming, Inc. Booth 1111.

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Epoxy Compound

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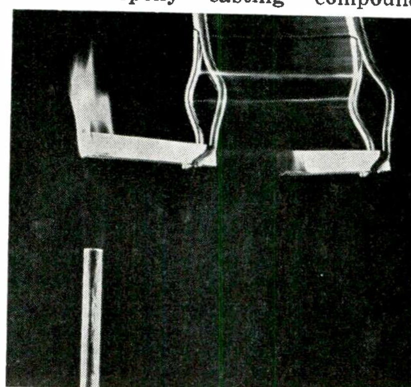

meets ASTM D635-56T and MIL T27. It snuffs out immediately upon removal from Bunsen burner flame. Hysol Corp. Booth 4231.

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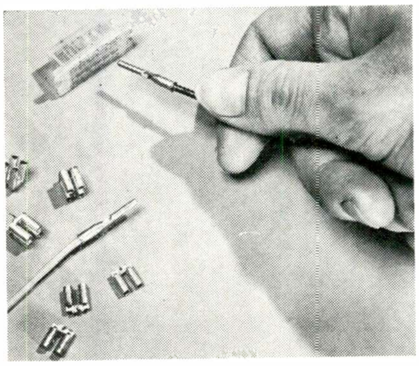
IRE New Products

Taper Pin Connectors

Small, pin and socket type, connectors in complex shapes, thin cross sections, close tolerances, etc. Units eliminate



soldering operations and simplify maintenance. Gries Reproducer Corp. Booth 4110.

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Generator

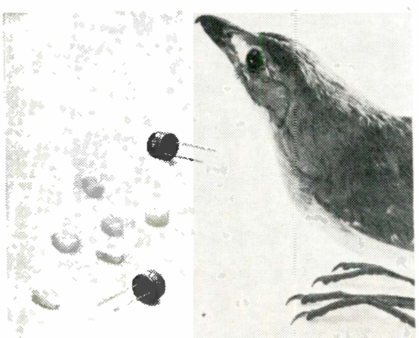
Model 250 Powertron Electronic Generator supplies 250 va power at either a fixed 400 CPS or a variable range

from 350 to 450 CPS. Output voltage continuously variable from 0 to 120 v. Industrial Test Equipment Co. Booth 3513.

Circle 289 on Inquiry Card

Toroidal Inductors

New MT series of microminiature Kernel toroidal inductors. The MT 34 Kernels are for frequencies to 30 KC



and can be supplied with inductances to 500 mh. MT 35 series to 200 KC. Burnell & Co., Inc. Booth 2909.

Circle 290 on Inquiry Card

International Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering journals

ANTENNAS, PROPAGATION

A Method of Antenna-Feeder Matching in Multi-Band Radio Relay Lines, V. I. Krutikov. "Radiotekh," 14, No. 11. 1959. 8 pp. Ferrite rectifiers are normally used for matching purposes at low powers and microwaves shorter than 10-15 cm. Whenever it is inconvenient to use them the method described in this article is recommended. It consists of rejector filters which provide a reflected voltage in the required magnitude and phase by means of attenuators and correct spacing of filters along the waveguide line. By this means a reflection coefficient between the antenna and the feeder not exceeding 2.5% in each of the several 20 Mc bands with a spacing of 40 Mc is obtained. The method was tested out on a three-band waveguide system with satisfactory results. (U.S.S.R.)

Determining the Conductivity of Soil by the Attenuation of Radio Waves in it. V. E. Kashprovskii. "Radiotekh," 14, No. 12. 1959. 7 pp. For the design of medium and long wave antennas, location of broadcasting and navigational stations, etc., it is essential to know the electrical parameters of the soil over which the ground wave is propagated. The most important parameter in practice is soil conductivity, yet to date no simple and reliable method of measuring it has been developed. In this article the author outlines the theoretical considerations on which his new method of measuring soil conductivity is based, describes the conditions under which it can be applied, and the equipment required, and provides some of the results obtained by his method. Essentially the method consists in measuring the attenuation of the field strength between the surface of the earth and some point below it. Since the method is local and envolves relative measurements, the apparatus required is very simple and subsequent calculations are not complicated. (U.S.S.R.)

Calculation of Losses in a Hyperbolic Lens Antenna Illuminated by a Hertz Doublet. I. F. Dobrovol'skii and V. P. Smirnov. "Radiotekh," 14, No. 12. 1959. 5 pp. The present practice of evaluating losses in lens antennas is very inaccurate and does not take into account the shape of the antenna. Calculations were, therefore, made on the basis of the lens antenna configuration of the losses on account of the energy reflected from the lens surface and heat losses in the lens material. Calculations were made for the case when the lens is illuminated by a Hertz doublet. The formulas and graphs obtained for this particular case can be used for tentative estimations of losses in hyperbolic lens antennas in general and for calculating lenses for minimum loss conditions. (U.S.S.R.)

300 Ohm Radio Transmitter Aerial Exchange, K. P. Carrey and P. Elias. "Proc. AIRE." Nov. 1959. 5 pp. Modern radio transmitting stations require a rapid, accurate yet electrically efficient system for transmitter-aerial switching in order that maximum operational flexibility may be achieved. This paper discusses the general requirements of such systems, and describes a 300 ohm indoor aerial exchange and associated transmission line suitable for this purpose. (Australia.)

Passive Microwave Mirrors, R. G. Medhurst. "E. & R. Eng." Dec. 1959. 7 pp. The performance of a few special types of passive reflector aerial systems have been evaluated by methods involving considerable numerical computation[1,3,4]. In this article it is shown that certain plausible assumptions concerning the near field of the primary aerial lead to quite a simple theoretical treatment applicable to a variety of shapes of reflector. (England.)

AUDIO

Modern Acoustical Engineers, II. Electro-Acoustical Installations in Large Theatres, D. Kleis. "Phil. Tech." #2, 1960. The main acoustical problems arising in theatres are those relating to intelligibility, to the acoustics for music and to the acoustics as they affect actors and musicians. A satisfactory solution is to back up the performance with direct and indirect sound from an electro-acoustical installation. Theatres also need various electro-acoustical facilities, such as monitoring and paging systems, installations for the hard of hearing, and so on. Television links have also proved useful. (Netherlands, in English.)

CIRCUITS

The Attenuation and Phase Constants of Balanced Hybrid Circuits, B. Hess and G. Kraus. "Nach. Z." Oct. 1959. 7 pp. The transmission properties of balanced pair hybrid circuits are investigated more closely. Losses and additional circuit elements are also taken into consideration. The numerical evaluation of the formulae can be simplified by a graphical method. (Germany.)

Negative Feedback Transistor Amplifier, R. Dallemagne & P. Caniquit. "Cab. & Trans." Oct. 1959. 10 pp. The application of transistors to voice frequency telephone amplifiers and to higher frequency amplifiers for multiplex transmission systems with high feedback rates makes it necessary to use direct coupling between successive amplifying stages. The authors have built such amplifiers with two and three stages and studied their operation as voice frequency repeaters and as line amplifiers for carrier current communication systems. (France.)

Diode Phase-Sensitive Detectors with Load, R. Chidambaram and S. Krishman. "El. Eng." Oct. 1959. 4 pp. A theoretical investigation of the operation of the simple diode push-pull phase-sensitive detector with load is carried out. The transfer ratios for the two diodes

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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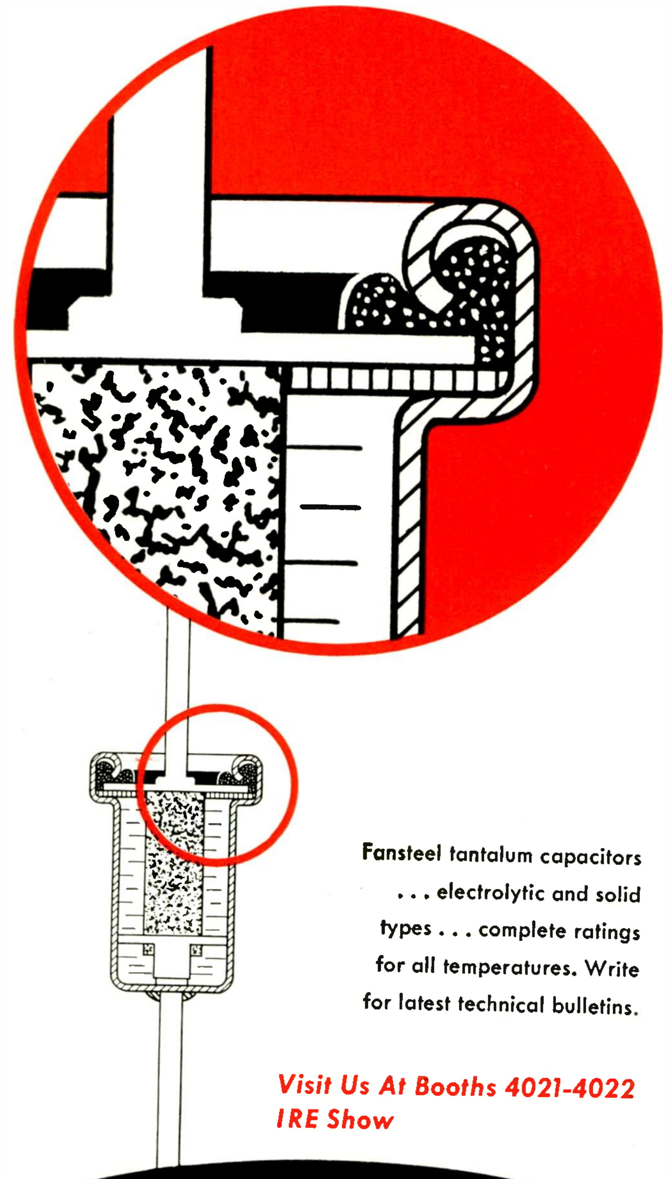

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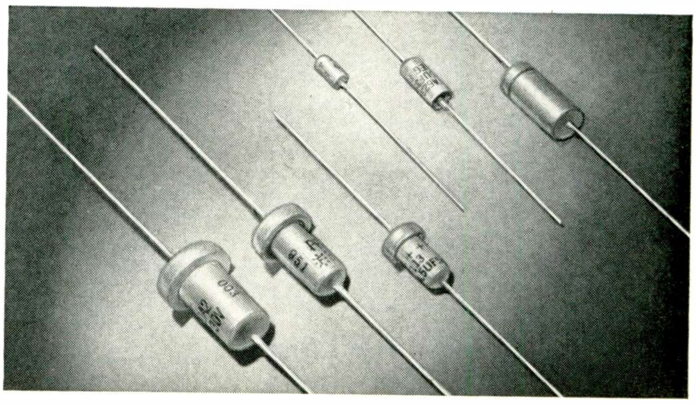

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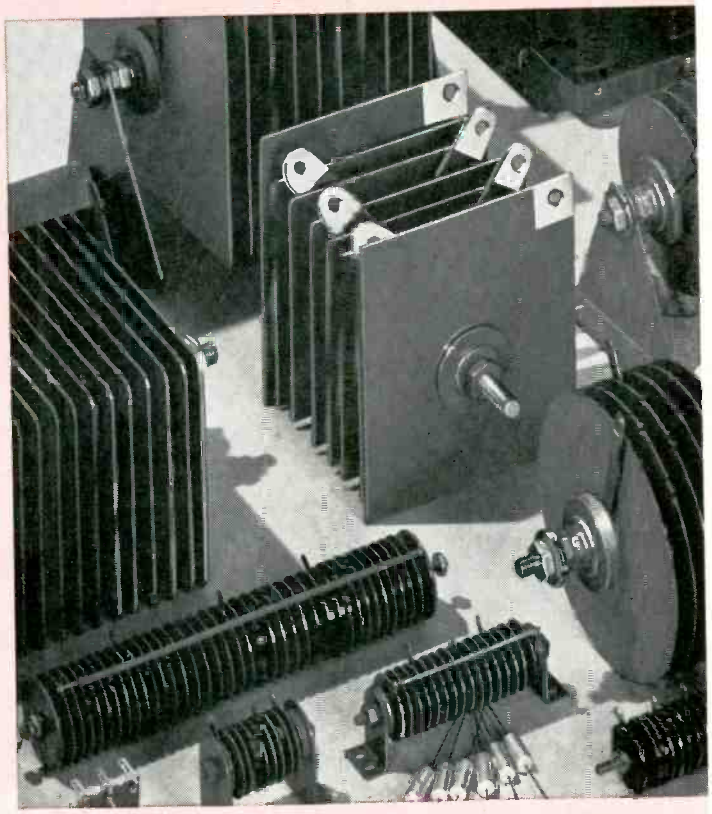

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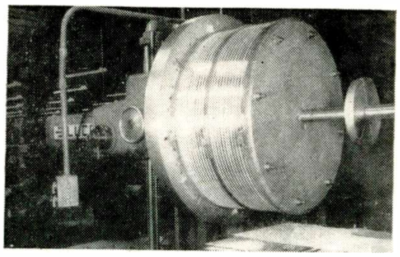

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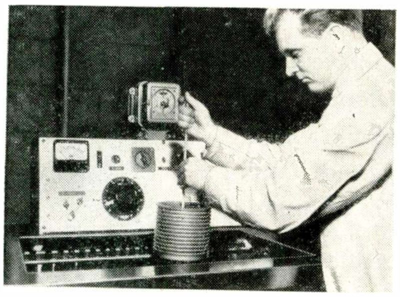
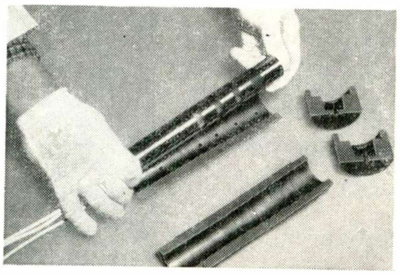


ELECTRO-PLATED



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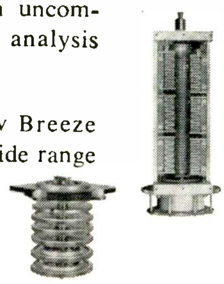

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are found to vary considerably with the signal. The non-linearity in the output due to these variations is evaluated and a table is given from which the suitability of a given detector may be judged immediately. Experiments confirm quantitatively the theoretical results. (England.)

An Investigation into Some Aspects of Diode Quantizing Circuits, H. V. Bell and W. Alexander. "El. Eng." Oct. 1959. 5 pp. Quantization is defined and some past work on diode quantizers is reviewed. Three circuits are compared both theoretically and by measurement, and the results presented. A possible application of these circuits is then described. (England.)

The Design of Transistor Push-Pull DC Converters, W. L. Stephenson, et al. "El. Eng." Oct. 1959. 5 pp. There are many methods by which dc may be converted from low to high voltage using some oscillating device, but one of the most efficient methods uses a transistor square wave oscillator controlled by a saturating transformer. For such a system design formulae are derived in terms of operating parameters. Most of the practical limitations and difficulties are outlined, but are not discussed in detail as individual solutions are usually required. (England.)

Optimum Tchebycheff Third-Order Filters, H. S. Heaps and L. J. Mason. "E. & R. Eng." Oct. 1959. 4 pp. An analysis is presented to determine the optimum design of a Tchebycheff low-pass, third-order filter to detect a rectangular pulsed signal upon a background of white noise. It is found that for a given length of input pulse the signal-to-noise ratio in a sample of the output is almost independent of the value of the filter parameter (chosen between zero and unity). (England.)

A Small, High Voltage, Regulated Power Supply with Variable Output, J. D. O'Toole. "El. Eng." Nov. 1959. 3 pp. An increasing field of application exists for high voltage power supplies with stable outputs, without any requirement for large amounts of power. The needs of this field appear to have been imperfectly satisfied due to apparent limitations of available small valves. (England.)

A Delta Modulation System Using Junction Transistors, B. E. Williams. "El. Eng." Nov. 1959. 7 pp. A delta modulation system, operating at a digit frequency of 14 kc/s, is described which provides a simplex speech link with good intelligibility. The equipment has only one manual control, the press-to-talk switch, other adjustments being preset or made automatically. The receiver regenerates the incoming signal by voltage and time slicing before feeding the decoder. (England.)

Nonlinear Distortion in Transistor Amplifiers with Automatic Gain Control. E. P. Dement'ev. "Radiotekh" 14, No. 11. 1959. 9 pp. Reasons for nonlinear distortion in automatic gain control by means of the collector voltage and the emitter current are examined. The analysis is made on the assumption that in the region of small emitter currents distortions are caused only by the nonlinearity of the emitter characteristic and in the region of small collector voltages only by the nonlinearity of the initial section of the collector characteristic. Distortions with a resistive and a tuned circuit load are considered. The basic quantitative relations are established. (U.S.S.R.)

Design for a Frame Sweep Oscillator Final Stage, A. A. Zakharov. "Radiotekh," 14, No. 11. 1959. 9 pp. The operation of the final, amplifying stage of a frame sweep oscillator with a choke and transformer coupling is analyzed. The anode current of a choke coupled amplifier is determined by considering its five components. The excitation voltage is calculated from a load line which is made to coincide with the ideal case at three points. Design formulas are given for the bias voltage, cathode resistor and the peaking resistor. Similar calculations are made for the transformer coupled case. The application of the formulas provides a design with a deflection current of good linearity. (U.S.S.R.)

An Autotransformer Circuit for High-Frequency Correction of an RC Amplifier, V. P. Shasherin. "Radiotekh," 14, No. 11. 1959. 8 pp. A special fourth order correcting circuit is described which provides by means of mutual induction between two tuned circuits the possibility of selecting optimum correcting parameters without altering the fixed stray capacities in the circuit. This is achieved at the cost of additional attenuation due to "reflected" resistance without introducing, however, any additional resistors in the circuit. This circuit provides a wider bandwidth than higher order and more complicated correcting circuits. Test results of pentode RC amplifying stages with a gain up to 10 confirm the calculations. At higher gains calculated and experimental results differ owing to larger mutual inductances involving increased stray capacities. (U.S.S.R.)

Analysis of Complicated Electronic Circuits, L. Ya. Nagornyi and V. P. Sigorskii. "Radiotekh," 14, No. 12. 1959. 10 pp. Analytical expressions for modern very complicated electical circuits are difficult to obtain. The problem is simplified by using generalized methods of nodal voltages and circuit currents. By this method basic parameters of an equivalent quadripole, such as input and output impedances, voltage and current transfer constants, transfer impedances and admittances, were expressed by means of a determinant of the circuit matrix included in the quadripole and by its algebraic complement. The majority of circuits can be represented by means of quadripoles. The expressions of the main complex quantities were investigated by means of conformal transformations. The techniques employed is illustrated by examples. (U.S.S.R.)

The Resistance Network, a Simple and Accurate Aid to the Solution of Potential Problems, J. C. Francken. "Phil. Tech." #1. 1960. 14 pp. A resistance network can be used to solve Laplace's equation for given boundary conditions. Conditions which must be satisfied by the resistance values, for both the two-dimensional and the rotationally-symmetric three-dimensional cases, are worked out in the article. (Netherlands, in English.)

Cold-Cathode Tube Circuits—Basic Elements for Automatic Control, H. Liebendorfer. "E. & R. Eng." Dec. 1959. 7 pp. (England.)

Multistage Amplifier Stability, L. G. Cripps. "E. & R. Eng." Dec. 1959. 4 pp. The stability of an amplifier consisting of N cascaded stages is considered for the two cases (a) where the stability factor of all the stages are equal before cascading, and (b) where the stability factors of all the stages are equal after cascading. A short discussion of the results is given. (England.)

COMMUNICATIONS

Effect of a Strong Interfering Signal on the Input of a Radio Receiver, L. M. Kononovich. "Radiotekh," 14, No. 11. 1959. 7 pp. A strong sinusoidal signal outside the receiver frequency band can decrease or increase the gain of the RF and even Mixer stages owing to changes in their biasing. The selection of the most suitable tubes and biasing for greatest interference resistance and highest gain are suggested. The best biasing for minimum secondary modulation is given. Tubes with the minimum mutual conductance to anode current ratio at zero biasing are found to be the most noise-proof. It is shown that with a suitable selection of tubes and operating conditions it is possible to obtain a larger signal to noise ratio at the output of the amplifying stage than at its input. Calculations were confirmed experimentally. (U.S.S.R.)

Evaluation of the Carrying Capacity of Communication Channels with Parameters Varying at Random, Ya. I. Khurgin. "Radiotekh," 14, No. 12. 1959. 9 pp. The carrying capacity of single and multi-beam communication channels is evaluated with the assumption that the transmitted signal, the propagation constant of the medium, the propagation time and the additive noise are all mutually independent stationary random processes. As an example the carrying capacity of a single-beam channel is calculated taking into account propagation time and additive noise fluctuations. (U.S.S.R.)

Magnetic Circuits for Contacts Hermetically Sealed in a Protective Gas Atmosphere, H. Rensch. "Nach. Z." Dec. 1959. 5 pp. This paper is a report on a switching element for telecommunications which now finds more widespread application in Germany and in which the magnetic path and the electric path are identical in the region of the contact. (Germany.)

The Distribution Law and the Addition Theorem for Traffic Sources and Line Lengths in Radial Networks with Square Boundaries, H. Kremer. "Nach. Z." Dec. 1959. 3 pp. The distribution law and the addition theorems for traffic sources and the line lengths within a square boundary subscriber region are derived. The addition theorems are compared with observed sum curves for a subscriber region with irregular boundaries. (Germany.)

A VF-Telegraphy System with Transistors for Narrow Band FM, H. Heller. "Nach. Z." Dec. 1959. 7 pp. The economical and technical considerations are outlined which have led to an optimum design of an FM-VF-telegraphy system with a channel spacing of 120 c/s and a bandwith of 80 c/s and an outlay comparable with AM-systems. The problems of the choice of frequency deviation, transmission function and phase equalization and the circuit principle applied to this system are discussed. (Germany.)

On Registration Precision of Magnetic Tape Recording, H. Volz. "El. Rund." Jan. 1960. 3 pp. By means of information theory the conception registration precision is defined also for more complicated transmission systems by example of magnetic tape channel. Its capacity is calculated by the three possible distorting influences (signal to noise ratio, noising AM and FM) of the general steady channel. The maximum obtainable registration prevision may be derived from this. (Germany.)

A Wide-Band Triode Amplifier with an Output of 10 W at 4000 Mc/s, J. P. M. Gieles & G. Andrieux. "Phil. Tech." #2, 1960. 6 pp. The construction and properties of an amplifier developed for the EC 59 disc-seal triode are described. The main differences between this amplifier and one earlier designed for the EC 157 are concerned with matching the tube to the input and output waveguides and with the fact that water cooling is necessary with the EC 59. (Netherlands, in English.)

The New South Wales North Coast Trunk Radio Network, J. D. Thomson & B. W. G. Penhall. "Proc. AIRE." Oct. 1959. 11 pp. The heavy 1955 floods had a calamitous effect on truck communications in the New South Wales North Coast area. Because of its nature, a radio network would have continued working under similar circumstances and the plan for the use of such a network is described in three main categories. (Australia.)

A Review of Long Distance Radio Communication, O. L. Wirsu. "Proc. AIRE." Oct. 1959. 7 pp. A general review is given of (a) the methods adopted to improve the performance of the older communication methods, viz. single sideband operation, automatic error correction, bandwidth restriction and rhombie aerials and (b) the new communications systems using scatter propagation waveguide transmission, repeatered submarine cables and satellite relay transmission. (Australia.)

Automatic Error Discrimination and Correction in Radio Teletype Systems, W. J. Griffiths. "Proc. AIRE." Oct. 1959. 10 pp. The

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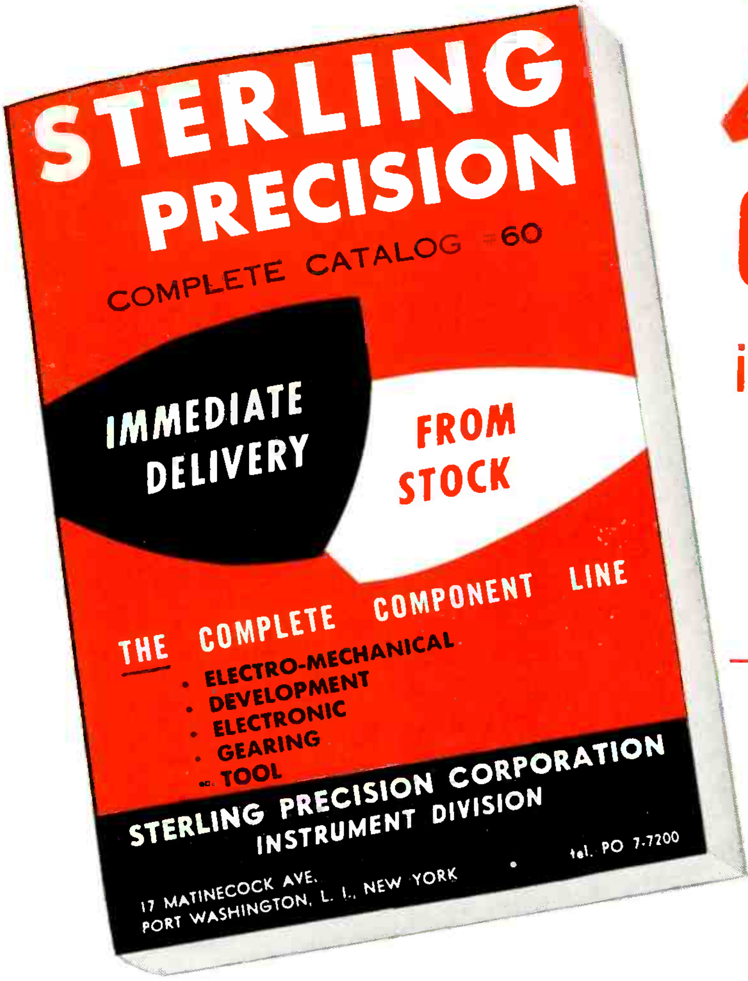

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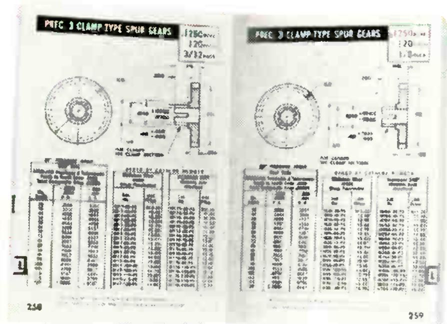

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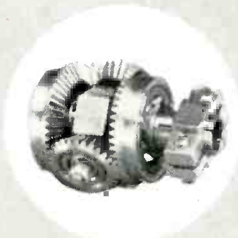

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efficiency and reliability of automatic teletype systems may be improved by the electrical recognition of an error at the time of reception followed by repetition of the mutilated signal. Error detection is based either upon special codes or the rejection of signals falling below a certain threshold. The operation of two equipments upon these systems is described. (Australia.)

Inter-Relation and Combination of Various Types of Modulation, W. D. Meewezen. "Proc. AIRE." Oct. 1959. 9 pp. An examination of the frequency distribution of the power in typical broadcast signals shows that low deviation phase modulation (PM) should have advantages over amplitude (AM) and frequency modulation (FM). A method of stereo broadcasting is also proposed in which the sum of the two channels is transmitted as AM and the difference as PM. (Australia.)

Correlation between Fading Signals, J. Bell. "El. Tech." Jan. 1960. 5 pp. Simple resistance-capacitance circuits enable the positive rectified fading signals, obtained at the outputs of two conventional radio-receivers, to be made to fluctuate about zero. The instantaneous sum and the instantaneous difference of the fluctuations are then separately squared, smoothed, and displayed continuously on pen recordings. (England.)

Communication Efficiency of Vocoders, A. R. Billings. "E. & R. Eng." Dec. 1959. 5 pp. To compare communication and bandwidth compression systems, a term communication efficiency is introduced which is defined as the ratio of the actual rate of transmission of information to the rate at which it would be transmitted by an ideal system subjected to the same restrictions. (England.)

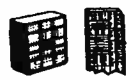
COMPONENTS

Effect of the Steepness of the Input Pulse Front in Pulse Transformers, L. Z. Gogolitsyn. "Radiotekh," 14, No. 11. 1959. 3 pp. The effect of the rate at which the input signal front rises on the output signal front in pulse transformers is investigated. Formulas and graph are given for the election of design parameters which provide the required output signal front shape for a given duration of the input signal front rise which varies according to the exponential law. The shape of the output pulse can be determined more accurately if the final rate of rise of the input pulse front is taken into consideration. The formulas can be used for designing pulse transformers. (U.S.S.R.)

Low Frequency Varicaps, L. S. Berman, A. P. Landsman and V. K. Subashiev. "Radiotekh," 14, No. 12. 1959. 2 pp. Low frequency semiconductor variable capacitors covering the range from a few hundred cps to a few tens of KC with a minimum Q = 10 are described. They are made of monocrystalline silicon in the form of discs 3-5 cm in diameter. Their capacity per unit of p-n junction, without an external voltage, lies between 0.02-0.03 microfarad/cm^2. Their capacity is little affected by temperature. (U.S.S.R.)

The Effect of Crystal Resonator Loading on the Frequency Stability of Crystal Oscillators. G. B. Al'tshuller. "radiotekh," 14, No. 12. 1959. 5 pp. Since in miniaturized equipment a relatively high output voltage of crystal oscillators is required, the effect of their loading on frequency stability becomes important. This effect is studied in the range of 4-12 Mc with crystal resonators which use metallized plates and transverse oscillations. Formulas for calculating the heating-up temperature of crystal plates are given and the technique of evaluating the frequency instability of crystal oscillators outlined. (U.S.S.R.)

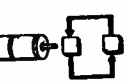
Equivalent Circuits of Ferrite Cores for a Wide Frequency Band, Yu. P. Mel'nikov. "Radiotekh," 14, No. 12. 1959. 11 pp. In milli-micro-second pulse transformers core losses cannot be ignored. Suitable cores for such transformers can only be selected with the knowledge of the high-frequency properties of ferrites. Yet the frequency characteristics of the material do not provide a convenient means of evaluating the HF properties of the cores; equivalent circuits are more convenient for this purpose. Several equivalent circuits of ferrite cores whose parameters are related with the frequency characteristics of the material are suggested. Simple formulas for determining these parameters are given. (U.S.S.R.)



COMPUTERS

Digital Analogues, A. V. Shileiko. "Avto i Tel." Dec. 1959. 11 pp. A systematic survey of devices of a new class called in the paper digital analogues is presented. The term digital analogues is used for the digital differential analyzers, incremental computers and some function generators, the input and output of the generators being in form of the delta-modulation of the pulse train. The theoretical concepts of the digital analogues are formulated and their characteristics are compared with those of electronic digital and analogue computers, the computer being assumed as an equivalent circuit which converts input signals. The product of resolution and frequency band of this circuit is taken for a figure of merit in comparing computers of different classes. (U.S.S.R.)

Equipments for the Datamation of Measured Traffic Units, A. Tonn & W. Tanzer. "Nach. Z." Dec. 1959. 5 pp. A program-controlled and datamating multi-purpose measurement method for a simultaneous analogue and digital determination of measured quantities is discussed. This new equipment consists of a 50-digit recording and controlling device, a 25-digit counter printer and a maximum value fault indicator. Its versatile applications are explained by means of practical examples from telecommunications. (Germany.)



CONTROLS

Pontrjagin Maximum Principle in the Theory of Optimum Systems. III, L. I. Rozonoer. "Avto i Tel." Dec. 1959. 18 pp. The most important problems of automatic control which are connected with proofing and using Pontrjagin maximum principle in the theory of optimum systems are expounded. The paper yields some new results. (U.S.S.R.)

Magnetic Logical Units for Automatic Control Circuits, N. P. Vasilieva, N. L. Prokhorov. "Avto i Tel." Dec. 1959. 12 pp. Logical unit circuits of main types based on magnetic cores and crystal diodes are considered. Comparative evaluating of these units is given. (U.S.S.R.)

Frequency Method to Determine Dynamic Characteristics by Normal Operating Records, V. V. Solodovnikov, A. S. Uskov. "Avto i Tel." Dec. 1959. 9 pp. The frequency method for determining dynamic characteristics by normal operating records is described. The systems with time-delay and several inputs as well as multipath systems with noises are considered. The analysis is made supposing the random processes are stationary and ergodic and the systems are stable. (U.S.S.R.)

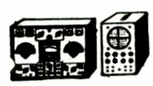
On Synthesis of Linear Variable Control Systems, S. V. Malchikov. "Avto i Tel." Dec. 1959. 7 pp. A determination of optimum weight functions of compensation elements, used both in the direct system circuit and in the feedback circuit, by a system optimum weight function and weight functions of the known separate elements is described. The method suggested makes it possible to remove difficulties of solving Volteurr first order integral equations. (U.S.S.R.)

Synthesis of Elements of Automatic Linear Control Systems, I. A. Orurk. "Avto i Tel." Dec. 1959. 8 pp. The synthesis method of elements of automatic control linear systems is described. The method is based on using time characteristics and ratios obtained from integral polynomial equations and on using the D-plot of parameters plane. The method may be used when programming synthesis problems on computers. (U.S.S.R.)

Frequency Responses of Relay Control Systems, Ya. Z. Tspkin. "Avto i Tel." Dec. 1959. 8 pp. A way of plotting accurate amplitude-frequency and phase-frequency characteristics of relay control systems for an outer periodic disturbance of an arbitrary form is described. This method is based on conception of the generalized characteristic of the relay system. The special case of this characteristic is used to investigate periodic modes. Examples are given to illustrate the method described. (U.S.S.R.)

Analysis of Control Systems Tracking Failure Due to Fluctuation Noise Influence, I. A. Bolshakov. "Avto i Tel." Dec. 1959. 12 pp. Using Fokker—Planck equations there is analyzed control system tracking failure due to intense fluctuation noise influence. The boundary problem in which the failure is an increase of the system tracking error over certain value is solved by Ritz—Galerkin method. The results are used to analyze noise stability of the system of automatic frequency control of the continuous signal receiver. (U.S.S.R.)

On Calculation of Mean-Square Error of Yielding Stationary Random Signal by Linear Control System, N. I. Sokolov. "Avto i Tel." Dec. 1959. 12 pp. The formula for approximate calculation of a convolution integral is proposed that provides a high accuracy at a large integration step. There is given a method of an approximate solution of integral equations that permits to quickly calculate a mean-square error of yielding a stationary random signal by an automatic control system. (U.S.S.R.)



MEASURE & TESTING

Electronic Strain Measurement — Modern Answers to an Old Problem, G. Hitchcox & L. W. Harrison. "Brit. C.&E." Dec. 1959. 5 pp. Strain measurement is growing in importance and popularity at a time when modern electronic techniques, especially the use of transistors, are giving increased accuracy and convenience. This article reviews the general problem, and describes recent progress, especially in instruments using resistance and acoustic gauges. (England.)

Tape Recorders for Scientific Purposes, F. Culbasch. "El. Rund." Nov. 1959. 2 pp. To date tape recorders for scientific purposes have hardly been used in Germany. The author has compiled a list of versatile applications, and shows the various recording methods possible when various electrical and designing possibilities are skillfully utilized. (Germany.)

Sources

The Telepulse Remote Gauging System, A. C. Ferguson & I. W. F. Paterson. "Brit. C.&E." Dec. 1959. 4 pp. A pulse telemetry system is described for the remote indication of liquid level and temperature in oil refineries and tank farms. (England.)

Generator Load-Angle Measuring Equipment for Marchwood, N. S. Annis. "Brit. C.&E." Dec. 1959. 4 pp. A digital technique is described for the direct on-site measurement of generator load angle. In this particular installation, indication is also provided in the plant control room for general observation and recording purposes. (England.)

The Ferrometric Method of Testing the Magnetic Properties of Ferromagnetic Materials, M. Nalecz B. Osuchiowska. "Roz. Elek." Vol. V, No. 2. 21 pp. The Theoretical foundations of the measurement of the magnetic properties of ferromagnetic materials are presented in the paper. Some of the ferrometric systems are described. The paper gives the results of measurements which have been performed in the Electrotechnic Laboratory of the Polish Academy of Sciences. (Poland)

Frequency Spectrum Display of Modulated R-F Voltages, J. Czech. "El Rund." Nov. 1959. 2 pp. The paper shows a relatively simple method of displaying with an oscilloscope the amplitude-modulated carrier as well as both sidebands and their amplitudes. The frequencies of carrier and sidebands are frequency-modulated by the horizontal-sweep frequency of the oscilloscopes. (Germany).

V.S.W.R. Indicators with Automatic Read-Out, M. Kollanyi, and R. M. Verran. "El. Eng." Nov. 1959. 6 pp. An automatic indicator giving a direct read-out either on a meter or a digital display unit can replace the conventional V.S.W.R. indicator with its time taking adjustments. The circuits can be used with any slotted line or equivalent device. A single movement of the probe carriage is all that is necessary for the instrument to supply the correct VSWR reading. (England).

An Amplitude Distribution Meter, M. Drayson. "El. Eng." Oct. 1959. 7 pp. The significance of signal amplitude distribution measurements is described, and a brief outline of the mathematical expression of amplitude distribution is given, with particluar reference to the approximations involved in any practical measuring system. A novel kind of waveform sampling device has been produced, which permits measurements to a resolution of at least 1%, and an account of this is followed by a detailed description of the circuits associated with it. (England.)

Providing a Precise Vector Voltage, D. J. Collins, and J. E. Smith. "El Eng." Nov. 1959. 2 pp. The article deals with a possible system for producing a precise vector voltage which can be of any amplitude less than reference and of a phase relationship between 0 and 360°. Such a system is of great use in the calibration of phase shifters and phase measuring devices. (England).

Peculiarity of Processes in Lines with a Zero Potential Conductor. V. A. Solov'ev. "Radiotekh," 14, No. 12 (1959). 4 pp. By means of infinite lines with a zero potential conductor it is possible to obtain pulses of half the width as compared with short or open circuited lines with the same delay. Pulse shaping can be made without losing the direct component or switching the charging and discharging line circuits. By means of zero potential conductor lines it is possible to form simple pulse shaping, and pulse amplitude and polarity changing circuits. Above properties of the lines are useful in time selector circuits. Best results are obtained with lines having evenly distributed constants. (U.S.S.R.)

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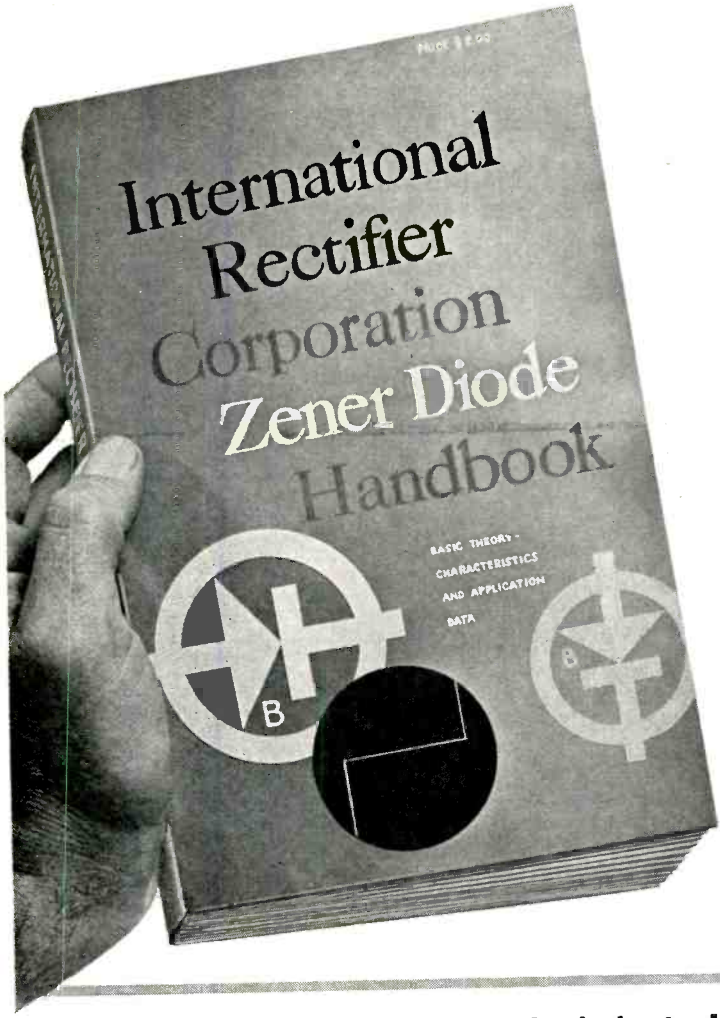

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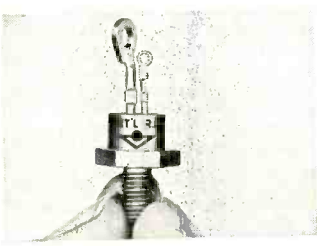

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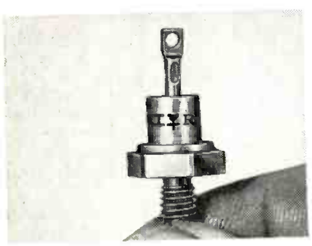

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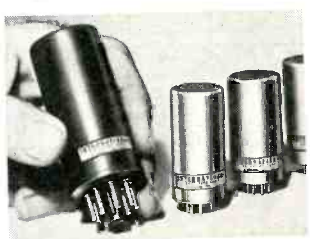

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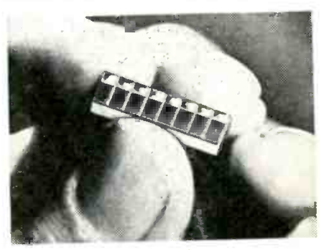

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Sources

Investigation of Methods for Preserving a High Accuracy of Scale Calibration by Means of Mechanical Correction and a Reference Oscillator. M. E. Movshovich. "Radiotekh," 14, No. 11 (1959). 7 pp. Optimum conditions for induction, capacity and combined trimming and pointer correction of logarithmic, straight-line, and straight and inverse square-law tuning capacitors of heterodyne oscillators in receiving sets is investigated by means of Chebyshev's minimum deviation theorem. The relations thus obtained determine the position of reference graduations, the limits of corrections and the values of the possible correction errors. The formulas also provide the maximum possible and the most probable scale calibration errors. The effect of the instability of the reference oscillator and the intermediate frequency amplifier on the calibrations is studied. (U.S.S.R.)

The Problem of Coefficient Determination of Optimum Pulse Transient Function, A. M. Perelman. "Avto i Tel." Dec. 1959. 4 pp. There is given the formula for the coefficient determination of the optimum, under flat noise, pulse transient function of the system. The formula does not require any complicated solution of an algebraic linear equation system when the desired signal is a high order polynomial. (U.S.S.R.)

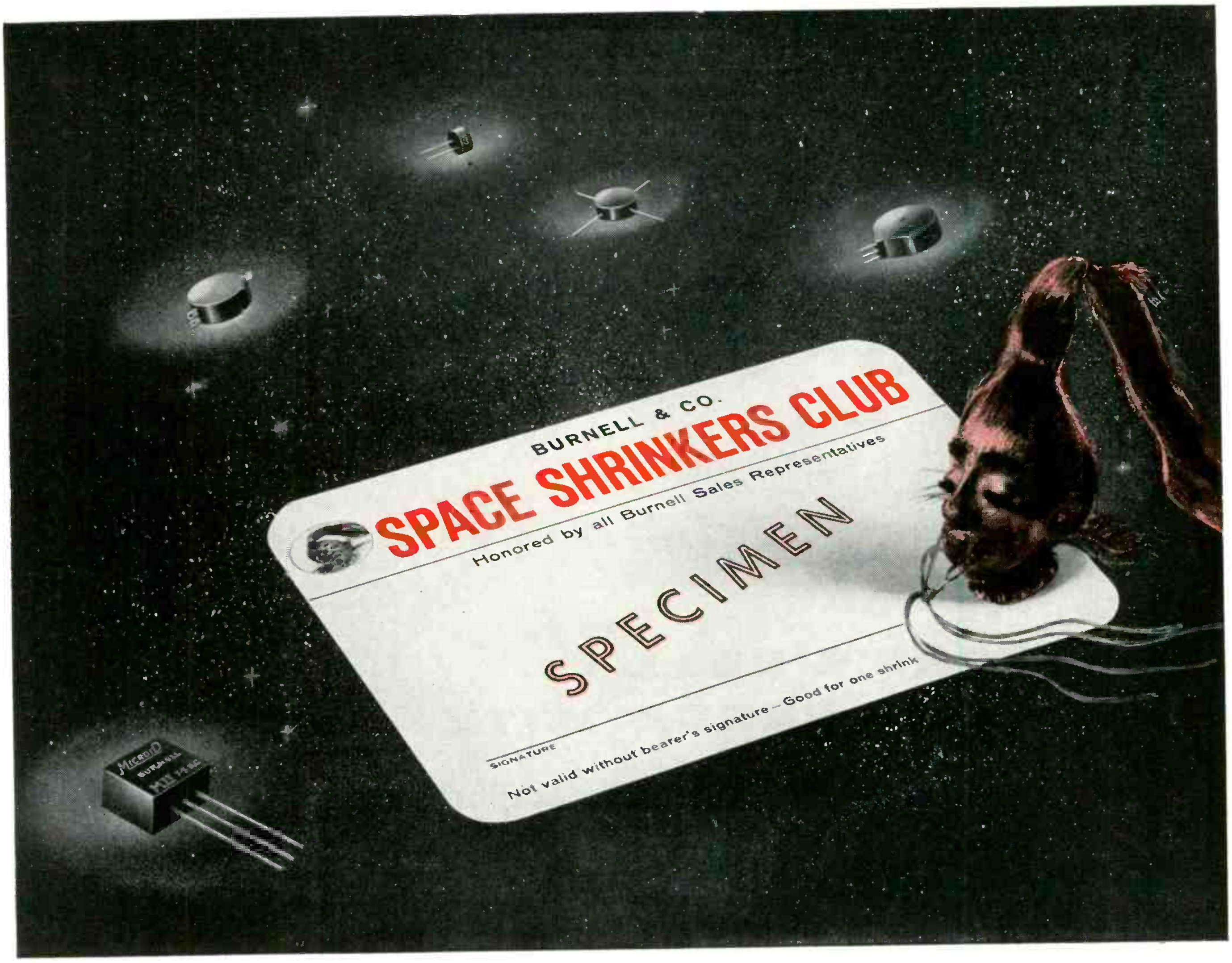
An Instrument for Determining Frequence Responses of Non-Linear Systems, K. V. Zakharov, V. K. Svjatodukh. "Avto i Tel." Dec. 1959. 8 pp. The existing methods of harmonic analysis used in experimental determination of frequency responses of non-linear automatic control systems require preliminary record of input signals of the systems investigated. The circuit and the operation of a new electronic instrument which permits to very accurately determine the said frequency responses for f=0.25/50 Hz during the experiment is described. (U.S.S.R.)

A Slotted Lecher Line for Impedance Measurements in the Metric and Decimetric Wave Bands, G. Schiefer. "Phil. Tech." #3, 1960. 4 pp. For impedance measurements on balanced objects in the V.H.F. bands (80-300 Mc/s), a balanced, screened transmission line about 2 meters long has been designed in the Philips Laboratory at Aachen. The characteristic impedance is approx. 105 ohms. (Netherlands, in English.)

The Teleprinter Distortion Indicator, an Automatic Test Equipment, E. Schenk. "Nach. Z." Dec. 1959. 4 pp. An electronic indicator for relative distortions of teleprinter signals has been developed and this equipment gives an alarm when the distortion of these signals exceeds a preadjusted maximum value. (Germany.)

Orthonull—A Mechanical Device for Bridge Balance, H. P. Hall. "El. Rund." Jan. 1960. 3 pp. Orthonull delivers a quick convergence of the bridge balance in impedance bridges, even if the quality of the measured object is small, and eliminates the sliding null. The precision of the bridge is not influenced, the Orthonull being a special balance type. The practical result is the increase of the precision at low quality values, "false null" error being avoided. (Germany.)

The Hall Generator and Its Use in Measurement Technique, F. Kuhrt. "El. Rund." Jan. 1960. 4 pp. The intermetallic connection semiconductors indiumantimonide and indiumarsenide render possible the production of powerful Hall generators. Their electric properties are discussed. Among the application examples from the measurement technique there are discussed: measurement of magnetic fields, power measurement and power oscillograms, contactless signalling, transfer of smallest movements in electrical voltage as well as the static interrogation of magnetic diagrams. (Germany.)



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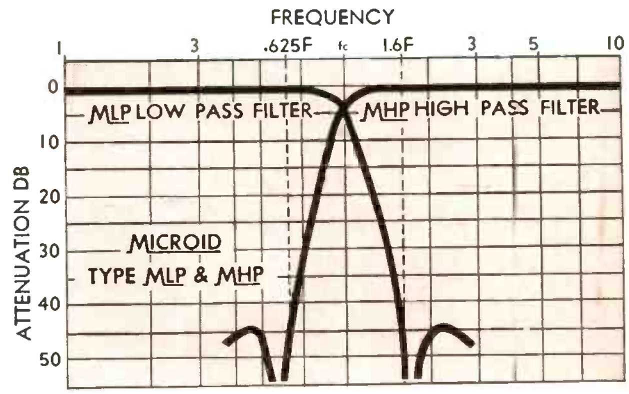

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RADAR, NAVIGATION

The Theory of Radio-thermal Direction Finders with Conical Scanning. Yu. V. Pavlov. "Radiotekh," 14, No. 12 (1959). 8 pp. Direction finding of weak radio-thermal signals, whose spectral density is lower than that of the receiving set internal noise, is of great interest, since such signals occur in radio-astronomy. This article analyses the properties of a direction-finder designed to work with an automatic radio-thermal radiation recording equipment. Expressions for the limiting and angular sensitivity of a modulation type direction-finder with conical scanning are derived. Formulas for the equivalent antenna temperature which hold for any noise factors are given. (U.S.S.R.)

An 8 mm High-resolution Radar Installation, J. M. G. Seppen & J. Verstraten. "Phil. Tech." #3, 1960. 12 pp. The 8 mm radar installation described, Philips 8 GR 250, is distinguished from the more familiar and widely ued 3 cm radar systems by its higher resolution. This is due to the fact that with a shorter wavelength a shorter pulse length (0.02 usec) and a narrower angular beam width (0.3°) can be obtained. The narrower beam calls for a higher pulse repetition frequency. (Netherlands, in English.)

The Design and Construction of Ground-Based Navigational Aids and Their Effect on Maintenance, M. Cassidy. "Proc. AIRE." Oct. 1959. 10 pp. This paper opens with a brief description of the geographical distribution of the radio navigational aids operated by the Australian Dept. of Civil Aviation and the associated organization required to deal with the problem of maintaining a large network of stations, many of which are remotely located. (Australia.)

SEMICONDUCTORS

Equivalent Admittance Parameters of a Transistor with a Resistor in its Emitter Circuit. E. N. Garmash. "Radiotekh." 14. No. 11 (1959). 6 pp. A commonly used transistor feedback circuit obtained by inserting a resistor in the emitter circuit can be represented by an equivalent circuit without the resistor, but with changed admittance parameters. Such equivalent Y-parameters are derived and their application illustrated by examples. Variations of the equivalent Y-parameters with respect to the value of the emitter resistance are shown in graphs. The effect of the negative feedback on the frequency characteristic is examined. (U.S.S.R.)

Transfer and Frequency-Phase Characteristics of the Current Transfer Constant of a Diffused-Junction Transistor, T. M. Agakhanyan, "Radiotekh," 14. No. 12. (1959). 6 pp. The relationship of the transfer and frequency-phase characteristics of the current gain to the mean diffusion time, the drift time and the life time of minority carriers is established theoretically. For design purposes above time parameters can be substituted by quantities which can be relatively easily measured and which completely determine α and β. These parameters are the low frequency current gain, the cut-off frequency or the current gain time constant and the phase shift factor. In practice it is easier to calculate with sufficient accuracy the phase shift factor instead of measuring it. (U.S.S.R.)

Transistor Matching Impedances, A. G. Bogle. "El. Tech." Jan. 1960. 3 pp. Calculations and measurements are described, relating to the variation of input impedance, output im-

Sources

pedance and gain of an OC71 transistor with operating point and with negative feedback. (England.)

Equivalent Circuit Diagrams for the Transistor Driven as Linear Amplifier, W. Benz. "El. Rund." Jan. 1960. The present first part of this article gives a survey of the different transistor equivalent circuit diagrams, describes their properties and demonstrates schematic diagrams and four-pole evaluations. (Germany.)

Transistor Circuit Design Using Modified Hybrid Parameters, R. E. Aitchison. "Proc. AIRE." Nov. 1959. 7 pp. By the use of modified hybrid parameters the normal expressions for transistor amplifier characteristics can be extended to special cases where the circuit is modified by shunt, series, or common impedances in the circuit. (Australia.)

TELEVISION

Alignment and Maintenance Tests on the Television Radio Link Milan-Rome-Palermo, E. Castelli. "Alta Freq." Aug. 1959. 15 pp. The test equipment employed in the terminal and relay stations of the Milan-Rome-Palermo radio link is described. The procedure is outlined for the different type of measurements, particular attention being paid to linearity measurement of modulator and demodulator separately and globally, to transmission curve of the equipment and to impedance, gain and output level measurements. The wave forms used for checking operation of the whole chain are described and typical results are shown. (Italy.)

The Synthesis of Black and White Television Images from Coloured Picture Tube Phosphors, C. H. Laurence. "Proc. AIRE." Aug. 1959. 8 pp. The color of a picture tube screen must be carefully chosen as the eye is extremely sensitive as a color-comparison device and color preception of an object is influenced by its surroundings. Thus, during manufacture it is necessary to control the final color by measurement to a tolerance corresponding to the critical nature of human color preception. The screen of a black and white picture tube is composed of 2 or more phosphors, chemical materials capable of giving colored luminescence when excited by an electron beam. By suitable choice of phosphors a screen color is achieved which can be closely duplicated from batch to batch. The C.I.E. system of color specification and the black body curve on the C.I.E. diagram are used extensively in phosphor blending. (Australia.)

The A.B.C. Sydney Programme Centre, F. M. Shepherd. "Proc. AIRE." Aug. 1959. 6 pp. The paper describes a recently completed program center which controls a large multistudio group and feeds the transmitter networks. Various choices of arrangement and control are outlined and it is shown that the method adopted was the most logical one. The system provides a flexible ond expandable arrangement of motor uniselectors and relays which provides interconnections between studios, stations and recording facilities. (Australia.)

Effect of the Storage Surface on the Signal in an Image Iconoscope, L. I. Khromov. "Radiotekh." 14. No. 11 (1959). 8 pp. New types of image iconoscopes have been recently developed, but the effect of their storage surface on the signal has not been sufficiently studied. On the basis of theoretical considerations and mainly experimental results the author arrives at the conclusion that some of the secondary electrons possess sufficiently high velocities to strike the target in advance of scanning. He finds an optimum storage surface for efficient scanning. The application of the suggested pulse operation improves the

(*Continued on page* 252)

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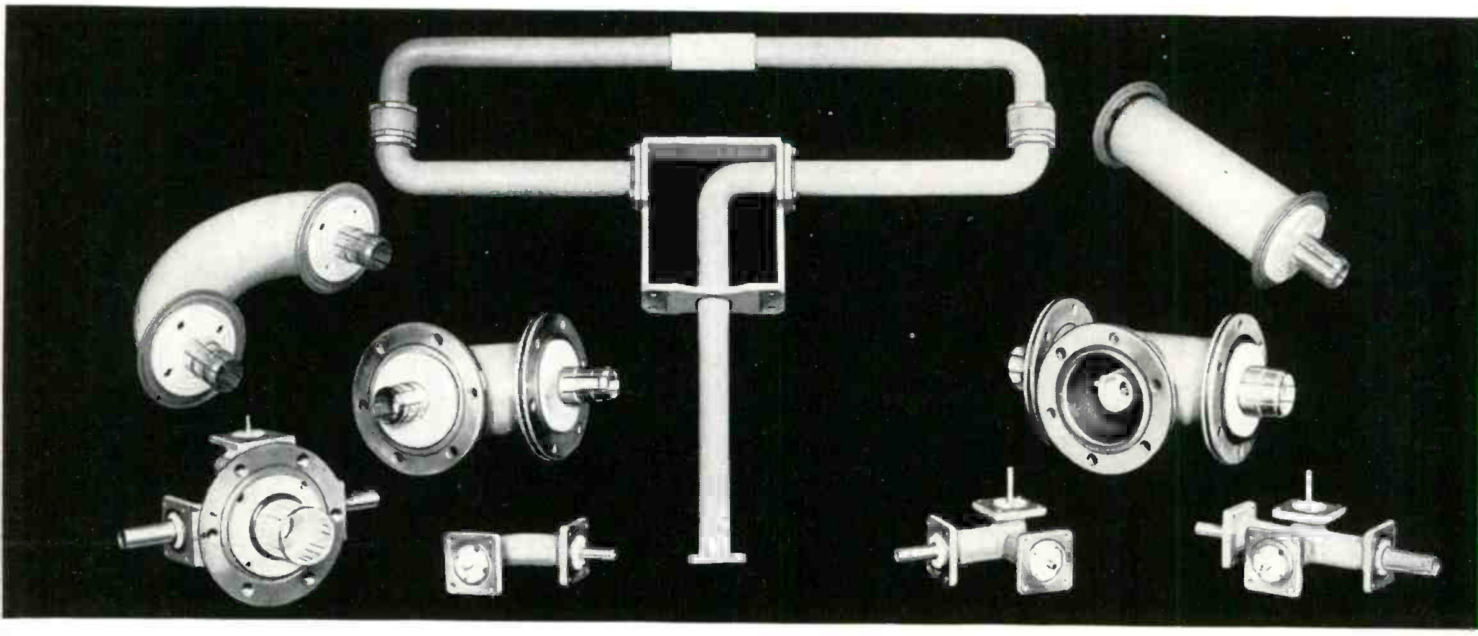

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±2 MC/Sec. receiver stability with a Receiver/Transmitter frequency range of 2750 - 2950 MC/Sec. Combined weight of 4.7 lbs.

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Frequency stability: ±2 MC/Sec.
Pulse Power: 100 watts peak (min.)
Pulse repetition rate: 2000 P.P. Sec.
Pulse Width: 0.65 ± 0.05 microsecond
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Weight: 3.45 lbs.
Power Supplies Available on Special Order

MODEL SRT-3081

RECEIVER
Frequency range: 2750 - 2950 MC/Sec.
Bandwidth: 6-12 MC/Sec. @ 3 DB Points
35 MC/Sec. maximum @ 40 DB Down
Triggering sensitivity: −41 DBM
Interrogation: Single or double pulse
Frequency stability: ±2 MC/Sec.
Size: 1¼" x 2⅞" x 5¾"
Weight: 1.25 lbs.

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 μsec
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.
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28± 2 v transistorized converter drawing 4 A and requiring no external heat sink, or 115 V 400 cycle supply.

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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
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6¼" L. x 2½" Diam.
Weight (Receiver-Transmitter): 2 lbs.
Size (Power Supply): 5" L. x 2½" Diam.
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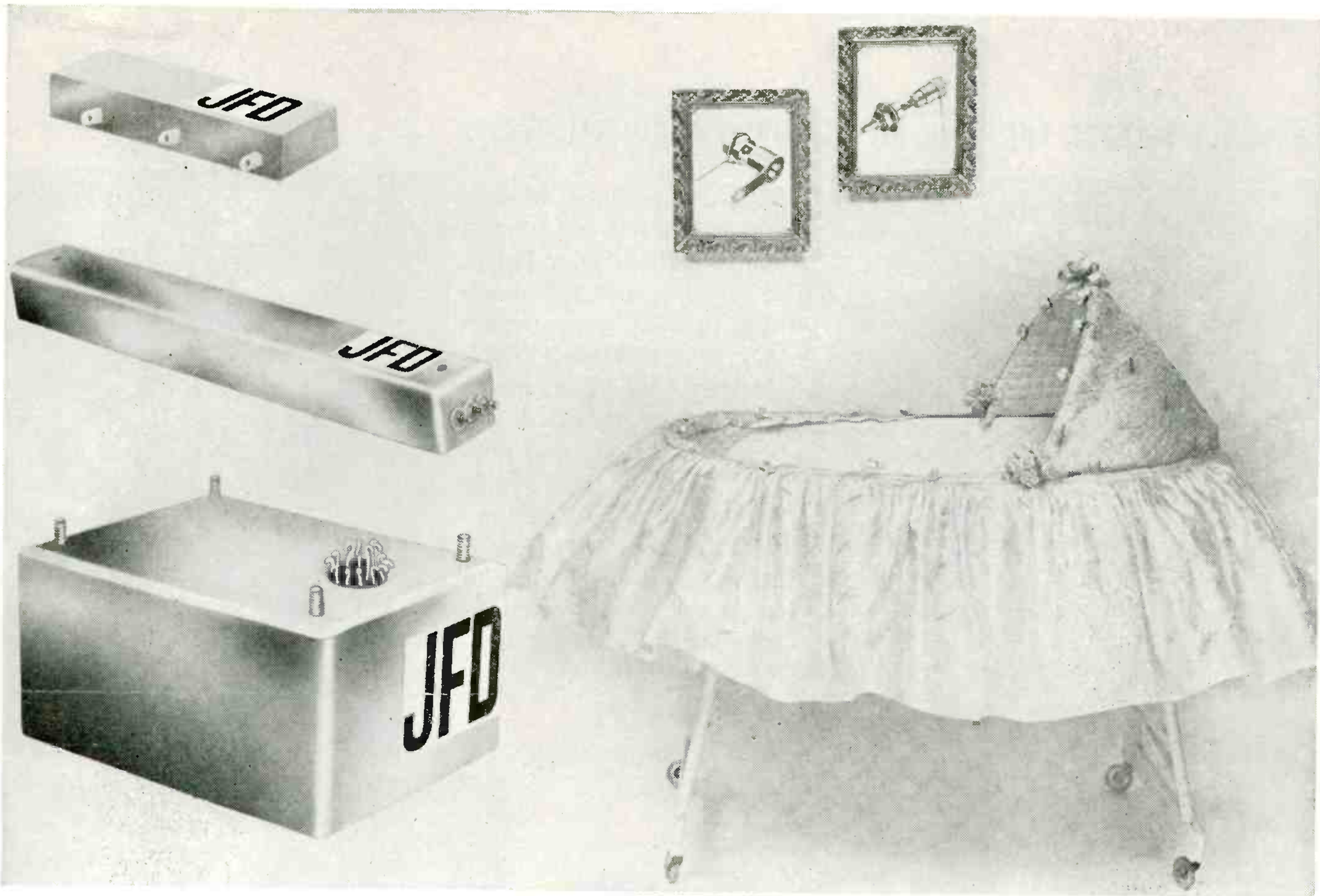
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this standing wave amplifier defies comparison

FEATURES:

- A new low in noise levels — down to 0.007 μv providing 0.02 μv full scale sensitivity at minimum bandwidth.
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- All meter scales automatically normalized when switching ranges
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Input Connector: BNC Jack.

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Dimensions: Cabinet: 7¾" wide, 10½" high, 11" deep.

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(*Continued from page* 243)

signal to noise ratio in standard Soviet and Telekino image iconoscopes by a factor of 2-3. (U.S.S.R.)

Minimum Spacings Between Interfering Television Broadcasting Stations, H. Edan & K. H. Kaltbeitzer. "Rundfunk." Dec. 1959. 6 pp. Harmful mutual interference within a network of television broadcasting stations can be suppressed by maintaining minimum spacings between interfering stations. The article gives directives for evaluating such spacings, taking into account appropriately that different kinds of interference differ in harmfulness. (Germany.)

Methods of Background Projection in Television, Udo Stepputat. "Rundfunk." Dec. 1959. 5 pp. The paper discusses the various methods of imitating scenery in television (background with large-scale photographs, electronic trick backstage, projection from behind of moving or still pictures). The author indicates the differences between this and background projection in cinema technique and describes a projection installation from behind using large transparencies specially developed for television. (Germany.)

Monitoring and Cutting Technique for Video Tapes, Hans Friess. "Rundfunk." Dec. 1959. 3 pp. The article describes three instruments for shortening and changing video tapes. (Germany.)

The Equipment of the New Television Outside Broadcast of the NWRV at Hamburg. "Rundfunk." Dec. 1959. 3 pp. To supplement an earlier article published here concerning the planning and construction of television outside broadcast vehicles, the equipment of a further vehicle is described which is operated by the NWRV at Hamburg. (Germany.)

The Television Switching Centre at Frankfurt/Main, Kurt Thom. "Rundfunk." Dec. 1959. 3 pp. A new vision switching centre is to be constructed by the Hessischer Rundfunk at Frankfurt/Main to supplement the sound switching centre. The article discusses the considerations taken into account in the planning and the functions of the various switching points in the television network. The ideal would be a radial vision and sound network with synchronous switching. (Germany.)

Portable Television Outside Broadcast Equipment, Ernst Legler. "Rundfunk." Dec. 1959. 4 pp. The article describes a radio camera for television outside broadcast purposes, which can be easily carried by one person. The equipment, which consists of a camera unit and a case carried on the back, weighs 11.4 kg. 8.5 kg being for the case including the transmitting aerial and support and 2.9 kg for the camera unit. (Germany.)

Vector Recorder—a Check Unit for the NTSC-Colour Studio. "El. Rund." Jan. 1960. 5 pp. An NTSC-colour modulator includes three modulation channels (Q-, I-, and colour synchronizing channels) in addition to the brightness channel. It is used to check level and phase relations of these channels. (Germany.)

A TV Sound Section Using the Locked-Oscillator Quadrature-Grid Detector, R. A. Darnell. "Proc. AIRE." Nov. 1959. 8 pp. Efforts to produce a sound section for a television receiver which was simpler than the conventional ratio detector circuit, resulted in the introduction of the quadrature-grid detector circuit. (Australia.)

TRANSMISSION

Transmission of a Pulse Signal and Fluctuation Interference Through a Voltage Limiter and Integrator, B. N. Mityashev. "Radiotek." 14, No. 10, (1959). 8 pp. The effect of interference can often be reduced by the use of a special voltage limiting stage. In this article

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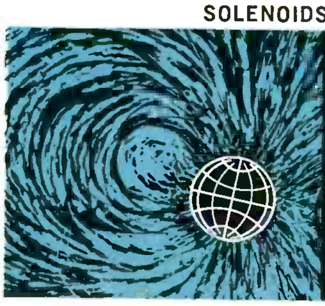

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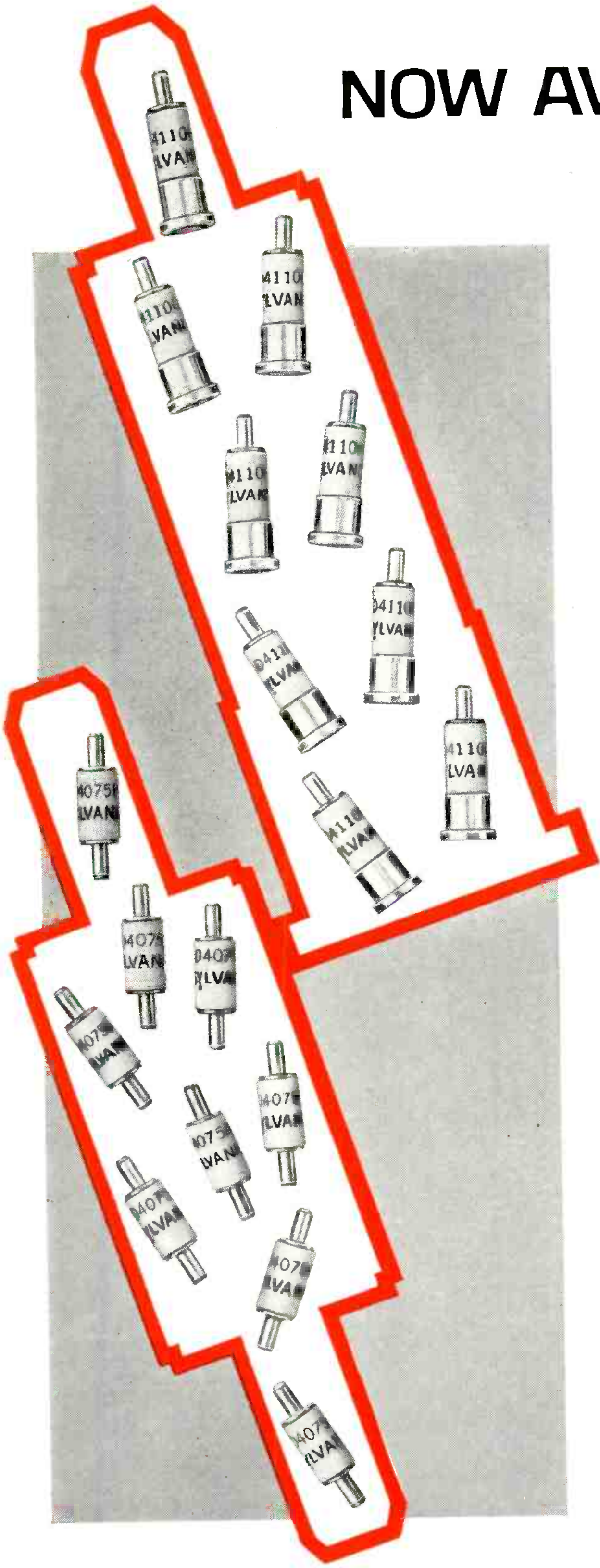

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D4075	D4110	20	4.5	1.0
D4075A	D4110A	30	3.0	2.0
D4075B	D4110B	40	2.0	3.0
D4075C	D4110C	50	1.8	4.0
D4075D	D4110D	60	1.4	5.0
D4075E	D4110E	70	1.0	6.0
D4075F	D4110F	80	1.0	7.0
D4075G	D4110G	90	1.0	8.0
D4075H	D4110H	100	1.0	9.0

Breakdown voltages are −6 volts min. at $I_R = 200$ μa.
†Calculated from f_{co}=(Q at 10 kmc and measured at BV) X 10 kmc.
‡Net junction capacitance measured at f=100 kc, $V_R = -6$V.
‡‡Measurement frequency=10 kmc, $V_R = -6$V.

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the conditions under which such a stage produces an improvement in the signal to noise ratio at the integrator output are analyzed. It is assumed that the voltage is fed to the input of the limiter from the output of a linear nonreactive detector, preceded by an ideal band-pass filter and that fluctuation noise has at the input of the filter a uniform spectral density. Limiting voltage level for a minimum noise to signal ratio are given. (U.S.S.R.)

Long Distance Transmission of the Angular Informations from a Shaft Rotating with an Average Uniform Speed, K. Dinter. "Nach. Z." Oct. 1959. 6 pp. Search antennas of radar equipment rotate with a constant velocity superimposed with relatively small fluctuations mainly caused by wind. In this case these fluctuations are the only proper information which would be transmitted to a distant point where the rotating movement is to be reproduced. The information contents of such fluctuations is calculated on the basis of many measurements carried out, the minimum channel capacity required for the transmission is determined and compared with the channel capacity required for the transmission of the rotating movement without prior removal of the part not containing information. (Germany.)

Group Velocity and Group Delay, H. Debart. "Cab. & Trans." Oct. 1959. 11 pp. The paper first reminds us of the standard definitions of group velocity and group delay and then establishes some of their general properties when applied to various transmission systems. Examination of their physical meaning shows that these quantities are closely related to signal propagation functions, as they appear in Fourier analysis. (France.)

Overmoded Waveguides Optical Approach to Mode Conversion, L. Solymar. "E. & R. Eng." Nov. 1959. 3 pp. The amplitudes of the spurious modes generated at the joint of two overmoded waveguides are calculated. One of the waveguides is circular and is excited by an H_{01} mode, the cross-section of the other waveguide is slightly different. It is shown that no E modes are excited by the joint. The amplitudes of the H modes are expressed in a closed form. (England.)

Surface-wave Transmission Lines for Transmitters, Properties and Operational Experience, F. R. Huber & H. Rudat. "Rundfunk." Dec. 1959. 7 pp. The paper describes the use of a surface-wave transmission line in a novel fashion to feed a transmitting aerial, this device having heretofore been used mainly for transmitting energy over long distances. (Germany.)

The Differences Between Single and Periodic Transient Processes in Low-pass Transmission Systems, R. Elsner & K. H. Steiner. "Nach. Z." Dec. 1959. 7 pp. In the investigation of the transient response for a single process by means of measurements it is frequently found advantageous to replace such a single process by a periodic process. However, calculations of transient responses for periodic functions can be simplified when the periodic process is treated like a single process. (Germany.)

Rectangular-Waveguide Loads, W. Geoffrey Voss. "El. Tech." Jan. 1960. 3 pp. Certain modifications are described to the construction and mounting of resistive element dissipative strips when used either as a fixed flat load or as an adjustable sliding termination. Results are given of measurements in S-band but the technique is adaptable to all sizes of rectangular waveguide. (England.)

Mode Conversion in Pyramidal-Tapered Waveguides, L. Solymar. "E. & R. Eng." Dec. 1959. 3 pp. It is shown that if two rectangular waveguides of different cross-section are connected by means of a taper higher-order modes will be generated. The electric intensities in the taper and in the large waveguide are determined, the amplitudes of the spurious modes are computed and an extension of the results discussed. A simple design formula


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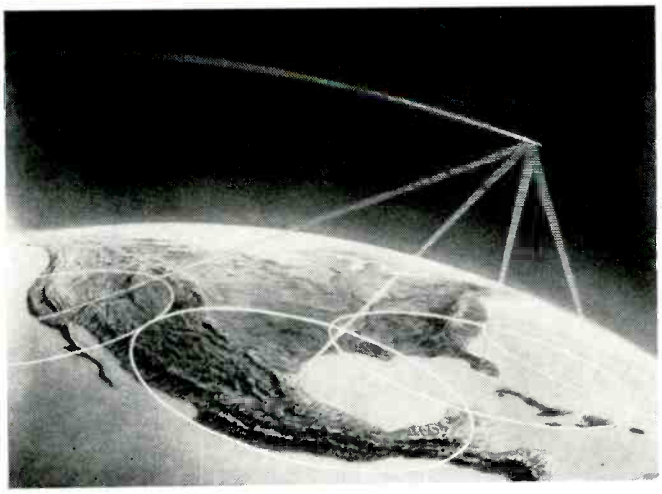
The Systems Engineering Section of ELECTRONIC INDUSTRIES • MARCH 1960

SYSTEMS—WISE . . .

▸ **A multi-purpose, precision 30 ft. reflector is the first standard product offered by Antenna Systems, Inc., a newly organized antenna systems and components manufacturer located in Hingham, Mass. Their product line will include feeds, waveguide, rotary, joints, towers, pedestals, and other related antenna equipment. Charles W. Creaser, Jr., is President. Walter W. VanderWolk is Exec. Vice President and Leon O. Paulding is Treasurer.**

PROJECT MERCURY TRACKING SYSTEM



Western Electric Co., New York, is the prime contractor for the new Project Mercury tracking and ground instrumentation system being developed by NASA. Others in the program are: Bell Telephone Labs., Whippany, N. J.; Bendix Aviation Corp., Detroit, Mich.; and Burns and Roe, Inc., New York. Construction of the 18-site net has already begun.

▸ Over 60% (1,219 radio stations) of the radio membership of the National Association of Broadcasters are now subscribers to the "Standards of Good Practices for Radio Broadcasters." The Program, at present, is limited to NAB member stations, but the NAB Radio Board is expected to open it to non-members soon.

▸ **Records of radio noise recorded by the National Bureau of Standards at Hawaii show significant changes that occurred as a result of two high-altitude nuclear explosions in the summer of 1958. Different effects were noted on different frequencies. In the hour following the blast, the noise decreased by as much as 32 db (at some frequencies) at a time of day when it would normally be rising or holding steady. Recovery varied from a matter of hours at 13 KC and 5 MC to several days from 51 KC through 2.5 MC.**

▸ The theoretical knowledge for predicting weather accurately now exists, but the calculations are so lengthy and involved that even the fastest of today's computers could not complete an analysis until long after the weather has arrived. Computers, fast enough to do the job (10,000,000 calculations per sec.) are projected for the 1960's by Dr. Peter J. Isaacs, Sperry Gyroscope Co.'s head of digital computer research.

▸ **The Southern Railway System has ordered IBM's newly-developed 7080 data processing system. It will be installed in the railroad's Computer Center in Atlanta, replacing an IBM Model 11. It will be used for management reports, accounting, including cost-finding techniques, and business problem simulations.**

▸ An IBM type 709 electronic computer is now in use at the Pacific Missile Range Hdqts., Point Mugu, Calif. With the computer, the range safety officer can observe the position of a missile from launching to impact. It can be destroyed in flight within a second and a half after the computer reveals it is off course.

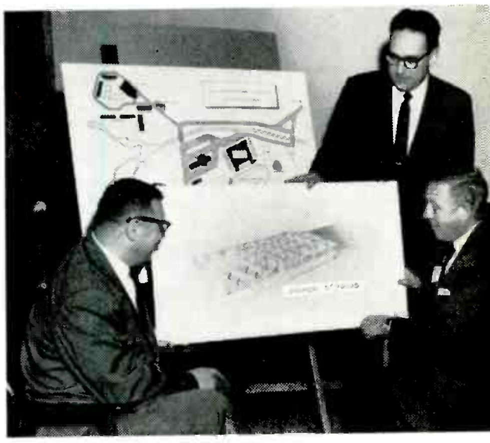
▸ **The first underseas telephone cable above the Arctic Circle is now completed. Owned by the U. S. Air Force, it connects Greenland and Canada. For use in the Ballistic Missile Early Warning System, it was built by Western Electric Co. and installed by Long Lines Dept. of the American Telephone and Telegraph Co.**

▸ RCA has formed a new department to design, manufacture and market industrial electronic computers and systems. The new department will be located in the Boston area. C. M. Lewis is Manager. R. W. Sonnenfeldt is Manager of Engineering, and C. E. Asch is Manager of Operations Control.

▸ **Raytheon Co., Bedford, Mass., has a contract from the Navy Special Projects Office for guidance components for the Polaris fleet ballistic missile. They will provide industrial support to M.I.T.'s Instrumentation Lab which has responsibility for design of the guidance system.**

▸ Currently available "average" commercial UHF-TV receiving sets "are probably not adequate" for air-borne TV, says Martin T. Decker, Central Radio Propagation Lab., National Bureau of Standards. The system will require the use of equipment with max. possible transmission power and low receiver noise figures.

STUDIO FOR OLYMPIC GAMES



Russ Hodges (r), N. Y. Giants sportcaster, Franklin Mieuli (l) radio producer, and Neal K. McNaughten, Manager of Ampex Professional Products Co., inspect Ampex's plans for special recording studio to service the Winter Olympic Games at Squaw Valley, Calif.

Here's a remote location studio that can be built for less than $200. It is portable and can easily be carried by one man. Studio folds into a compact unit for transporting in a car. Complete construction details are given.

Broadcast Engineers . . .

Build a "Suitcase" Studio

By PHILIP WHITNEY
Manager
Richard F. Lewis Jr. Radio Stations
WINC Building
Winchester, Virginia

AS the broadcasting picture becomes more and more competitive, radio stations look for ways in which to program better and easier. The old fashioned "remote broadcast" has grown until today many stations originate more programs outside the studios than within them. This lets the public see the personality they hear on the air, and frequently draws large crowds to the sponsor's location where the broadcast is originating. It is one of many things modern radio broadcast stations are doing to become more "progressive."

To make the modern platter hop or store broadcast quick, easy and inexpensive, this station built a "suitcase studio." It is used in conjunction with their 150 MC remote pickup broadcast transmitter. These, together with a small motor-generator make a broadcast possible at any time. There is no need to burden the telephone company with a quick decision necessitating a telephone drop installation within the hour. Pickups are possible which previously had been impossible because of no telephone facilities or facilities not good enough for broadcast. With the equipment to be described, broadcasts utilizing two microphones, two turntables and a tape recorder can be originated anywhere upon the spur of the moment.

The "suitcase studio" is so named because it is a complete consolette with turntables and microphone mounted on a single table. The legs can be removed, tables strapped down, and the whole unit easily picked up by the carrying handle. One man can carry the suitcase studio in one hand and a portable tape recorder or the remote pickup transmitter in the other. It is easily transported in a car or station wagon.

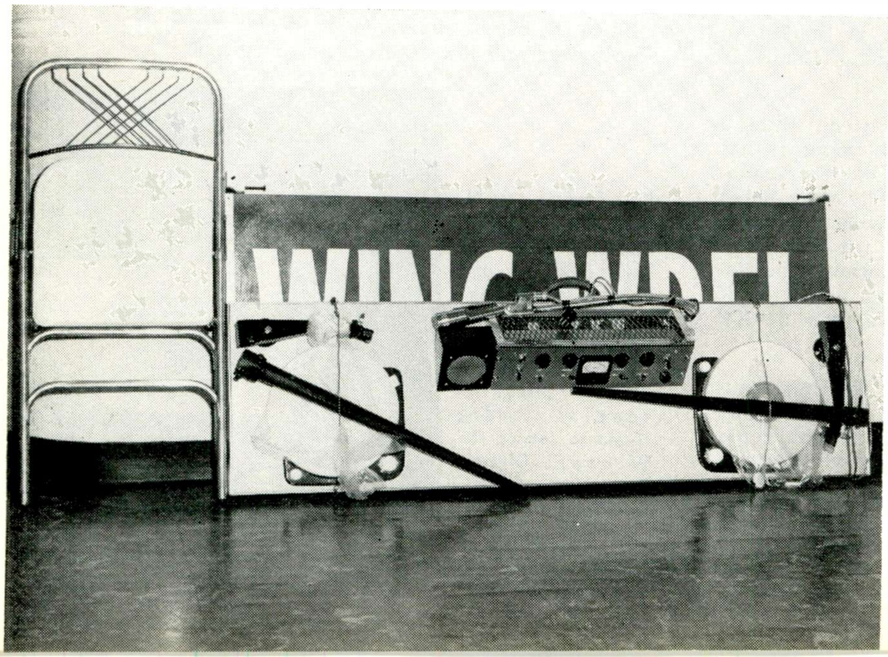


Fig. 1: The suitcase studio is packed and ready for travel to a new location.

Simple high impedance mixing is used in the consolette, with a flat preamplifier being used for the microphone input, and equalized preamps being used for the GE variable reluctance pickup inputs. The circuit used in the latter is similar to the one recommended by the manufacturer.

One microphone preamplifier is used. The two microphone inputs are switched with a dpdt telephone type lever switch. All inputs are switched into the program amplifier, off, or into the audition amplifier with the same type of switch, obtainable at supply houses for 79 cents each. The program and audition busses are switched to the inputs and audition amplifier with a similar type switch. An earphone jack is provided. Most operators prefer to use a set of phones because of the high ambient noise generally prevalent at a remote broadcast.

The diagram of the table top is self-explanatory. It consists of 1/4 inch plywood, topped with mottled gray linoleum (or Formica). The legs are turned from pine or redwood and bolted to the drop-edge of the table top with carriage bolts. The drop-edge protects the turntable motors and the portion of the consolette projecting below.

This consolette is built on a 4 x 17 x 3 in. chassis, which is mounted on a 5 1/4 x 19 in. gray hammertone aluminum panel. The panel is tipped at a 60 degree angle so that the chassis protrudes through a hole cut in the table top. Thus all microphone and turntable inputs are readily accessible from the bottom of the table, and all tubes are quickly reached. The panel is mounted on two triangles of wood which were painted to harmonize. These are screwed to the edges of the hole cut in the table top, and the panel is then, in turn, fastened to these with screws and countersunk washers. The table is edged with either chrome plated or stainless steel edging. Avoid aluminum edging. This has been found to rub off and announcers complain of dirty shirts as a result.

The front billboard is made of 1/8 in. Prestwood or hardboard, painted by a local sign painter with the station call letters. This hides the storage area under the table where the announcer keeps the power supply for the consolette, a receiver for talk-back from the studio, prizes and stacks of records.

A multiple outlet is screwed to one table edge. Into this are plugged the two turntables, a small work light mounted over the table work area, and the consolette power supply. A long, heavy-duty extension cord is attached to the multiple outlet.

The power supply is assembled on a separate 4 x 4 x 6 in. minibox, with a five-prong power output socket mounted on its side. Into this the operator plugs the consolette power cable when setting up. This allows the power supply to be set on the floor far enough away from the input transformers to prevent hum.

Common screen door springs are fastened to screw eyes so that when the unit is being transported, the springs are brought up over pads on the tops of the turntables to hold them in place.

The turntables are inexpensive four-speed tables obtainable for about $37.50 each. They are entirely satisfactory, with a heavy machined cast-aluminum table. They must, of necessity be small and light, or the whole purpose is defeated. The tables are mounted

Fig. 2: Front view of studio. Note the carrying handle above letter "C".

Fig. 3: Studio is compact and uncluttered. Space under table is used for storage.

Suitcase Studio *(Continued)*

according to the manufacturer's specifications and templates. The pickup arms are also inexpensive units obtained from a supply house for less than $13 apiece. They are viscous damped arms. This is helpful when the unit is being used at a record hop session, where the floor is apt to be rocking with the music. The viscous damping helps keep the pickup needle in the record groove under adverse conditions. GE variable reluctance, high impedance, cartridges were used. Keep the unshielded lead from the arm to below the table short. As soon as possible after the line is through the table top, attach a shielded line. It was found impossible to use shielded line above the table top, as this seriously hampered the movement of the arm and caused groove-skip. The shielding is important, especially if the unit is to be used with a remote pickup broadcast transmitter.

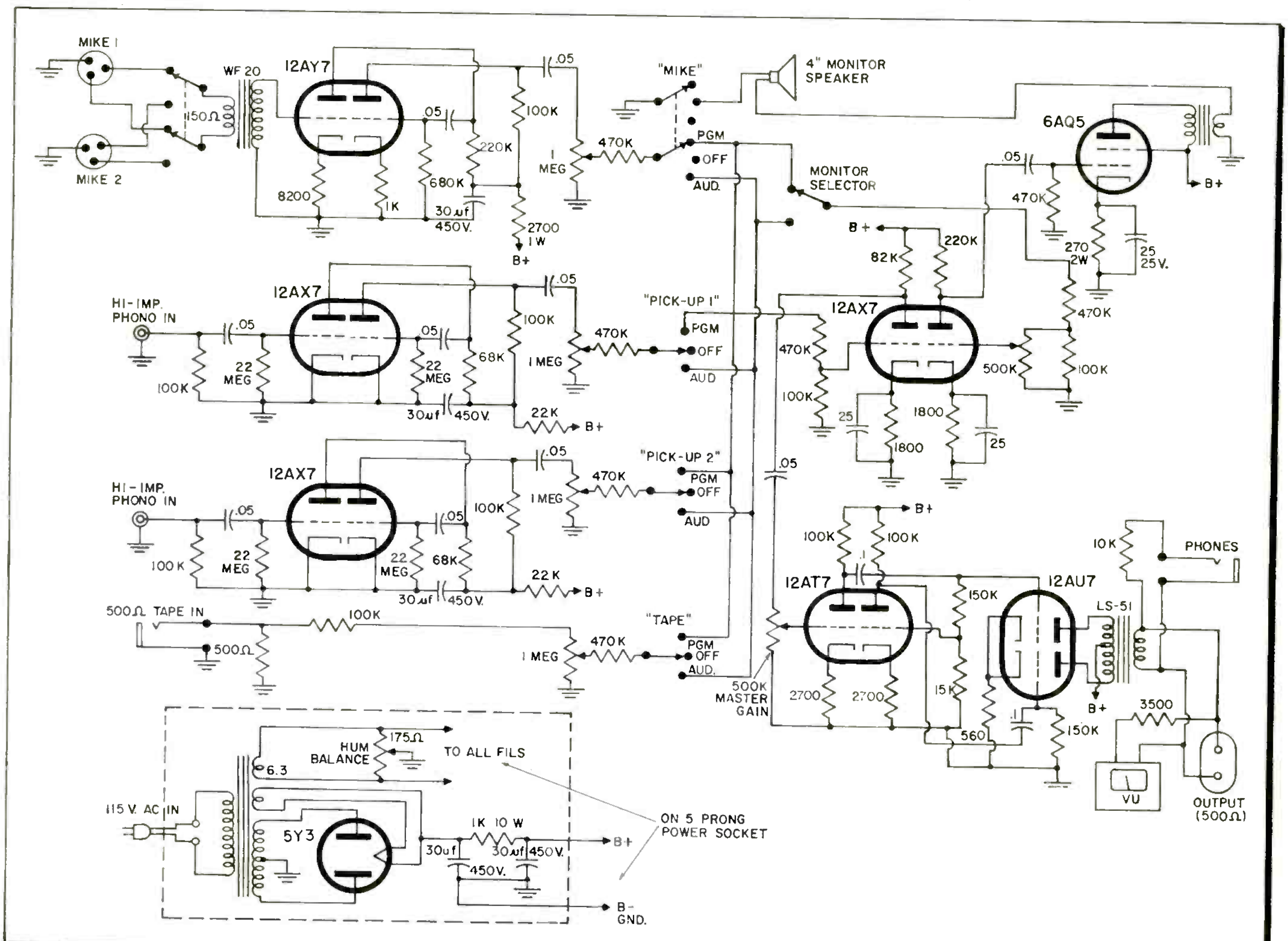
The consolette output is 500 ohms to feed either a telephone line or the 500 ohm input of a remote broadcast pickup transmitter. The output level is measured by a three-inch square, inexpensive VU meter ($7.50). The monitor speaker is mounted in an aluminum chassis which has been cut off at a 60 degree angle so that it can be mounted beside the consolette on the table top. A relay cuts the speaker off when either mike is used.

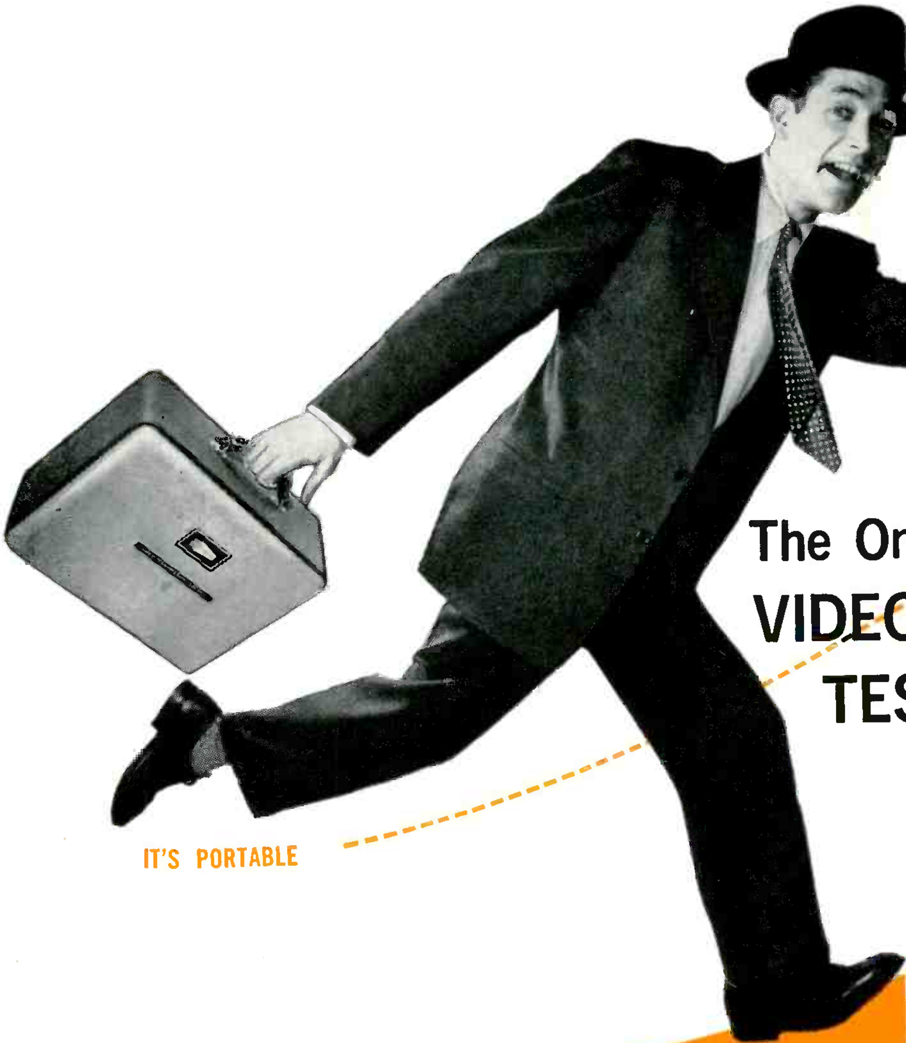
The size of the consolette dictates that 2-in. round knobs be used for the faders. The fader pots and switches were mounted on aluminum angles attached to the side of the consolette chassis, so that merely by removing the knobs, the panel can be quickly removed for servicing.

A small level was cemented to the table top in an out-of-the-way location. This is used when setting up the unit at a new location to be sure that the table is level to avoid pickup tracking problems.

The complete consolette, power supply, turntables, arms, pickups, table, and billboard sign cost less than $200 to build. It has earned more than this amount in the time that it has been used. Besides this amount, the promotional value of the unit has exceeded its cost many times.

Fig. 4: Schematic diagram shows circuits of the "suitcase studio". Entire studio can be built for less than $200.





TELECHROME

The Only Complete Line of
VIDEO TRANSMISSION TEST EQUIPMENT

IT'S PORTABLE

1003-C3 VIDEO TRANSMISSION TEST SIGNAL GENERATOR

Produces multi-frequency burst, stairstep, modulated stairstep, white window, composite sync. Variable duty cycle. Regulated power supply. Operates from internal or studio sync. Checks video tape recorders.

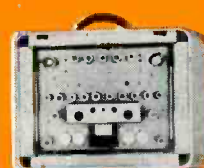
1004-B VIDEO TRANSMISSION TEST SIGNAL RECEIVER

Very rapid and accurate measurement of differential phase and differential gain characteristics of video facilities. Responds to standard stairstep test signal modulated with 3.58 mc, or any differential phase or gain test signal.

1005-A VIDEO TRANSMISSION TEST SET

1005-A1 — Produces composite television waveforms suitable for measuring amplitude vs. frequency; differential gain vs. amplitude; dynamic linearity; differential phase vs. amplitude; high frequency transient response; low frequency transient response; low frequency phase of streaking, smears, mismatches; and other video characteristics.

1005-A2 — Supplies composite EIA Sync, blanking, horizontal and vertical drive signals and regulated B + power for itself and 1005-A1. Features magnetic core binary counters.



1008-A VERTICAL INTERVAL KEYER

Permits test and control signals to be transmitted simultaneously with program material, between frames of TV picture. Any test signal (multi-burst, stairstep, color bar, etc.) may be added to the composite program signal. Test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.

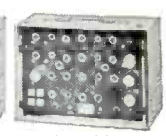
1073-D1 SINE SQUARED (SIN^2) —SQUARE WAVE GENERATOR

Produces new waveform for testing TV or other pulse unit or system for amplitude and phase characteristics. Sin^2 — Square Wave pulse is equivalent to TV camera signal and is more sensitive than a Square Wave in indicating ringing. Operates with internal or external drive. Now in use by major TV networks and telephone companies.

MODEL 490A SPECIAL EFFECTS GENERATOR
With Exclusive 'Joy Stick' Control

Waveform Generator

Remote Control Unit



Switching Amplifier

Improved System Produces over 300 Wipes, Inserts, Keying and Other Special Effects.

Full Specifications & Details
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Western Engineering Division — 13635 Victory Blvd., Van Nuys, Calif., STate 2-7479
Southwestern Division — 4207 Gaston Ave., Dallas, Tex., TAylor 3-3291

CUES

for Broadcasters

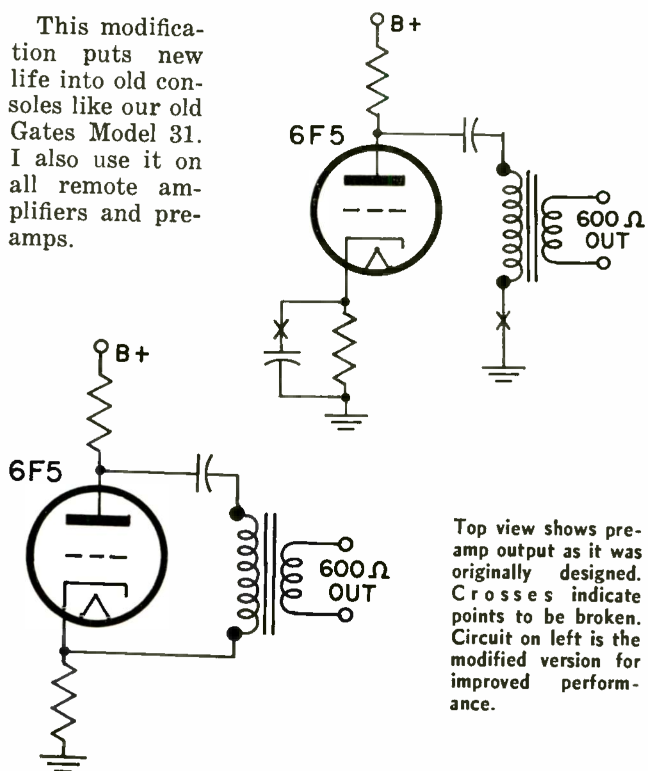
Improving Pre-Amps Performance

CLOVIS L. BAILEY, Ch. Eng., KJEF, Jennings, La.

A very simple modification of broadcast preamplifier output transformer connections improves performance. These pre-amps use a plate blocking condenser to keep dc out of the primary of the output transformer, and the transformer primary winding is returned directly to ground as shown in Figure 1 of the enclosed sketch.

A vast improvement is noted when the ground connection is broken and the primary winding returned directly to the cathode (see Fig. 2). The cathode by-pass capacitor is removed. The single-ended output stage will now exhibit push-pull characteristics, with the primary functioning as though there were a virtual floating centertap. Less hum will be noted, and the low bass end extended with smoother response.

This modification puts new life into old consoles like our old Gates Model 31. I also use it on all remote amplifiers and pre-amps.



Top view shows pre-amp output as it was originally designed. Crosses indicate points to be broken. Circuit on left is the modified version for improved performance.

Turntable Equalizer Indicator

NORMAN F. ROUND, Ch. Eng.
WCCM, Lawrence, Mass.

On many occasions the operator would put the Gray equalizer switch in the roll-off position when using a scratchy record and forget to put it back in the correct position. This has happened for hours at a time and can be very detrimental to building a listening audience. Operators can't be blamed, for they have enough to do as it is, and especially when one can't hear anything above 5000 cycles anyway.

(*Continued on page 266*)

WASHINGTON

News Letter

TV ALLOCATION PROBLEMS—The FCC Commissioners desire a definite answer on television allocations through Congressional policy guideposts, and after comprehensive technical studies as to whether an expanded VHF television system can be established or whether all TV should be shifted to UHF. Optimism over the current negotiations between the FCC and the Office of Civil & Defense Mobilization on the possible exchange of radio spectrum space for an expanded VHF television system is practically non-existent among the FCC members.

VIEWS BEFORE SENATE BODY—In a two-day session, the FCC Commissioners were subjected to intensive and well-informed questioning by the Senate Interstate & Foreign Commerce Communications Subcommittee Chairman Pastore and his staff on TV allocation problems. Chairman John C. Doerfer of the FCC presented four expanded VHF system possibilities and a 70-channel all-UHF system, together with the present 82-channel VHF-UHF system as possibilities for the long-range reallocation of TV. FCC Commissioner Robert E. Lee was the only one of the seven FCC members who supported the transfer of all TV into the UHF portion of the spectrum. All Commissioners stressed to the Senate body that the public must be insured of sets capable of receiving signals on all the channels allocated to TV broadcasting.

AIR-GROUND SERVICE—While supporting the FCC rule proposals for the use of frequencies in the 454-455 and 459-460 MC bands in public air-ground radiotelephone service, the American Telephone & Telegraph Co., General Telephone & Electronics Corp. and Aeronautical Radio have emphasized to the Commission, in recent comments, that the service will require many more than the two radio channels. It was estimated that at least six to eight channels will be needed to handle public air-ground telephone service from planes flying the New York-Chicago corridor. The AT&T again strongly advocated the establishment of a broadband mobile radiotelephone system for all types of mobile communications service, including air-ground service.

INDUSTRY FORECAST—The present volume of business of Raytheon Company is about one-fourteenth of the roughly $7 billion total being spent in the U. S. on military, commercial and industrial electronics. Raytheon President Charles F. Adams stated this in a recent address in Washington. He pointed out that electronics in a few short years has grown to be the fifth largest industry in the nation. Much of the impetus for the industry's growth, Mr. Adams stated, has come from government and military business "which today accounts for slightly more than half of the total industry volume." Besides equipment and systems for the armed services, substantial increases in purchases are coming from the National Aeronautics and Space Administration and the Federal Aviation Agency. The potential growth in commercial and industrial electronics is tremendous, he stressed, and should double in volume in the next ten years.

SCATTER TECHNIQUES—The Joint Technical Advisory Committee, formed in 1948 by the Institute of Radio Engineers and the Electronic Industries Association to assist the FCC, has completed a most authoritative study and report on ionospheric and tropospheric scatter techniques, which the JTAC stated "must be considered in planning for future efficient utilization of the radio spectrum." Scatter communications systems are essential for reliable transmission for the fixed services and have a valuable potential in long-range air-to-ground communications, the JTAC emphasized in its report.

MICROWAVE COUNCIL—The annual meeting of the Operational Fixed Microwave Council, to be held in Washington March 18, is slated to appoint Regional Microwave representatives to assist the Council chairman in investigation and reporting of problems of frequency assignments in and around major terminal areas and to coordinate activities in their areas. The meeting has scheduled reports on the assignment of frequencies, the FCC plans and proposals affecting private microwave usage and on microwave equipment technical standards.

National Press Building
Washington 4

ROLAND C. DAVIES

MISSILE SPENDING—Defense Secretary Thomas S. Gates predicted that military spending for expensive and complex missile and communications-electronic systems will increase for the next few years.

MOON RELAY SYSTEM—The Navy demonstrated a new communications system which utilizes the moon as a passive reflector or relay for radio signals. The demonstration included radio transmissions between Washington, D. C. and Pearl Harbor via the moon.

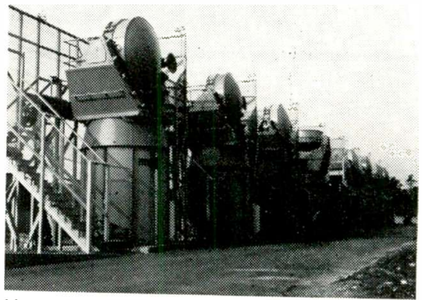
RESEARCH & DEVELOPMENT — The Federal budget for the fiscal year beginning July 1st was sent to Congress. In the budget is funds for $8.4 million to be used for research and development. This is a six percent increase over this fiscal years expenditures.

(Continued from page 264)

Just for the fun of it, give your men an audio spectrum test and the result may be surprising. There are many people who couldn't hear hi-fi even if they wanted to.

A simple remedy, with a few hours of work, is to put an indicator light on the console or another place where the operator can easily see it. Use one indicator for each equalizer, which is better than one for both equalizers. Take the Gray switch box apart and remove the one section, two pole, shorting type switch making note of the connections beforehand. In it's place, use a Centralab 1424, 3-section, 6-pole, 5-position shorting type switch. Wire the first section the same as the original switch, leave the 2nd section unused for possible stereo adaptation in the future, wire the 3rd section so that the indicator will light on all positions except the NAB position or whichever one you want. Other makes of equalizers can also be wired in the same way. Use the filament voltage of the console to light the indicators.

RADAR ROW



Nine SPG-55 radars, used with the Navy's ship-to-air TERRIER missile, are being tested at this facility operated by Sperry Gyroscope Co. at MacArthur Field, L. I. Testing program involves an area of over 100,000 square feet.

Control for U.S. Instrument

British electronic engineers have developed equipment to drive an American - made instrument. The equipment, amplifier and filter unit, has been developed by Armstrong Whitworth Equipment, Ltd., Baginton, Coventry, to drive the Glennite Interferometer made by Gulton Industries for the calibration of accelerometers.

The A.W.E. equipment enables correct excitation of the equipment to be obtained at reduced power output from the driving source and, at the same time minimizes the effects of any harmonics present in the driving source output.

FILTERS FOR ALL APPLICATIONS FROM STOCK

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327 SPECS.

Write For NEW Catalog

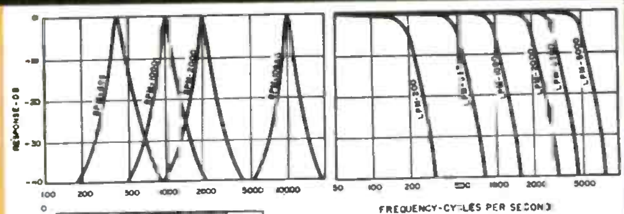
MINIFILTERS

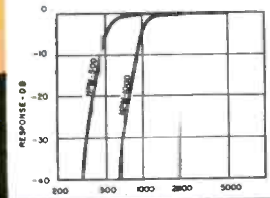
New Minifilters provide almost the same characteristics (with attenuation only slightly less) as the industry's standard interstage and line filters immediately below.

BPM band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db ±3% from center frequency, then 35 db per octave.

HPM high pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at .67 cut-off frequency, 40 db at .6 cut-off frequency. Input and output 10K.

LPM low pass units; loss of less than 6 db at cut-off frequency; attenuation of 30 db at 1.5 cut-off frequency, 40 db at 1.65 cut-off frequency. Input and output 10K.





STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BPM-400	BPM-10000	LPM-1000
BPM-750	HPM-500	LPM-2000
BPM-1000	HPM-1000	LPM-3000
BPM-1500	LPM-200	LPM-5000
BPM-2000	LPM-500	

BPM case (MIL AF) ¾ x ¾ x 1⅛" Weight....1 oz.

HPM and LPM case (MIL AG) 1 x 1 x 1⅜" Weight....2¼ oz.

INTERSTAGE & LINE

These six basic types cover most popular filter applications and frequencies.

BMI band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

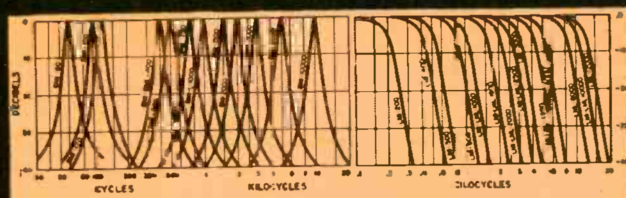
HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

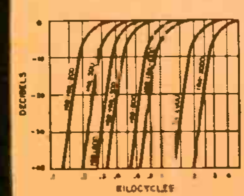
LMI low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

HML high pass filters are same as HMI but 500/600 ohms in and out.

LML low pass filters are same as LMI but 500/600 ohms in and out.

BML band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.





STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BMI-60, 100, 120, 400, 500, 750, 1000, 1500, 2000, 3000, 4000, 5000, 10000
BTI-60, 100, 120
HMI-200, 400, 500, 800, 1000, 2000, 3000
LMI-200, 400, 500, 800, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 10000
BML-400, 1000
HML-200, 300, 500, 1000
LML-1000, 1500, 2000, 2500, 4000, 8000, 10000, 12000

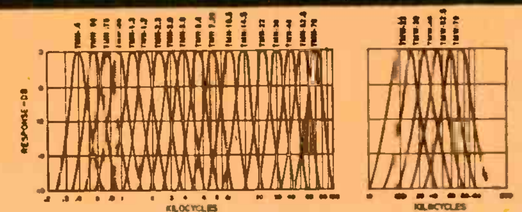
Base .... 1⁵⁄₁₆ x 1¹¹⁄₁₆"
Height, BMI, LMI, BML....... 1⅝"
Height, HMI, HML, LML ..... 2½"
Weight .... 6 oz. and 9 oz.

TELEMETERING BAND PASS

UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

TMN units are within 3 db at ± 7.5% of center frequency . . . down more than 18 db at ± 25% . . . more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at ± 15% of center frequency . . . down more than 20 db at ± 50% . . . more than 40 db beyond 2.5 and .4 center frequency.



STANDARD STOCK FREQUENCIES
(number in figure is KC)

TMN- .4	TMN-1.7	TMN- 5.4	TMN-30	TMW-22
TMN- .56	TMN-2.3	TMN- 7.35	TMN-40	TMW-30
TMN- .73	TMN-3.0	TMN-10.5	TMN-52.5	TMW-40
TMN- .96	TMN-3.9	TMN-14.5	TMN-70	TMW-52.5
TMN-1.3		TMN-22		TMW-70

TMN-2.3 thru TMW-70 ²³⁄₃₂ x ²³⁄₃₂ x 1⅜" Weight....1.2 oz.

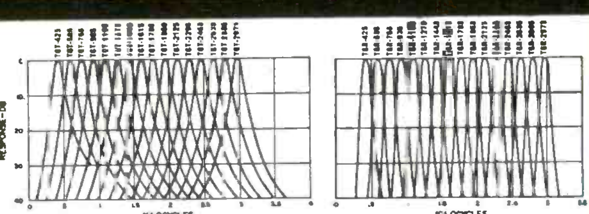
TMN-.4 thru TMN-1.7 ¹⁵⁄₁₆ x 1³⁄₃₂ x 2" Weight....3.5 oz.

TELEGRAPH TONE CHANNEL

These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

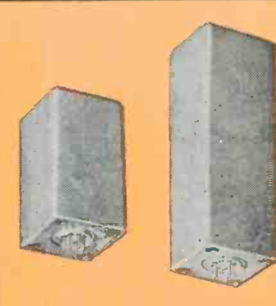
TGT transmitting filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 16 db at ± 170 cycles . . . down more than 7.5 db at adjacent channel crossover.

TGR receiving filters are within 3 db at ± 42.5 cycles from center frequency . . . down more than 30 db at ± 170 cycles . . . down more than 15 db at adjacent channel crossover.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

TRANSMITTING		RECEIVING	
TGT-425	TGT-1785	TGR-425	TGR-1785
TGT-595	TGT-1955	TGR-595	TGR-1955
TGT-765	TGT-2125	TGR-765	TGR-2125
TGT-935	TGT-2295	TGR-935	TGR-2295
TGT-1105	TGT-2465	TGR-1105	TGR-2465
TGT-1275	TGT-2635	TGR-1275	TGR-2635
TGT-1445	TGT-2805	TGR-1445	TGR-2805
TGT-1615	TGT-2975	TGR-1615	TGR-2975



TGT CASE 1⅓ x 1⅓ x 2½" Weight....8 oz.

TGR CASE 1⅓ x 1⅓ x 4¼" Weight....15 oz.

And Special Units to Your Specifications

UNITED TRANSFORMER CORP.
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Circle 111 on Inquiry Card

Slide Plate

(*Continued from page* 145)

than 5 milliwatts of signal power.

The unit stores and displays the last signal entered into it until commanded to accept and display a new signal input. In simple English, this means the following: Once the Slide Plate has been set to display a given character, then if the signal inputs are removed or even changed, it will not affect the character being displayed. This in turn means that a group of Slide Plates, once set up to display a given message or number, will continue to display this message without the use of any auxiliary memory or storage equipment. In other words, the Slide Plate contains its own memory storage.

The Slide Plate is available with 16 40, or up to 64 characters for special uses.

Besides the signal inputs, there is a single "set-pulse" input. To command the change to a new number and store the new number, it is merely necessary to impulse the "set-pulse" lead of the Slide Plate or bank of Slide Plates. This commands the units to drop the old digit and accept and display and store the signal information available to each at that moment.

The equipment has suitable check-back and verification circuits to verify that the signals have been properly accepted. It also has storage readout so that digits or characters previously read into a bank can be read back into the source equipment at some subsequent date or time.

Included are all of the practical characteristics desired in today's readout devices, such a high brightness, wide viewing angle, single plane presentation, and so on.

Not only numeric information,

but also all of the alphabetic information plus special symbols, can be displayed. The Slide Plate will be available with 16 characters, 40 characters, and for special applications, up to 64 separate characters may be presented by a single Slide Plate.

Further, it will be available not only in the super-sensitive version to work directly from flip-flops, but also in a self-setting version where the signal power required will set the Slide Plate directly, without the necessity for a set-pulse command. This unit will operate from relay contact closures or higher powered flip-flops. It will work on either unprimed inputs only or both primed and unprimed inputs. Any BCD code can be provided and direct translation from teletype signals can be provided.

Here is an example of how the device works: An airline wishes to display scheduled departure times for various flights at numerous locations such as passenger terminal, commissary, maintenance shops, downtown ticket sales office, and so on. If a bank of Slide Plate displays are set up at each location together with some common control equipment, it is only necessary to send out appropriate pulses over a single pair line to simultaneously set up, store, and display the desired information at each location. As the Slides Plates contain their own storage, the latest impulse information will continue to display until changed by new information.

Scope

(*Continued from page* 146)

delay units with resolution to 1 x 10^{-10} sec., wide band sampling scope, and power access plug-ins will shortly become available.

The new cathode-ray tube, especially designed for incorporation with the scope, offers good sensitivity, high light output, fine resolution, and an acceleration potential of 12,000 volts.

The 425 measures 27 x 13½ x 16½ in. and requires 1000 watts at 60 CPS, 115 v. Operation from 48 through 450 CPS can be made with the selection of an optional motor. The instrument weighs 125 lbs. and is ventilated by filtered forced air.

Molecular Electronics *(Continued)*

the affected portion can be cut away and the unaffected portion put to use.

Now, although this dendritic method has immediate usefulness in molecular electronics today, its greatest significance is its ability to bring about a number of completely new processes for producing functional blocks. We are now most interested in a recent modification which makes it possible and practical to carry out diffusion, plating, and evaporation processes directly on the crystal as it grows from the furnace melt. With this technique, we are able to create semiconductor devices ready for the attachment of leads. One of the first uses has been to grow transistors in the form of a long germanium crystal.

Fig. 9: The button-like object performs the same function as the conventional amplifier on the table.

When the ribbon-like crystals are cut into segments, only simple processing is needed to produce transistors at a yield very near 100%. By this method we have produced lengths of ribbon along which small multiple-junction subsystems are distributed, Fig. 5. Since these ribbons can easily be processed to become a long series of tiny amplifiers, it is not at all facetious to say that this ribbon can be snipped into lengths to give us amplifiers of whatever gain we desire.

A more recent and extremely significant achievement resulting from research is that we have now discovered how to grow multizoned crystals as dendrites, directly from the furnace melt. This development is a major event in new technology of molecular electronics. It makes available basic building blocks having at least three layers of zones and two interfaces. Thus it will no longer be necessary to perform many operations to create multizone elements.

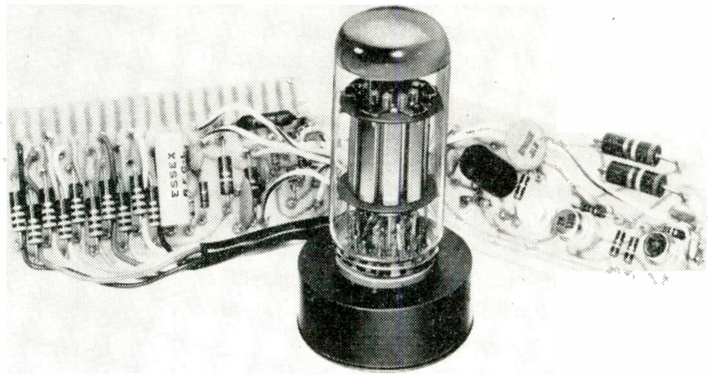
In considering the implications of this basic method for crystal growth, one most interesting possibility is that it will prove practical to combine our ability to grow multizoned crystals with ability to perform operations on the crystal at the time it is growing in the furnace. Admittedly, to achieve near-automatic production of semiconductor devices and molecular electronic function blocks is a long-range objective, but it is probable that we will eventually be able to "grow" from a pool of molten semiconductor materials some items of electronic equipment that today are of the order of complexity of radio receivers and amplifiers.

Fortunately to achieve these and other objectives, we are not forced to rely on "wild-catting" methods of prospecting for new materials. Instead, present programs of planned research will yield solutions to such problems as the development of materials that will withstand very high temperatures and intensive radiation and the development of function blocks that will have high power handling capacities.

Investigation now underway with the so-called 3-5 compounds supports our approach to the development of heat- and radiation-resistant materials. And our ability to produce large, perfectly flat working surfaces on crystals of germanium will be basic to increasing the power-handling capacity of molecular electronic function blocks.

TRULY COMPATIBLE STEREO records are claimed by a new process of recording developed by Fairchild. The process was researched and developed initially by engineers of the Beltone Recording Studios in New York. As part of the test full stereo discs were packed as monaural records, and according to reports there have been no complaints that the stereo discs sounded inferior on monaural phonos.

The BEAM-X for Switching



This Beam-X counting module uses only 56 components. All transistor module would require 146. Unit handles 110 KC counting frequency.

THE BEAM-X, a new decimal electronic switch, is expected to effect a major change in basic electronic design logic from binary to decimal systems. It is manufactured by Burroughs Corp.'s Electronic Tube Div., Plainfield, N. J.

The switch uses small rod magnets within a vacuum to control the position of an electron beam to any one of ten output positions. The result is a decimal switch so reduced in size, weight, cost, and power as to outperform all existing vacuum· magnetic, and solid state devices in multiposition switching, counting, distributing, multiplexing, and allied operations.

In a typical ten-position switching application, the new decimal switch eliminates the 90 transistors, diodes, and resistors which must be used with binary logic to achieve the same results.

The BEAM-X Switch type BX-1000 is the first in a new series. Though functionally similar to its predecessor, the Beam Switching Tube, its radical design makes it a completely new device. The BX-1000 is 10 times lighter (1½ ozs.), 5 times smaller (3 cu. inches) and ½ the price (less than $25.00 in small quantities).

Not only have size and weight been tremendously reduced through the elimination of heavy external magnets and still larger magnetic shields· but other major factors of performance, cost and packaging have been vastly improved. Tubes may now be stacked directly adjacent to each other on approximately one-inch centers without concern for magnetic interreaction. Major factors of cost previously associated with critical alignment of external magnets or shields and expensive potting compounds have been eliminated. Improved uniformity of characteristics and ex-

tended operating ranges are natural by-products.

The BX-1000 has useful constant current outputs, positive switching elements, and memory in each of its ten positions. It may remain stationary indefinitely or switch at speeds exceeding 10 MC either sequentially or at random. Further, it may be interconnected as a distributor of any number of positions less or greater than 10, and be preset to any position and reset in less than a miscrosecond.

Operating flexibily and efficiently with respect to B+ voltages, it can be used equally well in high or low voltage systems. In vacuum tube circuits, outputs as high as 200 volts can be obtained while in transistorized systems it can be operated by 12 volt signals directly from the solid state circuitry.

Ruggedly constructed to withstand shock and vibration, and insensitive to temperature extremes, the new BEAM-X Switch is an ideal component for applications in ground support equipment, missiles· aircraft and space technology, and in commercial and industrial products.

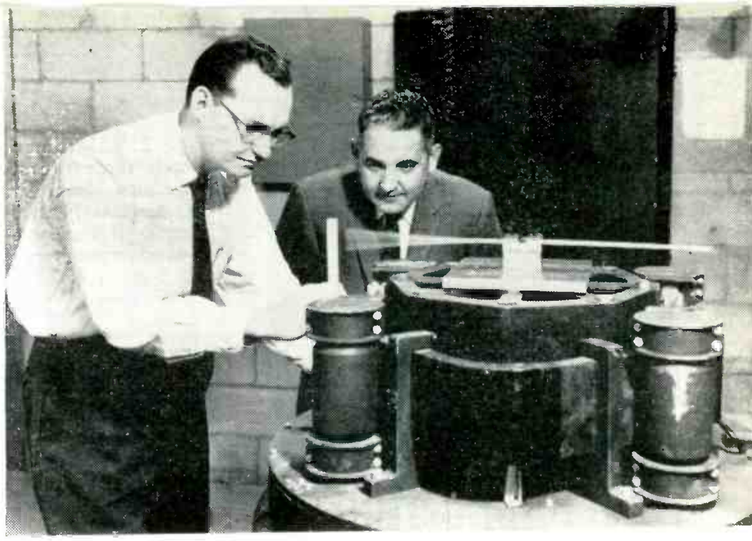


Fig. 1: E. Pietz® Pres., and J. Ruzicka, R & D Engineer at Barry Controls, Inc., test internally-damped cantilever beam in a vibration exciter. Damped beam is at right.

"Built-In" Damping

VIBRATION-RESISTANT structural members and production assemblies with high damping characteristics "built-into" the structural fabrications have been developed by Barry Controls, Inc., Watertown, Mass. The Company sees applications of these Rigidamp[R] structures in electronic circuit boards, electronic chassis, shelves, dust covers, aircraft parts, test fixtures, missile skins, relays, and other parts. Although most of the research has been with metal structures, successful applications have been made with structural plastics as well.

The low resonant response of the new structural members is illustrated in Fig. 1. Two cantilever beams of similar cross section are mounted in a vibration exciter. The beam on the left is solid aluminum, the other is the Company's new vibration resistant construction. Both are tuned to the same resonant frequency, with the damped beam resonating far less

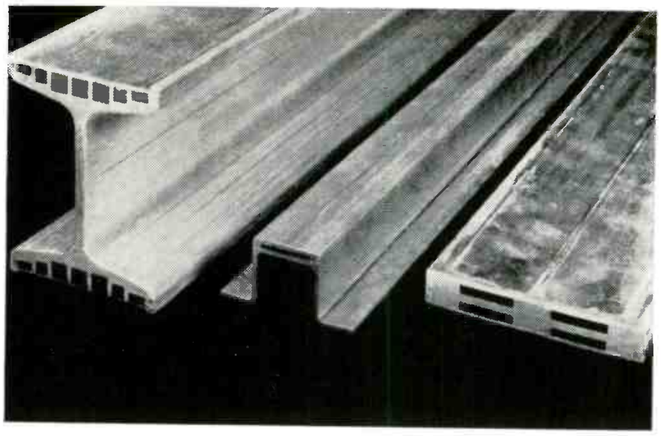


Fig. 2: Rigidamp structural members. Aluminum beam at left contains 14 steel inserts. It has same dimensions as standard 3 in. I-beam.

(*Continued from page* 273)

than the conventional one. The action is shown at the two beams' fundamental resonant frequency and at their first and second harmonics.

The materials attain their high damping action by special laminated and cellular construction. Sheets and thin rectangular section beams are laminated of conventional materials, either metal or plastic, separated by a viscoelastic damping medium. In flexing under the impressed vibration, the separate laminations of structural material slide relative to each other. This sliding is impeded by the viscoelastic material, and most of the energy of resonance is absorbed in straining the viscoelastic layer in shear. Other structural shapes such as I-beams, channels, and angles are of cellular construction (Fig. 2). Each cell contains an insert separated from the cell walls by the viscoelastic damping material.

All portions of the structural fabrication act as load carrying members and materials can be designed for virtually optimum damping characteristics in all frequencies normally encountered in most dynamic environments.

A viscoelastic damped member or structure has slightly less load carrying capacity than a conventional member of the same material and cross section. For identical stiffness, structural damping imposes a slight increase in weight. For identical cross section it means reduced load capacity. Since many designs are based on dynamic stress level, these designs may not require an increase in weight or cross section. The construction is not limited to a narrow range of frequencies, by temperature variations, or by size and materials involved.

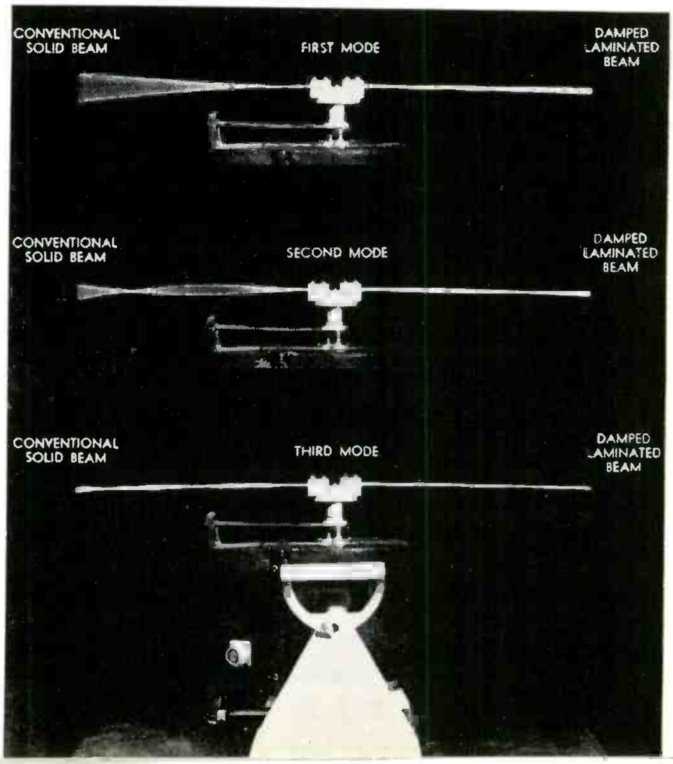
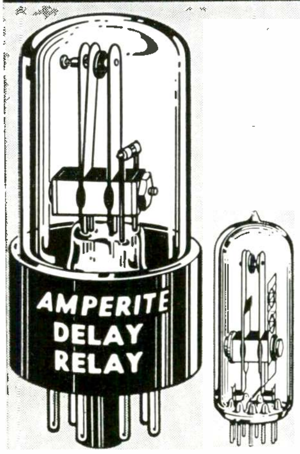


Fig. 3: At 17 CPS sinusoidal vibration input, the conventional beam amplifies the vibration by a factor exceeding 100. The damped beam amplifies by an approx. factor of 10. At the second harmonic the factors are 100 and 3. At the third the conventional beam is 50 times that of the damped beam.

AMPERITE

THERMOSTATIC DELAY RELAYS



2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived, and—inexpensive!**

TYPES: Standard Radio Octal, and 9-Pin Miniature . . **List Price, $4.00.** Standard Delays

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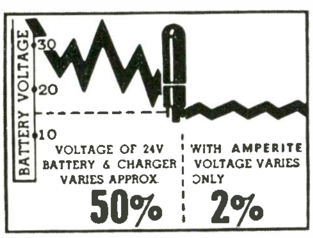

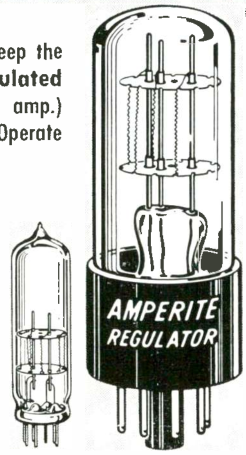

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . **List Price, $3.00.**

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Circle 341 on Inquiry Card

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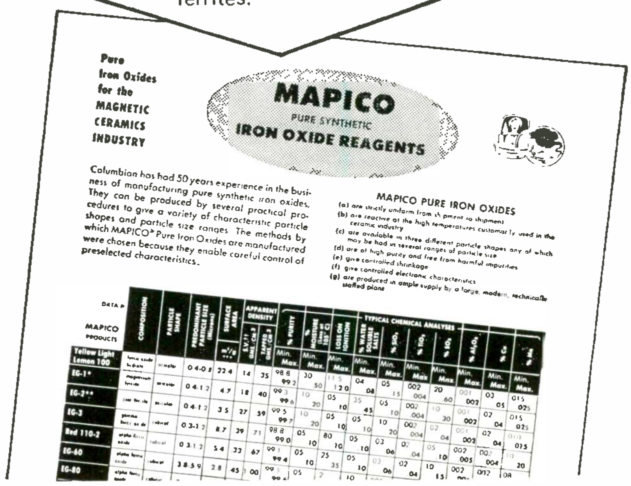


Circle 342 on Inquiry Card

IRE Technical Papers

Radio Frequency Interference

Sert Room, Waldorf-Astoria

"Simulation Tests on an Interference Rejection Antenna System," W. D. White and C. O. Ball.
"Computer Simulation of Signal Environments," W. G. James.
"Wiring of Data Systems for Minimum Noise," J. V. White.
"Receiver Analysis for Interference Prediction Purposes," D. C. Ports, R. Miller, John Savage.
"Electromagnetic Interference and Vulnerability Reduction," J. J. Egli.
"Fire Fighting or Fire Prevention," L. A. Yarbrough and J. W. Worthington, Jr.

Engineering Management—I

Empire Room, Waldorf-Astoria

"Management and the Employee-Owned Concept of Young R and D Growth Firms," D. M. Kruchko.
"An Engineering Management View of the Maintainability Problem," M. J. Marcus.
"Engineering Management for Creative Appraisal of New Ideas—The Secret Weapon for Technical Progress?" W. H. Beaubien.
"How to Produce Reliable Products at a Profit," C. W. Watt.
"Concepts of Capital Financing for Electronic Companies," R. T. Silberman.

Advances in Aerospace Subsystems

Faraday Hall, New York Coliseum

"Range Ambiguity Resolution in High PRF Radar," N. S. Potter.
"An Ion Altimeter for Pressure-Altitude Measurements," G. V. Zito.
"The Nature of Astro Doppler Velocity Measurement," J. E. Abate.
"Generation of Artificial Electronic Displays with Application to Integrated Flight Instrumentation," G. H. Balding, Charles Susskind.
"The Synchro-Magnetic Approach and Terminal Landing System for Aircraft," Ross Gunn.

Production Techniques

Marconi Hall, New York Coliseum

"Fabrication and Interconnection of Micro-Circuits Applicable to Data Processing Equipment," J. E. Richardson, J. W. Burkig.
"Ultrasonic Welding of Electronic Components," W. C. Potthoff, C. F. DePrisco, W. N. Rosenberg.
"A Disquisition of the Innovations and Gadgetry Used in the Volume Production of a Super Power Electron Device," J. A. Jolly.
"Design and Manufacturing of a Simplified Grid Module," Leon Jacobson.
"Micromodule Components: A Review of the State of the Art," R. A. Felmly.

Electronic Devices

Morse Hall, New York Coliseum

"Rating Power Transistors for High Current Pulses," Peter Balthasar.
"An NPN Fusion Alloy Silicon Transistor for Avalanche Mode' Operation," R. C. Wonson, W. A. McCarthy.
"Photoconductor Optical Encoders for In-Line Readout Devices," Carl Isborn.
"Advances in Screen Structure and Data Distribution for the ELF Display System," E. A. Sack.
"Shadow Grid VHF RF Tuner Tubes," F. R. Snyder, C. D. McCool.
"Focus-Reflex Modulation for Electron Guns," Kurt Schlesinger.

Control Applications
Tuesday Morning—March 22

Starlight Roof, Waldorf-Astoria

"Decoupling Techniques in Multi-Loop Control Systems," R. H. Loomis.
"Optimum Compensation of a Position Servo with a Magnetic Clutch Actuator," R. J. Hruby.
"Synthesis of a Self Adaptive Autopilot for a Large Elastic Booster," G. W. Smith.
"Design of Optimum Beam Flextural Damping in a Missile by Application of Root-Locus Techniques," R. J. Hruby.
"Flywheel Control of Space Vehicles," J. E. Vaeth.

Direct Conversion

Astor Gallery, Waldorf-Astoria

"Thermoelectric Converters," Kurt Katz.
"Thermionic Converters," Walter Grattidge.
"Noble-Gas Plasma-Diode Thermionic Converter," F. E. Jamerson.
"Magnetohydrodynamic Approaches," R. J. Rosa.
"Direct Conversion—Where Do We Stand?" R. J. Pidd.

Broadcasting—I

Jade Room, Waldorf-Astoria

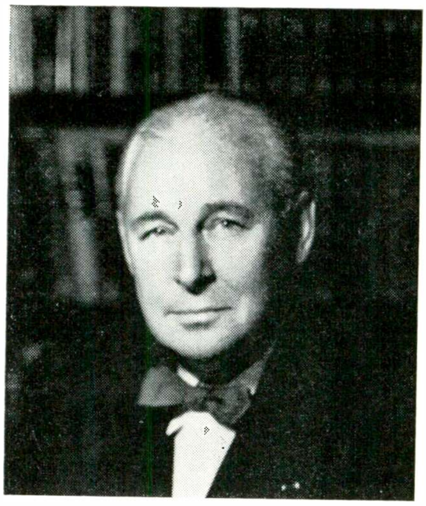
"Report on Geneva Radio Conference," W. H. Watkins.
"Future Possibilities for Film Room Mechanization," J. H. Greenwood.
"Directional Antennas for Television Broadcasting," G. H. Brown.
"Service Area of an Airborne Television Network," M. T. Decker.

Audio

Sert Room, Waldorf-Astoria

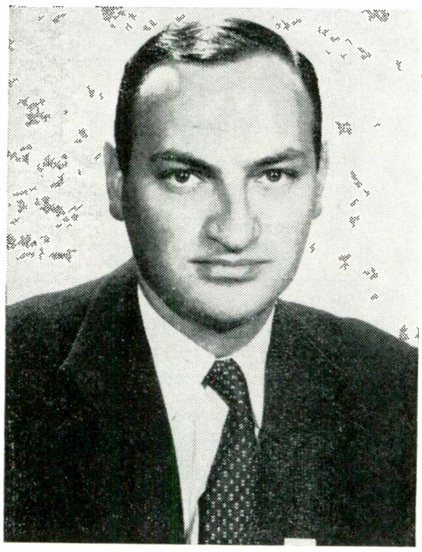
"A Plotter of Intermodulation Distortion," E. F. Feldman.
"Listener Ratings of Stereophonic Systems," H. B. Moore.
"Calculation of the Gain-Frequency Characteristic of a Multi-Mesh Transistor Amplifier Stage Using a Programmed Computer," D. E. Brinkerhoff.
"Automatic Compensation of an Audio System Spectrum Operating with a Random Noise Input," C. E. Maki.
"An Analysis of Factors Affecting Recording Reliability and Digital Tape Recorders," Ken Taylor.

SPEAKER



Lloyd V. Berkner: Principal Speaker, Annual Meeting

W.R.G. BAKER AWARD



To: E. J. Nalos, General Electric Co., Palo Alto, Calif. For: "author of the best paper published in the IRE Transactions of the Professional Groups."

Engineering Management—II

Grand Ballroom, Waldorf-Astoria

"More Effective Engineering Proposals—One Key to Success," F. W. Evans, Jr.
"The Application of Closed Loop Control Techniques to Engineering Project Planning and Control," R. W. Haine, W. Lob.
"The Professional Register—A Program for Improving Engineering Management Visibility of Technical Capabilities," N. A. Begovich.
"Management Control of Engineering Effort through Graphic Methods," B. P. Gollomp.

Varied Views of Medical Electronics

Faraday Hall, New York Coliseum

"Introductory Remarks—Training of Medical Engineers," H. H. Zinsser.
"Automatic Measurement of Enzyme Activity," D. I. Weinberg.
"Biological Microwave Hazards," V. T. Tomberg.
"An Automatic Physiological Telemetry and Analog-to-Digital Conversion System," W. E. Sullivan, J. T. Farrar, C. A. Steinberg.
Panel: Significant Variables in Biophysical Evaluation of the Human under Stress
Members: Charles D. Ray, Leland Clark, Members of the Staff of Col. John P. Stapp, Aero Medical Div., Wright-Patterson AFB, Otto H. Schmitt.

Modern Approaches for Improved Air Traffic Management

Marconi Hall, New York Coliseum

"An Air Height Surveillance Radar (AHSR-1)," T. J. Simpson.
"Automatic Ground-Air-Ground Communications for Control of Air Traffic," W. R. Deal.
"Technical Research for Future Aviation Facilities," Nathanial Braverman, W. W. Felton, Simon Justman, R. E. Kester, L. J. Schaub, Arthur Wetter.
"A Mathematical Analysis of the Performance of the ATC Radar Beacon System," A. Ashley, F. H. Battle, Jr.

Broadening Device Horizons

Morse Hall, New York Coliseum

"Masers," J. W. Meyer.
"Variable Reactance Devices," B. Salzberg.
"Tunnel Diodes," H. S. Sommers, Jr.
"Functional Devices," W. A. Adcock.

Tuesday Afternoon—March 22

Radar and Coding Theory

Starlight Roof, Waldorf-Astoria

"Sequential Procedures in Radar Pre-Tracking," Mischa Schwartz.
"Detection Range Predictions for Pulse Doppler Radar," S. A. Meltzer, S. Thaber.
"The Search Efficiency of the Sequential Probability Ratio Search Radar," G. W. Preston.
"Group Codes for Correcting Prescribed Error Patterns," R. T. Chien.
"Some Results on Best Recurrent-Type Binary Error-Correcting Codes," W. L. Kilmer.

Industrial Electronic Instrumentation

Astor Gallery, Waldorf-Astoria

"An Inquiry into the Computer Automation of Supermarkets," R. R. Segel.
"Automatic Testing and Calibration of Central Air Data Computer," H. Langenthal.
"Electronics in Agriculture," F. C. Jacob.
"The Shawmeter—An Electronic Two-Color Pyrometer," V. G. Shaw.

Broadcasting—II

Jade Room, Waldorf-Astoria

"Some Engineering Aspects of Video Tape Recording Production," E. E. Benham.
"A Modern TV Transmitter Plant Input System," J. L. Stern.
"A Special Effects Amplifier for Non-Composite or Composite Monochrome or Color TV Signals," R. C. Kennedy.
"Remote Control of TV Microwave Equipment," J. B. Bullock.

Audio and Broadcast and Television Receivers

Sert Room, Waldorf-Astoria

"The Present Status of Stereo Broadcasting," C. G. Lloyd.
"Receiver Design Considerations for Stereophonic FM Multiplex Broadcasting," C. G. Eilers.
"The Percival Stereophonic Sound System," W. S. Percival.
"A Continuously Variable Wireless Remote Control for Stereophonic Phonographs," A. A. Goldberg, Arthur Kaiser.
"Automatic Stereophonic Phaser," B. B. Bauer, A. A. Goldberg, G. Pollack.

The Human as Originator of Signals and Schemes

Faraday Hall, New York Coliseum

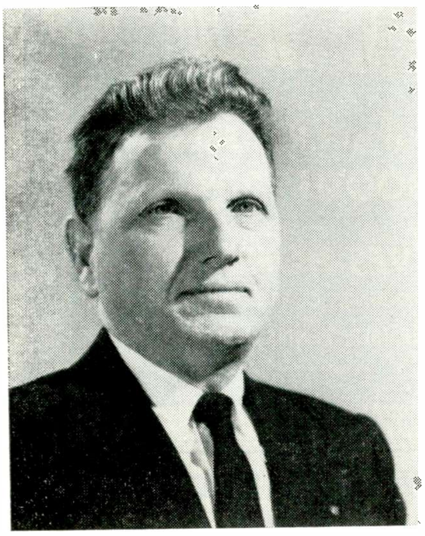
"Implantable Cardiac Pacemakers," Wilson Greatbatch.
"Detection and Analysis of HF Signals from Muscular Tissues with Ultra Low Noise Amplifiers," W. K. Volkers, William Candib.
"Stereo Dynamic Aspects of Fetal Auscultation and Its Application to Medical Diagnosis," F. D. Napolitani, L. E. Garner, Jr.
"Use of a High Sensitivity Capacitance Pick-up in Heart Sound Research," Dale Groom, Y. T. Sihvonen.
Panel: Discussion of Human Factors in Electronic Design, Leslie Kaeburn, Walter Tolles, Edward Llewellyn-Thomas.

Design of Equipment Reliability

Marconi Hall, New York Coliseum

"Safety Margins Established by Combined Environmental Tests Increase Atlas Missile Component Reliability," C. C. Campbell.
"Segregating Subsystem Errors of a Transistor Magnetic Circuit," W. R. Kuzmin.

HARRY DIAMOND AWARD



To: K. A. Norton, National Bureau of Standards. For: "person in government service for outstanding contributions in the field of radio or electronics as evidenced by publication in professional journals."

"The Statistical Analysis of Redundant Systems," Fred Moskowitz.
"Some Results of an Early Reliability Program," R. E. Kuehn.
"Maintainability Profile Analysis," H. E. Thomas, J. Soukup, W. Brobst.

Microwave Tubes

Morse Hall, New York Coliseum

"High Power CW X-Band Amplitron," W. C. Brown.
"High Power L Band CW Traveling Wave Tube Amplifiers," R. Strauss, J. McCammon.
"The Effects of Magnetic Focusing Fields and Transverse Beam Velocities on Spurious Oscillations in Backward-Wave Oscillators," L. L. Maninger.
"The Design and Performance of a Commercial Ammonia Maser Oscillator," S. Hopfer.
"Extended-Dynamic-Range Traveling-Wave Tubes," J. Kliger, E. J. Downey.

Tuesday Evening—March 22

Electronics—Out of This World

Grand Ballroom, Waldorf-Astoria

"Inter-galactic Data," Lloyd V. Berkner, Morris Tepper.
"Weather Forecasting and Control," Louis deFlorez.
"Reconnaissance—Radio, Radiation, Infrared, Optical," B. S. Pulling.
"Design for Survival (Personnel and Material)," Hubertes Strughold.
"Communication Relaying," Jerome B. Wiesner.

Wednesday Morning—March 23

(Continued on page 278)

IRE Technical Papers

Detection Theory and Applications to Physics

Starlight Roof, Waldorf-Astoria

"Estimation of Doppler Shifts in Noise Spectra," Peter Swerling.
"Optimum Coincidence Procedures for Detecting Weak Signals in Noise," Jack Capon.
"A General Theory of Signal-to-Noise Ratio Improvement, with Application to the Visual Detection of Weak Signals," N. S. Potter.
"Information Rates in Photon Channels and Photon Amplifiers," T. E. Stern.
"An Aspect of Information Theory in Optics," Hideya Gamo.

Broadcast and Television Receivers

Astor Gallery, Waldorf-Astoria

"Reduction of Modulation Defocussing in Television Picture Tubes," Joseph Hoehn.
"Recent Developments in Scan Magnification," N. Parker, I. Csorba, N. Frihart.
"Noise Figure Performance of VHF Transistors and Tubes at Various Operating Conditions," J. F. Bell, L. E. Matthews.
"A New High Performance AM/FM Transistorized Portable Receiver," B. J. Miller, E. A. Snelling.
"Filter-Phaser AM Stereophonic Receiver," A. A. Goldberg, Arthur Kaiser.

Electronic Component Parts

Jade Room, Waldorf-Astoria

"An Evolution Is Coming," Richard Dewitt.
"Tomorrow's Technology—Functional Electronic Blocks," W. S. Heavner.
"Electronic Progress—Circa 1960," L. J. D. Rouge, G. M. R. Winkler.
"The Thermionic Integrated Micro-Module Program," C. G. Childs, A. P. Haase, M. W. Hamilton, R. M. Hughes.
"Microcircuitry—A Practical Technology for Reliable Microminiaturization," F. P. Granger, Jr., J. G. Smith.

Space Telemetry

Sert Room, Waldorf-Astoria

"A Versatile Data Processing Facility," J. P. Randolph.
"Evaluation of Modulation Methods for Telemetry Usage," M. Rudin, D. Childers.
"Conceptual Design of a General Purpose Telemetry System," W. F. Link.
"Detection Levels and Error Rates in PCM Telemetry Systems," A. V. Balakrishnan, I. J. Abrams.
"A Highly Precise FM/FM Telemetering Device," H. K. Schoenwetter.

Communication Systems Design

Faraday Hall, New York Coliseum

"Equipment Configuration and Performance Criteria for Fully Optimized Tropospheric-Scatter Systems," C. A. Parry.

BROWDER J. THOMPSON AWARD

To: J. W. Gewartowski, Bell Telephone Labs., Murray Hill, N. J. For: "best technical contribution and presentation written by an author under thirty."

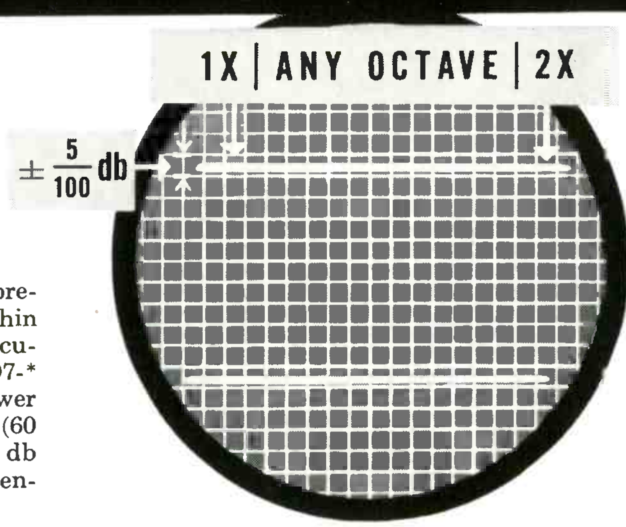
JERROLD

PRECISION SWEEP FREQUENCY GENERATOR model 707-*

5/100 db

ULTRA

FLAT



Featuring... variable-rate, all-electronic sweep with plug-in oscillators covering 2 to 265 mcs.

The ultra flat sweep generator model 707-* is a precision instrument with an rf output that is flat within ±5/100 of a db over highest single octave. Particularly adaptable for use with an X-Y plotter, the 707-* features: plug-in oscillator heads; high output power (+20 dbm below 150 mcs.); variable sweep rate (60 per sec. to 1 per 2 min.); and harmonics down 40 db over highest single octave (down 30 db over the entire range).

*Order Model 707-1, 2, or 3 shipped respectively with oscillator heads H-71 (4-100 mcs.), H-72 (12-220 mcs.), H-73 (2-50 mcs.) **$795.00 each**

Model 707-4 shipped with H-74 (any single octave 2-265 mcs.) special order.................................... **$845.00 each**

Additional oscillator heads for any model 707

H-71, H-72, and H-73.......................... **$250.00 each**

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Write for catalog and technical Newsletter series on Measurements By Comparison using sweep frequency techniques. Prices and data subject to change without notice.

HIGH
output power—
+20 dbm

WIDE
sweep width—1% to
over 120% of c.f.

FLAT
output—±.05 db over
the highest octave

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Export Representative: Rocke International, New York 16, N. Y.

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IRE Technical Papers

"Multifold Diversity Combining Techniques," R. T. Adams.
"Simple Methods for Designing Tropo-Scatter Circuits," L. P. Yeh.
"Optimized SSB Transmitter Loading by Multi-Channel Frequency Division Data," A. T. Brennan, J. P. Daly, Bernard Goldberg.
"Quicksilver—A Long Range General Purpose Digital Communications System," A. C. Chapman.

Aspects of Component Reliability

Marconi Hall, New York Coliseum

"The Reliability of Components Exhibiting Cumulative Damage Effects," George Weiss.
"Statistical Models for Component Aging Experiments," Joan Rosenblatt.
"Statistical Approach to Reliability Improvement," N. P. Demos.
"Quality Acceptance Measures—ADL vs AQL," G. V. Herrold.
"Accelerated Environmental Testing of Automotive Electronic Components," F. R. Khan.

Microwave Filters

Morse Hall, New York Coliseum

"Band-Pass Microwave Filter Design—A New Method and Its Relation to Other Methods," G. L. Matthaei.
"Optimum Quarter-Wave Transformers," Leo Young.
"Magnetically Tunable Microwave Filters Employing Single Crystal Garnet Resonators," P. S. Carter, Jr.
"Harmonic Calorimeter for Power Measurements in a Multimode Waveguide," V. G. Price.

Wednesday Afternoon—March 23

Electronic Computers and Circuit Theory: How Each Technology Can Help the Other

Starlight Roof, Waldorf-Astoria

"Switching and Memory Criterion in Transition Flip-Flops," D. O. Pederson, D. K. Lynn.
"Monte Carlo Analysis of Transistor-Resistor Logic Circuits," Y. C. Ho, W. J. Dunnett.
"An Analog Computer Nyquist Plotter," E. A. Goldberg.
"Smoothing and Prediction of Time Series by Cascaded Simple Averages," R. B. Blackman.
"Synthesizing Minimal Stroke and Dagger Functions," John Earle.

Ultrasonics Engineering I

Astor Gallery, Waldorf-Astoria

"Eigen Coupling Factors and Principal Components, The Thermodynamic Invariants of Piezoelectricity," H. G. Baerwald.
"Piezomagnetic Ceramic Transducers," O. E. Mattiat.
"An Ultrasonic Power Source Utilizing a Solid State Switching Device," W. C. Fry.
"Ultrasonic Cleaning Tests For a Variety of Driving Waveforms," R. C. Heim.
"The Effectiveness of Ultrasonic Degreasing as Measured by Radiotracer Techniques," E. L. Romero, H. A. Stern.
"A Spaced Lamination Transducer For Industrial Use," E. B. Wright.
"An Efficient Low-Cost Ultrasonic Transducer For Use in Remote Control and Carrier Frequency Applications," Frank Massa.

Component Parts

Jade Room, Waldorf-Astoria

"Magnetostrictive Ultrasonic Delay Lines for a PCM Communication System," D. Aaronson, D. B. James.
"The Reliable Application of Electronic Component Parts," H. L. Dudley.
"The Transient Effect in Capacitor Leakage Resistance Measurements," R. W. France.
"Dynamic Temperature Coefficient of Micro-Element Inductors," G. Hauser.
"A New Automatic Method for the Design of Low Voltage Transformers on the IBM 704," D. A. Franks.

Stereophonic Sound Reproduction

Sert Room, Waldorf-Astoria

"Stereophonic Sound Reproduction," H. F. Olson.
"Psychoacoustics of Stereophonic Reproduction," R. L. Hanson.
"Some Considerations in Design and Application of a Compatible Magnetic Tape Cartridge," Marvin Camras.
"A 1-7/8 IPS Magnetic Recording System for Stereophonic Music," P. C. Goldmark, C. D. Mee, W. P. Guckenburg.
"Automated Magnetic Tape Cartridge Mechanisms," J. D. Goodell.

IRE Technical Papers

Communication System Techniques

Faraday Hall, New York Coliseum

"Analysis of a Phase Modulation Communications System," R. L. Choate.
"An Improved Decision Technique for Frequency Shift Communications Systems," Elmer Thomas.
"High Sensitive Receiving Systems for Frequency Modulated Wave," Masasuke Morita, Sukehiro Ito.
"An Improved Multiplex Voice Frequency Carrier System," Bernard Tennent.
"Model of Impulsive Noise for Data Transmission," Pierre Mertz.

Antenna Pattern Synthesis

Marconi Hall, New York Coliseum

"Panel Members":
R. C. Spencer, P. A. Bricout, Robert Bickmore.
"Derivative Control in Shaping Antenna Patterns," A. Ksienski.
"Some New Methods of Analysis and Synthesis of Near-Zone Fields," Ming-Kuei Hu.
"Synthesis of CSC²O Type Antenna Patterns Using Two-Dimensional Surface Wave Arrays," H. W. Cooper, H. R. McComas.
"Determination of Optimum Primary Feed Ellipticity Setting to Obtain Circular Polarization from Reflector Type Antennas," L. J. Kuskowski, A. M. McCoy.

MORRIS LIEBMANN MEMORIAL AWARD

To: J. A. Rajchman, RCA Labs., Princeton, N. J. For: "contributions to the development of magnetic devices for information processing."

Microwave Interaction with Matter

Morse Hall, New York Coliseum

"Panel Members":
Professor S. C. Brown, Dr. C. L. Hogan, Dr. H. Kroemer.
"Recent Progress in Microwave Beam, Plasma and Solid State Devices," L. M. Field.
"Microwave Interaction with Plasmas," R. G. Buser, P. Wolfert.
"A New Semiconductor Microwave Modulator," Harold Jacobs, F. A. Brand, Michael Benanti, Richard Benjamin.

Thursday Morning—March 24

Adaptive Networks

Starlight Roof, Waldorf-Astoria

"Pattern Recognition with an Adaptive Network," Lawrence Roberts.
"On Predicting Perceptron Performance," R. D. Joseph.
"The Mark I Perceptron—Design and Performance," J. C. Hay, F. C. Martin, C. W. Wightman.
"A Magnetic Integrator for the Perceptron Program," J. K. Hawkins.

Circuit Theory: Current Contributions

Astor Gallery, Waldorf-Astoria

"Transfer Function Synthesis of Active RC Networks," E. S. Kuh.
"Broad-Band UHF Distributed Amplifiers Using Band-Pass Filter Techniques," F. C. Thompson.
"A Fourier Series Time Domain Approximation," D. R. Anderson.

IRE Technical Papers

"Spectral Measurements of Sliding Tones," Will Gersch, J. M. Kennedy.
"An Approach to the Synthesis of Linear Networks Through Use of Normal Coordinate Transformations Leading to More General Topological Configurations," E. A. Guillemin.

Ultrasonics Engineering—II

Jade Room, Waldorf-Astoria

"The Measurement of River Flow by the Use of Underwater Sound," G. E. Miller, W. F. Richardson, N. Serotta.
"Ultrasonic Flowmeter," H. Dahlke, W. Welkowitz.
"Optical Studies of Delay Line Transducers," R. F. Weeks.
"Ultrasonic Delay Line Analysis," D. L. Schilling, A. N. Silver.
"A Comparison of Several Dispersive Ultrasonic Delay Lines Using Longitudinal and Shear Waves in Strips and Cylinders," A. H. Fitch.
"Physical Principles and Operational Characteristics of Variable Ultrasonic Delay Lines," Walther Andersen.
"New Techniques in Ultrasonic Delay Lines," D. L. Arenberg.

Equipment and Systems

Sert Room, Waldorf-Astoria

"Missile Master (AN/FSG-1)—System Functional Description," George Romano, D. L. Prentice, James Hayne.
"Missile Master (AN/FSG-1)—System Equipment Description," Ralph Staschke, Douglas Noden.
"Weather Radar Data Processing," O. Lowenschuss.
"A Building-Block Approach to Multi-Purpose Communication Equipment," L. G. Fobes, J. E. Martin, H. A. French, W. L. Glomb, M. W. Green.
"An Integrated Approach to the Design of Mobile Tactical Electronic Systems," R. N. Skalwold, M. N. Scheiderich.
"Electronic Equipment Weight and Volume Penalties to Flight Vehicles," W. V. White.

Satellite Communications

Empire Room, Waldorf-Astoria

"Radio Relaying by Reflection from the Sun," D. J. Blattner.
"Active Versus Passive Satellites for a Multi-Station Communication Network," L. Pollack, D. Campbell.
"Satellite Communication Problems and Solutions in Ground Station Design," W. L. Glomb, W. Teetsel.
"Detail Design of an Operational Missile Voice Frequency Communications System," W. S. Cayot.
"A Digital Data Handling System for Real-Time Computation on the Atlantic Missile Range," M. P. Falls, T. A. Christie, Jr.

Human Factors in Electronics

Faraday Hall, New York Coliseum

"Coding Equipment for Ease of Maintenance," J. H. Ely.
"The Replaceable Component: Key to Maintainability," R. B. Miller.
"A Procedure for Predicting Reliability of Man-Machine Systems," P. C. Berry, J. J. Wulff.
"A Method for Anticipating Human Factors Requirements in Manned Weapon System," M. A. Grodsky.

Scanning Antenna Arrays

Marconi Hall, New York Coliseum

"Panel Members":
John Ruze, Harold Shnitkin, A. E. Marston.
"An Electronically Scanned Circular Antenna Array," H. P. Neff, J. D. Tillman.
"Multidirectional Antenna—A New Approach to Stacked Beams," Judd Blass.
"Parasitic Spiral Arrays," R. M. Brown, Jr., R. C. Dodson.
"An Electromechanically Scannable Trough Waveguide Array," W. Rotman, L. G. Hanscom Field, A. Maestri.

Magnetic Recording

Morse Hall, New York Coliseum

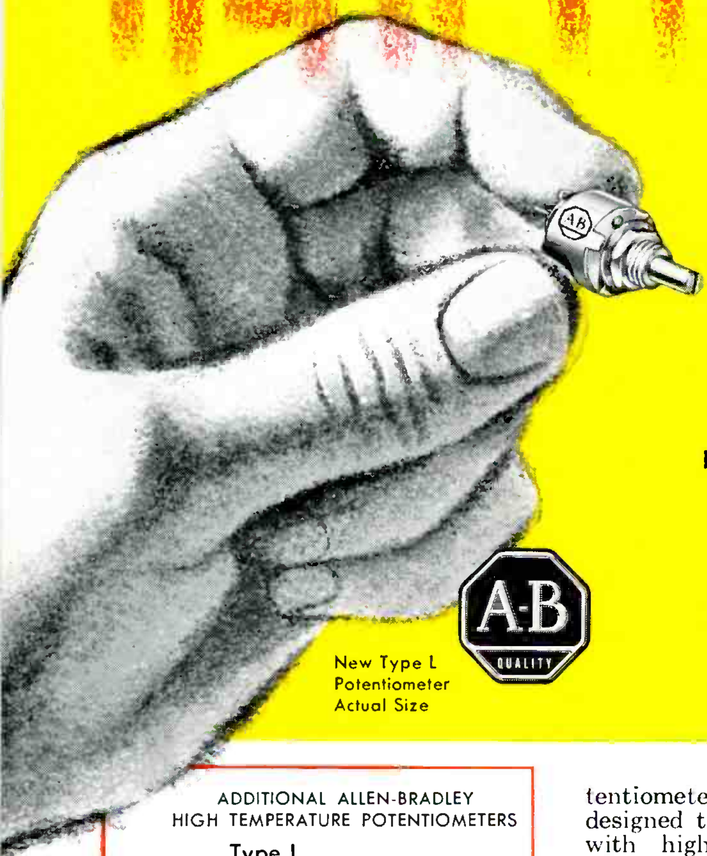
"The Effects of Track Width in Magnetic Recording," D. F. Eldridge, Albert Babba.
"Erased Carrier Recording," W. J. Murphy.
"Reliability and Drop-Out Studies for Long-Playing Loops," Al Wilson.
"Digital Magnetic Recording with High Density Using Double Transition Method," Andrew Gabor.
"Automatic Error Detection Equipment for Digital Tape Recorders," G. J. Slusarchyk, T. D. Radway, Paul Heller.

Thursday Afternoon—March 24, 1960

Electronic Computers

(Continued on page 285)

HEAT PROBLEMS?



New Type L Potentiometer Actual Size

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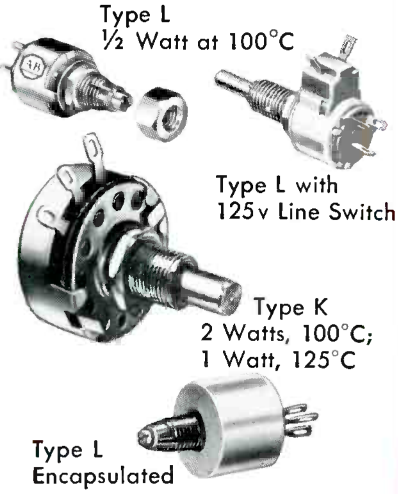
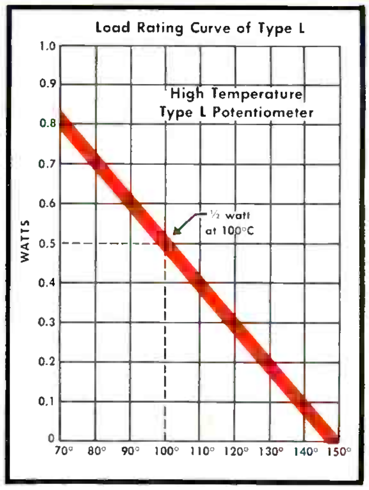
...up to 150°C!

ADDITIONAL ALLEN-BRADLEY HIGH TEMPERATURE POTENTIOMETERS



This new Allen-Bradley potentiometer—the Type L—is especially designed to solve problems associated with high ambient temperatures—*and* space conservation. Although extremely compact—0.5 inch in diameter—the Type L control has a conservative rating of 0.5 watt when operating in an ambient temperature of 100°C. And, it provides reliable performance when operated at a temperature of 150°C—under "no load" conditions. (See graph at right.)

The new Type L control features the same solid, *hot molded* resistance element that has proved unequaled for long life, smooth operation, and low "noise" characteristic in Allen-Bradley's popular Type J, Type K, and Type G potentiometers. When temperature and space problems in your designs plague you, this new A-B "high temperature" potentiometer is a reliable answer. Please send for complete information, today.



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IRE Technical Papers

Starlight Roof, Waldorf-Astoria

"An On-Line Solid State Analog Computer for Automatic Gas Flow Compensation," F. P. Simmons.
"Very High Density Digital Magnetic Recording," D. E. Killen.
"A Tunnel Diode Tenth Microsecond Memory," M. M. Kaufman.
"Automatic System and Logical Design Techniques Used on the RW-33 Computer System," T. A. Connolly.
"Logical Design Features of the LARC System," W. F. Schmitt, L. F. Harrison.

Symposium on a Decade of Progress in Network Theory

Astor Gallery, Waldorf-Astoria

"Graph Theory and Electric Networks II," Frank Harary.
"Physical Realizability Criteria," D. Youla.
"Some Properties of Time Varying Networks," J. M. Manley.
"Application of Synthesis Techniques to Electronic Circuit Design," F. H. Blecher.

Space Electronics

Jade Room, Waldorf-Astoria

"A Broad Band Spherical Satellite Antenna," H. B. Riblet.
"A Pulsed Plasma Mechanism for Propulsion in Space," P. M. Mostov, J. L. Neuringer, D. S. Rigney.
"Design Considerations of Television Satellite Reconnaissance Systems," R. L. Zastrow, D. J. Ritchie.
"Scanning Methods for Satellite-Borne Radars," A Rosenfeld, O. Lowenschuss.
"A Study of Natural Electromagnetic Phenomena for Space Navigation," R. G. Franklin, D. L. Birx.

Check-Out Instrumentation and Circuity

Sert Room, Waldorf-Astoria

"Trends in Complex Weapon Systems Check-Out," F. C. Corey.
"The Role of Multipurpose Automatic Test Systems in Testing Integrated ABNMGS Systems," I. H. Rubaii.
"Selecting the Optimum Test Interval for Static Alert Systems," F. L. Paulsen, L. Mast.
"Rapid Detection of Coherent Signals in Noise," R. J. Metz, J. M. Walker, N. L. Weinberg.
"Determination of Repetition Frequencies of Intermixed Pulse Trains," R. J. Kern.
"Coherent Enhancer for Pulse Radar Application," E. Brookner, J. Flink.

Vehicular Communications

Faraday Hall, New York Coliseum

"Past and Future Techniques of Vehicular Communication," E. W. Chapin.
"Radio Coverage—Area Survey—Instrumentation Research," C. E. Sharp, R. E. Lacy.
"Cryptographic Signaling Applied to Radio Communication Circuits," O. E. Thompson.
"Highway Alert Radio," E. A. Hanysz.
"A New Colinear Antenna Array," A. H. Second, W. V. Tilston.

Antenna and Propagation Problems

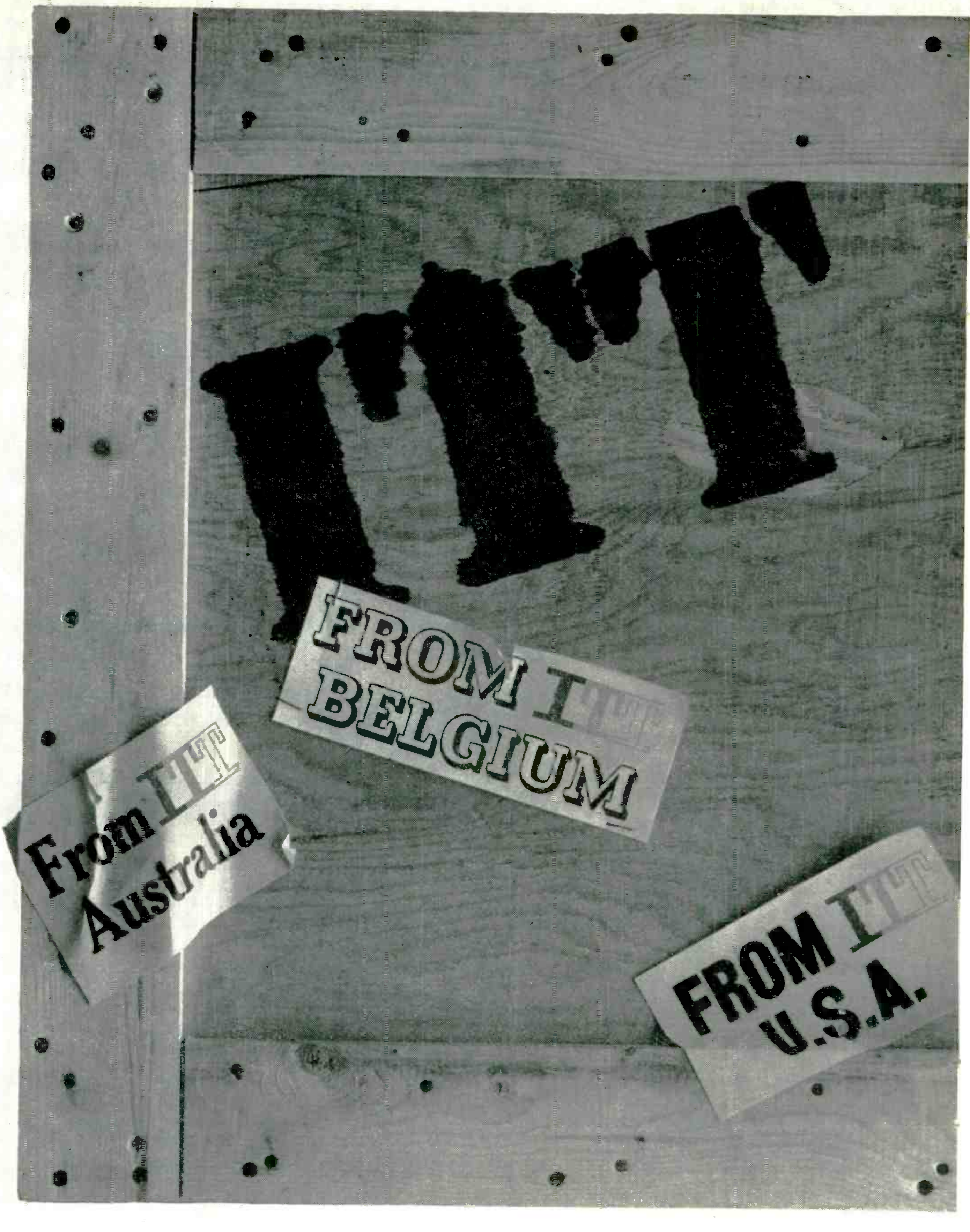
Marconi Hall, New York Coliseum

"Spiral Antenna Systems," R. Bower, J. J. Wolfe.
"A Monopulse Cassegrainian Antenna," L. Schwartzman, R. W. Martin.
"Power-Handling Capability of Antennas at High Altitude," W. E. Scharfman, T. Morita.
"Propagation Measurements in Shock-Ionized Media," D. E. Sukhia, G. H. Hampton.
"Ultra-Low Frequency Atmospherics," Herbert Konig.
"Ray Tracing for Whistler-Mode Signals at Low Frequencies," E. R. Schmerling, R. Goerss, S. Miluschewa, P. Hertzler, I. Pikus.

Waveform Analysis and Random Vibration

Morse Hall, New York Coliseum

"A Time-Compressor Using Magnetostrictive Delay Lines," S. J. Meyers, L. Rosenberg, A. Rothbart.
"Utilization of The Quadrature Functions As A Unique Approach to Electronic Filter Design," Henry Paris.
"A Magnetostrictive-Filter Random Wave Analyzer," Richard Boynton.
"A Numerical Method for Determining The Vibration Acceleration Density Directly from The Sinusoidal XY Plot," W. Reich, Marvin Schnee.
"A New Approach to Random Vibration Control Instrumentation," W. W. Caldwell.



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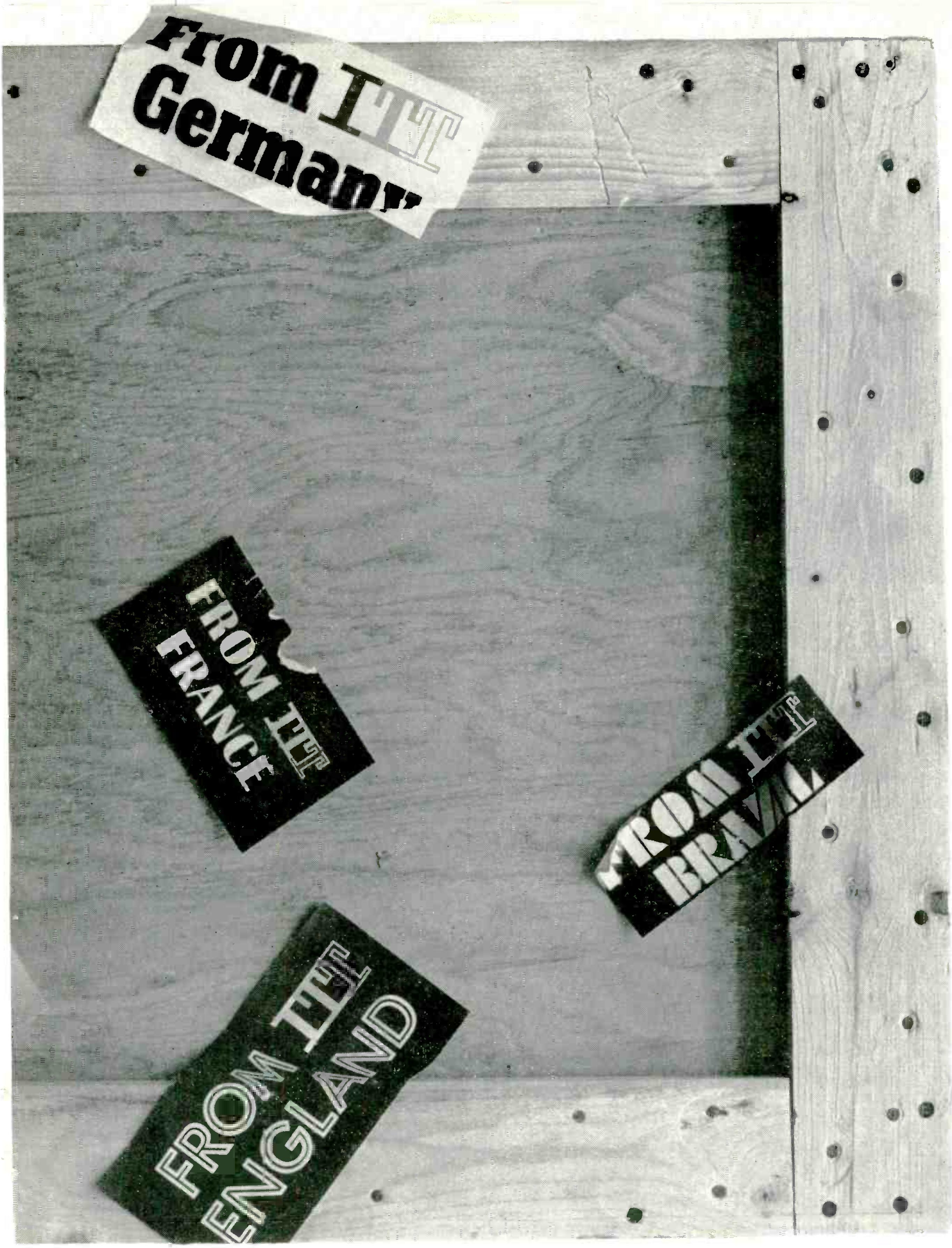

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IRE New Products

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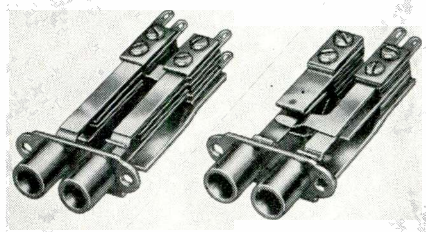
Long frame type "Twin-Jax" for communication equipment. Available in two types, the MT-388 has a

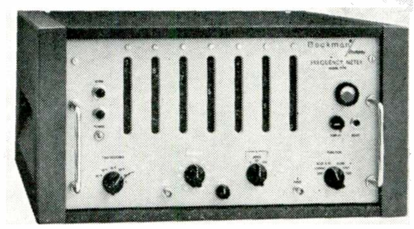


"shorting" feature that is "broken" when a 2-conductor plug is inserted into either sleeve. Switchcraft, Inc. Booth 2827.

Circle 263 on Inquiry Card

Frequency Meter

Model 7175 measures frequencies from 10 CPS to 110 MC. Accuracy is



0.00003% ±0.1 CPS. Input impedance is 1 M ohms to 10 MC, 100 ohms above 10 MC. Berkeley Div., Beckman Instruments, Inc. Booth 3416.

Circle 264 on Inquiry Card

Time Delay Relay

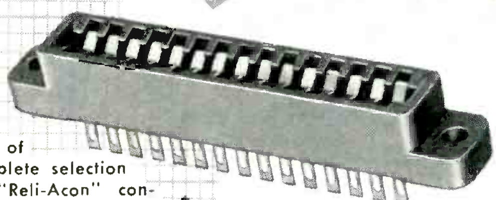
Series 1100 electronic time-delay relay has standard delay times of 50 ms

to 3 min. during operate or release cycle. Accuracies of 10% or better up to a vibration of 20 g to 2000 CPS. Hi-G, Inc. Booth 2227.

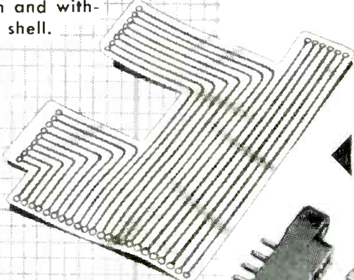
Circle 265 on Inquiry Card

Wiring Devices from Methode

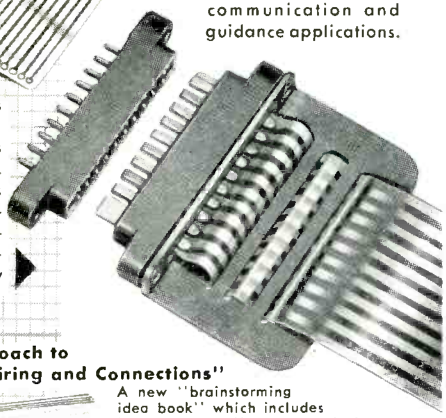
Printed circuit complement; for guidance device in operational missile includes 32 different circuit configurations. Produced in small quantities to close tolerances without use of production tools.



One of complete selection of "Reli-Acon" connectors, which include card receptacles, plugs, paired receptacles, paired plugs; with and without shell.



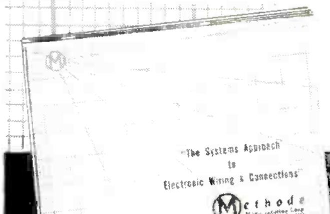
Custom sandwich of Methode Plyo-Duct using film insulation for pre-positioned conductor spacing and close control of capacity and induction conditions. The use of flexible film harnesses can affect weight savings up to 75% . . . ideal for airborne communication and guidance applications.



Methode connectors and tap-off terminal blocks supplement its Plyo-Duct wiring. Methode also makes special stripping machines permitting uniform harness construction without highly developed skills.

"The Systems Approach to Electronic Wiring and Connections"

A new "brainstorming idea book" which includes "case histories" on printed circuit and wiring device applications; check lists on product design and integration, I.P.C. Tolerances, and Methode products; complete description of Methode's design, tooling, manufacturing and inspection facilities.



Write on your company letterhead for your FREE copy of this valuable book which also offers engineering analysis designed to assist in packaging and inter-connecting high density electronic assemblies

Methode Manufacturing Corp.

7447 W. Wilson Ave. Chicago 31, Ill.

Circle 357 on Inquiry Card

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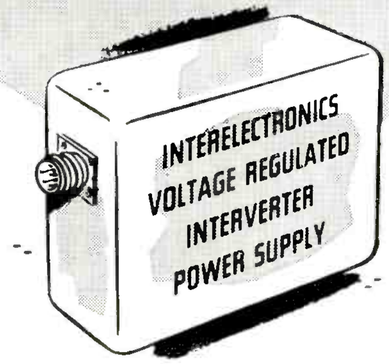
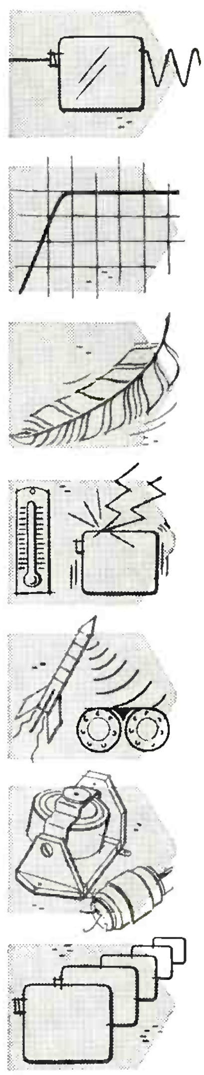
over 260,000 logged operational hours— voltage-regulated, frequency-controlled, for missile, telemeter, ground support, 135°C all-silicon units available now—





Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. High conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry.)

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards.)

Complies with MIL specs. for shock (100G 11 mlsc.), acceleration (100G 15 min.), vibration (100G 5 to 5,000 cps.), temperature (to 150 degrees C), RF noise (I-26600).

AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

For complete engineering data, write Interelectronics today, or call LUdlow 4-6200 in New York.

INTERELECTRONICS CORP.

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IRE New Products

Overspeed Sensor

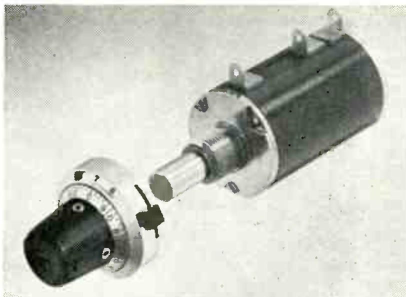
Model 9353B trips an internal relay when input speed signal reaches 12.8 KC. Twenty-eight vdc is applied

through relay contacts until overspeed condition is relieved. Varo Mfg. Co., Inc. **Booth 1731.**

Circle 291 on Inquiry Card

Potentiometers

Line of potentiometers, meters, and servomotors include three new trimmer potentiometers: Model 7216,

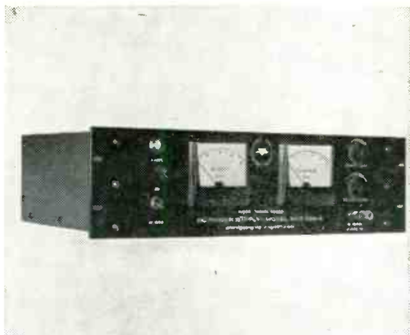


Model 71, and Model 70. Also Size 8 servomotors, and a line of panel meters. Helipot Div., Beckman Instruments. **Booth 1203.**

Circle 292 on Inquiry Card

Power Supply

Laboratory dc power supply, magnetic amplifier-transistor regulated. Model MTRO36-5's output is 0-36 vdc



at 5 a. Line regulation is ±10 mv for step changes of 10 mv between 105-125 vac input. Perkins Engineering Corp. **Booth 1416.**

Circle 293 on Inquiry Card

IRE New Products

Battery

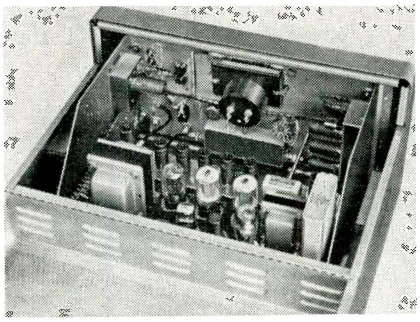
Silicad battery uses rechargeable silver-cadmium battery system. The 9 v battery is made up of 8 cells of 0.1

ampere-hr nominal capacity. It operates for 12 to 15 hrs before recharging. Yardney Electric Corp. Booth 2127.

Circle 294 on Inquiry Card

Receiver

Model LR 1297 provides a laboratory receiver suitable for noise figure measurements, nuclear resonance

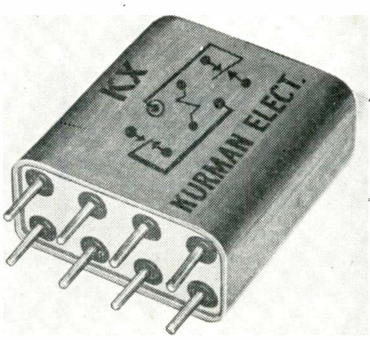


work, antenna pattern recording, etc., and with other LEL units a microwave receiver in the L through K bands. LEL, Inc. Booth 2102.

Circle 295 on Inquiry Card

Relay

Series KX-1 has DPDT, 2 a, contacts for any load from dry circuits to full rating. Nominal operating power is



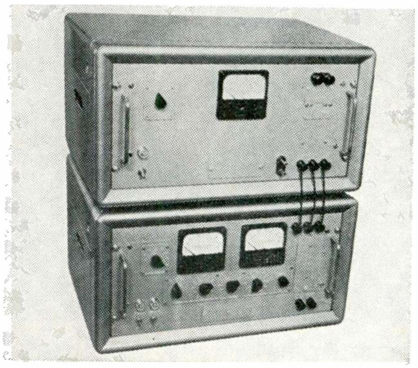
250 mw. Armature offers 20 g 2,000 cycle vibration and 50 g shock immunity. Kurman Electric Corp. Booth 2134.

Circle 296 on Inquiry Card

IRE New Products

Microwave Wattmeter

For bolometric power measurements, microwave wattmeter uses self-balancing bolometer bridge. Two basic units are used: the Weston Model



1493 bolometer bridge and Model 1494 reference-current generator. Daystrom Inc., Weston Instruments Div. Booth 1708.

Circle 297 on Inquiry Card

Power Oscillators

Precision Power Oscillator, the DK-115-14, is a 15 w unit with 1,000 and 100 v outputs. Regulation is better

than 0.1% on both outputs. Elin Div., International Electronic Research Corp. Booth 3018.

Circle 298 on Inquiry Card

Timing System

Transistorized Timing System with a drift of better than 1 part in 10^7 per week provides accurate clock, pro-

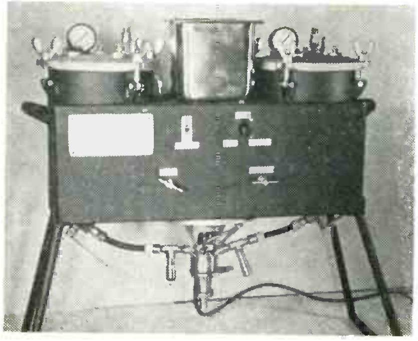
grammed timing pulses, precise 60 CPS power and WWV comparison. Geotechnical Corp. Booth 3240.

Circle 299 on Inquiry Card

IRE New Products

Resin Dispenser

Portable resin dispenser for foam, epoxies, and polyesters. Also the Model 359D encapsulating machine



for use with thermosetting molding compounds from epoxies to diallyl phthalates, alkyds and silicones. Hull Corp. **Booth 4114.**

Circle 441 on Inquiry Card

Pressure Gauge

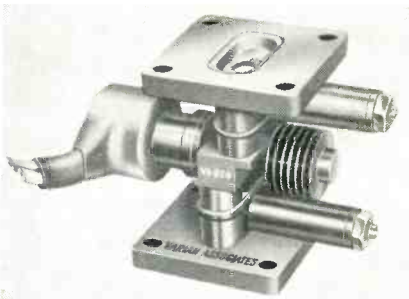
Series of electrical instruments for accurate determination of differential pressure of air and other gasses. Full

scale range is 0 to 0.01 in. H_2O. Detects differences as small as 0.0001 in. H_2O. Hastings-Raydist, Inc. **Booth 3807.**

Circle 442 on Inquiry Card

Microwave Amplifier

The VA-824B is a two cavity amplifier for airborne systems. Mid-band saturated outputs of 5 w are attained



with power gains up to 10 db. Also Oscillator Klystrons, Power Supplies, Mixers, etc. Varian Assoc. **Booth 2714.**

Circle 443 on Inquiry Card

IRE New Products

CR Tube

Rayonic Type 3ATP1 CR Tube is designed for frequencies in the 100 MC range at altitudes up to 90,000 ft.

without the disadvantage of potted bases or special containers. Waterman Products Co. **Booth 3105.**

Circle 444 on Inquiry Card

Phase Detector

Type 205B2 Precision Millimicrosecond Phase Detector measures time delay or phase angle with an error of

±1% or ±0.05° from 200 MC to over 1000 MC. Operating principle based on comparison method. Ad-Yu Electronics Lab. **Booth 3705.**

Circle 445 on Inquiry Card

Environmental Chamber

Model Temp RAC 19 portable chamber for high and low temperature testing. Temperature range is +300°-

F to −90°F with −100°F attainable. 2.3 ft³ chamber occupies 24 x 36 in. of floor space. Conrad, Inc. Booth 3818.

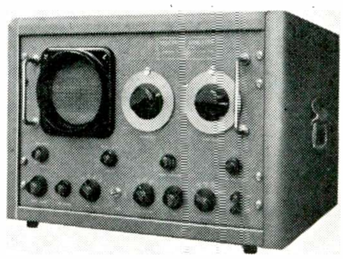
Circle 446 on Inquiry Card

Circle 368 on Inquiry Card

IRE New Products

Spectrum Analyzer

Model SS-20 Spectrum Analyzer will give high resolution fourier analysis in the 7 cycle to 23 KC spectrum. For

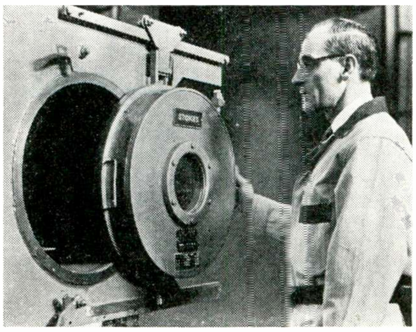


use with vibration systems, sonic noise and whistle analysis, etc. Probescope Co., Inc. Booth 3116.

Circle 447 on Inquiry Card

Baking Oven

For outgassing and sealing semi-conductor components under high vacuum. Self-contained "package unit"

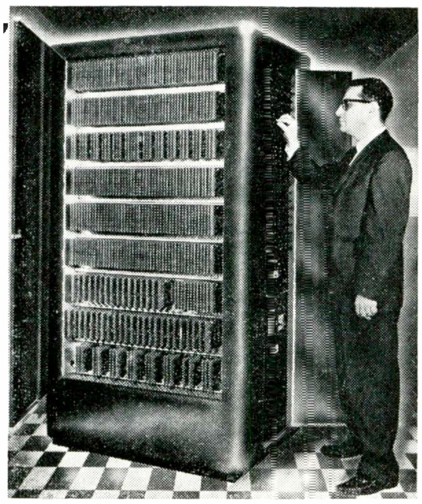


produces high vacuum and non-oxidizing environment. Unit has sliding door. F. J. Stokes Corp. Booth 4125.

Circle 448 on Inquiry Card

Computer

The 2003 Computer is a medium size, general purpose digital computer. Transistorized, it is adaptable to ap-



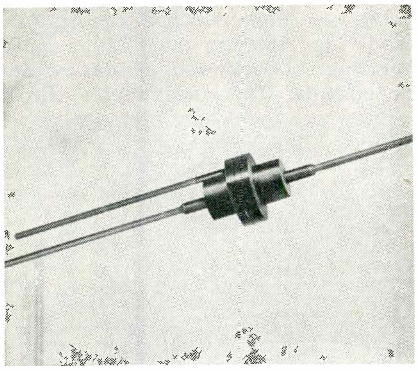
plications where external equipment must be integrated into a system. General Mills, Inc. Booth 3937.

Circle 449 on Inquiry Card

IRE New Products

Switching Transistors

Line of pnp silicon high speed switching transistors in a coaxial or single-ended package. Types 2N1254 through

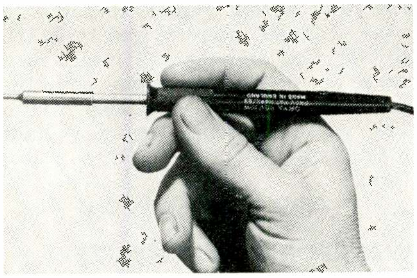


2N1259 are for low and medium power levels. Hughes Aircraft Co. Booth 1609.

Circle 450 on Inquiry Card

Soldering Instruments

New 115 vac pencil-type soldering instruments, Models 115-10W and 115-15W, are designed for continuous

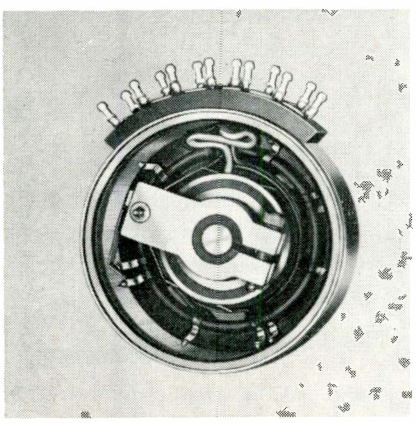


production, research, or service work for close quarter work. Oryx Company. Booth 4111.

Circle 451 on Inquiry Card

Potentiometers

BC-200 Ball Bearing Precision Potentiometer with a one-piece molded housing and complete phenolic en-



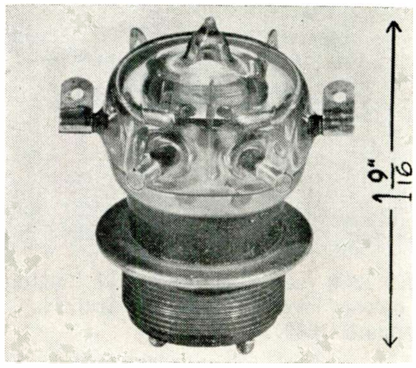
velope inside. 2 in. dia. unit is a single turn pot with low starting and running torque. DeJur Amsco Corp. Booth 2307.

Circle 452 on Inquiry Card

New Products

VACUUM RELAY

RB7B vacuum transfer relay for relatively high voltage applications involving antenna switching, pulse forming networks, and similar r-f and dc circuits. Two pole double throw,

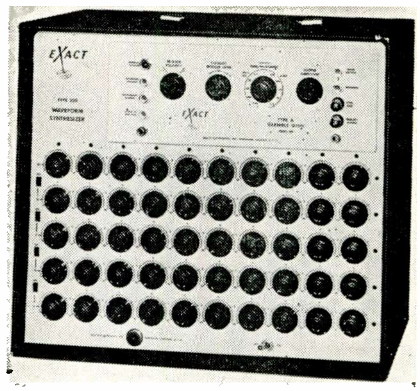


it measures 1-9/16 in. overall but has a rated operating voltage of 4 kv at 60 CPS and 2.5 kv at 16 MC. Continuous current rating is 6 a. at 60 CPS and 3 a. at 16 MC. It has a vacuum dielectric, sapphire actuating rod, and sealed rocker contacts for heavy contact pressure and resistance to vibration and shock. Contact resistance is low. Removable actuating coils are available for 26.5 vdc or 115 vdc operation. Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif.

Circle 453 on Inquiry Card

WAVEFORM SYNTHESIZER

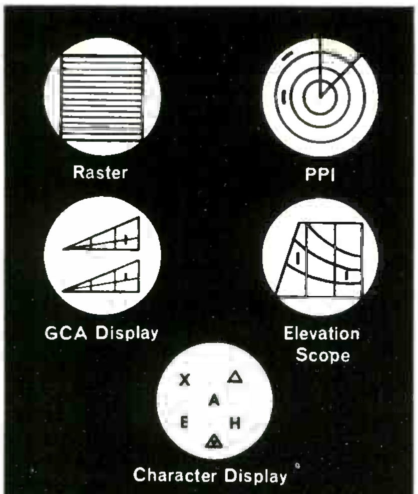
Type 200 Waveform Synthesizer creates a stable output waveform of almost any shape. This is achieved by separately controlling the characteristics of small segments of the total waveform, using different plug-in units. The amplitude and slope of each of the 50 increments may be independently varied without interaction to create the desired waveform;

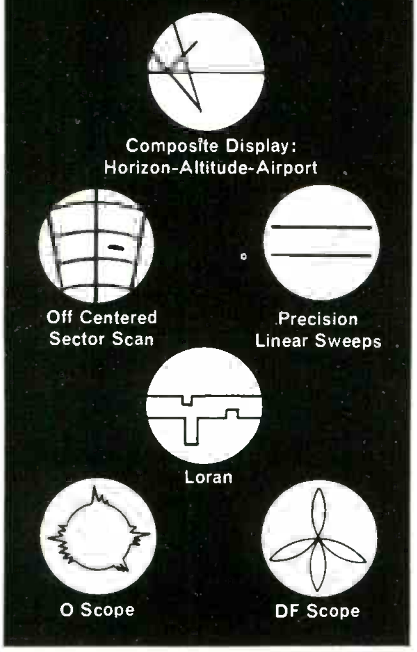


and the over-all amplitude and waveform duration may then also be varied over a wide range. Additional plug-ins are being developed. Exact Electronics, Inc., P. O. Box 552, Portland 7, Oregon.

Circle 454 on Inquiry Card

POWER LINE INTERFERENCE with radio broadcasting power line interference threatened to disrupt radio communications in one section of Japan. Power transmitting voltages were up in the neighborhood of 250,000 volts, severely effecting radio reception in the vicinity of the lines. In cooperation with a number of Japanese broadcasting firms, the power company arrived at the conclusion that the simple answer was to transmit the power at the same frequency as the broadcast station carriers. All the preliminary work has been theoretical. The actual field test will be completed by March of next year. The research scientists working on the job are estimating the chances of success at 50-50.

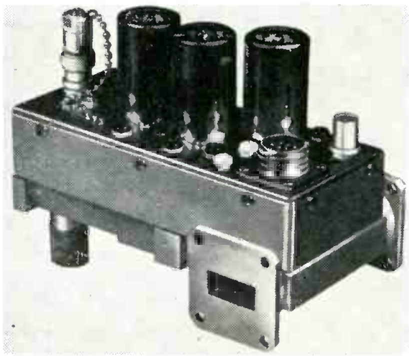




New Products

MIXER-PREAMPLIFIER

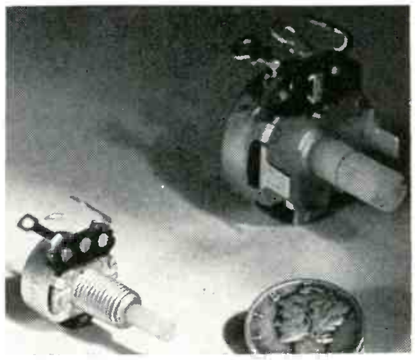
Operating over the 10.5 to 12.4 KMC spectrum, the MMX-3, mixer-preamplifier, is gain stabilized, has a 20 MC i-f bandpass centered at 60 MC, 25 db. min. overall gain, and a 9 db max. noise figure. It provides a 50 ohm output impedance making it suitable for gain and noise figure measurements on masers and parametric up-converters in addition to use as standard sub-assembly for incorporation into a radar or missile receiving system. LEL, Inc., 380 Oak St., Copiague, N. Y.



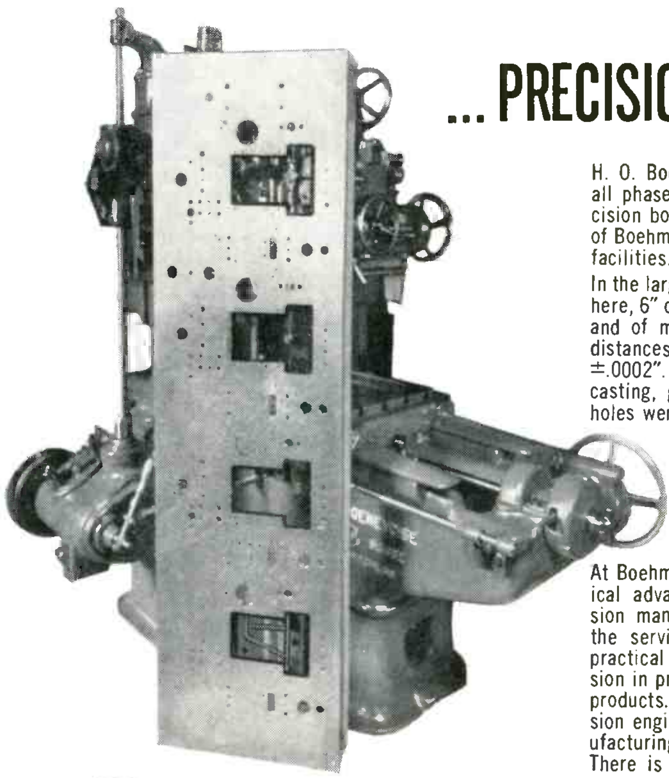
Circle 455 on Inquiry Card

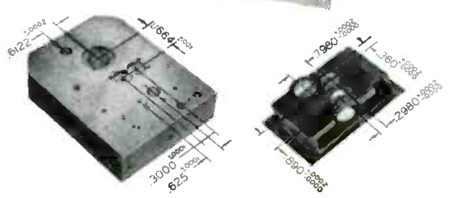
CONTROL

Type MLC carbon control is only ½ in. in dia. It can be supplied with a full-rated switch for 2 a, 125 v ac service, using a floating contact ring of the same size and design used in larger switches for minimum contact resistance. Either nylon or steel shaft can be supplied with the control. It has applications in miniature table and clock radios, portable TV receivers, hi-fi amplifiers and test instruments. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Indiana.



Circle 456 on Inquiry Card





New Products

AC TO DC CONVERTER

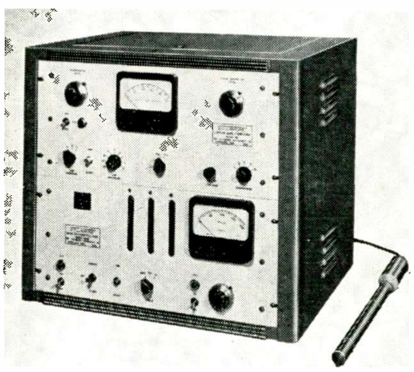
Linear ac to dc converter, Model 710, converts an ac voltage to a dc voltage which can be measured with an accurate dc device. A wide range of voltages can be measured with an accuracy of 0.25%. Input range covered is 1 mv to 1000 v in 6 decade ranges. Input impedance has a resistive component of 2 megohms

shunted by 15 $\mu\mu$f to 25 $\mu\mu$f depending on range. Output is a linear function of input voltage within its range. Ballantine Laboratories, Inc., Boonton, N. J.

Circle 457 on Inquiry Card

NEUTRON COUNTER

"Long" type neutron proportional counter for neutron monitoring applications, the Model NC-1, detects thermal neutrons with a BF_3-filled counter. In fast neutron counting, it



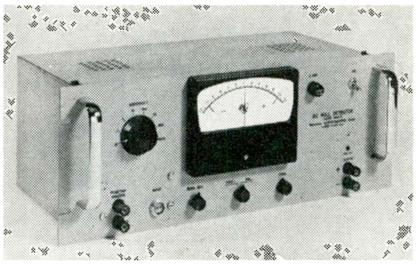
is used with either the Model MC-1, a non-directional moderator, or with the Model SMC-1, a shielded directional moderator. This detector-moderator combination gives the system a relatively flat response over range of neutron energies from 100 Kev to 5 Mev with the MC-1 unshielded moderator, and from 10 Kev to 5 Mev with the shielded SMC-1 moderator. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 458 on Inquiry Card

New Products

NULL DETECTOR

Model 56A-R, dc null detector, is a rack-mounted detector for production testing of close tolerance components normally tested on dc bridges. It has 8 ranges of sensitivity, covering from 10 μv to 100 v full scale. Input resistance is 10 megohms on all ranges.

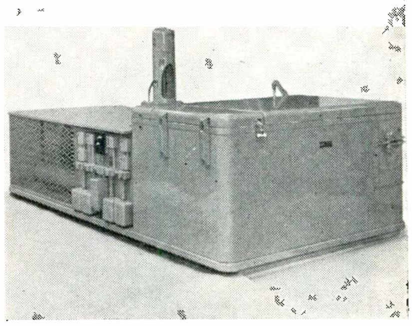


The input floats above ground by a minimum of 200 megohms. It may be used as a dc amplifier with a gain of 100 db. The amplifier output is available at front panel binding posts. Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J.

Circle 459 on Inquiry Card

CHILLING MACHINE

Low temp. production chilling machine, Model 7SR-120-32, is for stabilization of metal aircraft structures. It uses a convection fluid for rapid uniform chill, has a max. low temp. of —150°F and a thermal capacity of 14,000 Btu/hr at —120°F. With the



pre-chilled liquid in the chamber, 500 lbs. of steel per hr. can be chilled from ambient temp. to —10°F. Overall dimensions are 140 x 66 x 38 in. Cincinnati Sub Zero Products, 3932 Reading Rd., Cincinnati 29, Ohio.

Circle 460 on Inquiry Card

New Products

DC AMPLIFIER

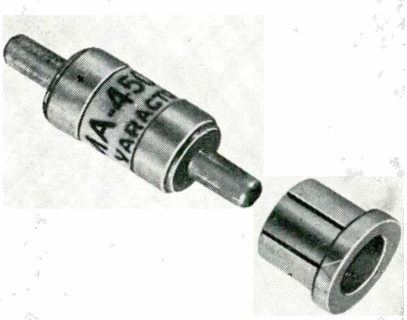
Transistorized DC Amplifier, Model DA-11, withstands vibration of 20 g from 15 to 2000 CPS, shock of 100 g, acceleration of 100 g (each axis), and operates over +32°F to +150°F. It

meets MIL-E-5272B Procedure III. It handles signals as low as 0 to 10 mv and as high as 250 mv. Under max. gain, an input signal of ± 10 mv will produce output signals of ± 5 v. Carrier rejection is 60 db or greater below max. output. Operating power is +20v. at 25 ma ±5%. United Electro-Dynamics, 200 Allendale Rd., Pasadena, Calif.

Circle 461 on Inquiry Card

DIODES

Series of hermetically sealed silicon Varactor diodes, designated MA-450A through MA-450E, feature reversible polarity. A base adaptor is supplied with each diode. Cartridge shunt capacitance, at 100 KC, is about 0.4 $\mu\mu$f. Series lead inductance is less than 10^{-9} h. Power dissipation rat-



ing ranges between 300 mu for lowest cutoff types to 150 mw for highest cutoff types. They conform to MIL-E-1 dimensions. Microwave Associates, Sales Dept., Northwest Industrial Park, Burlington, Mass.

Circle 462 on Inquiry Card

New Products

DC BRIDGE

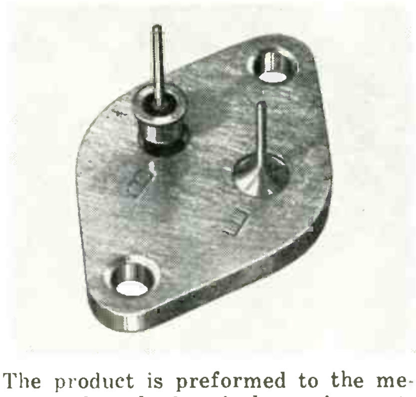
High speed dc bridge, Model AB-4-5, can sort resistors into 3 groups automatically at rates of 5000 pieces per hr. It can sort to high accuracy as shown: 10 ohms to 100 ohms, ±0.3%; 100 ohms to 2 megohms,

±0.1%; 2 megohms to 10 megohms, ±0.2%; 10 megohms to 100 megohms, ±0.3%. A built-in 7-dial resistance decade is provided for setting to nominal values of resistance. Tolerance limits are set by plug-in units. Resettable electro mechanical counters tally the pieces in each bin. Industrial Instruments Automation Corp., 89 Commerce Rd., Cedar Grove, N. J.

Circle 463 on Inquiry Card

GLASS PREFORMS

Copper sealing glass preforms, Cop-seal, for true glass-to-copper seals with no intermediate materials or components. Specific electrical resistance at 100°C is of the order of Log_{10} 11.1 ohms per centimeter and increases as temperature is decreased. Coefficient of expansion is 155 x 10^{-7}.



The product is preformed to the mechanical and electrical requirements of the components manufacturer. Mansol Ceramics Company, 140 Little Street, Belleville, New Jersey.

Circle 464 on Inquiry Card

TUNING FORK CONTROLLED PRECISION FREQUENCY PACKAGES

FROM 1.0 TO 4,000 CPS.

Overall accuracies from ±.05% to ±.01% over −55°C to +85°C range, and to ±.001% from zero °C to +75°C, **without** use of ovens.

Silicon and germanium transistorized. Sinewave, squarewave and pulse outputs. 18, 20, 24, and 28 volt DC inputs.

Conservatively designed **reliable** units, potted in silicone rubber and hermetically sealed, for operation under **MIL** environmental conditions.

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PHILAMON LABORATORIES INC.

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Circle 382 on Inquiry Card

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

Engineering Interns

"Internships" and "residencies" in engineering education are not far off because of the increasing complexity of the subject, says Prof. William G. Dow, chairman of the Dept. of Electrical Engineering at the Univ. of Michigan.

He told the Northeastern Michigan section of the AIEE that, "the last 25 years have produced so much new, professionally valuable scientific knowledge that graduate level instruction is increasingly important."

The university is extending its instructional resources to areas outside the campus and trying to work out plans to make off-campus graduate level teaching more fully an integral part of the total program.

"Outstanding" EE of '59

ETA Kappa Nu Association, a national honorary electrical engineering fraternity, has selected Dr. Edgar A. Sack, Jr., as the "Outstanding Young Electrical Engineer" for 1959. The award jury considers a broad range of qualifications including professional achievement and what the young engineer has accomplished in civic and social leadership.

Dr. Sack, manager of the dielectric devices section of the Westinghouse Research Labs, has been working on special applications of electroluminescence. Away from the job he serves as a volunteer fireman, and is active in civil defense, politics, and amateur radio communications.

AEC Grant to Lehigh

A boiling water heat transfer unit for Lehigh University's nuclear education program will be the major purchase of a $38,500 grant from the Atomic Energy Commission. The equipment will be used to study heat transfer pressure drop characteristics of high pressure water and heat transfer problems in nuclear reactors.

Administrative Skill A Must For The Successful Electronic Firm

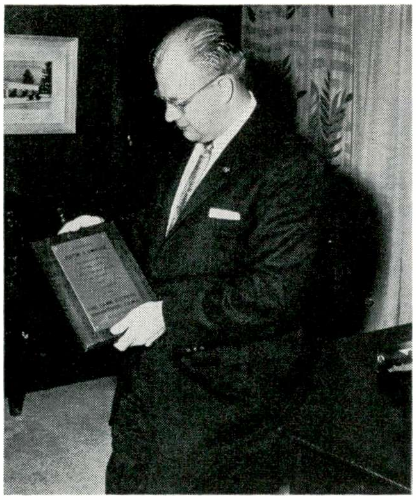
The 1960's will bring a new challenge to the management of electronic firms, said Kenneth F. Julin, President of Leach Corp., Compton, Calif. The challenge, he said, will face both small and large companies, and will call for reservoirs of management skill without precedent in the industry's history.

The industry, he predicted, will scale a new peak of $9.5 billion in military and commercial production. He saw narrowing profits for electronic manufacturers despite a larger share of the defense dollar—possibly as much as 20% larger—going to the industry as military systems grow more complex and sophisticated. He cited mounting competition, and the higher cost of research and development as factors eating into the profit dollar.

Large companies, strong in potential and facilities, will find themselves facing grave problems in production because they lack the flexibility of small manufacturers to meet the demands of a rapidly changing technology. On the other hand, smaller companies which have prospered because of almost unlimited opportunities despite often questionable management, will find themselves facing increasing competition from the larger corporations. It may take a decade before large and small companies alike finally find their niche in the industry, and learn that certain jobs can be performed better by large producers and other jobs better by smaller, highly specialized and flexible suppliers.

The west coast executive saw unprecedented opportunities in commercial electronics as the industry projects its engineering know-how and capability into plant automation, testing and measuring devices, communication and navigation, and commercial application of computational equipment.

FOR LEADERSHIP



Elston H. Swanson, President of Instruments for Industry, Inc., Hicksville, N. Y., holds plaque presented to him in "appreciation of his vision, leadership, and service." The Long Island Electronic Manufacturers Council made the award.

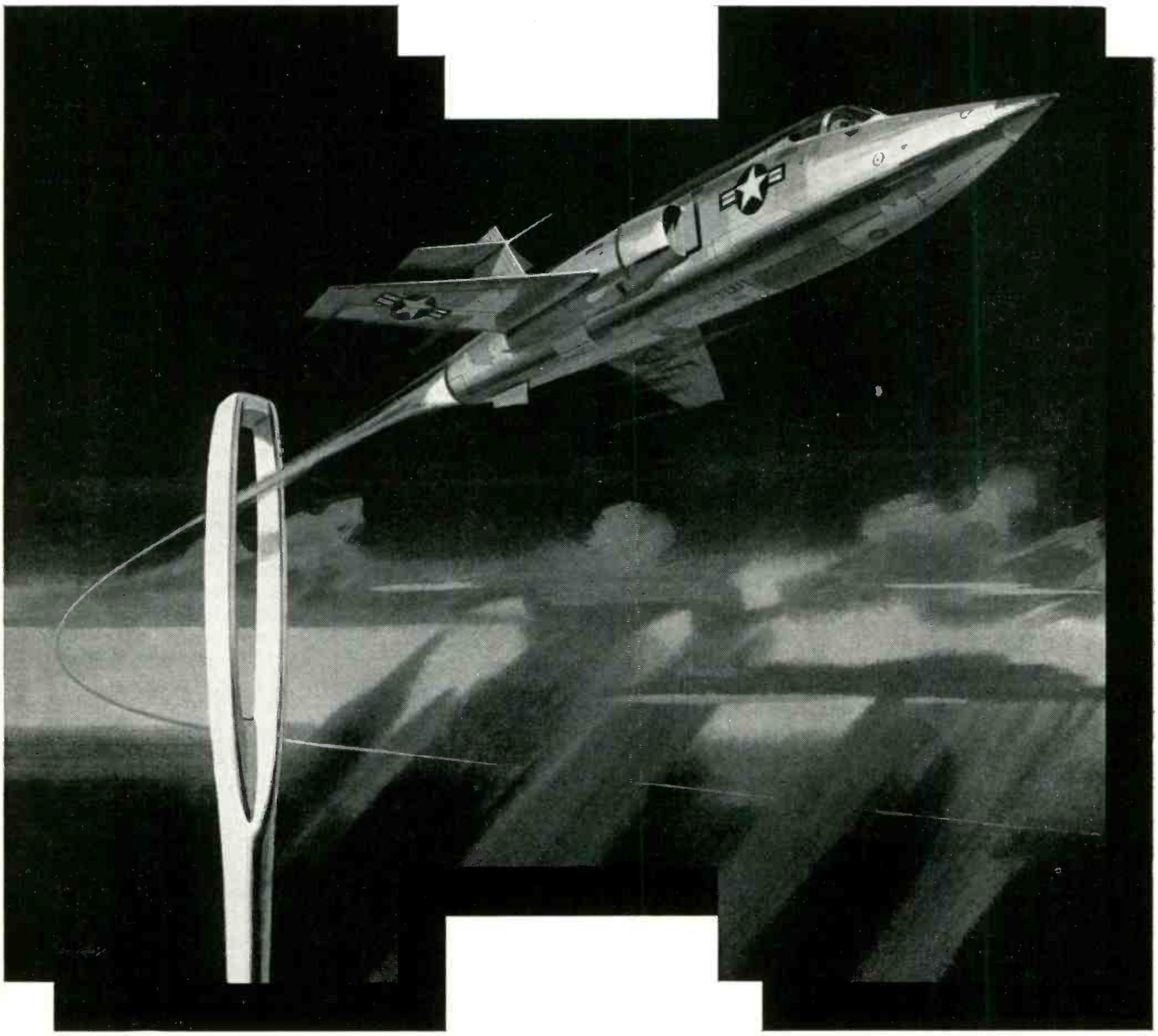
School Gets TV Equipment

The GPL Division of General Precision, Inc., Pleasantville, N. Y., has shipped two model PD-250 viewfinder TV cameras and associated equipment to the Dept. of Radio, TV and Motion Pictures at the University of North Carolina for its Chapel Hill Communications Center.

In addition to the vidicon cameras, the TV equipment includes three studio control and monitoring consoles, two rack mounted camera control units, three 14 in. TV monitors and 3 in. waveform monitors, a video switcher-fader, and related accessories. The equipment will be used in teaching courses in TV production techniques. Later on the gear will be used in experiments with various subjects in direct TV teaching.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 250.

How to thread a needle



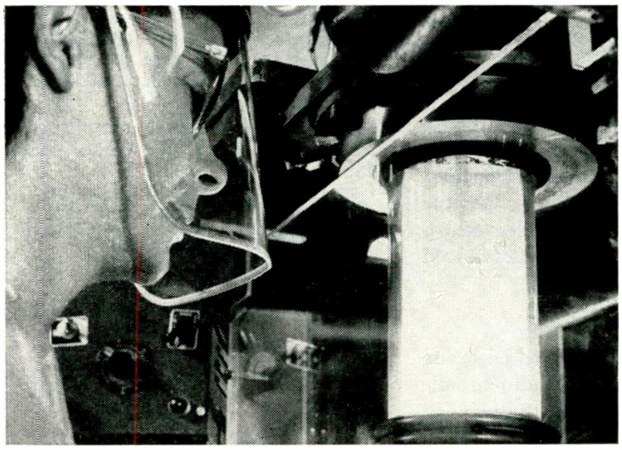
The Fording Test *is typical of the tough environmental tests imposed upon advanced electronic equipment designed and produced by Hughes Fullerton engineers.*

in the dark

TARAN (Tactical Attack Radar and Navigator) is typical of the important new electronic systems developed by Hughes—in an atmosphere famed for its engineering orientation.

Hughes engineers have designed this system to enable pilots to fly blind at very low altitudes in any kind of weather—and actually deliver any kind of armament at tactical targets.

TARAN's amazing abilities are based on several major electronic advances developed by Hughes engineers: A radar system with several times the range and azimuth resolution of current radars. An Automatic Navigation and Display System which pinpoints position continuously and automatically corrects for any navigational deviations. A unique terrain clearance indication warns the pilot of any obstacles when flying at low altitudes. A radar antenna utilizing electronic rather than mechanical lobing.



Molten Ladle *of silicon is watched during first step in the precise manufacture of Hughes semiconductors, just one of the Hughes commercial activities.*

Other Hughes activities provide similarly stimulating outlets for creative engineers. A few representative project areas include: advanced data processing systems, molecular electronics, advanced 3-D surface radar systems, space vehicles, nuclear electronics, ballistic missiles, infrared devices—and a great many others. The commercial activities of Hughes have many interesting assignments open for imaginative engineers to perform research, development, manufacturing of semiconductors, electron tubes, and microwave tubes.

Whatever your field of interest, you'll find Hughes' diversity of advanced projects gives you widest possible latitude for professional and personal growth.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Electroluminescence	Equipment Engineering
Infra-red	Microwave & Storage Tubes
Solid State Physics	Communications Systems
Digital Computers	Inertial Guidance
Reliability & Quality Assurance	Field Engineering
Systems Design & Analysis	Circuit Design & Evaluation

Write in confidence to Mr. R. A. Martin
Hughes General Offices, Bldg. 6-C3, Culver City, Calif.

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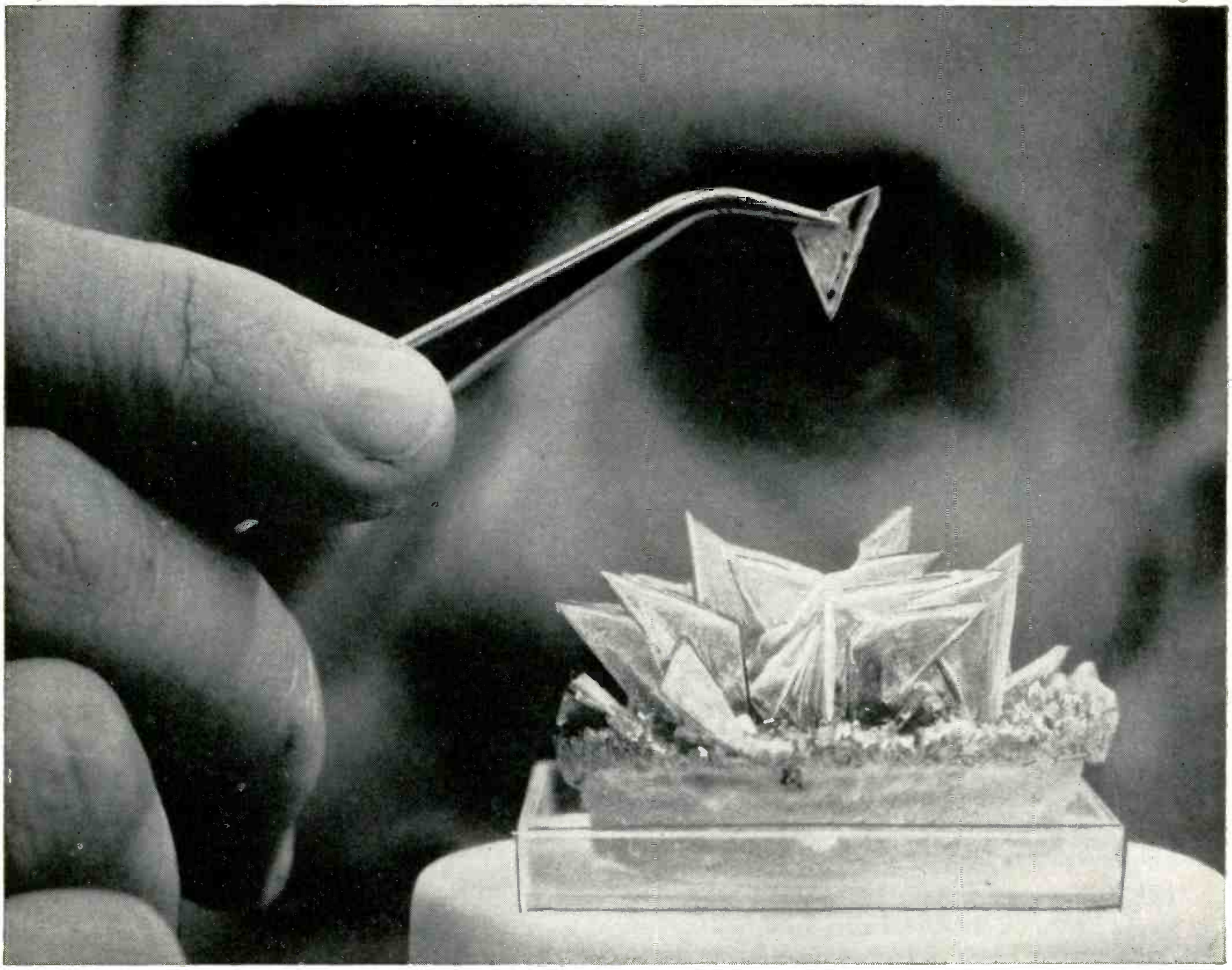
HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton, Newport Beach, Malibu and Los Angeles, California; Tucson, Arizona



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National's Research and Development Center is located at its production and sales headquarters in Dayton, Ohio. You may also wish to investigate the opportunities at our Electronic Division at Hawthorne, California.

For complete information, simply send your résumé to Mr. T. F. Wade, Technical Placement Section F9-1, The National Cash Register Company, Dayton 9, Ohio. All correspondence will be kept strictly confidential.

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ELECTRONIC INDUSTRIES STAFF REPORT

Just one year ago EI published "Today's Electronic Engineer" an outstandingly successful feature on the personal traits of electronic engineers. Here is the sequel, covering other sides of the engineer's character.

"Today's Electronic Engineer"

Part II

In accordance with our policy of supplying information of interest to our readers, a further analysis of the profile study on Today's Electronic Engineer has just been completed (see Today's Electronic Engineer, March, 1959).

Following the appearance of that article many readers inquired about other aspects. The majority of the inquiries were about these specific areas:

1. What is the relationship between the *number of plants* in which an engineer has worked and other aspects of his profile? (See table A)
2. What is the relationship between the *value of the engineer's home* and his pensions, life insurance and liquid assets? (See table B)
3. How do engineers who work for companies *which provide pensions* differ from engineers who work for companies *which do not provide pensions?* (See table C)

Those questions have been answered in the tables shown.

These tabulations offer additional data to assist you in evaluating your present and future ambitions. And they are presented in a form which you can interpret on an individual basis.

TABLE A

PRESENT ANNUAL INCOME

Number of Plants Worked Since School

Age - Under 29	Total	%	1	2	3	4	5	6	7	8	9
	430	100.0	226	125	54	14	6	3	1	1	
Under $5,000	5	1.2	2	1		1				1	
5.000 - 5,999	39	9.0	19	10	7	2		1			
6,000 - 7,449	186	43.3	123	42	17	2	1		1		
7,500 - 9,999	170	39.5	76	59	23	6	4	2			
10.000 - 12,499	27	6.3	6	12	5	3	1				
12,500 - 14,999	3	.7		1	2						
15,000 - 17,499											
17,500 - and over											

Number of Plants Worked Since School

Age - 30 - 39	Total	%	1	2	3	4	5	6	7	8	9
	1050	100.0	246	279	228	156	66	37	18	12	8
Under $5,000	3	.3	1	1			1				
5,000 - 5,999	15	1.4	4	5	2	3			1		
6,000 - 7,449	105	10.0	28	28	16	18	5	7	2	1	
7,500 - 9,999	434	41.3	113	121	97	57	21	8	8	5	4
10,000 - 12,499	306	29.2	66	79	78	42	17	15	3	3	3
12,500 - 14,999	122	11.6	21	34	22	25	13	3	1	3	
15,000 - 17.499	47	4.5	9	8	8	7	9	3	2		1
17,500 - and over	18	1.7	4	3	5	4		1	1		

Age - 40 - 49	Total	%	1	2	3	4	5	6	7	8	9
	339	100.0	30	55	78	51	37	30	17	17	24
Under $5,000	1	.3	1								
5,000 - 5.999	6	1.8			1	2		1	2		
6,000 - 7,449	24	7.1	2	4	5	5		6	1	1	
7,500 - 9,999	99	29.2	8	17	22	14	11	9	3	7	8
10,000 - 12,499	98	28.9	10	18	18	16	10	6	9	3	8
12,500 - 14,999	51	15.0	3	7	16	7	6	4		3	5
15,000 - 17,499	36	10.6	2	6	8	4	6	3	2	2	3
17,500 - and over	24	7.1	4	3	8	3	4	1		1	

Age - 50 and over	Total	%	1	2	3	4	5	6	7	8	9
	120	100.0	8	17	13	14	16	13	9	11	19
Under $5.000											
5,000 - 5,999	1	.8									1
6,000 - 7,449	8	6.7		3					1	1	3
7,500 - 9,999	20	16.7	1	1	1	1	2	4	1	5	4
10,000 - 12,499	29	24.1	3	1	3	2	3	3	4	4	6
12,500 - 14,999	22	18.3	3	5	3	4	2	2	1	1	1
15.000 - 17,499	17	14.2	1	3	3	3	3	1	1		2
17,500 - and over	23	19.2		4	3	4	6	3	1		2

PRESENT APPROXIMATE VALUE OF LIQUID ASSETS

Number of Plants Worked Since School

Age - under 29	Total	%	1	2	3	4	5	6	7	8	9
	441	100.0	235	127	54	14	6	4	1		
Under $500.00	89	20.2	56	22	9	2					
500 - 1,999	170	38.5	87	51	23	6	2	1			
2,000 - 3,999	77	17.5	41	23	8	1	2	2			
4,000 - 5,999	49	11.1	21	19	5	2	1	1			
6,000 - 8,999	28	6.3	17	5	4	1			1		
9,000 - 12,999	17	3.9	10	4	2		1				
13,000 - 17,999	8	1.8	1	3	2	2					
18,000 - 23,999	2	.5	2								
24,000 - 39,999	1	.2			1						
40,000 - and over											

Number of Plants Worked Since School

Age - 30 - 39	Total	%	1	2	3	4	5	6	7	8	9
	1059	100.0	244	280	236	156	68	37	18	12	8
Under $500.00	113	10.7	30	27	18	18	6	6	5	1	2
500 - 1,999	312	29.4	78	72	76	39	26	12	4	4	1
2,000 - 3,999	216	20.4	44	71	51	36	9	1	4		
4,000 - 5,999	142	13.4	33	35	17	11	11	6	2	3	2
6,000 - 8,999	80	7.6	18	26	17	11	1	3	1	2	1
9,000 - 12,999	66	6.2	12	14	18	14	2	6			
13,000 - 17,999	44	4.2	7	16	7	6	5	1	1		1
18,000 - 23,999	30	2.8	9	5	4	4	4	1	1	1	1
24,000 - 39.999	24	2.3	5	6	7	4		1		1	
40.000 - and over	32	3.0	8	8	5	7	4				

TABLE A (Continued)

Number of Plants Worked Since School

Age - 40 - 49	Total	%	1	2	3	4	5	6	7	8	9
	343	100.0	30	55	80	52	37	31	17	17	24
Under $500.00	16	4.7		3	2	4	2	3	1		1
500 - 1,999	53	15.5	2	8	16	7	5	5	1	5	4
2,000 - 3,999	80	23.2	9	16	15	16	9	7	2	2	4
4,000 - 5,999	50	14.6	7	9	10	8	5	5	3	2	1
6,000 - 8,999	31	9.0	2	7	8	1	3	2	4	1	3
9,900 - 12,999	30	8.7	1	1	9	5	5	1	5	2	1
13,000 - 17,999	28	8.2	1	5	6	5	3	4			4
18,000 - 23,999	14	4.1	3	2	3		1	2			3
24,000 - 39,999	17	5.0	1	2	5	3	2	1		2	1
40,000 - and over	24	7.0	4	2	6	3	2	1	1	3	2

Number of Plants Worked Since School

Age - 50 & over	Total	%	1	2	3	4	5	6	7	8	9
	122	100.0	9	19	13	14	15	13	9	11	19
Under $500.00	2	1.6								1	1
500 - 1,999	16	13.1	3	4		2	2		1	2	2
2,000 - 3,999	11	9.0	2	2				2		1	4
4,000 - 5,999	14	11.5		1	1	3	3	2		1	3
6,000 - 8,999	8	6.6		2	2		1	1		2	
9,000 - 12,999	7	5.7		1		1	1		3		1
13,000 - 17,999	9	7.4	1	1		2	2	1	1	1	
18,000 - 23,999	10	8.2	1	1	1	1	1	2	1	2	
24,000 - 39,999	9	7.4			3	2		2			2
40,000 - and over	36	29.5	2	7	6	3	5	3	3	1	6

HIGHEST LEVEL OF FORMAL EDUCATION ATTAINED

Number of Plants worked Since School

Age - Under 29	Total	%	1	2	3	4	5	6	7	8	9
	443	100.0	234	129	54	14	6	4	1	1	
High School	4	.9	2	1			1				
Tech. School	19	4.3	5	6	5	1	1	1			
College	236	53.3	131	63	31	7	1	2		1	
Post Graduate	184	41.5	96	59	18	6	3	1	1		
Age - 40 - 49											
	348	100.0	31	56	80	54	38	31	17	17	24
High School	15	4.3	1	3	2	3	4	1	-	1	
Tech. School	31	8.9	4	4	5	6	2	3	5	1	1
College	180	51.7	16	27	39	32	20	14	8	10	14
Post Graduate	122	35.1	10	22	34	13	12	13	4	5	9

Number of Plants Worked Since School

Age - 30 - 39	Total	%	1	2	3	4	5	6	7	8	9
	1076	100.0	250	288	238	158	68	38	17	11	8
High School	19	1.8		5	6	2	1	1	1	2	1
Tech. School	72	6.7	10	20	13	14	6	3	3	1	2
College	446	41.4	120	122	87	63	24	14	7	6	3
Post Graduate	539	50.1	120	141	132	79	37	20	6	2	2
Age - 50 and over											
	125	100.0	9	19	14	15	16	13	9	11	19
High School	3	2.4						1		1	1
Tech. School	16	12.8	1	3	2		1		3	2	4
College	56	44.8	5	8	7	8	7	3	4	5	9
Post Graduate	50	40.0	3	8	5	7	8	9	2	3	5

HOW MANY CHILDREN DO YOU HAVE?

Number of Plants Worked Since School

Age - Under 29	Total	%	1	1	3	4	5	6	7	8	9
	292	100.0	147	89	39	9	5	2		1	
1	99	34.0	54	25	10	4	4	1		1	
2	98	33.6	49	35	12	1		1			
3	34	11.6	16	9	5	3	1				
4	12	4.1	3	5	4						
5	1	.3	1								
6											
7											
8											
9 or more											
None	48	16.4	24	15	8	1					
Age - 40 - 49											
	315	100.0	27	52	74	47	37	26	14	15	23
1	48	15.2	6	11	7	7	6	5	2	3	1
2	138	43.9	14	21	43	21	12	11	4	5	7
3	70	22.2	5	13	12	11	6	5	7	3	8
4	31	9.8	2	1	6	5	6	3	1	2	5
5	7	2.2			1	1	5				
6	3	1.0		1	1	1					
7	3	1.0					2	1			
8	1	.3									
9 or more	1	.3		1							
None	13	4.1		4	3	1		1		2	2

Number of Plants Worked Since School

Age - 30 - 39	Total	%	1	2	3	4	5	6	7	8	9
	956	100.0	222	245	214	144	61	36	16	11	7
1	198	20.7	52	58	38	24	13	7	4	1	1
2	335	35.1	79	92	73	50	13	14	5	7	2
3	244	25.5	51	58	55	40	21	10	5	2	2
4	107	11.2	22	24	32	19	7	2			1
5	18	1.9	4	2	7	3	2				
6	8	.8	1	3	2	1			1		
7	2	.2	1			1					
8	1	.1			1						
9 or more	1	.1						1			
None	42	4.4	12	8	6	6	5	2	1	1	1
Age - 50 and over											
	113	100.0	7	18	13	13	15	12	7	11	17
1	31	27.4	1	6	4	2	1	5	3	3	6
2	42	37.1	4	4	6	5	8	6	2	3	4
3	22	19.5	1	4	2	3	5	1		3	3
4	9	8.0	1	1		2	1		2		2
5	2	1.8		2							
6	2	1.8				1					1
7											
8											
9 or more											
None	5	4.4		1	1					2	1

REQUIRED PERCENTAGE OF SALARY INCREASE TO CHANGE JOB (LOCALLY)

Number of Plants Worked Since School

Age - Under 29	Total	%	1	2	3	4	5	6	7	8	9
	427	100.0	225	126	51	13	6	4	1	1	
1% - 9%	22	5.1	8	8	6						
10% - 19%	252	59.1	129	84	31	3	1	3	1		
20% - 29%	135	31.7	75	32	14	9	3	1		1	
30% - 39%	12	2.8	9	1		1	1				
40% - 49%	1	.2	1								
50% - 59%	3	.7	2				1				
60% - 69%	1	.2		1							
70% - 89%											
90% - 99%	1	.2	1								
100% - and over											
Age - 40 - 49											
	315	100.0	29	52	72	47	36	27	15	14	23
1% - 9%	16	5.1	1		6	2	3	1	2	1	
10% - 19%	122	38.8	8	18	28	24	13	12	7	5	
20% - 29%	116	36.8	11	18	24	19	9	12	5	6	12
30% - 39%	28	8.9	2	8	9	2	2	1	1	1	2
40% - 49%	8	2.5	1	2	1		3			1	
50% - 59%	16	5.1	2	4	2		6				2
60% - 69%											
70% - 89%											
90% - 99%	8	2.5	4	1	2			1			
100% - and over	1	.3		1							

Number of Plants Worked Since School

Age - 30 - 39	Total	%	1	2	3	4	5	6	7	8	9
	1000	100.0	231	270	228	142	63	33	16	9	8
1% - 9%	43	4.3	7	13	14	3	3	2	1		
10% - 19%	524	52.4	120	134	121	81	36	18	3	7	4
20% - 29%	340	34.0	81	98	74	44	17	10	10	2	4
30% - 39%	45	4.5	10	13	12	7	2	1			
40% - 49%	9	.9	6		3						
50% - 59%	31	3.1	7	9	2	5	5	2	1		
60% - 69%											
70% - 89%											
90% - 99%	6	.6		2	1	2			1		
100% - and over	2	.2		1	1						
Age - 50 and over											
	96	100.0	8	13	110	12	13	9	5	11	15
1% - 9%	1	1.0									1
10% - 19%	25	26.1	2	1	3	4	4	2	4	1	4
20% - 29%	41	42.7	2	8	6	5	5	4	1	3	7
30% - 39%	7	7.3	1	1	1		2			1	1
40% - 49%	2	2.1								2	
50% - 59%	14	14.6	3	2		3		2		2	2
60% - 69%	1	1.0								1	
70% - 89%											
90% - 99%	4	4.2		1			2	1			
100% - and over	1	1.0								1	

TABLE B

PRESENT APPROXIMATE VALUE OF LIQUID ASSETS

Approximate Value of Home

	Total	%	Less than $10,000	$10,000 14,999	$15,000 19,999	$20,000 24,999	$25,000 29,999	$30,000 39,999	$40,000 49,999	$50,000 & over
Present Income Under $7,500	207	100.0	15	64	93	26	5	3	1	
Under $500.00	44	21.3	1	12	23	6	2			
500 - 1,999	89	43.0	7	32	43	5	1	1		
2,000 - 3,999	35	16.9	3	9	13	8		1	1	
4,000 - 5,999	16	7.7	2	2	8	3		1		
6,000 - 8,999	9	4.3		3	3	2	1			
9.000 - 12,999	8	3.9	1	6	1					
13,000 - 17,999	3	1.4	1			2				
18.000 - 23,999	1	.5			1					
24,000 - 39,999	1	.5			1					
40,000 - & over	1	.5					1			
Present Income 10.000 - 12,499	384	100.0	4	67	125	102	55	25	6	
Under $500.00	22	5.7	1	4	5	10	2			
500 - 1,999	95	24.7	1	18	35	28	7	5	1	
2,000 - 3,999	87	22.7	2	13	26	22	15	6	3	
4,000 - 5,999	73	19.0		14	29	13	11	5	1	
6,000 - 8.999	33	8.6		7	10	8	8			
9,000 - 12,999	28	7.3		5	7	8	4	4		
13,000 - 17.999	18	4.7		3	5	3	5	5		
18,000 - 23.999	9	2.3		2	2	4	1			
24,000 - 39,999	8	2.1			4	2	1	1		
40.000 - & over	11	2.9		1	2	4	1	2	1	
Present Income 15,000 - 17,499	92	100.0		2	14	26	24	15	7	4
Under $500.00										
500 - 1,999	7	7.6			1	1	4	1		
2,000 - 3,999	10	10.9				3	4	2	1	
4,000 - 5,999	15	16.3		1	4	4		2	3	1
6,000 - 8,999	11	12.0			2	5	4			
9,000 - 12,999	7	7.6			2	3	1		1	
13,000 - 17,999	13	14.1		1	2	5	2	3		
18,000 - 23,999	6	6.5			1	1	2	1		1
24,000 - 39,999	8	8.7				1	5	1		1
40,000 - & over	15	16.3			2	3	2	5	2	1

Approximate Value of Home

	Total	%	Less than $10,000	$10,000 14,999	$15,000 19,999	$20,000 24,999	$25,000 29,999	$30,000 39,999	$40,000 49,999	$50,000 & over
Present Income $7,500 - 9,999	510	100.0	17	120	231	95	36	10	1	
Under $500.00	69	13.5	1	13	38	14	3			
500 - 1,999	179	35.1	5	39	88	32	11	4		
2,000 - 3,999	132	25.9	2	32	58	24	12	4		
4,000 - 5,999	49	9.6	4	10	22	9	2	2		
6,000 - 8,999	35	6.9	3	11	10	6	4		1	
9,000 - 12,999	16	3.1	1	4	7	3	1			
13,000 - 17,999	13	2.5		7	4	2				
18,000 - 23,999	4	.8		1	1	1	1			
24,000 - 39,999	7	1.4	1	1	1	4				
40,000 - & over	6	1.2		2	2		2			
Present Income 12,500 - 14,999	170	100.0		14	37	54	35	25	4	1
Under $500.00	4	2.4				2	1	1		
500 - 1.999	33	19.4		3	10	13	5	2		
2.000 - 3,999	31	18.2		3	3	13	8	2	2	
4,000 - 5,999	28	16.5		2	9	7	3	7		
6,000 - 8,999	17	10.0		1	4	6	4	2		
9,000 - 12,999	12	7.1			2	2	5	3		
13,000 - 17,999	12	7.1		1	4	4	1	2		
18,000 - 23.999	6	3.5				1	3	2		
24,000 - 39,999	13	7.6		3	3	3	1	3		
40,000 - & over	14	8.2		1	2	3	4	1	2	1
Present Income 17,500 - over	62	100.0			3	12	9	19	9	11
Under $500.00	1	1.6								1
500 - 1,999										
2,000 - 3,999	3	4.8			1		1		1	
4,000 - 5,999	6	9.7				1	1	1	2	1
6,000 - 8,999	3	4.8				2	1			
9,000 - 12,999	7	11.3				2	1	3	1	
13,000 - 17,999	2	3.2						1		1
18,000 - 23,999	4	6.5				1		2		1
24,000 - 39,999	8	12.9			1	3	2	2		
40,000 - & over	28	45.2			1	3	3	10	4	7

HOW MUCH LIFE INSURANCE DO YOU CARRY?

	Total	%	Less than $10,000	$10,000 14,999	$15,000 19,999	$20,000 24,999	$25,000 29,999	$30,000 39,999	$40,000 49,999	$50,000 & over
Present Income Under $7,500	204	100.0	15	64	90	26	5	3	1	
1,000 - 5,000	10	4.9	4	3	3					
6,000 - 10,000	43	21.2	3	16	16	4	3	1		
11,000 - 15,000	46	22.5	4	14	23	4	1			
16,000 - 20,000	46	22.5	2	12	24	8				
21,000 - 25,000	26	12.7	1	6	13	5		1		
26,000 - 30,000	17	8.3		7	5	4		1		
31,000 - 40,000	11	5.4		5	5				1	
41,000 - 50,000	4	2.0	1	1	1		1			
51,000 - 75,000										
76,000 - 99,000										
100,000 & over	1	5				1				
Present Income 10,000 - 12,499	386	100.0	4	69	125	103	55	24	6	
1,000 - 5,000	5	1.3		1	2		1		1	
6,000 - 10,000	12	3.1		3	4	3	1	1		
11,000 - 15,000	28	7.3	1	9	7	5	4	2		
16,000 - 20,000	56	14.4		16	22	12	6			
21,000 - 25,000	47	12.2		6	15	15	8	3		
26,000 - 30,000	61	15.7		8	18	22	7	4	2	
31,000 - 40,000	92	23.8	1	17	29	25	14	6		
41,000 - 50,000	58	15.0	1	5	20	16	11	4	1	
51,000 - 75,000	18	4.8	1	3	4	4	2	2	2	
76,000 - 99,000	5	1.3		1	2		1	1		
100,000 & over	4	1.1			2	1		1		
Present Income 15,000 - 17,499	93	100.0		2	14	27	24	15	7	4
1,000 - 5,000										
6,000 - 10,000	2	2.2				1			1	
11,000 - 15,000	3	3.2				1	1	1		
16,000 - 20,000	7	7.5			1	4	1		1	
21,000 - 25,000	6	6.5		1	1	1	2	1		
26,000 - 30,000	11	11.8		1	2	4	3	1		
31,000 - 40,000	14	15.0			1	5	3	4	1	
41,000 - 50,000	13	13.9	4	3	1	3	1	3	2	
51,000 - 75,000	21	22.6			4	6	5	4	1	2
76,000 - 99,000	5	5.5			1	1		2		1
100,000 & over	11	11.8				1	8		1	1

	Total	%	Less than $10,000	$10,000 14,999	$15,000 19,999	$20,000 24,999	$25,000 29,999	$30,000 39,999	$40,000 49,999	$50,000 & over
Present Income $7,500 - 9,999	509	100.0	17	120	230	96	36	9	1	
1,000 - 5,000	17	3.3	1	5	7	3	1	1		
6,000 - 10,000	52	10.2	5	13	21	7	5	1		
11,000 - 15,000	88	17.3	2	22	37	18	8	1		
16,000 - 20,000	103	20.2	5	22	44	23	5	4		
21,000 - 25,000	78	15.3	3	19	40	11	4	1		
26,000 - 30,000	69	13.6	1	16	33	14	4	1		
31,000 - 40,000	63	12.4		12	31	13	6		1	
41.000 - 50,000	25	4.9		7	13	4	1			
51,000 - 75,000	10	20.0		4	3	1	1	1		
76,000 - 99,000	2	.4			1	1				
100,000 & over	2	.4				1	1			
Present Income 12,500 - 14,999	165	100.0		15	35	53	33	24	4	1
1,000 - 5,000	1	.6				1				
6,000 - 10,000	5	3.0			2	1	2			
11,000 - 15,000	8	4.8		1	2	4		1		
16,000 - 20,000	14	8.5		2	4	4	3	1		
21,000 - 25,000	20	12.1		3	4	6	2	4	1	
26,000 - 30,000	22	13.4		1	5	7	7	2		
31,000 - 40,000	34	20.7		4	5	10	7	8		
41,000 - 50,000	38	23.1			10	13	7	6	2	
51,000 - 75,000	21	12.6		4	3	6	5	2	1	
76,000 - 99,000	1	.6								
100,000 & over	1	.6				1				
Present Income 17,500 - over	60	100.0			3	12	10	19	8	8
1,000 - 5,000	1	1.7								1
6,000 - 10,000	2	3.3				1			1	
11,000 - 15,000	1	1.7						1		
16,000 - 20,000	2	3.3						1		1
21,000 - 25,000	1	1.7						1		
26,000 - 30,000	1	1.7						1		
31,000 - 40,000	7	11.7				3	1	2		1
41,000 - 50,000	12	19.9				3	3	4		2
51,000 - 75,000	11	18.4			1	4	2	3	1	
76,000 - 99,000	3	5.0			1				2	
100,000 & over	19	31.6			1	1	4	6	4	3

TABLE B (Continued)

DOES YOUR COMPANY PROVIDE HEALTH BENEFITS?

			Approximate Value of Home							
	Total	%	Less than $10,000	$10,000 14,999	$15,000 19,999	$20,000 24,999	$25,000 29,999	$30,000 39,999	$40,000 49,999	$50,000 & over
Income today under $7,500	206	100.0	15	65	91	26	5	3	1	
Co. provides health benefits	190	92.2	12	60	84	25	5	3	1	
Co. doesn't provide health benefits	16	7.8	3	5	7	1				
Income today $7,500 - 9,999	510	100.0	17	120	231	95	36	10	1	
Co. provides health benefits	483	94.7	15	115	218	93	32	9	1	
Co. doesn't provide health benefits	27	5.3	2	5	13	2	4	1		
Income today $10,000 - 12,499	386	100.0	4	68	127	102	54	25	6	
Co. provides health benefits	369	95.6	4	66	122	94	54	23	6	
Co. doesn't provide health benefits	17	4.4		2	5	8		2		
Income today $12,500 - 14,999	173	100.0		16	37	54	36	25	4	1
Co. provides health benefits	168	97.1		16	37	51	35	25	4	
Co. doesn't provide health benefits	5	2.9				3	1			1
Income today $15,000 - 17,499	93	100.0		2	14	27	24	15	7	4
Co. provides health benefits	90	96.8		2	14	26	23	15	7	3
Co. doesn't provide health benefits	3	3.2				1	1			1
Income today $17,500 & over	62	100.0			3	11	10	19	8	11
Co. provides health benefits	59	95.2			3	11	10	16	8	11
Co. doesn't provide health benefits	3	4.8						3		

DOES YOUR COMPANY PROVIDE A PENSION PLAN?

	Total	%	Less than $10,000	$10,000 14,999	$15,000 19,999	$20,000 24,999	$25,000 29,999	$30,000 39,999	$40,000 49,999	$50,000 & over
Income today under $7,500	205	100.0	15	65	91	25	5	3	1	
Co. provides pension	166	81.0	10	51	76	20	5	3	1	
Co. doesn't provide pension	39	19.0	5	14	15	5				
Income today $7,500 - 9,999	508	100.0	17	120	229	95	36	10	1	
Co. provides pension	431	84.8	15	103	200	74	32	6	1	
Co. doesn't provide pension	77	15.2	2	17	29	21	4	4		
Income today $10,000 - 12,499	384	100.0	4	69	123	102	54	26	6	
Co. provides pension	325	84.6	3	54	107	87	48	20	6	
Co. doesn't provide pension	59	15.4	1	15	16	15	6	6		
Income today $12,500 - 14,999	171	100.0		16	37	54	35	25	3	1
Co. provides pension	143	83.6		16	27	47	31	20	2	
Co. doesn't provide pension	28	16.4			10	7	4	5	1	1
Income today $15,000 - 17,499	92	100.0		2	14	27	24	15	7	3
Co. provides pension	67	72.8		2	13	20	16	12	3	1
Co. doesn't provide pension	25	27.2			1	7	8	3	4	2
Income today $17,500 & over	58	100.0			3	10	9	18	8	10
Co. provides pension	43	74.1			2	9	7	10	7	8
Co. doesn't provide pension	15	25.9			1	1	2	8	1	2

TABLE C

HAVE YOU ESTABLISHED YOUR OWN PRIVATE PENSION?

	Company Provides Pension		Company Does Not Provide Pension	
	Total	%	Total	%
	1394	100.0	323	100.0
A. Established Own Private Pension	500	35.9	109	33.7
B. Hasn't Established Own Pension	894	64.1	214	66.3

DOES YOUR COMPANY PROVIDE HEALTH BENEFITS?

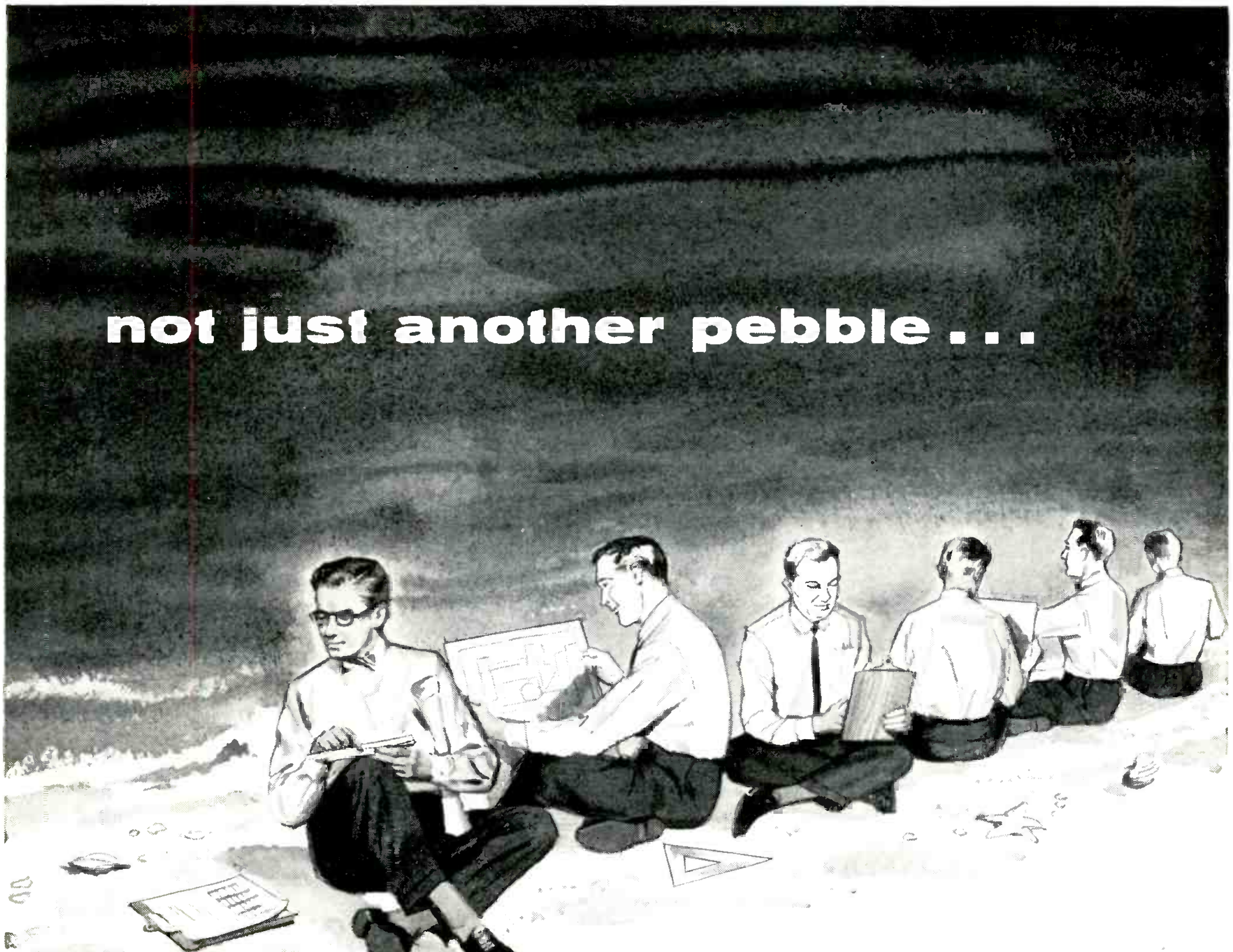
	Company Provides Pension		Company Does Not Provide Pension	
	Total	%	Total	%
	1611	100.0	342	100.0
A. Provides Health Benefits	1577	97.9	273	79.8
B. Doesn't Provide Health Benefits	34	2.1	69	20.2

APPROXIMATE VALUE OF LIQUID ASSETS

	Company Provides Pension		Company Does Not Provide Pension	
	Total	%	Total	%
	1600	100.0	339	100.0
Under $500.00	184	11.5	35	10.3
500 - 1,999	459	28.7	86	25.4
2,000 - 3,999	315	19.7	64	18.9
4,000 - 5,999	214	13.4	39	11.5
6,000 - 8,999	126	7.9	19	5.6
9,000 - 12,999	93	5.8	23	6.8
13,000 - 17,999	74	4.6	15	4.4
18,000 - 23,999	45	2.8	9	2.7
24,000 - 39,999	31	1.9	19	5.6
40,000 & over	59	3.7	30	8.8

PRESENT INCOME

	Company Provides Pension		Company Does Not Provide Pension	
	Total	%	Total	%
	1575	100.0	339	100.0
Under $5,000	2	.1	7	2.1
5,000 - 5,999	47	3.0	14	4.1
6,000 - 7,499	268	17.0	53	15.6
7,500 - 9,999	606	38.6	111	32.8
10,000 - 12,499	375	23.8	78	23.0
12,500 - 14,999	161	10.2	33	9.7
15,000 - 17,499	73	4.6	26	7.7
17,500 & over	43	2.7	17	5.0



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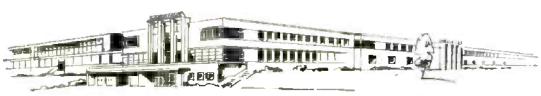
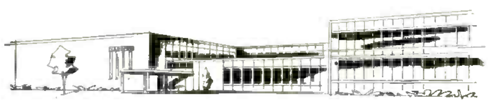
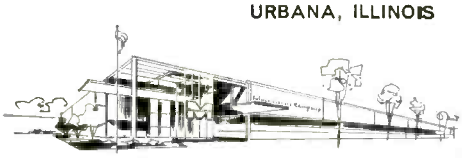
At present, we need engineers to carry on expanding programs in communications, airborne radar, missiles, anti-submarine warfare systems and data processing equipment. The projects we have on tap are broad and challenging. The men we offer as your associates are high caliber creative scientists like yourself. And the technical facilities we provide are the finest, most complete anywhere.



FORT WAYNE, INDIANA



URBANA, ILLINOIS



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Why Do Teachers Quit?

Money—more of it—so says a report on faculty loss to industry published in the Journal of Engineering Education, American Society for Engineering Education. The report was prepared by A. R. Hellwarth, Assistant Dean, Univ. of Michigan College of Engineering.

Other reasons include dissatisfaction with teaching loads, administrative details, and relations with college and administration. But the deciding factor in their moves was income and fringe benefits said 116 out of 235 former teachers queried.

Annual salaries of the 235 averaged $5,800 ($7,600 with "extra" income included). During their first year in industry they averaged $9,800.

Asked to name two advantages in industrial employment, 37% cited "salary and money factors" while 50% mentioned "work or working conditions."

Asked for the advantages of teaching, they replied, "satisfaction of teaching and the feeling that one is doing something of value to the society he serves." Also ranking high were "academic freedoms and time freedoms as well as the environment of the campus." Many hoped to eventually return to teaching "when I can afford to return."

New College on L.I.

The Polytechnic Institute of Brooklyn is establishing the first graduate engineering school in Farmingdale, L. I. The school will be erected on 25 acres of land donated by Republic Aviation Corp.

The curricula will be restricted to graduate study with full-time and part-time programs leading to master's and doctor's degrees in aeronautical, electrical and mechanical engineering, and in physics and mathematics. Present plans are for approximately 1,000 students.

Among the major research projects to be conducted at the new center are studies in high-power microwaves and warm plasmas. Warm plasmas are ionized gases ranging from 10,000 to 100,000°F. Both studies will be made under $800,000 Air Force contracts. The Research and Development Facilities of Republic will be available to augment Polytechnic's research facilities.

Report Cautions—No Panacea for Labor Turnover

A company that is looking for a blue print to follow in reducing its labor turnover rate is "doomed to disappointment." So says Dr. Frederick J. Gaudet, Director of the Laboratory of Psychological Studies at Stevens Institute of Technology, Hoboken, N. J., in a recent research study. The study, "AMA Research Report No. 39, is entitled "Labor Turnover; Calculation and Cost."

Techniques for reducing labor turnover that have been reported as successful in one company almost invariably will be reported as failures in another company, and the findings of one researcher will often contradict the findings of another.

Some devices have reduced turnover in enough cases to warrant close study. Among them are: selection devices such as the weighted application form and psychological testing; on-the-job methods such as better training techniques and more effective communication, and devices aimed at finding out why employees leave the company. A relatively new technique he mentions that has produced significant information about why workers quit is the "post-terminal" interview. Workers who have been separated are asked on a questionnaire to state again their reasons for leaving. The reasons given are often quite different from the reasons given at the "exit" interview.

New Industry Center

A multi-million-dollar scientific industry center is to be built in suburban Minneapolis. Options have been secured on a 200 acre tract by International Properties, Inc., a Twin Cities real estate firm. The development will house electronic manufacturing firms and firms with related technological interests.

The site will be patterned after Stanford Industrial Park, developed by Stanford University, in Palo Alto, Calif. Stanford officials have been approached to serve as consultants in the advanced stages of development.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 250.

News of Reps

REPS WANTED

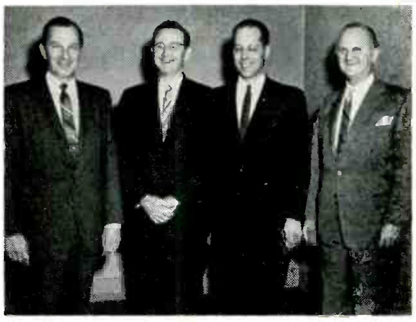
Manufacturer of perforated tape readers is seeking representation in the Chicago area and the Washington-Baltimore and Florida area. Write to Digitronics Corp., Box 417, Albertson, New York.

Waveline, Inc., Caldwell, N. J., is looking for reps in Illinois, Indiana, Missouri, and Kansas. The company manufactures microwave test equipment, precision instruments, and custom waveguide assemblies.

Manufacturer of servo amplifiers for the instrument, automation, and military fields is looking for reps in Northern California, Southern California, Florida, and Massachusetts. Control Technology Co., 1186 Broadway, New York, N. Y.

Environmental testing laboratory and equipment manufacturer desires reps selling to O.E.M. of electronic, mechanical and electro-mechanical components and systems. Associated Testing Laboratories, Inc., Clinton Road, Caldwell, N. J.

NEW OFFICERS



New officers of Electronic Representatives Assoc., New York Chapter are: (l to r) W. Shulan, Wally Shulan & Co.—Secretary Treasurer; R. A. Stang, Stang Sales Corp.—President; J. Hunter, Hunter & Salsbury, Inc.—1st Vice Pres.; L. Rocke, The New Hope Corp.—2nd Vice Pres.

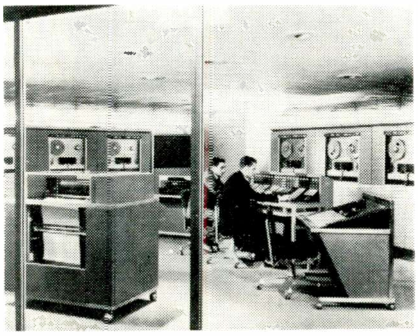
The Electronic Representatives Association (ERA) has scheduled a seminar for the morning of March 23, 1960, during the IRE Show in New York. Manufacturers and reps will discuss advertising and sales promotion. The session will be held at the Park-Sheraton Hotel.

Charles E. Babcock has formed a rep company in the electronics field. Headquarters is at 430 Huntington Drive, Wayne, Pa. The firm will represent Hickok Electrical Instrument Co.

Frank J. Campisano and **James W. Murray,** reps in Southern Ohio, Southern Indiana and Kentucky have opened a new office in the Bel Rue Crest Center Bldg., at Race Rd. and Harrison Ave., Cin.

New Data Processing Center

The first full-range electronic data processing center to serve all types of firms in New York's financial and business community has been opened by the Radio Corp. of America. John L. Burns, president, officiated at the opening of the new $4.5 million Electronic Systems Center. Photo shows view of control room where two type 501 computers are installed. Brokers were informed that cost of using center would range from $0.50 to $1.50 per trade in most cases a savings of up to 50%. The 501s are 98% RCA manufactured.

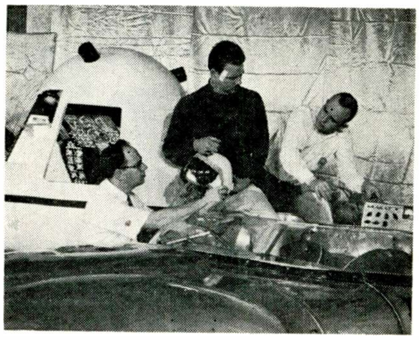


A similar center is under installation in Washington DC with three *(Continued on page* 320) others planned for completion by year's end.

In ultimate operation center input data will be transmitted by wire from the client and will be reproduced on perforated tape. This input or input from punched cards will be converted to magnetic tape for the computers. Output will be in form of punched cards, paper tape, or printed reports using RCA's 600-line-per-minute printer. New Electronic Systems Center will be staffed by 90 planners, programmers, operators, and maintenance personnel.

* * *

TEST SPACE INSTRUMENTS



A biomedical instrumentation system designed to flash the physical and emotional reactions of spacemen back to earth is tested in this racing car at Riverside, Calif. System was developed by Norair Div., Northrop Corp. Hawthorne, California. Northrop Corp's space capsule mock-up is in the background.

News of Reps

New officers for 1960 have been elected by the Northern California Chapter of Electronic Representatives Assoc. **Frank Lebell** is President, **Willard M. Nott**, Vice-President, **Ed W. Brandt**, Secretary, and **William A. Melchior**, Treasurer.

Dallons Semiconductors, Div. of Dallons Laboratories, Inc., has appointed the **Robert B. Hatch Co.**, Needham Heights, Mass., as sales rep in the New England States; **Pacent Engineering Corp.**, Great Neck, N. Y., as rep in Metropolitan New York and New Jersey; the **Allen Nace Co.**, Brecksville, Ohio, for Ohio, West Virginia and Western Pennsylvania; **Gray & Hill, Inc.**, of Oak Park, Ill., in Northern Illinois and the eastern portion of Wisconsin; the **William J. Purdy Co.**, San Francisco, in Northern California; the **C. R. Lynch & Son Co.**, Los Angeles, in Southern California and Arizona; and the **Richard Legg Co.**, Portland, in Oregon, Washington, Idaho, Montana and Alaska.

Clarostat Mfg. Co. has announced the following sales rep appointments: **Maury E. Bettis Co.**, Kansas City, Mo., in Kansas, Nebraska, Iowa, Missouri, and a portion of Southern Illinois, and **John O. Olsen Co.**'s territory extended to include Western Pennsylvania and West Virginia.

James J. Farley has been named sales rep by Synthane Corp. He will cover Maryland, Virginia, portions of West Virginia, and the northern portion of North Carolina.

John P. Shipley will now serve as sales rep in the Michigan area for the Broadcast and Television Equipment Div., Radio Corp. of America.

Computer Systems, Inc., has appointed **Robert Graanstra**, I.R.C.A., Voorburg, Holland, as European sales rep. He will cover the Netherlands, Belgium and Luxembourg.

Fred B. Hill Co., Minneapolis, Minn., is now sales rep in North and South Dakota, Minnesota, and Western Wisconsin, for the Data Equipment Div. of Telemeter Magnetics.

Wells Electronics Co. has named these sales reps: **The Robison Co.**, Torrance, Calif., in Southern California; and **Herb Mandell Co.**, Revere, Mass., in New England.

Tensolite Insulated Wire Co., Inc., Tarrytown, N. Y., recently named **C.F.L. Corp.**, Denver, Colo., as regional rep in Colorado, Wyoming, Utah, New Mexico, Western Nebraska, Southern Idaho, and El Paso County, Tex.

News of Reps

Waltham Precision Instrument Co. has appointed **R. C. Dudek & Co.,** Beverly Hills, Calif., as rep in California and Arizona.

John Mustico, Havertown, Pa., is now sales rep for Entron, Inc., in Southern New Jersey, Virginia, Maryland, Eastern Pennsylvania, Delaware and Washington, D. C.

Philip Goodrich and **Eric Ward** have been promoted to Field Engineer at Neely Enterprises, Los Angeles.

Robert L. Lang and Assoc. is now rep for Systron Corp. in Indiana, Illinois, Wisconsin and Eastern Iowa.

Electronic Instrument Co., Inc., has appointed **Roburn Agencies, Inc.,** New York, N. Y., as export rep.

The Government & Industrial Div., Philco Corp., has appointed **Western Scientific Contracting Corp.,** Redwood City, Calif. as rep throughout northern and central California and Nevada.

The Electric Regulator Corp., Norwalk, Conn., has appointed four new sales reps: **Glenn M. Hathaway Electronics,** Cambridge, Mass., will cover the New England states; The **Ellis-Haber Corp.,** Great Neck, L. I., N. Y., will cover the Greater New York Metropolitan area including Northern New Jersey; **Northport Engineering, Inc.,** St. Paul, Minn. will cover western Wisconsin, Minnesota, North and South Dakota; and **Engineering Services, Inc.,** St. Louis, Mo., will cover Southern Illinois, Missouri, Iowa, Kansas and Nebraska.

Roland Olander and Co., Los Angeles, is now rep in the Southern California, Clark County, Nevada, area for General Measurements Co., Inc.

Essex Electronics, Div. of Nytronics, Inc., has appointed **Engineering Services Co.,** Kansas City, Mo., as rep in Nebraska, Kansas, Missouri, Iowa and Southern Illinois.

Associated Testing Labs., Inc., has appointed **A R C O Engineering Co.,** Washington, D. C., as rep to the U. S. Government.

The Parker Seal Co., has appointed **Albert Wickson,** Newton Center, Mass., as rep in Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.

Trio Laboratories, Inc., has appointed **Comptronics,** Seattle, Wash., as rep in the Pacific Northwestern area.

Industry News

Col. Morris E. Galusha has been named Deputy Commander of the U. S. Army Signal Intelligence Agency of Arlington Hall Station, Virginia.

George E. Stoll and **A. P. Fontaine** have been elected Executive Vice-Presidents of the Bendix Aviation Corp. and **Dr. Albert A. Canfield** has been appointed Director of University and Scientific Relations. Their offices will be in Detroit, Mich.

Jackson S. Kolp is now Product Line Manager—germanium switching transistors—for the Semiconductor Div. of Sylvania Electric Products Inc.

Sierra Electronic Corp., Menlo, Calif., a division of Philco Corp. has appointed **H. D. Farnsworth** as Manager of Product Planning and **Sanford K. Ashby** as Sales Engineer.

Lawrence DeGeorge has been named operating head of Times Wire and Cable Co., Wallingford, Conn., an affiliate of International Silver Company. He succeeds Sidney Gulden who is retiring.

Richard H. Griebel has been appointed Vice-President and General Manager of Kellogg Switchboard and Supply Co., Chicago, Ill., Communications Div. of International Telephone & Telegraph Corp.

John J. McDonald and **Linden G. Criddle** have been elected Vice-Presidents of Consolidated Systems Corp., a wholly owned subsidiary of Consolidated Electrodynamics Corp., Pasadena, Calif.

C. Robert Paulson is the new Manager of the Professional Audio Products Div., Ampex Professional Products Co., div. of Ampex Corp., Redwood City, Calif.

Charles W. Chase has been appointed Product Planning Manager, Electronics, in the Tapco Group of Thompson Ramo Wooldridge Inc., Cleveland, Ohio.

Dr. Leland G. Cole is now Vice-President-Research for Beckman Instruments, Inc., Fullerton, Calif.

Thomas W. Waldrop has joined Daystrom, Inc., Control Systems Div., La Jolla, Calif., as Systems Coordinator.

The election of **William S. Ivans, Jr.** and **Robert E. McDowall** as Directors of Cohu Electronics, San Diego, Calif., has been announced.

George M. Arisman, Jr., has assumed the Office of Vice President at Aerovox Corp., Bedford, Mass.

Industry News

Two new Department Managers have been appointed by Intercontinental Electronics Corp., Mineola, N. Y. Named were: **William R. Stanton**, Aircraft Instruments, and **James Y. Nishimura**, Community Antenna TV Systems and Components.

William F. Boyd, formerly Vice-President of International Telephone & Telegraph Co., has been appointed General Manager of the Airtron Div., Litton Industries, Morris Plains, N. J.

W. F. Boyd

H. W. Pope

Harold W. Pope has been appointed to the newly created position of Corporate Vice-President of Sanders Associates, Inc., Nashua, N. H.

Dr. M. John Rice, Jr., has been appointed Manager of Semiconductor Material Engineering for CBS Electronics, Manufacturing Div. of Columbia Broadcasting Systems, Inc., Danvers, Mass.

C. Carver Pope has been elected to the newly created position of Vice President-personnel at Clevite Corp., Cleveland, Ohio.

Charles J. Chapman will now serve as Vice President, Marketing for National Carbon Co., div Union Carbide Corp.

Continental-Diamond Fibre Corp., a subsidiary of The Budd Co., has appointed two men to direct its newly completed Research and Development Center in Newark, Del. The appointments are: **Dr. W. M. Lair**, Director of Research Development and **A. H. Haroldson**, Assoc. Director of Research and Development.

Two Philco Research Div. execs. have been promoted. **Allen C. Munster** is now Director of Research, Plans and Programs. **Lawton M. Hartman**, formerly Manager of Special Projects for Government and Industrial Research is Manager, Technical Planning for the Research Div.

James R. Linicome has been appointed to the newly created position of Manager of Program Planning for Motorola's Chicago Military Electronics Center.

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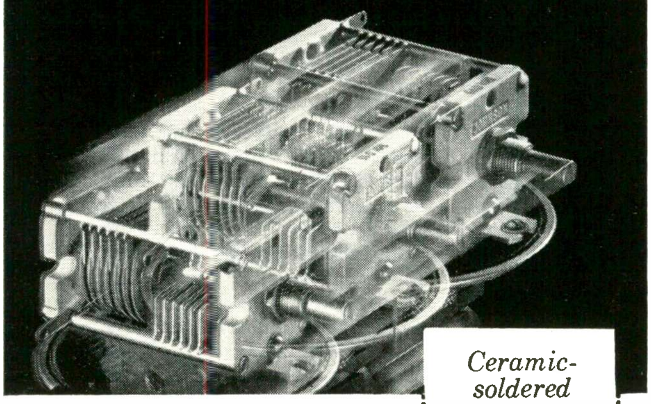
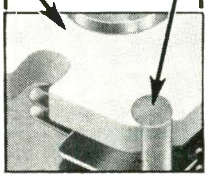


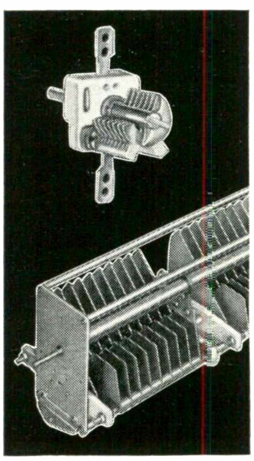
Parts can't break loose... capacity can't fluctuate!

Ceramic-soldered for greater strength!



Set your frequency... these tough Johnson "L" variables will hold it—even under severe conditions of shock and vibration! Designed to provide outstanding strength, rigidity and operating stability —rotor bearings and stator support rods are actually soldered directly to the heavy 3/16" thick steatite ceramic end frames. Parts can't break loose . . . capacity can't fluctuate!

Specially designed split-sleeve tension bearing and silver-plated beryllium copper contact provide constant torque and smooth capacity variation. Plating is heavy nickel—plate spacing .020", .060" and .080" spacing as well as special platings, shaft lengths and terminal locations in production quantities.



A complete variable capacitor line . . . from tiny sub-miniatures to large heavy duty types!

From the tiny Type "U" sub-miniature, which requires less than 0.2 sq. in. for chassis or panel mounting—to the rugged heavy-duty "C" and "D" types . . . the Johnson variable capacitor line is designed for more capacity in less space—offers you one of the widest standard capacitor lines in the industry! For detailed specifications on all Johnson variable capacitors, write for your free copy of our newest components catalog, described below.

New Catalog

8 MAJOR COMPONENT LINES

Write today for our newest electronic components catalog—complete specifications, engineering prints and current prices on:

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

E. F. JOHNSON CO.

2014 Second Avenue S.W. • Waseca, Minnesota

Circle 391 on Inquiry Card

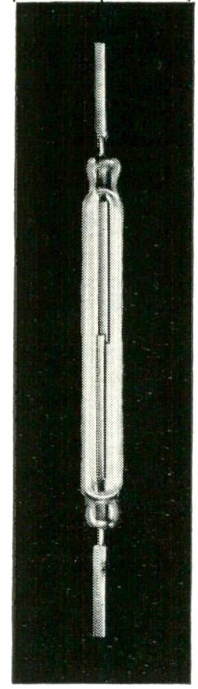
NOW! CLAREED®

a New Concept in Relay Design

The new CLAREED Sealed Contact Reed Relay effectively eliminates contact contamination. With its contacts hermetically sealed in contaminant-free inert gas, this new design assures millions of perfect operations. Hundreds of millions are possible when operated at up to ½ rated contact load.

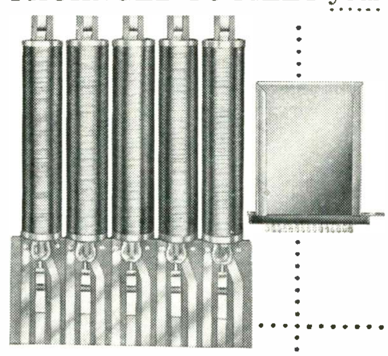
CLAREED relays are ideal components for transistor-drive applications and for use in computers and data-processing equipment. Their low inductance, and the low inductance change in the operating coil at each operation, limits the transients produced.

Important features of CLAREED relays are their simplicity and flexibility. They may be mounted to meet the requirements of almost any application and environmental condition, even on your own printed circuit board—to comply with your mechanical design configuration.



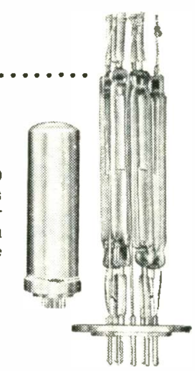
Switch capsule consists of a pair of magnetically operated contacts, hermetically sealed in an atmosphere of inert gas.

PACKAGED TO MEET your REQUIREMENTS



Ten CLAREED switches, mounted in line on a printed circuit board with five magnetic coils. This assembly can then be enclosed in the flat, rectangular container or it may be coated with "Skin-Pack," a tough vinyl plastic, and mounted directly into your equipment.

CLAREED relays are as flexible as your application requires. Additional information may be obtained from C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Limited, Box 134, Downsview, Ontario. Cable Address: CLARELAY. *Send for Bulletin CPC 5.*



Six CLAREED switches clustered for mounting in a single tube container.

CLARE

FIRST in the industrial field

SEE IT AT THE IRE SHOW BOOTH NOS. 2218 & 2220

New York Coliseum • March 21-24

Circle 392 on Inquiry Card

Industry News

Walter T. Buhl, formerly Vice President and General Manager of the Leland Electric Co., div., has been appointed Deputy Group Executive of American Machine & Foundry Co.'s Electrical Products Group, Vandalia, Ohio.

Recent Radio Corporation of America appointments include: **H. Joseph Chase**, Vice President and General Manager, Aviation Div.; **George W. Chane**, Vice President, Finance and Administration; **Fred R. Raach**, Staff Vice President, Management Engineering; **Francis J. Dunleavy**, General Manager, Industrial and Automation Div.; and **Leonard S. Holstad**, Vice President, Electronic Data Processing Service, RCA Service Co.; **Loren F. Jones**, Manager, Product Planning, Communications and Industrial Electronic Products Operations Div.

Tore N. Anderson has joined FXR, Inc., Woodside, N. Y., to fill the newly created position of Assistant to **Henry Feldmann**, President.

T. N. Anderson

H. Hertzog

Alpha Metals, Inc., Jersey City, N. J., has announced the election of **Harold Hertzog** as President. He was formerly Vice-President of the company.

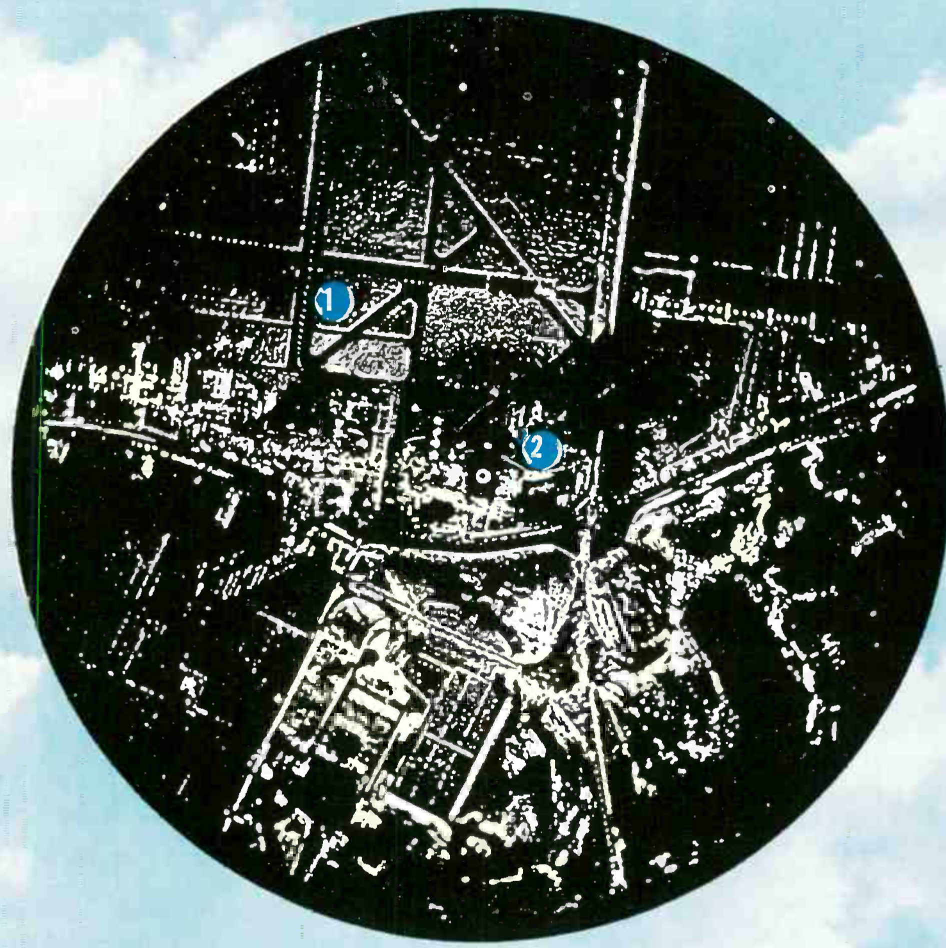
L. E. Blackwell is now a Products Sales Engineer for the Instrumentation Product Group of the Texas Instruments Incorporated Geosciences & Instrumentation Div., Houston, Tex.

John Soldavine is now Controller, Foto-Video Laboratories, Inc., Cedar Grove, N. J.

Recent appointments at Stromberg-Carlson Div., General Dynamics Corp. are: **James D. McLean**, President; **Gordon G. Hoit**, Senior Vice President; **Frank P. Norton**, Controller (Electronics Div.); **Robert J. Gilson**, Director of Systems Management (Electronics Div.); **Leslie D. Catlin**, Director of Management Services and **David Y. Keim**, Director of Engineering (both in Electronics Div.).

Harry G. Bowles has been elected Controller of Burroughs Corp., Detroit, Mich.

THE SHORTEST PULSE ON RECORD...



GENERATED BY THE NEW **Amperex**® TYPE 7093 K-BAND MAGNETRON

Illustration above is a direct line-conversion from an unretouched radarscope photo of Schiphol Airport, Amsterdam, Netherlands. Range—1500 meters.

1 *jeep travelling down runway at 55 mph.*

2 *slow moving vehicles and people walking.*

The 7093 permits the design of an extremely compact, short range radar system providing resolution of 4 meters at 1000 yards and a minimum range of only a few yards.

NOTEWORTHY FEATURES OF THE AMPEREX TYPE 7093

- Frequency Range: 34,512 - 35,208Mc.
- Power Output: 25KW
- Pulse Length: 0.02 microseconds
- Rise Time: 600KV per microsecond
- Weight: 4.2 lbs.
- Cathode: Philips dispenser-type
- Immediately available in production quantities.

ask Amperex

about microwave tubes for microwave applications

AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, Long Island, New York

Industry News

Officers of a new electronics firm, Antenna Systems, Inc., Hingham, Mass. have been announced. They are: **C. W. Creaser**, President; **W. W. Vander Wolk**, Executive Vice-President; **Leon O. Paulding**, Treasurer **Malcolm Winsor**, Chief Engineer; **Milton Higgins**, Product Manager; and **Russell Leishman**, Purchasing Agent. **Jordan Prouty** will be on the Engineering Staff.

James S. Galbraith has assumed the position of Vice-President of Microwave Associates, Burlington, Mass.


J. S. Galbraith


R. M. Brumfield

Richard M. Brumfield has become President of the National Assoc. of Relay Manufacturers. He is President of Potter & Brumfield Div., Princeton, Indiana, American Machine & Foundry Co., and Group Executive of AMF's Electrical Products group.

Henri Busignies, Vice-President and General Director of International Telephone & Telegraph Corp., New York, N. Y., has been elected a Fellow of the American Institute of Electrical Engineers.

Ashley A. Farrar has been named to the newly-created corporate post of Director, Government Contracts for Raytheon Co., Waltham, Mass., and **Dr. Seymour L. Blum** has been appointed Manager of the High Temperature Materials Dept. in Raytheon Co.'s Research Div.

Election of **Lewis L. Strauss**, former Chairman of the Atomic Energy Commission, to the Boards of Directors of the Radio Corp. of America and National Broadcasting Co., has been announced.

Neil H. McElroy, Chairman of the Board of Procter and Gamble Co. and former Secretary of Defense, has been re-elected to the Board of the General Electric Co.

Robert H. Garretson is now Group Vice-President, Data Processing Div., Consolidated Electrodynamics Corp., Pasadena, Calif.

Tech Data

for Engineers

High-Frequency Duct

Booklet, B-7326-380, describes high-frequency bus duct. It outlines bus duct features and containers a curve of voltage drop at 400 CPS plotted against load. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Circle 274 on Inquiry Card

Coiled Heating Elements

"Aids to Better Coiling"—a 16-page manual published by Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich., describes the basic factors and variables involved in forming nickel-chromium resistance wire into helically coiled electric heating elements. Subjects discussed include effects of work-hardening, wire temper, coiling tension and related variables. It contains step-by-step procedures for hand coiling operations and a "Trouble Shooting" chart for diagnosing and correcting the cause of defective coil production.

Circle 275 on Inquiry Card

Resistor Chart

Selector chart developed by Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J., gives info. that eliminates need for solving equations for power and Ohm's Law. Four numbered values—current, voltage, power, and resistance—are arranged on 4 individual chart axes. Take any 2 predetermined values and a quick glance at the chart will allow direct reading of the others.

Circle 276 on Inquiry Card

Control Panels

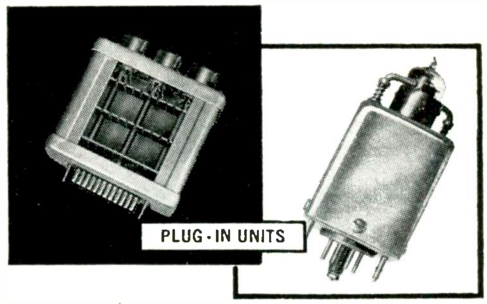
Selection of control panels for automatic materials handling systems is the subject of a 12-page, illustrated bulletin G-9 from Fuller Co., Catasauqua, Pa. Four basic types, the "walk-in" master control panel, the floor and wall-mounted types, and the explosion-proof type, are illustrated. Inside back cover is a chart of standard symbols used in graphic representation of electrical circuitry.

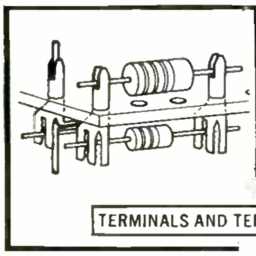
Circle 277 on Inquiry Card

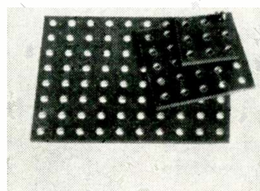
Flame-Retardant Laminate

Fireban X, a flame-retardant version of Grade X laminated plastic, is described in Bulletin 3.1.1.1 offered by Taylor Fibre Co., Norristown, Pa. The bulletin describes Fireban X as a paper base grade with low phenolic resin content. It was developed for use where both mechanical strength and flame retardance are required. Min. and max. property values are given plus physical, mechanical, and electrical properties.

Circle 278 on Inquiry Card







Circle 399 on Inquiry Card

Tech Data

for Engineers

4-Layer Diode Circuits

Detailed information on the design and operation of high speed flip-flop and multivibrator circuits using 4-layer diodes is given in Application Data publication No. AD-6 from Shockley Transistor Corp., Stanford Industrial Park, Palo Alto, Calif. It describes and diagrams free-running, monostable and bistable circuits and a square wave generator circuit. Suggested circuit values are given. Operation at high speeds and over wide temp. ranges is discussed.

Circle 279 on Inquiry Card

Computer Techniques

Donner Tech Notes, a 4-page publication from Donner Scientific Co., Concord, Calif., describes analog computer techniques and applications. Featured is, "How to Use and Program Analog Computers."

Circle 280 on Inquiry Card

Facilities

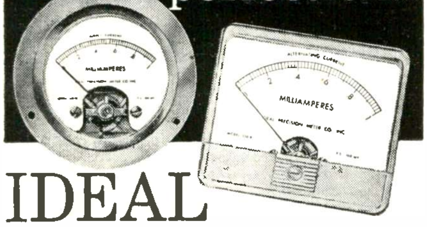
The ability and facilities to design and produce electronic, mechanical, and nuclear devices such as test benches, check out equipment, multiple van instrumentation systems, chambers, and remote manipulators is described in a brochure offered by Nucledyne Div., Cook Electric Co., 3412 River Rd., Franklin Park, Ill.

Circle 281 on Inquiry Card

ELECTRONIC INDUSTRIES Advertisers – March 1960

This index is published as a convenience. No liability is assumed for errors or omissions.

a measure of perfection...



IDEAL PRECISION

Panel Meters

a complete line for every application

IDEAL Panel Meters are assembled in controlled atmospheric and climate conditions and 100% inspected at every step of production to insure highest quality and dependability.

- **D'Arsonval movements guarantee minimum accuracy of 2% (full scale).**
- **Rugged construction means trouble-free, long-lived service.**
- **Durable plastic meter cases provide greater clarity, easier readability.**

For more information on the entire IDEAL line, write for Catalog No. 32.

IDEAL PRECISION METER CO., INC.
214 Franklin Street, Brooklyn 22, N. Y.

Sold to Electronic Parts Distributors exclusively through

WALDOM ELECTRONICS, INC.
4625 West 53rd Street, Chicago 32, Ill.

Circle 405 on Inquiry Card

Tech Data

for Engineers

PNP Transistors

Electrical and mechanical data, performance characteristics, and product features of a series of PNP silicon alloy transistors are treated in 3 tech. bulletins from National Semiconductor Corp., Sugar Hollow Rd., Danbury, Conn. The transistors designated by type numbers 2N1440, 2N1441, and 2N1442, are for low level amplification, small signal, and medium power applications.

Circle 282 on Inquiry Card

Time Delay Relays

Tempo Instrument Inc., P.O. Box 338, Hicksville, N. Y., offers Engineering Bulletin 5905, an 8-page illustrated catalog containing tech. data on line of electronic time delay relays. Typical ranges include: 0.50 to 1.00 sec.; 0.150 to 3.00 sec.; 0.750 to 15.0 sec.; etc. up to 15.0 to 300 sec.

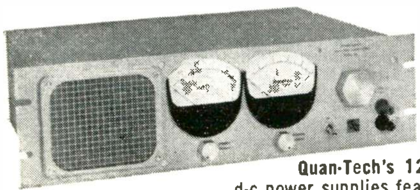
Circle 283 on Inquiry Card

Insulating Material

Single-sheet data page discusses electrical, chemical and physical properties of Rexolite 2200, a reinforced thermosetting plastic insulating material for use at ultra high and microwave frequencies in both wet and dry locations. Sheet includes curves for dissipation factor, dielectric constant and attenuation. Rex Corp., West Acton, Mass.

Circle 284 on Inquiry Card

Higher REGULATION *Lower* RIPPLE



TRANSISTORIZED POWER SUPPLIES

The 120 Series

Quan-Tech's 120 Series units are transistorized, low-voltage d-c power supplies featuring low ripple and closely regulated output. Regulation is to within ±0.01% or ± 3 mv for line or load. All electronic circuitry protects each unit from overload or short circuit—recovery is immediate when the fault is removed. Valuable equipment connected externally is protected by presetting current levels of any of the 120 Series. Provisions for remote error sensing are also incorporated. Where reliability rates equally with versatility—look to the **120 Series by Quan-Tech.** Write for technical details.

SPECIFICATION HIGHLIGHTS

Model	Output Range DC		Regulation				Ripple	Price
	Volts	Amps	Line		Load		mv RMS	
121	0.1-15	0-5	±0.01% or	3 mv	±0.01% or	3 mv	.5	$475.
122	0.1-36	0-3	±0.01% or	3 mv	±0.01% or	3 mv	.5	495.
123	0.1-50	0-2	±0.01% or	3 mv	±0.01% or	3 mv	.5	510.
124	0.1-50	0-5	±0.01% or	3 mv	±0.01% or	3 mv	.5	645.
Also Available								
101	0-8	0-2	±0.25% or ±25 mv				1	195.
102	0-14	0-1	±0.1% or ±10 mv		±0.1% or ±10 mv		1	190.
103	0-30	0-.5	±0.1% or ±10 mv		±0.1% or ±10 mv		1	190.
104B	0-50	0-1	±0.1% or ±10 mv				1	375.
105	0-50	0-.25	±0.25% or ±25 mv				2	205.
112	0-14	0-2	±0.1% or	10 mv	±0.1% or	10 mv	1	240.
113	0-30	0-1	±0.1% or	10 mv	±0.1% or	10 mv	1	240.

Units are available for bench or rack mounting

QTL Quan-Tech LABORATORIES, BOONTON, N. J.

SEE US AT I.R.E. SHOW BOOTH 3034

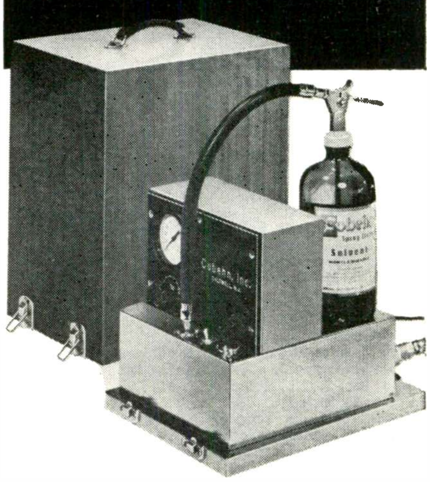
Circle 403 on Inquiry Card

CLEAN

Electronic, Electrical, Mechanical Components and Contacts with NO Film or Residue

Cobehn

HIGH-VELOCITY SPRAY-CLEAN TECHNIQUE



APPLICATIONS

Electronic Components & Assemblies: Diodes, Transistors, Slip-Ring Commutators, Crystals, Vacuum Tube Components, Sub-Miniature Assemblies.

Meter & Instrument Components: Instrument Bearings, Jewel Bearings & Pivots, Gear Trains, Lapped Surfaces.

Electrical Contacts: Relays, Vibrators, Voltage Regulators, Sensitive Switches.

FEATURES

No film, residue, or corrosive effect to damage surface, fire and explosion hazard nil, non-polar, non-ionic, an all around safe operation.

For specific information about your critical cleaning problems, send product information and production requirements.

Cobehn Inc.
226 Passaic Avenue
Caldwell, N. J. CApital 6-6675

See us at the IRE Show—Booth No. 4106

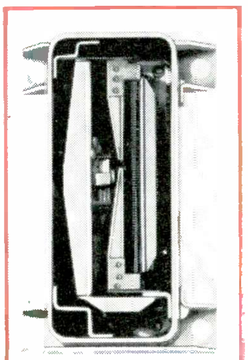
Circle 404 on Inquiry Card

The most precise, sturdiest thermal relay ever built... best for missile applications

...from the leader in thermal relay design!

Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most **precise** thermal relay ever built!

And the PT's **sturdiness** is unequalled in thermal relays. It withstands missile vibration and shock far better than any other thermal relay.



SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)
Setting Tolerance: ±5% (±¼ sec. min.)
Temperature Compensation: Within ±5% over −65°C. to +125°C. range (±¼ sec. min.)
Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.
Power Input: 4 watts. Rated for continuous energization at 125°C.
Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

Write for Product Data Bulletin #PD-1015

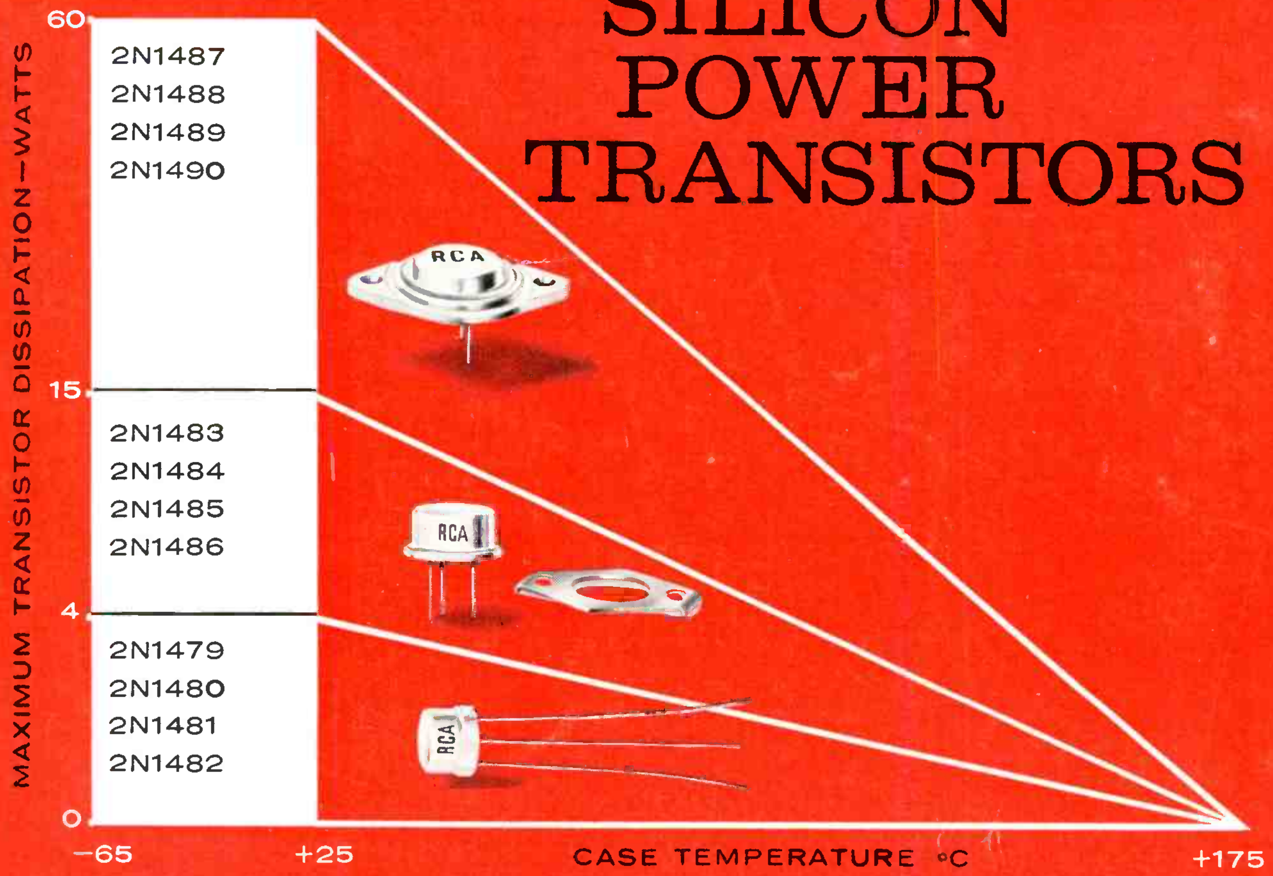
Insulation Resistance: 1,000 megohms
Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.
Vibration: Operating or non-operating, 20 g up to 2000 cps
Shock: Operating or non-operating, 50 g for 11 milliseconds
Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.
Weight: 2 to 2¼ ounces.

G-V CONTROLS INC.
Livingston, New Jersey

G-V

Circle 25 on Inquiry Card

NEW RCA SILICON POWER TRANSISTORS



12 new N-P-N diffused-junction mesa types with low saturation resistance • high-temperature performance • high current beta • high power-handling capability

Out of RCA's broad experience in diffused silicon mesa techniques comes a comprehensive new line of medium, intermediate and high power silicon transistors, featuring low saturation resistance characteristcs and high collector-current and voltage ratings.

These new RCA silicon types open the way to a wide variety of military and industrial applications—in power switching circuits such as dc-to-dc converters, inverters, choppers, solenoid drivers and relay controls; oscillator, regulator, and pulse-amplifier circuits, and as class A and class B push-pull amplifiers for servo and other audio-frequency applications.

RCA Silicon Power Transistors were developed in cooperation with U. S. Army Signal Corps, on an Industrial Preparedness Measure for military devices.

Contact your RCA Field Representative today for complete sales nformation. For additional technical data, write RCA Commercial Engineering, Section C-50-NN, Somerville, N. J.

ELECTRICAL CHARACTERISTICS
Minimum and Maximum Values at Case Temperature = 25°C

RCA Type	Min. V_{CEX} (volts)	Min. V_{CEO}• volts)	Max. I_C (amp)	Max. I_{CBO} (μa)	Max. Saturation Resistance (ohms)	h_{FE}
				V_{CB} = 30v	I_C = 0.2 amp	I_C = 0.2 amp
2N1479	60	40	1.5	10	7	15-75
2N1480	100	55	1.5	10	7	15-75
2N1481	60	40	1.5	10	7	35-100
2N1482	100	55	1.5	10	7	35-100
				V_{CB} = 30v	I_C = 0.75 amp	I_C = 0.75 amp
2N1483	60	40	3	15	2.67	15-75
2N1484	100	55	3	15	2.67	15-75
2N1485	60	40	3	15	1.00	35-100
2N1486	100	55	3	15	1.00	35-100
				V_{CB} = 30v	I_C = 1.5 amp	I_C = 1.5 amp
2N1487	60	40	6	25	2.00	10-50
2N1488	100	55	6	25	2.00	10-50
2N1489	60	40	6	25	0.67	25-75
2N1490	100	55	6	25	0.67	25-75

•sustaining volts

VISIT RCA AT THE N. Y. IRE SHOW—BOOTHS 1602-1608; 1701-1707

RADIO CORPORATION OF AMERICA

SEMICONDUCTOR AND MATERIALS DIVISION *SOMERVILLE, N. J.*

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AVAILABLE, TOO, THROUGH YOUR AUTHORIZED RCA DISTRIBUTOR