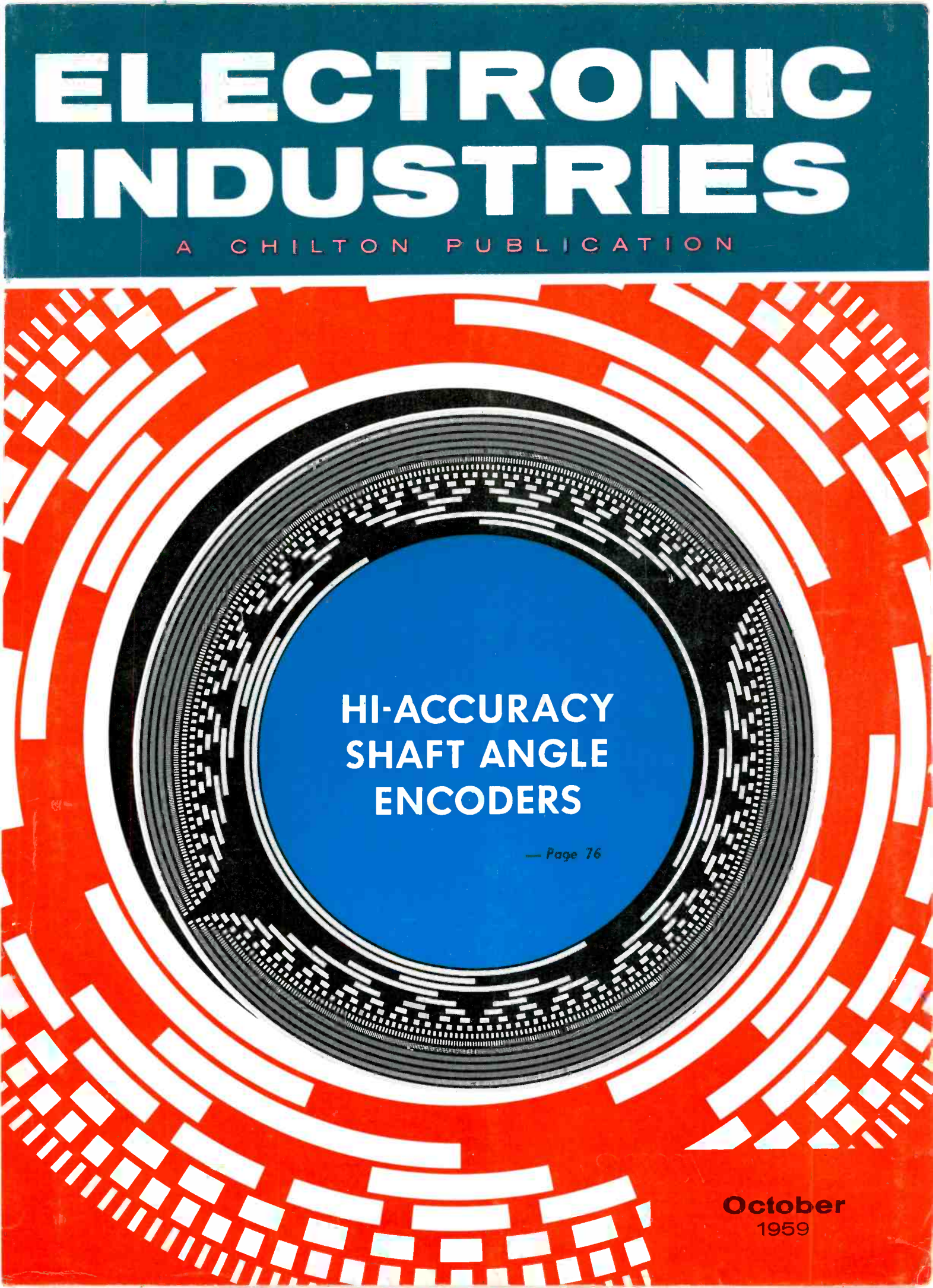
ELECTRONIC INDUSTRIES

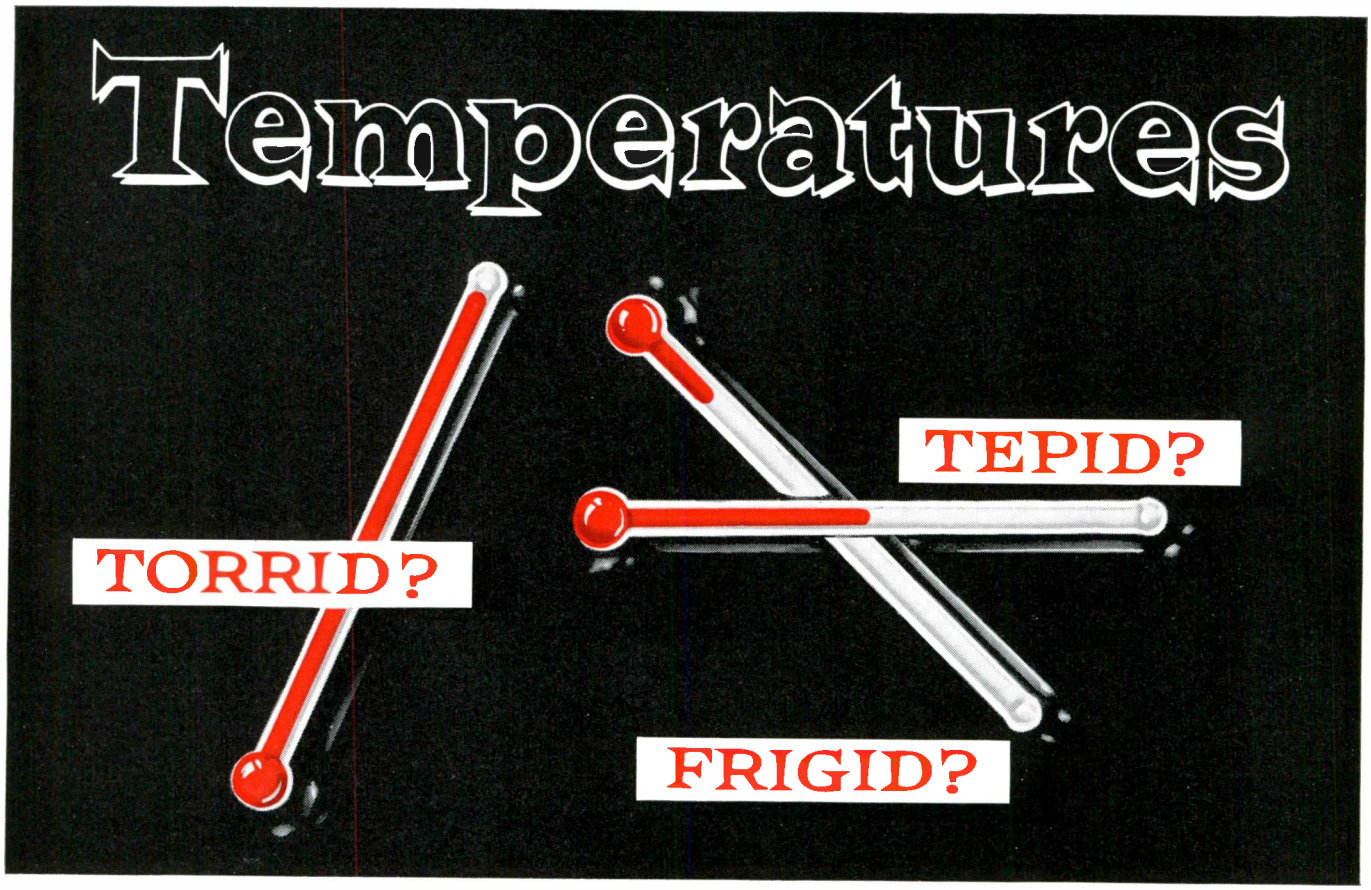
A CHILTON PUBLICATION



HI-ACCURACY SHAFT ANGLE ENCODERS

— Page 76

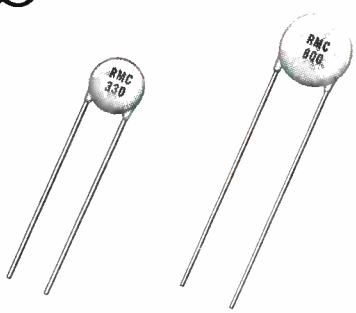
October
1959



RMC type JL DISCAPS

can provide the answer because these ceramic capacitors are especially engineered for applications requiring a minimum change in capacities as temperature varies between —60°C and +110°C. The capacity change over this extreme range is only ±7.5% of capacity at 25°C. Standard working voltage of Type JL DISCAPS is 1000 V.D.C.

Type JL DISCAPS also offer the advantages of longer life, dependability, and lower cost. Write on your letterhead for additional information on these and other DISCAPS.



SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic — vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

CAPACITY TOLERANCE: ±10% ±20% at 25° C

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

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

Ideas — Insure the Future!

AT the recent WESCON show in San Francisco, H. Leslie Hoffman, President of Hoffman Electronics Corp., delivered a most interesting keynote address at the annual corporate luncheon meeting of the Western Electronic Manufacturers Association. In his address he traced the growth of the Western electronic industries from World War II to the present and projected the overall industry pattern to 1975. One of the important points in his address is that by 1970 the dollar volume for military electronic equipment could well reach $9 to $10 billion. This is almost as much as the GNP is for the entire industry today. An examination of these figures and a little reflection explains the importance of the now "popular" statement "What Happens if Peace Breaks Out?"

In earlier editorials we have urged that every effort be made to expand the consumer and the commercial-industrial segments of our industry. Presently these latter segments are about equally divided with the military on a GNP basis. If Mr. Hoffman's predictions are correct, and if nothing is done to expand the volumes of these other segments, then by 1970 the military dollar will be controlling our industry by a factor of two or more to one!

Recognizing that much of to-day's electronic activity has had its root in the smaller one- or two-man organizations that have progressively expanded and developed, and realizing that such opportunities for growth still exist in this country, the editors of ELECTRONIC INDUSTRIES are now developing a new series of editorial features. The aim of this new series will be to present on a periodic (probably quarterly) basis reviews of new and unusual electronic devices and systems for consumer use and for use in our own and other industries. With each of these reviews we shall also seek to present a "marketing" analysis based on available statistical information.

As engineers, many of you frequently, through your own creativeness, obtain ideas for useful devices that are not directly connected with your company activities. We invite you to participate in this program too! If you will write and describe your idea, tell us where you feel it will be useful, and give us an approximate cost estimate we will:

a) Publish your material with credit to you
b) Augment it with any marketing data that we can develop
c) Maintain an exact time and date log on the receipt of the material to protect you for any subsequent patent position
d) Put you in communication with other readers who would be interested in developing and promoting your suggestion as a business enterprise.

We believe that through such a continuing and cooperative effort we can further develop and expand the base segments of the electronic industries for increased future stability and security.

A New Service

Each month we receive many more new product announcements and new literature announcements than we can publish in any one issue. Out of the group received we select for publication only those items that appear to be genuinely new or that offer a technical contribution to the art. Our Reader Service Department, however, maintains a log of new material received each month.

Recent discussions with engineer-readers indicate that such a log or record of each month's new product announcements and new literature announcements would be beneficial to the designers of new equipment. Accordingly we have arranged to make copies of our logs available to interested readers. If you would like a complete summary of the new availability announcements for this month, a letter on company stationery marked for the attention of our Reader Service Department will get this information for you. After you have had an opportunity to review these summaries we hope you will write and let us know how they have helped you or how we can improve this new service to be of greater benefit.

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ELECTRONIC INDUSTRIES

Vol. 18, No. 10 October, 1959

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

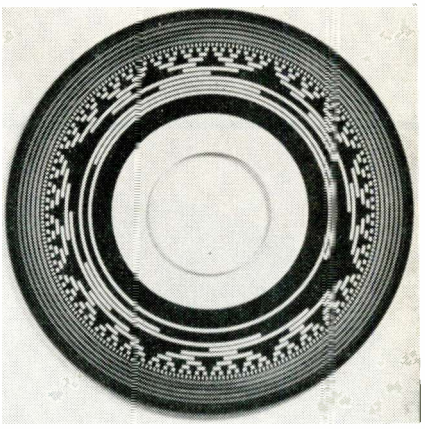
DEPARTMENTS

Highlights

Of This Issue

High Accuracy Shaft Angle Encoders page 76

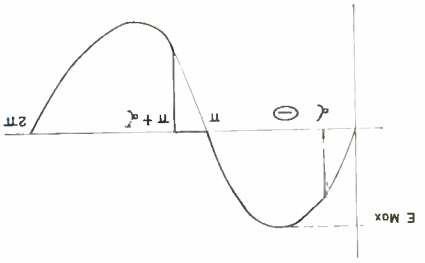
Where it is possible to obtain data in the form of shaft rotation the optical shaft angle encoder can convert analog data to digital data with extremely high accuracy. Most accurate units have accuracies of better than ±4 ppm. Previously restricted to military applications, the technique is now moving into machine tool industries and industrial production field.



Shaft Angle Encoders

Thermistors—From 10° to 600°K. page 81

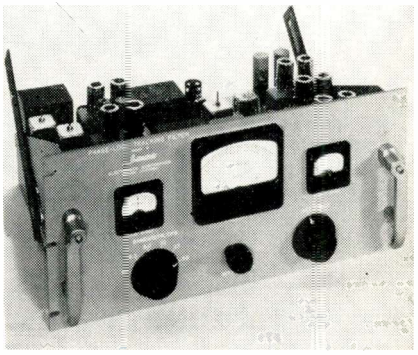
While not in the "glamour" class of semiconductors thermistors are finding their way into a wide variety of applications. The early limitations have been overcome and thermistors are now available in values down to fractions of 1 ohm and a wide range of temperature coefficients.



RMS Sensing

Sensing RMS Values For Servo Systems page 91

The technique of approximating RMS sensing should find many applications in airborne electronic gear where the life expectancy and reliability of equipment is enhanced by adequate control of the RMS voltage. The circuit efficiency is extremely high and the space consumed by the components is trivial as compared with more refined methods of ac regulation.

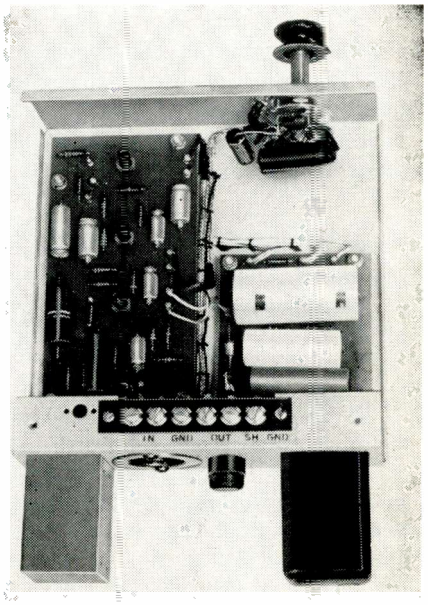


Phase-Lock Filter

DOPLOC Uses Phase-Locked Filter page 96

The problem of receiving and measuring the low-power, CW signals from satellites requires a narrow-band receiving system. Also, a Doppler shift on the received signal must be tracked automatically. An audio, phase-lock tracking filter is described which will fulfill these requirements.

Transistorized Preamp



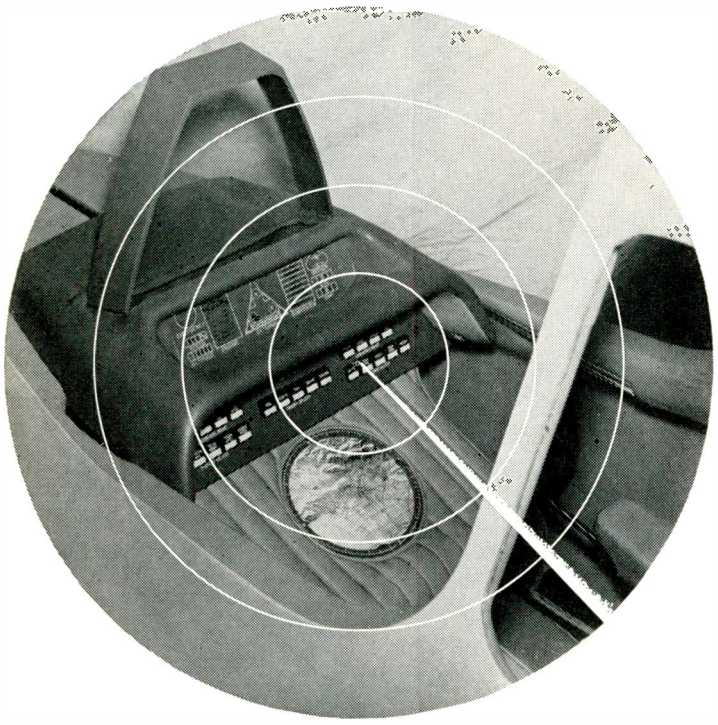
National Electronics Conference—1959 page 100

The three-day conference opening at Chicago's Hotel Sherman on Oct. 12 is expected to attract more than 10,000 engineers. The comprehensive technical papers program will include more than 110 papers. Products will be displayed by over 160 electronic manufacturers.

Transistorized Preamplifier Design page 184

The design of a broadcast station preamplifier equalizer for a magnetic pickup requires consideration of the normal recording level, pickup characteristics and output level requirements.

RADARSCOPE



ADVANCED COCKPIT

The "pathway in the sky" concept is illustrated by this advanced cockpit displayed at the recent Army-Navy Instrumentation Program exhibition in Dallas, Tex. Pilot would see a pre-determined pathway displayed on the television screen before him.

RENEGOTIATION ACT will be with us for at least three more years—till June 30, 1962. As extended, the act carries only a minor amendment. A five-year carry-forward is permitted on losses of renegotiable business.

NASA has started construction of a new center in the Washington area—the Goddard Space Flight Center—to house a good part of their space flight development activities. Total NASA plant investment is approximately $500,000,000.

NEW BUSINESS INCORPORATIONS SOARED during the first six months of this year. A record high of 103,130 was reported, 46% over the same months of 1958.

SPECULATION IS RISING that the big electronic stock boom of 1959 is over. The Khrushchev visit is looked to as a turning point in the cold war with diminished defense spending sure to follow. If these predictions hold true a large number of small firms that depend on R & D will find tough sledding in the fairly immediate future.

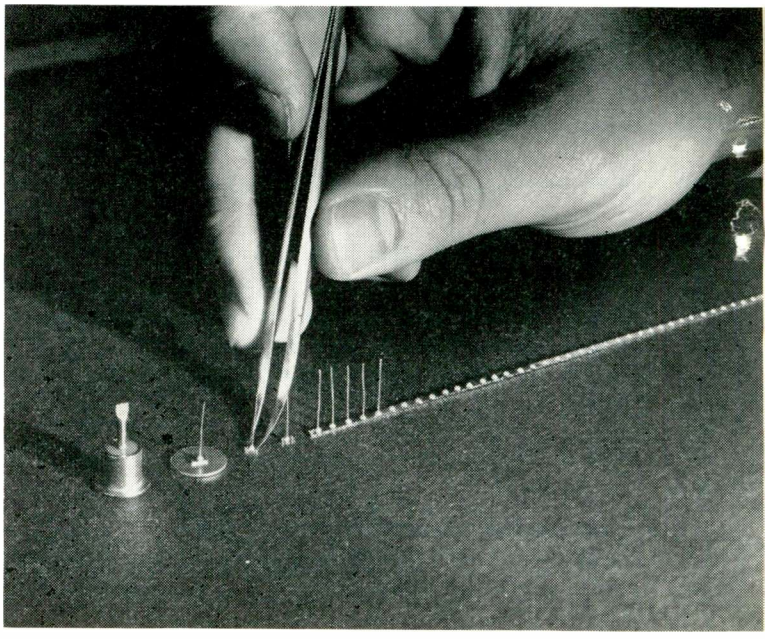
MICRO-MODULE PROGRAM, pet miniaturization project of the Signal Corps, is now approaching the automatic production stage at prime-contractor RCA. An additional $2.38 million contract is being drawn up to press the development of a wider variety of micro-elements.

BETTER PLANNING of large scientific meetings through use of data processing techniques, is the aim of a grant announced last month by National Science Foundation. Authors will be asked to classify their papers according to a coding sheet, and complementary papers will be presented close together.

DEFINITE COMPUTER TREND is seen in developments over the past few months. Three months ago RCA announced construction of local computer centers for use by smaller companies. Last month IBM announced plans for a string of Datacenters, located in all the large cities. This month, out of Washington comes news from C-E-I-R Inc. that they are planning giant computer centers for five key cities. The centers will contain over $25 million worth of computing equipment. C-E-I-R has ordered three IBM 7090 computers, to be installed in the New York City, Houston and Washington, D. C., areas.

TRANSISTOR PRODUCTION

This "hand-built" version shows how Westinghouse research scientists envision the automatic production of transistors. The thin-ribbon germanium crystal, just recently developed, would be the base on which tiny dots would be deposited. After leads are attached, the units are cut apart and mounted in a container.



NEW PHOTO-TRANSISTOR manufacturing method, announced in Japan, uses the heat evaporation technique. Aluminum is evaporated onto a silicon crystal heated to 750°C. The ratio resistance of the silicon crystal used is 0.8 ohm/cm. and the aluminum used was 99.95% pure. An extremely thin aluminum layer can be plated on both germanium and silicon using this process.

COLOR TV is receiving as much attention in Japan as it is here. Three Japanese TV manufacturers now have commercial TV sets available. The third, announced last month, has a 21-inch shadow mask tube and 27 vacuum tubes.

LOWER-PRICED TRANSISTORS are promised through a new semi-mechanized production method developed by Texas Instruments. All-purpose germanium transistors will be the first affected. Prices as low as 50¢ per unit are seen in economy lots.

TUNNEL DIODE is being rushed into equipment design just as quickly as possible, particularly in TV design. In many respects it is superior to transistors.

STANDARDS are sorely needed for the optical scanning equipment used by retail stores to convert arabic numerals into the "machine language" used in data processing systems. Special sub-committee of the Electronics Committee of the Retail Research Institute of National Retail Merchants Assoc. last month set out on a 1-year study of the problem.

SMALL BUSINESS got 520 of the 1,397 R & D contracts granted by ARDC during the first 6 months of 1959. During the same period, 669 of 1,038 support contracts were awarded to small concerns. In a number of categories the Air Force now includes as small business all firms with employment under 1,000.

RADIO SET MANUFACTURERS, showing varying degrees of concern over the big bites being taken by foreign imports, are going quietly about making their own arrangements for meeting the challenge. Most are finding it expedient to "join them," at least to some extent. Emerson last month made arrangements to buy 100,000 transistor portables from Japan's Standard Radio Corp., to be sold under a label "other than Emerson or DuMont." G. E. is incorporating Japanese components in their 6-transistor pocket radio, as are most of the top-name manufacturers. But Admiral is meeting the challenge head-on. They are readying a 7-transistor radio, using all American-made components, that will sell at a "price better than any Japanese set."

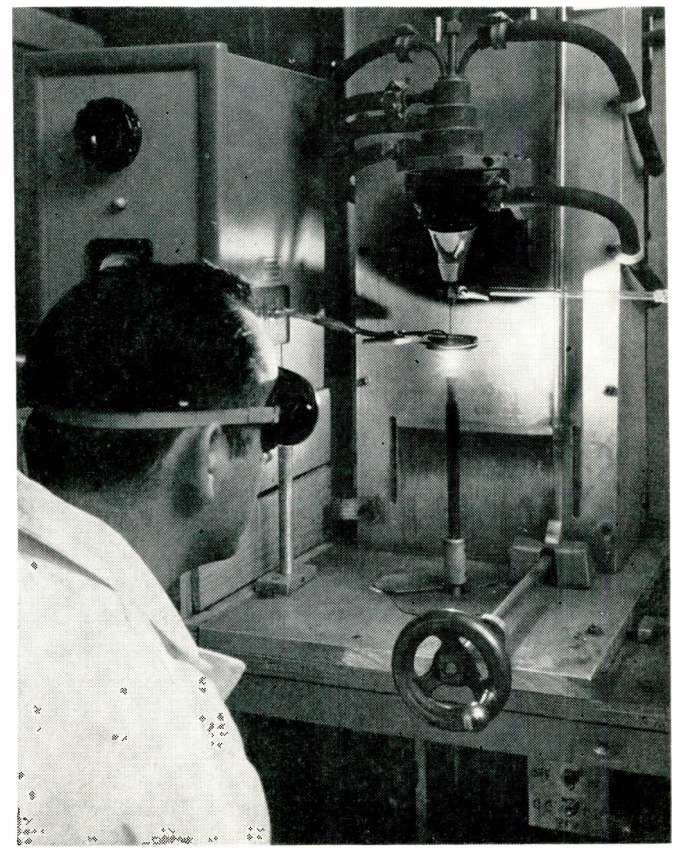
HIGH SPEED DIGITAL PLOTTER developed by Lockheed's Missile and Space Division speeds up flight evaluations by a factor of 17 over old reduction techniques.

TINTED MONOCHROME PICTURES being transmitted experimentally by NBC's Philadelphia outlet, WRCV-TV, may add considerably to the attractiveness of color TV. Color set owners will receive b&w pictures with a light tint or "color shading"—enther constant or changing in hue. The process, christened "Electronic Color Effects" (ECE) uses inexpensive equipment and requires no FCC approval.

VIDEO TAPE RECORDER design announced from Japan last month has some striking advantages: Only one head is used, and the scanning does not overlap. The entire tape width can be used. But there are also disadvantages: there is greater wear and tear on the head and there is no interchangeability with the already available video tape recorders.

CRYSTALS FROM RUST

"Flameless Fusion," a method of transforming a few cents worth of rust-like substance into a nearly perfect crystal, has been developed by scientists of I T & T Corp. The method produces a "monocrystalline ferrite," with many electronic applications.



SPRAGUE CUP TYPE

TANTALEX® CAPACITORS

now better than ever!

Sprague's NEW "Cup Type" Liquid-Electrolyte Sintered-Anode Tantalex Capacitors offer several major improvements in cup capacitor design: elimination of fluctuation in capacitance during operation; elimination of "early failures" from internal short-circuiting as sometimes occurs with other brands of cup capacitors; and large values of capacitance in small physical size. But there's more...

Rated for −55 C to +85 C operation without voltage derating (to +100 C with 15% derating), these capacitors provide equipment designers with long operating life, long shelf life, outstanding capacitance stability, and very low leakage currents.

Sprague "cup" capacitors are available in two series: Type 131D for industrial, communication, and general military equipment; Type 132D for the severe vibration requirements and close performance parameters of military aircraft and missiles. Type 131 D, moderately priced and furnished in the comparatively wide capacitance tolerance of −15, +75%, is especially suited for filter, coupling, and bypass applications where this wide tolerance is permissible. Type 132D is furnished as standard in the closer capacitance tolerances of −15, +20% and −15, +50%.

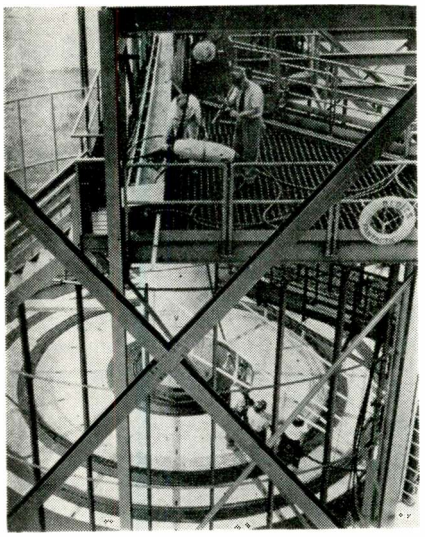
Complete data on Types 131D and 132D Capacitors is given in Engineering Bulletin 3710A. Write Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

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

As We Go To Press...

CABLE SHIP "FANTASTIC"



On this cable ship mockup at Bell Labs' Chester, N. J. location engineers are carrying out simulated undersea cable-laying operations.

First Matric Calculus Computer Developed

The first matric calculus computer to work with both general matric equations and with differential and integral calculus equations has been developed by Pierre M. Honnell, professor of electrical engineering at Washington University, St. Louis, and his doctoral students.

An expanded program of research on development of the computer will get underway this fall in a computing devices research laboratory which is being established in the school's new Engineering Laboratory Building.

While digital computers use the fundamental mathematical concepts of adding and subtracting almost exclusively in their operation, matric equation analyzers work with entire equation systems instead. The matric calculus computer designed by Honnell is the first to work with general matrix equations as well as with differential and some integral, calculus equations.

Advantages of the matric calculus are conciseness and generability of notation, high analytical power and wide applicability. Formerly used primarily in mathematical research, matric methods now are applied with increasing frequency to scientific problems in physics, dynamics, electric networks and econometrics.

Measurement Pinch Challenges Industry

How do you measure 1/1,000,000th of an inch? And with what equipment?

This is a problem faced in the aerospace industry right now and it brings into sharp focus the fact that on many fronts measurement techniques are lagging behind the requirements of advanced space projects.

Last month four organizations—the Air Force, Aerospace Industries Association, National Bureau of Standards, and Sperry Gyroscope Co.—announced a campaign to make industry aware of the seriousness of the problem.

Sperry has just completed a survey for the Quality Control Committee of the Aerospace Industries Association which spells out the various aspects of the measurement problem. The report, "Industry Calibration Survey," is being made available to standards people around the industry by Aerospace Industries Association.

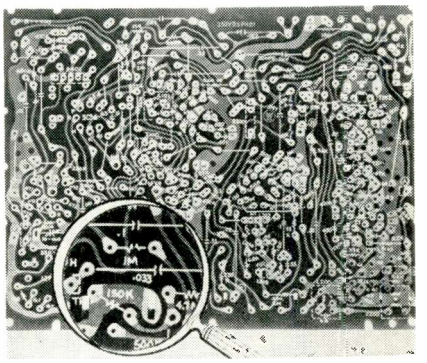
Aim of the joint program is to develop a heightened interest in all phases of industry in the need for improved standards — more accurate, and more easily determined—as a prerequisite for further technological advances.

Because all new standards must start at the source, it is most important that National Bureau of Standards receive more assistance and more cooperation. The accuracies which NBS provides must generally be ten or more times better than the accuracies required by industry. The program also calls for more basic research on the technical problems involved providing better calibrations and standards. And the rate of research, too, is very important.

The survey report also dwells on the matter of operating practices, the needs for the various types of standards and the ways in which such standards are utilized. It emphasizes the importance of these operating practices because the best standards are worthless without the related operating practices. For example, the procedure used in making a calibration is just as important as the standard itself if the calibration is to have any significance.

(*Continued on page* 218)

"SEE-MATIC" BOARDS



The new "See-Matic" board by Westinghouse carries all service information on the underside of a single board. Wiring diagram, key check points and all component values are clearly indicated in yellow ink. Boards are going into the 1960 line of TV receivers.

AMC Asks Industry— "How Can You De-Pot?"

How do you "de-pot" a potted electronic component?

This is the question being asked of the aircraft and electronic industry by the Manufacturing Methods Division of Aeronautical Systems Center of Air Materiel Command.

The answer would save many millions of Air Force dollars spent because potted circuitry components, those encased in resinous or epoxy-type substances, now usually are discarded because it is too expensive to reclaim them.

In some instances, wiring circuits for control or switching of impulses generated to gunsights, radar units, and communication equipment, usually are encased or encapsulated (buried) in the resinous substance to protect them from environmental conditions and for a host of other reasons. One individual item on the circuit board can go bad and destroy usefulness of the entire circuit system.

Normal practice is for field units to replace the whole circuit board or the sealed component and forward the discard to one of Air Materiel Command's depots for repair. There, the unit is subjected to reclamation, but usually the individual bad item cannot be pried or forced out of the sealant substance without damage to other elements.

More News on Page 8

ELECTRONIC SHORTS

▸ Colleges, universities, nonprofit research and higher educational institutions have been invited by the National Science Foundation to submit proposals for summer (1960) and academic-year (1960-1961) study-training-research projects designed to provide educational opportunities for science-minded secondary-school students, college undergraduates, and teachers.

▸ Expansion of work on an interplanetary propulsion system was reported recently by Republic Aviation Corp. The company will more than double the size of its Plasma Engine Laboratory and begin the construction of a second experimental magnetic pinch plasma engine. An estimated thrust of 8,000 pounds for a period of one microsecond was generated with the first experimental engine. The new engine model will permit the study of cycling these thrusts for continuous operation, much as the cylinders of an automobile engine are cycled.

▸ Research is being conducted on tin and other metals for application in superconductive thin film devices at several laboratories. According to the Arthur D. Little Co., alloys promise to provide the increased resistance necessary for high speed superconductive switching devices. Need for the higher resistance arises from the dependence of fast switching on a small circuit L/R time constant. The object of the program is to obtain these reduced resistance alloys without sacrificing some of the superconducting characteristics of pure metal.

▸ The communications equipment manufacturing industry looks to 1959 with optimism, instead of with caution as in 1958, according to the Business and Defense Services Administration, U. S. Dept. of Commerce. Although sales for the first quarter of 1959 were slightly lower than for the first quarter of 1958, the industry expects sales for the remainder of 1959 to exceed 1958 volume by 10 percent and thus approach the 1957 level.

▸ High precision quartz crystal oscillator units can now be fabricated with a nominal frequency tolerance of ±0.002% for the temperature range from −55 to +90°C. The program was accomplished through the combined efforts of Manufacturing Methods Division of Air Materiel Command's Aeronautical Systems Center and Dayton Air Force Depot. Previously, crystal units, operating in this temperature range, contained a frequency deviation of ±0.005% from the nominal frequency.

▸ A fully automatic brokerage private wire system, a 27,000-mile, two-way network leased from Western Union, was placed in operation recently linking the offices of Bache & Co. throughout the nation. Custom-engineered to meet the exacting needs of one of the nation's largest and oldest brokerage firms in an era of multi-million share markets, the ultra-modern system puts all Bache offices within seconds of the company's headquarters at 36 Wall Street, N. Y., and all stock and commodity exchanges.

▸ Flight tests of the first flying weather laboratory designed to gather and analyze global weather data for improved forecasting have been completed by Bendix Aviation Corp. and Boeing Airplane Co. Developed by an industrial team headed by Bendix, the weather project, named AN/AMQ-15 Air Weather Reconnaissance System, was described as the most significant advance in meteorology since the government's weather stations were first linked by the telegraph.

▸ A new concept of the distribution of ionized matter in outer space is being tested by the Explorer VI "paddlewheel" satellite. Proposed by Prof. Robert A. Helliwell, Stanford Electronics Labs., the theory postulates irregularities of ionization high above the ionosphere—up to several earth radii beyond.

▸ The FAA awarded a $573,963 contract to the Borg Warner Corporation, Chicago, Ill., for a two-year study of the information needed to satisfy aviation weather services for the next 15 years. Data derived from the study will be used not only for FAA's long range plans from now through 1975, but will also be put into use by operating bureaus of the FAA. U. S. civilian and military weather services will also make use of the study.

As We Go To Press (cont.)

New System Controls All Aircraft Types

Aviation's first universal flight control system has been developed by the U. S. Army Signal Corps and the Sperry Phoenix Co.

The new system operates automatically to precisely control any type of U. S. Army aircraft—helicopters, fixed-wing planes or high-performance pilotless drones.

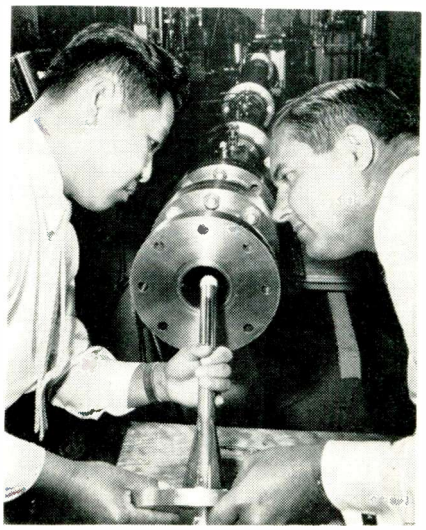
The system is designed around a set of electronic "building blocks" which can be installed in varying combinations to achieve any desired degree of automation in flight.

The universal system can be produced at about half the cost of the most advanced present-day systems to which it can be compared, Sperry said.

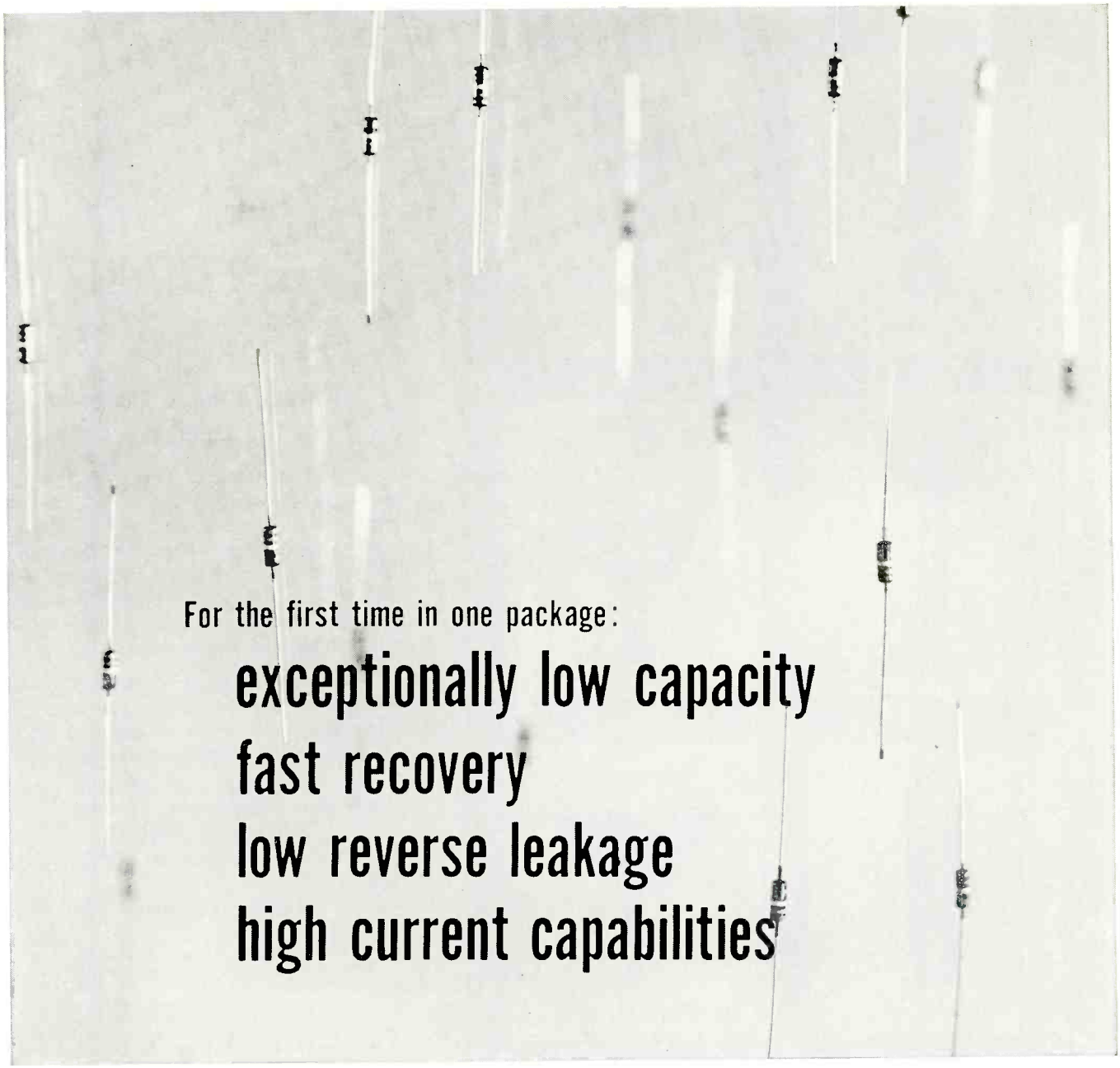
The system provides roll, pitch, yaw, and altitude control for fixed-wing planes, and in the case of helicopters, automatic five-axis control. Helicopters, with their unique capabilities, require automatic rotor speed adjustment as well as control of the other flight axes.

By using a unified coupling device, the system can be geared to take its commands from many types of automatic navigational equipment, employing signals from such sources as VORTAC, ILS, radar altimeters, Doppler radar, and terrain-clearance radar.

PROBING VENUS



Blunt nose cone to be used in experiment to study the problem of entry into the atmosphere of Venus is carefully inserted into end of 40-ft. long shock tube by scientists K. K. Chant and R. W. Rutowski at Lockheed's Palo Alto, Calif. research lab.



100 mA Min. @ 1V Forward Current...0.3 μsec recovery...4 μμf at −2V... that's what you get with the new Hughes computer diodes. With these characteristics, *these diodes will cover practically every major computer switching requirement.*

You can always count on them for top performance. Hermetically sealed in glass envelopes, these Hughes computer diodes have been engineered for extreme reliability under adverse environmental conditions.

For additional information concerning these unique Hughes diodes call or write the Hughes sales office nearest you. They are located at:

Boston, *4 Federal Street; Woburn, Mass.; WOburn 2-4824*
Newark, *80 Mulberry Street: Newark 2, N. J.; MArket 3-3520*
San Francisco, *535 Middlefield Road; Palo Alto, Calif.; DA 6-7780*
Syracuse, *224 Harrison Street; Syracuse 2, N. Y.; GRanite 1-0163*
Chicago, *6120 West North Ave.; Chicago 39, Ill.; NAtional 2-0283*
Philadelphia, *1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365*
Los Angeles, *690 N. Sepulveda; El Segundo, Calif.; OR 8-6125*

Or write, Hughes Products, Marketing Department,
SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.

TYPICAL SPECIFICATIONS:

Type	Min. E_S (@ 100μA)	Min. Forward Current @ 25°C (@ +1.0V)	Max. Reverse Current (μA) @ 25° C	@ 100° C	Reverse Recovery* Reverse Resistance (R) (ohms)	Maximum Recovery Time (μsec)
1N840	50	150	0.1 @ 40V	15 @ 40V	400 K	0.3
1N837A	100	150	0.1 @ 80V	15 @ 80V	400 K	0.3
1N841	150	150	0.1 @ 120V	15 @ 120V	400 K	0.3
1N843	250	150	0.1 @ 200V	15 @ 200V	400 K	0.3
1N844	100	200	0.1 @ 80V	15 @ 80V	400 K	0.5
1N845	200	200	0.1 @ 160V	15 @ 160V	400 K	0.5

*Measured in JAN test circuit and switched from 30mA forward current to −35V.

TYPICAL CAPACITANCE: C_{-10}=2.2μμf $C_{-1.5}$=4.4μμf C_{-0}=9.0μμf
Operating Temp. Range: −65°C to +150°C Storage Temp. Range: −65°C to +200°C

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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

VTP's FAMILY OF SPECIALIZED CRTs

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

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

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

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

TUBE CHARACTERISTICS

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

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

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

VTP

VACUUM TUBE PRODUCTS

a division of HUGHES AIRCRAFT COMPANY

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

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

9 additional TONOTRON tubes and 4 additional TYPOTRON tubes available.

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

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

ELECTRON TUBE DIVISION

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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

Coming Events

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

Sept. 28-30: National Symposium on Telemetering, IRE (PGTRC); Civic Auditorium and Whitcomb Hotel, San Francisco, Calif.

Sept. 28-Oct. 1: National Fall Meeting, American Welding Society; Sheraton-Cadillac Hotel, Detroit, Mich.

Sept. 30-Oct. 1: Industrial Electronics Symposium, IRE, AIEE; Mellon Institute, Pittsburgh, Pa.

Oct. 1-2: 15th New England Section Conf., SPI; Wentworth-by-the-Sea, Portsmouth, N. H.

Oct. 5-7: 5th National Communications Symp., IRE; Hotel Utica, Utica, N. Y.

Oct. 5-7: Joint Industry Fall Meeting, Material Handling Institute, Inc.; Lake Placid Club, Essex County, N. Y.

Oct. 5-9: 11th Annual Conv., Audio Engineering Society; Hotel New Yorker, N. Y., N. Y.

Oct. 5-9: 86th Semiannual Conv. including Equipment Exhibit, Society of Motion Picture and TV Engineers; Statler Hotel, N. Y., N. Y.

Oct. 5-16: 7th Anglo-American Conf. IAS, Royal Aeronautical Soc., Canadian Aeronautical Institute; Hotel Astor, New York, N. Y.

Oct. 6-7: Value Engineering Symposium, EIA; Univ. of Pennsylvania, Phila., Pa.

Oct. 6-7: Meeting, Powder Metallurgy Parts Manufacturers Assoc.; Sheraton-Cadillac Hotel, Detroit, Mich.

Oct. 6-8: Radio Interference Reduction and Electronic Compatibility Conf., U. S. Army Signal R&D Labs., Armour Research Foundation, IRE; Armour Research Foundation, Chicago, Ill.

Oct. 7-9: Canadian Conv., IRE; Automotive Bldg., Exhibition Park, Toronto, Canada.

Oct. 7-9: Conference, American Management Assoc.; Biltmore Hotel, N. Y., N. Y.

Oct. 7-9: National Symp. on Vacuum Techniques, American Vacuum Society; Hotel Sheraton, Phila., Pa.

Oct. 8-10: Meeting, Optical Society of America; Chateau Laurier, Ottawa, Canada.

Oct. 11-15: 3rd Pacific Area National Meeting, American Society for Testing Material; Sheraton-Palace Hotel, San Francisco, Calif.

Oct. 11-16: Fall General Meeting, AIEE; Morrison Hotel, Chicago, Ill.

Oct. 12-15: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Sherman Hotel, Chicago, Ill.

Oct. 13-14: Conference, Society of Plastics Engineers; Ambassador Hotel, Los Angeles, Calif.

Oct. 13-16: Midyear Meeting—Apparatus & Optical Sections, Scientific Apparatus Makers Assoc.; The Cavalier, Virginia Beach, Va.

Oct. 15-16: Meeting, National Assoc. of Broadcasters; Mayflower Hotel, Washington, D. C.

Oct. 15-17: Fall Meeting, National Society of Professional Engineers; Olympic Hotel, Seattle, Wash.

Oct. 17-25: International Fair of the Plastics Industry, Duesseldorf, Germany.

Oct. 18-22: Meeting, The Electrochemical Society, Inc.; Deshler-Hilton Hotel, Columbus, Ohio.

Oct. 19-20: Meeting, National Assoc. of Broadcasters; Sheraton Hotel, Chicago, Ill.

Oct. 19-21: URSI Fall Meeting, URSI, IRE; El Cortez Hotel, Balboa Park, San Diego, Calif.

Oct. 19-21: 11th Annual Machine Tool Conf., AIEE; Sheraton-Cleveland Hotel, Cleveland, Ohio.

Oct. 19-22: 64th Annual Conf., International Municipal Signal Assoc.; Stardust Hotel, Las Vegas, Nevada.

Oct. 20-22: Lubrication ASLE Conf., ASME; Sheraton-McAlpin; New York, N. Y.

Oct. 20-22: 10th National Conf. on Standards, American Standards Assoc.; Sheraton-Cadillac Hotel, Detroit, Mich.

Oct. 22-23: Meeting, National Assoc. of Broadcasters; Somerset Hotel, Boston, Mass.

Oct. 22-24: Meeting, Accoustical Society of America; AIP; Cleveland, Ohio.

Oct. 25-29: Midyear Meeting of Industrial Instrument Section, Scientific Apparatus Makers Assoc.; Camelback Inn, Phoenix, Ariz.

Oct. 26-28: East Coast Aero & Nav. Elec. Conf., IRE (Baltimore Section); Lord Baltimore Hotel, Baltimore, Md.

Oct. 27-29: Midwestern Meeting on New Frontiers in Aviation, Institute of Aeronautical Sciences; Broadview Hotel, Wichita, Kansas.

Oct. 28-29: Computer Conference, Armour Research Foundation; Morrison Hotel, Chicago, Ill.

Oct. 28-29: Michigan Industrial Electronics Exposition, Electronic Reps Inc., Electronic Reps Assoc.; Detroit Artillery Armory, Oak Park, Mich.

Oct. 28-30: Annual Industry Display, Aircraft Electrical Society; Pan Pacific Auditorium, Los Angeles, Calif.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Abbreviations

AIEE: American Institute of Electrical Engineers
AIME: American Institute of Mining & Metallurgical Engineers
AIP: American Institute of Physics
ARF: Armour Research Foundation
AEC: Atomic Energy Commission
ASME: American Society for Mechanical Engineers
ASTM: American Society for Testing Materials
EIA: Electronic Industries Association
IRE: Institute of Radio Engineers
ODR: Office of Director of Denfense Research
SMPTE: Society of Motion Picture & TV Engineers
IAS: Institute of Aeronautical Sciences

RELIABILITY IN THE PALM OF YOUR HAND...

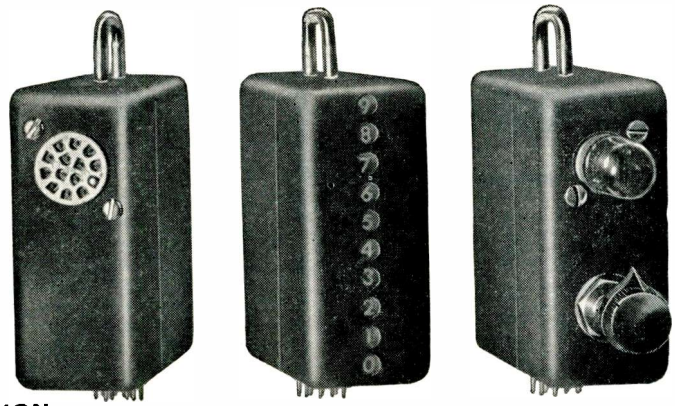
NEW

EECO N-Series *Transistorized* DECADES

for extremely reliable pulse-counting and frequency-division applications in the frequency range of 0 to 250,000 pulses per second.

FEATURES

The new EECO N-Series miniaturized and transistorized plug-in decimal counters feature simple power-supply requirements, low power consumption, small size, and extreme reliability. Saturation techniques, along with consistent derating of component tolerances result in a group of Transistorized Decades that will work dependably from 0 - 250 kcs even under adverse conditions of environment and power supply variations. All units are completely compatible with EECO T-Series Germanium plug-in circuits. In addition, an auxiliary 9-step staircase output is available. Most units are designed to plug into a special 13-pin miniature tube socket; other units plug into a standard 29-pin socket (Continental No. MM-29-22S). Mating socket is furnished with each decade.



ONE-HALF ACTUAL SIZE

WIDE SELECTION

EECO N-Series plug-in Transistorized Decades are available in a wide range of models. The counting circuitry is standardized for the various models. Provisions for visual readout and/or preset controls are as follows:

MODEL	DESCRIPTION
N-101	No readout.
N-102	Incandescent readout.
N-104	Incandescent readout (remote). Typically a projection readout module.
N-105	Nixie readout. (Can be cabled to remote Nixie.)
N-106	Nixie readout with preset control switch. (Can be cabled to remote Nixie.)
N-107	Incandescent readout with inputs for external preset control.
N-108	Incandescent readout (remote) with inputs for external preset control.
N-111	No readout, but with 1-2-4-2 code.

TYPICAL SPECIFICATIONS

The N-102 Transistorized Decade (with internal incandescent readout) employs four binary stages operating in a 1-2-4-2 code. Visual readout consists of the numerals 0 through 9 displayed vertically and illuminated by incandescent lamps. Total power consumption is approximately one watt. Outputs include (N/10), (N/10)′, and a 9-step staircase, which may be adapted for a visual display by means of an emitter follower and DC voltmeter.

ELECTRICAL SPECIFICATIONS

INPUT

Minimum Trigger Input: (0-100 kcs): 7 volts positive pulse or step at 0.5 μsec. rise time; (100 kcs to 250 kcs): 7 volts positive pulse or step at 0.2 μsec. rise time.
Maximum Operating Frequency: 250 kcs.
Input Impedance: 470 μμfd. capacitance, max.
DC Reset Input is provided (normally supplied by T-129 DC Reset Generator).

OUTPUT (No Load)

Amplitude: 8 volts, peak to peak.
Output Levels: (N/10) and (N/10)′: −11 volts DC and −3 volts DC, nom. Staircase: −11 volts DC to −3 volts DC in 9 steps.
Rise Time: (N/10): 0.5 μsec.; (N/10)′: 0.5 μsec.
Type: (N/10), (N/10)′, and 9-step staircase.
Load: Typical, two N-Series decades or two T-Series flip-flops. (Load information available on request.)

PHYSICAL SPECIFICATIONS

Dimensions: 1-5/16″ wide x 3″ deep x 3-7/8″ seated height (including handle). Dimensions are exclusive of external addenda found in external preset and Nixie models.
Mounting: Plugs into standard 9-pin miniature socket. (Some other models require a special 13-pin miniature socket, which is furnished with each such unit.)
Pin Connections: Arranged for in-line wiring of power and grounds.
Operating Temperature Range: −54°C to +71°C.

NOTE: 0 to 5 megacycle models available soon.

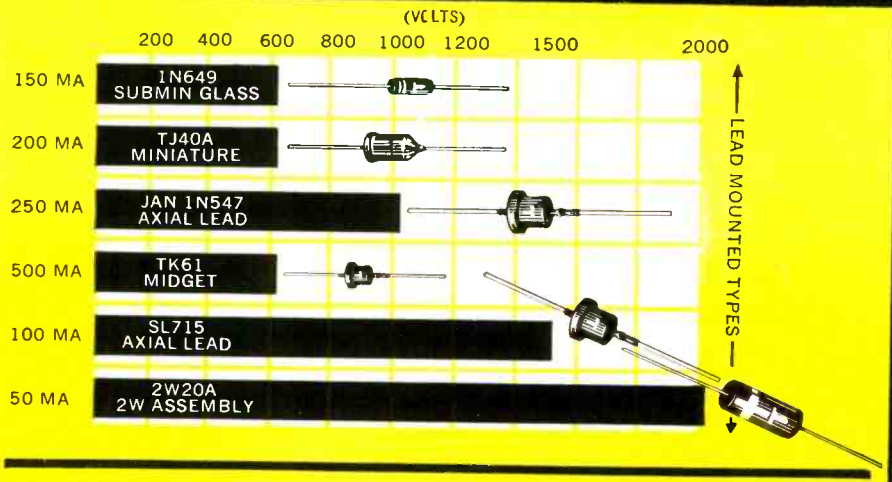
Additional information on N-Series Transistorized Decades and other EECO products available on request.

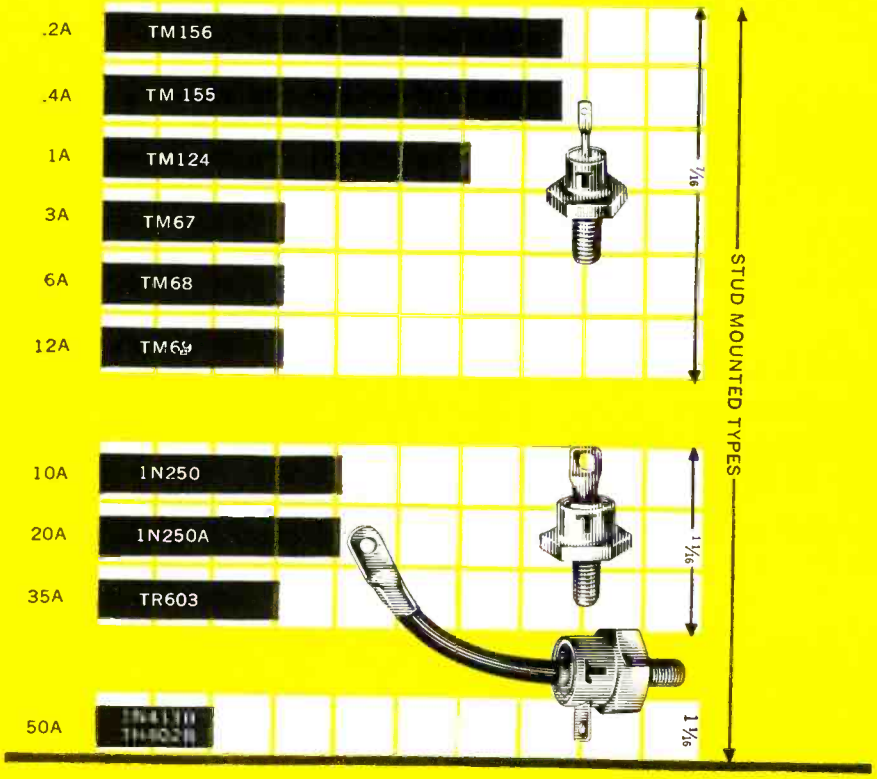
ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS COMPANY
(a subsidiary of Electronic Engineering Company of California)
506 East First Street • Santa Ana, California

Circle 7 on Inquiry Card

T® INDUSTRY'S MOST COMPLETE SILICON RECTIFIER LINE





SILICON CERAMIC BASE RECTIFIERS


Fig. 1

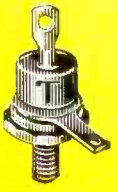


Fig. 2

Ceramic base rectifiers of compact design now eliminate the need for insulating hardware and "reverse polarity" units. These rugged stud-mounted silicon power rectifiers achieve their versatility by virtue of an alumina ceramic disc mounted between the top hat assembly and the hex base. The ceramic disc offers low thermal resistance and high electrical insulation properties. Further, bridge assemblies are now simplified and standardization of components is subsequently advanced.

The ceramic base rectifiers are available in ½" hex base configuration up to 12 amperes @ 150°C case, and in 1 1/16" hex base configuration up to 20 amperes @ 150°C case.

For example:

Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current @ 150°C Case (amps)	Figure
1N 341/C	400	.400	1
1N 250 A/C	200	20	2

For further information write in for bulletin TE-1351R.

Number 12, 13, 14 and 15 in a series of 37 new Transitron Products to be announced before 1960!

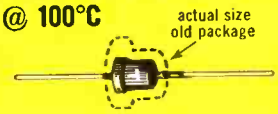
Circle 8 on Inquiry Card

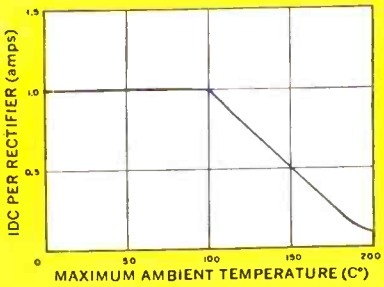
. . . designed to meet ALL your circuit requirements: current, voltage, temperature, size . . . now available from Transitron.

A complete description of the lead and stud mounted types, which are summarized below, is in bulletin TE-1351.

We welcome your inquiries concerning special requirements such as high frequency, fast recovery and high voltage applications.

MIDGET RECTIFIER
1 AMP @ 100°C



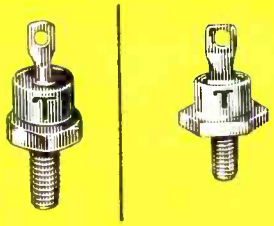


Transitron announces, higher ratings and *smaller* size in a lifetested lead mounted silicon rectifier. By establishing a high level of designed quality, these rectifiers feature reliable 200°C operation. Remember, the size is SMALLER, the flange is GONE! These units will meet all electrical and environmental requirements of the JAN-1N 547 series.

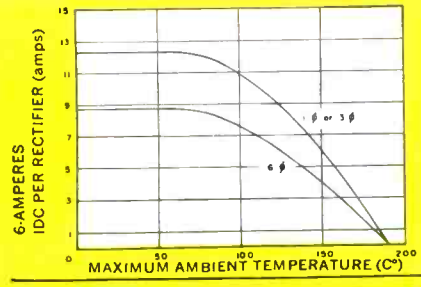
Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current @ 200°C (Milliamps)	Maximum Average Forward Current @ 100°C (Amps)	Maximum Forward Voltage @ 25°C (Volts) (Milliamps)
TK61	600	100	1.0	1.0 @ 750
TK41	400	100	1.0	1.0 @ 750
TK21	200	100	1.0	1.0 @ 750

Write for bulletin PB-58

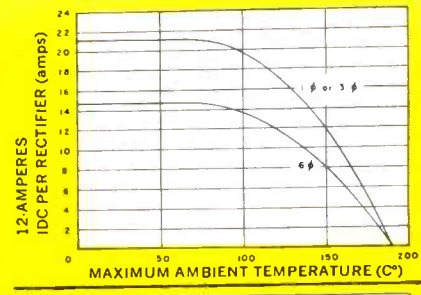
HIGH CURRENT RECTIFIERS



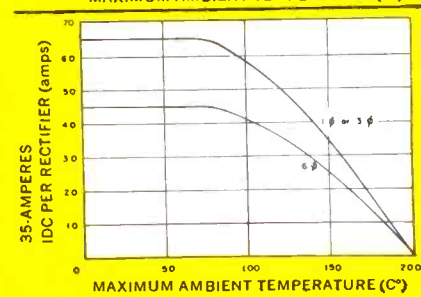
Now, from Transitron, stud-mounted silicon power rectifiers which combine high power handling ability with a minimum of size and weight . . . The extremely low forward resistance and thermal impedance of these units allow operation up to 12 amperes @ 150°C case temperature in the 7/16" hex base configuration, and similarly up to 35 amperes @ 150°C case temperature in the 1 1/16" hex base configuration. Still further, the inherently low leakage currents and high peak inverse voltage ratings allow flexibility in the design of both power supply and magnetic amplifier circuits.



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM68	600	1.1 @ 6	2
TM58	500	1.1 @ 6	2
TM48	400	1.1 @ 6	2
TM38	300	1.1 @ 6	2
TM28	200	1.1 @ 6	2
TM18	100	1.1 @ 6	2
TM8	50	1.1 @ 6	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM69	600	1.2 @ 12	2
TM59	500	1.2 @ 12	2
TM49	400	1.2 @ 12	2
TM39	300	1.2 @ 12	2
TM29	200	1.2 @ 12	2
TM19	100	1.2 @ 12	2
TM9	50	1.2 @ 12	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TR603	600	1.5 @ 100	5
TR503	500	1.5 @ 100	5
TR403	400	1.5 @ 100	5
TR303	300	1.5 @ 100	5
TR203	200	1.5 @ 100	5
TR153	150	1.5 @ 100	5
TR103	100	1.5 @ 100	5
TR53	50	1.5 @ 100	5

*Averaged over one cycle with rectifier operating at full rated current and voltage into a resistance load.

SILICON CONTROLLED RECTIFIER

Handling 10 KW Power

Transitron's Silicon Controlled Rectifier is a PNPN High power bistable controlled switching device. It is analogous to a thyratron or ignitron, with far smaller triggering requirements and microsecond switching. The low forward voltage drop permits high current ratings and provides high efficiency with low cooling requirements. The PNPN design permits higher voltage ratings and lower saturation resistance than power transistors. This permits the smallest packaging for high power control yet made possible.

NOW AVAILABLE IN TRANSITRON'S NEW PACKAGE

Type	Minimum Peak Reverse Voltage (Volts)	Minimum Forward Breakdown Voltage (Volts)	Maximum Average Forward Current (amps) at T case = 100°C	Maximum Average Forward Current (amps) at T case = 25°C
TCR102	100	100	10	20
TCR202	200	200	10	20
TCR302	300	300	10	20
TCR402	400	400	10	20

Maximum Storage Temperature Range −65°C to +150°C
Maximum Operating Temperature Range −65°C to +125°C

Send for Bulletin TE-1356A

Transitron

electronic corporation • wakefield, massachusetts

Leadership in Semiconductors SEE YOUR LOCAL AUTHORIZED TRANSITRON DISTRIBUTOR FOR QUANTITIES FROM 1-999.

Electronic Industries' News Briefs

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

EAST

GENERAL ELECTRIC'S Heavy Military Electronics Dept. has received a $22 million contract from the Air Materiel Command's Rome Air Materiel Area for the production of radar course directing groups. This advanced equipment will automatically detect and track air targets.

ROBERTSHAW-FULTON CONTROLS CO. has moved into their new Eastern Research Center which is located along the Schuylkill Expressway at King of Prussia, located near Philadelphia.

PAGE COMMUNICATIONS ENGINEERS, INC., a subsidiary of Northrop Corp., has been awarded a $10 million contract by the U. S. Air Force to design and build a multichannel, tropospheric-scatter, telephone, teletype and data communications network linking the United Kingdom, Spain, and Morocco.

ACOUSTICA ASSOCIATES and AEROJET-GENERAL CORP. have entered into a joint agreement to explore the application of sonic control to advanced space vehicle programs.

APPLIED SCIENCE CORP. of Princeton has received a contract award of $794,000 for supplying digital data transmission systems for the Eglin Gulf Test Range. As a subcontractor to ITT Labs., ASCOP has received nearly $2 million in contracts for telemetery and data handling equipment for the Eglin Range.

ASTRON CORP. has announced that the first phase of an expansion program for their subsidiary Skottie Electronics, Peckville, Pa., has been completed with the completion of a new building.

SYLVANIA ELECTRIC PRODUCTS INC. has arranged to purchase a 25,000 square-foot plant at Manchester, N. H., for the manufacture of transistors. The new plant is situated on a 10-acre site.

SPEER CARBON CO. is purchasing the Electronics Div. of Onondaga Pottery Co. Business will be carried on under the name of Onondaga Electronics Div.

NARDA ULTRASONICS CORP. has just expanded into a second building in the New Cassel area of Westbury. The new building contains 10,000 square feet of working space.

POTTER & BRUMFIELD has leased a 25,000 square-foot building in Marion, Kentucky, for the exclusive production of their line of telephone type relays.

FOOTE MINERAL CO. has broken ground for a new $2.2 million research and engineering building near Exton, Pa.

CORNELL-DUBILIER ELECTRIC CORP. has completed negotiations with the Toshiba Company of Japan to form a new international manufacturing-distribution association to market the Far-Eastern firm's transistors in the U. S.

RADIO CORP. OF AMERICA has received a $2.4 million contract from the Army Signal Corps. to expand a space-age electronics miniaturization program. This contract broadens the scope of a $5 million contract that was awarded in March of this year.

TAYLOR FIBRE CO. has more than tripled their space for research in vulcanized fibre and laminated plastics by occupation of their new three-story research center at the company's main plant site near Norristown, Pa.

MELPAR, INC.'s Applied Science Division located in Boston was recently awarded a contract by the USAF Air Research and Development Command for a Long Range Communications Interference study.

THE DUPONT COMPANY is building new laboratory and office facilities for its Mylar polyester film technical section adjoining its Circleville, Ohio plant where the Mylar is manufactured.

AVCO CORP.'s Research and Advanced Development Div. of Wilmington, Mass., has been awarded an Air Force prime contract for $36,655,000. The award calls for a program of basic research through prototype development of the re-entry vehicle (nose cone) for the Air Force Minuteman, this country's first solid-fueled intercontinental ballistic missile.

MID-WEST

MAGNAVOX CO. now has 125,000 square feet of engineering and administrative space at their Urbana, Ill., location. The 70,000 square-foot addition has just been completed at this location.

WEBCOR, INC., Government Electronic Div., has been awarded government contracts amounting to almost $7 million. They have received contracts from the Navy, Air Force, and the Federal Aviation Agency.

RADIO CORES, INC., Oak Lawn, Ill., has purchased the iron core division of the Stackpole Carbon Co., St. Marys, Pa.

CROSLEY DIV. of Avco Corp. has announced the receipt of additional contracts of $5.8 million for bomber fire control systems and spare parts.

CONTROL DATA CORP. has reorganized their digital computer activities into a full division status. The Computer Division will specialize in design and development of electronic digital computers.

BURROUGHS CORP. has received a letter contract from the U. S. Air Force for $9 million to begin work on an additional 36 SAGE units. This contract brings to $155 million the total business Burroughs has contracted for in the SAGE program.

G-C ELECTRONICS CO., a division of Textron, Inc., has made an outright purchase of Electrocraft, Inc., of Chicago. Electrocraft manufactures plugs, jacks, connectors and switches.

VICTOREEN - TENNEY proposed merger has been postponed. Both companies said that "in view of the increasing volume of business in both companies, and the work involved in other expansion moves, it was decided to defer action on the merger at this time."

WEST

AMPEX CORP. has received a $2 million order from the National Cash Register Co. for products of their Computer Products organization.

THOMPSON-RAMO-WOOLDRIDGE PRODUCTS CO. has moved its home offices to Beverly Hills. They are now located at 202 North Canon Drive.

ENGINEERED ELECTRONICS CO. has broken ground at Santa Ana, Calif., for a new plant. This is the first step of a master plan to develop a plant with 100,000 square feet.

NEELY ENTERPRISES expects to have their new facilities in Albuquerque completed by the end of November. This will mark the fourth Neely owned building out of eight locations.

HUGHES AIRCRAFT CO. now has a nuclear electronics lab. to handle their increasing activities in the nuclear field.

EPSCO-WEST is building a $240,000 high-speed digital data system for the structural testing of aircraft. It is being built for the Boeing Airplane Co.

HEWLETT-PACKARD CO. has acquired the Boonton Radio Corp. through the acquisition of their outstanding stock.

FAIRCHILD SEMICONDUCTOR CORP. has announced the opening of their new 68,000 square-foot facility at Mountain View, Calif. They expect to have further plant expansion by 1960.

KESTER SOLDER CO. has started production of solder and fluxes in their new west coast factory at Anaheim, Calif. Kester now has four plants in North America.

LOCKHEED AIRCRAFT CORP. formed separate aircraft and missile-electronics combinations with each headed by a group vice president.

TEXAS INSTRUMENTS INCORPORATED will manufacture and install a completely automated electronic supervisory control system for an offshore gas well production platform near Corpus Christi under a turnkey contract awarded by Gulf Oil Corp.

HOFFMAN ELECTRONICS CORP., Hoffman Labs. Div., has received a $5.9 million contract from the Navy for production of a passive countermeasures system for underwater and surface craft. The equipment was originally developed by Hoffman.

BJ ELECTRONICS, a division of Borg-Warner Corp., has received a $1.4 million contract for production of multi-purpose signal generator sets. Contract was awarded by the Air Force.

U. S. SEMICONDUCTOR PRODUCTS, INC., has purchased a manufacturing facility adjacent to their present location in Phoenix, Ariz.

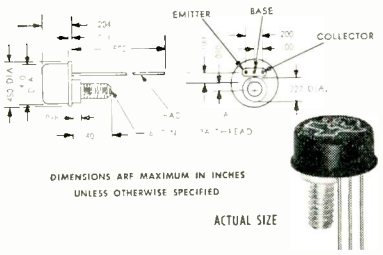
WESTERN GEAR CORP. acquired financial interest in Tridea Electronics, Inc., of Pasadena, Calif.

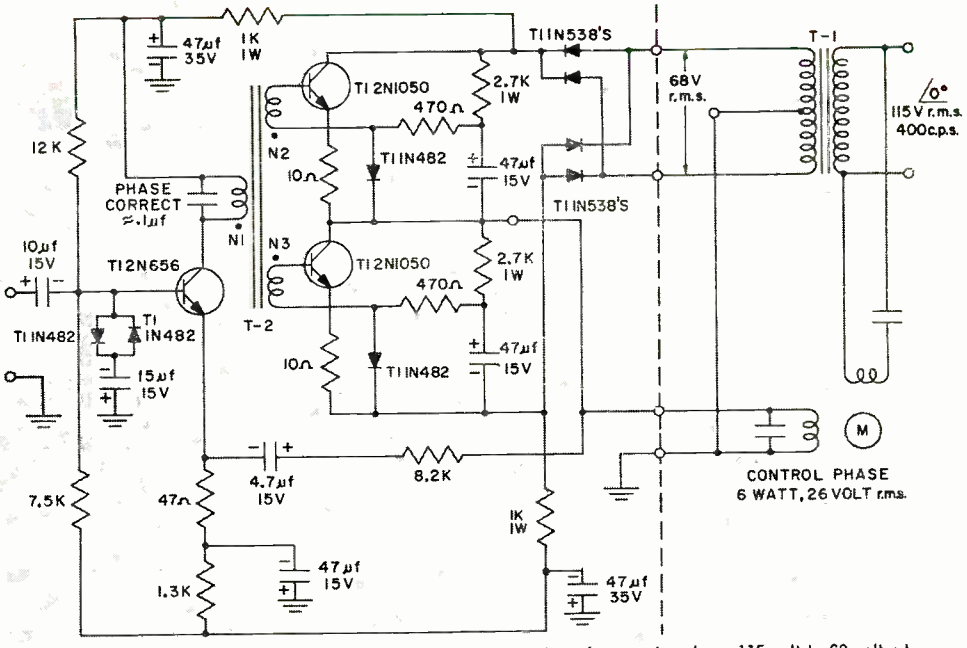
How to get 55% over-all efficiency in transistorized 6-watt servo amplifier

HIGH-EFFICIENCY SERVO CIRCUIT REQUIRES . . .

- no output transformer
- no center-tap motor winding

Higher over-all efficiency than in a conventional Class-B push-pull amplifier is achieved in this servo by use of unfiltered rectified a-c for current supply voltage—with resulting reduction in size, weight and power supply requirements. This higher efficiency means greater transistor reliability, smaller heat sink and/or higher allowable ambient temperatures. Output will remain sinusoidal when amplifier is overdriven.





TRANSFORMERS

T-1 400 cps, 12-watt power transformer step-down 115 volt to 68 volt c.t.

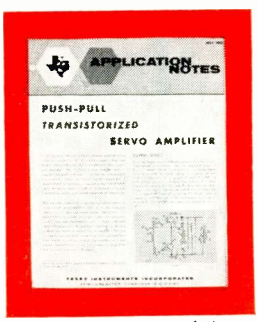
T-2 400 cps, 65-mw driver transformer. Turns ratio N1: N2: N3 = 2: 1: 1
Primary Current = 10 ma d-c. Primary Inductance = 1.5 hy.

...with TI 2N1050 N-P-N silicon transistors!

Exclusive TI 2N1047 intermediate-power series now gives you maximum design flexibility plus high efficiency . . . all in a miniature package!

Consider the design flexibility made possible by the exclusive features of this series . . . 40 watts dissipation at 25°C case temperature . . . unique stud mounting for maximum thermal efficiency . . . 80- and 120-volt BV_{CEX} . . . 15-ohm R_{CS} . . . −65°C to +200°C operating and storage range . . . choice of beta spreads.

Apply TI's guaranteed specs to your design situations today. This use-proved series is available off-the-shelf —*at factory prices*— in 1-999 quantities from your nearby authorized TI distributor, and in production quantities from your TI sales office.



Write on your company letterhead for illustrated TI APPLICATION NOTES on the transistorized servo amplifier.

PARAMETER	TEST CONDITIONS		2N1047	2N1048	2N1049	2N1050	unit
			min. max.	min. max.	min. max.	min. max.	
BV_{CEX} Breakdown Voltage	$I_C = 250\ \mu a$	$V_{BE} = -1.5V$	80	120	80	120	v
BV_{EBO} Breakdown Voltage	$I_E = 250\ \mu a$	$I_C = 0$	10	10	10	10	v
I_{CBO} Collector Cutoff Current	$V_{CB} = 30V$	$I_E = 0$	15	15	15	15	µa
h_{FE} Current Transfer Ratio †	$V_{CE} = 10V$	$I_C = 200ma$	12 36	12 36	30 90	30 90	—
h_{IE} Input Impedance †	$V_{CE} = 10V$	$I_B = 8ma$	500	500	500	500	ohm
R_{CS} Saturation Resistance †	$I_C = 200\ ma$	$I_B = 40ma$	15	15	15	15	ohm
V_{BE} Base Voltage †	$V_{CE} = 15V$	$I_C = 500ma$	10	10	10	10	v

†Semiautomatic testing is facilitated by using pulse techniques to measure these parameters. A 300-microsecond pulse (approximately 2% duty cycle) is utilized. Thus, the unit can be tested under maximum current conditions without a significant increase in junction temperature, even though no heat sink is used. The parameter values obtained in this manner are particularly pertinent for switching circuit design and, in general, indicate the true capabilities of the device.

germanium and silicon transistors
silicon diodes and rectifiers
*tan*TI*cap* solid tantalum capacitors
precision carbon film resistors
sensistor silicon resistors

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
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surpassing even military specifications

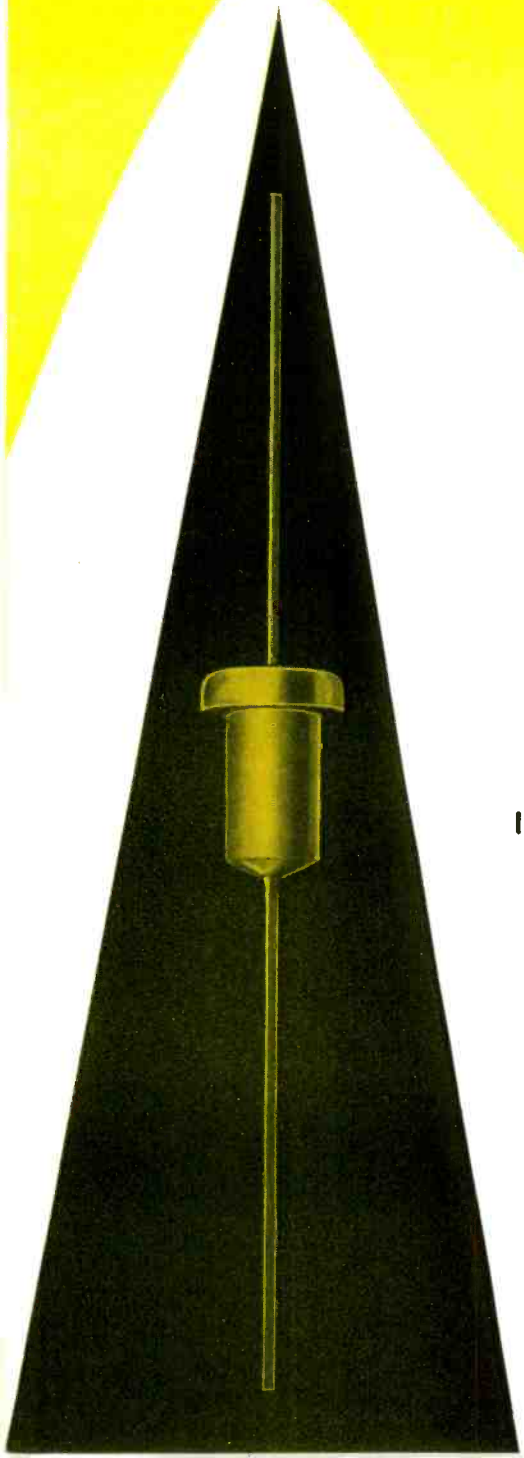
the new Fansteel

GOLD-CAP

TRADE MARK

TANTALUM CAPACITOR

the world's most reliable capacitor



INDIVIDUALLY TESTED

INDIVIDUALLY NUMBERED and REGISTERED

INDIVIDUALLY CERTIFIED

each conforming to the most complete and rigid specifications ever prescribed for any production component.

FANSTEEL® RELIABILITY

CERTIFIED

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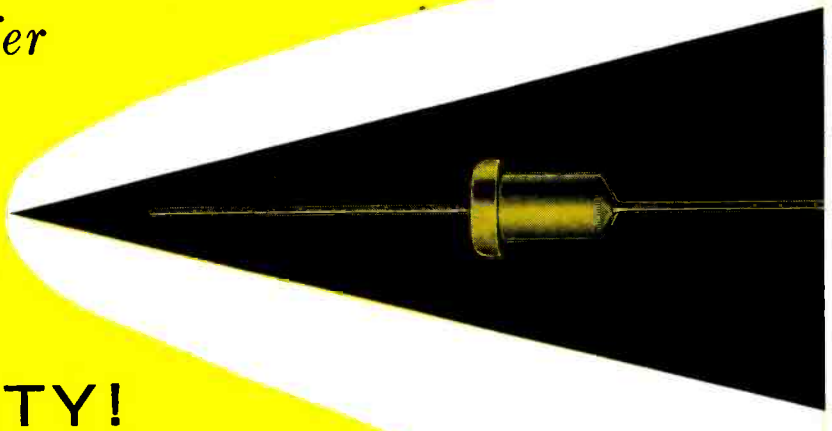
only Fansteel dares offer

PROOF

OF RELIABILITY!

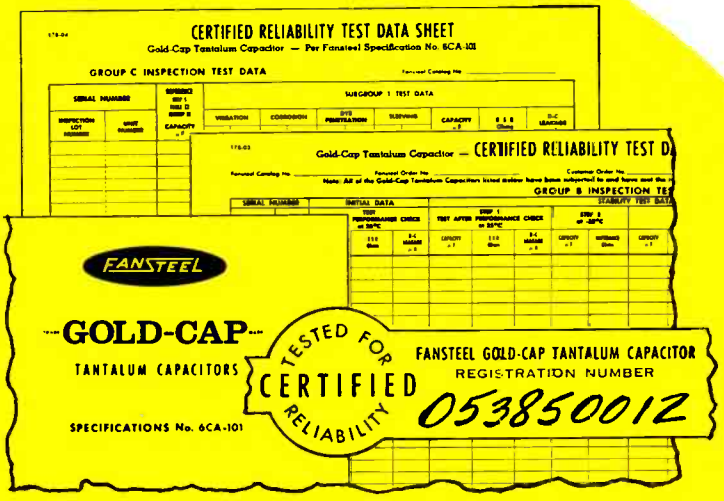


The Gold-Cap Tantalum Capacitor is Fansteel's solution to one of today's really critical problems—the urgent need for a tantalum capacitor of absolute, unquestioned reliability. It is the first capacitor ever to be offered with *proof in writing* of pre-tested reliability.

This proof is based upon a series of the most uncompromising tests ever devised for checking reliability in a tantalum capacitor. Each Gold-Cap is assigned a registered serial number and all test results are recorded by this individual number.

Thus, every Gold-Cap shipped to you has gone through exhaustive testing . . . meets all Gold-Cap Specifications No. 6CA-101 . . . and is accompanied by its own certified record of test results—written proof of its pretested reliability.

Only Fansteel dares take the responsibility of pretesting for you . . . *and certifying the results!*



THE FANSTEEL CERTIFICATION OF RELIABILITY
makes any further inspecting or testing for reliability unnecessary.

THE GOLD-CAP TESTS FOR CERTIFIED RELIABILITY

GROUP A TESTS

Sample Lot Inspection:

Material / Dimensions / Marking / Workmanship

Design and Construction

Note: All Group A Tests shall be in accordance with MIL-STD-105.

GROUP B TESTS

100% Inspection:

Performance check

Stability Tests at reduced and high temperatures (25°C. to –55°C. to 25°C. to 125°C. and back to 25°C.) for:

1. Capacitance
2. DC Leakage
3. Equivalent Series Resistance (ESR)
4. Impedance

GROUP C TESTS

Sample Lot Inspection:

Reduced Barometric Pressure (tested to equivalent of 100,000 feet). / Lead Tensile Test / Vibration / Shock / Salt Spray / Temperature and Immersion Cycling / Surge Voltage / Moisture Resistance / Lead Bend Test

Sample units selected from those meeting Group A and B Test requirements.
Continuing 2000-Hour Life Test

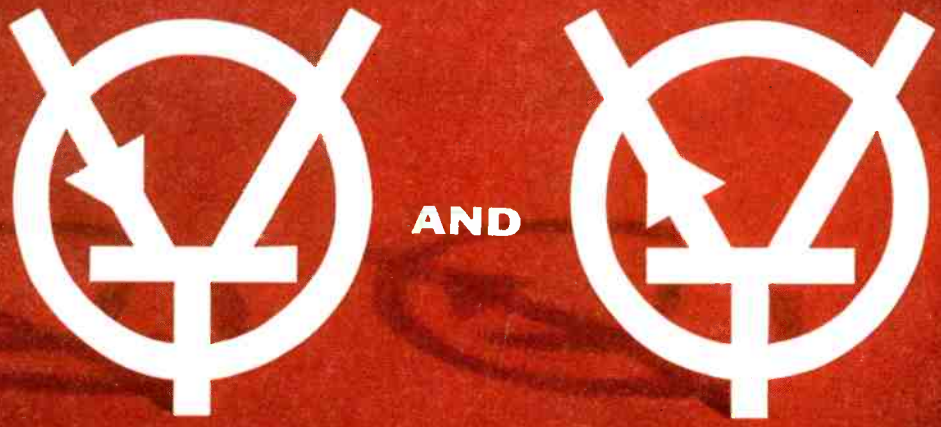
If you want to learn more about what makes the Fansteel Gold-Cap the world's most reliable tantalum capacitor, write to the Publications Department, Fansteel Metallurgical Corporation, North Chicago, Illinois and ask for Gold-Cap Tantalum Capacitor Specifications No. 6CA-101.

FANSTEEL CERTIFIED RELIABILITY

C5910

FANSTEEL METALLURGICAL CORPORATION / North Chicago Illinois, U.S.A.

NOW PHILCO OFFERS BOTH



AND

HIGH FREQUENCY SILICON TRANSISTORS

For High Temperature Applications

TYPES:

2N495
2N496
2N1118
2N1119

2N1199
2N1267
2N1268
2N1269

2N1270
2N1271
2N1272

- LOW SATURATION RESISTANCE
- LOW COLLECTOR CAPACITANCE
- UNIFORM CHARACTERISTICS
- HIGH RELIABILITY

For reliable performance in military and commercial circuits subject to high environmental temperatures, Philco now offers a full range of high frequency switching and amplifying silicon transistors . . . in both PNP and NPN types (SAT* and SADT**).

In high speed circuits, the switching types provide the lowest saturation resistance at high junction temperatures . . . permitting up to 5 mc pulse rates using saturated configurations and up to 30 mc pulse rates with non-saturating techniques.

The excellent high frequency response of the amplifier types permits the practical design of communications systems at frequencies up to 60 mc.

For complete data and application information, write Dept. EI-1059.

*Trademark Philco Corp. for Surface Alloy Transistor.
**Trademark Philco Corp. for Surface Alloy Diffused-base Transistors.

Immediately available off-the-shelf, in quantities of 1 to 99, from your local Philco Industrial Semiconductor Distributor.

PHILCO®

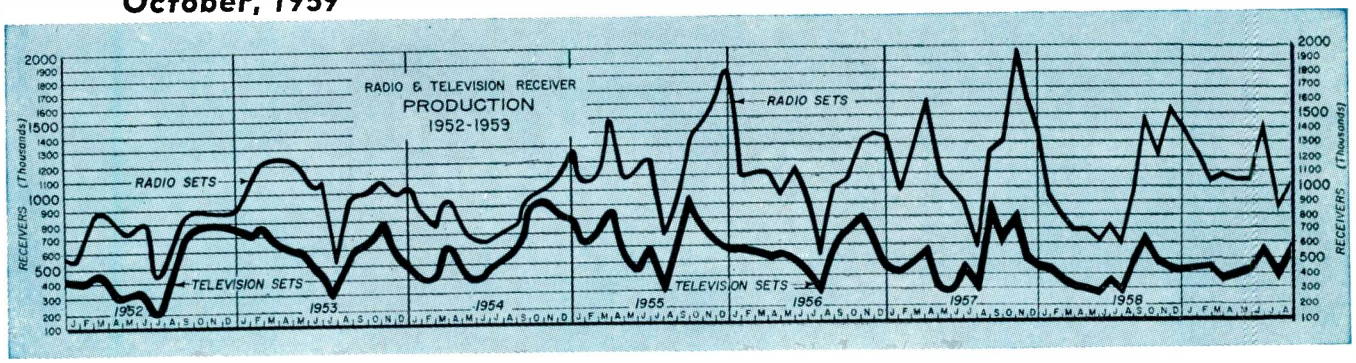
LANSDALE TUBE COMPANY DIVISION • LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.®

Circle 11 on Inquiry Card

Facts and Figures Round-up
October, 1959

ELECTRONIC INDUSTRIES TOTALS

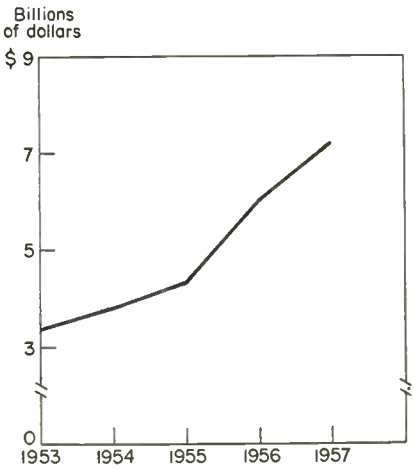


GOVERNMENT ELECTRONIC CONTRACT AWARDS

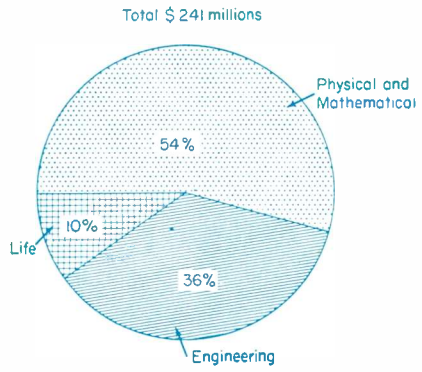
This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in August, 1959.

Amplifiers	155,937
Antennas	224,025
Batteries, dry	277,665
Batteries, storage	356,014
Cable assemblies	218,249
Cable, telephone	619,179
Capacitors	287,921
Cells, photoelectric	90,804
Converter, frequency	80,400
Delay line	25,730
Filter, band pass	61,560
Fuse, cartridge	91,247
Fuseholders	35,862
Loudspeakers	26,381
Meters, frequency	506,025
Meters, volt	75,756
Modulators	127,000
Monitor, coordinate data	1,365,343
Multimeters	650,019
Networks, communications	4,821,715
Oscillators	51,350
Paper, recording	25,599
Potentiometers	80,240
Radar sets	4,759,015
Radio sets	361,681
Receivers, d-f	80,403
Receivers, radio	341,277
Recorders/reproducers	997,493
Reflectors, antenna	29,360
Relay, armature	285,110
Relay assemblies	238,418
Relays, microwave	480,002
Relays, solenoid	44,808
Relays, thermal	53,387
Relays, time delay	167,764
Resistors	1,145,047
Semiconductor devices	272,740
Signal generators	1,095,439
Standards, frequency	38,730
Standards, resistance	80,254
Switches	63,395
Switches, pressure	258,144
Switches, toggle	28,350
Systems, data processing	134,000
Systems, telemetry	78,853
Tape, magnetic	92,500
Test sets, radar	556,800
Test equipment	156,044
Transformers	142,630
Transmitters	2,448,257
Transmitters, radio	647,953
Transceivers	683,196
Transmitters, telemetering	30,075
Transponders	803,452
Tubes, electron	3,268,067
Tubes, magnetron	1,163,379

FUNDS FOR R & D PERFORMED BY PRIVATE INDUSTRIAL FIRMS, 1953-57 *a*



FUNDS FOR BASIC RESEARCH PERFORMED BY PRIVATE INDUSTRIAL FIRMS, BY SCIENTIFIC FIELD, 1957 *a*



* Funds shown here are for private industrial firms, i.e., principally manufacturing and other industrial firms, which account for more than 90% of the total amount for the "industry sector" as a whole. Also included in the sector as defined by the National Science Foundation (but not represented in the chart) are independent commercial laboratories, trade associations, and research centers operated by private industrial organizations under contract with the Federal Government.

Note: Data for each year are expressed in current dollar terms.

National Science Foundation.

TV SET OWNERSHIP

More than 5 of every 6 U. S. households have television sets and about one in every 12 households have two or more sets, according to results of a sample survey conducted in May 1959 by the Bureau of the Census, Department of Commerce.

The May 1959 survey showed that the steady increase of recent years in households with television sets continued through 1958 and early 1959; 86 percent of all households had television sets as compared with 83 percent in January 1958, 80 percent in April 1957 and 12 percent in April 1950.

Not only did television spread to more households, but the proportion of households with more than one set increased. In the May 1959 survey 8 percent of all households had two or more sets as compared with 7 percent in January 1958, and 5 percent in April 1957. Households with one set were 78 percent of the total, and only 14 percent had no set.

Like the earlier surveys of the series, the May 1959 survey found television sets more common inside standard metropolitan areas than elsewhere. Among metropolitan area household, 91 percent had one or more sets, whereas the percentage for nonmetropolitan households was 80.

By geographic region the Northeast was highest, with 92 percent of its households reporting television sets. The North Central Region and the West were next, with 88 percent and 86 percent respectively, although the West had the higher increase of these two regions since the January 1958 survey. In the South, 79 percent of households had television.

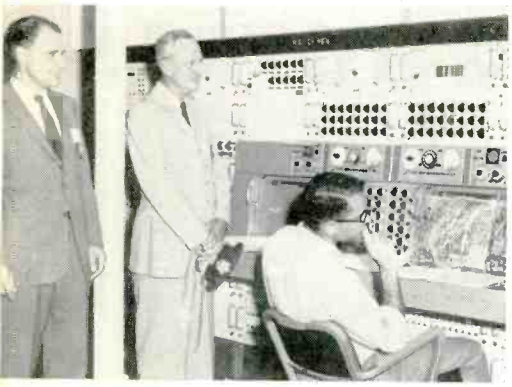
TUBE SALES

Producers sold 36,394,000 receiving tubes valued at $29,786,000 in July compared with 37,421,000 tubes worth $33,099,000 sold in June and 30,795,000 sold in July last year valued at $26,928,000.

Cumulative tube sales totaled 238,373,000 worth $205,560,000 compared with 221,201,000 tubes valued at $193,197,000 sold during the first seven months last year.

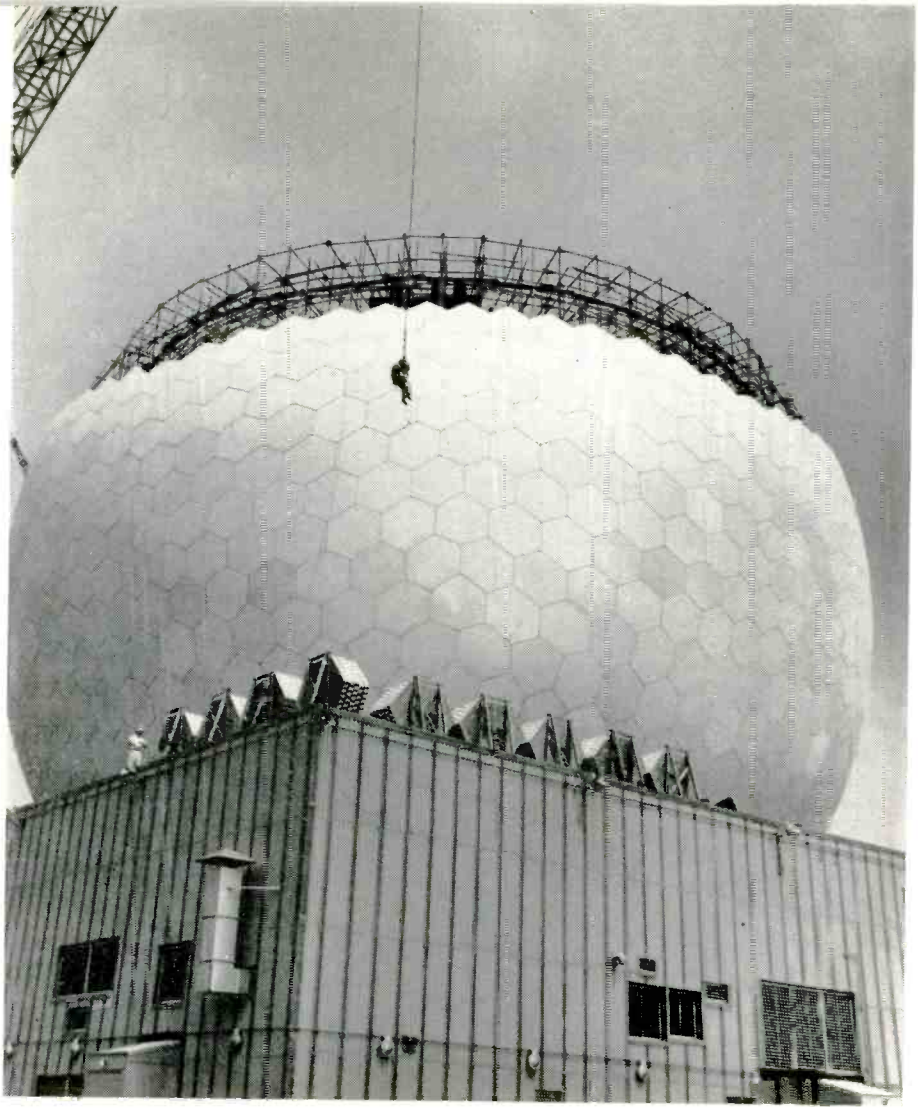
TV picture tube makers sold 750,352 tubes worth $14,648,444 in July compared with 766,566 tubes worth $15,136,612 sold in June and 549,817 units sold in July last year with a value of $11,109,048.

Cumulative TV picture tube sales totaled 5,120,887 worth $98,904,723 against the 4,239,404 tubes sold during the first seven months last year valued at $84,337,167, EIA reported.



SIMULATION TEST

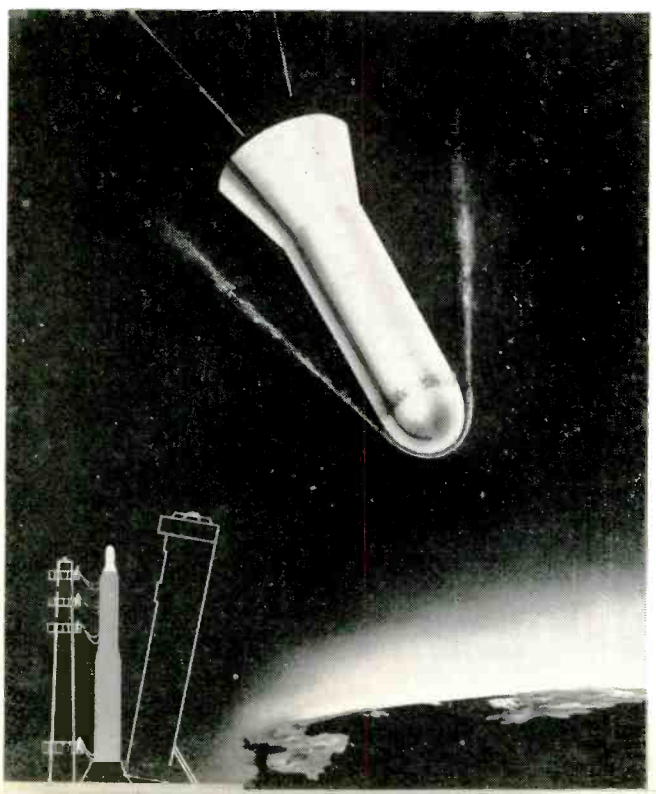
Closed loop simulation test is demonstrated to Air Force's Maj. Gen. Parmer W. Edwards while touring Sylvania's Electronic Defense Laboratory at Mountain View, Calif.



A PIECE OF THE ARCTIC

Strange-looking structure going up near the New Jersey Turnpike just east of Camden is a prototype of similar BMEWS installations in the Far North. RCA's Missile and Surface Radar Div. will use the 140-ft. diameter dome to check out equipment going into the BMEWS system.

Snapshots...of the Electronic

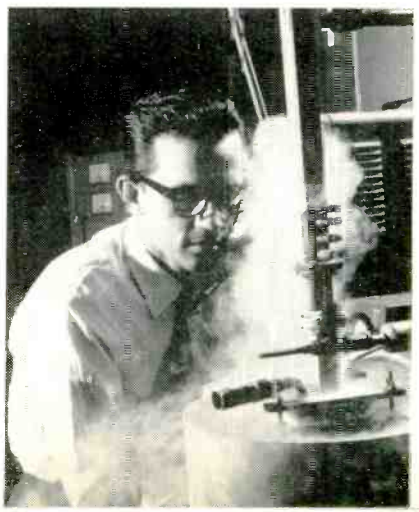


RE-ENTRY VEHICLE

This advanced-design Air Force Titan reentry vehicle (nose cone) employs the ablating principle in which very high-heat-resistant materials are "cooked away" to carry off excessive heat generated during re-entry. Avco's Research and Advanced Development Division has the Air Force contract for its development.

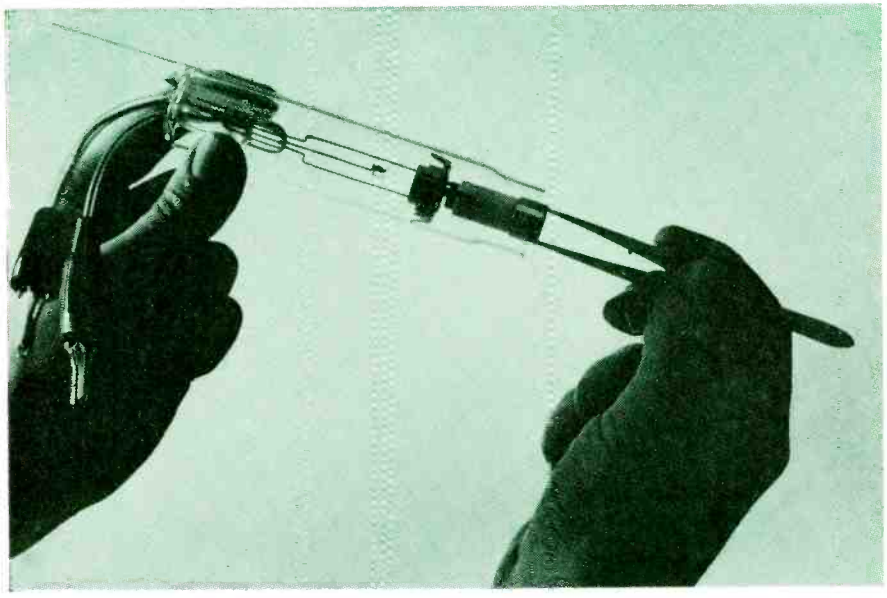
COOL AND CRAFTY

Absolute zero — —459°F.—is achieved within one degree by Sperry Gyroscope Co. scientist testing components for advanced electronic counter-measures systems. Equipment is being checked in bath of liquid helium.



STEPPING TRANSISTOR
At Bell Labs L. A. D'Asaro (r) and I. M. Ross examine characteristics of stepping transistor element in counting and decoding circuit by means of scope trace.

FOXHOLE MISSILE
New "Red Eye" guided missile is designed for use against low strafing and bombing aircraft. Convair developed the 20-lb. 4-ft. long missile for the Army and Marine Corps.

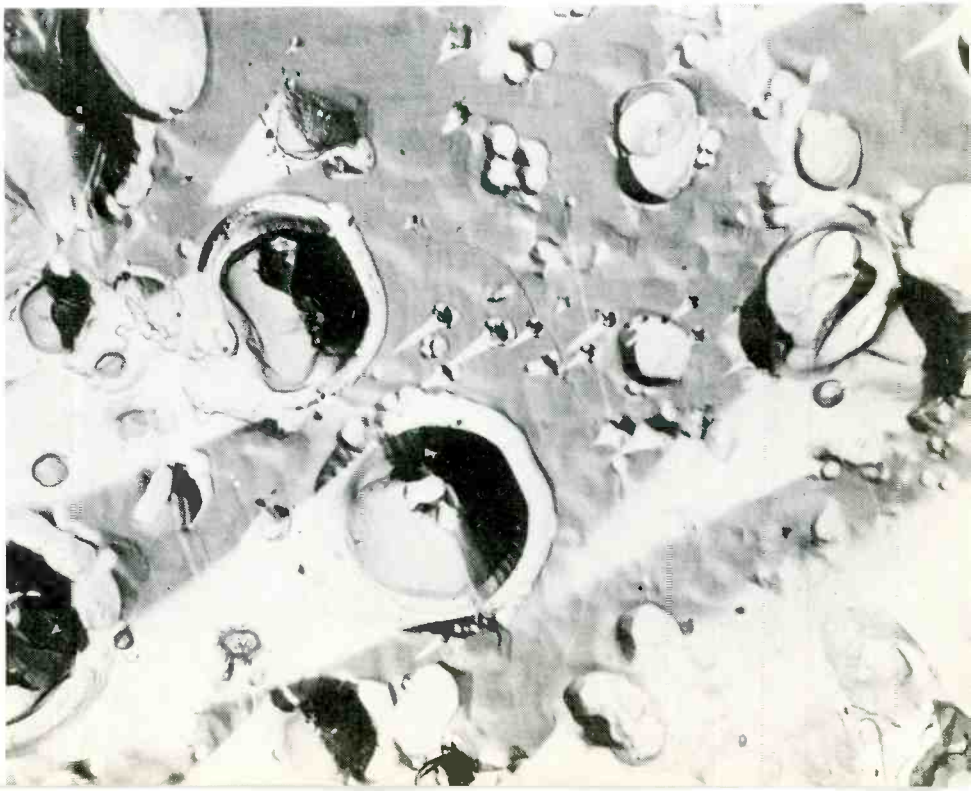


SEMICONDUCTOR CATHODE
This experimental electron tube, under development at Westinghouse, gets its supply of electrons from a crystal of silicon carbide no larger than the head of a pin.

Industries

NUCLEAR CRATERS
Not craters on the moon, but microscopic flaws in uranium irradiated at nuclear power reactor temperatures by General Electric scientists at the Hanford AEC atomic plant

SPUTTERED RESISTORS
Bell Labs' D. A. McLean compares the reduced size of a printed circuit using his newly developed sputtered resistors, with the comparable conventional printed board in his right hand.



Largest selection

Trimpot®

the original leadscrew-actuated potentiometer

More engineers specify Trimpot because:

Trimpot line is complete

Bourns offers you the largest selection of leadscrew actuated potentiometers... 20 basic models—4 terminal types—three mounting methods.

Trimpot is small

Space saving size and rectangular shape permit the installation of 12 to 17 units in one square inch of panel area.

Trimpot is accurate

Multi-turn screwdriver adjustment provides 9000° of rotation...you can make and repeat the finest adjustments.

Trimpot is stable

Adjustment shaft is self-locking...settings are virtually immune to severe acceleration, vibration and shock.

Trimpot is fully tested

All instruments are 100% inspected before shipment to assure you of reliable performance.

Trimpot is proved

It is used in more military and commercial equipment than any other leadscrew actuated potentiometer.

Only Bourns Trimpot potentiometers give you these outstanding features

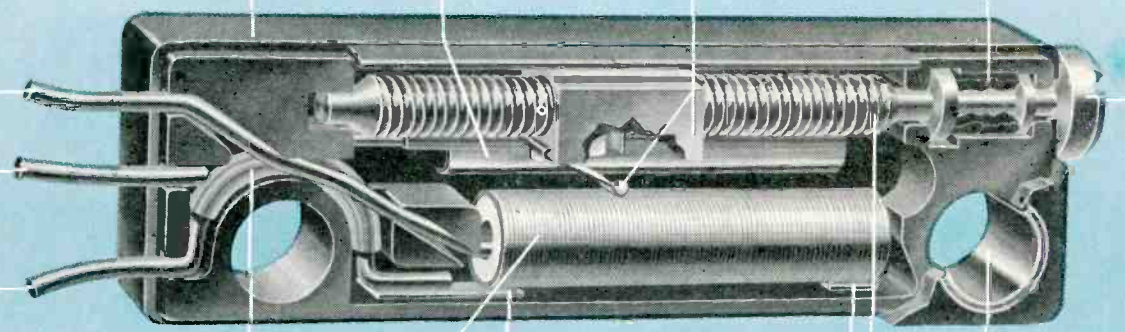
BODY—High-temperature, thermosetting plastic body is sealed, enabling potentiometer to meet Mil-Specs for humidity, sand, dust, fungus, salt spray, etc.

COLLECTOR BAR—Precious metal collector bar provides positive electrical contact, improves potentiometer performance and reliability.

WIPER CARRIAGE—Special high-temperature plastic carriage with precious metal contact spring permits exact settings and stability under severe environmental conditions.

SHAFT HEAD—Stainless steel with machined slot for screwdriver adjustment. Meets military salt spray requirements.

O-RING—Silicon rubber O-ring seals potentiometer against humidity, withstands high temperature.



TUBING INSULATION—Tubing around terminal eliminates possible short or electrical cross-over.

SILVERWELD* TERMINATION—This exclusive Bourns feature is unequalled in ruggedness. There is a metal-to-metal bond from the terminal to the resistance wire.

EYELETS—Stainless steel eyelets are set on ¾" centers and provide easy mounting with 2-56 screws.

TERMINALS—Three terminals are gold-plated copperweld wire or Teflon-insulated leads.

ELEMENT—Special ceramic mandrel is precision wound with low temperature coefficient resistance wire.

LEADSCREW—Stainless steel leadscrew is corrosion resistant, withstands salt spray.

*TRADEMARK

This cutaway of Model 220 is typical of the design of all Bourns Trimpot potentiometers though some features may vary from model to model.

Longest record of reliability

General Purpose Wirewound Trimpot—Model 200. Operates at 105°C / L,S,P terminals / 1/4 watt / 10 ohms to 100K. Available as rheostat, Model 201.

High-Resistance Wirewound Hi-R® Trimpot—Model 207. Operates at 175°C / L terminal / 2 watts / 100 ohms to 100K. Available as rheostat, Model 208 Hi-R Trim R®.

Dual-Element Wirewound Twinpot®—Model 209. Operates at 105°C / L terminal / 1/4 watt / 10 ohms to 20K. Two potentiometer outputs with one adjustment shaft.

General-Purpose Carbon Trimpot—Model 215. Operates at 125°C / L,S,P terminals / 1/4 watt / 20K to 1 Meg. Available as Mil-Spec humidity-proof unit, Model 235 (1K to 10 Meg).

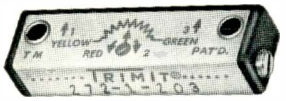
Subminiature Wirewound Trimpot—Model 220. Operates at 175°C / L & W terminals / 1 watt / 100 ohms to 20K. Meets Mil-Specs for humidity.

High-Temperature, Humidity-Proof Wirewound Trimpot—Model 224. Operates at 175°C / L,S,P terminals / 1 watt / 100 ohms to 100K. Meets Mil-Specs for humidity.

Humidity-Proof Wirewound Trimpot—Model 236. Operates at 135°C / L,S,P terminals / 0.8 watt / 10 ohms to 100K. Meets Mil-Specs for humidity.

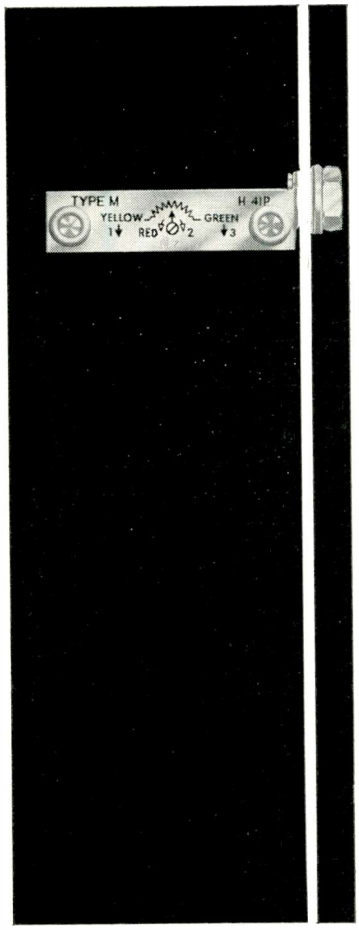
High-Temperature Wirewound Trimpot—Model 260. Operates at 175°C / L,S,P terminals / 1 watt / 10 ohms to 100K.

High-Quality Commercial Wirewound Trimit®—Models 271, 273, 275. Operates at 85°C / L,S,P terminals / 1/4 watt / 100 ohms to 10K.



High-Quality Commercial Carbon Trimit—Models 272, 274, 276. Operates at 85°C / L,S,P terminals / 0.2 watt / 20K to 1 Meg.

Low Cost Commercial Wirewound E-Z Trim®—Model 277. Subminiature—1" x 17/64" x 5/16". Tapered all-purpose lug terminals / 1/2 watt / 100 ohms to 10K. For computers, test equipment, industrial control systems, etc.



Panel-Mount Trimpot

All models are now available with the added convenience of panel mounting. Unique design permits quick factory attachment of rugged panel-mount assembly to standard "on-the-shelf" Trimpot potentiometers. The Panel Mount Trimpot takes as little as 1/12 sq. inch of panel space, meets Mil-Specs for vibration, shock, salt spray, etc. Recessed head prevents accidental changes of setting. Silicon rubber O-ring and Teflon washer provide moisture barrier.

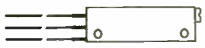
Key to terminals

L — insulated stranded Leads

S — Solder lugs

S — Solder lugs (Model 224 only)

P — Printed circuit Pins



W — uninsulated Wires

Standard resistances (ohms)

10	50	200	1K	5K	20K	100K	500K
20	100	500	2K	10K	50K	200K	1Meg

other Resistances Available

Write for detailed specifications and list of stocking distributors.

BOURNS Inc.

P.O. Box 2112P, Riverside, California

Plants: Riverside, California and Ames, Iowa

In Canada: Douglas Randall (Canada), Ltd., licensee

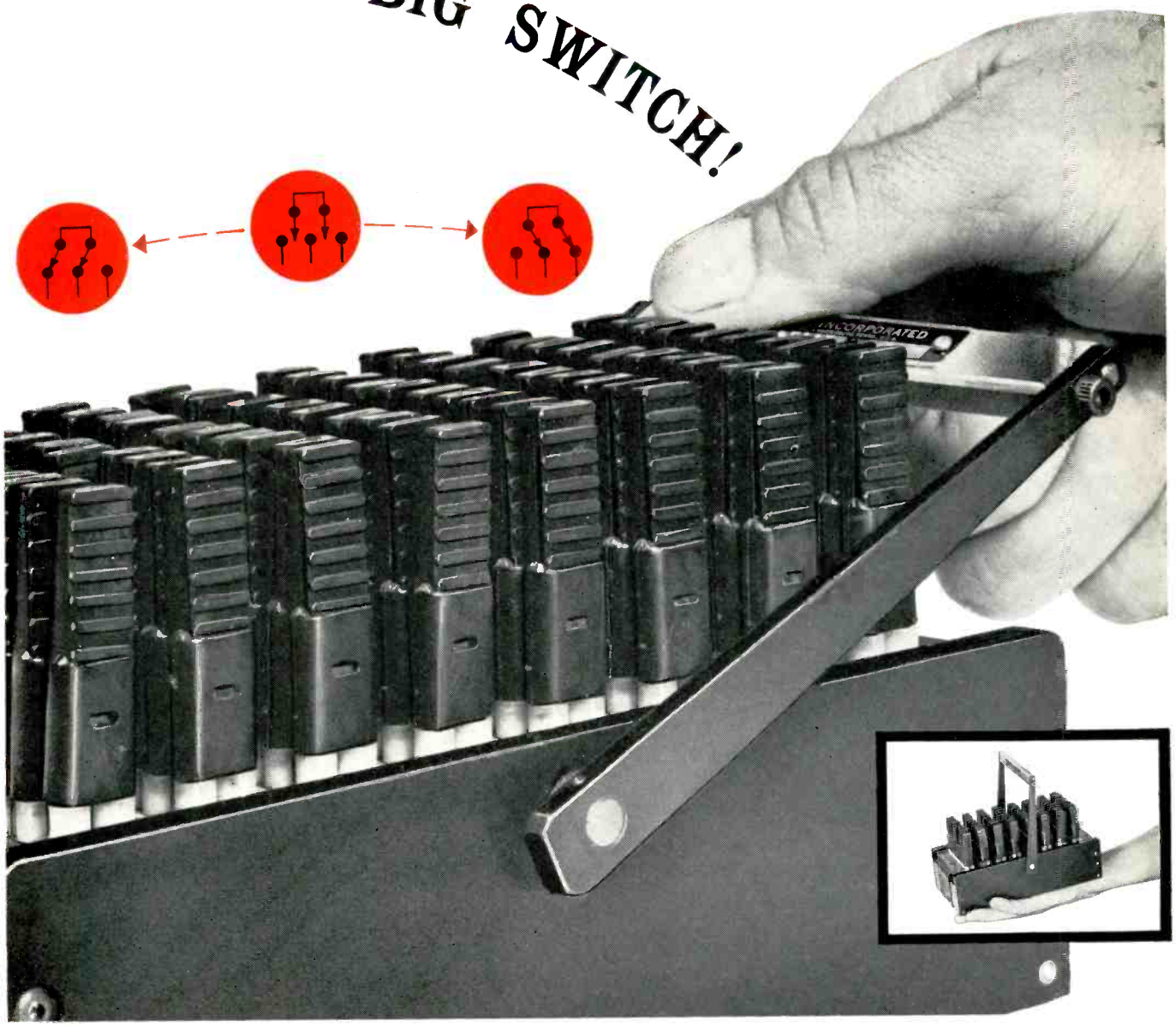
Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration.

Just flick your finger. That's all you do to select either of two circuit programs with AMP's new Program Selector Switch—up to 1500 poles, double throw. Compact in size, available in a fully shielded type, this new switch offers you all the reliability you need for any critical dry-circuit application.

The flick of your finger also pre-cleans all contacts for assured conductivity through AMP's patented wiping action. You get uniform pressure on all contacts . . . choice of tin or gold contact finish . . . exclusive contact and spring design plus many other features from AMP's industry-proved Patchcord Programming Systems . . . including A-MP Taper Pins, crimped to your leads and inserted into taper receptacles in the rear of the switch.

And—for flexibility, you can make a combination plug board and double throw switch with all throw positions independently patched.

THE BIG SWITCH!



Make the big switch to the A-MP Double Throw Program Selector Switch. Send today for more information.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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

Electronic Industries International

WESTERN EUROPE

Nuclear Conference To Define Responsibility

Edward Diamond, Secretary and General Counsel of Stromberg-Carlson Div., General Dynamics Corp., will represent the U. S. on an international panel of experts on Civil Liability and State Responsibility for Nuclear Hazards meeting in Vienna. The panel, an agency of the International Atomic Energy Commission, is drafting an international agreement covering these aspects of the peaceful applications of nuclear energy.

At its last meeting, the panel agreed that the courts of the state in which nuclear installations are located should adjudicate claims for damages, except for incidents occurring during transport of nuclear materials. These would be heard by the courts of the country in which the incident takes place. They also agreed that liability for a nuclear incident should be absolute—no proof of fault would be necessary — and that an international standard limiting the amount of liability should be established. Mr. Diamond will present his views on these aspects.

ASSIGNED TO EUROPE

Assistant Chief Engineer, Herman R. Buttner, Burndy Corp., Norwalk, Conn., will spend several months training company reps in Europe. He and Mrs. Buttner will live in Antwerp, Belgium.

Firm Forms International Division

Laboratory for Electronics, Boston, Mass., plans to establish a new International Division. Headquarters will be in Geneva, Switzerland, and Paris, France. The new division will be under the direction of M. J. Johnson, LFE's Director of Foreign Operations.

The firm manufactures electronic systems in the Airborne Navigation and Ground Control Approach radar fields. Typical is the firm's Doppler Airborne Navigation System being installed in the Air Force's F-105 Thunderchief.

Sweden Buys British TV Equipment

The TV and sound broadcasting equipment for a major expansion of the Swedish TV and FM networks will be supplied by Marconi's Wireless Telegraph Co. The equipment, costing over $800,000, will extend coverage of the net to over 7,000,000 people.

Included in the order are 20 Type BD321 5 kw FM transmitters and 16 TV transmitters.

U.S.S.R.

Russians Remove "Trademark" Set

A Russian-made "Admiral" TV set was removed from the Soviet Exhibition in New York following a strong protest made by Ross D. Siragusa, President of Admiral Corporation, Chicago, Ill. (See International News, Sept. '59.) He had pointed out that while Russia was not a signatory to the International Trademark agreement, the mere display of a TV set with an "Admiral" name on American territory constituted an open infringement of the company's registered trademark.

Said Mr. Siragusa, "We are satisfied with the results of our protest and now consider the matter closed."

Tours U.S.S.R.

L. J. Hartzer, President of Radiation Instrument Development Laboratory, Inc., Chicago, will visit Moscow, Stalingrad, Sochi, Kharkov, Kiev, and Leningrad during an 18-day stay in Russia. He will inspect current Soviet development and production in nuclear instrumentation.

WEST GERMANY

U. S. Firm Establishes Facility

Baird-Atomic, Inc., Cambridge, Mass., has established a distribution and installation service for its line of spectographic instrumentation in Kleve, West Germany. Joseph J. de Beer has been named manager of the new German office which will be responsible for marketing in Austria, Denmark, Germany, and Holland.

CANADA

First TV over Microwave Link

The first public transmission of TV over a new 524-mile, microwave system linking St. Johns, Newfoundland to Sidney, Nova Scotia, and thence to the rest of North America was the showing of the visit of Queen Elizabeth to North America. The system is said to include the world's longest over-water microwave link, a 70 mile path across Cabot Strait between Nova Scotia and Newfoundland. The microwave chain of 23 stations provides 600 two-way telephone circuits.

UNITED KINGDOM

Form Subsidiary in England

The Industrial Education Institute, Boston, Mass., has formed an overseas subsidiary with headquarters in London. The new organization, Industrial Education International, Ltd., was established to provide a means of exchanging technical and management information on an international basis.

In addition to training programs, IEI will present symposiums, conferences, seminars, etc., in major industrial centers throughout Europe. The first of these conferences is scheduled for London, Paris, Milan, and Madrid in the fall.

Develop High Frequency Radio System

Marconi's Wireless Telegraph Co., Ltd., has announced the development and engineering of a new system of high-frequency radio transmission. A way has been found to provide wideband amplification over the whole h-f band making it possible to dispense with all forms of operational tuning in the transmitter's h-f amplifier stages. At the same time it permits the simultaneous radiation of two or more independent transmissions from one equipment.

The new technique overcomes a major drawback with conventional transmitters—the stage-by-stage retuning of the h-f amplifier whenever it is desired to change frequency.

JAPAN

TV Specialist to Visit U. S.

Washington TV station, WRC-TV and the Dept. of State are jointly sponsoring a 3-month professional and cultural visit by a Japanese TV specialist, Mr. Hiroshi Saheke, Chief of the TV Broadcasting Branch of the Osaka TV Co.

(*Continued on Page* 32)

INHERENT STABILITY
Assured in a DALOHM RH Resistor

Even searing heat from a glowing bed of coals causes no deviation from the inherent stability that is standard in Dalohm resistors.

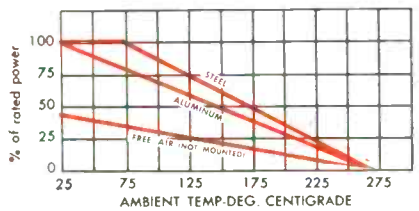
Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision resistors retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

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

HIGH POWER • WIRE WOUND • MINIATURE
DALOHM TYPE RH RESISTORS

Designed for specific application of high power requirements, coupled with precision tolerance. Mount on chassis for maximum heat dissipation.

TYPICAL DERATING CURVE



- **Rated at** 10, 25, 50, 100 and 250 watts
- **Resistance range** from 0.1 ohm to 175K ohms, depending on type
- **Tolerances** ± 0.05%, ± 0.1%, ± 0.25%, ± 0.5%, ± 1%, ± 3%
- **Temperature coefficient** 20 P.P.M.
- **Operating temperature range** from −55° C. to +275° C.
- **Welded construction** from terminal to terminal.
- **Ruggedly housed;** sealed in silicone and inserted in radiator finned aluminum housing.
- **Smallest in size,** ranging from 7/16" x ¾" to 3" x 4½"
- Surpass applicable paragraphs of MIL-R-18546B (Ships).

SPECIAL PROBLEMS?

You can depend on Dalohm, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

Write for Bulletin R-21, with handy cross-reference file card.

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1304 28th Ave., Columbus, Nebr.

Cutting costs of Switch Installation... your job...and Centralab's

New!

Centralab Printed Circuit Switches

the greatest advance in switch design in decades

The CENTRALAB Series 20 Printed Circuit Switch provides these cost-saving advantages:

1. Elimination of switch wiring errors.
2. Simultaneous connection of all switching leads during dip soldering of etched circuit boards.
3. No hardware is required for rigid anchoring of switch to the board.

SPECIFICATIONS:

Construction: 1¾" high x 2" wide laminated phenolic sections. Bolted construction multiple sections and staked single or dual section assemblies.

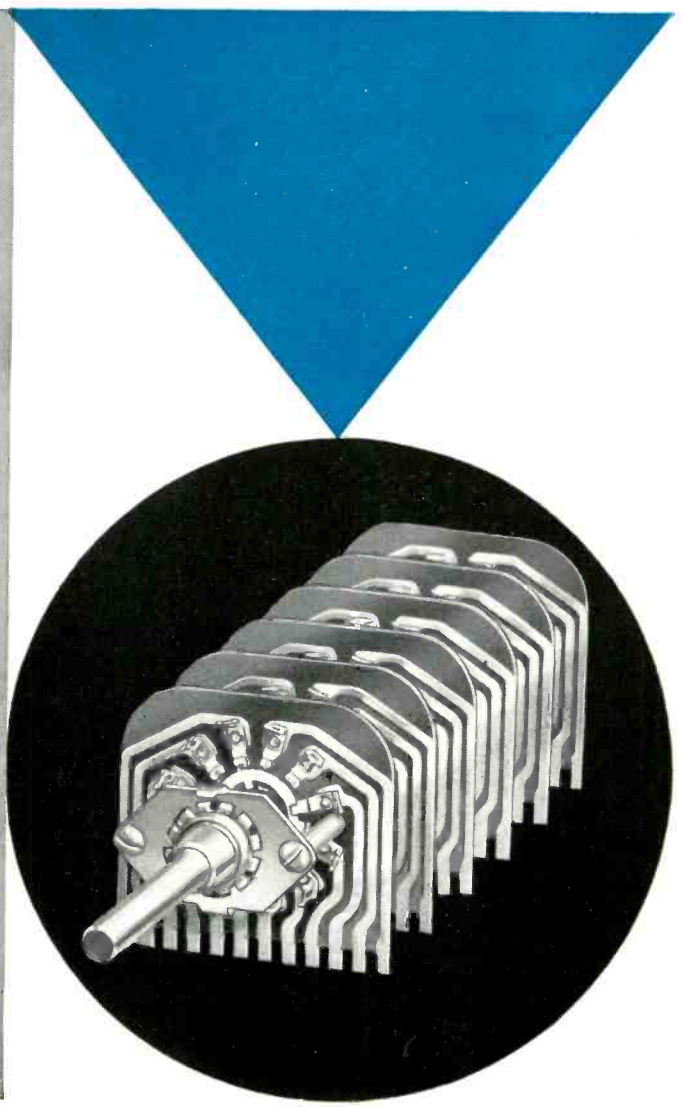
Switching Combinations: 1 pole—12 positions through 6 pole—2 positions. Also available with dual concentric shafts for A.C. line switch or ½ watt variable resistor, equipped with printed circuit terminals.

Rating: 2 amperes at 15 volts D.C., 150 ma. at 110 volts A.C. (make and break, resistive load).

Insulation: Laminated phenolic type PBE per specification MIL-P-3115. Voltage breakdown 1000 volts RMS.

Rotational Life: 10,000 cycles minimum.

For complete physical and electrical specifications on CENTRALAB Printed Circuit Switches ask for Bulletin EP-757.



Centralab
P-5956

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In Canada: 669 Bayview Ave., Toronto 17, Ont.

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

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 17 on Inquiry Card

ELECTRONIC INDUSTRIES *International*

(*Continued from page* 28)

Mr. Saheki will have a week of orientation at the Washington International Center. He will then spend 2 months as a member of the WRC-TV broadcasting staff. He will wind up his visit with a several week tour of other parts of the U. S.

GREENLAND

Test Hearing-aid in Arctic

Dr. R. W. Gerdel, Chief of the Climactic and Environmental Research Branch of the Department of Defense, will test a Zenith transistor hearing aid while directing snow, ice, and permafrost research in the arctic wastelands of Greenland. He will submit a detailed report to Zenith engineers on the effect of subzero weather on transistors, batteries, cords, and other mech parts of the hearing aid.

SOUTH AMERICA

Build TV Sets in Argentina

Industrias Plasticas y Electronicas de Cordoba S.A.C.I. (IPEC), Argentina, is building TV receivers under an agreement with Hoffman Electronics Corp., Los Angeles, Calif. Besides two console and two table model TV's, the company is manufacturing Hoffman solar-powered radios.

Loan to Improve Telecommunications

The U. S. Development Loan Fund is considering a $1,000,000 loan to the Government of Paraguay to help provide improved telephone, telegraph, and teletypewriter service between Paraguay and other countries. The loan is contingent upon an American engineering survey report as to the equipment needed. The loan is expected to improve service to New York, Europe, Rio de Janeiro, Montevideo and Buenos Aires. In each case 4 channels for simultaneous use will be provided.

New TV Station for Brazil

A new TV station is to be built at Recife, Pernambuco, Brazil. The equipment, $700,000, will be supplied by Marconi's Wireless Telegraph Co., Chelmsford, Essex, England. Empresa Jornal do Comercio S. A., Recife, owns the station.

Equipment includes 4½ in. image orthicon cameras (three studios), master control equipments, two vidicon telecine units, and lighting, sound, test, and ancillary equipment, a three-camera outside broadcast vehicle, and micro-wave link equipment.

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 Ez Min. (v)	Ez 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 42$_v$ 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...

Now available!

Varicap®
Voltage-Variable Capacitor

ACTUAL SIZE

Varicap Type	Capacitance @ 4VDC μμf	Approx. Range μμf*	Quality Factor (Q) @ 50 mc. Minimum @ 4VDC	Typical @ 4VDC	Typical @ MWV	Maximum Working Voltage (MWV) Volts D.C.
MODULATION, AFC AND OTHER APPLICATIONS						
V-7	7	3.0-18	13	18	43	25
V-10	10	4.3-26	13	18	43	25
V-12	12	5.2-31	13	18	43	25
V-15	15	6.5-39	13	18	43	25
V-20	20	10-50	7.0	18.7	40.2	20
V-27	27	14-70	7.0	15.7	33.8	20
V-33	33	17-85	7.0	14.6	31.4	20
V-39	39	20-100	7.0	15.1	32.4	20
V-47	47	24-120	7.0	15.4	32.4	20
V-56	56	32-145	7.0	13.5	24.8	15
V-68	68	39-175	9.0	14.0	25.8	15
V-82	82	47-210	9.0	13.0	23.9	15
V-100	100	57-260	8.0	11.0	20.2	15
HIGH VOLTAGE TYPES—TUNING AND OTHER APPLICATIONS						
V-7E	7	1.5-18.0	3.0	4.5	22.5	100
V-10E	10	2.2-26.0	3.5	5.5	27.5	100
V-12E	12	2.7-31.0	4.0	6.5	32.5	100
V-15E	15	3.3-39.0	4.5	7.5	37.5	100
V-20E	20	5.0-50.0	7.0	18.7	78.5	70
V-27E	27	7.0-70.0	7.0	15.7	63.5	65
V-33E	33	9.0-85.0	7.0	14.6	56.5	60
V-39E	39	11.0-100.0	7.0	15.1	55.8	55
V-47E	47	14.0-120.0	7.0	15.4	53.8	50
V-56E	56	20.0-145.0	7.0	13.5	41.8	40

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

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

*** Since preparation of these devices and types have been *now available.* Call your nea information!** *Standard Modulator & Rings... 10 to 20 KV High Voltage*

PSI Hi-Q Varicap®

ACTUAL SIZE

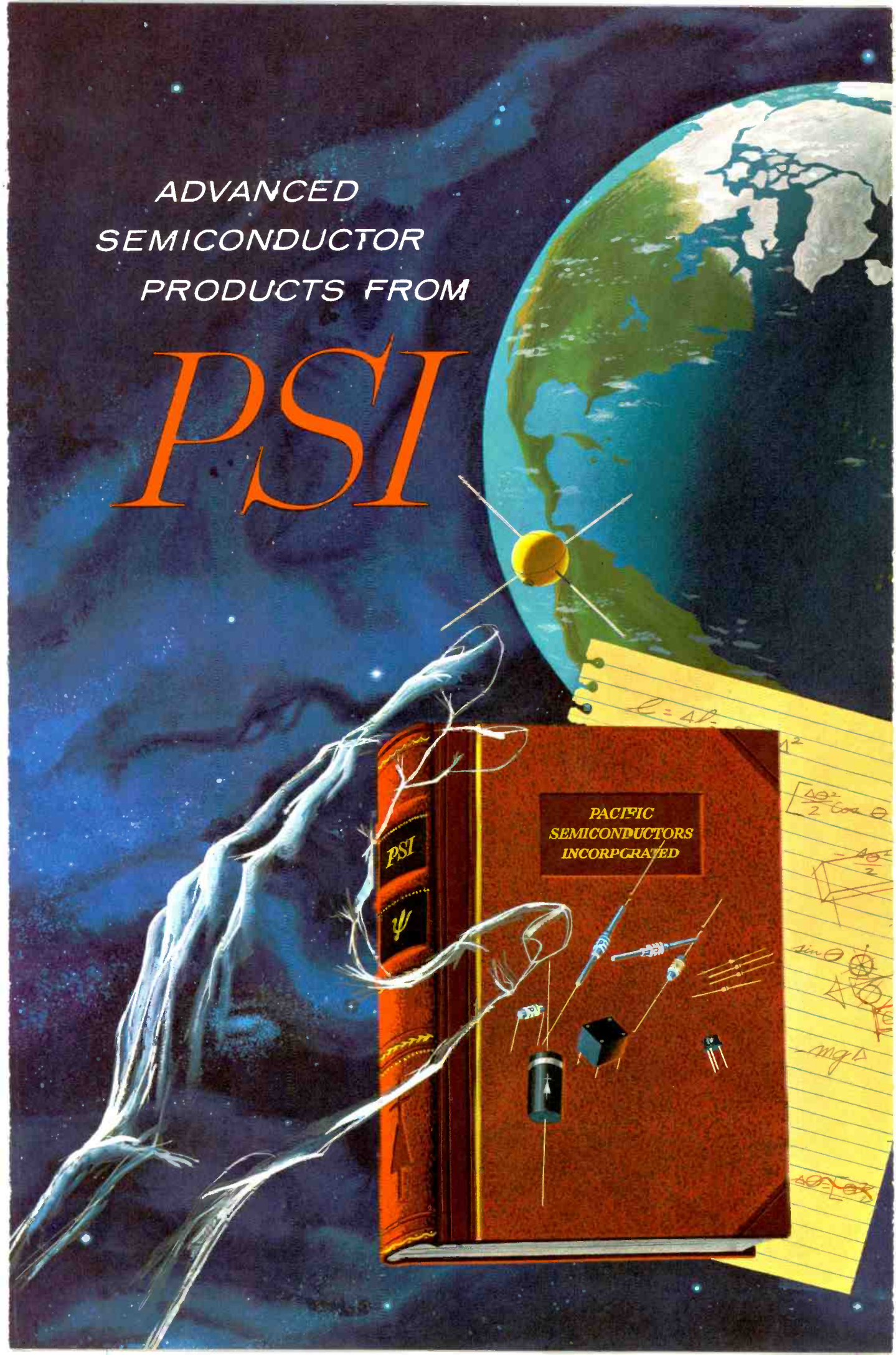
VARICAP TYPE	Capacitance* @ 4VDC 50MC (μμf)	Quality Factor Min. (Q) @ 4VDC 50MC	Max. Working Voltage (VDC)	Minimum Saturation Voltage @ 100 μADC (VDC)	Maximum Inverse Current @ 50VDC (μADC)
PC-112-10	10	50	80	90	1.0
PC-113-22	22	50	80	90	1.0
PC-114-47	47	50	80	90	1.0
CAPACITANCE CHANGE: From 2VDC to 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 @ 100 μADC (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.

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


ADVANCED
SEMICONDUCTOR
PRODUCTS FROM
PSI
PACIFIC
SEMICONDUCTORS
INCORPORATED
PSI
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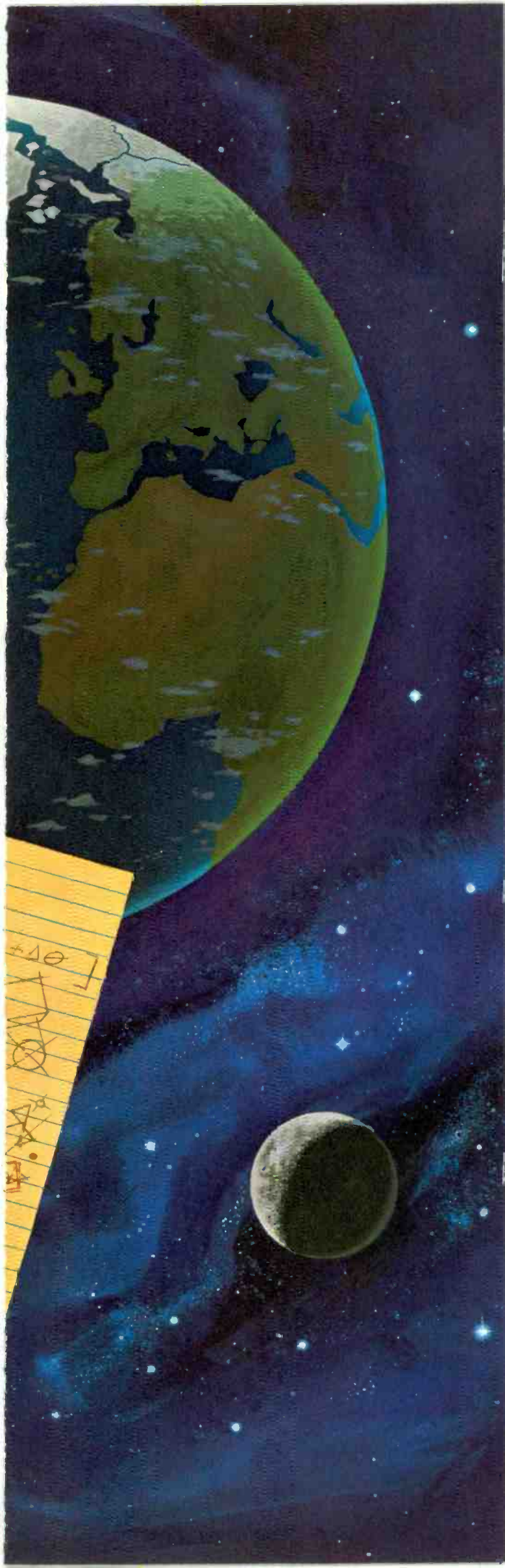


* NEW!

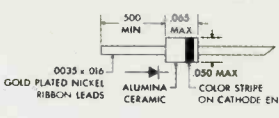
Immediately available from PSI important advances in Micro-Miniaturization...

PSI microdiode®

ACTUAL SIZE

TYPE No.	Min. Sat. Voltage @ 100 μa (v)	Min. Fwd. Current @ +1.0 V (mA)	Maximum Reverse Current (μA)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res (ohms)	Max. Recov. Time (μs)
PD-1	50	5	1(10v)	25(10v)	100K	1.0
PD-021	50	20	.5(10v)	25(10v)	100K	0.3
PD-031	100	5	.5(10v)	25(10v)	100K	0.3
PD-034	100	20	.5(10v)	25(10v)	100K	0.3
PD-041	200	10	.025(10v) 1(10v)	5(10v)	200K	0.3
PD-042	200	10	.5(10v) 5(10v)	25(10v)	200K	0.3

DIMENSIONAL SPECIFICATIONS



A major advance in micro-miniaturization featuring high standards of reliability. Volume and weight of these new PSI types are approximately 1/20 of present subminiature diodes.

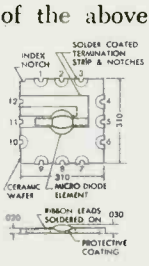
These six types of silicon diffusion computer Microdiodes, except for power ratings, are the electrical equivalent of PSI subminiature computer diodes.

All types immediately available.

PSI micromodule®

ACTUAL SIZE

The new PSI Micromodule is available now, in all of the above Microdiode types. Phone, wire, or write your nearest PSI Sales Office for detailed specifications, curves, reliability data, prices and delivery schedules.



Please Note: All specifications and information contained herein are current as of:

October 1, 1959.

*NEW!

VHF Silicon Power Transistors

N-P-N Triple-diffused mesa types

2N1335 2N1336 2N1337 POWER AMPLIFIERS

2N1339 2N1340 2N1341 POWER OSCILLATORS

HIGH FREQUENCY 170 mc Alpha Cut-off

HIGH VOLTAGE 160v Peak Collector—Base Voltage

HIGH POWER 2.8 watts @ 25°C case temperature

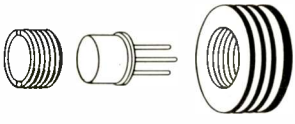
LOW OUTPUT CAPACITANCE 4$\mu\mu$f typical

Available in the JEDEC 30 (TO-16) package, these units are particularly well suited for general VHF use. Applications include power output stages, high level video amplifiers, power oscillators, and many others requiring the unique combination of high frequency, high voltage and high power.

*NEW!

PSI® Heat Dissipator

Low Cost... High Efficiency



*NEW!

High Speed N-P-N Silicon Switching Transistors

2N1409-2N1410

Immediately Available!

Phone, wire or write your nearest PSI sales office for full details.

Silicon Subminiature Rectifiers

ACTUAL SIZE

MEDIUM POWER TYPES

EIA TYPE NUMBER *	MAXIMUM RATINGS			ELECTRICAL CHARACTERISTICS			
	Peak Inv. Voltage (v)	Maximum Avg. Rectified Current (mA)[1]		Minimum Saturation Voltage @ 100°C	Maximum Reverse Current @ PIV (μA)		Max. Fwd. Voltage Drop @ Ib =400 mA @ 25°C (v)
		@ 25°C	@ 150°C		@ 25°C	@ 100°C	
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			ELECTRICAL CHARACTERISTICS	
	Peak Recurr. Inverse Voltage (volts)	Maximum RMS Input Voltage[2] (volts)	Maximum Average Rectified Current[1] (mA)	DC Forward Voltage @ Specified Current @ 25°C (volts @ mA)	Maximum Average Inverse Current[1] (@ 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)		MAX RMS Input Voltage (volts)	MAX DC Fwd Voltage Drop @ 100 mA DC 25°C	Dimensions (inches)	
		@ 25°C	@ 100°C			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.

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	Maximum Reverse Current (μa) 100°C	Reverse Recovery Characteristics: Reverse Resistance (ohms)	Reverse Recovery Characteristics: 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
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

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

*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 High Conductance Diodes

ACTUAL SIZE

PSI or EIA TYPE NUMBER	Minimum Saturation Voltage @ 100 μa @ 25°C (volts)	Maximum Forward Voltage DC @ 25°C (volts) @ 100 mA	Maximum Forward Voltage DC @ 25°C (volts) @ 200 mA	Maximum Inverse Current at Maximum DC Operating Voltage (μa @ volts) @ 25°C	Maximum Inverse Current at Maximum DC Operating Voltage (μa @ volts) @ 150°C	Maximum Average Rectified Current (mA) @ 25°C	Maximum Average Rectified Current (mA) @ 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.

pages, many *new* and exciting
dded to the PSI line *and are*
rest PSI sales office for latest
Quads . . . Standard Bridge Rectifiers
artridge Rectifiers . . . and many others!

Silicon General Purpose Diodes

ACTUAL SIZE

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

Now available!

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

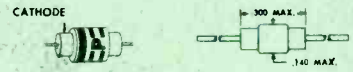
	"R" Package	"S" Package	"T" Package
Length	.375" to 1.75"	.45"	.50"
Width	.25"	.39"	—
Height	.50"	.40"	—
Diameter	—	—	.375"

Silicon Very High Voltage Cartridge Rectifiers

¼ ACTUAL SIZE

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
1N1139	4 5/16	3600	65	27.0	.025
1N1140	2 1/2	3600	65	18.0	.025
1N1141	4 5/16	4800	60	36.0	.025
1N1142	2 1/2	4800	50	24.0	.025
1N1143	4 5/16	6000	50	45.0	.025
1N1143A	4 5/16	6000	65	30.0	.025
1N1144	6 1/16	7200	50	54.0	.025
1N1145	4 5/16	7200	60	36.0	.025
1N1146	6 1/16	8000	45	60.0	.025
1N1147	6 1/16	12000	45	60.0	.025
1N1148	6 1/16	14000	50	52.0	.025
1N1149	6 1/16	16000	45	60.0	.025

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



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.

Unusual Opportunities in Semiconductor Electronics . . . in the New PSI Facility

With the opening of the first unit of the newest and most modern semiconductor manufacturing facility in the country, Pacific Semiconductors, Inc., announces exceptional technical staff opportunities in expanding programs for advanced semiconductor devices.

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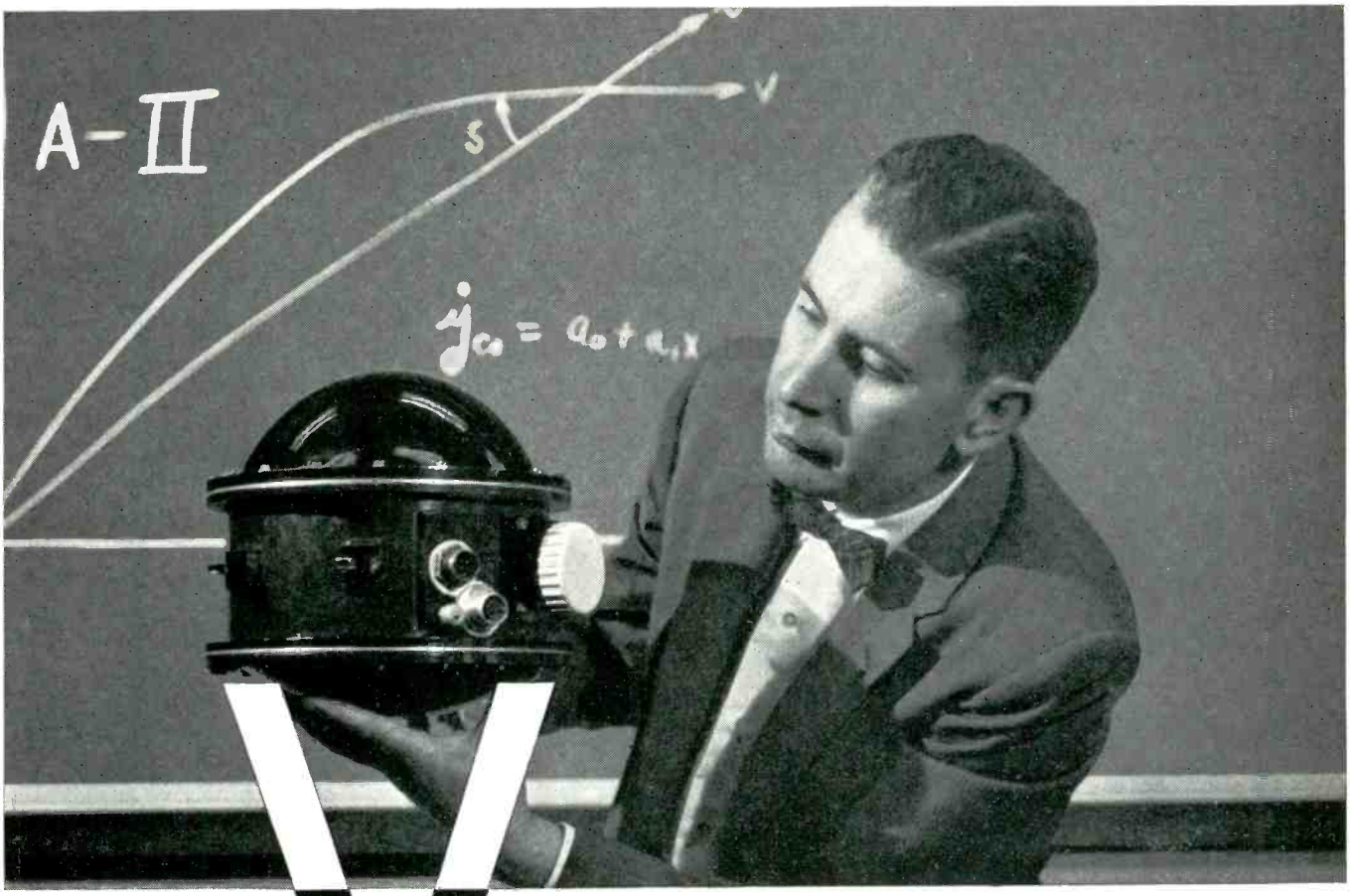


Edwin Felch, project director in charge of developing the Titan guidance system, holds the "voice" of the ICBM.

VOICE OF A GUIDED MISSILE

This is a missile-borne transmitter. It is the "voice" of a missile in flight . . . part of a new radio-inertial guidance system developed by Bell Telephone Laboratories for the Ballistic Missile Division of the Air Force.

This versatile system helped deliver the nose cone of a Thor-Able test missile precisely to its South Atlantic target area—5000 miles from Cape Canaveral, Florida. So accurately was the nose cone placed that a waiting group of ships and planes retrieved it in a matter of hours. It was the first nose cone ever to be recovered after so long a flight.

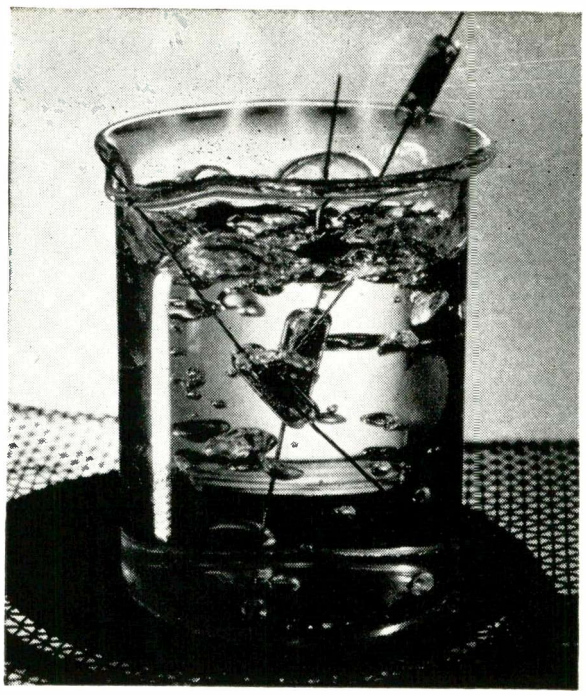
The command guidance system which made such accuracy possible combines precision tracking radar with a special Remington Rand Univac computer. Fed a steady stream of signals from the missile-borne transmitter, the ground-based equipment compares the missile's flight path with the preselected path. Corrective steering orders are computed and transmitted automatically to the missile. The ground station monitors the progress of the flight continuously and obtains immediate evaluation of mission success. And since the principal control equipment is kept on the ground, expendable hardware in the missile itself is minimized.

This radio-inertial guidance system is a product of the Bell Laboratories-Western Electric development-production team. It is in production at Western Electric for the first operational squadrons of the Titan intercontinental ballistic missile.

Bell Labs scientists and engineers developed the world's most versatile telephone network and much of our nation's radar. They have constantly pioneered in missile systems. From their storehouse of knowledge and experience comes this new achievement in missile guidance.

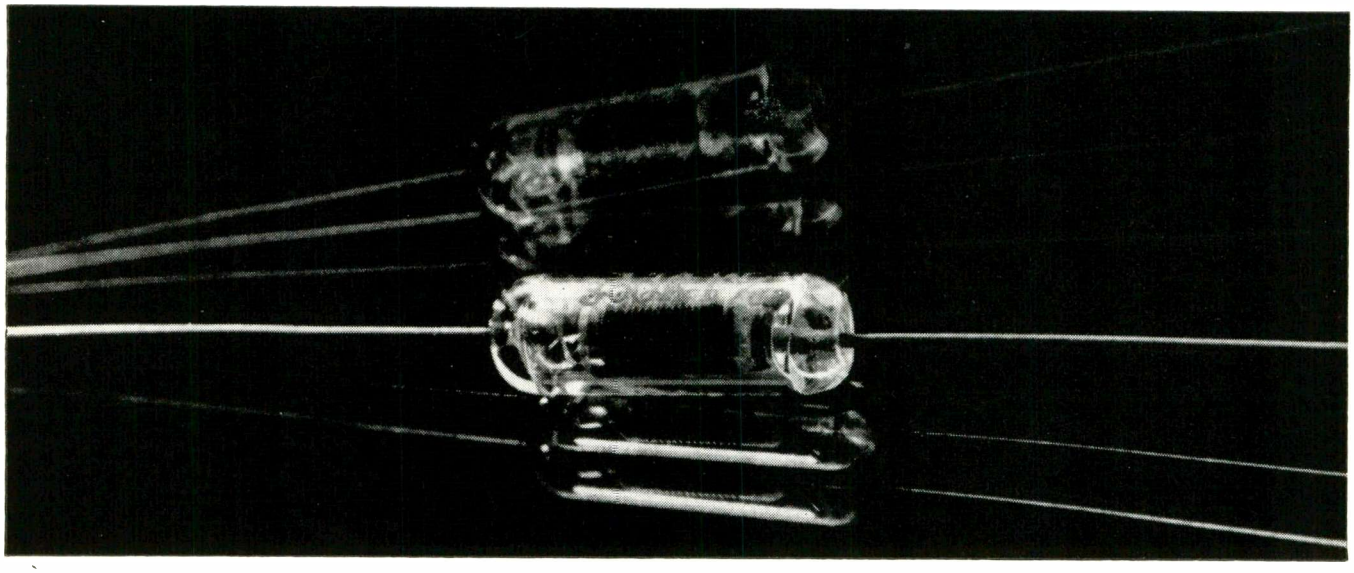
BELL TELEPHONE LABORATORIES

World center of communications research and development



boil it

bounce it



New fusion-sealed resistor from Corning with zero moisture absorption

When your work borders on the exotic and your components all have to be *ultra*, take a look at this new glass-enclosed, fusion-sealed resistor.

The glass enclosure lets this ¼-watt resistor defy all environmental conditions... exceeding MIL-R-10509C, Characteristic B. We've even boiled it in salt water for days without altering electrical characteristics. The glass enclosing the resistor has zero moisture absorption.

The glass-to-metal seal is comparable to that in a vacuum tube . . . and is even more resistant to physical shock.

The Dumet leads, sealed to a thermally compatible glass case, create a true hermetic seal. The leads are fused directly to the resistance element.

The tin oxide film resistance element is similar in design and performance to that of a Corning N-style resistor. Resistance ranges from 10 ohms to 360 K ohms; full rating at 70° C. with derating to 150° C. Temperature coefficient is less than 300 ppm/° C.

For the complete story, write for data sheet to **Corning Glass Works,** 546 High Street, Bradford, Pa. Or contact our sales offices in New York, Chicago, or Los Angeles.

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U.S. Major Missile Makers Depend on ND Reliability!

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N.D. reliability is maintained in manufacturing . . . where advanced methods and successive inspections pay off in unerring prototype precision and uniformity . . . to ASA and AFBMA standards.

N.D. reliability costs no more . . . the growing number of America's leading missile manufacturers that are counting on N.D. reliability is proof in itself . . . it costs no more. In fact, many manufacturers find it *costs less!*

N.D. availability is added assurance . . . while original orders are delivered in quantity when and where they're needed, strategically located inventories prevent lost time and shortages in vitally important missile projects.

For immediate information call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

Tele-Tips

A METAL IS A METAL, or is it? When an item came across our desk about how anodized aluminum wafers were being used to insulate power transistors from the chassis we took a double-take. Metal wafers as insulators? Was someone pulling our leg? It turned out that—no, it is really being done. One of our metallurgist friends described how. It seems that in the anodizing process a thin film of aluminum oxide is formed underneath the brittle outer surface and this thin film is an excellent insulation. At the same time it is a very fine conductor of heat. So in the same metal wafer we have an electrical insulator and a fine heat conductor to carry the transistor's heat to a heat sink or chassis.

CLOSED-CIRCUIT TV will be used by the government to dispose of $1.5 million worth of surplus equipment. Prospective buyers in six cities — Boston, New York, Philadelphia, Columbus, Ohio, Chicago and St. Louis—will be included in the network that will flash pictures directly from the Granite City, Ill. Army engineer depot, the Shelby, Ohio Air Force depot and the Philadelphia Navy Shipyard. The broadcast will take place on Oct. 7th.

AUTOMATIC BETTING machines that went into operation at Yonkers Raceway, Yonkers, N. Y. last month, electronically identify $5 bills. The three "Ameteller" units, first ever installed at any racetrack, also handle bet details—whether customer wants to go for win, place, or show. The unit is coordinated with a standard parimutuel ticket-issuing machine.

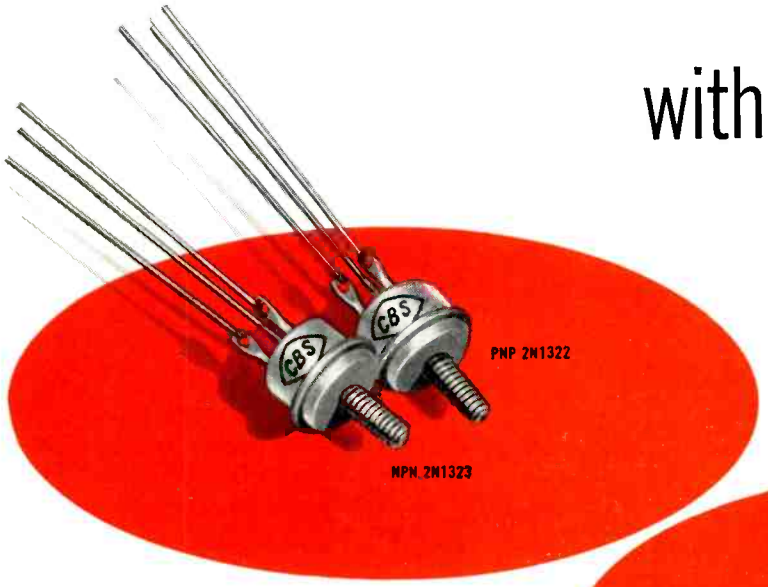
FIRST STAGE of an ICBM can lift a total weight of 110 tons—equivalent to 12 city buses. Its thrust equals the combined horsepower of 15,300 average U. S. automobiles.

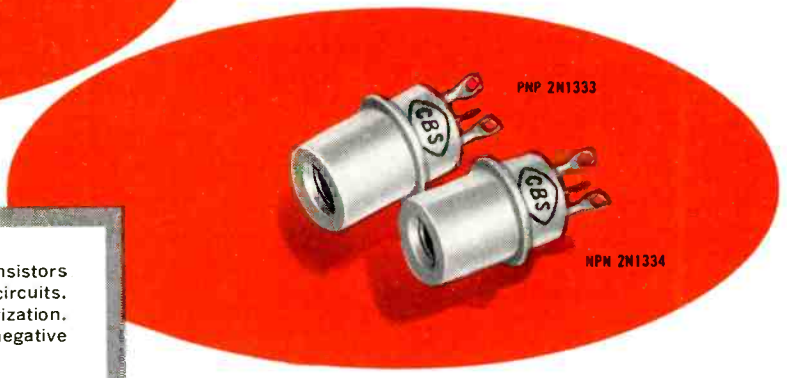
JET FUEL monitoring system recently developed detects particles as small as one micron (3.937 and 10^{-5} in.) and up to 25 microns.

(*Continued on page* 48)

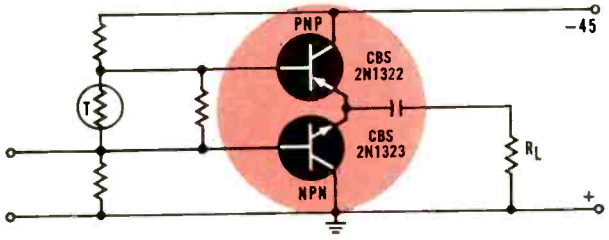
Second of a series of complementary power transistor lines

NOW . . . COMPLEMENTARY CIRCUIT ECONOMIES with INDUSTRIAL NPN-PNP POWER TRANSISTOR PAIRS





Complementary pairs of CBS NPN and PNP power transistors eliminate input and output transformers in push-pull circuits. Resulting advantages are many: Economy. Miniaturization. Improved frequency response. Ease of applying negative feedback. Etc.



Typical Industrial Complementary Push-Pull Amplifier

INDUSTRIAL NPN-PNP POWER TRANSISTOR PAIRS

NPN Type	Package	Max. W. Diss.*	Max. V_{CBO}‡	Max. V_{CES}‡	Min. h_{FE} (I_C=0.5A)	Max. Thermal Res. °C/W	PNP Type
2N1321 2N1329	Male Female	20	35	30#	30	3	2N1320 2N1328
2N1323 2N1330	Male Female	20	60	45#	30	3	2N1322 2N1078
2N1325 2N1332	Male Female	20	80	60#	30	3	2N1324 2N1331
2N1327 2N1334	Male Female	20	100	80#	30	3	2N1326 2N1333

All types have: Max. collector current, 3 amps; storage temperature, −65 to +85°C.
*25°C base mounting temperature. ‡Polarity: NPN positive, PNP negative.
#I_{CES} = 10 ma.

Enthusiastic acceptance of the diamond-package line of CBS NPN-PNP power transistors has disclosed a demand for additional pairs in industrial packages. These new industrial types make possible the same design economies of complementary circuitry. Mounted in TO-10 and TO-13 male and female packages, they are supplied with solder lugs or flying leads. And they feature high voltages (up to 100 volts) and proven quality (they exceed the MIL-T-19500A specification). The new units add another complete industrial line to the growing lines of CBS complementary power transistors for audio, control, voltage-regulation, servo and computer applications. Check circuit and abbreviated data. Write for complete data sheets: Industrial types, Bulletin E-360; diamond types, E-355. Order now from your local Manufacturers Warehousing Distributor. Watch for a higher power line soon.

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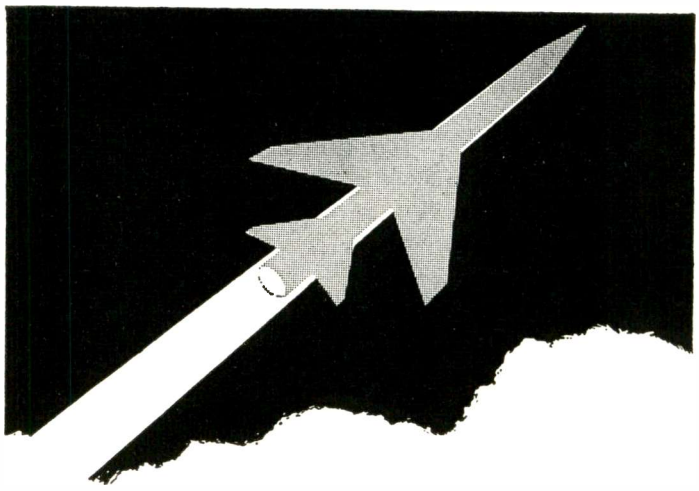
THE HIGHER THE STAKES

THE MORE YOU NEED

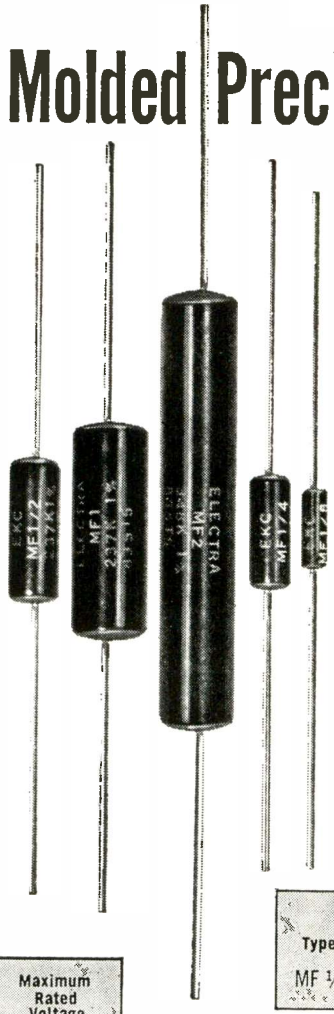


Electra's New Molded Precision Metal Film Resistor

IF YOU WANT . . .

- Low controlled temperature coefficient
- Low noise level
- Combination of high stability on load, in addition to low controlled temperature coefficient
- Close tracking of the resistance values of two or more resistors over a wide range of temperature
- High stability under severe humidity conditions
- Special resistor combinations to produce accurate ratios.

YOU WANT NEW ELECTRA MOLDED METAL FILM RESISTORS



Razor Sharp Precision, plus Amazing Stability— Here is new and greater-than-ever accuracy, coupled with new and greater-than-ever stability . . . the kind of a combination you need to meet the continuing demand for more and still more reliability. To give you this truly outstanding combination, a metallic resistive film is firmly bonded with exacting precision to an especially compounded ceramic core. This unit is then coated and molded in a compound of resins selected for the exceptional thermal stability it offers. The result is a metal film resistor that offers you performance which equals or surpasses that of a precision wire wound resistor, yet is smaller, lower in cost, also gives you better RF performance plus uniformity in size over wide resistance ranges. Here is a real "break-through" in resistor manufacturing. Why not get all the facts, **today.**

AVAILABLE IN THESE SIZES

Electra Part No.	Wattage	Resistance Range	Maximum Rated Voltage
MF 1/8	1/8	100 ohms 300 K	250
MF 1/4	1/4	100 ohms 500 K	300
MF 1/2	1/2	100 ohms 1 meg	350
MF 1	1	100 ohms 2 meg	500
MF 2	2	250 ohms 5 meg	750

TYPICAL PERFORMANCE IN % OF CHANGE UNDER TEST

Type	Temp. Cycle	Low Temp. Exposure	Short Time Overload	Solder Change	Moisture	1000 Hours @ 125°C
MF ½	.025%	.07%	.035%	.02%	.03%	.035%

TEMPERATURE COEFFICIENT — Available in three standard temperature coefficient tolerances:

T.C.	CODE MARKINGS**
0 ± 100 PPM/°C.*	T-1
0 ± 50 PPM/°C.	T-2
0 ± 25 PPM/°C.	T-5

Proposed MIL-R-10509C specification calls for temperature coefficient measurements from −55°C to +165°C. The lowest temperature coefficient is 0 ± 50 PPM/°C. Code T-2 meets this requirement. Resistors in code T-5 are production tested over a range of +25°C to +105°C. Special temperature coefficients—Code T-3, 0 to +100 PPM, and Code T-4, 0 to −100 PPM—are available for special applications.

*Parts Per Million Per Degree Centigrade (100 PPM equals 0.01%)
**The T.C. code marking is combined with the code for the date of manufacture

Electra **MANUFACTURING COMPANY**
Electronics Division
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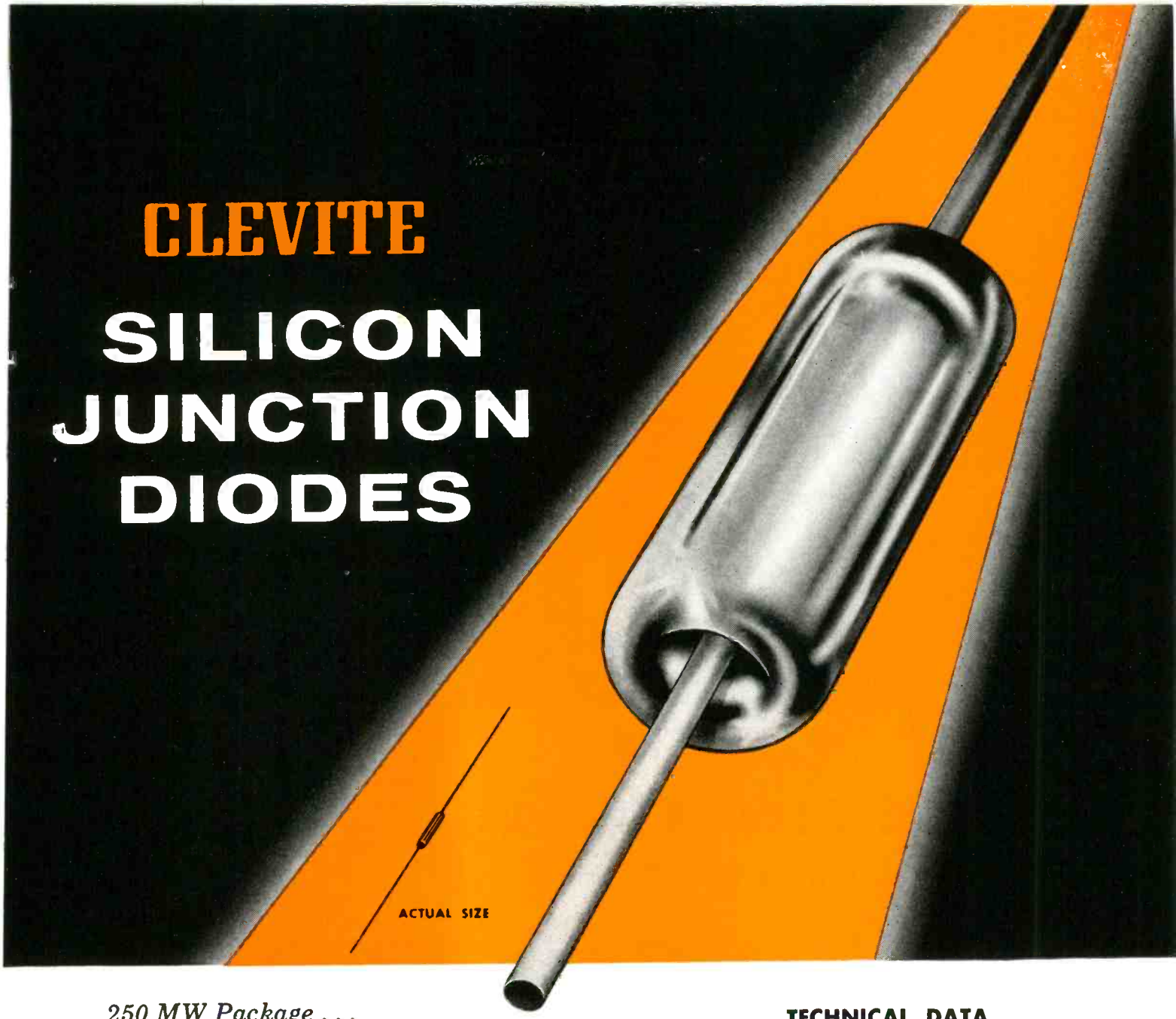

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- **PRODUCT UNIFORMITY** — Tight manufacturing controls.

For details, write for Bulletin B217A-1 B217A-2

TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current @ 25°C	Max. Inverse Current @ 150°C	Test Volts
1N457	60 V	20 ma @ 1.0 V	0.025 μa	5.0 μa	60 V
1N458	125 V	7 ma @ 1.0 V	0.025 μa	5.0 μa	125 V
1N459	175 V	3 ma @ 1.0 V	0.025 μa	5.0 μa	175 V
1N662	90 V	10 ma @ 1.0 V	20 μa	100 μa (@ 100° C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 μa	50 μa (@ 100° C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	175 V

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A DIVISION OF CLEVITE

Circle 25 on Inquiry Card

Tele-Tips

(*Continued from page 44*)

FCC FIELD ENGINEERS are running into their usual quota of odd-ball experiences.

At a Florida race track FCC staffers were called on to locate a tipster who was using a radio concealed in his clothing to flash race results to henchmen outside the track.

"Build - it - yourself" kits are causing various interference problems. One enterprising youngster in Oregon illegally broadcast "music by request" programs, giving his telephone number. He abandoned his enterprise with an apology when FCC engineers traced him down.

Another high school boy in New England bought a kit from a mail order house, connected it to a 40-ft. antenna and started to broadcast to his neighbors. Interference resulted. Investigation showed that the radiation was in excess of that allowed, and the "do-it-yourself" operation was discontinued.

A high school teacher interested in radio, but not to the extent of seeking a license, was discovered near St. Louis operating on an amateur frequency and experimenting with various antennas and transmitters. To conceal his identity he used various call signs of domestic and foreign stations. When apprehended, his excuse was that he did not have enough time from his teaching duties to take the license exam. But he found time to dismantle the station.

Boats having radio equipment are required by law to maintain a watch on marine distress frequency, but how to put teeth in this law was a problem that baffled FCC enforcement people. In the Gulf area FCC engineers have tied in their operations with the Coast Guard. A CG helicopter takes an FCC engineer on flights over waters where small craft are concentrated. By calling vessels individually on the distress frequency it is possible to determine if they are on watch.

DO IT THE

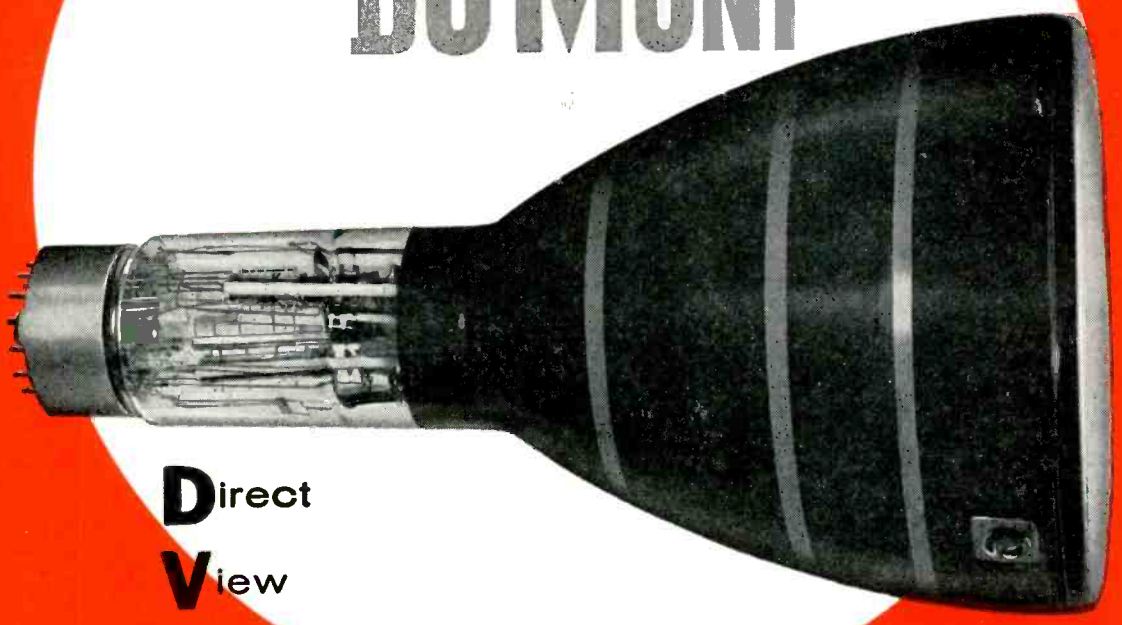
MODERN

WAY

ADD

DISPLAY RETENTION

VIA DU MONT®



Direct

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Tubes

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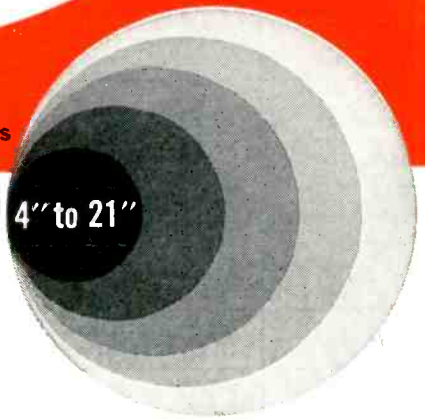

Du Mont DVST cathode-ray tubes offer the distinct advantage of display retention far beyond the capabilities of usual phosphor persistence, **plus** the added feature of erasing **all or part** of presentation. This is the modern display method, adding virtually all the advantages of other types of display to the exclusive, inherent advantages of CRT display.

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Circle 27 on Inquiry Card

Books

Digital Computing Systems

By Samuel B. Williams. Published 1959 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 229 pages. Price $7.75.

Presented in this work is a broad technical introduction to digital computing systems, especially written for readers with engineering backgrounds and others familiar with electrical circuits and apparatus.

In ten fact-filled chapters it treats everything from coding and components to computer applications. It describes the various elements contained in modern computers, explaining the underlying principles of the devices used and illustrating the devices themselves. The circuitry by which the elements are made to perform the desired functions is clearly covered, with many examples of typical circuits. Logical design and programming are discussed in thoroughly realistic terms. A brief picture of how digital computers can be used to help solve scientific, business, and data handling problems is presented in the final section.

No knowledge of mathematics is required to understand this book. Its more than 150 carefully selected illustrations give a wide pictorial survey of available equipment in components, and each chapter ends with a concise summary of key points. One can use this lucid treatment to gain a sound technical grasp of what computing systems contain and how they accomplish their purpose.

Fundamentals of Electron Devices and Circuits

By Herman R. Weed and Wells L. Davis. Published 1959 by Prentice-Hall, Publishers, 70 Fifth Ave., New York 11. 591 pages. Price $9.50.

A new and highly practical approach to the vital field of electrical engineering, this work presents the reader with a clear survey of the problem of electron devices—a survey consistent with the standards of an electrical engineering text, yet within the grasp of a non-electrical student as well.

Always combining modern advances with a conventional approach, the authors give a complete analysis of such new devices as transistors, diodes, and magnetic amplifiers — in conjunction with the more orthodox vacuum and gas tubes. Wherever feasible the utilization of all devices bearing similar characteristics are considered in unit-like form.

To clarify these advances as well as conventional devices, the authors employ a thorough, yet simplified analytic approach. Throughout the book basic ideas are explained by constant emphasizing of physical phenomena—mathematical description is used only where it is most appropriate. This analytical approach will help

(*Continued on page* 52)

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PNP:	2N1219	2N1220	2N1221	2N1222	2N1223
V_{CBO}	30 v	30 v	30 v	30 v	40 v
V_{CEO}	25 v	25 v	25 v	25 v	40 v
V_{EBO}	20 v	20 v	10 v	10 v	10 v
I_{CO}	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.
h_{FE}	18 min.	9 min.	—	—	—
f_{ab}(mc)	5 min.	2 min.	5 min.	2 min.	2 typ.
h_{fe}	—	—	18 min.	9 min.	6 min.

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Circle 29 on Inquiry Card

Books

(*Continued from page* 50)

the reader build a strong and solid foundation of knowledge in the field.

Proving the authoritative value and reliability of the text is the fact that it has been classroom tested. The text comes to publication after more than 3 years of use in note form with both electrical and non-electrical engineering students. Both groups have used the text with success.

Servomechanisms and Regulating System Design, Vol. I, 2nd Ed.

By Harold Chestnut and Robert W. Mayer. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 680 pages. Price $11.75.

This second edition has been prepared to reflect recent advances in the field. Although the text has been altered extensively, the object remains the same—to train design and application engineers in the basic principles of feedback control.

Major additions include a new chapter on the application of root-locus to the analysis and synthesis of control system design and a chapter on use of an analog computer for the solution of control systems problems.

Other new features include: updating of feedback nomenclature, modification and presentation of transfer function material, addition of supplemental ways relating open-loop frequency response to approximate closed-loop transient response.

Circuit Theory of Linear Noisy Networks

By Herman N. Hause and Richard B. Adler. Published 1959 by the Technology Press of the Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 79 pages.

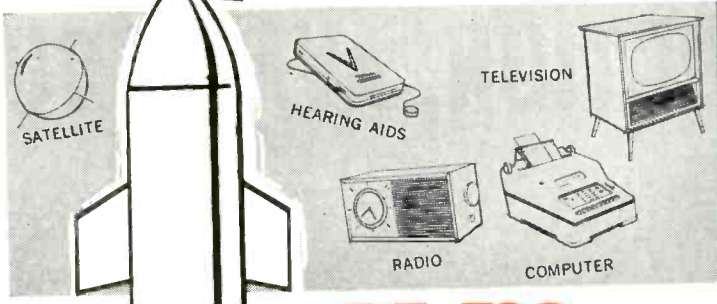
A great need for low-noise amplifiers has inspired the authors to look for a rational approach to the characterization of amplifiers spot-noise performance. This study, based on a single hypothesis concerning the essential function of an amplifier, leads to a characterization that avoids pitfalls previously associated with the effect of feedback upon noise performance.

The problem of noise-performance optimization leads naturally to a search for the property of linear noisy networks that are invariant under lossless network transformations. These invariants are determined for multiterminal-pair networks, and their physical interpretations in terms of a generalized "available power" are presented. A "canonical" form is also developed which exhibit all the invariants in a particularly simple way.

The invariants are then considered for the important specal case of a linear two-terminal-pair amplifier,

(*Continued on page* 56)

Engineering *SUPERIORITY*



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El Menco Dur-Mica Capacitors have proved their powerful performance under accelerated conditions of 1½ times rated voltage at ambient temperatures of 125°C and 150°C — proving longest life, greatest stability, finest performance.

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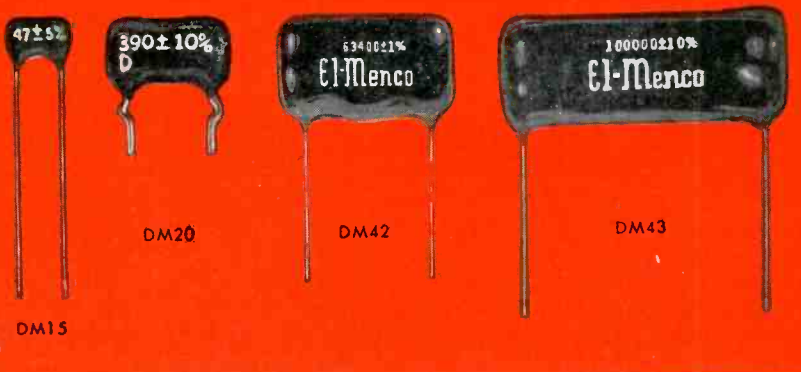

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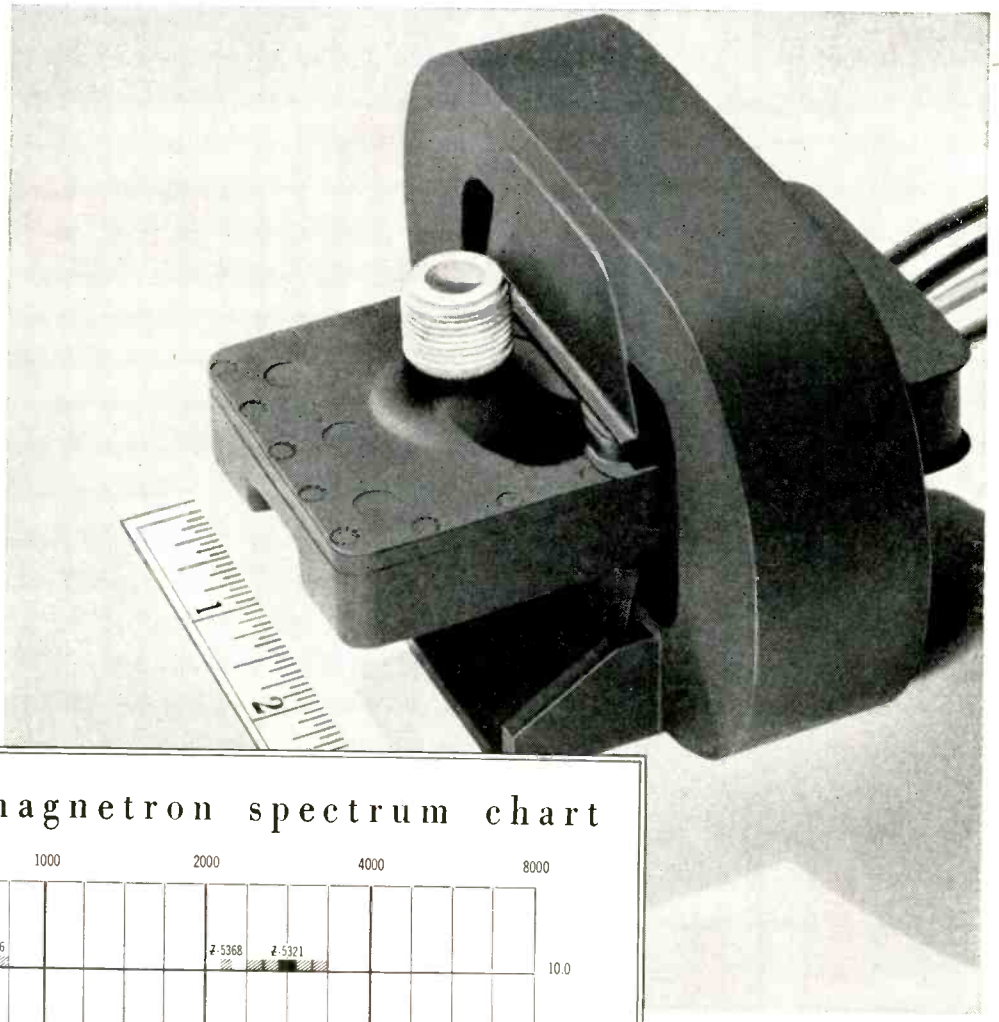
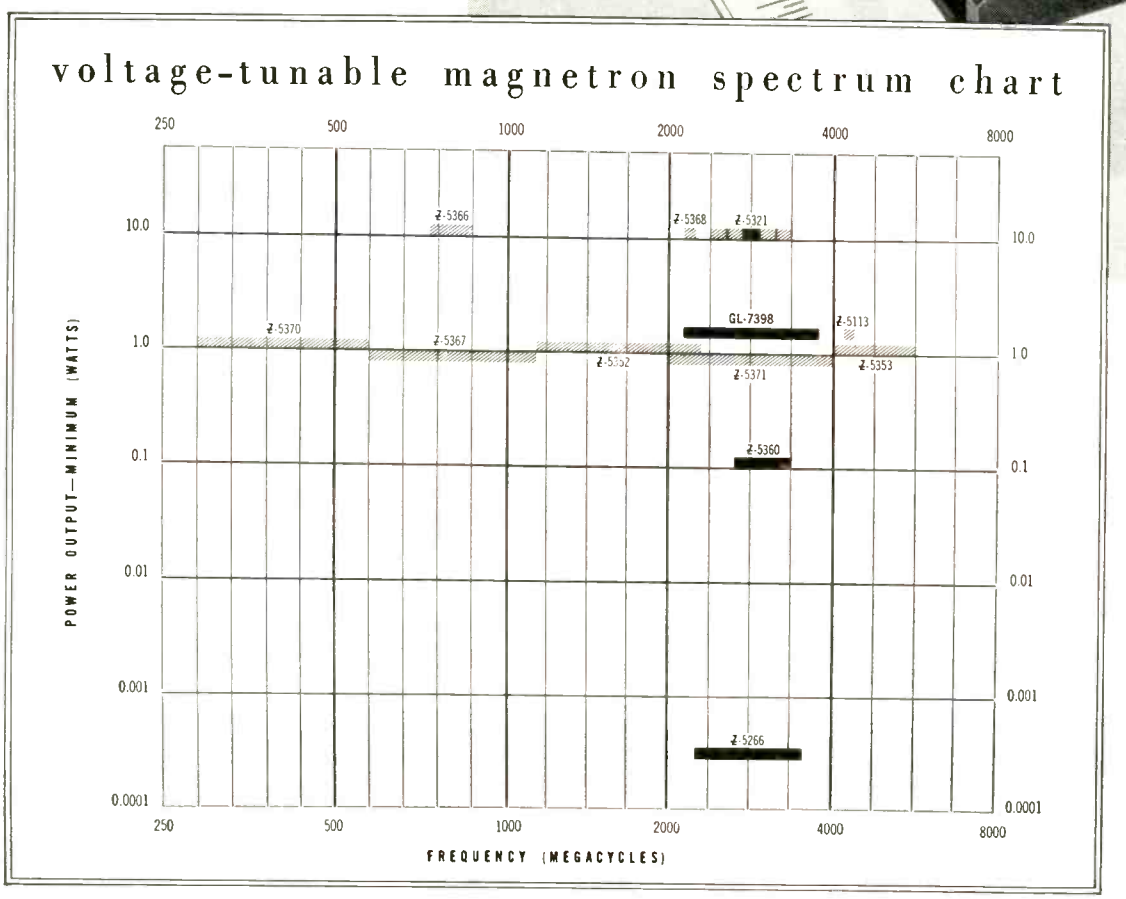
GENERAL ELECTRIC GL-7398* VOLUME PRODUCTION, AVAILABLE

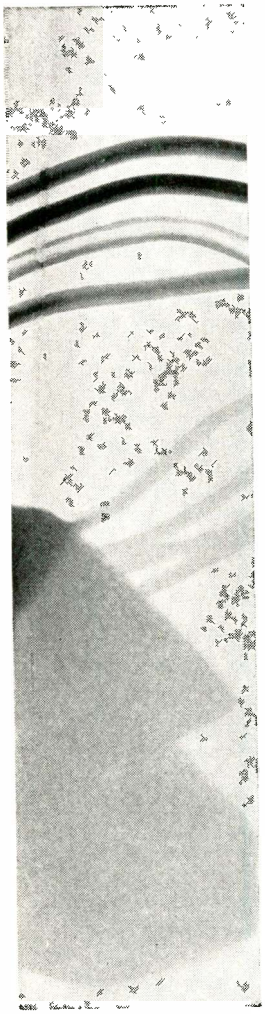
**formerly designated Z-5300*



Voltage-tunable magnetrons now available are indicated by solid areas. Other developments are shown by cross-hatched areas.
▼



VOLTAGE-TUNABLE MAGNETRON IN FOR IMMEDIATE DELIVERY!



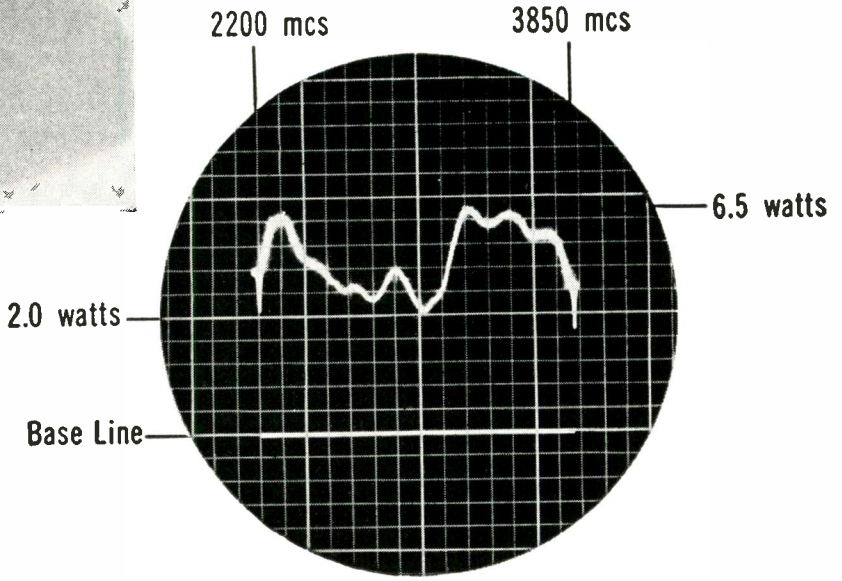
The General Electric GL-7398 voltage-tunable magnetron, a complete RF power source ideal for FM modulation, is now in volume production and available for immediate delivery. Moreover, samples are currently available or can be developed by use of proved technology to meet any need within the frequencies charted on the opposite page. The GL-7398 is designed for use in many applications, such as:

- FM telemetering or video transmission
- Beacon transmitters
- Local oscillators in electronically tunable radars
- Drivers in pulse-to-pulse frequency-shift radars
- FM altimeters
- Broad-band signal generators
- Countermeasure transmitters
- Drivers for countermeasure amplifiers

Output frequency can be varied linearly over a range of nearly 2 to 1 by sweeping the anode voltage. Power output is relatively flat at a minimum of 2 watts. The GL-7398 is a rugged, compact, packaged unit with these characteristics:

Anode voltage at 3 kmc	— 1250 volts
Anode current	— 10-20 ma
Frequency range	— 2200-3850 mcs
Tuning rate	— approx. 3 mcs/volt
FM rate	— 10 mcs or higher
Weight	— 3.1 lbs.

By use of internal narrow-band circuits, a variation (Z-5321) is available which gives a minimum of 10 watts power over a 200 mc bandwidth at a factory-predetermined centerpoint in the 2 to 4 kmc band. Other variations with built-in attenuators for local oscillator applications can be supplied (Z-5360 and Z-5266). *Power Tube Department, General Electric Company, Schenectady, New York.*



Typical power – frequency of the GL-7398 shows power constant over the full band to within plus-or-minus 3 db.

Progress Is Our Most Important Product

GENERAL ELECTRIC

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Circle 32 on Inquiry Card

Books

(*Continued from page* 52)

and are shown to establish a lower limit on its noise performance. Various ways of achieving this limit are presented for all classes of such amplifiers, including those with negative resistance.

Mathematical Programming and Electrical Networks

By Jack E. Dennis. Published 1959 by the Technology Press, Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 186 pages. Price $4.50.

This research monograph offers a new approach to mathematical programming based on an analogy with electrical circuits. It is shown that any direct current electrical network made up of current sources, voltage sources, ideal diodes, and ideal transformers is equivalent to a pair of dual linear programs.

This relation is extended to embrace a correspondence between the red current networks including resistors and quadratic programming. An immediate consequence is the appropriate generalization of the duality principle of linear programming to the quadratic and concave cases.

Books Received

AIEE Telemetering, Supervisory Systems, and Associated Channels, 1959 Report

Published 1959 by the American Insitute of Electrical Engineers, 33 W. 39th St., New York 18. Order Publication #S-111. 71 pages, paper bound. Price $2.50.

1958 Canadian Convention Record

Published 1959 by the IRE Canadian Convention, 1819 Yonge St., Toronto 7, Ont. 643 pages, paper bound. Price $5.00.

Environmental Requirement Guide for Electronic Component Parts PB131423R

Published 1959 by the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. 13 pages. Price 50¢.

1959 Registry of Radio Systems in the Transportation Services

Published 1959 by Communication Engineering Book Co., Radio Hill, Monterey, Mass. 76 pages, paper bound. $4.00.

Stereo . . . How it Works

By Herman Burstein. Published 1959 by Gernsback Library, Inc., 154 W. 14th St., New York 11. Paper bound edition, price $2.90.

Basics of Missile Guidance and Space Techniques

By Marvin Hobbs. Published 1959 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11. 304 pages, total, 2 volumes, paper bound. Price $3.90.

Errata

The following book, reviewed on page 50 of the July 1959 issue, should have the authors' names as given below:

Linear Network Analysis

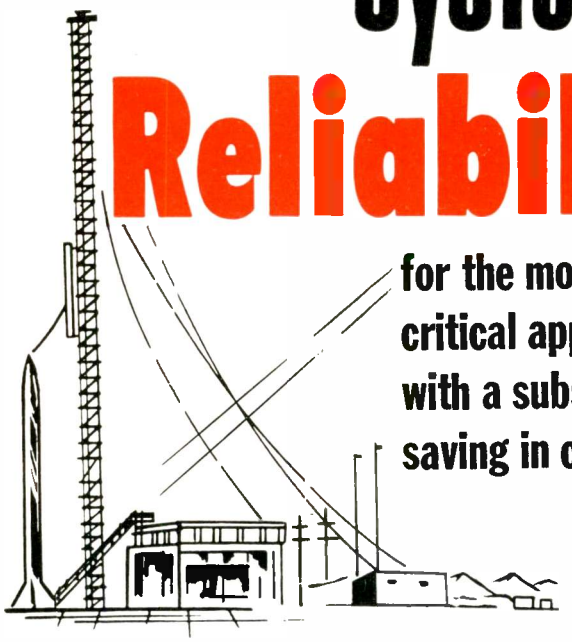
By Sundaram Seshu and Norman Balabanian. Published 1959 by John Wiley & Sons, Inc., 440 4th Ave., New York 16. 571 pages. Price $11.75.

ELMENCO** DIPPED MYLAR*- PAPER CAPACITORS (TYPE MPD)

achieve

missile system Reliability

for the most critical applications with a substantial saving in cost!



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These capacitors will exceed all the electrical requirements of E.I.A. specification RS-164 and military specifications MIL-C-91A and MIL-C-25A.

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SPECIFICATIONS	
TOLERANCE	±10%.
VOLTAGE RATINGS	100VDCW, 200VDCW, 400VDCW, 600VDCW, 1600VDCW.
INSULATION RESISTANCE	@25°C.: 5000 megohm-microfarads or 100,000 megohms minimum, whichever is the lesser. @110°C.: 70 megohm-microfarads or 1400 megohms minimum, whichever is the lesser.
POWER FACTOR	1.0% maximum at 1kc.
Temperature Range	—55°C. to +110°C. with no voltage derating.
Capacitance Change vs. Temperature	From 25°C. to —55°C. [— 9.0% max.] From 25°C. to +110°C. [+10.0% max.]
LONG TERM OPERATING STABILITY AT FULL RATED VOLTAGE AND RATED TEMPERATURE EXTREMES IS ±2% MAXIMUM.	

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100	1	60	240	9¼	5	6	12	25
120	2	125	500	10½	8½	6	24	27
140	7	250	1000	14¾	11¾	10	48	27.5
160	13	500	2000	20	16	10	96	30

HEAVYDUTYLINE for industrial applications requiring high energy density

Model 240

Model No. (115 volts A.C. 1 phase 60 cycle)	Capacity (gallons)	Power Output (watts) Average	Power Output (watts) Peak	Inside Tank Dimensions (in.) Length	Width	Depth	Crystal Radiating Surface (sq. in.)	% of bottom covered with crystals
200	1	60	240	7	4	7	12	43
220	2	125	500	9	6	10	24	44.5
240	5	250	1000	12	9	12	48	44.5
260	12	500	2000	16	12	16	96	50

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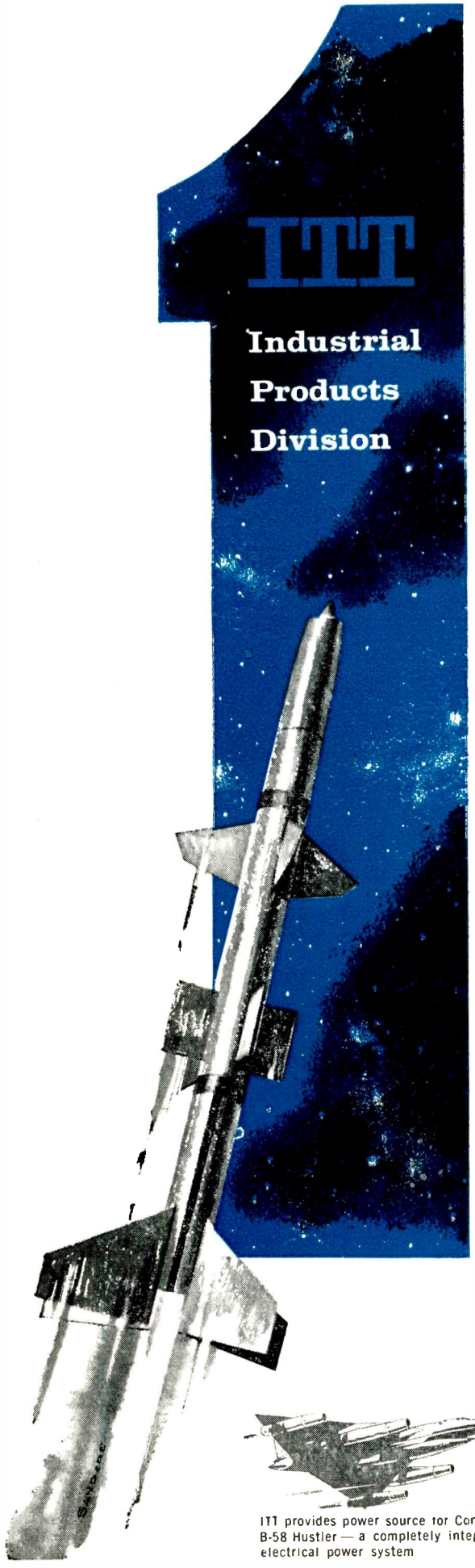

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- High-voltage Supplies
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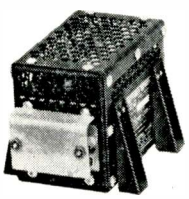
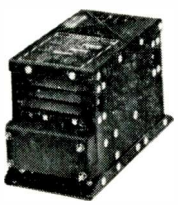


20-Amp Silicon T/R used on Chance-Vought F-8-U and Douglas A4D-2N



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Personals

William E. Seaman is now Chief Engineer at Midwestern Instruments, Inc. He was formerly assistant to the Manager, Video Products Dept., Ampex Corp.

The Missile Systems Div., Raytheon Co., has named **Harold Asquith**, NATO Hawk Program Manager. The program calls for Raytheon to provide technical assistance to 5 NATO nations which will produce HAWK in Europe.

Dr. James H. Turnock, Jr., has been named IBM Project Manager for Project Mercury, the Man - in - Space program.

Frank Garbis is now Vice President, Director of Engineering, at General Transistor Corp.

F. Garbis

A. C. Emanuel

A. Charles Emanuel has been named Vice President, Director of Manufacturing, at General Transistor Corp.

Robert W. Matthews has been appointed Chief Engineer at National Pneumatic Co., Inc., and its Holtzer-Cabot Div.

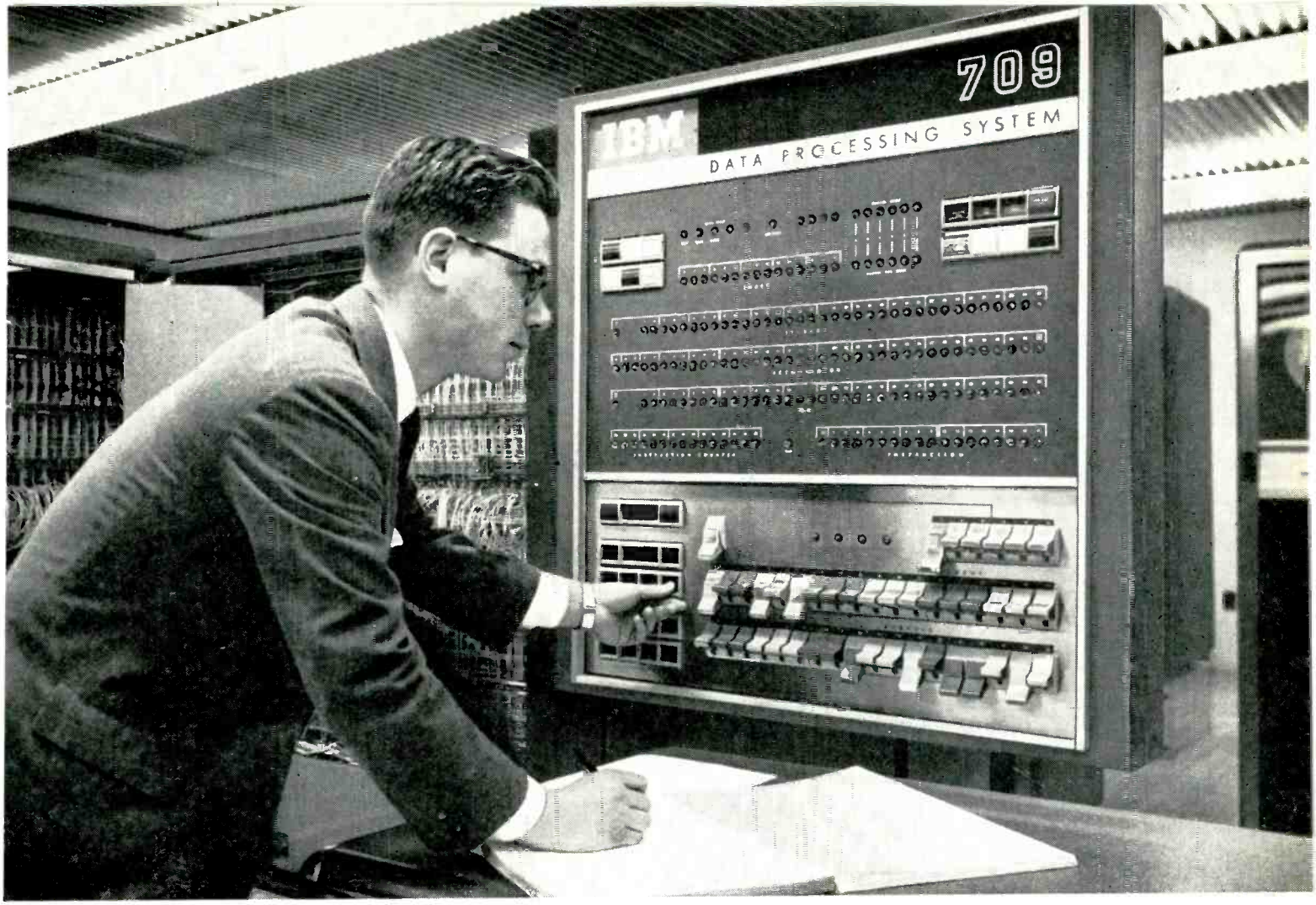
The appointment of **Sidney Herman** as Chief Engineer has been announced by North Atlantic Industries, Inc. He was formerly with Waldorf Instrument Co. and Reeves Instrument Corp.

Hi-G, Inc., has appointed **Michael Lanes** as Project Engineer. He was formerly with Avco, R.A.D. Div.

Leo J. Kowal, formerly District Service Manager, Sylvania Electric Products, Radio and Television Div., has been appointed Senior Field Engineer at Cinema Engineering.

Dr. Roy E. Olson has been named chief Engineer of the Monogram Precision Industries, Lewis and Kaufman Div. He was formerly with Eitel-McCullough as a physicist in the Advanced Research Group.

Edwin D. Sisson is now Chief Engineer of F. W. Bell, Inc. He was formerly with the Bell Sound Div., Thompson Ramo Wooldridge, Inc.



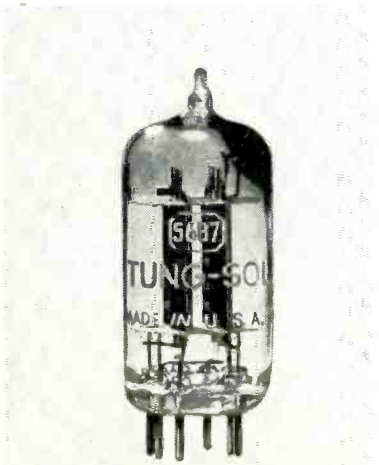
Programmer makes operational check from "driver's seat" of IBM 709 Data Processing System — the most up-to-date system utilizing electron tubes.

Tung-Sol 5687 contributes to the prime reliability of the IBM® 709 Data Processing System!

The IBM 709 Data Processing system counts on unfaltering dependability from over 500 Tung-Sol 5687 Twin Triodes — approximately 340 5687's are found in the Arithmetic and Logic unit; the remainder in the Magnetic Drum Storage unit.

Because the Tung-Sol 5687 offers excellent power handling ability, the IBM 709 employs it largely in power follower circuits to supply high current requirements . . . in driving lines with high capacity loading. Frequent 200 millimicrosecond pulses make the latter a key job in the 709. Other special-circuit uses of the 5687 include: master oscillator, pulse shaping inverters, magnetic drum write head drivers, relay drivers and single-shot multivibrators.

5687 performance points up the reliability you'll find characterizes Tung-Sol tubes and semiconductors. It gives designers in-use testimony that lets them specify Tung-Sol for critical sockets with complete assurance of full-life trustworthiness. For full technical information on the Tung-Sol 5687, or other Tung-Sol tubes or semiconductors, contact: Tung-Sol Electric Inc., Newark 4, New Jersey. TWX: NK 193



ts TUNG-SOL®

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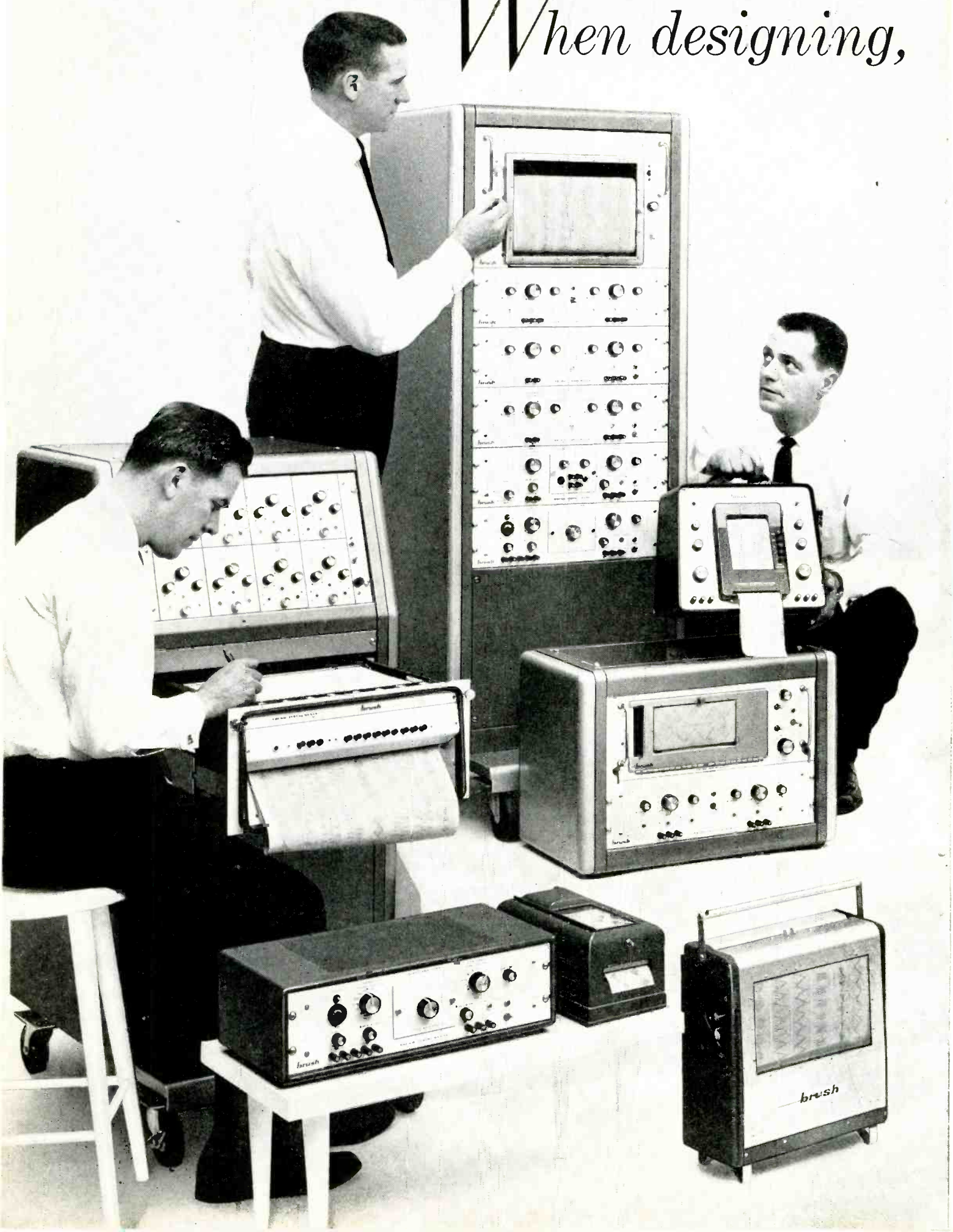

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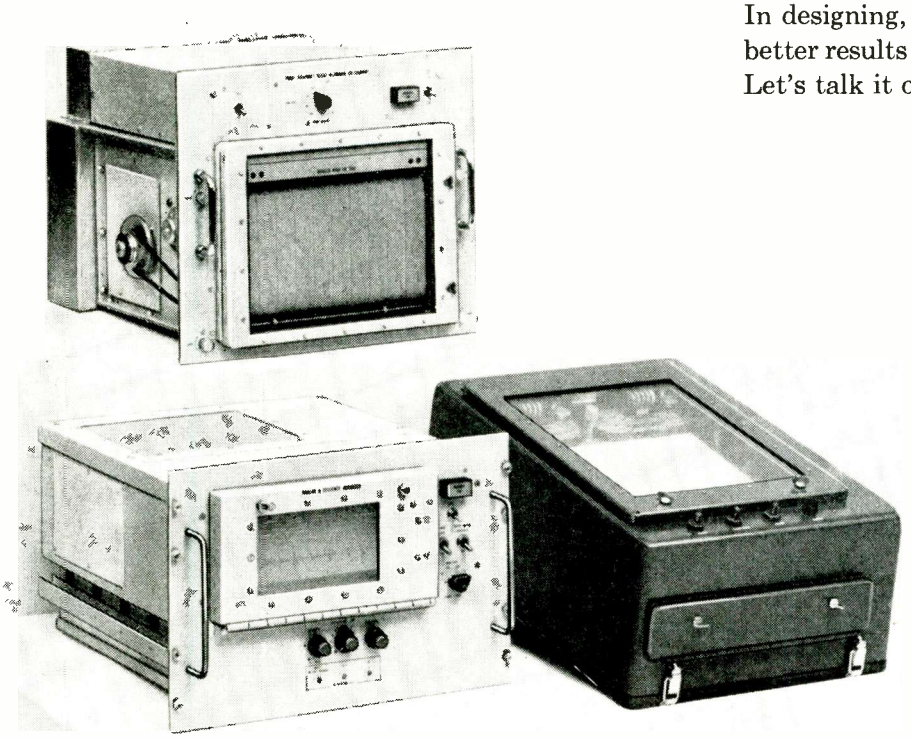
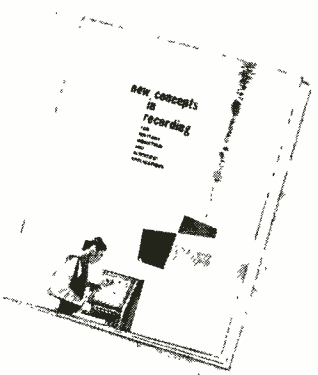


Write for free informative booklet, "New Concepts in Recording." Contains helpful ideas and suggestions.



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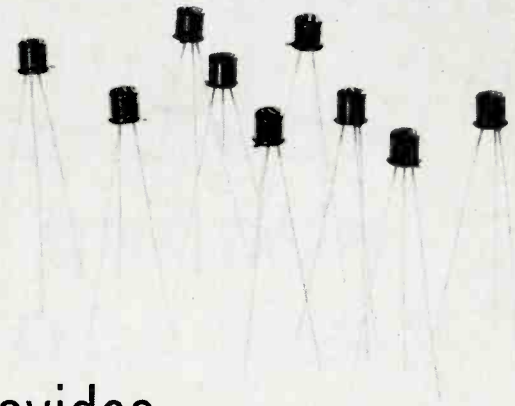


NEW FAIRCHILD 2N706 provides

TRANSISTOR LOGIC OF MAXIMUM

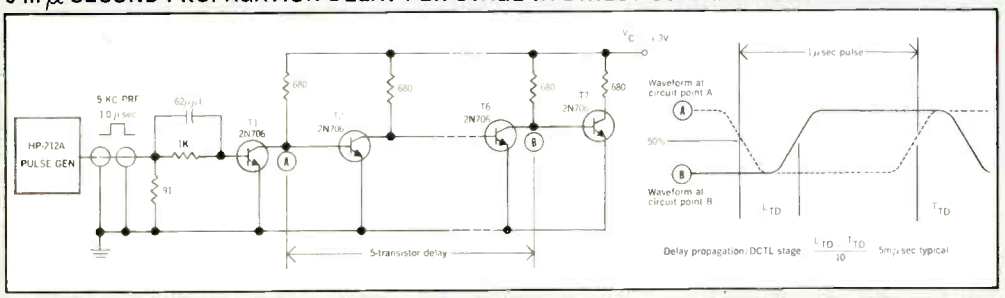
Saturating high-speed silicon logic ends the need to sacrifice one requirement in favor of another. The Fairchild 2N706 diffused silicon mesa transistor is as fast as the fastest germanium — and in addition has the inherent advantages of silicon. This combination fulfills all these logic-circuit design objectives:

SPEED	**10 megapulse operation saturated**
	25 megapulse operation nonsaturated
	Guaranteed low storage
RELIABILITY	**Large power reserve: 150 mW dissipation at 100° C ambient (no heat sink)**
	300° C stabilization of all units
	Rugged mesa construction
CIRCUIT SIMPLICITY	**Saturating logic with fewer components**
	3 to 5 milliampere current level
	Small JEDEC TO-18 outline

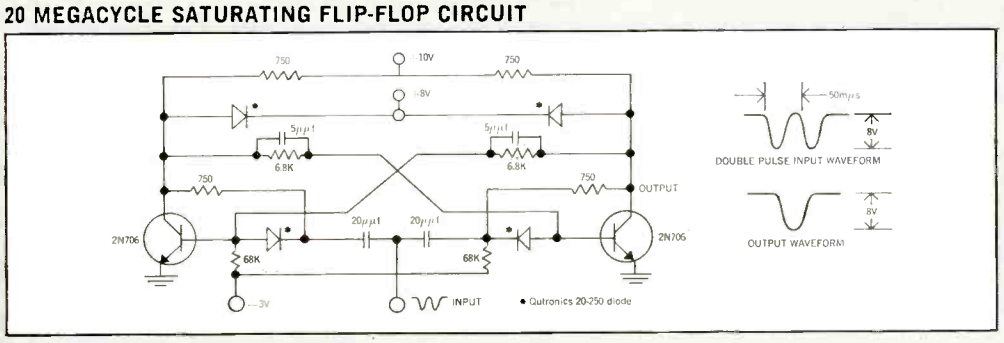
Fairchild's 2N706 provides optimum performance in the most-used logic circuit configurations and has a broad current and power range that covers many alternate approaches. It is ideally suited for high-density modular equipment because of its small size and its high performance in simple, low-power saturated circuits. The 10 megapulse speed is conservative, applying specifically to saturating logic and a 3 to 5 milliampere current level.

SPEED, RELIABILITY, SIMPLICITY

5 mμ SECOND PROPAGATION DELAY PER STAGE IN DIRECT COUPLED LOGIC



20 MEGACYCLE SATURATING FLIP-FLOP CIRCUIT



RATINGS AND CHARACTERISTICS (25° C) — 2N706 NPN DIFFUSED SILICON TRANSISTOR

Symbol	Characteristics	Rating	Min.	Typ.	Max.	Test Conditions
V_{CBO}	Collector to base voltage	25 v				
V_{EBO}	Emitter to base voltage	3 v				
	Total dissipation, 100° C free air ambient	150 mw				
h_{FE}	D.C. pulse current gain		15			I_C = 10mA V_C = 10v
$V_{BE(SAT)}$	Base saturation voltage				0.9	I_C = 10mA I_B = 1mA
$V_{CE(SAT)}$	Collector saturation voltage			0.3	0.6	I_C = 10mA I_B = 1mA
h_{fe}	Small signal current gain at f = 100 mc			4		I_C = 20mA V_C = 10v
C_{ob}	Collector capacitance (140Kc)			3.5 pf	6 pf	I_E = 0mA V_C = 10v

For specification sheets, write Dept. 2N706

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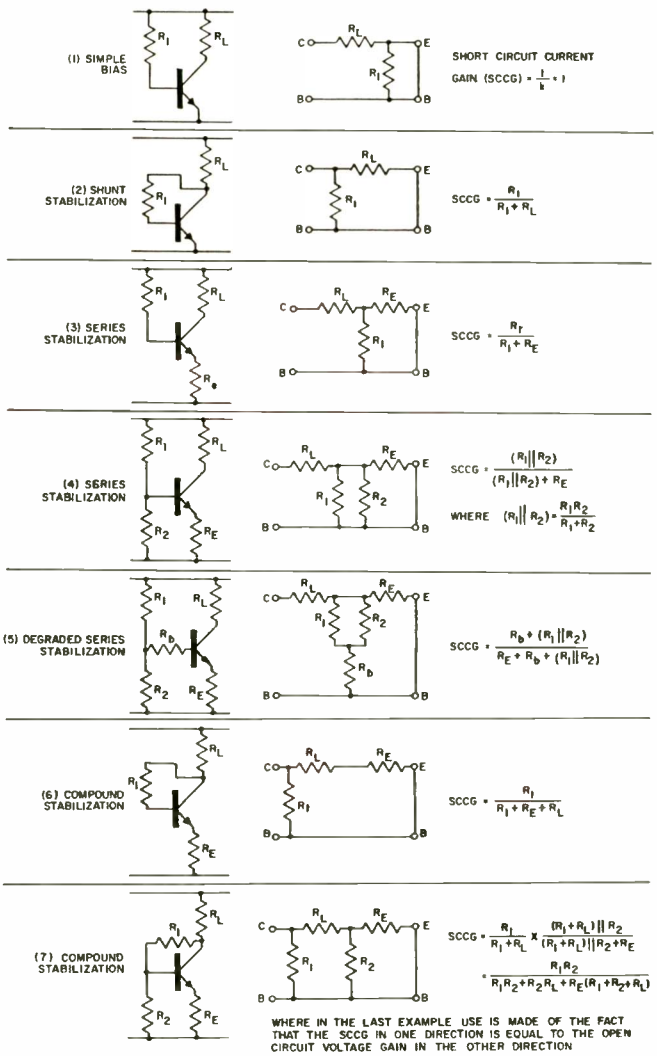
Letters
to the Editor

"Equations Speed Common Emitter Design"

Dear Mr. MacDougall:

In your article "Equations Speed Common Emitter Design" in the January 1959 issue of Electronic Industries, you refer to a factor k which can be separated out of the equations for the stability factor of specific bias circuits. I would like to point out that this is true in general, and in fact, your factor k is actually the negative reciprocal of the short circuit feedback current gain of the bias network. The collector and base terminals are considered as the output terminals (2) while the emitter and base terminals of the bias network are considered as the input terminals (1). In terms of conventional two port impedance parameters, $^1/k = (z_{12}/z_{11})$. With this understanding the



role of the bias network in stabilizing against changes in I_{co} is evident from the equation for stability factor, i.e.,

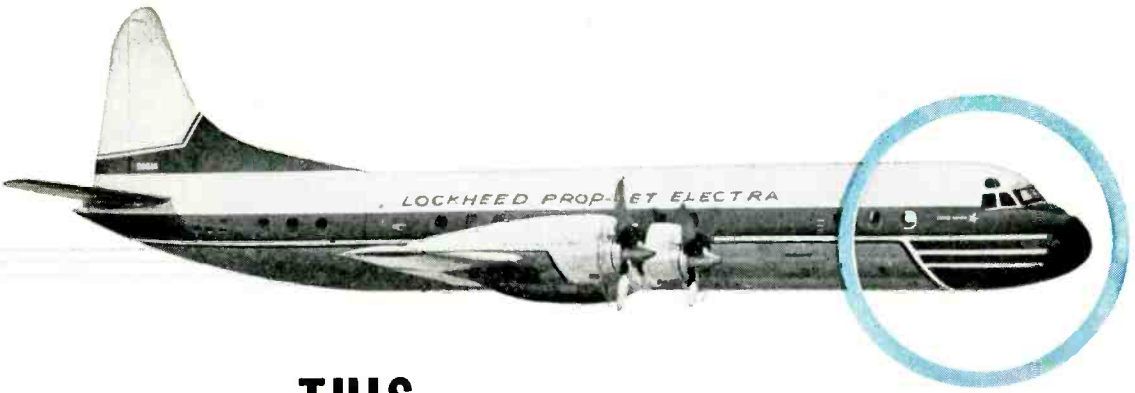
$$S = \frac{1}{1 - \alpha\,(z_{12}/z_{11})} = \frac{1}{1 - (\text{Short Circuit Loop Gain})}$$

which is of the form encountered in negative feedback systems.

Thus, with the logical definition of the stability factor given in this relation, it is not necessary to remember or

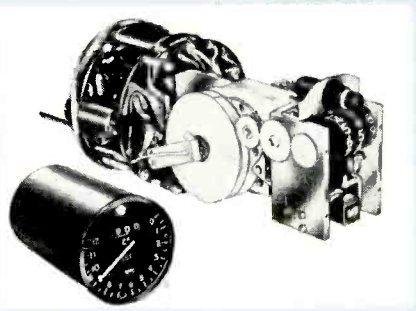
(*Continued on page* 68)

A HOFFMAN SEMICONDUCTOR APPLICATION CASE HISTORY



THIS VOLTAGE STABILITY PROBLEM HAD TO BE SOLVED

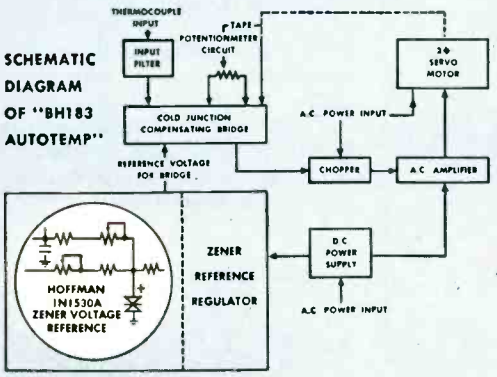
FOR CIRCUIT RELIABILITY IN A JET ENGINE TEMPERATURE INDICATOR



Hoffman Zener Voltage Reference Elements were the solution

1N1530A

SCHEMATIC DIAGRAM OF "BH183 AUTOTEMP"



Engineers of the B & H Instrument Company, Fort Worth, Texas, required an extremely reliable voltage reference device for their BH183 AutoTemp jet engine temperature indicator, used in the Lockheed Electra. . . . They chose a Hoffman 1N1530A Zener Reference Element, because of its STABLE characteristics even when subjected to widely varying environmental conditions.

The low 8.4 volt, zener operating voltage of Hoffman 1N430 and 1N1530 Zener Reference Elements, makes them uniquely suited for use in circuits which are operating at a low D.C. voltage level (from 10 to 30 volts). The units have a voltage stability of ±0.1%, or less, over a temperature range from −55°C to +100°C, at 10mA.

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Circle 42 on Inquiry Card

Letters

to the Editor

(*Continued from page* 66)

tabulate any "k" factors, or given S factors, because they can be written almost by inspection.

For the seven circuits you presented in your article, I have shown on the accompanying sheets the redrawn networks for which the current gain can be determined by inspection. Values of S follow immediately from the definition in terms of loop current gain.

This material has been published in the Transactions of the PGBTR, September, 1958.

M. J. Hellstrom

"Analyzing Systems By Superposition"

Editor, ELECTRONIC INDUSTRIES:

Mr. Jerome E. Toffler's dissertation on the superposition integral, which appeared in the August 1959 issue of ELECTRONIC INDUSTRIES, was one of the clearest explanations of convolution I have read. It should be noted, however, that the theory presented applies to "arbitrary" *continuous* functions and to this extent it possesses limitations. In many practical situations which confront today's engineers it is necessary to deal with a driving function which contains one or more discontinuities, such as a pulse or staircase function. In such cases the Stieltjes integral (see References 1 and 2) provides a powerful tool that, in appropriate situations, will conserve the engineer's time in analysis and greatly increase his efficiency.

To demonstrate briefly the method of the Stieltjes integral,

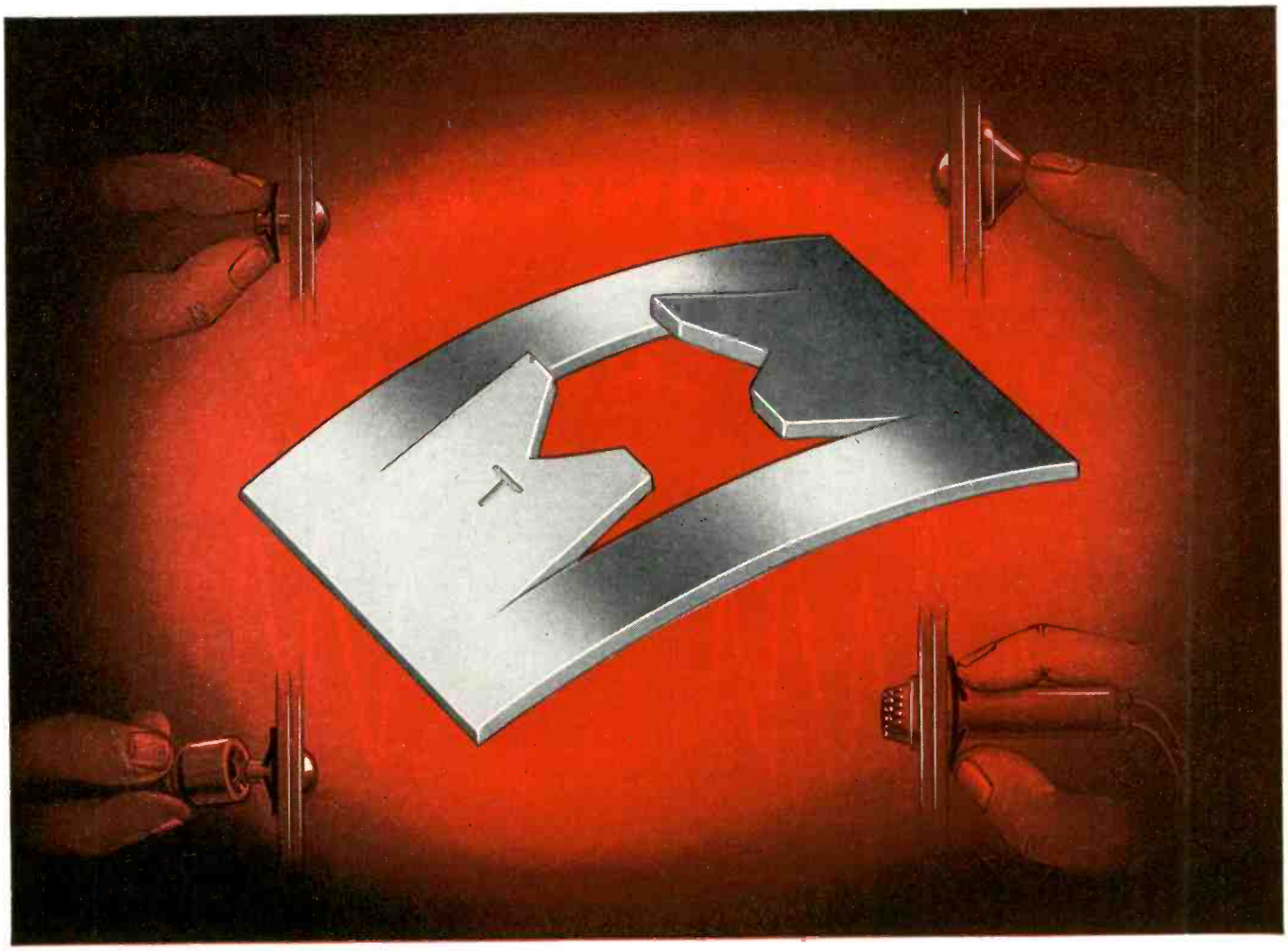
let $g(t)$ be a general network or system function which is continuous at all points,

and $f(t)$ be a function of "bounded variation" but which can contain a limited number of finite "jumps" or steps.

Then the Stieltjes integral enables us to integrate $g(t)$ with respect to the *entire function,* $f(t)$, as written on the left side of the following equation. It can be evaluated in terms of the two summations given on the right side of the equation:

$$\int_a^b g(t)\, df(t) = \sum_0^n g(t_k)\, h_k + \sum \int g(t)\, f'(t)\, dt$$

(*Continued on page* 72)



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Application is easy—finger pressure starts it; a push with a simple hand tool locks it under live spring tension. No threads to worry about, no spot welding, no riveting, no special inserts, bushings or washers necessary. Elimination of extra parts and assembly operations may save you up to 50% or more in fastening costs.

Push-On SPEED NUTS lock on everything from thermoplastics to die-cast, chrome-plated steel. Hundreds of variations to fit any shape or size stud —from very small diameters to larger rectangular shapes. Some Push-Ons have "caps" that cover exposed shaft, axle or stud ends.

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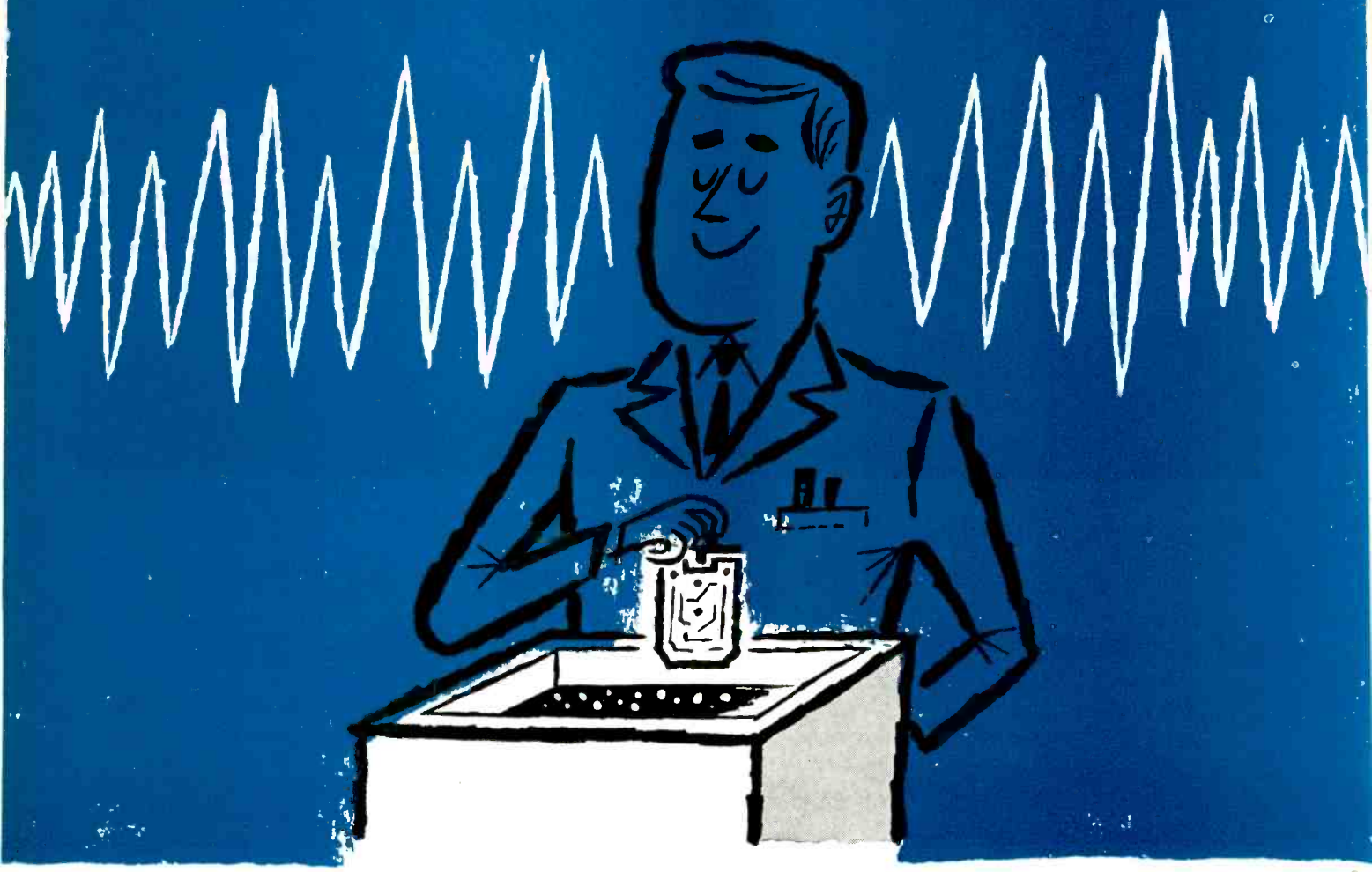

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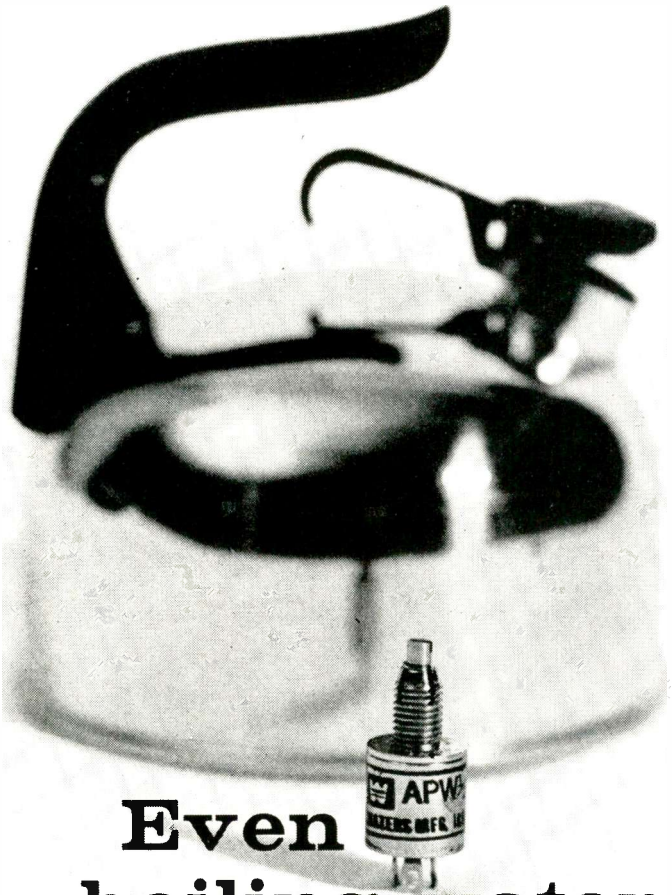

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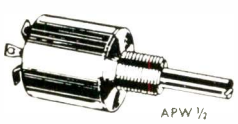

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Letters

to the Editor

(*Continued from page* 68)

where the first summation represents the value of the integral at the points where the "jumps" in f(t) occur, and the second summation gives the value of the integral over the continuous sections of f(t) that lie between the "jumps." The first summation is simply the sum of the products of the ordinates of g(t) at the time of any jump, t_k, by the corresponding amount of the jump in f(t), which is denoted by h_k. It is important to note that h_k is positive for "upward" jumps and negative for "downward" jumps in f(t).

After "breaking out" and summing the discontinuities, the remaining terms, included in the second summation, are seen to consist of the more familiar Riemann integrals over the smooth portions of f(t), where f'(t) is simply the first derivative of f(t). A more rigorous explanation of the properties and uses of the Stieltjes integral will be found in the references cited above.

Now let's see how the Stieltjes integral can be applied to give us a more general definition of convolution. The Stieltjes integral form of the superposition integral given in equation (5) of Mr. Toffler's article is as follows (assuming no energy in the system at t = 0):

$$h(t) = \int_0^t c(t - x)\, df(x)$$

in which,

h(t) = the response of the system to *any* f(t), with or without discontinuities, but subject to the requirement that the amplitude of any discontinuity be finite,

c(t − x) = the response of the system to a unit step that occurred x units of time "ago." Here we use x as a secondary time scale to measure the time elapsed since any given discontinuity took place,

df(x) = the differential of f(t) with respect to the secondary time parameter, x. Note that this differential of a *function* is characteristic of the Stieltjes integral.

To demonstrate the power and versatility of this completely general form of the convolution integral, we will "derive" equation (6) of Mr. Toffler's article from the above Stieltjes form by "breaking out" the jump due to the discontinuity at t = 0 (when,

(*Continued on page* 138)

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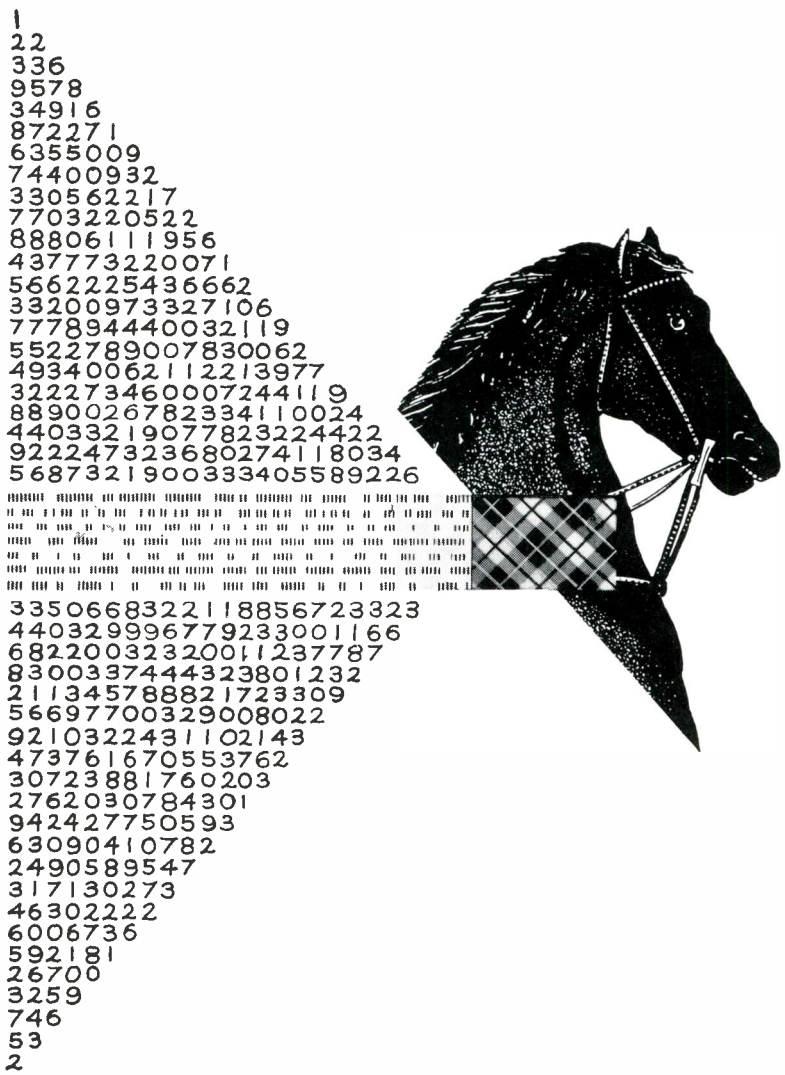
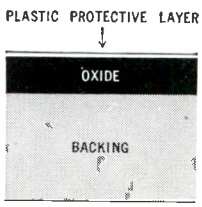


Tote that tape—change that reel—clean that head! If your project atmosphere sometimes seems that way, "SCOTCH" BRAND Sandwich Tape comes to the rescue. How about the possibility of getting over 50,000 passes out of a computer tape? And if that sounds attractive, consider the value in a tape that has no rub-off, won't give you any head build-up, drastically reduces maintenance and replacement on costly head assemblies.

One user found that the simple change to "SCOTCH" BRAND Sandwich dramatically reduced head replacements. And—where heads previously had to be cleaned after every run, "SCOTCH" BRAND Sandwich Tape cut cleaning to once a week.

The secret's in the Sandwich—the high potency oxide magnetic coating is sandwiched between the tough polyester base and a thin protective plastic layer. The coating never contacts the head—you get smooth, low-friction tape movement, plus an end to rub-off, head build-up, and a reduction in erosion of the critical slit in the recording head. Though the 50 micro-inch protective layer causes some slight reduction in high frequency response, the plain facts are that Sandwich Tape packs up to 600 pulses per inch in digital work—has broad usage in AM, FM, or PDM applications.

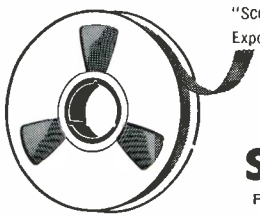


In "SCOTCH" BRAND Sandwich Tape you have a tape workhorse, pulling a big load over long distances. One user reported fewer drop-outs with each successive pass. As his recording heads were cleaned, the contaminates proved to be in the system, not the tape. Speaking of drop-outs, beware the villainous cigarette—often a culprit. One careless gesture and an ash can cause 40 to 60 drop-outs.

Whatever your application — data reduction, acquisition or control programming — count on 3M technology to create tape of higher uniformity and reliability for error-free performance.

"SCOTCH" BRAND High Output Tape No. 128 gives you top output at low frequencies, even under extremes of ambient temperatures. "SCOTCH" BRAND High Resolution Tape No. 159 lets you pack more bits per inch, offers extra playing time. Finally, for top performance at low cost per foot, "SCOTCH" BRAND Instrumentation Tapes Nos. 108 and 109 remain the standard for the industry.

Where there's no margin for error, there's no tape like "SCOTCH" BRAND. For more details, write Magnetic Products Div., Dept. MBR-109, 3M Co., St. Paul 6, Minn., or mail reader inquiry card.



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Conclusion of a three part series. In the first section Professor Cameron defines the terms that would be used in describing relay action. In the second section, appearing in this issue, he discusses exactly how a relay behaves during the period when the armature is moving from an open to a closed position.

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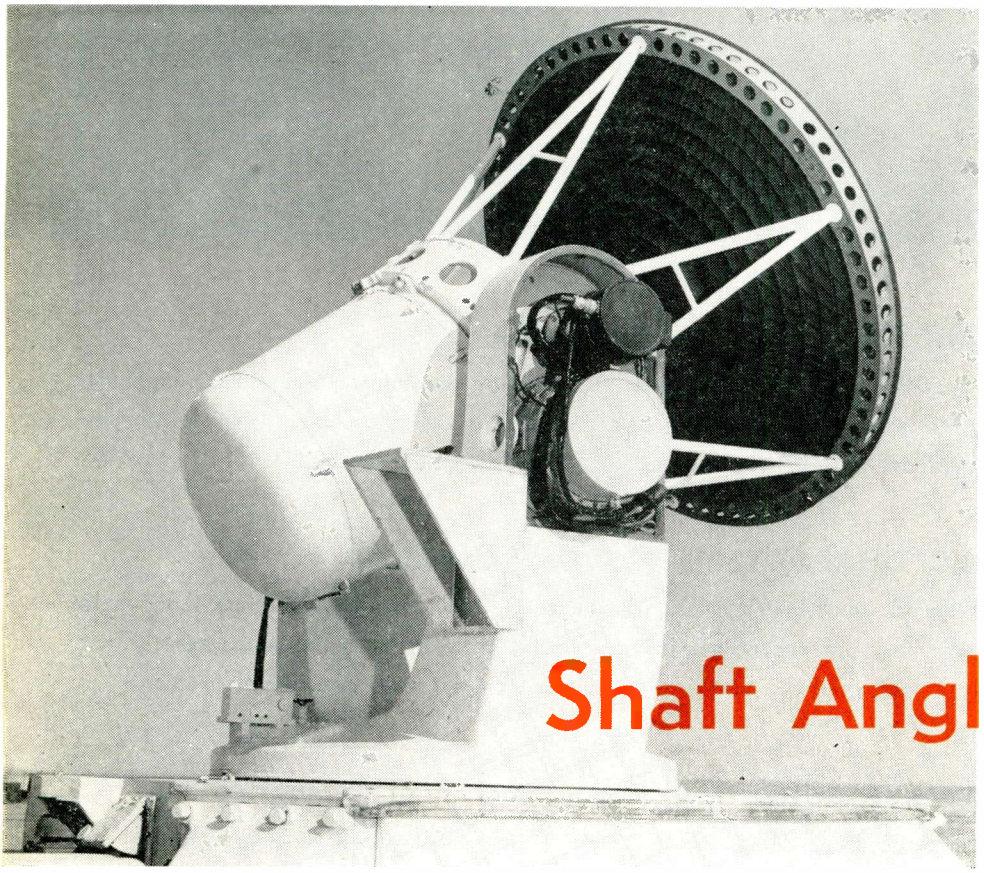


A 16-digit encoder, black drum, mounted on a Nike Radar elevation shaft. Another is mounted on the azimuth shaft but is not visible.

Shaft Angle Encoders

By C. FARRELL WINDER
Baldwin Piano Co.
1801 Gilbert Avenue
Cincinnati, Ohio

Shaft position information is essential in all automatic processes. The trend toward digital data is becoming very widespread. The optical shaft angle encoder can convert this analog data into digital data with accuracies of ±4 parts per million.

A DESCRIPTION or definition of the word "encoder" may be helpful in understanding its function in data processing. The encoder, sometimes called a "converter" or "coder,"[1] is basically a device which provides an electrical coded output in response to an input. For the shaft-angle encoder, the input is in the form of shaft-angle rotation (analog information), the output, in the form of electrical signals (digital output) of the "on"-"off" type.

Shaft rotation in these devices, when properly designed, meets the requirements for high accuracy analog input. It is then necessary to convert this physical input into digital form without loss of accuracy. There are at least four categories of shaft-angle encoder types. All employ a shaft input, bearings to support the shaft, a coded disk and some type of sensing means. The four categories can be broken into two groups of two basic types:

1. (a) Those having the code disk directly attached to the shaft so that full data is available in only a single turn of the shaft.

1. (b) Those having geared arrangements, such that total data from the device is available only through multiple turns of the input shaft.

C. F. Winder

2. (a) Those having sensing means which do not touch the disk such as magnetic, capacitive and photoelectric pickup means.

2. (b) Those devices having commutator or brush sensing elements.

Outstanding Features

For high accuracy applications to practical systems, the photoelectric types without gears have progressed farthest. Some of the outstanding features of photoelectric units compared to the other types are:

1. Optical wavelengths are small, relative to the dimensions required for the code patterns. This permits not only fine lines, but sharp transitions from "0" to "1" within the pattern.

2. Negligible grain structure is now possible in special photographic emulsions.

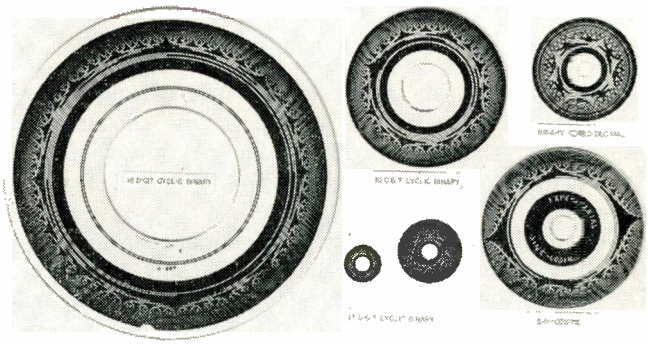


Fig. 2: Sampling of disks used in encoders. Size: 2 to 16 in. dia.

Afford High Accuracy

3. Optical images can be projected accurately over the very short distances required, with sharply defined shadows.

4. Optical readout means are relatively free from edges effects, in comparison to other proximity types of readout.

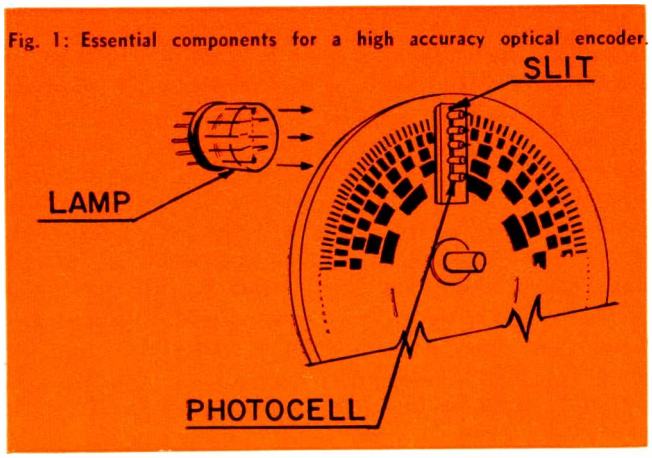
5. No contact is required between the code medium and the reading means, reducing the electrical noise, mechanical and electrical wear, and friction. Also vibration problems as might be experienced with contacting media are eliminated.

6. The high resolution which can be provided makes gearing, and related inaccuracies, unnecessary in a majority of applications.

Essential Components

Essential components for high accuracy optical encoders are shown in Fig. 1.

Fig. 1: Essential components for a high accuracy optical encoder.



These include:

1. A glass disk containing the desired binary code pattern. This part is essentially the "heart" of the encoder device. The disk acts as a storage medium for many forms of high accuracy information. Clear and opaque sectors are very precisely placed on the disk in a group of concentric circles. Each opaque sector represents a binary "0" and each clear sector represents a binary "1."

2. An input shaft supporting the disk and supported by bearings of the required accuracy.

3. A light source.

4. An optical system providing a narrow indexing beam of light to the sensing elements. In its simplest form this is radial slit as shown in the figure. More advanced techniques utilize a combination of a slit and one or more lenses.

5. A group of photocells. One photocell is required for each track of the disk, in order to sense the illuminated code pattern and to provide corresponding electrical outputs.

Optical Types

One of the most widely used types of optical shaft angle encoder is that type employing a gaseous flash type of lamp for the light source. Present models of this type give outputs up to and including 18 bits.

The 18 bit encoder resolves 2^{18} or 262, 144 positions with an overall accuracy of ± 4 parts per million including the inherent quantization error. Fig. 3 shows an exploded view of a 4 in. dia. flash lamp model which reads 2^{13} bits of information or 8, 192 positions. At the left of the picture is the bearing assembly. This assembly contains a set of precision pre-

Encoder *(Continued)*

loaded bearings, an input shaft, a slit of only a few microns width positioned within a few thousandths of the disk, a 13 bit disk of 3½ in. O.D. and the bearing support which also serves as the mount for the encoder.

The photocells mount directly under the slit and are shown assembled in their removable cartridge. These cells are a silicon barrier type. Trimming resistors are attached to the cell outputs. This feature allows adjustment for equal outputs from all tracks in the full "on" condition. The housings in the center enclose the disk and amplifier assembly. The "pulser" packaging for fixing the lamp is below the group of amplifiers.

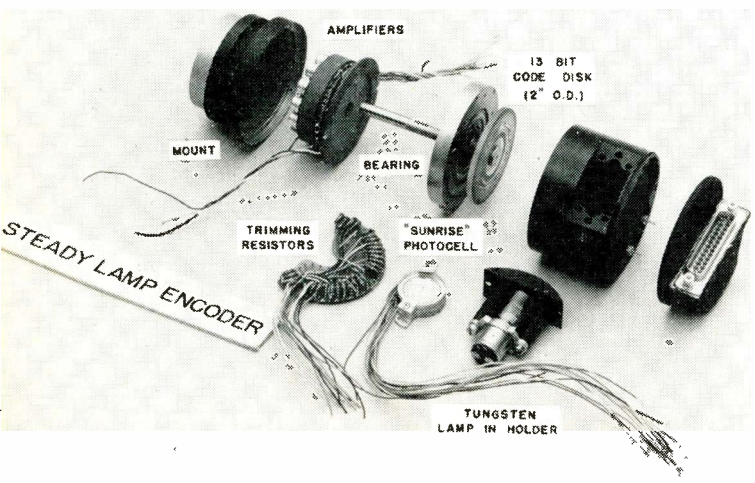
The "pulser" assembly contains the charging capacitor and resistor for supplying energy to the lamp electrodes. A high voltage transformer is also located on this assembly. A pulse from this transformer causes the lamp to fire. The lamp is shown removed from its exciter assembly. Within this encoder package, photocell outputs are amplified in a group of three stage transistorized amplifiers, one amplifier being required for each photocell. Power, interrogating and output signals are channeled through a single connector shown at the right.

A different technique in encoder construction is a type shown in Fig. 4. This also shows a 13 bit unit but one of much smaller size. This encoder is 2.6 in. in diameter. The principal difference is that this model uses a steady light source of the incandescent type. One objective was to make the unit as small as possible. Special microminiature photocells were developed by Baldwin in a hermetically sealed printed circuit arrangement, to use a smaller code disk than would otherwise have been possible. This photocell has been termed the "sunrise" cell because of its resemblance to the rising sun.

Shown at the left is the encoder mounting which also serves for the amplifier housing and bearing support. A special single bearing was designed to conserve space while at the same time providing a very accurate rotational support for the disk. Trimming resistors are used as with the previous unit to obtain uniform outputs. A steady light uses an entirely different method of sampling the disk position. If stable dc amplifiers could be provided, sampling would not be necessary for parallel output as the digital data would change as the disk position changed. However, as ac amplifiers are easier to provide, the photocell is pulsed to sample the disk position. A further advantage of pulsing the cell becomes readily apparent. Besides higher sampling rates than possible with flash lamp types (up to 1 MC has been demonstrated using the "sunrise" cell) the steady lamp arrangement has the unique advantage that sequential information can be obtained directly from the photocells. This point will be discussed further in a following section. The lamp is at the right of the cell. It is easily replaced by removal of 4 screws.

A common plug shown on the extreme right handles power input to the lamp, photocells, and amplifiers as well as sampling and output signals.

Fig. 4: Steady lamp encoder technique allows a 1/3 size reduction.



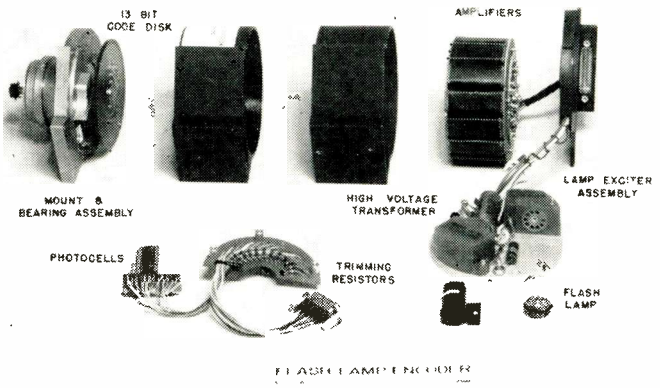


Fig. 3: Exploded view of flash lamp encoder which reads 2^{13} bits.

Code Patterns

The type of code wheel most popular in optical encoders contains a cyclic binary code pattern designed to give a cyclic sequence of "on-off" outputs. The cyclic binary code is also known as the cyclic progression code, the reflected binary code, and the Gray code. This code was originated by G. R. Stibitz, of Bell Telephone Laboratories, and was first proposed for pulse code modulation systems by Frank Gray, also of BTL.[2] Thus the name Gray code. The Gray or cyclic code is used mainly to eliminate the possibility of errors at code transition which could result in gross ambiguities.

Fig. 5 shows a comparison between two types of codes. Actually the end answer is usually desired in straight binary coded form. However, if one attempted to use a straight binary code disk with the encoder, it is apparent in looking at the two codes that serious ambiguities could result from the straight code arrangement. Consider, for example, a reading from a sector on the straight coded disk near 180°, and another reading from a sector near 270°. If for some reason there was a small defect in the boundary of the second innermost track, caused by this segment being too short, then a reading would be obtained showing that the position of the code was 180° instead of 270°. This gross error would of course be intolerable.

In the cyclic code, only one zone is permitted to change conditions at a time. Hence, there will be no more than one quantum error existing, presuming that reasonable care has been used in centering the disk and adjusting the slit. Of secondary consideration the width of the cyclic code pattern segments are twice that of the straight code except for the innermost track. This permits placement of one more track on a disk of given size.

Most computers are designed to handle only the straight code. It is a fairly simple matter to convert cyclic code to straight code, as will be shown later.

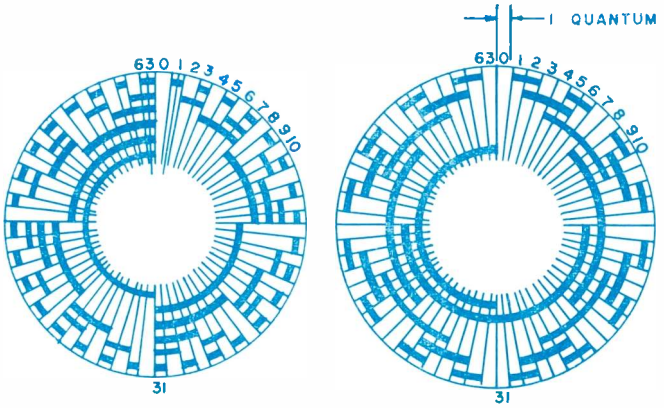


Fig. 5: Comparison of straight (left) and cyclic (right) binary codes.

The small inconvenience of conversion for the readout methods described is, without exception, justified by the elimination of gross errors.

Coded Disks

Fig. 2 shows several types of disks actually used in encoders. These range in size from 2 in. in diameter through 16½ in. in diameter. The 13 bit disks provide 8, 192 discrete positions, the 16 bit disk 65, 536 and the 18 bit disk 262, 144 positions. The width of the smallest light or dark sector in the outer track of the 18 bit disk is 0.0004 in. Shown also are some special types of disks. One is shown which has a binary coded decimal arrangement, and reads hours and minutes of the day. An example of nonlinear binary code discs which can be produced is a sinusoidal type.[3]

For both sine and cosine outputs from the same disks, two reading heads are placed exactly 90° apart within the encoder. If special coded functions are placed on the disk, substantial computer time and circuitry can be saved in the final data processing steps. All of these disks are produced on a very special and unique divided circle machine which was designed, developed and produced by The Baldwin Piano Co.

Flash Lamp Types

For a flash lamp type encoder, the output is available only in parallel form. Fig. 6 shows how the flash lamp encoder is interrogated and the output data is processed. A pulse from a programmer or computer initiates the trigger pulse. This pulse is fed to a blocking oscillator or other driving circuitry which is coupled to a high voltage transformer. A voltage in the order of 4,000 volts is then supplied to the lamp trigger electrode. The lamp is supplied with energy by a capacitor placed across its electrodes. Upon receipt of a high voltage pulse, the gas ionizes and the lamp emits a high intensity light pulse of a few microseconds duration. This light pulse is projected onto the code disk and the light received by the photocells forms a parallel cyclic binary coded electrical word defining one of the disk positions. Usually some amplification is required for the individual signals before they are further processed.

After amplification, the usual practice is to store the cyclic information in parallel form in circuitry such as a shift register. A shift register has the property that when shift pulses are sent into the first stage of a series-connected group of shift register elements, the information is shifted down the line by one pulse. Thus, the output information is available in sequential cyclic form.

To convert the cyclic code information to straight binary code it is only necessary to process the sequential cyclic information through a flip-flop circuit. In the flip-flop, the first input pulse sets the output positive and the next pulse sets it negative, yielding a sequence of voltage pulses representing a straight binary code. Fig. 7 also shows the possibilty of "restoring" the converted information in the shift register so that it is available when required by a computer or other equipment.

(Continued on following page)

Fig. 6: Interrogation of flash lamp encoder and processing of output.

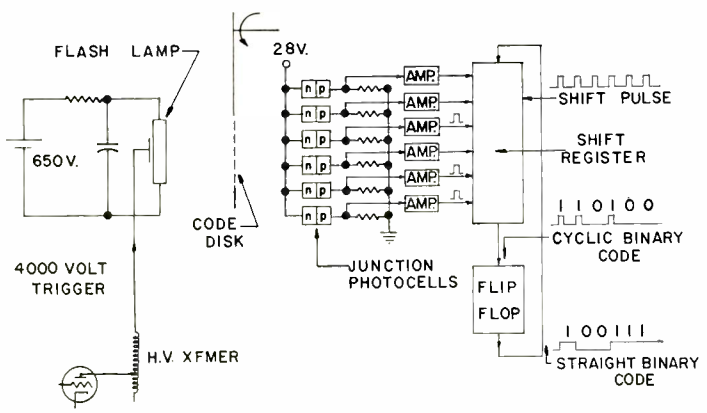
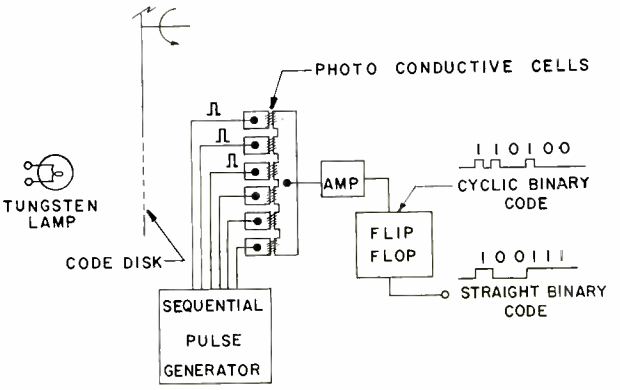


Fig. 7: Processing of data from the steady light sequential encoder.



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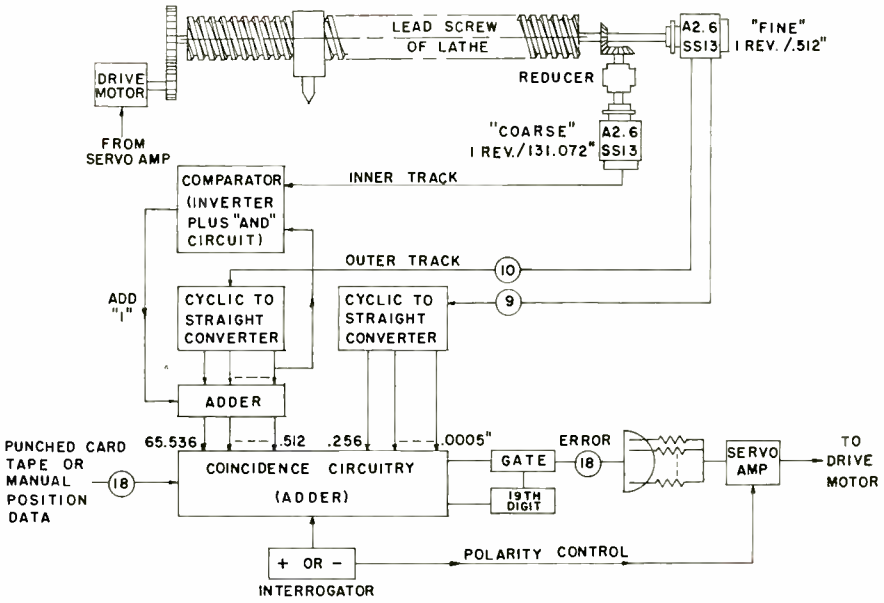


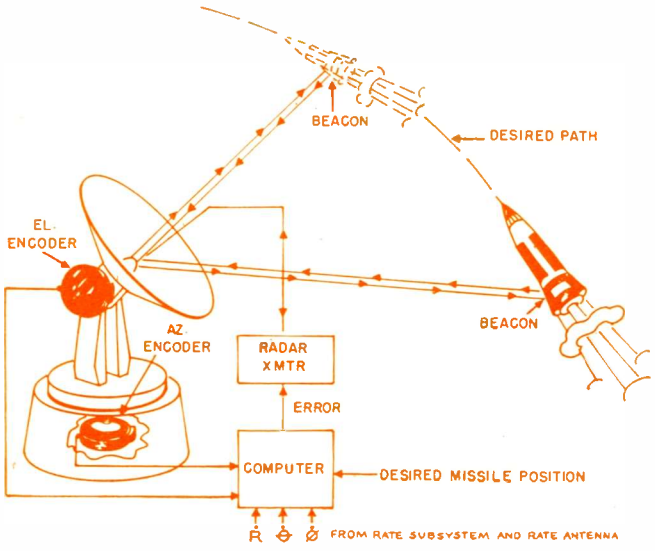
Fig. 8: Application of encoders in automated machine tool control systems.

Encoder *(Continued)*

Steady Lamp Encoder

Fig. 7 shows how the data from the steady light encoder are processed. As mentioned before, the steady light unit has a unique advantage in that sequential information can be obtained directly from the photocells. In this case, pulses are applied sequentially from a programmer or computer to individual leads of the photocells and the combined outputs are on a common lead. Only one amplifier is then needed to amplify the output signals. The sequential information can then be fed directly to a flip-flop and converted from cyclic to straight code. The sequential arrangement is outstanding in applications where the number of leads is restricted as on a gyro gimbal. By including the sequential pulse generator within the encoder the total number of leads can be reduced to as few as four leads.

Fig. 9: This diagram illustrates the basic General Electric guidance system used for the Atlas Intercontinental Ballistic Missile. Encoders, the black drums, are used on both the elevation axis and the azimuth axis. A prototype is in operation at the Atlantic Missile Range; another is being installed at Vandenberg AFB, Calif.



If parallel output is desired it is only necessary to reverse the wiring of the circuitry within the encoder so that the common lead of the cell is interrogated. Parallel information is then read from the individual output leads.

Applications

Some of the smaller 13 bit encoders are being used in a prototype automated machine tool system. Military applications include a shipboard measurement station which will supply the most precise data yet collected at sea on missile flights. Projects Datum and High Range, currently in operation at Edwards AFB, Calif., are other typical military applications. These projects are used in the X-15 testing program.

One of the most outstanding and notable applications of high accuracy shaft angle encoders is the Atlas Missile Guidance System now being installed at Vandenberg AFB, Calif.

Acknowledgments

It is impossible to give complete acknowledgments for all of the noteworthy contributions by Baldwin engineers to the encoder program. However, the untiring encouragement and interest given by Mr. John F. Jordan has been an important factor. Acknowledgment is also given to Mr. E. M. Jones for his many outstanding novel ideas and illuminating discussions which have contributed to the successful realization of high accuracy encoders.

Appreciation is expressed to the Radio Corporation of America, the General Electric Co., the Electronic Engineering Co., and to Edward AFB for the use of material describing applications of various Baldwin encoders.

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Though other solid state devices are more in the professional limelight, the thermistor will continue to grow in value when the former become obsolete. This article presents a small inventory of the materials and types presently available, with special emphasis on a rather broad temperature scope.

Thermistors . . . . . 10 to 600°K

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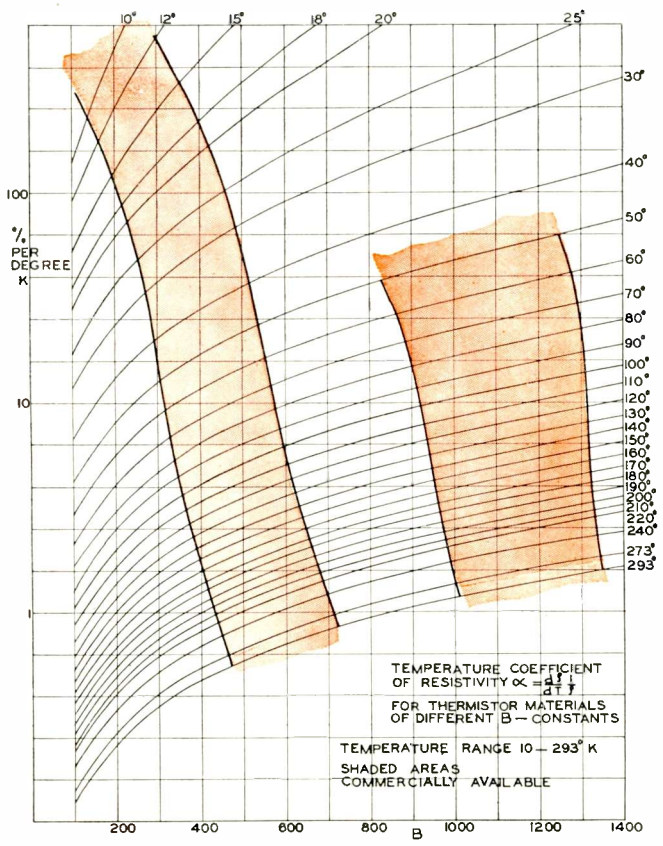
THE first thermistors produced on a large scale in Europe during the 1930's by Philips and Osram were made from materials which easily oxidized in air and had to be sealed into evacuated or hydrogen filled glass bulbs. This restricted their application mainly to stationary equipment such as surge protection in radios and similar apparatus. Most applications, especially for temperature compensation and temperature measurement in electrical aircraft equipment, called for thermistors with smaller weight and faster response time. This prompted during 1935-1940 the development of thermistors which could be operated in air. The pioneers in this field were Bell Telephone Laboratories in this country and Siemens in Germany.

Osram during this period was still committed to lamp bulb type thermistors but followed suit in the middle 40's. What has happened since this time in extension of ranges, refinement of design, and miniaturization is impressive.

The trouble with the earlier thermistors for operation in air was always that their resistance at room temperature was rather high. Even so-called "reduced oxide" Osram types were not lower than 2000 ohms; Western Electric, 100 ohms. Siemens reached down to 1 ohm for single, unshunted units at room temperature. Today thermistors can be produced down to fractions of 1 ohm with a wide variety of temperature coefficients.

The majority of applications calls for intermediate resistance values with temperature coefficients between 3-6%/°C and resistance values between 100 and 5000 ohms.

Fig. 1: Temperature coefficient for two low temperature materials, 10 to 293°K. Shaded areas indicate the commercially available values.



Temperatures Far Below Ambient

Since the room temperature resistance for thermistor types operating in temperatures far below ambient is normally of minor importance, a useful and more realistic classification has been based upon the re-

Digest of a paper presented at the IRE "Thermistor Seminar," Philadelphia, Pa., March 19, 1959.

Thermistors *(Continued)*

sistance value in liquid oxygen (—183.3°C). The available resistance range for this temperature extends from 100 ohms to 30 K ohms.[1] This wide scope reflects the variety of ratios between the temperature of liquid oxygen and room temperature; in other words, the variety of slopes of the logarithm of the resistance vs the reciprocal absolute temperature characterized by the material constant B in the well-known equation

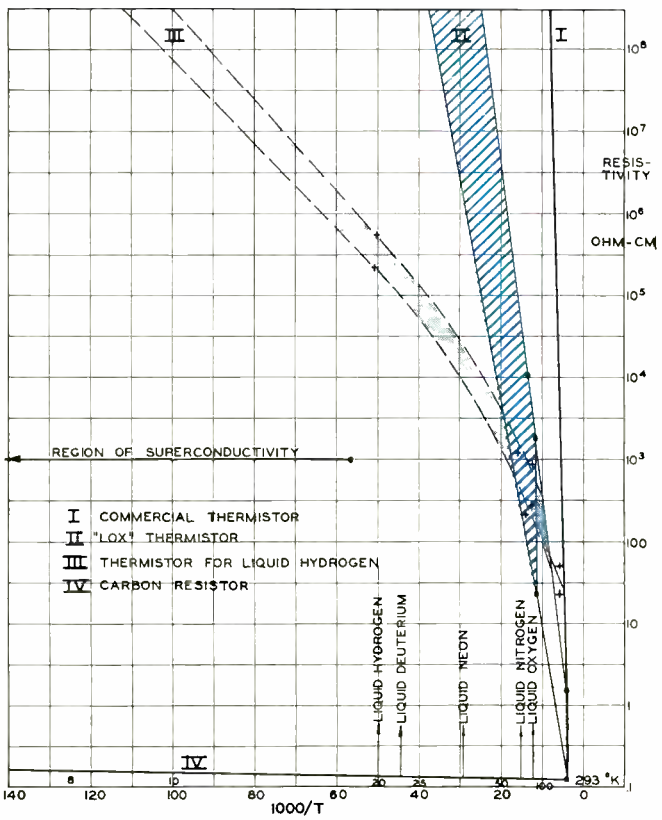
$$\log R = B/_{2.303T} + \log A.$$

In this equation, B determines the resistance temperature slope as just mentioned and A is a constant determining the resistance as such, independent of the temperature. Formally, it is the "residual" resistance for very high temperatures: For $T = \infty$: $R = A$.

For applications in the liquid oxygen-liquid nitrogen range, thermistors with B-values of 1000 to 1300 can be made. These correspond to temperature coefficients between 13.5 and 17%/°C for liquid oxygen and 18 to 24%/°C for liquid nitrogen (—195.6°C).

For lower temperature applications, such as liquid hydrogen (—252°C), a larger step in the direction of lower B-values is necessary.[2, 3] With B-values of the order of 1000, even thermistors of only 100 ohm resistance in liquid oxygen would reach the enormous resistance value of more than 10^{15} ohms and would therefore be less conductive than most of the insulators at room temperature.

Fig. 2: Resistivity vs. reciprocal temperature for various thermistor materials and carbon resistors.



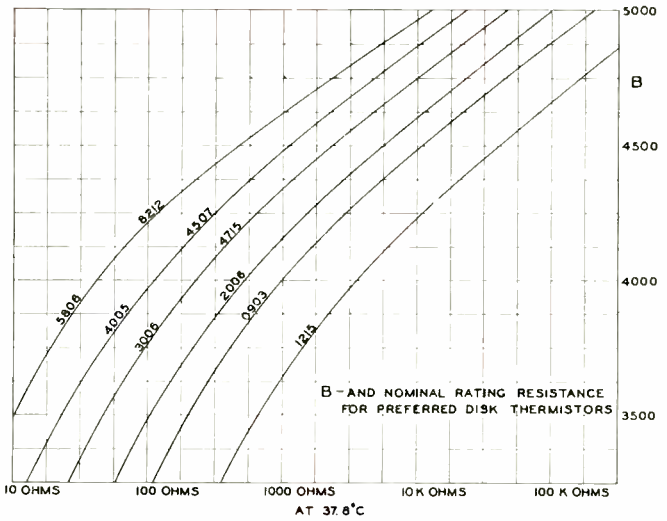


Fig. 3: Materials constant B and normal rating resistance for preferred disk thermistors.

It was found that B-values between 200-250 are sufficiently small to keep the resistance value in liquid hydrogen within practical limits.[4]

The shaded areas in Fig. 1 indicate the scope of temperature coefficients which can be produced by the low temperature thermistor types in the temperature range from 10 to 293°K. The "sausage" like bend of these bands is caused by a decrease of B with falling temperature. Thermistors in the narrow band (III) can be used down to 10°K, those in the wide band (II) to 50°K. The corresponding resistivities plotted vs 1000/T are shown in Fig. 2.

Temperatures Near Ambient

Thermistor materials useful for very low temperatures exhibit, at room temperature, temperature coefficients of only 1%/°C or less. Even at —50° the coefficient is still very low (—2%/°). It would make these thermistors too insensitive for many applications at moderate subzero temperatures.

Another material is more suitable for this temperature range. It has B-values from 1100 to 2800 and resistivities at 25°C from 0.40 to 700 ohm centimeter. Thermistors normally made from these materials in rod form cover a resistance range from 30 ohms to 90 K ohms at 25°C. Production-wise they are normally rated 37.8°C. The temperature coefficient of this intermediate material at room temperature is between 2 and 3.6%/°.

Temperatures Above Ambient

The temperature coefficient α of resistance in thermistor materials drops considerably with increasing temperature according to the relation

$$\frac{dR}{dT}\frac{1}{R} = \alpha = -B/T^2$$

(by differentiation of the basic equation relating resistance and temperature $R = e^{B/T}$).

It is obvious that materials with negative α-values from 2 to 3.6%/°C at room temperature will become rather temperature insensitive above 100°C. Thus the need for higher B-values is rather evident. It is satisfied by materials with B-constants between 3400

and 4800 which are manufactured mainly as disks of various dimensions or as washers. The list of preferred disk types covers the range from 15 ohms to 520 K ohms at 25°C by exploiting all the possible variations of the physical dimensions. The standard rating temperature is 37.8°C with other reference points at 104.4°C or optionally also −21.5°C. The temperature coefficient at the rating temperature ranges from 3.5 to 4.9%/°C.

Fig. 3 correlates the temperature material constant B with the resistance values of preferred disk types.

For thermistors with a specified resistance vs temperature characteristic or B, the maximal scope of resistance values producible by the various standard dimensional types corresponds approximately to a factor 8. Fig. 4 shows the standard types of disk thermistors with their resistance and B range. The nominal operating temperature limit dictated by stability considerations of these "high temperature coefficient materials" is 150°C. It is worthwhile to mention an off-spring of the high temperature coefficient materials characterized by a much higher operating temperature limit of 260°C. B- and α-values for this high temperature material lie within the scope of the normal high coefficient materials (B-3770-4680), therefore they do not require a redesign of circuits as the switch from normal to high temperature material is made.

General Considerations

Now a short flash-back to low temperature thermistors might be of interest. We can ask: How do these different material types blend together? For such blending we have to know how B changes with the temperature for different thermistor materials. At

Fig. 4: List of standard disk thermistors of high temperature coefficient materials.

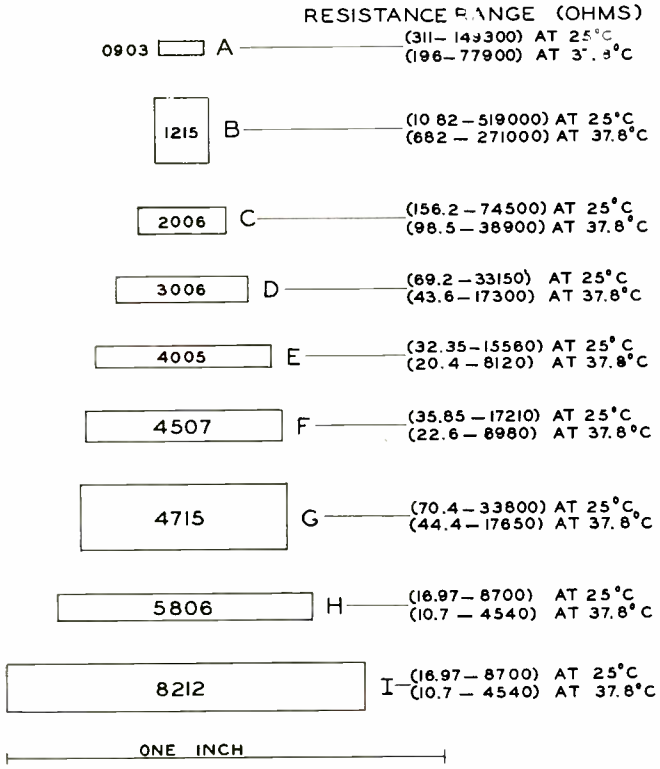


Table 1

Material	Resistivity in Megohm · Centimeter Polycrystalline	Single Crystal
MnO	200	10,000
CoO	10	8,000
NiO	1	2

the first glance it seems somewhat illogical to speak of a temperature dependence of B. Was this material constant not introduced to correlate resistance and temperature? A little side trip into semiconductor physics might explain what happens if B changes with the temperature.

We can discriminate between two types of semiconduction: intrinsic and extrinsic.

At low temperatures, extrinsic semiconduction tends to prevail; at high temperatures, intrinsic. The intrinsic type is characterized by the electronic band structure of the semiconductor or, in simpler terms, by the energy to remove one bound electron from a metal ion and to make it free for conduction. This energy is relatively large and corresponds to ½ to 1 electron volt (B = 6000-11,500) in most of the oxide semiconductors. If impurities are responsible for the electrical conduction at low temperature, the energy to release electrons for conduction becomes much smaller, resulting in smaller B-values.

Usually there is no sharp transition between the conduction types. We can expect, especially in multicomponent systems of technical thermistor materials, a wide transition range between the types. We might even expect, that both types of conduction appear simultaneously; extrinsic semiconduction prevailing at low temperature; intrinsic at high.

For ultra low temperatures, a fine analysis of the temperature dependence of B has been made. This is a slight understatement. Just the development of a highly desirable drop of B with the temperature was necessary to extend the application range of these thermistors down to 10°K as recently reported.

Between 80 and 20°K, B drops considerably from 250 to 150. If we consider a larger temperature interval, for instance between room temperature (300°K) and 20°K, the drop is still larger and corresponds to a decrease from 600 to 150, Fig. 5. This is a very remarkable effect. It will be of great interest to see whether and to which extent other thermistors, domestic and foreign, exhibit this trend to increase B with the temperature. In Fig. 6 the latitude of the B spectrum is shown for domestic thermistors and a few French, German, Italian, Japanese and Russian thermistors. Though the foreign thermistors, since chosen at random, will not claim to be representative for each country in general, it is

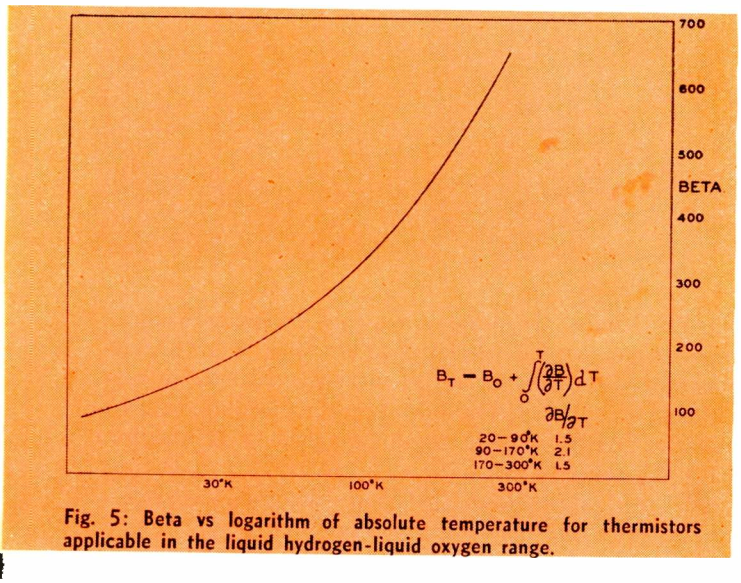


Fig. 5: Beta vs logarithm of absolute temperature for thermistors applicable in the liquid hydrogen-liquid oxygen range.

Thermistors *(Continued)*

obvious that the domestic thermistor production is leading in extension of the spectrum. Most of the thermistors lie in the B-range between 3000-5000 corresponding to temperature coefficients from 3.5 to 7% at room temperature or 1 to 1.6% at 300°C.

The ideal thermistor should have a large, however rather constant, negative temperature coefficient. This is intrinsically impossible because of the basic relationship in $\rho = Ae^{B/T}$, resulting in $\alpha = -B/T^2$. To compensate for the drop of α with increasing temperature, at least partially, a substantial increase of B with the temperature is mandatory.

The heavy curve in Fig. 6 can be considered as the B vs T relationship of some kind of a "dream" thermistor applicable for a relatively wide temperature range. A few thermistor types tend to approximate this ideal curve while others "ignore" it completely.

Returning to the original question: How do the different materials blend together, it is useful to look at Fig. 7 which demonstrates that at moderate subzero temperatures not much "open space" is left which is not covered by one of the existing types. For temperatures below —120°C (150°K) the spread becomes much larger as previously shown in Fig. 2.

Production Processes

The basic production steps are: blending of the mixture, molding of the units, sintering and contacting.

The sinter conditions are of vital importance for the technical performance and the economical yield of the thermistor output. Optimal sinter conditions must be matched to the composition of the mixture not only to produce the right resistance and B-values but also to guarantee stable and reliable thermistors.

The sinter conditions influence three basic properties of the thermistor material:

(a) Its mechanical stability.
(b) Its grain structure and the particle size in the sinter body.
(c) The oxygen surplus or deficiency in the semiconductor material.

Point (a) needs no further comment—a soft sintered thermistor is like a piece of chalk and cannot be contacted.

A model experiment with a few oxides (Ni-Mn- and Co-oxide) which are often used in thermistor compositions as constituents demonstrates point (b).

Sinter bodies made from pure powders of these oxides are mechanically strong and composed of individual crystal grains of 10^{-3} to 10^{-5} inch dia. The electrical resistivity of these sinter bodies, though very high, can still be measured with conventional methods. At 20°C for instance resistivities (ohm-centimeter) as given in the second column of Table 1 are found. Single crystals of these same materials with the same grade of purity have much higher resistivity (column 3).

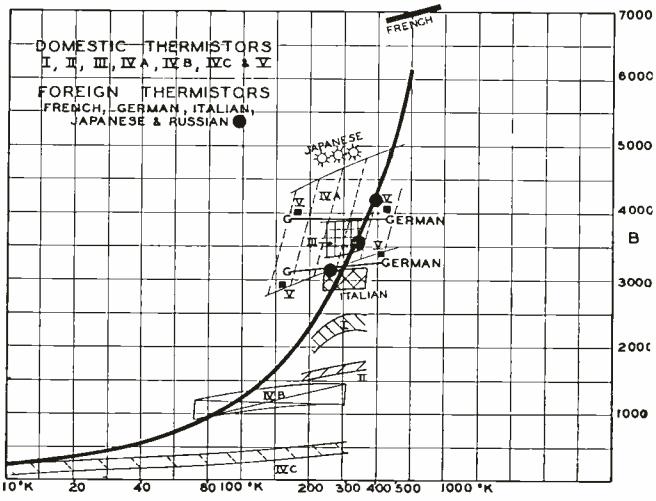
Table 1 demonstrates drastically the influence of the particle size—or in other words—the contributions made by the surface conductivity of the semiconducting grains within the sinter body. Though this model experiment is rather far away from the practical conditions of thermistor production (most of the thermistor materials are compositions of several basic materials), it emphasizes the importance of the crystal growth during the sintering process, especially since tolerances of 10% or less are required in production.

Oxygen surplus or deficiency, caused by variations of sinter conditions, is a problem of more direct consequence. Fine grain materials will respond even much faster to oxygen than single crystals.

In nickel monoxide, freshly prepared as compressed powder, which has at room temperature a resistivity of the order of 10^7 ohm-centimeter, the resistivity drops 4 to 5 orders of magnitude by absorption of approximately 1 to 3 % atomic oxygen.

Similar effects can be observed with cuprous oxide and a series of other materials. In view of the drastic magnitude of this effect, one can again imagine that even minor changes in the oxygen environment can produce resistance and ratio changes of 5-10% which might make or break the economy of a thermistor production. Considerable work has been done to determine the active oxygen surplus or deficiency in semiconducting oxides. The method has been refined

Fig. 6: Temperature dependence of the material constant B for domestic and foreign thermistors.



to such a degree that we can discover deviations of 1 atom of oxygen in 1000 molecules of oxide, or, in other words, deviations from 0.01 to 0.1% in oxygen. For instance, single crystals just mentioned before had the following compositions:

$MnO_{1.00075}$ $CoO_{1.0038}$ $NiO_{1.001}$

The error in these tests is only ±20% for the fourth digit and corresponding less for the third digit. This shows that the specified high resistivities of the single crystals are not caused by some kind of chemical disorder, since they all are nearly theoretically monoxides.

Next to the sinter process, proper contacting is of vital importance to avoid instability, nonlinearity of resistance and rectifying barrier layers. A discussion of this point is beyond the scope of this article.

Conclusion

Thermistors are at the present time available for temperature range between 10 and 540°K (−263-+270°C) with a great variety of resistance and temperature coefficients. The natural decrease of the temperature coefficient with $1/T^2$ is partially compensated by a large scope of material constants B increasing with the temperature range of application. Certain types display an increase of B with the temperature thus extending their useful temperature range. Some basic factors influencing the tolerance of thermistors during production are pointed out.

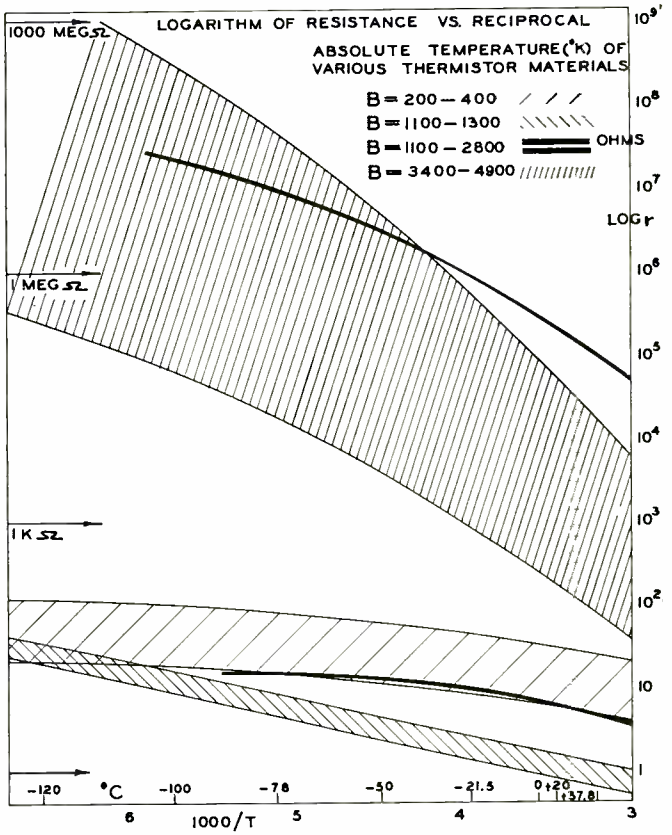


Fig. 7 (above): Resistance vs. reciprocal temperature for various thermistor types between —130 and +37.8°C.

The size 5 motor generator weighs less than half that of its size 8 counterpart.

Size 5 Motor Generator

A NEW servo mechanism, the size 5 Motor Generator provides the same working efficiency at up to 50 per cent savings in weight over the next smallest model now available. Used largely in missile guidance systems, it is manufactured by Daystrom Transicoil, a division of Daystrom, Inc., Worcester, Pa.

Up to now, the size 8 MG, weighing 2¼ ounces, was the smallest practical motor generator. The new size 5 MG weighs one ounce and does the same job.

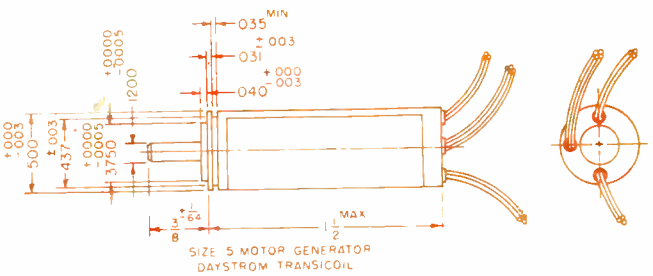
The weight and size reduction in the motor generator permits a series of other miniaturizations in missile components and equipment. For example:

1. Power requirements are reduced—allowing lighter and smaller power supplies.
2. Smaller servo amplifiers may be used to control the 5 MG.
3. Temperature rise is lessened—which means a decrease in heat sinks, insulation, and other heavy thermal protection equipment.

Also, the overall reduction in mass better equips the guidance and control systems to withstand the severe vibrational environment of today's missiles.

The size 5 MG develops a minimum stall torque of 0.11 oz-in and has a free speed of 10,000 rpm. Units are available for 400 cycle operation with 26 or 33 control phase winding. The control phase is split for operation directly with transistor amplifiers.

Use of this smaller unit permits smaller, and lighter power supplies, servo amplifiers, and greatly reduced heat sinks.



There are two differential equations which govern the mechanics of relay operation. These equations are: (a) armature motion during release, and (b) armature motion during make. Oscillograms of relay action substantiate the results.

The Dynamics of Relays

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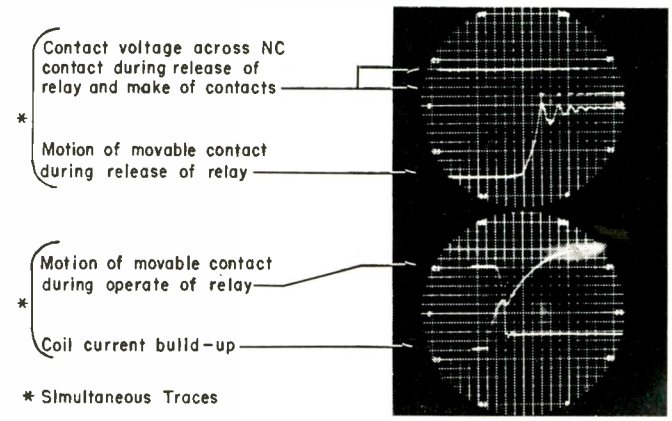
Part Two of Three Parts

IN addition to recording armature motion it is possible to record the motion of other moving parts of a relay such as the movable contact. The top half of the oscillogram shown in Fig. 7 shows traces of contact voltage and contact motion of the movable contact during the release operation of the relay. The contact voltage is across a NC set of contacts which for release results in make of the contacts. The contact voltage shows considerable chatter. From the contact motion trace it can be seen that the oscillation of the contact caused this contact chatter. It is possible that the contact oscillation was caused primarily by armature rebound.

The bottom half of the oscillogram in Fig. 7 shows the coil current build-up and contact motion of the movable contact during operate. Only a little contact oscillation is evident.

Fig. 7: (Top) Contact voltage and contact motion of movable contact during release. (Bottom) The coil current build-up and contact motion of the movable contact during operate.



Armature Overtravel Time

The time interval from the instant the contacts function to the instant the armature seals or closes is referred to armature overtravel time. The top half of the oscillogram in Fig. 8 shows an example of practically zero armature overtravel time for operate while the release shows some armature overtravel time. It is difficult to locate accurately the point at which the armature opens from studying the coil current decay. Generally the highest peak on the coil current hump occurs slightly before the armature hits the back stop. In the release case, shown in the top half of the oscillogram, the contacts function in about 75% of the operate time. This would result in an armature overtravel time of about 25% of the operate time.

The lower half of the oscillogram in the Fig. 8 shows a condition that could be called negative armature overtravel time during operate. This exists because the contacts functioned after the armature sealed. This was caused by the fact the contacts were on a microswitch which was actuated by the armature of the relay. For release, this combination caused practically zero armature overtravel time.

Armature overtravel time may be different for different contacts on the same relay. This may be caused by different contact separation and different contact locations.

Relay Mechanics

There are two differential equations which contain the answers to the mechanics of relay operation. These equations are: (a) armature motion during release, and (b) armature motion during make. The first of these equations has been solved with the sim-

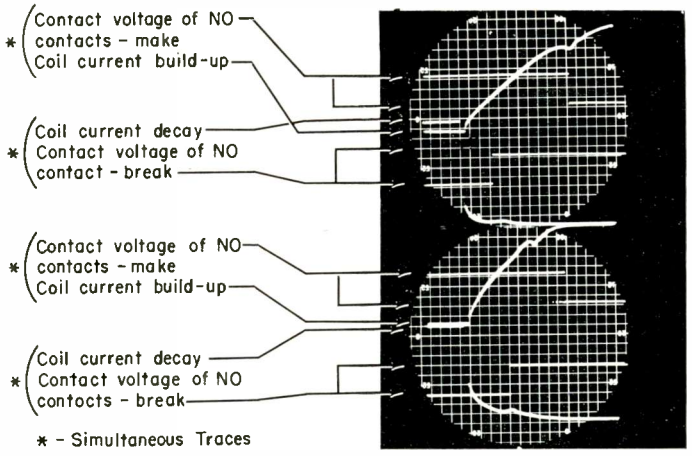


Fig. 8: (Top) An example of practically zero armature overtravel time for operate. (Bottom) Negative armature over-travel during operate; contacts functioned after the armature sealed.

plifying assumption that the current is reduced to zero at the instant that the coil of the relay is de-energized.

The diagram of Fig. 9 may be used to find the forces acting upon the armature. The resulting differential equation is at a time "t" and an armature position "x" and it is

$$M \frac{d^2x}{dt^2} = - Kx + P + KA - Mg - h^2 \frac{dx}{dt} \qquad (9)$$

where:
- M = mass of the armature
- k = spring constant
- P = spring pull, armature open
- g = gravitational acceleration
- h^2 = friction constant
- A = air-gap
- dx/dt = velocity
- d^2x/dt^2 = acceleration
- x = armature travel

The solution of this differential equation contains three cases: (a) oscillatory condition, (b) critically damped, and (c) over-damped. It is evident that with the proper choice of parameters, the over-damped case would apply.

The differential equation of the armature motion during make is somewhat more involved than that for release. This equation may be written

$$M \frac{d^2x}{dt^2} + h^2 \frac{dx}{dt} + Kx + f\left(\frac{i}{x}\right)^2 = P + KA - Mg \qquad (10)$$

where the term $f\left(\frac{i}{x}\right)^2$ has been added to take into consideration the pull on the armature exerted by the coil. In other words, the pull is a function of the instantaneous transient current and the instantaneous position of the armature.

This current is given by Eq. 4. The solution of the resulting differential equation is seen to be somewhat involved and cannot be solved directly. Some other methods have to be used.

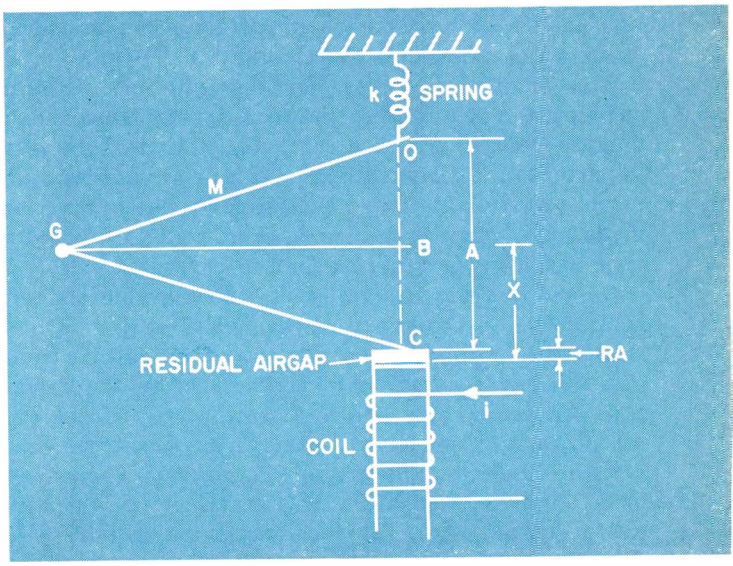
An analysis of Eq. 10 shows that motion of the armature is included as well as the effect of the spring, the pull of the coil and the mass of the armature. This is a dynamic relationship and while it is true for steady-state conditions, it is likewise true for dynamic conditions.

The pull on the armature is a function of the current, and starts as soon as the current begins to build-up in the coil. A differential equation has been given for this current as well as current traces on oscillograms. When the armature begins to move the value of "x" decreases until $dx/dt = 0$.

With the armature open "x" is air-gap between the shim and the armature. The current in the coil increases and the value of "x" decreases as the armature moves from the open position to the closed position. It would be suspected that the pull on the armature has increased greatly as it moves to the closed position.

Electrical and mechanical considerations must be included in an analytical approach to relay perform-

Fig. 9: Forces acting upon the armature of a relay



ance and design. It is surmised that terms to include shock and vibration could be included in the differential equations to find a structure which would perform satisfactorily. While no progress on this problem has been made, it offers tremendous opportunities. It must be pointed out, however, that the time involved could be considerable. Much work remains to be done.

Operate Time as a Function of Air-Gap and Spring Tension

It has been found that the operate time of a relay is a function of the length of the air-gap and also a function of the spring tension. It would be desirable to have the operate time plotted against the spring tension for different values of air-gap. This would

Relay Dynamics *(Continued)*

give a family of curves for various values of air-gap. Since the operate time is also a function of the volt input, and since the resistance of the coil will change with time with a constant voltage impressed across the coil, it is necessary to allow the coil to heat up to a constant temperature in order that the current taken by the coil will be constant.

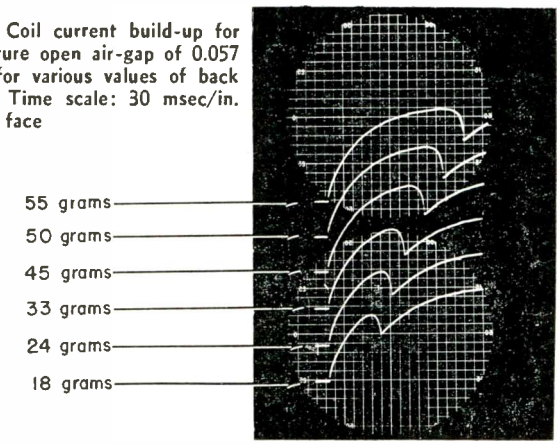
The operate time of the relay is found from the transient coil current build-up which was recorded from an oscilloscope. For a series of values of tension of the restoring spring of the armature, the air-gap is held constant and records made of the transient coil current. As previously mentioned, the operate time may be found from the transient current curve. This process is repeated for various values of air-gap. The air-gap is measured by a thickness gauge and the spring tension is measured by a gram gauge.

Fig. 13 shows the results of a series of measurements of the operate time and spring tension for various values of air-gap. The relations are plotted as curves for the relay under test. Other relays will show other tendencies. It is to be noted that for the largest air-gap, the operate time has a larger variation for the various values of spring bias, whereas for the smallest air-gap, the change in spring tension has the least effect upon the operate time. It would be quite unusual for a relay to have an air-gap as small as the curve which represents the air-gap for 0.017 in.

This family of curves, for the different air-gaps showing the relationship between spring tension and operate time, illustrate a characteristic which is very important in relay design. This characteristic is often referred to as an adjustment which may be made on a relay to secure a given value of operate time and a given value for pull-in current.

On many relay design types, the movable contact is attached to the armature by a leaf spring. On a relay with normally-open contacts, the movable contact touches the stationary contact before the armature has sealed-in or before the armature touches the core. During this short interval of time, the contacts are touching and are in compression. There may be a slight tendency for a lateral motion which is called contact wipe. This contact wipe is purposely introduced by many relay manufacturers to improve

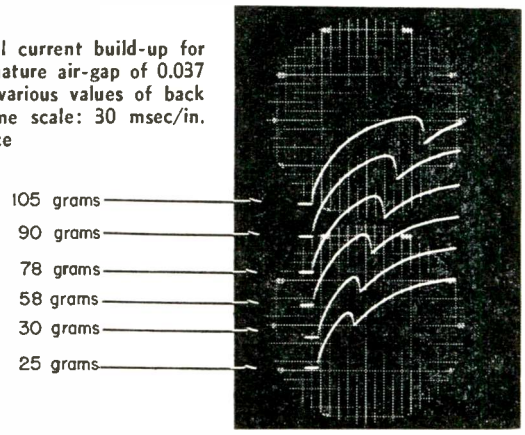
Fig. 10: Coil current build-up for an armature open air-gap of 0.057 in. and for various values of back tension. Time scale: 30 msec/in. of scope face



the conductivity of the two pieces of metal which form the contacts.

When the series of tests were conducted on the relay to find the relation which existed between operate time and spring tension for various values of air-gap, the leaf spring which held the contact was removed. The oscillograms which are shown in Figs. 10, 11, and 12 give such a series of traces. By proper manipulation, several traces may be recorded on one print. Oscillograms were taken of the transient coil

Fig. 11: Coil current build-up for an open armature air-gap of 0.037 in. and for various values of back tension. Time scale: 30 msec/in. of scope face



current when the air-gap was held at a given value and the spring tension varied. This process was repeated for several values of air-gap. The curves of Fig. 13 are the results of this series of tests.

The air-gap and the spring tension will determine the maximum and minimum limits of operate time for a given relay design. While the user will not, in general, make a series of adjustments on a relay, some knowledge of these characteristics will be of value to him in order that he may appreciate the limits and the operational characteristics of the relay.

It is stressed that the family of curves shown in Fig. 13 are average results. The curves which were drawn for the different air-gap settings were not continued beyond the measured values. At higher values of spring tension, the lines, if continued, would have a tendency to curve to the right. It is quite possible that other relays would show somewhat different characteristics.

Operate Time

Operate time of a normally-open relay has been defined as the total elapsed time from the instant the coil is energized until the contacts are closed and all contact chatter or bounce has ceased. For a relay with normally-closed contacts, the operate time has been defined as the total elapsed time from the instant the coil is energized until the contacts have opened, that is, the contact current is zero.

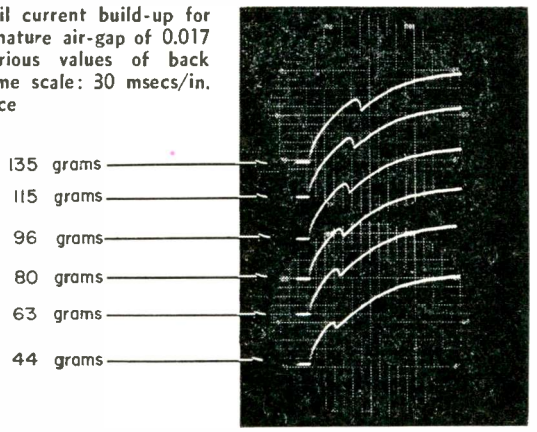
The oscillograms of Figs. 14 and 15 illustrate that "operate time" is not a fixed term which may be determined once and that remains that value there after. Fig. 14 shows two transients coil current build-up curve for the same relay and contact curve for a normally-closed relay. The upper pairs of traces were obtained after several operations of the relay and the middle set of traces were recorded after

a reversal of the polarity of the coil voltage. The operate time was longer for the middle set of traces. The normally-closed contacts opened the circuit a very short time before the cusp on the transient coil current reached a minimum value.

In Fig. 15, it is to be noted that the NO contacts make, as shown by the two horizontal lines, sometime after the armature reaches the core. The upper set of traces are for one polarity and the lower traces are for the opposite polarity of the coil voltage. In this relay, which was manufactured by a different concern than the relay in Fig. 14, the armature reaches the core before the contacts make electrically. The series of dashes immediately after the initial make indicates contact chatter. The situation in Fig. 15 is different than Fig. 14 As for the previous case, the upper traces are for one polarity and the lower is for the opposite polarity. According to the definitions of "operate time," this relay shows an increased value because of contact chatter. The contacts first made, in the upper set of traces, a very short time after the armature touched the core but contact bounce or chatter did not cease until a few milliseconds later. The operate time as defined includes the chatter time which adds several milliseconds to the value of operate time if there was no chatter.

In some relay designs it is found desirable to have

Fig. 12: Coil current build-up for an open armature air-gap of 0.017 in. and various values of back tension. Time scale: 30 msecs/in. of scope face



the contacts engage early in the travel of the armature or sometime before the armature has struck the core. In other designs which was noted in the oscillograms, the armature has just about completed its travel before the contacts touch.

Variable Supply Voltage-Variable Resistance

In another section the effect of series resistance at constant supply voltage is discussed. This section is similar except the supply voltage and series resistance are varied in such a manner that the steady state or final value of coil current will be the same. The results are shown in the oscillogram of Fig. 16. The top half shows armature motion and coil current build-up with a supply voltage of 24.8 volts dc. and no series resistance. This is normal operation for this relay. The sawtooth effect shown at the end of the armature motion trace is the result of armature rebound.

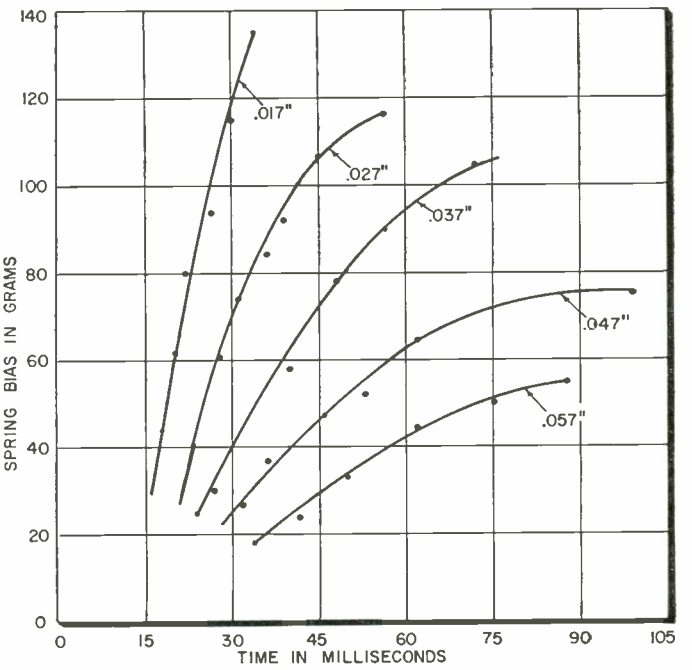
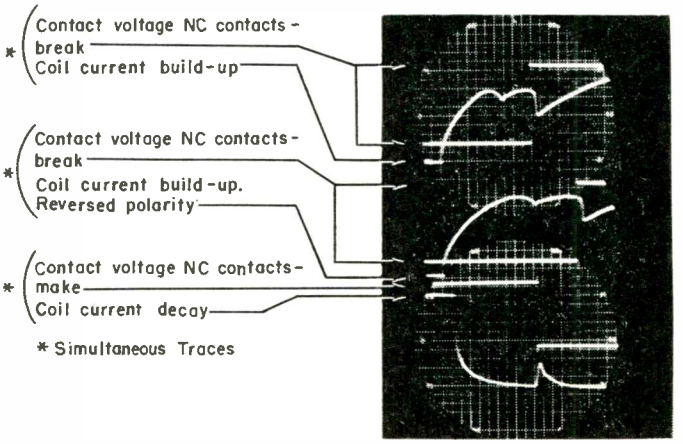


Fig. 13: Armature closure time vs. spring bias; air gap constant

The bottom half of the oscillogram shows the modified case in which the supply voltage was increased to 49.5 v. dc. and sufficient series resistance used to make the final or steady state value of current the same as the first case. In this modified case the operate time was about 70% of the operate time of the first case. By close examination of the armature motion it will be observed that the armature started to move much sooner in the modified case. The armature started to move in about half the time as the first case. The time taken by the armature to move from the open to the closed position, or the travel time, is essentially the same in both cases.

The decrease in operate time of the modified case is caused by the faster rise of coil current especially at the instant the coil is energized. By reasoning based on the emf equation of the circuit involving the relay coil and supply voltage, it can be shown, that with twice the supply voltage and the same steady state current, the initial rate of change of the

Fig. 14: Two transients coil current build-up curve for the same relay and contact curve for normally-closed relay



Relay Dynamics *(Continued)*

current will be twice as large as in the first case. This is demonstrated by observing the coil current build-up in the top and bottom halves of the oscillogram. The coil current trace in the bottom half shows twice the rate of change, at the instant the coil was energized, as the coil current in the top half.

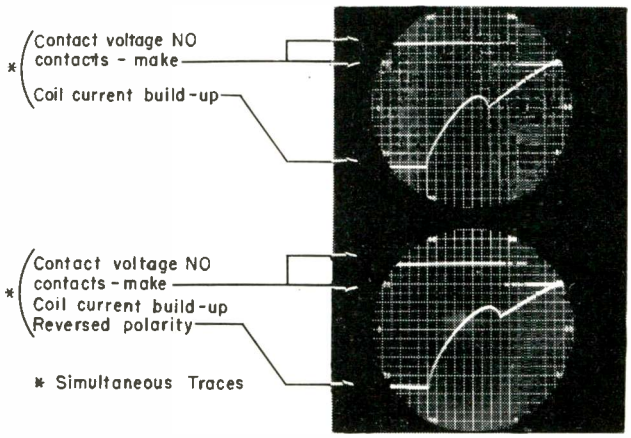


Fig. 15: With this relay the armature reaches the core before the contacts make electrically. Dashes indicate contact chatter.

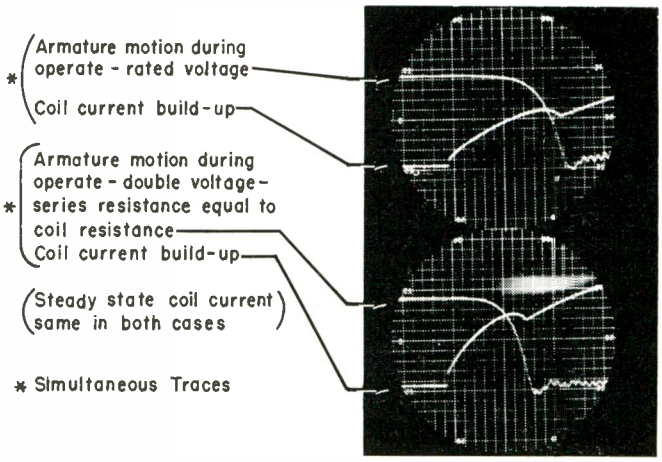
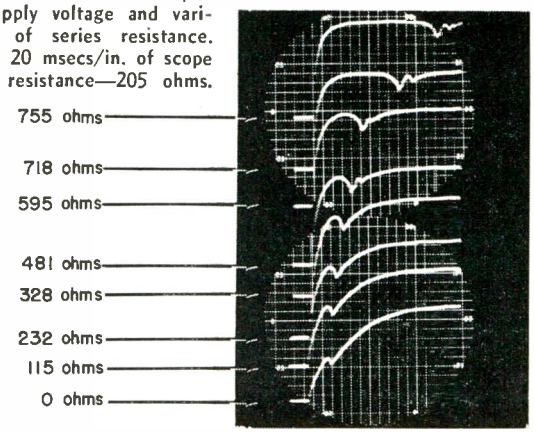


Fig. 16: Series resistance inserted to hold coil current steady

Fig. 17: Coil current build-up—constant supply voltage and various values of series resistance. Time scale: 20 msecs/in. of scope face. Coil resistance—205 ohms.



The results shown by this oscillogram give a method of decreasing the operate time of a relay without exceeding rated power input.

Influence of Series Resistance on Relay Operation

Power supplies and associated networks used to operate relays vary all the way from low internal resistance high capacity batteries to electronic power supplies with different values of internal impedance. To specify the operate time of a relay when operated at a given voltage without indicating something about the power supply is misleading. As mentioned previously, the power supply used for testing the relay was lead acid storage batteries of large capacity compared to the current requirements of the relays.

To demonstrate the effect of different power supplies upon the operation of a relay, resistance was connected in series between the relay coil and the battery. The results are shown in the form of coil current build-up traces presented in the oscillogram of Fig. 17. The time or horizontal scale was the same for all the eight traces but the vertical or current scale was changed for each trace. The scale change was necessary in order to present reasonable detail since the steady state current was changed 500%.

The bottom trace shows the coil current build-up for zero series resistance or normal operation. The next curve up from the bottom is the first one taken with a resistance connected in series with the coil. Starting with the bottom trace and going up the series resistance values used are 0, 115, 328, 481, 595, 718, and 755 ohms.

This results in a steady value of coil current starting with the bottom trace of 117, 75, 55, 45, 35, 30, 26, and 25 milliamperes. As indicated, the current scale has been changed for each trace. Therefore, the maximum height of the top trace represents 25 miliamperes while the maximum height of the bottom trace represents 117 milliamperes.

As expected, the operate time increased as the value of the series resistance was increased. In fact a series resistance having a value much greater than 775 ohms would result in infinite operate time or in other words, it never operates. For the large values of series resistance the coil current traces show some evidence of armature rebound. Armature rebound caused a variation in the coil current after the armature touches the core. This variation takes the form of small humps in the coil current trace. These traces then show the effect of resistance in a power supply since by a theorem used in electrical enginering any two terminals of a network at constant frequency containing linear bilateral elements can be represented by an emf and series impedance.

(Continued next month)

The papers presented at the 7th Annual Conference on Electromagnetic Relays, held at Stillwater, Okla. on May 5, 6, 7—1959, have been combined into a 134-page booklet by relay manufacturer, Potter & Brumfield. They are making copies available free of charge to interested readers. Write Advertising Dept., Potter & Brumfield Div., American Machine & Foundry Co., Princeton, Indiana

The heart of a servo problem is often the sensing element. There are methods available for sensing peak and average values. From these measurements we can sense the RMS value of an interrupted sine wave form.

Sensing RMS Values For Servo Systems

By RICHARD L. PHILLIPS
Chief Development Engineer
Servomechanisms, Inc.
Special Products Division
1000 West El Segundo Boulevard
Hawthorne, California

A TYPICAL servo system is indicated, with reference to its most primitive form, in Figure 1. A quantity X_r which may be a constant or a variable is compared with an output quantity X_o, and the difference is amplified in a high gain amplifier. The difference between the reference quantity X_r and X_o is less than a specified minimum e. The regulation is $\frac{100e}{X_r}$ percent.

If the gain of the amplifier is designated as A, the following equations relate to the steady state behavior of the system.

$$(1) \quad X_r - X_o = e$$

$$(2) \quad Ae = X_o$$

$$\text{or} \quad (1a) \quad X_r - X_o = \frac{e}{A}$$

As the gain of the amplifier is increased without limit, there is a one to one correspondence between X_r and X_o.

In electromechanical systems, the quantities X_r and X_o are usually voltages or currents which are proportional to speed, frequency, position, temperature, or actual quantities to be regulated.

If X_r is a dc voltage, X_o can be a dc voltage functionally related to a tachometer, discriminator or the output of a dc amplifier.

Sensing Problems

With the advent of the magnetic amplifier, the transistor, and more recently, the gated diode, nonlinear types of amplifiers opened up new horizons in the field of regulation.

Enormous gain factors in nonlinear amplifiers, together with size and weight reduction, make these items invaluable to aircraft electronic equipment.

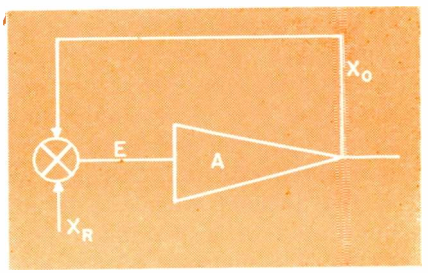


Fig. 1: Elementary servo system. The difference between reference and output is amplified by "A".

In the predominance of problems encountered in the electrical industry, the performance of these regulators is established by providing accurate reference standards, X_r and a linear relationship between X_o and the speed, frequency, position, etc., which it depicts.

The heart of the servo problem is often the sensing element. In particular, consider a problem frequently encountered by the radar engineer. An interrupted sine wave of voltage is to be compared with a dc reference and provide a one to one correspondence between the RMS value of the output quantity X_o and a variable reference X_r.

Obvious circuitry is available for peak voltage sens-

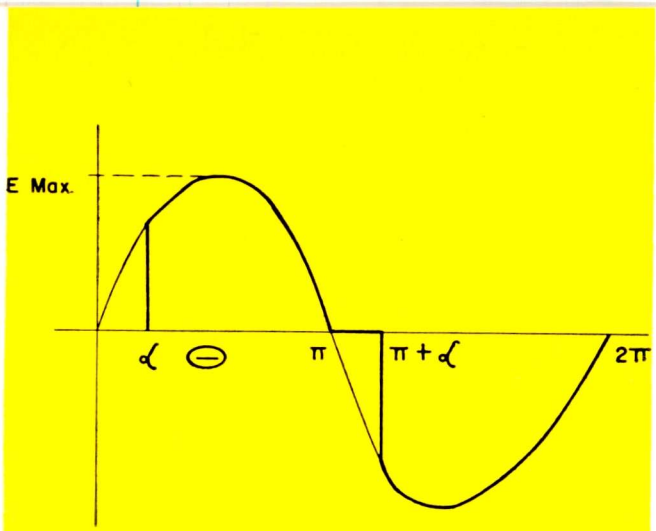


Fig. 2: The output waveform of a typical ac magnetic amplifier is an interrupted sine wave. The peak and average values can be summed into separate control windings.

Sensing RMS *(Continued)*

ing and average voltage sensing. The problem of sensing the RMS value of an interrupted sine wave form is of general interest to those engaged in the solution of RMS programmed regulation.

Consider the output wave form of a typical ac magnetic amplifier (Figure 2). With the aid of a bridge rectifier one can sense the average value of this voltage. If the proper value of condenser is used across the dc terminals of the bridge, the peak voltage of this wave can be sensed. The magnetic amplifier, in all cases, can have a multiplicity of inputs and is ideal for summing applications. It is quite practical to sense the peak and average output voltage of Figure 2 in independent networks and sum their weighted values into separate control windings.

An Application

A particular application of the magnetic summing amplifier will now be considered in connection with a typical problem in RMS regulation.

An ac generator is to be used to energize the filament of a magnetron. The line voltage may vary ± 10%, the line frequency may vary between 380 and 1600 CPS. The maximum allowable capacity to ground at the regulated terminals is 40μμf. For maximum tube life, the RMS voltage should be 6.3 v at the filament when the tube is pulsed at low frequencies. At a maximum pulse repetition rate of 27 KC, the filament voltage should be 5.5 v RMS. A current of 100 μa/KC repetition rate is available for controlling the magnetron RMS filament voltage.

A block diagram of the regulator is shown in Figure 3 where each arrow depicts a control winding on a high gain ac magnetic amplifier.

The equation for the steady state performance of this regulator is

$$X_r - k_a X_o - k_p X_o - X_c = e \qquad (3)$$
$$e \rightarrow o$$

where:

X_r = ampere turns proportional to a reference voltage
$k_a X_o$ = ampere turns proportional to the average output voltage
$k_p X_o$ = ampere turns proportional to the peak output voltage
X_c = ampere turns proportional to the pulse repetition rate

With a high gain amplifier, the output voltage X_o is adjusted by circuit action to instrument equation 3.

The circuit of Figure 4 was used to achieve RMS programmed regulation to specifications as follows:

1. Line voltage 115 v RMS ± 10%.
2. Line frequency 380 to 1600 CPS.
3. Filament resistance 13 Ω ± 10%.
4. Temperature ambient — 55° C to + 125° C.
5. RMS filament voltage. $e_o = (6.3 - .029\ P_{rr})$ v ± 2% (P_{rr} = pulse rep. rate in KC).
6. Capacity to ground 35 μμf.
7. Case size: 1.438 x 2.06 x 2.5 in. high.
8. Case weight: 1 lb.

Selecting Values

In selecting the amount of weighted peak and average sensing required to simulate actual RMS sensing, refer to Figure 2.

The average rectified value of this wave form is:

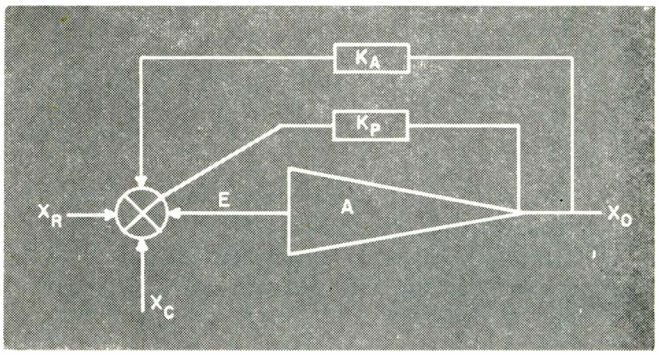


Fig. 3: Block diagram of the regulator. Each arrow depicts a control winding on a high gain ac magnetic amplifier.

$$E_{av} = \frac{1}{\pi}\int^{\pi} E_{max} \sin\theta\, d\theta$$
$$= \frac{E_{max}}{\pi}(1 + \cos\alpha) \qquad (4)$$

The peak value is simply E_{max}.

The RMS value is

$$E_{RMS} = \sqrt{\frac{1}{\pi}\int_{\alpha}^{\pi} E^2_{max} \sin^2\theta\, d\theta}$$
$$= E_{max}\left[\frac{1}{2} - \frac{\alpha}{2\pi} + \frac{\sin 2\alpha}{4\pi}\right]^{\frac{1}{2}} \qquad (5)$$

Let a k_a the portion of the average output be added to a k_pth portion of the peak output; thus,

$$\frac{k_a E_{max}(1 + \cos\alpha)}{\pi} + k_p E_{max}$$
$$= E_{max}\left[\frac{1}{2} - \frac{\alpha}{2\pi} + \frac{\sin 2\alpha}{4\pi}\right]^{\frac{1}{2}} \qquad (6)$$

$$\frac{k_a (1 + \cos \alpha)}{\pi} + k_p = \left[\frac{1}{2} - \frac{\alpha}{2\pi} + \frac{\text{Sin } 2\alpha}{4\pi}\right]^{\frac{1}{2}} \quad (6a)$$

With α as an independent variable, the RMS sensing can be made exactly equal to the weighted peak and average values at two values of the "firing angle." The maximum sensing error for intermediate values of α can then be checked by numerical methods.

It should be noted that in the circuit of Figure 4. P_1 and P_2 are provided to alter the weighted peak and average sensing.

The equation of (6a) can be made exactly accurate at two arbitrary values of α by selecting k_a and k_p corresponding to values of α consistent with the specified line variations. Numerical methods must be used to check intermediate points.

Two simultaneous equations in k_a and k_p result from the selection of two "firing angles."

Thus:

$$\frac{k_a (1 + \cos \alpha_1)}{\pi} + k_p = \left[\frac{1}{2} - \frac{\alpha_1}{2\pi} + \frac{\text{Sin } 2\alpha_1}{4\pi}\right]^{\frac{1}{2}}$$

$$\frac{k_a (1 + \cos \alpha_2)}{\pi} + k_p = \left[\frac{1}{2} - \frac{\alpha_2}{2\pi} + \frac{\text{Sin } 2\alpha_2}{4\pi}\right]^{\frac{1}{2}}$$

This technique of approximating RMS sensing should find many applications in airborne electronic gear where the life expectancy and reliability of equipment is enhanced by adequate control of the RMS voltage.

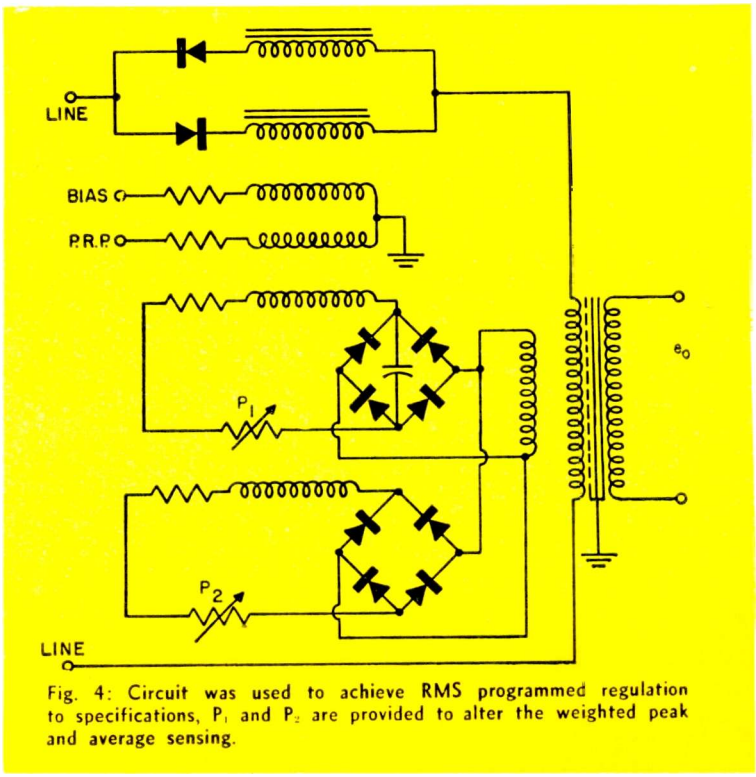


Fig. 4: Circuit was used to achieve RMS programmed regulation to specifications, P_1 and P_2 are provided to alter the weighted peak and average sensing.

The circuit efficiency is extremely high and the space consumed by the components is trivial as compared with more refined methods of ac regulation.

High Output Linear Transducer

AN improvement in the differential transformer principle, widely used in transducers, is incorporated in a line of displacement and velocity transducer forms now in production at Brush Instruments Div., Clevite Corp., 37th and Perkins, Cleveland, Ohio.

The new principle, known as Metrisite, promises true linearity, accurate null-point control, low reactive force and high output in measuring and control devices. No wearing parts are involved; maintenance requirements are negligible.

A typical Metrisite transducer currently used in an industrial control has an output of approx. 1 v across a 330 ohm load in response to a movement of 0.2 in. Special units can be made with outputs as high as 100 v. Operated on a 60 CPS line, full scale operation of a suitable meter is obtained from movements as small as 0.005 in. With amplification, full-scale response may be obtained from displacements of 1 microinch.

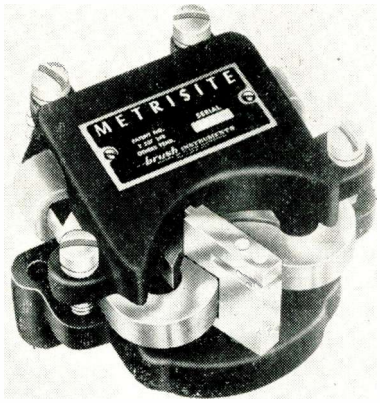
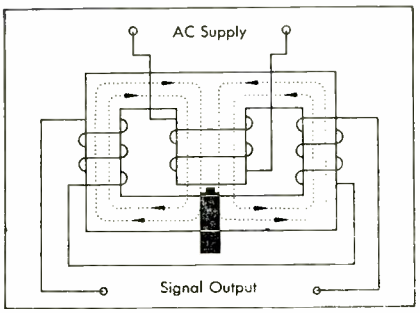
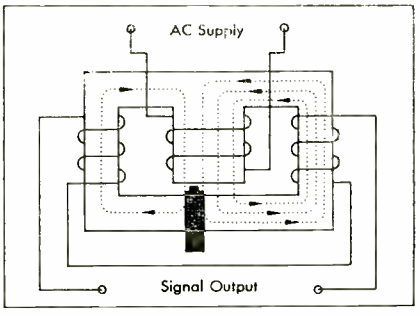


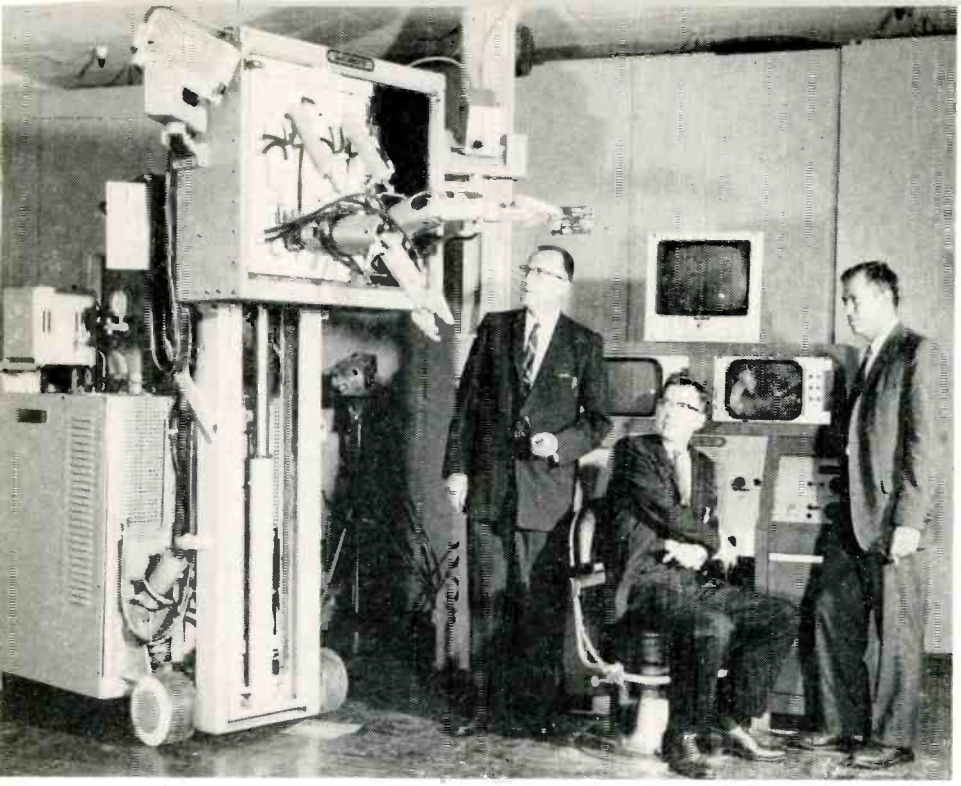
Fig. 1 (top): Field excitation is symmetrical when armature is at center, becomes asymmetrical when armature is displaced. Fig. 2 (right): Flux pattern centered and off center

A very lightweight armature is suspended in an air-gap of a laminoted magnetic structure. Movement of the armature from center produces an imbalance in flux distribution in direct proportion to the degree of travel. The difference in voltage of the two secondary circuits resulting from this imbalance constitutes a highly stable ac output (see fig. 1).

Because the armature has very low mass and is non-magnetic, energy needed to move it is slight and reaction on the mechanical input is negligible. Excellent resolution at null-point, mid-range, and full-scale eliminates problems of "hunting" close to the null or signal decay at extreme range.







The 3 TV receivers mounted above console give the views from each shoulder of Mobot, plus an overall view of the area.

What's New . . .

Mobot Mark I

THE Mobot Mark I, predicted for years in scientists' speeches and fancied in cartoonists' conceptions, recently appeared in the "flesh" of steel, felt electricity pulse through its cables, flexed its metal fingers and "cased" the scene with television-camera eyes.

Then Mobot—termed "man's replacement for man in dangerous areas"—signaled that it was ready to show how it will do its job in "hot" areas.

Mobot Mark I was developed by Hughes Aircraft Company for its purchaser, the Sandia Corporation, direct contractor to the Atomic Energy Commission for phases of special weaponry. The Mobot, which carries 200 feet of cable, will work in Sandia's new underground reactor facility scheduled for 1960 completion, helping man test radiation effects on materials in areas too dangerous for man to enter. A human operator can sit at console far removed from dangerous radioactivity, and with no direct view of the Mobot can feed it more than 100 commands through electronic "reins" while viewing the actions through Mobot's TV-camera "eyes."

The handling arm assembly (with wheels and appropriate controls) is the only equipment which operates in the radioactive area. A cable extension on a reel connects the handling equipment to an operator's console located up to 200 feet from and out of sight of the radiation cell.

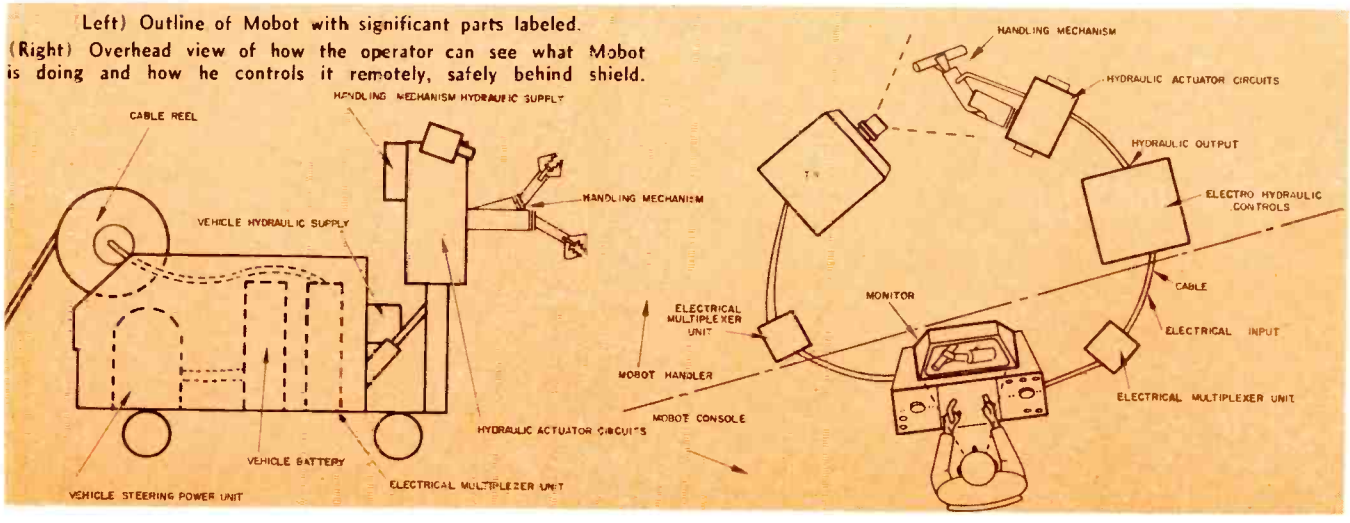
All controls, signals, and data transmission, as well as power, travel to and from the mobile equipment and the operator's position through a tri-axial cable 200 feet long. Over 100 commands may be sent to the Mobot handler through this cable. Power for the handling equipment is 7.5 Kva.

The vehicle has its own battery and DC motor. Provision is made for automatic trickle charging of the battery. Power is transformed to a higher voltage at the console before it is sent through the cable. Transformers and rectifiers in the vehicle provide necessary operating voltages for the handling equipment.

Signal multiplexers are located in the vehicle and operator's console station. All Mobot commands

(*Continued on page* 136)

(Left) Outline of Mobot with significant parts labeled.
(Right) Overhead view of how the operator can see what Mobot is doing and how he controls it remotely, safely behind shield.



"Freon" Cleans Printed Circuits

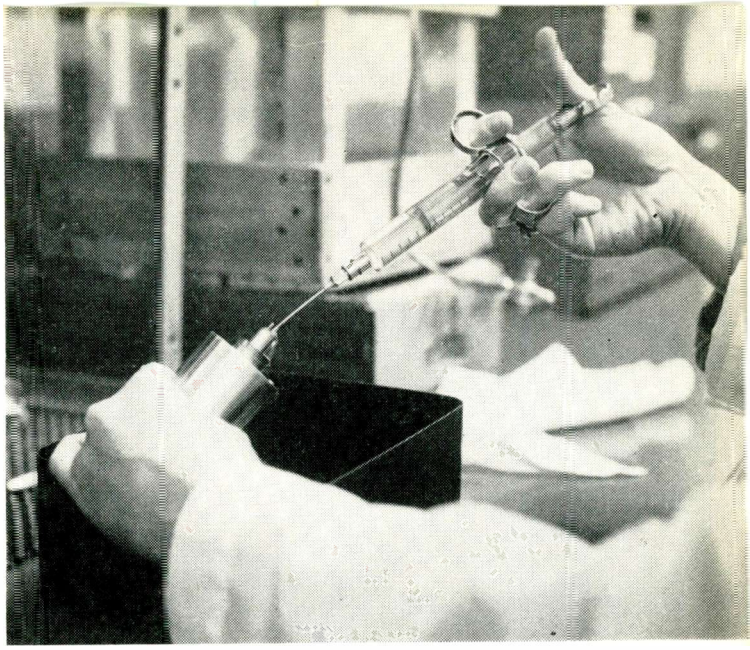


Fig. 1: Hypodermic needle squirts "Freon" solvent into hard - to - reach parts of gyroscope part during fabrication.

A FAST, easy, and safe way of cleaning printed circuit boards and precision parts during manufacture is now possible. "Freon" solvents and solvent mixtures are the answer.

The solvents — nonflammable, nonexplosive, and much less toxic than any other commercial solvent —are supplied by E. I. du Pont de Nemours & Co., "Freon" Products Div., Wilmington 98, Del.

Big advantage of these solvents is their selective solvency and safety. Three types of straight "Freon" solvents, with boiling points ranging from 24° C. to 93° C., and a special "Freon"-PC solvent formulation composed of "Freon"-TF solvent and a specially denatured anhydrous alcohol with an initial boiling point of 43° C., are available.

The latter blend, specifically developed for cleaning printed circuit boards, effectively handles the job of cleaning excess rosin flux, oil, grease, fingerprints and other dirt from delicate printed circuit boards after completion of soldering and other assembly operations. Adaptable to use in simple hand-dip bath equipment or semi-automatic cleaning machinery, it does the cleaning job without adversely affecting the laminating cement, circuit components, and most color codes or labeling on circuit parts.

Components of the "Freon" Printed Circuit Cleaner formulation have a low level of toxicity. The accepted rating for "Freon"-TF solvent, which constitutes the major portion of the recommended blend, is 1,000 parts per million. This means that human beings can be exposed continually to a concentration of 1,000 parts of "Freon"-TF per one million parts of air without adverse effects. For purposes of safety comparison, the maximum allowable concentration (MAC) values of other commonly used solvents range from 25 parts per million in the case of carbon tetrachloride and 200 ppm for trichloroethylene and perchlorethylene to 400 ppm for isopropanol.

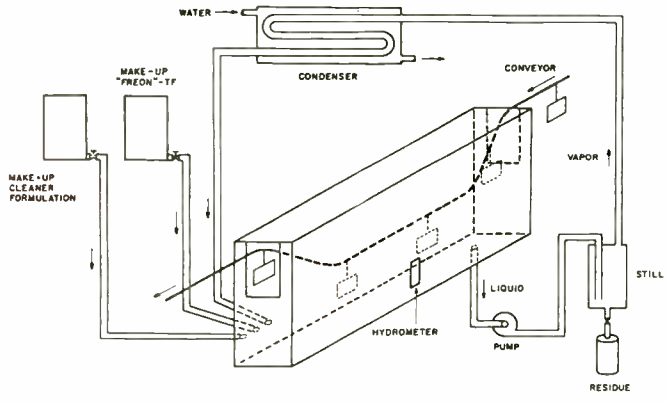


Fig. 2: Schematic drawing of equipment for using "Freon" printed circuit cleaning formulation.

While the recommended formulation of "Freon"-TF and alcohol has no flash point to boil by the Tag open cup test, it must be remembered that the mixture is a blend of solvents, Du Pont chemists point out, and fractionation will occur because of the higher evaporation rates of the lower boiling "Freon"-TF. With continuous automatic cleaning in a system designed to recover or reclaim the vapors of "Freon"-TF, the composition of the blend must be checked occasionally.

In small scale printed circuit cleaning operations, the solvent mixture can be used in a static bath. Immersion of the printed circuit boards for about two minutes with slight agitation usually is sufficient for satisfactory cleaning. In no case did Du Pont's "Freon" Products Laboratory find a rosin soldering flux that could not be removed entirely with slight

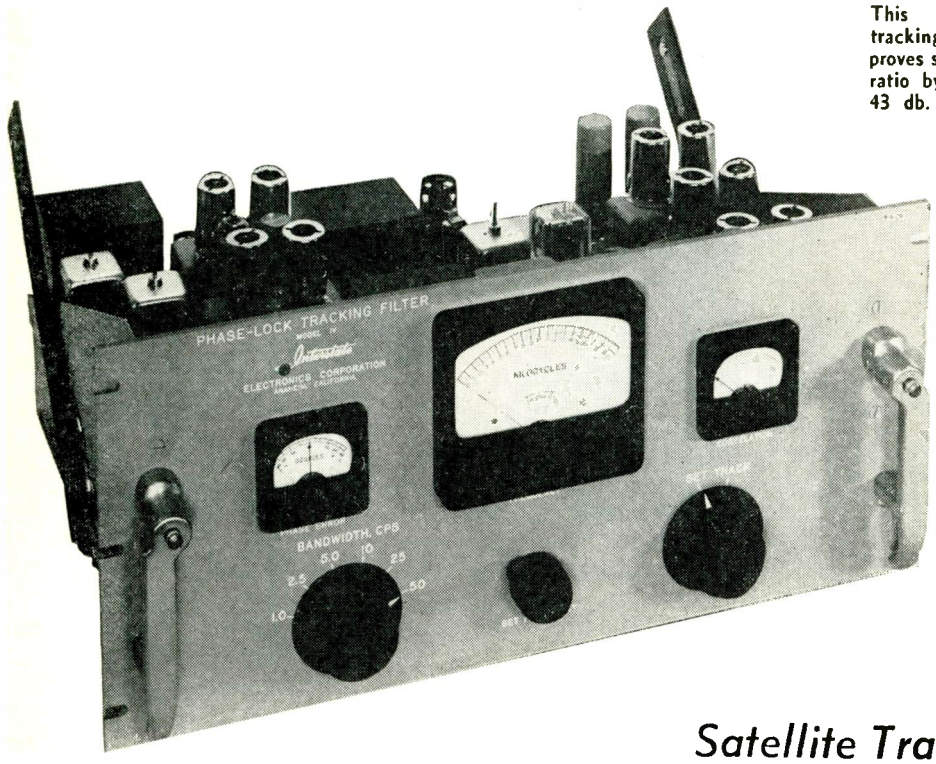
(*Continued on page* 124)

Film Thermistors

UNTIL recently thermistor beads represented the smallest and most sensitive temperature and wattage measuring devices. Now, film thermistors, developed by Keystone Carbon Company, St. Marys, Pa., have 10% or less ($\leq 10^{-3}$ g) of the mass of bead thermistors, relatively high wattage rating due to their large ratio surface to mass, and the same temperature sensitivity as bead thermistors.

They have been used for temperature cycles up to 600°C. However, their practical operational temperature limit will be determined by the outcome of current life tests.

The possibility to adapt these thermistors to the Micro Module concept is under evaluation. Further reduction of the thermistor mass by application of semitransparent thermistor films seems feasible.



This phase-locked tracking filter improves signal-to-noise ratio by as much as 43 db.

By DR. FLOYD M. GARDNER
Asst. Director of Research
Interstate Electronics Corp.
707 East Vermont Ave.
Anaheim, Calif.

Satellite Tracking . . .

DOPLOC Uses Phase-Locked

Reception and measurement of the low-power, CW signals from satellites require a narrow-band receiving system. Also, a Doppler shift on the received signal must be tracked automatically. Presented here is an audio, phase-lock tracking filter which fulfills these requirements.

THE various American satellites carry low-power CW transmitters which operate near 108 MC. The signals radiated can be used to track the satellites either by interferometric techniques (such as Minitrack) or by Doppler shift measurements. This article deals with some aspects of the latter method.

If the satellite transmitter frequency is f_s, the frequency of the signal received on the ground will be

$$f_r = f_s \left(1 + \frac{v_s}{c}\right) \qquad (1)$$

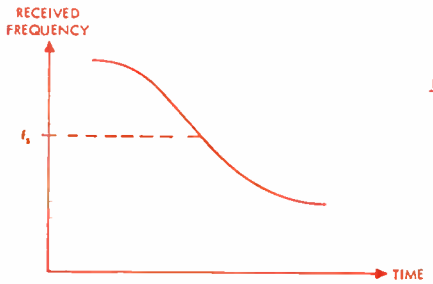
where,

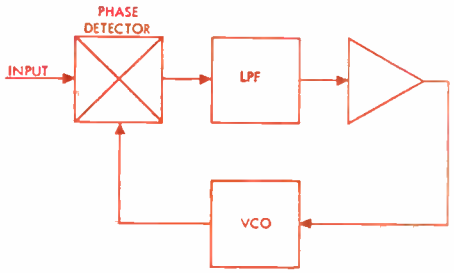
v_s = radial velocity of the satellite towards the receiver, and

c = speed of light. That is, received frequency is shifted by $f_s v_s/c$. For typical satellite velocities of 18,000 MPH, the maximum shift at 108 MC is about 3 KC, both above and below the carrier, for a range of 6 KC. Escape bodies having higher velocities or satellites using higher frequency transmitters will have a correspondingly greater range of frequency shift.

Fig. 1 (near right): Frequency record assumes characteristic S-shaped curve.

Fig. 2 (far right): Basic phase-lock loop.





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A plot of received frequency vs. time results in a characteristic S-shaped curve as shown in Fig. 1. The exact form of the S curve is a unique function of the satellite's orbit; by means of suitable analysis the orbital parameters may be calculated. Accuracy of the results will be determined in large degree by the signal-to-noise ratio at the output of the receiving system.

Noise Reduction

Inasmuch as the transmitter signal is very weak, the received signal is typically smaller than the receiver noise level. Received signal strength can be increased by using greater transmitting power on the satellites (e.g., Sputnik) or by using highly directive receiving antennas. Another approach is to reduce receiver noise power which is given by

$$N_R = FkTE \qquad (2)$$

where,

F = noise figure, k = Boltzmann's constant,
T = absolute temperature, and
B = predetection bandwidth. At room temperature $kT = 4 \times 10^{-21}$ watts/CPS. Noise may be reduced by decreasing either F, T, or B. Here we are concerned only with B. However, in an ultimate installation, all factors would be refined to the utmost.

From Eq. 2 it may be seen that noise can be substantially reduced if bandwidth is minimized. For example, if the signal varies over a 6 KC range, one might use a 6 KC receiver bandwidth to avoid the need for retuning during a satellite pass. However, if the bandwidth were reduced to 1 CPS, a signal-to-noise ratio improvement of 6000 to 1 or 37.8 db can be achieved. To obtain an improvement of this magnitude by altering other parameters could entail a radical change in the system. Bandwidth reduction of this sort may be accomplished with a reasonable amount of electronic filter circuitry.

There are many ways to build very narrow bandpass filters. For the application in question, though, the filter must be tunable since the received frequency is continually changing. To be useful, the tuning must be automatic; it is extremely difficult to try to manually track a signal with a 1 CPS bandwidth filter.

One type of tracking fillter which has proven useful for satellite tracking is an audio, phase-locked loop.

Phase-Lock Principles

A basic phase-lock loop is shown in Fig. 2. It consists of a phase detector, a low-pass filter (LPF), a DC amplifier, and a voltage-controlled oscillator (VCO). The phase detector (PD) compares (actually multiplies) the input signal and the output of the VCO. Average PD output is proportional to the cosine of the phase angle between the two inputs so that at 90° there is an output null. If phase varies from 90°, PD output will be either plus or minus, depending upon sign of variation.

The DC amplifier strongly amplifies the error signal from the PD and controls the VCO in such a manner as to drive the phase error back to zero. Thus, we have an electronic servo in which the inputs and outputs are phases of sine waves rather than positions of mechanical shafts. Actually, the analogy to a servo is very close since the VCO has a true integrating (1/p) term in its open-loop phase transfer function.

Slow changes of input phase (or frequency) will be transmitted by the low-pass filter and will therefore correct the VCO to maintain track. Rapid fluctuations—as arise from noise—will be attenuated and will not affect the VCO.

Filter

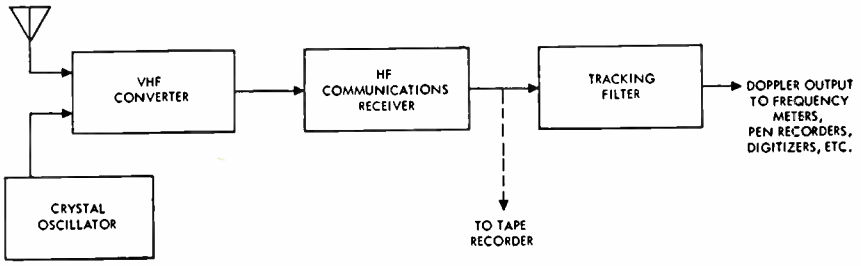


Fig. 3: This complete receiving system, using a tracking filter, is called DOPLOC.

Observe now what has been accomplished: by locking the oscillator to the input signal we have a means of automatic tuning. By doing the filtering with a low-pass configuration it is possible to achieve a very narrow bandwidth using only simple RC components. The useful output is the *frequency* of the VCO. The *waveform* of the VCO is a "clean" sine wave without any amplitude fluctuations due to noise. These characteristics are precisely those required for a Doppler tracking filter.

Receiving System

Fig. 3 shows a block diagram of a complete receiving system using a tracking filter. The receiver and converter are entirely conventional; exactly the same considerations apply to them as to any other 108 MC CW receiver. The overall system has been named "DOPLOC."

As mentioned earlier, this is an audio tracking filter—its input frequency must be in (or near) the audio range. A simple CW input signal, of course, yields no audio output by itself; a beat oscillator is required. In principle, the BFO in the communications receiver can be used for this purpose. In practice, the stability of this oscillator, and the various local oscillators in the receiver and converter, is usually not good enough. A drift in any local oscillator would appear as an error in the Doppler S curve.

To avoid relying upon receiver oscillator stability,

Tracking Filter

(Continued)

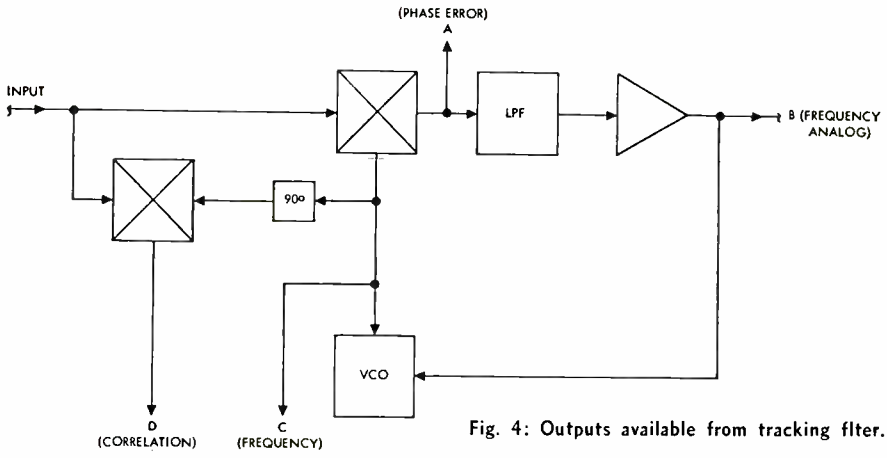


Fig. 4: Outputs available from tracking filter.

beat frequency injection is performed with a highly stable crystal oscillator at the converter input. Crystal frequency is chosen to provide a convenient beat with the satellite signal. Injection level is sufficiently low that overload never occurs in the receiver, but high enough that the injection signal exceeds noise at the receiver audio detector.

Thus, the two signals, one from the satellite and the other locally injected, are amplified and processed together in the receiver. There is no interaction between the two prior to the audio detector. However, at the detector, amplitude of the injected signal is sufficient to heterodyne with the much weaker satellite signal to yield an output audio tone. Because of this mode of operating the detector, there is no detection threshold to degrade signal-to-noise ratio. That is, the detector is really a mixer and further filtering is effective in reducing noise, even when noise exceeds the satellite signal by many db.

Two DOPLOC installations have been active for almost two years. One is at the Army's Ballistic Research Laboratories at the Aberdeen Proving Ground in Maryland and the other is at the Signal Corps receiving site at Deal (Ft. Monmouth), New Jersey. Between them, these two stations have recorded many thousands of satellite passes. Typically, the signal is acquired shortly after the satellite rises above one horizon and track is maintained until the vehicle disappears over the other horizon.

Other similar stations have been installed by various university tracking stations affiliated with the Applied Physics Laboratory of Johns Hopkins University. Eventually there will be a network of stations spanning the entire country.

Refinements

So far, only one output—Doppler frequency—has been shown. A phase-lock loop can also supply other very useful outputs, Fig. 4. At point A, phase error may be measured. This error is an indication of the noise that is actually being filtered out. If there is any frequency modulation on the input signal it can be recovered here.

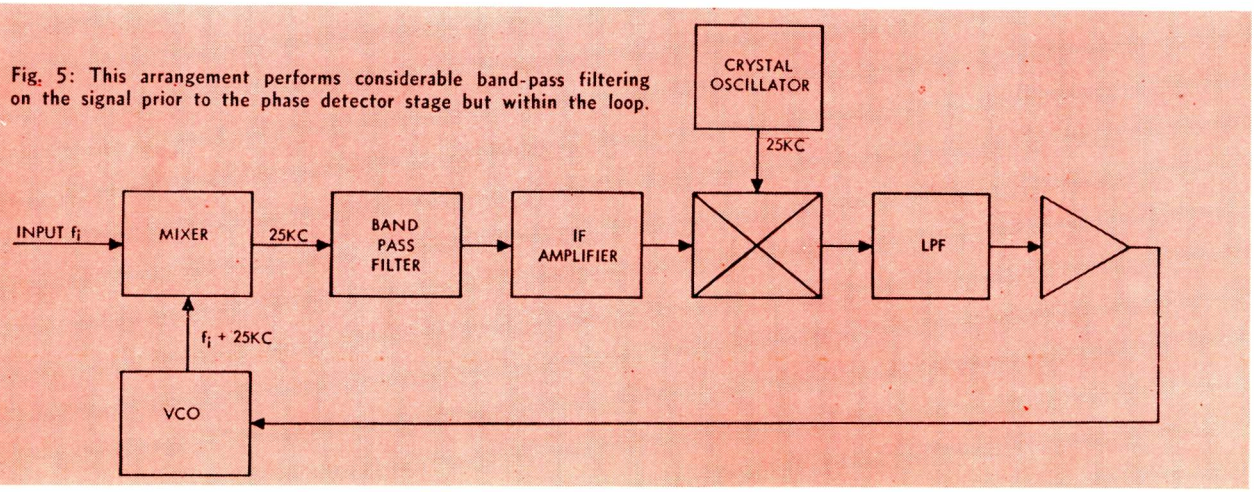
With suitable calibration, the filtered VCO control signal present at point B provides a voltage analog of frequency. This analog is very useful for "quick-look" purposes.

The VCO output present at point C is the precision frequency output for Doppler tracking purposes.

As explained previously, operation of the main phase detector and phase-lock loop is such that the input signal and VCO are maintained 90° apart and PD output is at a null. However, shifting the output from the locked VCO by 90° and feeding the shifted voltage to an auxiliary phase detector (APD) yields a phase-shifted signal which is in phase (or 180° out of phase) with the signal input. This signal input is then fed to the other input of the APD. Output of the APD is proportional to signal strength and does not exhibit a null. Since the entire process resembles cross-correlation, the output at point D has been called the correlation output.

This output at D is most useful. It indicates whether or not the loop is locked; that is, whether the input and the VCO are correlated. Since it is proportional to signal strength it is readily utilized for AGC purposes. With suitable calibration and a meter it provides a signal level indicator. If there

Fig. 5: This arrangement performs considerable band-pass filtering on the signal prior to the phase detector stage but within the loop.



is any amplitude modulation on the signal, it can be recovered at D.

Up until now little has been said about the low-pass filter. There are two conflicting requirements on the filter design; (1) it is desirable to make the filter bandwidth as narrow as possible to achieve the maximum noise rejection; however, (2) the filter bandwidth must be sufficiently wide to be able to follow actual changes of Doppler frequency due to vehicle acceleration. This last requirement is most severe when high-speed missiles are tracked from launch. In addition, the filter must be designed so that the loop is stable even with extremely large amounts of feedback.

Typically, the filter may be equivalent to a one- or two-section, RC, low-pass ladder circuit. Actually, the RC components are combined with the DC amplifier in an active filter to be able to use convenient size components. Transfer functions can be chosen to minimize velocity and acceleration error coefficients.

The simple phase-lock loop illustrated thus far does work but its performance is limited by the dynamic range of the phase detector. Consider, for example, an input bandwidth of 20 KC and a tracking bandwidth of 1 CPS. If output signal-to-noise ratio is 1 to 1, noise at the phase detector exceeds signal by 20,000 to 1. As might well be expected, the PD tends to overload and does not function as it should. Practical phase detectors or, more generally, electronic multipliers, cannot readily accommodate such extreme conditions.

To improve requirements on the PD, considerable band-pass filtering is performed on the signal prior to the PD stage but within the loop. The arrangement used is shown in Fig. 5. As secondary benefits, this modified loop permits simpler PD circuitry and reduces the fractional tuning required of the VCO.

The DOPLOC tracking filter uses the modified scheme of Fig. 5. Input frequency range is 100 CPS to 20 KC. Bandwidth is adjustable between 1 and 50 CPS in 6 steps. Signal-to-noise ratio improvement can be as much as 43 db. A photograph of the filter is shown on the first page of this article.

Other Applications

Tracking filters can obviously be used in any CW Doppler system. In fact, the prototype of the one described here was originally built several years ago for use with DOVAP. A number of tracking filters have been built for use with Doppler radar velocimeters.

In standard FM/FM telemetry reception, signal-to-noise ratio of individual subcarriers can be improved by inserting a tracking filter between the telemetry receiver output and the subcarrier discriminator.

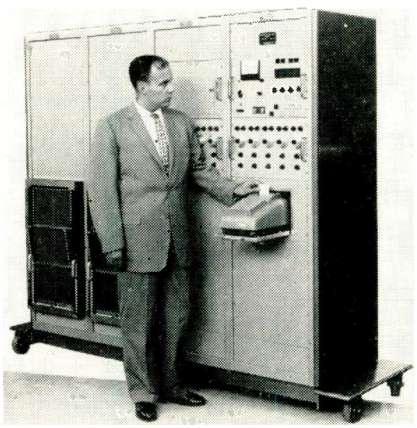
Short-term oscillator stability can be observed. Phase fluctuation appears at the phase error output and amplitude fluctuation appears at the correlation output. Sensitivity to phase fluctuation is far greater than could ever be realized by conventional means. If the oscillator to be observed is outside the tuning range of the filter, it can be heterodyned against another oscillator known to be stable.

A tracking filter can be employed as a narrow-band harmonic analyzer. As such it is particularly useful in that it is not necessary to continually readjust it to maintain proper tuning.

In conjunction with an ordinary receiver, a tracking filter can be used as an extremely sensitive field strength meter. The narrow band feature permits detection of very weak signals and the tracking feature compensates for the inevitable drift of oscillators. Signal level is read at the correlation output (point D, Fig. 4).

Acknowledgments

A tracking filter of the type described herein was designed and developed by Louis Katz of Interstate Electronics Corp. The work was supported by Army Contract DA-001-509-4953 from Ballistic Research Laboratories. The overall DOPLOC system was devised by personnel at BRL under the direction of L. G. deBey.



The Automatic Multiple Circuit Analyzer was designed to test complex circuits, such as those found on missiles and computers.

Automatic Multiple Circuit Analyzer

USED to check the accuracy of wiring and the effectiveness of insulation in complex electronic systems, such as those found in missile and computer applications, an Automatic Multiple Circuit Analyzer has been introduced by Consolidated Avionics Corp., a subsidiary of Consolidated Diesel Electric Corp., 800 Shames Drive, Westbury, N. Y. The analyzer automatically steps through as many as 2,000 two-terminal circuits in a pre-determined sequence, printing out the type of failure when a defective circuit is located.

In checking a circuit, the analyzer measures the series resistance between its terminals to determine whether or not the circuit is continuous and whether or not it is connected to the proper terminals in the system. It also measures the leakage resistance between the circuit undergoing analysis and all other circuits grounded to determine effective insulation values.

To operate the unit, connec-

(*Continued on page* 138)

Virgil H. Disney, Pres.
1959 National Electronics Conference

The three-day conference of technical sessions and exhibits by electronic manufacturers is expected to attract more than 10,000 engineers, scientists and management personnel to Chicago's Hotel Sherman.

National Electronics Conference

THE Midwest's top electronic show, the 15th Annual National Electronic Conference, opens in Chicago's Hotel Sherman on Monday, Oct. 12th.

The 3-day show and convention, expected to attract more than 10,000 engineers, will feature approximately 260 product exhibits and a technical program of more than 110 technical papers.

Panels of distinguished industry representatives will discuss key subjects, "Recruiting of Scientific Personnel" and "Education for Leadership."

The conference is being sponsored by the AIEE, IRE, Illinois Inst. of Technology, Northwestern University and the University of Illinois. Cooperating agencies include EIA, SMPTE and Michigan, Notre Dame, Purdue, Michigan State, Wisconsin and Wayne State Universities.

Emphasis in this year's technical program is on advanced techniques, with sessions scheduled on "Adaptive Servomechanisms," "Parametric Amplification," "Perception and Recognition," and "System Analysis," among others.

Monday evening, October 12, will be set up for panel discussions on three subjects receiving a great deal of attention.

"Recruiting of Scientific Personnel," a panel discussion sponsored by the IRE PG on Engineering Management, will have as moderator John D. Ryder, of Michigan State University. Participants will be Frank S. Endicott, Northwestern Univ.; Edward Conley, Conley Assoc.; Harry Kentone, Argonne National Labs.; Richard C. Swander, Cinch Mfg. Co., and Lowell H. Good, RCA, Camden, N. J.

"Problems in Circuit Theory," sponsored by the IRE PG on Circuit Theory, and moderated by Geo. I. Cohn, of Illinois Inst. of Technology, will have as participants T. J. Higgins, Univ. of Wisconsin; Gail T. Flesher, Bendix Aviation Corp., and B. Saltzberg, Space Technology Labs.

The third panel discussion, "Education for Leadership," sponsored by IRE PG on Education, and moderated by Edward W. Ernst, Univ. of Illinois, will have as participants A. D. Arsem, Wurlitzer Corp.; F. W. Braden, Illinois Bell Telephone Co.; J. E. Gibson, Purdue Univ., and A. H. Waynick, National Science Foundation.

Conference Officers

The officers for this year's show are: President—V. H. Disney, Armour Res. Fndn.; Exec. Vice-pres.—L. W. Von Tersch, Michigan State Univ.; Chairman of the Board of Directors—A. Crossley (deceased); Exec. Secy.—J. J. Gershon, De Vry Technical Inst.; Secy.—G. E. Anner, Univ. of Ill.; Treas.—G. J. Argall, De Vry Technical Inst.; Asst. Treas.—H. E. Ellithorn, Univ. of Notre Dame.

Coincident Activity

Among the trade organizations planning activities during the week of the Show is the Electronic Representatives Assoc. On Oct. 12, the opening day of the Conference, ERA will hold the first combined workshop of its industrial Components and Instrument Divisions. Some 200 manufacturers and representatives of instrument equipment and components

are expected to gather for the roundtable-type meeting, which will be held in the Illinois Room of the LaSalle Hotel, Chicago.

The management consulting firm of Booz, Allen and Hamilton is now obtaining background information for the meeting through questionnaires mailed to some 1,000 manufacturers and 700 representatives. Those questionnaired are being asked to point out problems in the various areas of communication between electronic manufacturers and their reps.

Opens Oct. 12th

Site of the Conference is Chicago's Hotel Sherman

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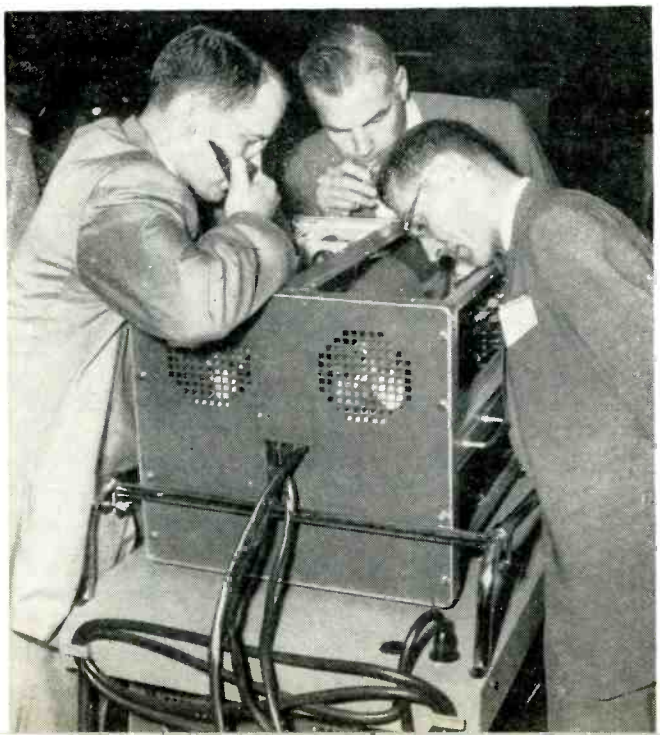
A. R. F. Products, Inc., River Forest, Ill.	236
Ace Electronics Associates, Inc., Somerville, Mass.	13
Aerovox Corp., New Bedford, Mass.	156-157
Alac, Inc., Glendale, Cal.	237
Allied Radio Corp., Chicago	32-34
Alpha-Loy Corp., Div., Alpha Metals, Inc., New York	125
Alpha Wire Corp., New York	42
American Institute of Electrical Engineers, New York	235
Amphenol-Borg Electronics Corp., Chicago	176
Jay C. Angel & Co., Chicago	171-173
Assembly Products, Inc., Chesterland, Ohio	29-30
Associated Research, Inc., Chicago	147
Automatic Electric Sales Corp., Northlake, Ill.	83
Ballantine Laboratories, Inc., Boonton, N. J.	190
Barry Controls, Inc., Watertown, Mass.	79
Berkeley Div., Beckman Instruments, Inc., Richmond, Cal.	66-67
Leroy W. Beier Co., Chicago	163-164
Behlman Engineering Co., Burbank, Cal.	5
Bendix Aviation Corp., South Bend, Ind.	121-122
Bird Electronic Corp., Cleveland	126
Boesch Mfg. Co., Inc., Danbury, Conn.	185
Bomac Laboratories, Inc., Beverly, Mass.	74-75
Boonton Radio Corp., Boonton, N. J.	136-137
Boston Insulated Wire & Cable Co., Dorchester, Mass.	102
Bowmar Instrument Corp., Ft. Wayne, Ind.	151
The Bristol Co., Waterbury, Conn.	162
Burndy Corp., Omaton Div., Norwalk, Conn.	60-61
California Technical Industries, Div. of Textron, Inc., Belmont, Cal.	81
Cambridge Thermionic Corp., Cambridge, Mass.	12
Cannon Electric Co., Los Angeles	165
Carter Motor Co., Chicago	6
Cinch Mfg. Co., Chicago	98
Coil Winding Equipment Co., Oyster Bay, N. Y.	159
Computer Control Co., Inc., Wellesley, Mass.	206
Computer Measurements Co., Div., Pacific Industries, Inc., North Hollywood, Cal.	154-155
Cozzens & Cudahy, Inc., Evanston, Ill.	167-169
Crossley Associates, Inc., Chicago	117-118
Davenport Mfg. Co., Chicago	31
DeMornay-Bonardi, Pasadena, Cal.	221-222
Design Tool Corp., Brooklyn, N. Y.	278
Dressen-Barnes Corp., Pasadena, Cal.	14
Allen B. Du Mont Laboratories, Clifton, N. J.	82, 88-89
E. I. du Pont de Nemours & Co., Wilmington, Del.	19-20
Edgerton, Germeshausen & Grier, Boston	160-161
Eitel-McCullough, Inc., San Carlos, Cal.	230
Elastic Stop Nut Corp. of America, A'G'A Div., Elizabeth, N. J.	86
Elco Corp., Philadelphia	129
Electra Mfg. Co., Kansas City, Mo.	191-192
Electro-Measurements, Inc., Portland	46-47
Electro-Pulse, Inc., Culver City, Cal.	59
Electronic Engineers Master, Hempstead, N. Y.	35
Electronic News, Fairchild Publications, Inc., New York	250
Engineered Electronics Co., Santa Ana, Cal.	40

Products will be exhibited by more than 260 manufacturers



NEC Exhibitors (*continued*)

EXHIBITOR	BOOTH NO.
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Freed Transformer Co., Inc., Brooklyn, N. Y.	210
G-L Electronics Co., Inc., Camden, N. J.	127
The Gamewell Co., Newton Upper Falls, Mass.	166
General Electric Co., Schenectady, N. Y.	7-11
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General Radio Co., West Concord, Mass.	177-179
Gertsch Products, Inc., Los Angeles	141-142
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F. L. Moseley Co., Pasadena, Cal.	119-120
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Optron Corporation, Santa Barbara, Cal.	17
Pacific Semiconductors, Inc., Culver City, Cal.	260-261
Panoramic Radio Products, Inc., Mt. Vernon, N. Y.	233
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Plastic Capacitors, Inc., Chicago	15
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The Potter Co., North Chicago, Ill.	218
Price Electronics, Frederick, Md.	85
Products Research Co., Los Angeles, Cal.	18
Quan-Tech Laboratories, Morristown, N. J.	39
Radio Frequency Laboratories, Inc., Boonton, N. J.	199-200
Raytheon Mfg. Co., Waltham, Mass.	49-51
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The Rex Corp., West Acton, Mass.	87
Ridgway Engineering, Inc., Chicago	68-73
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Sensitive Research Instrument Corp., New Rochelle, N. Y.	22-23
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Sigma Instruments, Inc., South Braintree, Mass.	188-189
Simpson Electric Co., Chicago	174-175
Skydyne, Inc., Port Jervis, N. Y.	91-92
Slaughter Co., Inc., Piqua, Ohio	38
Sola Electric Co., Chicago	148-150
Sorenson & Co., Inc., South Norwalk, Conn.	111-113
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R. Edward Stemm, Chicago	214-217
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Syntron Co., Homer City, Pa.	208-209
Technology Instrument Corp., Acton, Mass.	134-135
Tektronix, Inc., Elmwood Pk., Ill.	193-194
Texas Instruments, Inc., S-C Div., Dallas, Tex.	243-245
Thermo-Fax Sales Corp., Chicago	281
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United Aircraft Prod. Inc., Dayton, Ohio	282
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Vitramon, Inc., Bridgeport, Conn.	212
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Wayne Kerr Corp., Philadelphia	101
Weckesser Co., Chicago	16
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Westinghouse Electric Corp., Pittsburgh	90-145
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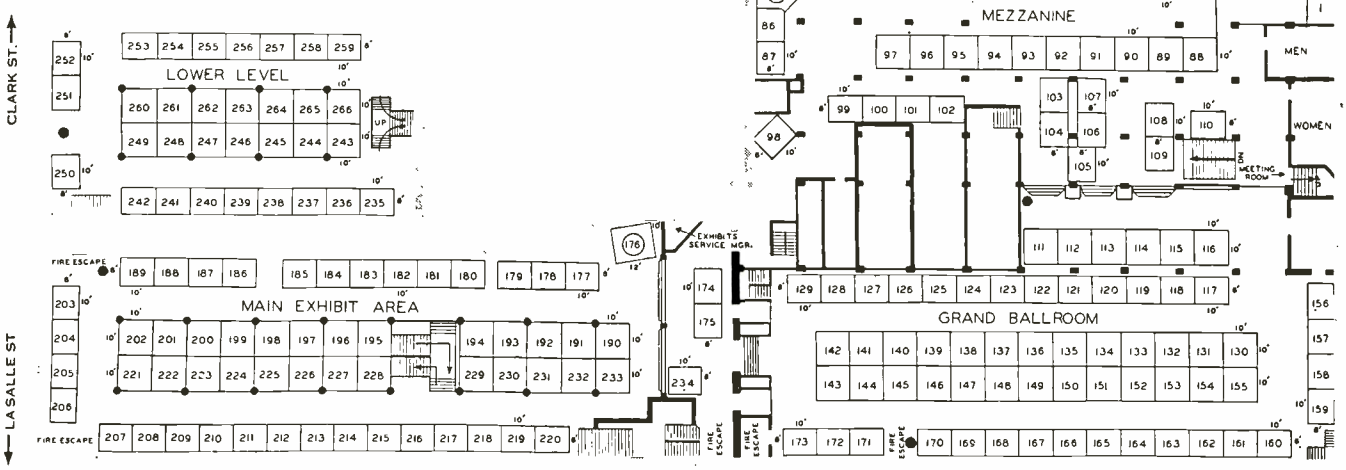
Technical Papers Program
to be found on page 196.

FLOOR PLAN OF SHOW



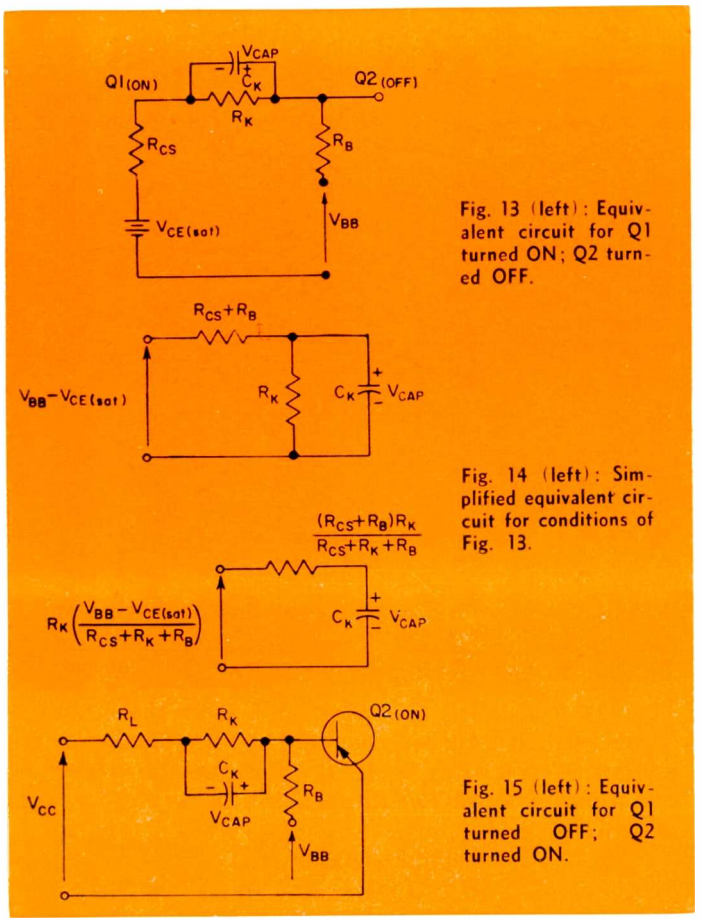


Fig. 13 (left): Equivalent circuit for Q1 turned ON; Q2 turned OFF.

Fig. 14 (left): Simplified equivalent circuit for conditions of Fig. 13.

Fig. 15 (left): Equivalent circuit for Q1 turned OFF; Q2 turned ON.

Several methods have been used to design bistable flip-flop circuits using transistors as saturated switches. The method presented here separates the design into a steady-state solution and a transient solution.

Flip-Flop Circuit Using Saturated Transistors

Part Two of Two Parts

By JAMES E. HULL
Application Engineer
Development Department
Semiconductor-Components Division
Texas Instruments Incorporated
Dallas, Texas

THE steady-state ON and OFF equations have been developed and plotted to solve for the two unknown resistors, R_K and R_B. Then, the composite curve was obtained and the safety factor established. Now, the transient response can be discussed.

TRANSIENT SOLUTION
(Speed-up Capacitors)

The upper frequency limits of triggering can be increased by using a speed-up capacitor, C_K, across each coupling resistor, R_K. The value of the speed-up capacitor should only be large enough to give good speed-up times. Its value will normally range from about 39 μμf to 200 μμf. In the following circuits, the transistor capacitances are neglected.

Time Constant Added

Making C_K too large defeats its purpose since it adds a time constant that will limit the maximum frequency. The following approximate time constants are added to the circuit. The instant after Q1 is switched ON, the equivalent circuit is that shown in Fig. 13. The capacitor's initial voltage is:

$$V_{cap} = \left(\frac{V_{BE\,(ON)} - V_{CC}}{R_L + R_K}\right) R_K \qquad (21)$$

The simplified equivalent circuit is shown in Fig. 14.

The time constant for the circuit is:

$$T_1 = \frac{C_K R_K (R_{CS} + R_B)}{R_{CS} + R_K + R_B} \qquad (22)$$

For the capacitor to discharge 63%, the time before the next pulse should equal T_1. The maximum trigger frequency as limited by this time constant is given by:

$$\text{maximum trigger frequency} \approx \frac{1}{T_1} \qquad (23)$$

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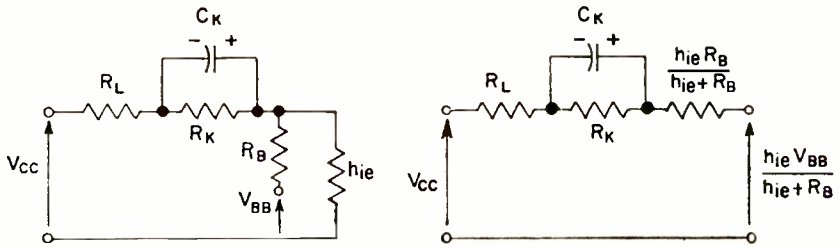
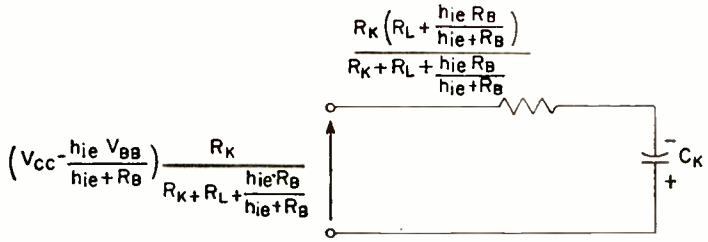


Fig. 16 (right): Simplified equivalent circuit for conditions of Fig. 15.



Flip-Flop *(Continued)*

The next case would be when Q1 is switched OFF and Q2 is switched On. The equivalent circuit becomes that shown in Fig. 15.

If it is assumed that no reverse current is required to turn the transistor OFF, the voltage on the capacitor is initially:

$$V_{cap} = \left(\frac{V_{BB} - V_{CE\,(sat)}}{R_{CS} + R_K + R_B}\right) R_K \qquad (24)$$

The derivation of the time constant from the equivalent circuit is shown in Fig. 16.

The time constant for this circuit is:

$$T_2 = \frac{C_K R_K \left(R_L + \dfrac{h_{ie} R_B}{h_{ie} + R_B}\right)}{R_K + R_L + \dfrac{h_{ie} R_B}{h_{ie} + R_B}} \qquad (25)$$

The maximum trigger frequency as limited by this time constant is given by:

$$\text{maximum trigger frequency} \approx \frac{1}{T_2} \qquad (26)$$

Usually T_1 is greater than T_2; therefore: maximum trigger frequency

$$\approx \frac{1}{T_1} = \frac{R_{CS} + R_K + R_B}{C_K R_K (R_{CS} + R_B)} \qquad (27)$$

$$C_K \leqq \frac{R_{CS} + R_K + R_B}{R_K (R_{CS} + R_B)} \frac{1}{\text{maximum trigger frequency}} \qquad (28)$$

In calculating the value of C_K for the circuit developed, it will be assumed that the maximum triggering frequency is 1 MC. For this triggering frequency and neglecting R_{CS}, the value of C_K is calculated as:

$$C_K \leqq \frac{(12 + 8.2)\,10^3}{(12)\,(8.2)\,10^6} \frac{1}{10^6} = 206\ \mu\mu f$$

A value of 100 $\mu\mu$f was also tried in the circuit and performed satisfactorily. Because of stray triggering considerations discussed below, the value of 100 $\mu\mu$f was decided upon.

Stray or False Triggering

If only a low trigger frequency is required, the above equation will give a large value of C_K. The disadvantage is that stray noise or spikes in the power supply can cause false triggering. The amplitude of power supply spikes (sufficient to false-trigger the flip-flop circuit thus far developed) as a function of C_K is shown in Fig. 17. For low-frequency triggering, it may be best to use a lower value than that calculated by Eq. (28) to help eliminate false triggering by the power supply.

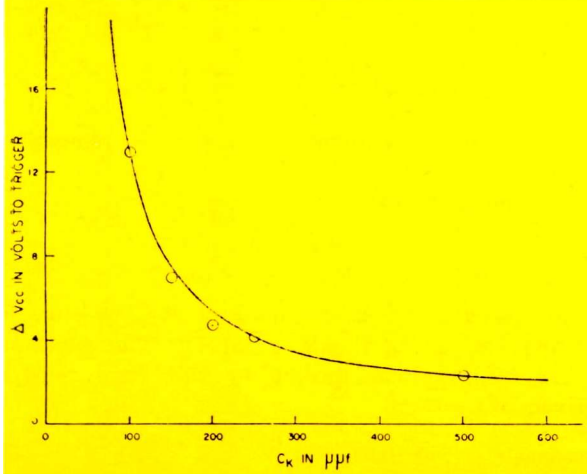


Fig. 17 (left): Amplitude of power supply spikes as a function of C_K.

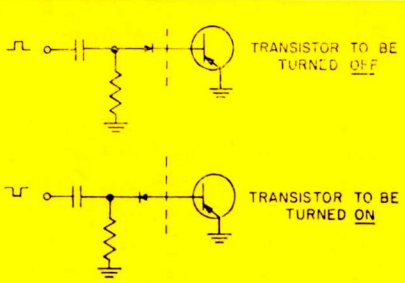


Fig. 18 (right): Examples of reset triggering circuits which may be used.

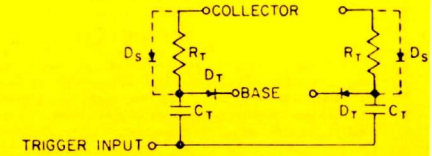


Fig. 19 (right): This is a common circuit for binary triggering.

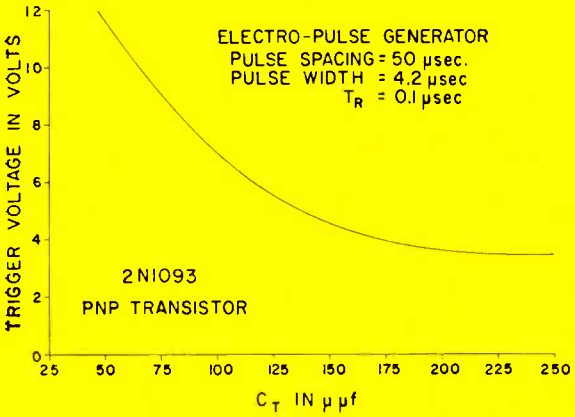


Fig. 20 (above): Trigger voltage as a function of trigger capacitance.

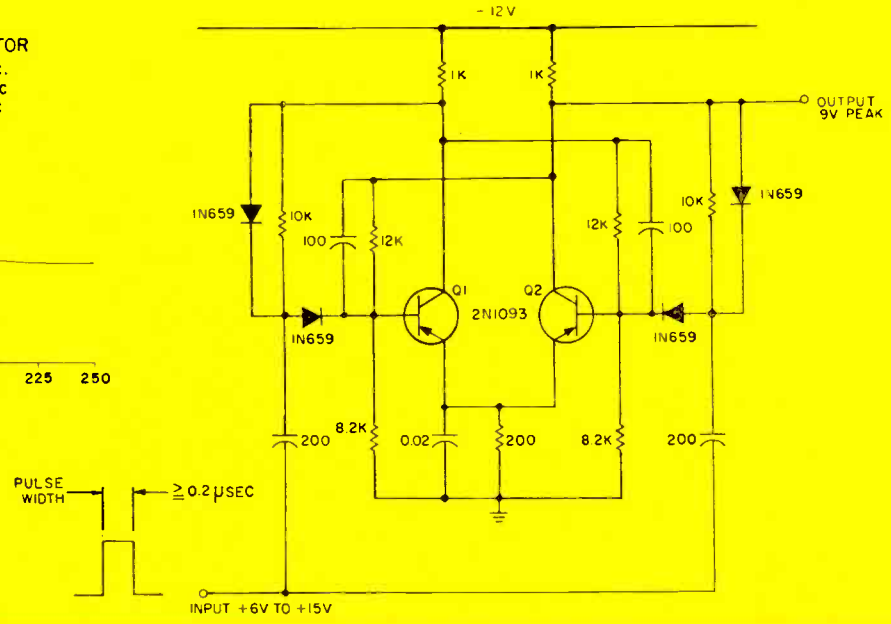


Fig. 21 (right): Flip-flop circuit developed for operation at 1 megacycle.

If a common-emitter resistor is used, it should be by-passed by a capacitor sufficiently large to hold its voltage approximately constant during the transient time of switching from one state to the other.

TRIGGERING METHODS AND LEVELS

The flip-flop circuit can be triggered in a number of ways. For reset triggering, circuits such as shown in Fig. 18 may be used.

A common circuit for binary triggering is shown in Fig. 19.

To reduce the R_T C_T time constant, a speed up diode, D_S, should be placed across R_T when fast triggering times are needed. If D_S is not used and fairly fast switching times are needed, then the product R_T C_T should be made small. In particular, 2.5 R_T C_T then should be $\approx$ 1/maximum trigger frequency. If a speed-up diode is used, then the R_T C_T product need not be as low. For 1 or 2-MC triggering, an R_T C_T product of about 2 μsec has been used when D_S was incorporated, e. g., R_T = 10K ohm and C_T = 200 μμf.

The triggering voltage required is a function of the trigger capacitor, C_T. The smaller the capacitance, the higher the trigger voltage required to trigger the binary. This is shown in Fig. 20 for the flip-flop circuit shown in Fig. 21 that uses Texas Instruments 2N1093 transistors.

As mentioned earlier, the most adverse triggering condition usually exists at the highest temperature. because h_{FE} increases with temperature. This is shown in Fig. 22 for the circuit of Fig. 21. Therefore, the value of C_T should be determined from the highest h_{FE} units at the highest temperature to provide as low a trigger as required.

The input and output waveforms of the developed flip-flop for a 1 MC input are shown in Fig. 23.

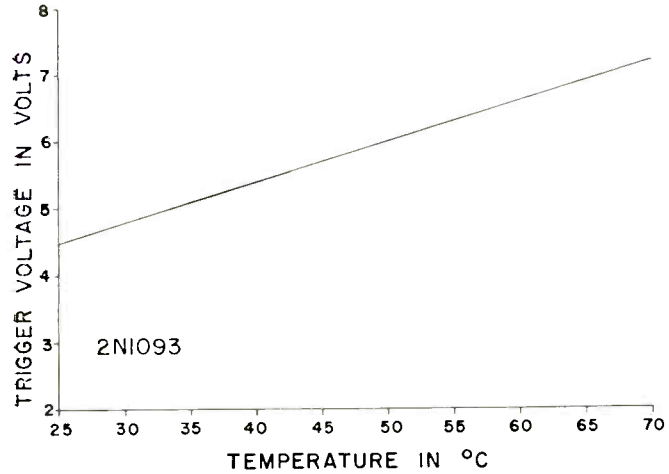


Fig. 22 (left): Trigger voltage as a function of temperature for the most adverse triggering condition.

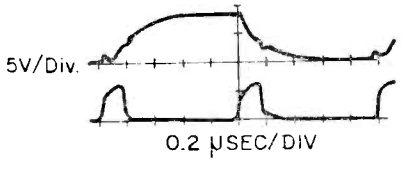


Fig. 23 (right): Input and output waveforms for the circuit of Fig. 21.

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(Appendix appears on following page)

Flip-Flop *(Continued)*

Appendix

Calculation of the valley voltage V_Q in the composite curve. For $I_{B1} = 0$,

$$\frac{V_{CE2}}{R_K} = \frac{-V_{BB}}{R_B} \text{ and } V_{CE2} = \left(\frac{-V_{BB}}{R_B}\right) R_K$$

$$I_{C2} \approx \frac{V_{CC} - V_{CE2}}{R_L} - \frac{V_{CE2}}{R_K} = \frac{V_{CC} - V_{CE2}}{R_L} + \frac{V_{BB}}{R_B}$$

$$I_{C2} = \frac{V_{BB}}{R_B} + \frac{V_{CC} + \left(\frac{V_{BB}}{R_B}\right) R_K}{R_L}$$

$$I_{C2} = h_{fe} I_{CO2} + h_{fe} I_{B2}$$

$$\frac{V_{BB}}{R_B} + \frac{V_{CC} + \left(\frac{V_{BB}}{R_B}\right) R_K}{R_L} \approx h_{fe} I_{CO2} + h_{fe} I_{B2}$$

$$I_{B2} \approx \frac{V_{CE1}}{R_K} + \frac{V_{BB}}{R_B} \approx \frac{V_Q}{R_K} + \frac{V_{BB}}{R_B}$$

$$V_Q \approx R_K \left[\frac{V_{BB}}{h_{fe} R_B} + \frac{V_{CC} + \left(\frac{V_{BB}}{R_B}\right) R_K}{R_L h_{fe}} - I_{CO2} - \frac{V_{BB}}{R_B} \right]$$

$$V_Q \approx R_K \left[\frac{\left(\frac{V_{BB}}{R_B}\right) R_L + V_{CC} + \left(\frac{V_{BB}}{R_B}\right) R_K}{R_L h_{fe}} - I_{CO2} - \frac{V_{BB}}{R_B} \right]$$

$$V_Q \approx R_K \left[\frac{\frac{V_{BB}}{R_B}(R_L + R_K) + V_{CC}}{R_L h_{fe}} - I_{CO2} - \frac{V_{BB}}{R_B} \right]$$

What's New . . .

Magnetic-Film Memory

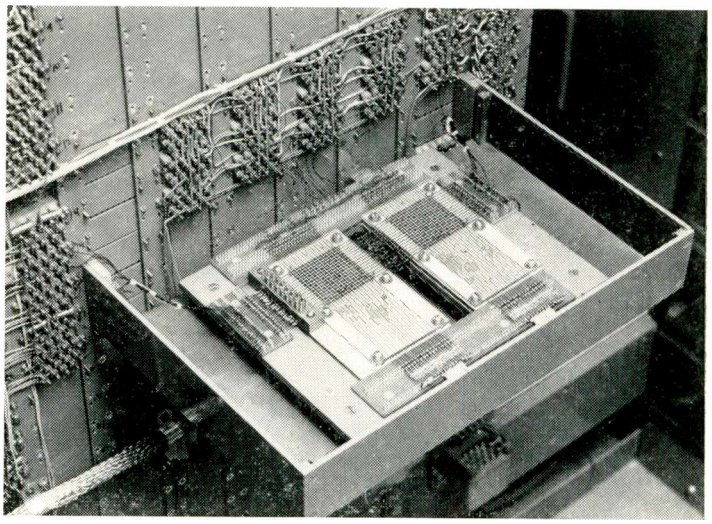
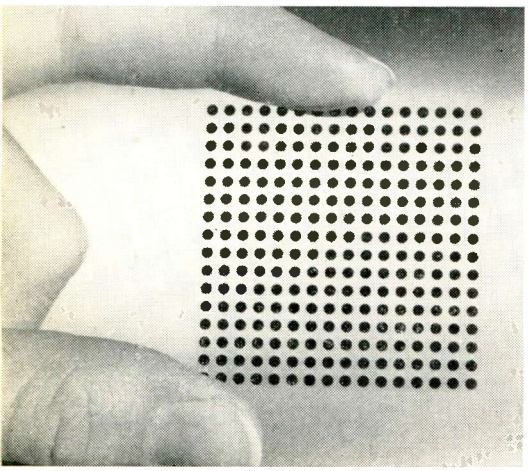


Fig. 2: The memory has a capacity of 32 ten-bit words and a read - and - write cycle time of 0.8 microseconds.

A HIGH - SPEED magnetic film memory is now in operation as a part of the TX-2 digital computer at the M.I.T. Lincoln Laboratory. Its performance has been entirely satisfactory since its installation in July 1959. It has a capacity of 32 ten-bit words, suitable for evaluation testing, and serves as an experimental prototype for larger units. This new memory, and the TX-2 computer of which it is a part, were developed by Lincoln Laboratory under Air Force contract, with the joint support of the Army, Navy, and Air Force.

Fig. 1: Experimental magnetic film memory array of the type installed in the TX-2 computer at M. I. T. Lincoln Laboratory.



The read-and-write cycle time of 0.8 μsec. is consistent with the speed of the computer itself, although bench tests demonstrated successful operation at a cycle time as short as 0.4 μsec. Net driving current for writing is 150 ma, and 1 mv. output signals are obtained from individual memory elements.

Each memory element is a circular spot of Permalloy film (82% nickel, 18% iron) 750 Angstroms thick, 1.6 mm. in diameter, centered 2.5 mm. apart. The spots are deposited by evaporation on a flat glass substrate, 0.1 mm. thick, in 16 x 16 unit arrays. The complete memory unit as installed in TX-2 and one of the experimental arrays are shown in Figs. 1 and 2. The transistor drive and sense circuits can be seen surrounding the memory.

A thin film memory has several potential advantages over the familiar ferrite toroidal core memory: faster cycle time, lower power dissipation, greater compactness, and simpler fabrication. The unit now in operation confirms these expectations, although none of these factors has been fully exploited in this first developmental model.

More than thirty years experience in the design and manufacture of standard electronic components insure Cannon Connectors by CINCH to be of the highest quality materials, fabricated to specifications to maintain consistent quality of product; highest standards throughout all operations.

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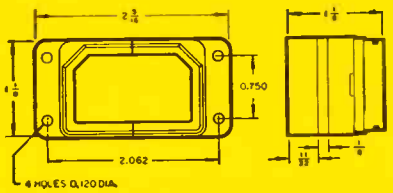
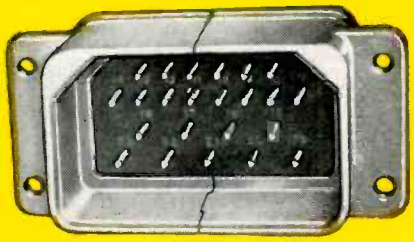
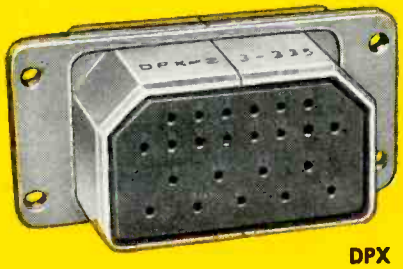




DPX 23-34P



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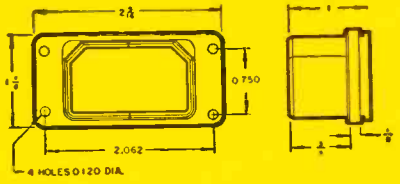

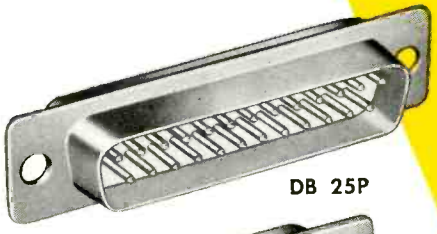

DB 25P

DB 25S

Send for illustrated catalog No. 100 with details of "D" Sub-Miniature and "DPX" Series.

DPX SPECIFICATIONS:
Shell, die cast aluminum alloy. Finish, cadmium plate with clear Irridite. Contacts—Plugs, brass, Socket, phosphor bronze both with gold plate finish. Insulation material, Melamine type MME. Operating temperature −67° to +280° F. Available in 7 to 57 contacts in multiple variations of 5 and 10 amp terminals as well as coaxial terminations. Keystone cornered shell polarization.

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Division of United-Carr Fastener Corporation, Boston, Mass.

D SUB-MINIATURES:
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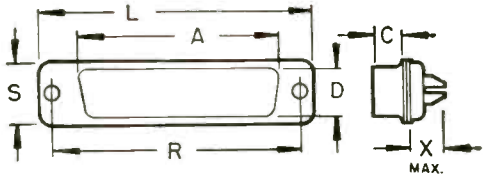


size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	15/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	31/32	15/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 9/16	15/64	23/64	2 3/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	15/64	5/16	2 3/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	15/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	15/64	5/16	2 23/32	2.500	31/64	5/16	.035
DD-50P	2 7/64	15/64	1 5/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 5/64	15/64	2 7/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	45/64	15/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	15/64	5/16	1 13/64	.984	31/64	5/16	.012

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

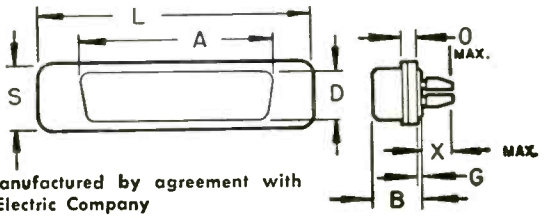
D SUB-MINIATURE SPECIFICATIONS:
Shell, including flange, steel or brass. Finish, Cadmium plate or Irridite. Contacts — No. 20, 5 ampere rating. Copper base alloy, gold plate finish. Insert arrangements — 5 plus coaxials in 9, 15, 25, 37, and 50 contacts.
Insulation material — Zytel 101, DIALL or Melamine.
Polarization — Keystone cornered shell.
Operating temperature −67° to +310° F.

D SUB-MINIATURES:
HERMETIC SEAL PIN INSERTS

size	A	B	O	D	G	L	S	X max.	weight
DAH-15P-001	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	5/32	0.021
DAH-15P-002	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	15/64	0.021
DBH-25P-001	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	5/32	0.027
DBH-25P-002	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	15/64	0.027
DCH-37P-001	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	5/32	0.037
DCH-37P-002	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	15/64	0.037
DDH-50P-001	2 7/64	23/64	3/32	1 5/32	1/32	2 41/64	39/64	5/32	0.041
DDH-50P-002	2 7/64	23/64	3/32	1 5/32	1/32	2 41/64	39/64	15/64	0.041

Variation in final dash number indicates type of contact terminal. —001 = eyelet type; —002 = solder pat type.

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance



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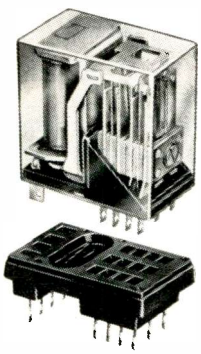

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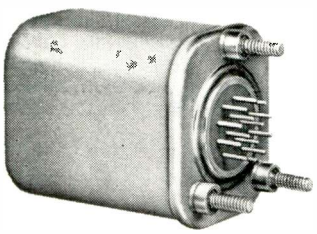

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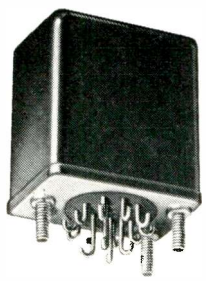

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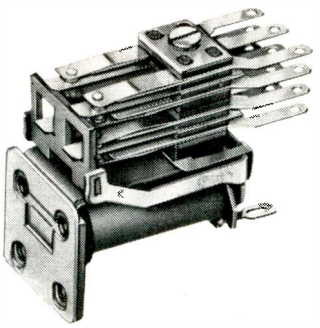

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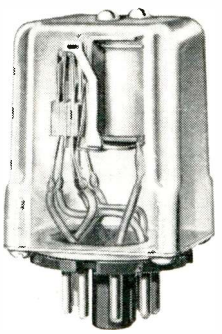


TYPE TADO

PERFORMANCE CHARACTERISTICS

Contact Arrangement
Up to 12 springs maximum form A, B or C

Contact Rating
2 amperes resistive or 1 ampere inductive at 29 volts d-c or 115 volts a-c
Low level or 5 ampere contacts available on request

Standard Coil Voltages
Suitable coil resistances can be supplied for operation at any voltage within the range of 0.5 to 130 volts d-c

Coil Power
Nominal: 700 milliwatts
Minimum Operate Power: 60 to 150 milliwatts depending on application, contact arrangement and coil resistance.

Timing at Nominal Voltage
Operate time: 7.5 milliseconds maximum
Release time: 3.5 milliseconds maximum

Vibration
10-55 cps at .062 inch double amplitude
55-500 cps at a constant 10g

Shock: 25g operational

Enclosure
Open, dust cover or hermetically sealed

Weight
Open type 1.0 ounce maximum
Sealed type 2.0 ounces maximum

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, NEW YORK

Fig. 1: Equipment will check the active defense system of the B-58. Note the location of the system at the tail above the Vulcan gun which fires 6000 round/min. Details are shown in Fig. 8.

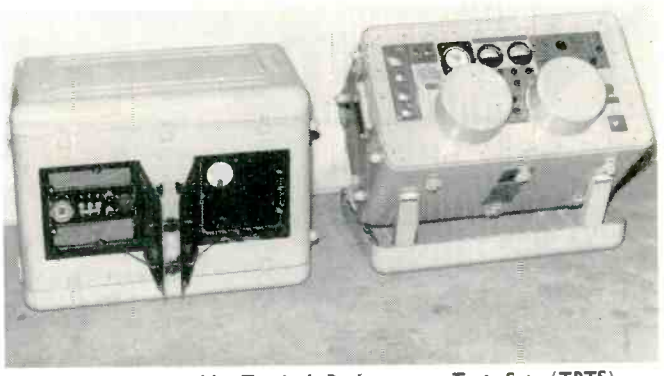


Fig. 2: This portable Tactical Performance Test Set (TPTS) can quickly determine whether the MD-7 Fire Control System meets tactical requirements. System decabling is not necessary for operation.

Fig. 3 (above): A & E Shop equipment tests the system's line replaceable units (LRU) like the tactical stable platform.

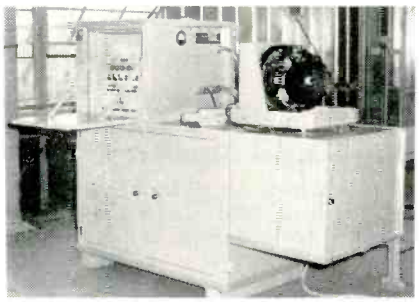


Fig. 4 (above): Checking the antenna. Similar panels make personnel training easy.

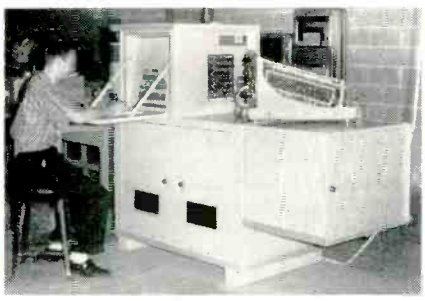


Fig. 5 (above): While testing indicator control assembly, panel cover provides a good writing surface for operator.

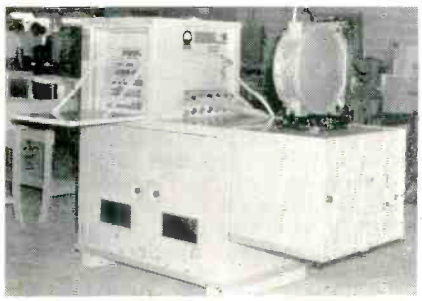


Fig. 6 (below): The Computer Assembly Test Set.

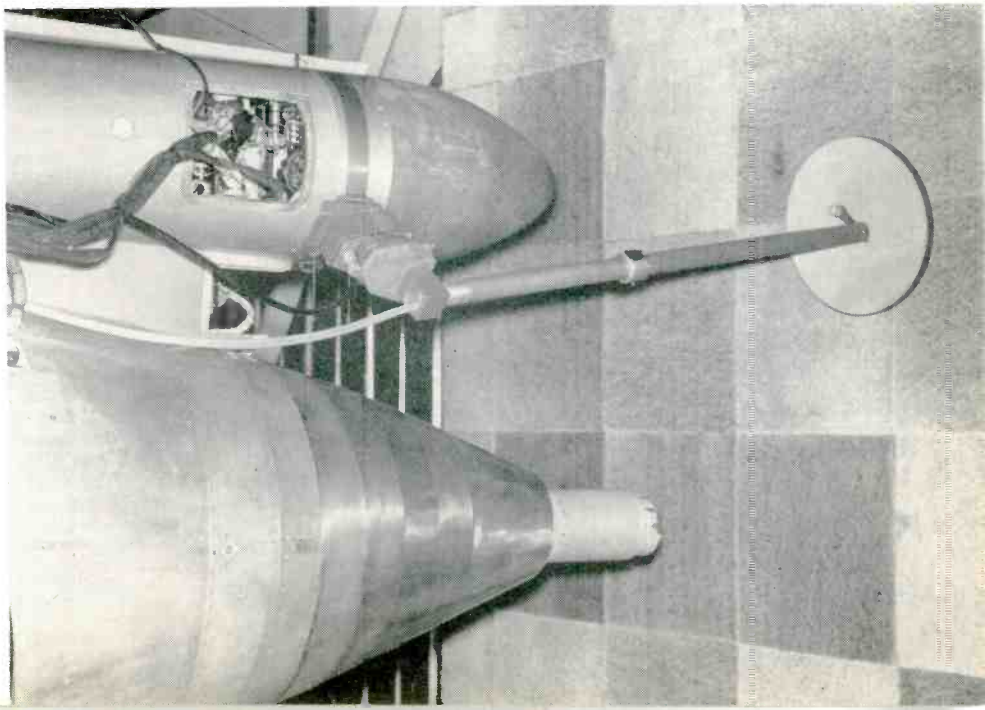
Checking Defense Systems

THE automatic self-checking tactical ground support equipment shown on this page was developed by the Emerson Electric Mfg. Co., Electronics and Avionics Div., St. Louis, Mo. It is used to check the MD-7 Fire Control System, built by Emerson, for the Convair B-58 bomber.

The equipment, in accord with the tactical maintenance philosophy, is divided into three groups, viz., Flight Line, Armament Electronics Shop (on Base), and Repair & Overhaul Depot.

Fig. 7: Tactical System Test Set (TSTS) isolates a malfunction to a defective LRU which can be replaced on the flight line.

Fig. 8: Moving boom simulates an attacking target. System will track boom during test



New Tech Data for Engineers

Voltage Breakdown

Voltage breakdown, the major cause of transistor failures, and leakage currents are discussed in Transistor Kinks, Volume I, No. 1, a 4-page publication. Five types of voltage breakdown (avalanche breakdown, alpha multiplication, punch-through, thermal runaway and miscellaneous breakdowns) and their effects on transistors are discussed. Three leakage currents which are closely related to the breakdown voltages of transistors are also defined and discussed. Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

Circle 178 on Inquiry Card

Microwave Equipment

Twelve-page, 2-color booklet describes a complete line of millimeter wave components and instruments which generate, detect and measure microwave frequencies up to 140 KMC. Performance characteristics, precision construction features, and dimension drawings are supplied for transmission line components, detectors, power absorbing units, horns, tees, frequency and impedance meters, phase shifters, shorts, tuners, and accessories. The text describes many uses for millimeter waves in advanced research. DeMornay-Bonardi, 780 S. Arroyo Pkwy., Pasadena, Calif.

Circle 179 on Inquiry Card

Solid State Research

A 44-page book from Hofman Laboratories, Inc., 5 Evans Terminal, Hillside, N. J., discusses developments in low temperature chemistry, solid state physics, superconductivity, metallurgical research, maser research, microwave spectrometry, etc. Hofman manufactures liquid helium research dewars and related apparatus for cryogenics, and the book relates the application of this equipment in various fields of low temperature studies. Engineering drawings and performance curves of Hofman's line are included. Includes technical data on liquid helium, hydrogen and nitrogen.

Circle 180 on Inquiry Card

Frequency Standards

Two-color data sheets from Hathaway Instrument Div., Hamilton Watch Co., 5800 E. Jewell Ave., Denver, Colorado, describe the company's oscilloscope camera, type C6, Tuning Fork Frequency Standards, Nos. 52790, 52858, 55906. Included are performance, operating condition and environment data, outline drawings, specifications, and instructions on installation, operation, and engineering service available.

Circle 181 on Inquiry Card

Electronic Training Aid

A new type of training aid is described in a bulletin from Plastic Associates, 185 Mountain Rd., Laguna Beach, Calif. The device is a flat plastic board having a rectangular array of contact cells. Wires may be electrically connected by inserting their ends into one of these cells. It may be used in the classroom to allow students to build and rebuild circuits using standard components purchased in bulk.

Circle 182 on Inquiry Card

Panel Instruments

Bulletin 3-15, 24-pages, covers a full line of panel instruments ranging from those used in standard commercial applications to those used for military purposes. Federal Pacific Electric Co., 50 Ave. L, Newark 1, N. J. Described are ac meters, dc meters, elapsed time meters, aircraft instruments, and shunts and current transformers. Photographs, dimension drawings, tables of ratings, and complete descriptive data are given for each.

Circle 183 on Inquiry Card

Waveguide Chart

Adjustable Waveguide Chart indicates RETMA and Armed Services (JAN) standards for rectangular waveguides and flanges. One side of the chart indicates all RETMA specifications for the entire frequency range of 960 MC to 110 KMC. Information such as a waveguide type, flange number, inside and outside dimensions, tolerances, wall thickness, type of material, etc., are shown in an indicator window by a setting of the frequency dial. Polytechnic Research & Development Co., Inc., 202 Tillary St., Bklyn 1, N. Y.

Circle 184 on Inquiry Card

Tantalum Capacitors

Revised bulletin, GEA-6766A, on G. E.'s rectangular tantalum electrolytic capacitors gives performance data, outline drawings, tables of sizes and ratings for operation at 85° and 125°C, polar and non-polar applications. General Electric Co., Schenectady 5, N. Y.

Circle 185 on Inquiry Card

PNPN Triodes

Bulletin C410-01 from Solid State Products, Inc., 1 Pingree St., Salem, Mass., describes the Trigistor, a new "circuit equivalent" component with flip-flop characteristics. From "triggered bistable transistor" the device is a silicon PNPN device which has the property of triggered turn-off as well as triggered turn on control at its base.

Circle 186 on Inquiry Card

Environmental Testing

Capabilities for the isolation and reproduction of a wide variety of environmental characteristics are described in a brochure entitled Environmental Facilities, published by the General Electric Co., Missile and Space Vehicle Dept., Room 4A, 3198 Chestnut St., Phila. 4, Pa. Reproducible environments discussed in the brochure include conditions of vibration, with varying temperatures and altitudes; humidity; tension and compression; shock; acoustics; acceleration; and pressure. Also described are chambers designed to simulate natural conditions of rain, sunshine, sand, dust, salt spray, and fungus culture.

Circle 187 on Inquiry Card

Precision Meters

Literature on the company's line of microammeters, milliammeters, ammeters, millivoltmeters, voltmeters, megohmmeters, multi-range meters to 23 ranges, and voltammeters for current and voltage in the same instrument are available from Greibach Instrument Corp., 315 North Ave., New Rochelle, N. Y.

Circle 188 on Inquiry Card

Multi-Channel Amplifier

A 6 channel amplifier, the Model 6006, for use in vibration analysis systems is described in a bulletin from Columbia Research Laboratories, McDade Blvd. & Bullens Lane, Woodlyn, Pa. Included are operating specs, circuit techniques and performance curves.

Circle 189 on Inquiry Card

Batteries

"The Battery for you . . . Whereever Long Life, Maximum Power and Minimum Space and Weight are Required," a technical brochure on Silcad batteries, has been issued by Yardney Electric Corp., 40-50 Leonard St., New York City. The brochure supplies data on physical and electrical characteristics of Silcad cells, as well as graphs comparing performance of this system with that of other types of batteries.

Circle 190 on Inquiry Card

TW Tubes

The Electron Tube Div., Hughes Products, International Airport Sta., Los Angeles, 45, Calif., offers 2 new pieces of literature. The first covers 5 of its traveling wave amplifiers, backward wave amplifiers and backward wave oscillators. The second describes the complete line of Typotron, Menotron, and Tonotron CR storage tubes. Specs and applications included.

Circle 191 on Inquiry Card

after routing, clip and save

a continuing series on technical topics of specific interest to engineers

Folio 59-7 REFERENCE DATA FILE SANGAMO

notes on the life expectancy of capacitors

"At half past nine by the meet'n-house clock,—
Just at the hour of the Earthquake shock!
What do you think the parson found,
When he got up and stared around?
The poor old chaise in a heap or mound,
As if it had been to the mill and ground!
You see, of course, if you're not a dunce,
How it went to pieces all at once,—
All at once, and nothing first,—
Just as bubbles do when they burst.
End of the wonderful one-hoss shay.
Logic is logic. That's all I say."

From the "One-Hoss Shay" by Oliver Wendell Holmes

The designer and builder of the One-Hoss Shay achieved an interesting objective of some modern-day designers—a product utilizing component materials of great uniformity and well-coordinated life expectancy.

In capacitor design the One-Hoss Shay concept would result in enormously expensive units since materials normally vary in their physical and electrical characteristics. Therefore, the manufacture of capacitors with perfectly uniform characteristics from one to the next would involve a complex process of detailed selection of their component materials, and uniform assembly procedures. Economical and practical capacitors must accordingly be designed with two points in mind:

1) They will have a finite, but should have a very low, failure rate.
2) They will have a finite, but should have a long, life expectancy.

Exact determination of these levels for any capacitor design is a complex process of analysis and testing. A few of the highlights of these methods will be discussed below.

It has previously been shown (1) that the life expectancy of paper-oil dielectric capacitors is inversely proportional to the fifth power of the applied DC voltage. Further studies (2) indicate that one responsible mechanism for this exponential relationship is gassing of the oil. The life expectancy was also found to be halved for each ten degree Centigrade increase in operating temperature, over the normal range. This effect is probably analogous to the familiar chemical rule concerning the electrolytic action rate of solutions. Thus the actual measured life under a set of test conditions can be translated into expected life under another set of conditions of voltage and temperature, as follows:

$$L_2 = \left(\frac{E_1}{E_2}\right)^5 \cdot T_1 \cdot 2^{-\left(\frac{t_2 - t_1}{10}\right)}$$

where L_2 = expected life in hours
E_1 = test voltage
E_2 = actual working voltage
T_1 = time duration of test in hours
t_1 = test temperature in degrees Centigrade
t_2 = actual operating temperature in degrees Centigrade

This relationship applies only to a failure caused by the actual degradation of the paper-oil dielectric brought about by the stresses of voltage and temperature. It would be most misleading to say that each and every failure experienced in any production lot will obey this law—some failures may be the result of manufacturing errors or material flaws.

This basic formula, although evolved for paper-oil capacitors, appears to apply to other types, such as mica and plastic film, but the fifth power law does not hold for these types since their molecular structure is significantly different. A voltage exponent of seven to ten appears to be appropriate for these types. It is also possible that the rule of halving of life expectancy with each ten degree Centigrade rise in temperature may not strictly apply to materials other than paper-oil because of their inherently different sensitivity to temperature, and due to different ranges of operating temperature. These points are the subject of much continuing investigation.

The formula shown has thrown a new light on the use of accelerated conditions as a production evaluation tool. Accelerated tests have, in certain instances, become a processing procedure, offering two major advantages:

1) So-called "early" failures can be eliminated to a high degree by proper over-stressing.
2) Life expectancy can be better evaluated since measured results are available in a short time.

Thus accelerated, or "screening," tests can serve a highly useful purpose where very high degrees of reliability are required, and must be measured or estimated quickly. This processing and evaluation, of course, involve additional expense, and are therefore not used for run-of-the-mill products. They also do not ensure a good product if the design or manufacturing controls are basically inadequate, and must never be used to sort good units from an inherently bad population.

One additional point should be made before we summarize an example: since, unlike the One-Hoss Shay, we cannot have all production capacitors fail simultaneously, some attention must be paid to the distribution of the failures with regard to time. It is important to know the shape of the failure rate curve.

Some hypothetical numbers can be used to illustrate the previous discussion. Assume that a group of 200 silvered mica button® capacitors, designed for 500 WVDC and 125°C., is subjected to an accelerated test of 1000 VDC and 150°C. for 50 hours. At the end of this time, a failure level of one per cent is found, and the failures have occurred at 10 and 40 hours (we assume they are "pure" dielectric failures). Assuming a voltage exponent of 8 to apply, we may use the expected life equation as follows:

$$L_2 = \left(\frac{1000}{500}\right)^8 \cdot T_1 \cdot 2^{-\left(\frac{125 - 150}{10}\right)}$$

therefore, $L_2 = 1435\ T_1$

or, under actual conditions, these failures would have occurred at 14,350 and 57,400 hours of continuous operation. These failures then represent 0.035 and 0.009 per cent failures per 1000 hours, respectively. These times to failure correspond to over 16 and 65 years of normal, intermittent service.

References:

1) J. R. Weeks, Capacitor Life Testing, Bell Laboratories Record. Vol. XXIV, No. 8. August, 1946.
2) Harold Basseches and Mary W. Barnes, Gassing of Liquid Dielectrics Under Electrical Stress. Industrial and Engineering Chemistry. Vol. 50, No. 6. June, 1958.

SC-59-8

New Tech Data for Engineers

Transformers

A short-form interpretation of transformer type designation per MIL-T-27A. This listing is included in a transformer design specification sheet which may be used as a guide in specifying custom-built transformers. Microtran Co., 145 E. Mineola Ave., Valley Stream, N. Y.

Circle 192 on Inquiry Card

Magnetic Clutches

A 4-page, 2-color catalog from Dynamic Instrument Corp., 59 New York Ave., Westbury, L. I., N. Y., describes the company's complete line of magnetic clutches and clutch brakes. Data includes: clutch torque, brake torque, breakaway torque, (energized and de-energized), and general specs.

Circle 193 on Inquiry Card

Microwave Test Equipment

Catalog 590 from Polarad Electronics Corp., 43-20 34th St., Long Island City, N. Y. (153 pages) details theory, applications, and test procedures for their line of Microwave signal generation, spectrum analysis, reception, components & accessories and general laboratory equipment.

Circle 194 on Inquiry Card

Computing Instruments

George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass., has a 4-page short form catalog on their various lines of analog computing instruments. It contains brief data on their operational amplifiers, operational manifolds, linear operators, non-linear operators, regulated power supplies and a calibrated display, as well as a summary of Philbrick services in the field of analog computing.

Circle 195 on Inquiry Card

Encoders

Bulletin No. 300-5 from Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif., is a summary of Datex shaft position encoders. Included are data on rotation, readout, and special features of each model.

Circle 196 on Inquiry Card

Electroplating

A 4-page illustrated brochure describes the Dalic process of electroplating selected areas without using immersion tanks. Sifco Metachemical Inc., 935 E. 63rd St., Cleveland 3, Ohio.

Circle 197 on Inquiry Card

Instruments

A 6-page short-form catalog, describes and illustrates 20 instruments, products of Wayne Kerr Corp., P. O. Box 801, Phila. 5, Pa. The 2-color brochure includes product and basic specs on transformer ratio-arm bridges, oscillators, transistor adaptors, milliwattmeters, and wattmeter.

Circle 198 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.

Wire Marker

A 4-page color brochure covers the E-Z Code line of self-adhering markers for all size wire, cable and harness identification. Included are descriptions of a variety of stock and special markers for use in high temp. applications, resistance to water, oils, solvents and fungus, and markers meeting military spec. Western Lithograph Co., 600 E. 2nd St., Los Angeles, Calif.

Circle 199 on Inquiry Card

Solid State Computer

The new Univac Solid-State Computer is explained and illustrated in a colorful 12-page booklet from Remington Rand Div., Sperry Rand Corp., 315 Park Ave., New York 10, N. Y. Compatible to punched-card installations, this new system provides high-speed processing at relatively low cost, compactness, and accuracy and reliability.

Circle 200 on Inquiry Card

Surface Temp Measurement

Data sheet from Royco Instruments Inc., 874 Fabian Way, Palo Alto, Calif., describes the Models DTR and DTF surface temperature measuring devices. Discussed are accuracy, automatic compensation, response, scales and construction.

Circle 201 on Inquiry Card

Potentiometers

A 4-page, 2-color brochure describes the applications, operation, and specs. of a line of self-balancing potentiometer models that can be used in flight test instrumentation as pyrometers or millivoltmeters. Block diagrams show the operating principles of both the pyrometer and millivoltmeter designs. Featured is tabulated spec on 40 autopot models. From Daystrom Pacific, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Circle 202 on Inquiry Card

Wire & Cable Terms

Glossary of Wire and Cable Terms is a 4 x 6 in. pocket sized publication which lists alphabetically common terms, expressions, and units used in the electrical wire and cable industry. Standard Wire & Cable Co., 3440 Overland Ave., Los Angeles 34, Calif.

Circle 203 on Inquiry Card

Filters & Transformers

General catalog from United Transformer Corp., 150 Varick St., New York, N. Y., covers over 800 stock items complete with specs, applications, and pertinent information. Also, a separate catalog, consisting of filters and inductors contains specs and pertinent information in its category.

Circle 204 on Inquiry Card

TW Tubes

Traveling-wave tubes, 15 of them are described on a catalog sheet from Sylvania Electric Products Inc., Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif. Included are electrical and physical characteristics of both permanent magnet and solenoid focused types, with frequencies as low as 1 KMC and as high as 11KMC, and powers up to 1 kw. Also included are backward-wave oscillators.

Circle 205 on Inquiry Card

Transistorized power supply

Two-color catalog sheet offers detailed technical data on Model 851H transistorized power supply. Unit is designed to develop any voltage from 26 to 2000 vdc at 100 w output power from an input of 28 vdc. Also included are dimensional drawings and complete specs and ordering information. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 206 on Inquiry Card

utmost in performance

TYPE 33M MOLDED mylar* CAPACITOR

applications | *computers · instrumentation · test equipment filter networks · transistor circuitry · amplifiers*

Sangamo Type 33M molded mylar* capacitors combine the excellent electrical performance characteristics of mylar* dielectric material with a molded case of high moisture resistant thermosetting plastic.

Temperature Range: "The Type 33M is designed to operate over the temperature range of —55°C. to +85°C. Satisfactory performance at 125°C. can be obtained by derating the voltage to 50% of the 85°C. value."

Dissipation Factor: The dissipation factor of the Type 33M capacitor does not exceed 1% at normal equipment operating temperature over the complete audio frequency range.

Tolerances: Available in capacitance tolerance values of ±5%, ±10%, ±20%.

Life Test: These units will withstand a life test of 250 hours at 125% of rated voltage at 85°C. Life tests at 125°C. should be made at 125% of the derated voltage.

Dielectric Absorption: Dielectric absorption of Type 33M capacitors is less than half that of oil impregnated paper capacitors.

Moisture Resistance: Type 33M capacitors will successfully withstand the moisture resistance tests specified in Spec. MIL-C-91A.

Insulation Resistance: The insulation resistance of these capacitors will exceed 5,000 meg/mfd. over the normal operating temperature range.

• Write for engineering bulletin TSC-206A

*DuPont's trademark for polyester film.

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

SC-59-6

New Tech Data for Engineers

Servo Motors

A reference data sheet from Induction Motors of Calif., 6058 Walker Ave., Maywood, Calif., describes the Step-Servo Motors, designed for digital-to-analog conversion in 45° reversible increments up to 120 pulses per sec.

Circle 207 on Inquiry Card

Modular Control Systems

A 4-page bulletin, PS-5A, from Airborne Accessories Corp., Hillside 5, N. J., describes the company's packaged modular control systems built or assembled from standard units, assemblies and sub-assemblies. Included are charts and photographs of units.

Circle 208 on Inquiry Card

Recorder/Reproducer

An 8-page booklet describes a 24-hr. continuous tape recorder-reproducer. The booklet illustrates operational features and contains a complete list of specs. The SoundScriber Corp., 6 Middletown Ave., North Haven, Conn.

Circle 209 on Inquiry Card

Recording Tape Vault

Data Sheet 147 illustrates and gives complete technical specifications of walk in Netic Co-Netic magnetically shielded recording tape storage vault that prevents stray magnetic fields from damaging valuable magnetic tape recordings. Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.

Circle 210 on Inquiry Card

Indicating Recorders

A 4-page, 2-color bulletin, No. 66, from the Thermo Electric Co., Inc., of Saddle Brook, N. J., describes their Thermo Electronic Indicating Recorders and Indicating Recorder-Controllers. It provides information on sensitivity, accuracy, control and alarm function, installation, operation and maintenance.

Circle 211 on Inquiry Card

Temp. Controls

Nineteen different midget and miniature Thermoswitch Controls are described in a brochure, MC-182, issued by Fenwal Inc., Pleasant St., Ashland, Mass. Dimensions, temp. range, and electrical ratings are given for each unit.

Circle 212 on Inquiry Card

Frequency Converter

A 4-page tech. bulletin, No. 2024, describes a broad range frequency converter for 15 to 40,000 CPS inputs. Complete application specifications are presented in the bulletin discussion and tabular data, including frequency ranges and linearities at various output ratios; input signals required; output current at various linearities; accuracies; filtering; time constants; and power requirements. Cox Instruments Div., George L. Nankervis Co., 15300 Fullerton, Detroit 27, Mich.

Circle 213 on Inquiry Card

Plug-in Units

Detailed physical and electrical spec. of DYKOR transistorized plug-in units for digital systems is described in 6 pages of catalogue PI-79. The illustrated catalogue describes other services offered to the computer design engineer. Design criteria as well as systems applications are described in a 5-page addenda. The addenda includes an assortment of novel circuits for application in digital systems ranging from a simple data converter to a complex computer. In addition to describing the flip-flop, amplifier, gating, buffing and other standard DYKOR packages, there is also a discussion of core memory selection, signal circuits and encoding and decoding networks. Digitronics Corp., Alberton Ave., Albertson, L. I., N. Y.

Circle 214 on Inquiry Card

Vacuum Pumps

Bulletin 515, 4 pages, describes the complete line of Stokes mechanical booster vacuum pumps (4 standard models with max. pumping speeds of 1100, 1200, 3200, and 5700 cfm). Performance curves and complete specs. are given, as well as a description of the outstanding design features. Vacuum Equipment Div., F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.

Circle 215 on Inquiry Card

Indicating Controllers

A 4-page Bulletin No. 65 from Thermo Electric Co., Inc., Saddle Brook, N. J. describes their Thermo Electronic Self Balancing Indicators and Indicating Controllers. These instruments indicate process variables convertible to an electrical quantity, such as dc potential, current, or resistance, and may be connected to multi-point switches to check up to several hundred sensing elements. In addition to the primary indicating function, the instruments can be provided with 2-position or 3-position control, or up to 6 alarm contacts.

Circle 216 on Inquiry Card

Rectification Equipment

A new condensed catalog, No. 596, 68 pages, of materials handling equipment, parts handling equipment, power rectification equipment, mechanical Shaft Seals, Paper Joggers and portable power tools is announced by Syntron Co., 263 Lexington Ave., Homer City, Pa. Catalog has descriptions, data, specifications and is illustrated.

Circle 217 on Inquiry Card

Thermistors

Technical literature available from Victory Engineering Corp., 521 Springfield Rd., Union, N. J., includes a series entitled "Meet the Veco Thermistors," literature Catalog SB51, and 4 information folders on matched thermistors, temperature sensor assemblies, thermal conductivity cells and experimentors items, and circuit design kits.

Circle 218 on Inquiry Card

Tantalum Slug Capacitors

Bulletin 159C from Ohmite Mfg. Co., 3639 Howard St., Skokie, Ill., describes their new style "UC" tantalum slug capacitor rated for 125° C ambient as well as the previously developed style "UB" for 85°C ambient. Included are details concerning the military shock and vibration requirements which both types of slug capacitors exceed.

Circle 219 on Inquiry Card

Synchronous Motor

A 12-page bulletin describes an enclosed permanent magnet type synchronous motor, Slo-Syn, which is adaptable for a wide variety of applications such as servomechanisms, automatic machines, remote control and numerical control system. At 60 cycles the speed accurately remains at 72 RPM without gear reduction. Torque is conservatively rated at 150 oz.-in. The Superior Electric Co., Dept. SS, Bristol, Conn.

Circle 220 on Inquiry Card

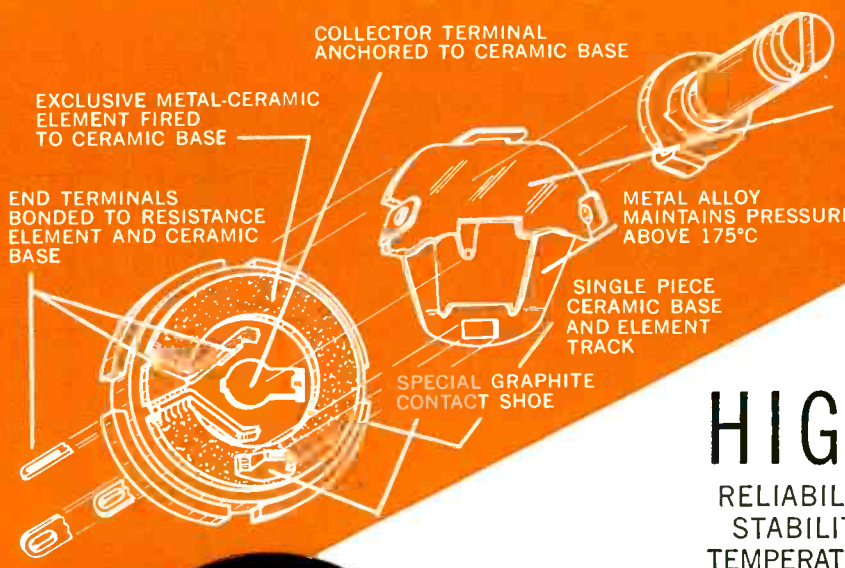
Radioisotopes

The fifth in a series of technical bulletins describing uses of radioisotopes in industrial research describes the uses of radioactivity in helping the chemist prove a new method of analysis or extend an established method to a new type of unknown mixture. Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.

Circle 221 on Inquiry Card

STABILITY & HEAT BARRIER BROKEN

with Metal-Ceramic Variable Resistor



HIGH

RELIABILITY
STABILITY
TEMPERATURE

Miniature
CERATROLS
with new metal-ceramic element

CeraTrolS' rugged, hard-surfaced metal-ceramic element, having been fired at temperatures exceeding 600°C, meets temperatures up to 500°C with high safety factors at ratings listed below.

New Series 600 Characteristics:

- Infinite resolution.
- 100 ohms thru 5 meghoms (linear taper) resistance range.
- ½" diameter; interchangeable with Style RV6 MIL-R-94B.
- Power ratings: ¾ watt @ 85°C, ½ watt @ 125°C, zero load @ 175°C.

CTS®

COMPARATIVE TEST DATA: No carbonaceous variable resistors (either film or molded) can equal Series 600 performance. Ideal for critical applications requiring high stability and reliability. Far exceeds MIL-R-94B.

Tests	MIL-R-94B (Style RV6, Char. Y) Requirement	Series 600 CTS Maximum	Series 600 CTS Average
Load life 1000 hrs.			
½ watt @ 125°C, 350 V max.	±10% @ 70°C	±7% @ 125°C	±4% @ 125°C
¾ watt @ 85°C			
Thermal Stability (1000 hrs. @ 175°C no load)	No test in MIL-R-94B	±5%	±3%
Temperature Co-eff.* (Room to −63°C; room to +175°C)	No test in MIL-R-94B		
25K and over		±250 PPM/°C	±150 PPM/°C
under 25K		±500 PPM/°C	±300 PPM/°C
Moisture Resistance	± 6% avg. ±10% max.	± 2% avg. ± 4% max.	±1.3%
Low Temp. Storage	±2%	±1%	±.5%
Low Temp. Operation	±3%	±2%	±1%
Thermal Cycling	±6%	±3%	±2%
Voltage Co-efficient	No test in MIL-R-94B	±.01%/volt	±.005%/volt
Rotational Life	±10% (after 25,000 cycles)	±10%	±7.5%
Acceleration	±3%	±2%	±1%
High Freq. Vibration	±2%	±2%	±1%
Shock	±2%	±2%	±1%

* Lower temperature coefficient can be developed for specific applications.

Note Exceptional Stability. Note extent that MIL-R-94B is exceeded.

Newly developed 500°C Metal-Ceramic Resistance Element is separately available for other applications than variable resistors. Because the element is very stable to 500°C, it is extremely reliable at the elevated temperatures currently demanded and anticipated in military requirements. Ceramic bases can be made in a wide variety of shapes and sizes; the metal resistance film can be made to cover an entire surface or an accurately defined pattern. Consult CTS engineers on your requirements.

Complete Series 600 CeraTrolS electrical and mechanical specs and dimensional drawings will be sent upon request.
CTS manufactures a complete line of composition and wirewound variable resistors for military, industrial and commercial applications. CTS specialists are willing to help solve your variable resistor problems. Contact your nearest CTS office today.

Founded 1896

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

CHICAGO TELEPHONE SUPPLY Corporation

ELKHART • INDIANA

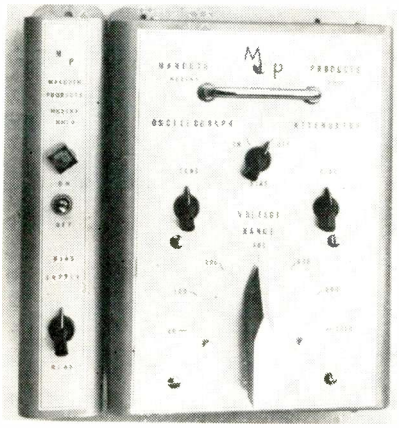
BURTON BROWNE ADVERTISING

Circle 52 on Inquiry Card

New Products . . . for the Electronic Industries

OSCILLOGRAPH ATTENUATOR

The RS-1 attenuator is a 100 w attenuator for operating direct writing oscillographs from high voltage power equipment without the use of an amplifier. It is useful for the supervision

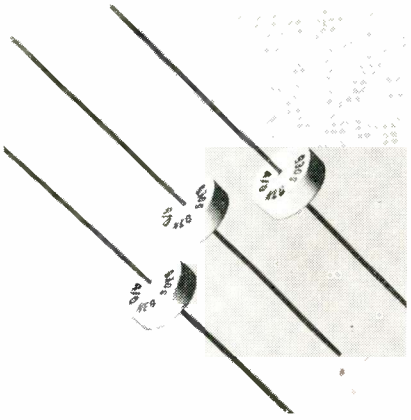


and service of dynamic power equipment as well as experimental and laboratory use. The current drain from the source is 0.1 a. The output impedance is approximately 250 ohms (to be used with loads of 1000 to 2000 ohms). The full scale voltage range is 40 to 1000 v. Marduth Products, R. D. #4, Box 228, Medina, Ohio.

Circle 161 on Inquiry Card

SILICON RECTIFIER

Silicon rectifier is designed for a variety of applications in radio, TV, tape recorders and other electronic instruments. Model E-5, a wafer-shaped 5/32 x 7/16 in. dia. electric-

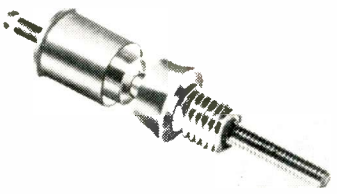


ally insulated rectifier, is available with solder or plug-in connectors. Five models, rated at 100 PIV, 200 PIV, 300 PIV, 400 PIV and 500 PIV each handle 750 ma with resistive load or 500 ma with capacitive load. Rectifier Div. Audio Devices, Inc., 620 E. Dyer Rd., Santa Ana, Calif.

Circle 163 on Inquiry Card

TRIMMERS

Variable trimmer series, the MAX-C, feature a wide range of capacity per unit. The electrode band is of metallized silver laminated on to a thin high dielectric constant precision-bore

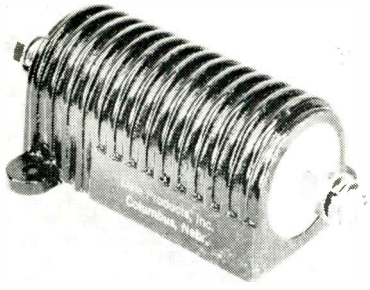


glass cylinder. To compensate for the fineness of the glass, a thicker outer concentric glass cylinder is added over the inner to strengthen the assembly. It has improved backlash design for excellent tuning resolution and no capacitance reversal while tuning. JFD Electronics Corp., 1462-62nd St., Brooklyn 4, N. Y.

Circle 164 on Inquiry Card

POWER RESISTOR

Wire-wound precision power resistor, RH-100, is rated at 100 w. It is sealed in an aluminum radiator finned housing for mounting on chassis to provide max. heat dissipation. Designed for applications requiring high power coupled with precision tolerance. Available in 0.05, 0.1, 0.25, 0.5, 1.0, and 3.0% with re-



sistances ranging from 0.25 ohms to 40 K. Housing size is 3½ x 2 13/16 x 1¾ in. Terminals are plated ¼-20 studs. Dale Products, Inc., Box 136, Columbus, Nebr.

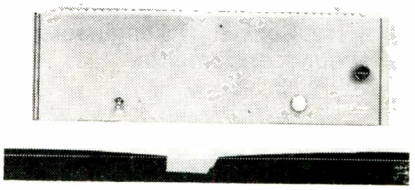
Circle 162 on Inquiry Card

! 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.

HIGH SPEED MULTIPLEXER

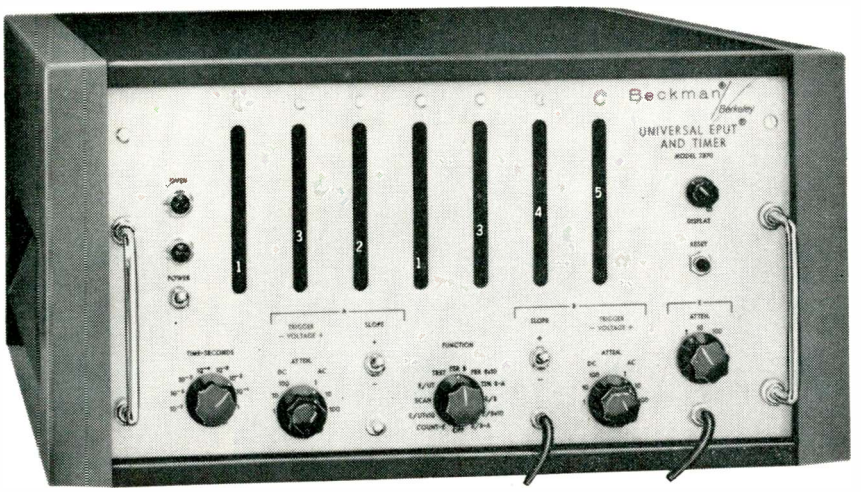
The Model TMX-841-S Multiplexer is a solid state, high speed, precision electronics switch that can be used to sample a maximum of 20 data inputs with a full scale voltage range of ±10 v. It has an inherently high transfer accuracy and a low noise level. It will provide a time shared data output pulse train of high ac-



curacy to be used with the Epsco Transicon Datrac to increase the number of data channels to be digitized. Epsco, Inc., 275 Massachusetts Ave., Cambridge, Mass.

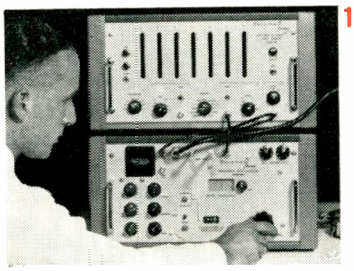
Circle 165 on Inquiry Card

10 Mc Counter displays microwave frequencies



to transfer oscillator

Coupled to a computing transfer oscillator, this counter will display the 13,213.45Mc reading shown...one more instance of the unique utility of Model 7370.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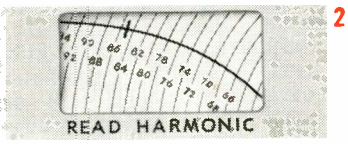

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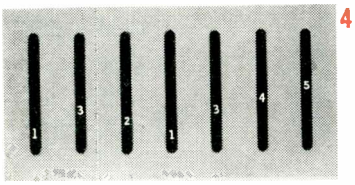

4

SPEEDY, PRECISE METHOD

1. Operator tunes transfer oscillator in the conventional way—finds two adjacent fundamentals having harmonics that zero-beat with the unknown frequency.
2. Reads harmonic number appearing on built-in automatic calculator.
3. Sets digital switches to harmonic number.
4. Reads microwave frequency as it appears on the face of the counter. The entire procedure takes less than one-fifth the time ordinarily required.

SPECIFICATIONS

Model 7370 used with transfer oscillator (Model 7580)

Frequency measuring range	dc to 15KMc
Types of signals accommodated	CW, AM, FM, pulsed r–f
Sensitivity	100 mv rms
Input impedance	50 ohms
Accuracy	up to ± 3p in 10^7
Fundamental range of trans. osc.	75 to 150 Mc & 7.5 to 15 Mc
Harmonics available	up to 100th
Stability of fundamental	.0001% per min

Model 7370 alone

Frequency counting range	dc to 10Mc
Sensitivity	selectable: 0.1v,1v & 10v
Input impedance	10M ohms
Stability of time standard	3 parts in 10^7 per week
Additional functions	Measures period, phase & frequency ratio. Times interval between independent signals.

Prices

Model 7370 Universal EPUT® & Timer	$1975
Model 7580 Computing Transfer Oscillator	$1650

Write for detailed technical bulletins

Beckman®

Berkeley Division
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc.

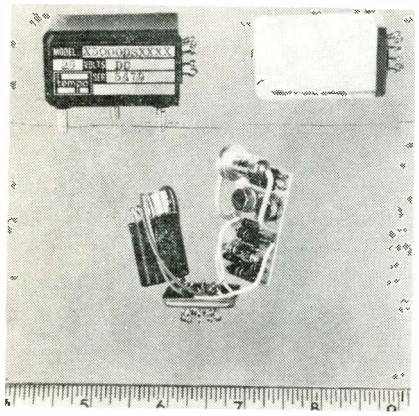
T22

Circle 53 on Inquiry Card

New Products . . . for the Electronic Industries

TIME DELAY RELAYS

Two lines of time delay relays, with accuracy ratings of 10% or 5% meet the accuracy and reliability requirements of high performance electronic systems. Six units provide a range

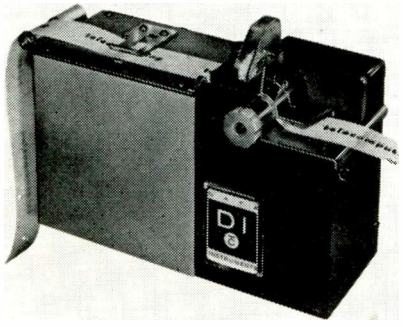


from 0.050 to 300 sec. Environmental and operating conditions include: Input voltage variations from 18 to 31 vdc; temp. from −55° to +125°C; vibration to 20 g's, 2000 CPS; shock to 50 g's, 11 msec.; acceleration to 20 g's. Meet MIL-E-005272B, MIL-E-5400B, MIL-R-5757C, MIL-R-6106C, and MIL-R-25018. Tempo Instrument Inc., P. O. Box 338, Hicksville, N. Y.

Circle 166 on Inquiry Card

TAPE PERFORATOR

High-speed tape perforator with a punching speed of 40 columns per sec. has a simplified drive mechanism which requires only one eccentric and one cam-generated motion. Feature is 4-way staggered positioning of the large, rugged punching electro-magnets to provide compactness and maximum force. Safety features include an interlock to prevent the feed from advancing tape until a column has been

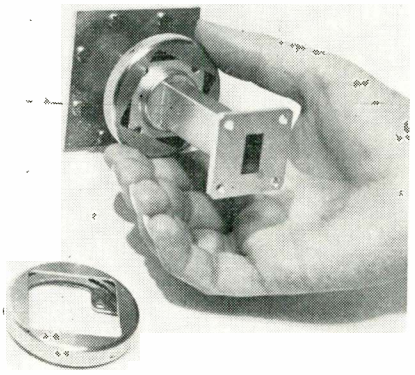


punched. A visual alarm indicates low tape supply, and audible alarms are available. Data Instruments Div., Telecomputing Corp., 915 N. Citrus Ave., Los Angeles 38, Calif.

Circle 167 on Inquiry Card

WAVEGUIDE DISCONNECT

For quick connections of all types of waveguide components, the Model 3419 waveguide quick disconnect offers simplicity of operation. A slight CW rotation is all that is needed to fasten

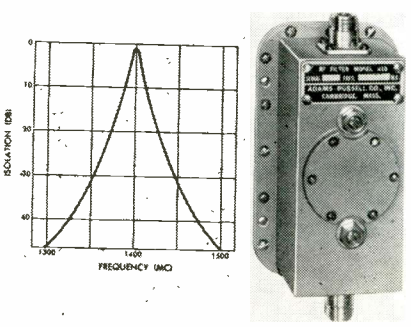


the two pieces of waveguide together. Alignment of the two sections of guide is assured by the two screws used to mount the coupling. There are no loose parts to be lost, no springs to break, no fingers to bend. The coupler is made in 2 sizes: one for K-band (Model 3419K) waveguide; one for X-band (Model 3419X). Aircraft Armaments, Inc., Sales Dept., Cockeysville, Md.

Circle 168 on Inquiry Card

CAVITY FILTER

Midget Cavity Filter, Model 410, for the 400-2000 MC frequency range is tunable over a limited range of from 3 to 10% depending on center frequency. It is airtight and will withstand shock, vibration, and temperature extremes. Response curve and bandwidth are essentially the same for any pass frequency. Other features: Power, 20-50 w, according to pass frequency; insertion loss, 1 db;

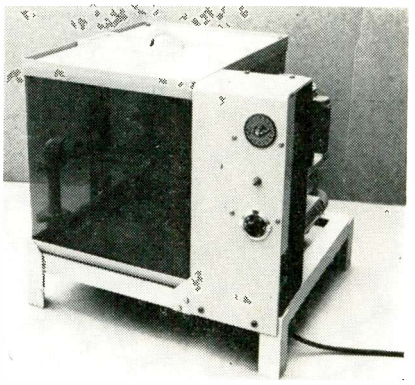


3 db bandwidth, 7 MC; 30 db bandwidth, 60 MC; size, 3 x 3 x 5½ in.; weight, 28 oz. Adams-Russell Co., Inc., 200 Sixth St., Cambridge 42, Mass.

Circle 169 on Inquiry Card

PRINTED CIRCUIT ETCHER

Oscillating Spray Nozzle Etcher for proto-type printed circuit work has polyvinyl chloride and titanium construction throughout and a variable spray nozzle pattern. Quartz-

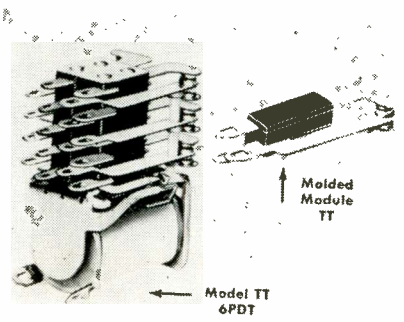


cased immersion heater is optional. It uses ferric chloride or chromic acid to etch both sides simultaneously on boards up to 10¾ x 13¾ in. Line widths obtainable to 0.003 in. Transparent construction allows view of work. Has a 7 to 12 gal. sump capacity. Model designation: 200. Size: 29 x 25 x 26 in. Power 115 vac 60 cycles. Centre Circuits Inc., P. O. Box 165, State College, Pa.

Circle 170 on Inquiry Card

RELAYS

Models TT and TS relays are designed to meet MIL-R-5757C and MIL-R-6106C. A design innovation is the molding of standard contact spring combinations into integral units or "modules" for unvarying alignment, and permanence of adjustment of mating contact springs as well as accurate alignment of whole combinations (modules) on the relay. Featured are sensitivity, small size



and operation in ambients as high as 125°C. Model TS relay is a larger version of the Model TT and will transfer heavier currents. Ohmite Mfg. Co., 3646 Howard St., Skokie, Ill.

Circle 171 on Inquiry Card

SQUEEZING HIGH POWER INTO small packages

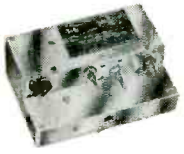
Unhampered by traditional thinking, TELECHROME engineers have developed an entirely new concept in telemetering equipment — unequalled in compactness, ruggedness and dependability.

TELEMETERING TRANSMITTERS

FM/FM or PDM/FM Crystal Controlled

215 to 260 Megacycles

Model 1472



4" x 1.5" x 2.7"
2 Watts

Model 1463

5 9/32" x 3 3/16" x 4"
15 to 30 Watts

Model 1462

6" x 4 1/4" x 3 3/4"
50 to 80 Watts

Model 1466A

6.5" x 4" x 3.25" RF Amplifier
2 watts in — 100 watts out

SUB-CARRIER OSCILLATOR.
Model 800C — 1.5" x 1.9" x 2.45"

Deviation stability ±1% of band width. Deviation linearity less than 1% of band width under all conditions measured from a straight line drawn between end points.

COLOR TV • INDUSTRIAL INSTRUMENTATION • TELEMETRY

TELECHROME MANUFACTURING CORP.

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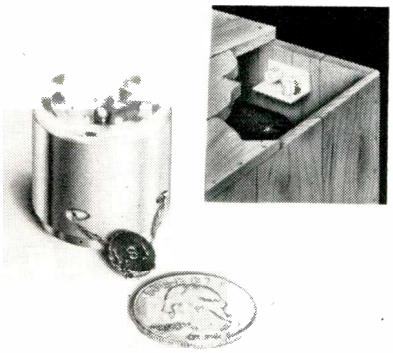
Western Engineering Division — 13635 Victory Blvd., Van Nuys, Calif., State 2-7479

Circle 54 on Inquiry Card

New Products . . . for the Electronic Industries

SHOCK DETECTION DEVICE

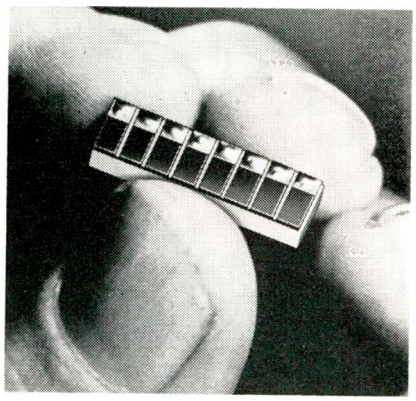
A shock detection system to protect shipments of delicate equipment and fragile instruments in transit, the V-Dot Indicator, has one moving part, an indicating ball, held in center position by a controlled magnetic field, factory-set to withstand normal handling and shocks. A shock greater than the allowable maximum from any direction in a single plane will dislodge the ball from the center and trap it against the edge of the circle. Once the ball is triggered it can be moved back only by breaking the seal and opening the case. Inertia Switch Inc., 311 W. 43 St., New York 36, N. Y.



Circle 172 on Inquiry Card

READOUT PHOTOCELLS

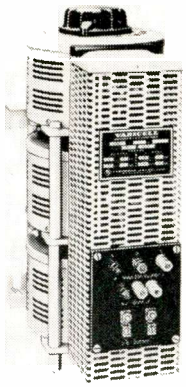
Designed specifically for computer and data processing equipment where rapid detection of light passing through punched cards or tape is required, these silicon photovoltaic readout matrices feature response time in the order of 10 μsec. Each matrix is made up of a multiple array of individually segmented silicon cells. Light energy striking a particular segment will cause power to flow from that segment only. Typical current generated is 300 μa for 0.01 sq. in. of active cell area at 1,000 foot-candles illumination. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.



Circle 174 on Inquiry Card

AC/DC POWER SUPPLY

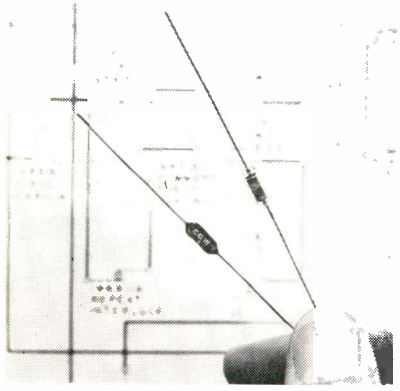
Adjustable ac/dc power supply can be used independently or as an apparatus component. Filtering is usually not required because the low ripple content is approx. 4.2% and ripple frequency 360 cycles at a supply frequency of 60 cycles. Ac output can be either 0-30 v., 40 a (secondary delta connected) or 0-50 v. 25 a (secondary wye connected). Dc output can be either 0-35 v, 50 a (secondary delta connected) or 0-60 v, 30 a (secondary wye connected). Ac or dc regulation is approx. 10% at the max. voltage setting. The Superior Electric Co., Dept. V4050, Bristol, Conn.



Circle 176 on Inquiry Card

OXIDE FILM RESISTORS

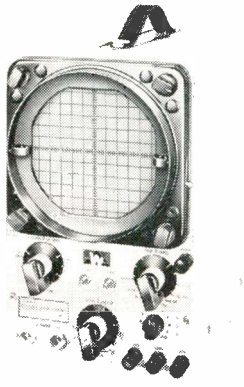
Oxide film resistors in new ⅛ w ratings, the epoxy-coated N-60 resistor and the glass-enclosed NF-60 resistor, conform to MIL-R-10509C, characteristic B. They are approx. ⅜ in. in length and 1.8 in. in dia. Applications include transistorized equipment, and miniaturized computer and switching circuits. Both ⅛ w units have a resistance range of 10 to 100,000 ohms at 250 v and 70°C, with derating to 150°C. Corning Glass, Corning, N. Y.



Circle 173 on Inquiry Card

OSCILLOSCOPE

Occupying less than ½ cu. ft. and weighing only 18½ lbs., the S-16-A, Craftscope, is a portable 5 inch oscilloscope. It features dc to 7 MC response, direct reading vertical calibration, wide range repetitive sweep with additional fixed sweeps for color and industrial TV work, trace inversion, edge-lighted graph screen and many other features. Waterman Products Company, Incorporated, 2445-63 Emerald Street, Philadelphia 25, Pennsylvania.



Circle 175 on Inquiry Card

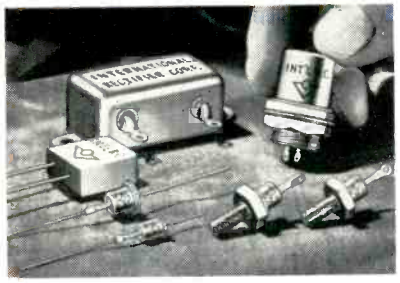
CONDENSER MICROPHONE

Measurement microphone series of microphone cartridges includes the Model 4131 with a flat free-field response from 20 to 18,000 CPS and the Model 4132 with a flat response conforming to the ASA Standard ZS24.8—1949 L-type microphones. The cartridges are dimensionally interchangeable with the ASA standard microphone. Integrated supporting equipment simplifies measurement. B & K Instruments, Inc., 3044 W. 106 St., Cleveland 11, Ohio.

Circle 177 on Inquiry Card

INTERNATIONAL RECTIFIER CORPORATION

RECTIFIER NEWS



644 Zener Diode Types Offer Advantages to Every Voltage Regulator Circuit

As compared to other voltage reference elements, the silicon diode regulator has a longer life expectancy because of its mechanical ruggedness. It does not deteriorate under storage nor age during its operating life. Small size and light weight make its use in airborne or portable equipment especially desirable from many standpoints.

International Rectifier Corporation now offers an extensive line of zener types numbering 644 in seven basic styles. From the miniature type rated at 750 milliwatts to the precision 1N430 reference element types, all are manufactured to meet the most rigid military requirements. *See how these all-welded, hermetically sealed diodes can improve your circuit design. . . .*

CIRCLE READER SERVICE CARD NO. 137

Miniature Voltage Reference Packs Maintain Voltage Regulation to within ± 0.01%!

REF-PAK MODEL 4RV8
Standard MIL Transformer Case

REF-PAK MODEL RV8-PC
Special Housing for insertion into printed circuit boards.

Designed around the highly stable 1N430 silicon reference element, these miniature reference supplies may be considered to be the solid state equivalent of the standard cell. A high degree of stability is attained by maintaining a precise constant current through the reference element, regardless of temperature or line voltage variations.

Ref-Paks will operate directly from an unregulated power source . . . maintain voltage regulation to within ± 0.01%! Output voltages of either 8.4 or 16.8 volts dc are available in 5 distinct types that allow operation from 28 or 115 volt dc, 400 and 60 cycle power supplies. Temperature coefficient of these devices is ± 0.001%/°C from −55° to +100°C.

For complete details ask for SR-401.

CIRCLE READER SERVICE CARD NO. 138

ZENIAC Provides a Shortcut to the Application of Silicon Zener Diodes

A flip of the Zeniac selector switch quickly tells you the exact diode required in complex breadboard circuitry. This unique innovation — the first semiconductor substitution box in history — has been designed specifically to aid system design groups by saving valuable lab time in the application of zener diodes.

Two units are available, each housing 11 diodes in voltage steps from 3.9 thru 27 volts. Model A Zeniac is rated at 1-watt; Model B is rated at 10-watts. Both are now in stock at your Authorized Distributor. Ask for details on this time saver . . .

CIRCLE READER SERVICE CARD NO. 139

Technical Service Provides XY Plot of Reverse Breakdown Characteristics of Each Diode in all Prototype Orders

To eliminate guesswork and tedious testing on your part, every zener diode sent on prototype orders will be accompanied by a specially plotted XY recording of its exact breakdown voltage point! This permanent record can come in mighty handy when it's time to match diodes or reorder to the same specs. This is just one of the many application engineering services we are prepared to extend to you at all times!

Write to the factory *for Bulletin SR-250-A, a four page technical article describing the characteristics of zener diodes, how to select them, and application data with circuit schematics.*

FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA
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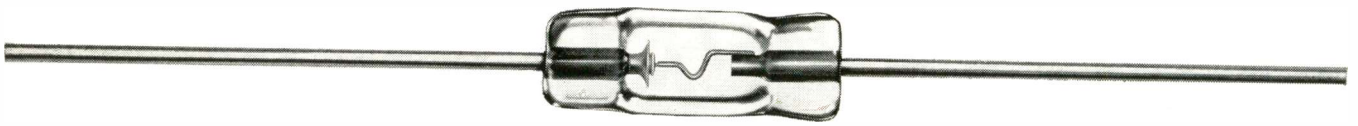
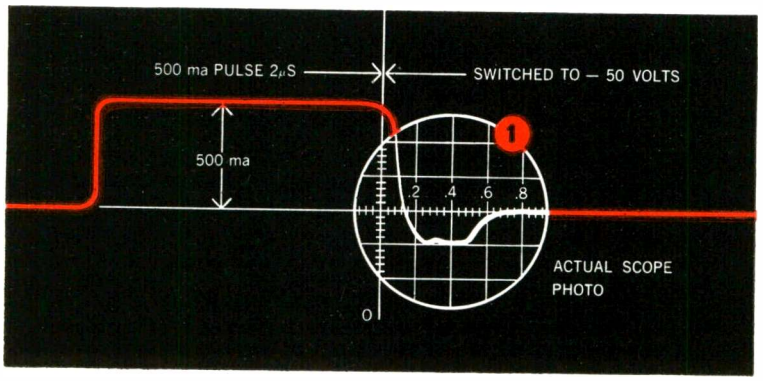
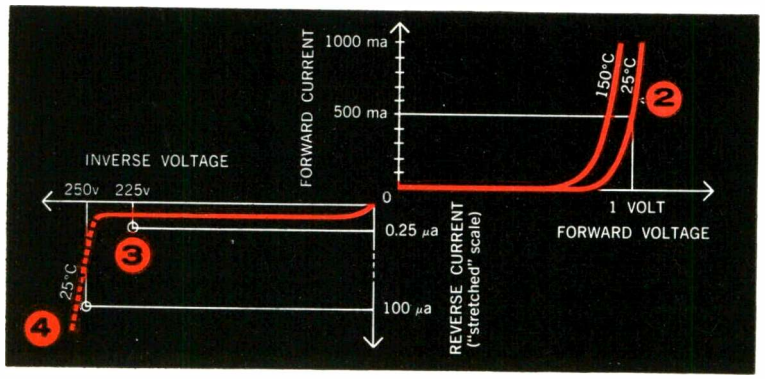
WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

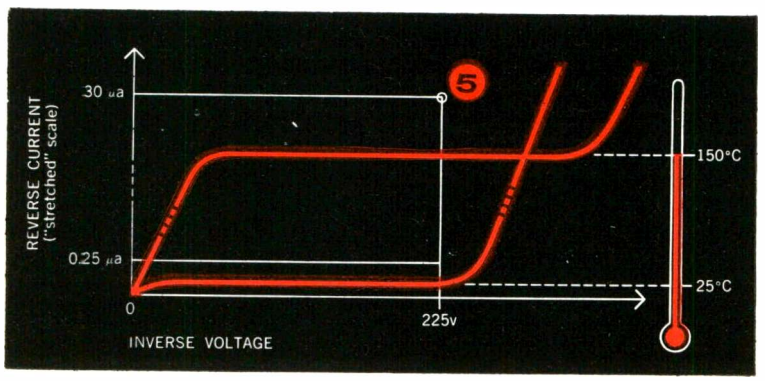
1/2-AMPERE FAST



SWITCHING DIODE







NEW FROM SPERRY is this high-temperature IN690 series silicon diode which gives you greater current-handling capability than germanium diodes – *with no sacrifice in recovery time!*

Check for yourself the performance characteristics of this new diode in the graphs at left . . . then compare them with our *minimum* specifications below.

1 **FAST RECOVERY.** Maximum recovery time is 0.8 microseconds to return to 10 K ohms. Recovery test switches from a forward current 2 microsecond pulse of 500 ma, to a reverse voltage of –50 volts with a loop impedance of 1 K ohm.

2 **HIGH FORWARD CONDUCTANCE.** The forward current specification is 400 ma at 25° C with 1.0 volt maximum drop under static (d-c) conditions. Conductivity increases with temperature – diagram shows typical "x-y" plots at 25° and 150° C.

3 **LOW LEAKAGE** at high inverse voltage. Specification at 25° C is maximum 0.25 μa at rated voltages.

4 **HIGH INVERSE VOLTAGE.** Saturation voltages can be supplied in a range from 40 to 150 volts for this high current series.

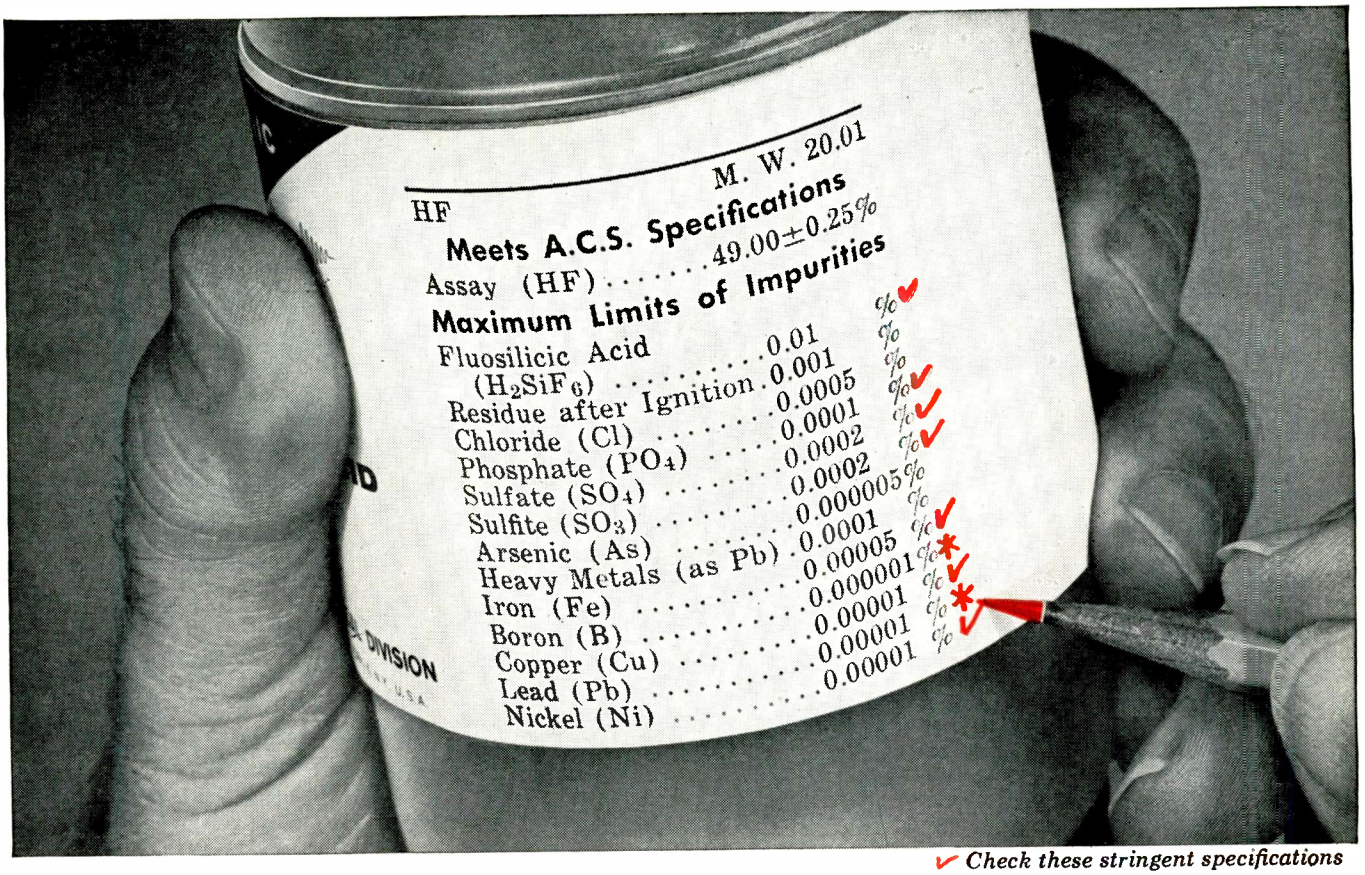
5 **HIGH-TEMPERATURE OPERATION.** Typically, leakage current is no greater than 30 μa at working inverse voltage and 150° C. Diodes are rated for both operation and storage at temperatures from –65° to +150° C.

SPERRY

SPERRY SEMICONDUCTOR DIVISION

SPERRY RAND CORPORATION · SOUTH NORWALK, CONN.

Sales Offices: *Baltimore, Boston, Brooklyn, Chicago, Cleveland, Los Angeles, New Orleans, Philadelphia, San Francisco, Seattle.*



✓ *Check these stringent specifications*
* *Now added for the first time*

BAKER & ADAMSON® ANNOUNCES

HIGHEST PURITY YET FOR "ELECTRONIC GRADE" *HF*

For years, Baker & Adamson's "Electronic Grade" Hydrofluoric Acid has been the purest available. Now, to serve electronic requirements even better, this high purity has been still further improved.

Utilizing the most advanced production techniques and quality control methods, B&A is now making its "Electronic Grade" HF Acid to meet stringent new specifications in which impurities are held to the lowest levels ever attained. In addition, maximum limits for boron and lead have been established and are included for the first time . . . enabling still further control of impurities. Result: B&A "Electronic Grade" Hydrofluoric Acid offers greater reliability in critical etching operations . . . helps reduce rejects and improves quality control in the production of semiconductors.

These new ultra pure specifications for "Electronic Grade" HF point up Baker & Adamson's continued leadership in supplying high purity production chemicals for the electronic industry. B&A "Electronic Grade" Hydrofluoric Acid is available in 1 lb. plastic bottle, 10 lb. returnable plastic jug, 10 lb. non-returnable polyethylene bottle, and 6½ gal. polyethylene carboy. Remember . . . for the finest in electronic chemicals—specify B&A!

Quality specifications have also been improved for B&A Reagent Hydrofluoric Acid, 48% A.C.S. The new reagent grade promises greater reliability in research . . . fewer variables in laboratory control work . . . better analytical control . . . more reproducible results.

BAKER & ADAMSON®
"Electronic Grade" Chemicals

Allied Chemical

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

Circle 57 on Inquiry Card

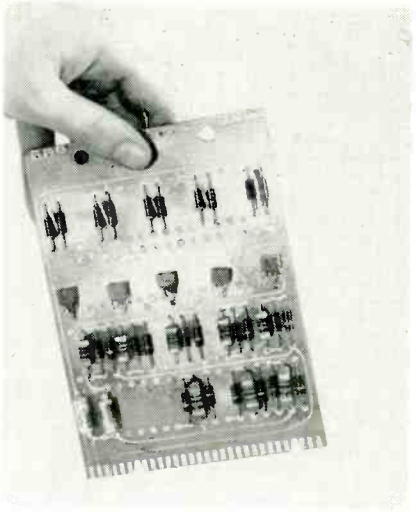


Fig. 3: Shiny coat on panel is deposit of soldering flux left after assembly.

"Freon"

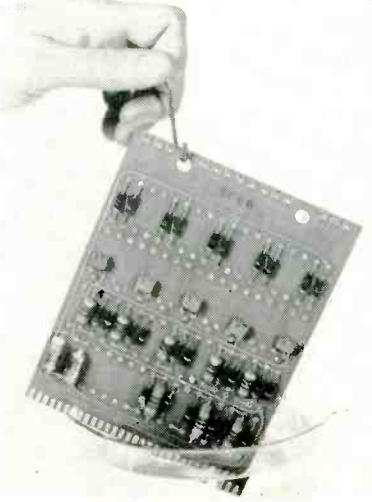
(*Continued from page 95*)

agitation in four minutes time and, in most cases, considerably less time was required.

In all cases, the flux removal time can be shortened considerably by application of ultrasonic cleaning techniques. Ultrasonic equipment, in which high frequency electrical energy is converted through a transducer into high frequency mechanical energy, makes it possible to clean equipment with the "Freon" solvents in seconds where minutes normally would be required. Such equipment is available in a wide price range, depending upon its capacity, with quart-size units being available in the United States for about $200.

Time required to remove rosin flux, of course, varies with the type of solder flux used.

Fig. 4: Slight agitation during 2 to 3 second dip in solvent removes solder flux.



MUIRHEAD

New to the family of Muirhead Oscillators, comes the D-880-A Two-Phase Low Frequency Decade Oscillator. Having a frequency range of 0.01c/s (one cycle in a hundred seconds) to 11.2kc/s, this oscillator forms part of the Muirhead Transfer Function Analyser and has many other applications in the servo-engineering field where the study of low frequencies is of increasing importance. Write for publication 130.

NEW Two Phase Low Frequency Decade OSCILLATOR D-880-A

376

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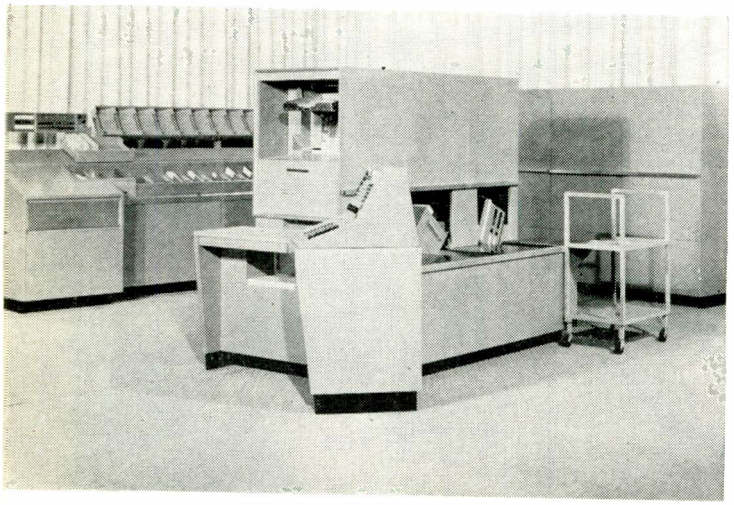
Solid State Computer Uses MICR



All of the equipment for the computer system is shown. Computer can perform 4,000 arithmetical functions per minute.

A NEW electronic data processing system has been developed by the Burroughs Corporation. It is a high speed, solid-state computer which is called the B251 Visible Record Computer.

The computer is specifically designed for the banking industry. While the system will have other applications, marketing plans call for concentrating first on the bank market.

It is named the Visible Record Computer because it selects and writes directly on individual account records. The computer reads information directly from checks, deposit slips and other documents of varying thicknesses and sizes, processes the information and automatically computes, selects and posts directly to the correct customer's account record.

The system utilizes Magnetic Ink Character Recognition (MICR), the term for numbers that can be read by electronic machines as well as by people. MICR was announced last winter by the American Bankers Association as the "common language" for that industry.

Four units comprise the system. The first is the fast sorter, a solid-state device. This machine sorts and reads checks, deposit slips and other bank media through the means of the magnetic ink characters printed on these items.

The second unit is the computer, a completely transistorized machine with magnetic core memory. The computer processes the information read by the sorter from the magnetic characters on the documents and sends it back to the third unit, the record processor. Here items are automatically posted on ledger and statement forms, proved and the customer's current balance computed and printed.

The Visible Record Computer is controlled from a console, fourth

(*Continued on page 134*)

Handy & Harman Silver Powder and Flake for Electronic Applications

Among the many forms of silver and silver alloys manufactured by Handy & Harman are:

Fine silver (wire, strip and foil) • Silver anodes and grain for plating • Silver contact alloys • Silver powders • Silver flake, paints and paste • Silver brazing alloys • Silver electronic solders • Silver sintered metals • Solder-flushed silver alloys • Silver chloride and oxide • Coin silver (wire and strip) • Silver bi-metals

The increased acceptance of silver powder and flake in electronic circuitry and components has created a demand for a source that can supply these materials at a consistently high level of quality.

Handy & Harman manufactures silver powder and flake in all types and forms, for use in formulations on printed circuitry and wiring, resistors, condensers, thermistors, printed terminal strips on glass, ceramics or plastic laminates, etc.

If you are working on conductive or resistive coatings where you require excellent electrical conductivity, Handy & Harman will welcome the opportunity to assist you in the choice – or discussion of *any* silver product that may interest you. Write for Technical Bulletin A-4 on Silver Conductive Coatings and Bulletin A-5 on Silver Powder and Flake.

Our technical service and field application experience are at your disposal... we welcome inquiries on products and product problems involving any form of silver.

Your NO. 1 Source of Supply and Authority on Silver Alloys

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Photo shows some of the many electronic parts that can be quickly and thoroughly cleaned with an ultrasonic cleaner.

Selecting an Ultrasonic

Several factors must be considered when buying an ultrasonic cleaner. The information below will help you select the one for your application.

By STANLEY E. JACKE
Chief Product Engineer
Acoustica Associates, Inc.
Plainview, L. I., N. Y.

THE choice of ultrasonic cleaning equipment should be governed not so much by its transducer type as by the intensity of cavitation needed to perform a given task, the cost of the equipment, and its reliability under conditions of rigorous field use. Not all electronic parts require a maximum of energy, in fact delicate parts such as transistors may be damaged unnecessarily by subjecting them to fields of higher intensity ordinarily reserved to remove buffing compounds and other tenacious soils. The uninitiated may be unaware of the fact that there are substantial differences in power level between various ultrasonic cleaners and that care must be exercised in selecting the best equipment for the job.

The potential user of ultrasonics should be certain that he selects equipment and chemicals which perform together to produce the desired result. A purchase based on gallons, watts and dollars with no

Cleaner

cleaning evaluation on the dirty parts themselves can result in serious disappointment. Since the present loose definition of an ultrasonic cleaner can permit a marginally low level of energy in the cleaning tank, most manufacturers have banded together as a committee in the Ultrasonic Manufacturers Association to set up definitions and standards which will protect the potential customer and the future of the cleaning industry. The attached tabulations will be of assistance to members of the electronics industry who are considering ultrasonics for cleaning components and assemblies. Further information can be obtained from the various equipment manufacturers.

General-Purpose Ultrasonic Cleaner

A general-purpose ultrasonic cleaner is one in which the acoustic energy applied to the tank is slightly more than that necessary to reach the "threshold of cavitation." The amount of energy required by the transducers to reach this threshold naturally is dependent on the efficiency of the transducers as well as acoustic properties of the liquid, frequency, temperature, presence of standing waves, and other factors. For example, a 1-gallon cleaner with a vibrating tank bottom area measuring 54 square inches when driven by a 50-watt average, 200-watt peak power pulsed generator will develop roughly 3 watts per square inch on peaks after deducting transducer losses. If the frequency of operation of this unit is in the vicinity of 40 kc or less, enough acoustic energy will be produced in the solution to pass well beyond the "threshold of cavitation." Typical electronic industry applications for such equipment include:

Type Part	Usual Cleaning Vehicle	Comments
Transistor (and diode)	Pure de-ionized water	Thorough ultrasonic cleaning reduces back leakage, eliminates corrosive by-products which cause premature failure.
Electron gun	Water plus ultrasonic detergent	Alcohol rinse may be used to remove water stain following cleaning.
Potentiometer	Water plus ultrasonic detergent	A "must" for good, low-noise potentiometer performance
Printed circuit	½ trichlorethylene ½ alcohol	After dip soldering, whole board is immersed with components affixed to remove excess flux and render "cold joints" visible.

Heavy-Duty Ultrasonic Cleaner

Heavy-Duty ultrasonic cleaners are more powerful versions of light-duty equipment. Power per unit

(*Continued on page* 132)

Eimac Klystron final amplifier at Millstone Hill Radar site.

EIMAC KLYSTRON POWERS VENUS CONTACT— 100 TIMES FARTHER THAN PREVIOUS RECORD!

On February 10 and 12, 1958, a high-power radar of M.I.T.'s Lincoln Laboratory transmitted and received radar signals between Earth and Venus. A round-trip of 56,000,000 miles! This historic event was man's first radio contact with another planet. It was by far the longest man-made radio transmission on record.

The final amplifier tube of this giant radar is a super-power Eimac Klystron, the same used in missile and satellite detection and tracking. Eimac's long experience and leadership in the development and manufacture of ceramic-metal power klystrons enabled the firm to design a super klystron capable of producing tremendous amounts of RF energy at the desired frequency.

In this application, as in tropo-scatter installations throughout the world, Eimac Klystrons have won a reputation for exceptional reliability and long life. Today Eimac manufactures power amplifier klystrons for ultra high and super high frequencies.

The transmitter for Lincoln Laboratory's giant radar was built by Continental Electronics Manufacturing Company. The radar was sponsored and is supported by the Air Research and Development Command of the United States Air Force.

EITEL-McCULLOUGH, INC.

Eimac

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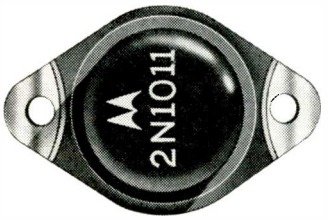
proven reliability for all applications

3 NEW MIL SPEC POWER TRANSISTORS FROM MOTOROLA



For highest reliability in the toughest environments, specify one of these new Motorola germanium PNP, alloy junction power transistors:

TYPE 2N1011 — 3AMP to 80 Volts (meets MIL-T-19500A/67 Sig C)
TYPE 2N1120 — 10AMP to 80 Volts (meets MIL-T-19500A/68 Sig C)
TYPE 2N297A — 3AMP to 80 Volts (meets MIL-T-19500A/36 Sig C)

Immediately available from Motorola's bonded warehouse, these high-voltage units are designed for use in military equipment where semiconductor devices must meet MIL-T-19500 specs—including audio amplifier, power supply and converter applications in aircraft and ground support equipment. Motorola's copper-strap internal construction provides the ruggedness they need for operation under environmental extremes at temperatures ranging from —65°C to +100°C. All are hermetically sealed in an industry standard TO-3 package with type 2N1120 having .052″ pins with solder lugs attached.

Production Quantities available from Motorola stock for immediate delivery. For engineering quantities, contact your nearest Motorola Semiconductor distributor.

WHAT IS YOUR POWER NEED?

Motorola's complete range of industrial power transistors gives you power for every purpose. Three separately designed series offer current handling capacities of 3, 10 and 25 amps...and a wide range of voltage ratings to suit your individual requirements. All of the transistors listed in the adjoining table have welded hermetic seals and meet or exceed mechanical and environmental requirements of MIL-T-19500A.

POWER TRANSISTOR	Maximum Ratings			Typical Electrical Characteristics	
	Type Number	BV_{CBO} volts	BV_{CES} volts	h_{FE} @ I_C amps	
25 AMP TO 100 VOLTS	2N1167*	100	75	25	25
	2N1166	100	75	25	25
	2N1165*	80	60	25	25
	2N1164	80	60	25	25
	2N1163*	50	35	25	25
	2N1162	50	35	25	25
	$T_j = 100°C$				
10 AMP TO 100 VOLTS	2N630*	100	75	18	10
	2N629*	80	60	18	10
	2N628*	60	45	18	10
	2N627*	40	30	18	10
	2N1120*	80	70	20	10
	$T_j = 100°C$				
3 AMP TO 80 VOLTS	2N375	80	60	22	3
	2N618	80	60	35	3
	2N297A	60	50	35	2
	2N1011	80	80	45	3
	$T_j = 100°C$				

*Supplied in TO-3 package with solder terminals.

FOR COMPLETE TECHNICAL INFORMATION regarding Motorola power transistors contact your nearest Motorola Semiconductor regional office:

RIDGEFIELD, NEW JERSEY
540 Bergen Boulevard
WHitney 5-7500
from New York WI 7-2980

CHICAGO 39, ILLINOIS
5234 West Diversey Avenue
AVenue 2-4300

HOLLYWOOD 28, CALIFORNIA
1741 Ivar Avenue
HOllywood 2-0821

OUTSIDE U.S.A. AND CANADA WRITE: MOTOROLA INTERNATIONAL, S.A.
4545 West Augusta Boulevard
Chicago, Illinois

"DEPENDABLE QUALITY - IN QUANTITY"

MOTOROLA SEMICONDUCTORS

MOTOROLA, INC.,
5005 E. McDOWELL, PHOENIX, ARIZONA

Ultrasonic Cleaner Selection

(*Continued from page* 129)

vibrating area ranges from 4 watts per square inch to 20 watts per square inch average power. The higher energy densities are obtained from magnetostrictive transducers or the recently introduced "Multipower" transducers with the former type being more expensive and less efficient in terms of cost per unit tank volume. Typical applications are shown in the following chart.

Type Part	Usual Cleaning Vehicle	Comments
Waveguide structure	Trichlorethylene or caustic solution	Excellent for cleaning inaccessible interiors from without.
Castings	Caustic solution	Removal of mold materials and buffing compounds.
Glassware	Water plus ultrasonic detergent	Fine for stripping off pitch, rouge, polishing compound and unwanted markings on vacuum tubes.

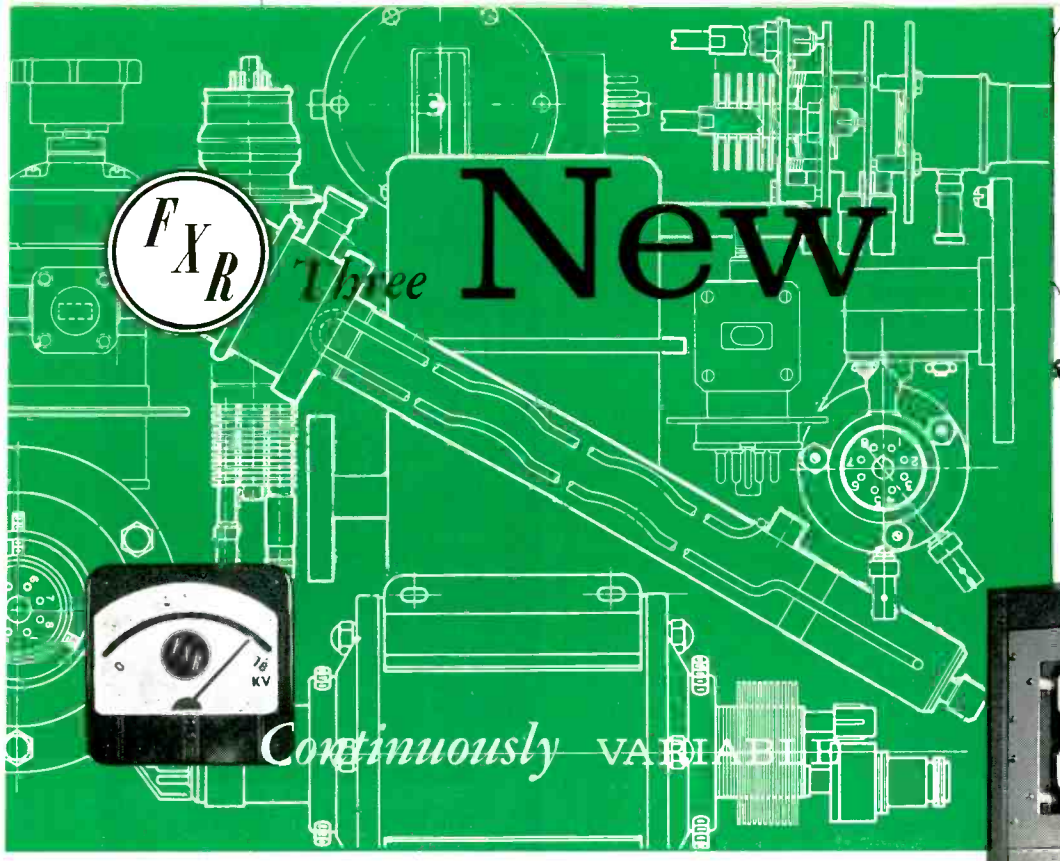
New ITT Laboratories Dedicated at Nutley

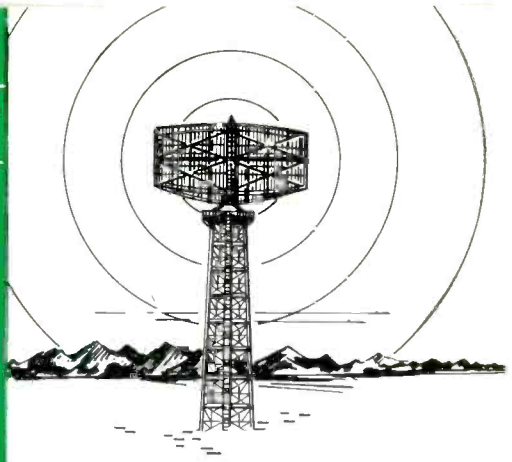
On September 3, Gov. Robt. B. Meyner of New Jersey helped dedicate the latest addition to the chain of ITT Laboratories at Nutley, N. J., headquarters of the group.

Guest speaker at the ceremony was Dr. Edward M. Purcell, Donner Professor of Science, Harvard Univ. Dr. Purcell won the Nobel Prize in 1952 for his part in developing a method of accurately measuring certain nuclear properties. It is known as the magnetic resonance absorption method.

The aluminum-sheathed structure, which adds 100,000 sq. ft. of floor space, provides the most modern equipment for research and development in communication and electronic fields.

Lobby of the new ITT Laboratories Building at Nutley. On the wall is a 3-D, stainless steel and bronze mural representing the propagation of a radio signal's magnetic and electrical fields.





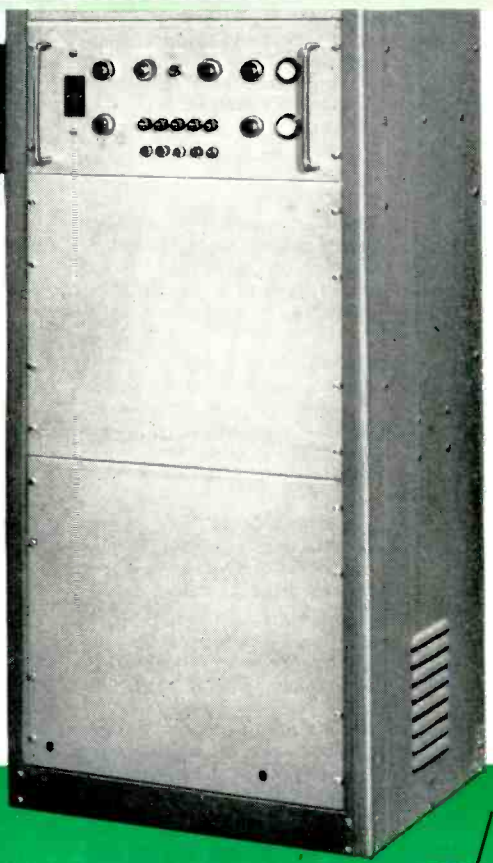
HIGH-VOLTAGE REGULATED POWER SUPPLIES*

- EXCEPTIONAL REGULATION—BETTER THAN 0.1% WITH A 10% FLUCTUATION OF PRIMARY POWER.
- LOW RIPPLE.
- BUILT-IN FOCUS, FILAMENT AND MAGNET SUPPLIES.
- RF INSULATION TECHNIQUES INCORPORATED TO MINIMIZE PICK-UP AND CORONA NOISE.

1 *FXR Model Z850A*
- 0 to 12 KV
- 150 MA
- Ripple, 4 MV

2 *FXR Model Z851A*
- 0 to 10 KV
- 250 MA
- Ripple, 5 MV

3 *FXR Model Z852A*
- 0 to 18 KV
- 1 AMP
- Ripple, 5 MV



shown here, FXR Model Z850A

* Newest representatives of FXR's commercial line of high-voltage power supplies.

FXR, Inc.

formerly F-R MACHINE WORKS, Inc.

DESIGN • DEVELOPMENT • MANUFACTURE

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WOODSIDE 77, N. Y.
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PRECISION MICROWAVE EQUIPMENT • HIGH-POWER MODULATORS • RADAR COMPONENTS • ELECTRONIC TEST EQUIPMENT

FXR pioneers in the design and manufacture of custom and standard high-power pulse modulators.

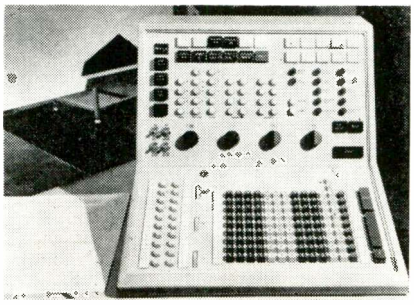
Circle 66 on Inqpiry Card

(*Continued from page* 126)

unit of the system. It consists of program selector knobs, special controls, a panel of lights that displays status of the computer, and a keyboard which permits entry of unusual items if desired.

Individual account information printed in standard type on the face of each ledger is also stored electronically in two narrow magnetic stripes on the back of the form. This enables the machine to read the ledger as well as carry out special instructions also stored in the stripes.

The pair of stripes, performing the same function as magnetic tapes used by other computers for input and storage of data, have a capacity of seven "words" of information. (Computer "word" consists of 12 digits plus sign.) They will contain such information as account number, balance, account activity, check and deposit counts and numerous computer commands.



Computer control console is shown. System requires only one operator.

Computer programs are stored on long-lasting Mylar plastic tapes, which are easily installed on tape readers in the control unit. The system may use up to 12 tape readers, permitting more than 2,500 programming instructions at any one time.

The system utilizes advanced new memory core packets, each with a capacity for storing 10 computer "words." This will permit a bank to tailor capacity of the computer to its individual needs, saving the expense of buying core storage that will not be used. As a bank's requirements grow, the core memory capacity can be increased simply by inserting additional memory packets into the computer. Installation costs are held to a minimum. Specially-built rooms, air conditioning and humidity controls are not required.

Mobot

(*Continued from page* 94)

go through these units and the cable.

The equipment is designed to pick up mechanical components, electrical objects, soldering irons, voltmeters, etc., used in semi-hot radiation testing areas. Normally, equipment which has been irradiated is removed from the irradiation area and transferred by the Mobot to a hot laboratory. Extreme mobility, including the equipment's 3-foot horizontal and 10-foot vertical reach, make it a versatile remote handler in most environments where man cannot, or does not, desire to work because of hazardous conditions.

Two remote-controlled TV "eyes" are provided to take the operator's eyes and mind into the hazardous area. Remote control pan (270 degrees), tilt and focus are provided separately and independent of the two handling arms. Handling arms are hydraulically operated and capable of lifting 150 pounds. A lifting hook is provided on the lift mechanism to handle weights up to 1500 pounds.

Four-speed control with complete steering is provided in the vehicle power assembly. Two separate hydraulic systems are used, one for the lift mechanism and the other for handling arm assemblies. Electro-hydraulic controls especially adapted for this purpose were developed by Hughes Aircraft Company personnel.

The Mobot Mark I is 84 inches high, 36 inches wide, excluding the TV cameras, and 96 inches long wth arms extended. The mobile assembly weighs approximately 4500 pounds.

The first model is the beginning of a family of similar type equipment with sizes ranging from several hundred pounds to 20 tons or more. Future models include applications requiring arm reaches of 50 feet or more.

While the Mobot Mark I is an indoor model, rough terran and outdoor-types may be easily provided.

Tool and machine handling are accomplished by simple, inexpensive custom handles attached to the tool desired. No changes are necessary in the basic grasping assembly.

new!.. ...from Continental Connector

152 CONTACT

CENTER SCREWLOCK CONNECTOR WITH PROVEN RELIABILITY

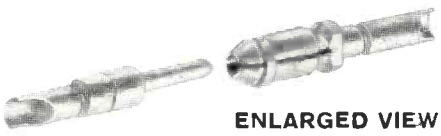
MINIATURE POWER CONNECTORS FOR HEAVY DUTY APPLICATIONS

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, green). The double lead thread action center screwlock and stainless steel channels are extra features that contribute to the rugged construction and performance-proven reliability.

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

ILLUSTRATION SHOWS WIRE WRAP TERMINALS WITH ONE, TWO AND THREE WIRE CONNECTIONS

also available with 104, 78 or 34 contacts



ENLARGED VIEW CLOSED ENTRY CONTACT

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

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

Letters

to the Editor

(*Continued from page* 72)

for example, we close the switch). Then, assuming that the remaining variable of integration is differentiable, the integral takes the following form:

$$h(t) = f(x)\, c(t-x)\Big|_{x=0} + \int_0^t c(t-x)\, f'(x)\, dx,$$

$$= f(0)\, c(t) + \int_0^t c(t-x)\, f'(x)\, dx, \quad t \geq 0.$$

This has the same form as the very important relation given in formula (19), page 234, Gardner and Barnes, "Transients in Linear Systems."

This explanation of the Stieltjes integral has been "oversimplified" to a considerable extent in order to "trap" the unsuspecting reader into getting out his math books and "boning up" on a tool that will be invaluable in the analysis of many systems involving inputs having discontinuities.

Forrest G. Allen
Colonel, USAF (Ret.),
Military Systems
Consultant to Management

References

1. Widder, David V., *Advanced Calculus*, New York, Prentice-Hall, Inc., 1947, Chapter V.
2. Taylor, Angus E., *Advanced Calculus*, Boston, Ginn and Company, 1955, page 532.

Circuit Analyzer

(*Continued from page* 99)

tions are led from test points in the equipment to be checked (normally accomplished when the equipment is built) to connectors which plug into the automatic multiple circuit analyzer. The operator then uses a patchboard to set up the sequence in which the circuits are to be tested. Other controls enable him to set up proper acceptable limits of series resistance and circuit-to-ground resistance for each of the circuits to be checked. He then presses the "Auto" button. The analyzer proceeds to test each circuit in sequence. As the values for any given circuit are measured, a visual numerical indication of the circuit currently being measured

(*Continued on page* 141)

SERIES	10B	20	116-216	117-217	126-226	136-236	1156C-1256C	H-C
AMPERES	1.75	3.0	7.5 3.0	10.0 4.0	12.5 6.0	20.0 9.0	45.0 28.0	200 and up

the NEW 10B SERIES

POWERSTAT® variable transformers

40% INCREASE IN RATING...

NO INCREASE IN PRICE!

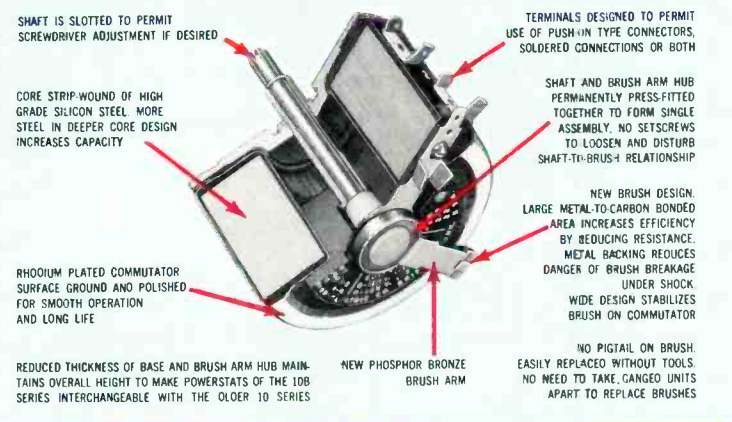
NO INCREASE IN SIZE!

POWERSTATS of the new 10B Series incorporate the most up-to-date variable transformer design refinements to provide the highest ratings and performance characteristics in their price and size range. Separate ratings are given for constant-impedance and constant-current loads to permit maximum utilization of the POWERSTAT. Features include a rhodium-plated commutator surface and space-saving core and coil design. Ruggedly constructed for long life and dependable service. Two- and three-gang assemblies are available for increased ratings and three-phase operation.

TYPE 10B

RATING CHART

INPUT		OUTPUT					
VOLTS	CYCLES	VOLTS	CONSTANT CURRENT LOAD MAX. AMPS.	MAX. KVA	CONSTANT IMPEDANCE LOAD MAX. AMPS.	MAX. KVA	TYPE
SINGLE PHASE							
120	50/60	0-120	1.75	.21	2.5	.30	10B
120	60	0-132	1.75	.23	1.75	.23	
240	50/60	0-240	1.75	.42	2.5	.60	10B-2
240	60	0-264	1.75	.46	1.75	.46	
THREE PHASE							
120	50/60	0-120	1.75	.36	2.5	.52	10B-2
120	60	0-132	1.75	.40	1.75	.40	
240	60	0-240	1.75	.73	2.5	1.0	10B-3



THE SUPERIOR ELECTRIC COMPANY

Bristol, Connecticut, U.S.A.

ADAPTER KITS are available for mounting potentiometers, rheostats, tap switches and other devices to operate in unison with POWERSTAT type 10B. If desired, complete assemblies are furnished with the device already mounted.

SERIES	10B	20	116-216	117-217	**126-226**	136-236	1156C-1256C	H-C
AMPERES	1.75	3.0	7.5 3.0	10.0 4.0	**12.5/6.0**	20.0 9.0	45.0 28.0	200 and up

the NEW 126-226 SERIES

TYPE 126

POWERSTAT® variable transformers

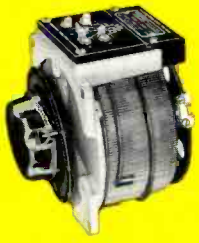
For control applications having

. . . up to 12.5 amperes constant-current loads

. . . up to 18.0 amperes constant-impedance loads

This all-new series rounds out the complete POWERSTAT variable transformer line. The 126-226 series offers open, enclosed, fused, cord-plug and enclosed terminal models; single, two- and three-gang types; manually operated and 5, 15, 30 or 60 second motor-driven assemblies – all available in a new, compact functional design. They incorporate the characteristics inherent in every POWERSTAT: zero wave-form distortion, excellent regulation, high efficiency, conservative ratings, smooth control and linear output voltage.

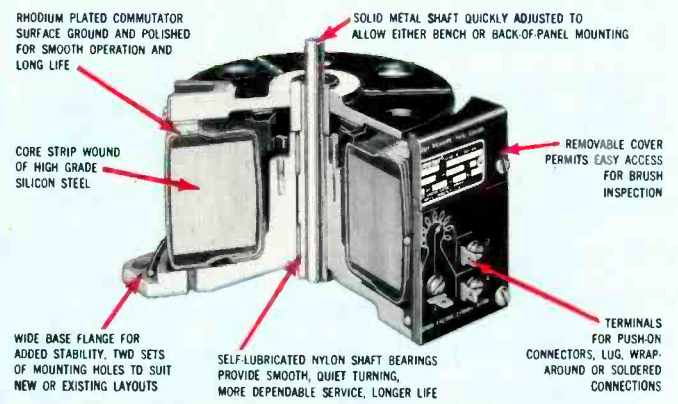
TYPE 3PN126



TYPE 126U

RATING CHART

INPUT VOLTS	INPUT CYCLES	OUTPUT VOLTS	CONSTANT CURRENT LOAD MAX. AMPS.	CONSTANT CURRENT LOAD MAX. KVA	CONSTANT IMPEDANCE LOAD MAX. AMPS.	CONSTANT IMPEDANCE LOAD MAX. KVA	TYPE
SINGLE PHASE							
120	50/60	0-120	12.5	1.5	18.0	2.2	126
120	50/60	0-140	12.5	1.8	12.5	1.8	
240	50/60	0-240	6.0	1.4	9.0	2.2	226
240	50/60	0-280	6.0	1.7	6.0	1.7	
240	50/60	0-240	12.5	3.0	18.0	4.3	126-2
240	50/60	0-280	12.5	3.5	12.5	3.5	
480	50/60	0-480	6.0	2.9	9.0	4.3	226-2
480	50/60	0-560	6.0	3.4	6.0	3.4	
THREE PHASE							
120	50/60	0-120	12.5	2.6	18.0	3.7	126-2
120	50/60	0-140	12.5	3.0	12.5	3.0	
240	50/60	0-240	6.0	2.5	9.0	3.7	226-2
240	50/60	0-280	6.0	2.9	6.0	2.9	
240	50/60	0-240	12.5	5.2	18.0	7.5	126-3
240	60	0-280	12.5	6.1	12.5	6.1	
480	50/60	0-480	6.0	5.0	9.0	7.5	226-3
480	60	0-560	6.0	5.8	6.0	5.8	



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(*Continued from page* 138)

is given. Should the analyzer detect a wiring or insulation error, the circuit designation and type of defect are printed on a paper tape. The analyzer then automatically continues its search.

In addition to its ability to handle 2,000 two-terminal circuits, the analyzer can measure the same values on 800 multi-terminal networks, 400 of which can be relay controlled.

The analyzer uses 28 vdc to measure series resistances from one ohm to 1,000 ohms with accuracies ranging from 20% at the lower value to 1% at 1,000 ohms. It measures leakage resistance at 28 or 500 vdc with 1% accuracy from 100,000 ohms to 500 megohms.

Unusual operator flexibility has been incorporated in the equipment. For instance, rather than automatic analysis, the operator can step from one circuit to the next manually, or he can pre-set to any of the 2,000 positions so that the equipment will start at his chosen circuit and proceed to a programmed step to await special test instructions. Such special instructions might include the feeding in of actual circuit voltages to determine how the circuit reacts under operating conditions.

As a safeguard of the unit's own accuracy, it incorporates a self-checking test which operates after each step. If the analyzer cannot pass its own test, it automatically stops.

The time required for each circuit check is variable from 0.1 to 10 seconds, the longer time being required, for example, in circuits where insulation values may decay with time.

The equipment can be provided to record all circuit numbers and pass reject information on high speed digital magnetic tape recorders when necessary.

Designated Model 501, the unit is the culmination of two years of development by a team of Consolidated Avionics Engineers led by George C. Rabin, the firm's President Harry R. Glixon reported. During that period, earlier versions of the equipment were delivered to several customers in the electronics, aviation and missile industries.

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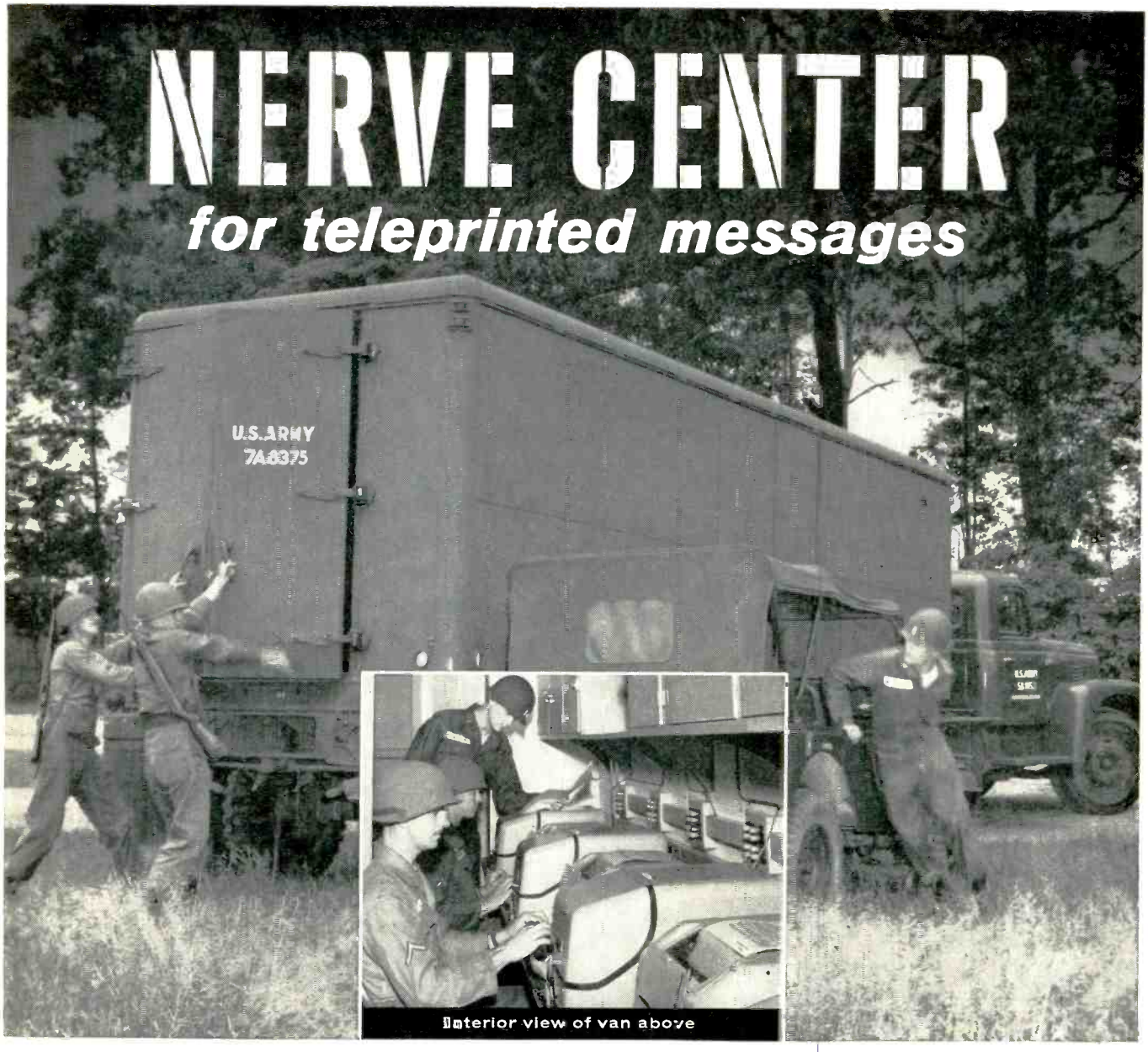

Interior view of van above

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ANTENNAS, PROPAGATION

Traveling Wave Antenna with Resistive Coupling, G. Z. Aizenberg. "Radiotek." June 1959. 14 pp. This antenna was first patented by G. Z. Aizenberg in June 22, 1953 (author's certificate No. 97750). A more complete and as yet unpublished description of its properties is given together with an account of its recent improvements. Graphs of its theoretical and experimentally obtained parameters and a comparison with double rhombic antenna are given. A double traveling wave antenna BS-2 is superior to a double rhombic in its selectivity, mainly due to smaller side lobes, and in the much smaller area which it covers. New formulas for determining directional gain for various radiation patterns of its elements are supplied. (U.S.S.R.)

The External Noise in Antennas for Commercial Radio Installations, W. Kronjager and K. Vogt. "Nach. Z." July 1959. 3 pp. The paper reports on measurements of the frequency distribution of the external noise in antennas for commercial radio installations, covering the frequency band from 2 to 30 Mc/s. (Germany.)

The Satellite Observations and Their First Results for the Knowledge of Radio Propagation, B. Beckmann. "Nach. Z." July 1959. 9 pp. The paper is a reproduction of a speech given at the international annual meeting "Aeronautics and Air Supervision" held at Berlin during the 19-24 May 1958 by the (German) Committee for Radiolocation. In addition to results known from the literature, the observation results of the study group "Satellite Observations" in the section "Ionospheric Problems" are reported. These observation results have been made available by the institutes concerned. A summary is given of the important results from satellite observations for ionospheric research. (Germany.)

Radiation of Four Ultra-Short Wave Programmes from One Aerial. "El. Rund." Aug. 1959. 4 pp. The British Broadcasting Corporation has recently taken a considerable step forward in increasing reception facilities in the ultra-short wave band, the importance of which should not be overlooked in relation to a similar increase in TV reception facilities. A single aerial arrangement used for the radiation of the programmes supplied simultaneously by four ultra-short wave stations. The result is exclusively for the benefit of the listener who up to now has only had the chance to choose between two or three ultra-short wave programmes on the average. (Germany.)

Transmitting Aerials for Television Broadcasting in the United Kingdom, A. Brown. "J. BIRE." July 1959. 11 pp. The development of transmitting aerials for television broadcasting in Band 1 is surveyed. Reference is made to the increase of gain, and to the splitting of the aerial system for increased flexibility and reliability. Aerials having directional radiation characteristics have been required for filling gaps in the service areas of other stations, and giving adequate protection against interference with other services. (England.)

CIRCUITS

Simulation of Saturable Reactor Magnetic Amplifiers, V. P. Gluhkov and E. V. Jakubaitis. "Avto i Tel." July 1959. 8 pp. Conditions of saturable reactor magnetic amplifier are considered. On the basis of the analysis of differential equations there are deduced similarity criteria for amplifiers with serial and parallel connection of a-c windings. Simulation of amplifiers on one and the same model having cores of any electrotechnical steel is shown to be possible. (U.S.S.R.)

Analysis and Synthesis of Certain Electric Circuits by Means of Special Logical Operators, A. D. Talantsev. "Avto i Tel." July 1959. 10 pp. An algebraic theory of the logical operation of some electric circuits is developed. This theory takes into account the time behaviour of circuit processes. (U.S.S.R.)

A Contribution to the Theory of Linear Four-Terminal Networks, O. Heymann. Arc. El. Uber." No. 11, Issue 12. Nov. 1958. 9 pp. The matrix characteristics of general linear quadripoles are investigated. A distinction is made between the transfer matrix and image matrix. The paper ends with matching problems and provides a simple formula for the power gain. (Germany.)

The Scatter Matrix for Multi-Pole Networks, E. Schuon and H. Wolf. "Nach. Z." July 1959. 6 pp. The scatter matrix is defined and its relationship to the properties of the circuit is summarized for multi-pole networks in general. A method of calculating the scatter matrix for the remaining pole pairs of a multiple network, which is partly loaded with resistances, is shown. (Germany.)

Technical High-School-Universal-Mixer for Experimental Purposes, F. Winckel. "El. Rund." July 1959. 7 pp. After a careful study of the sound mixers in broadcasting and television stations, cinemas, record studios, and theatres, a universal stereo 4 channel mixer was built at the Technical University Berlin. All 33 amplifiers of the mixer were built step by step, having unbalanced input and cathode amplifier output. The microphone amplifier is switchable in stages up to 85 dB. Special storage is provided for experimental equipment. Push-button operation is provided throughout. (Germany.)

A New Unsymmetrical Push-pull Amplifier with Extremely Small Internal Resistance, H. Volz. "El. Rund." July 1959. 3 pp. A new push-pull output stage with its properties is described. The triode, otherwise used for the generation of symmetrical voltage, is a part

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electric Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann. de Radio. Annales de Radioelectricite
Bull. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Uebertragung
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 Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR.

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of the push-pull half. Owing to additional positive current feedback and negative voltage feedback, the ensuring gain reserve gives this half an extremely small internal resistance and a small distortion factor. (Germany.)

Stability Problems with Monostable Multivibrators, G. Kosel. "El. Rund." Aug. 1959. 3 pp. The trigger pulses necessary for the operation of monostable multivibrators are obtained in general by differentiation of square pulses. As the trigger pulses must not be below a certain minimum amplitude, the influence of the time constants on the pulse amplitude is examined first of all. The second part of the article deals with a problem of frequency dependence of the output pulse width. A stable circuit is demonstrated by results. (Germany.)

Two Amplifiers Using Cathode Follower Output Stages, R. Geffre. "Toute. R." No. 232. Jan. 1959. 5 pp. Directions are given for the design and construction of two high fidelity audio-amplifiers; one with output power of 8W, the second with 25W. (France.)

Power Amplifiers, J. Riethmuller. "Toute. R." No. 232. Jan. 1959. 6 pp. The author discusses advantages and disadvantages of the various coupling elements used in the construction of power amplifiers. (France.)

An Analogical Approximation Method, J. Paquet. "Cab. & Trans." July 1959. 5 pp. The paper relates to an electrical analogy method for solving in a simple way certain approximation problems. This method, based on the extension of a similar resolution process used for linear equation systems, has been especially applied to an approximation problem relating to the impedance of a two-terminal network. (France.)

On a Four-Terminal Network Transformation, J. Oswald. "Cab. & Trans." July 1959. 9 pp. The paper is a study of a transformation through which there may be derived, from given four-terminal network, a new one having different and to some extent complementary properties. The wave impedance of the network behaves as an invariant quantity (among others) in the transformation. It results therefrom that any antisymmetrical four-terminal network transforms into another network of the same type. (France.)

Approximation and Synthesis of Two-Terminal Networks, H. Debart. "Cab. & Trans." July 1959. 7 pp. The two-terminal network synthesis method proposed by the author is the following: assuming a positive real function, rational or not, to be known and to behave in the selected frequency band in the same way as the desired two-terminal impedance, a satisfactory approximation of such a function is obtained in the form of the impedance of a network made up of several sub-networks with a minimum number of elements which can be synthetized by an already known procedure. (France.)

Constant Impedance Amplitude Equalizers, J. Bimont. "Cab. & Trans." July 1959. 31 pp. The constant impedance amplitude equalizers dealt with in this paper are bridged-T's with reciprocal and purely reactive arms of the nth degree or those derived therefrom by inserting a series resistance in the bridging arm or a shunt resistance in parallel connection with the shunt arm. (France.)

COMMUNICATIONS

Signal Envelope Distortion by Keyed Detectors of Sinusoidal Voltages, V. M. Ravikovich. "Radiotek." June 1959. 11 pp. A synchronous phase sensitive detector in which both the commutating and signal voltages are purely sinusoidal is here called a keyed detector. The detector works with a double triode whose two halves are connected in parallel opposing. Expressions for the values of the signal envelope lag and output ripple voltage were obtained by means of equivalent circuits, and confirmed experimentally. It is shown that the voltage of lag and the output ripple swing voltage are inversely proportional. On the basis of these investigations an instrument was constructed whose output voltage was proportional to the angle of rotation of a shaft with a to and fro movement. The carrier frequency used was 6 kc that of the envelope was 0.5 cps. (U.S.S.R.)

Sporadic Ionization of the E-layer Above Lindau/Harz During the Last Years, W. Becker. "Arc. El. Uber."—No. 11, Issue 12. Nov. 1958. 7 pp. The data evaluated in this paper comprise the time from August, 1957, to July, 1958. The statistical investigation revealed a dependence of the intensities on the time of the day and the year, with maxima around summer and noon time. About every fifth noon, tide record presents at least two E-traces. Three E-traces were observed most frequently during noon-tide in winter. (Germany.)

Telegraphy Transmission in the Shortwave Range, H. H. Voss and H. J. Neumann. "Nach. Z." July 1959. 5 pp. The paper contains a survey on the types of telegraphy used so far in the short-wave range. Subsequently, the operational methods preferably used at present for teleprinter traffic, i. e. frequency shift keying and VF-telegraphy systems utilizing single side band transmission, are compared with one another. (Germany.)

New Isolators for Radio Links, J. Deutsch et al. "Nach. Z." July 1959. 4 pp. New resonance type isolators have been developed for use in frequency modulated radio links for 960 channels in the 4000 Mc/s band, 1800 channels in the 6000 Mc/s band and 120 channels in the 7000 Mc/s band. Newly acquired knowledge in physics has been applied. This has made it possible to obtain, in comparison with earlier designs, higher ratios of reverse to forward attenuation (up to 150:1) and an increased stability against temperature effects. (Germany.)

Stereophonic Sound in the Cinema, Real and Artificial Methods, G. Grau. "El. Rund." July 1959. 7 pp. Whereas the record industry and presumably also the broadcasting companies, achieve the stereo effect by the binaural method, wide-screen film uses 3 and 5 channel systems, to provide the acoustical background. Aural directivity plays a large part here and the significance of the cinematic "effects" channel is dealt with, from the point of view of comparison with the technically "genuine" system. Mention is made of the conflict of the two systems resulting in general delay in adoption of a standard system. (Germany.)

Parallel Operation of Several Feed Systems in Micro-Wave Generators with Closed Operating Space, W. Schmidt. "El. Rund." Aug. 1959. 3 pp. Constant current magnetrons with output power of some kilowatts are currently available. If units of higher output are to be built parallel operation of the magnetrons is necessary. With separate feed systems there is no mutual influence of power coupling between the magnetrons. (Germany.)

Sound and Television Broadcasting on the CCIR Conference in Los Angeles, H. Rindfleisch. "El. Rund." Aug. 1959. 3 pp. The report of the XI. Plenary assembly (2.29.4.-1959) deals above all with the results gained by the commissions X (sound broadcasting) and XI (television broadcasting). (Germany.)

Extension to 12 Mc/s of the Frequency Band Transmitted on 2.6/9.5 mm Coaxial Pairs, F. Job and M. Toutan. "Cab. & Trans." July 1959. 12 pp. The steadily growing demand for long-distance telephone facilities has led the French P. T. T. Administration to consider the extension of the channel capacity of coaxial cables. (France.)

COMPONENTS

Polarized Relay Vibration Regulating Unit for Pneumatic Actuators, N. S. Gorskaya and B. I. Myzin. "Avto i Tel." July 1959. 7 pp. The paper deals with the polarized relay vibration regulating unit for pneumatic actuators. (U.S.S.R.)

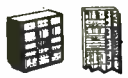
Magnetic Circuit Analysis of High-Speed Relay MS1 Type, K. Kassenberg. "Prace. ITR." Vol. 3, No. 1 (7). 32 pp. In the high-speed relay MS1 type an original magnetic circuit with an auxiliary pole shoe has been applied. Owing to this a considerable increase of force acting on the armature is attained, while relatively small dimensions of the latter have been maintained. (Poland.)

High Speed Miniature Telephone Relay, St. Witulski, and A. Jastrzebski. "Prace. ITR." Vol. 3, No. 1 (7). 24 pp. A description is given of a telephone relay in which magnetic flux is conducted to the main air gap via the armature and a pole shoe, the latter constituting a magnetic resistance shunting the magnetic resistance of the armature. (Poland.)

Electrical Equivalent Circuits and Vibration Pattern of Bariumtitanate Transducers, H. Leisterer. "Arc. El. Uber." No. 11, Issue 12. Nov. 1958. 12 pp. From the piezo-electric equations electrical equivalent circuits are developed for bariumtitanate ceramic cubes. The uni-axial case leads to the resonance frequencies and the vibration pattern of the slender plate; the bi-axial case to the thin walled tube. The electrical equivalent circuits are distributed lines with constant frequencies and frequency dependent phase velocities, respectively. (Germany.)

The Total Excursion Resistor, A New Concept, R. H. Burkett. "El. Eng." July 1959. 5 pp. The increasing demand for electronic equipment to give reliable operation over long periods has made it necessary to examine the behavior of resistors when loaded for several years. Certain types of film resistor have controlled and predictable characteristics so that it is possible to guarantee that such resistors will hold their tolerance over several years of continuous use. Thus a resistor may be supplied to be within a guaranteed "Total Excursion" which will include selection tolerance and all changes tending to cause the resistor to vary from its nominal resistance. (England.)

Approximate Methods for Calculating the Behavior of Square Loop Magnetic Cores in Circuits, D. A. H. Brown. "El. Eng." 4 pp. July 1959. The switching time in a square loop magnetic material is inversely proportional to the excess of driving m.m.f. over the coercive m.m.f. This well-known result is combined with the m.m.f. equation to calculate the switching time and secondary current when the core has a loaded secondary winding. (England.)



COMPUTERS

The Analog Computer Set Up Procedure for Solving Linear Differential Equations with Variable Coefficients, J. Matyash. "Avto i Tel." July 1959. 9 pp. Two methods of solving variable coefficients linear differential equations of the type (1) on analog computers are described. The methods are illustrated with examples. (U.S.S.R.)

DELCO RADIO

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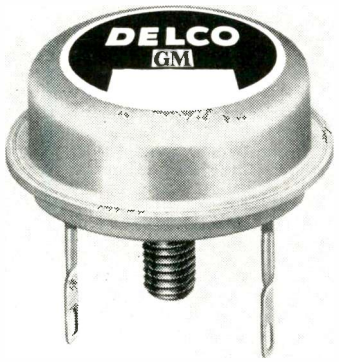

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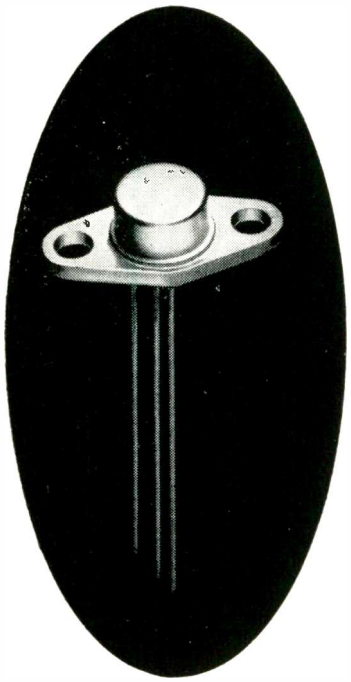

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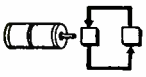
International ELECTRONIC SOURCES

Transistor Circuits for a 1 Mc/s Digital Computer, J. Krajewski. "El. Eng." July 1959. 5 pp. The requirements of amplifiers used for pulse regeneration are considered and blocking oscillators and regenerative amplifiers employing transistors suitable for reshaping and retiming pulses in a digital computer with a 1 Mc/s digit rate are described. Some details of their practical application are given. (England.)

An Analogue Computer for the Prediction of Acoustic Propagation in the Atmosphere, F. A. Key and W. G. P. Lamb. "El. Eng." July 1959. 5 pp. An analogue computer designed to enable the prediction of acoustic propagation conditions in the atmosphere is described. Data concerning the variations of air temperature and wind velocity with altitude are fed to the computer and ray patterns representing acoustic propagation in any required direction are presented on the screen of a cathode-ray tube. (England.)

A Negative Resistance for D. C. Computers, P. V. Indiresan. "J. BIRE." July 1959. 10 pp. A d.c. negative resistance suitable for use in analogue computers is described. The circuit uses two transistors and eight resistances and is compensated against unbalance in the two transistors. (England.)



CONTROLS

Optimum Laws for Electric Drive Control, Yu P. Petrov. "Avto i Tel." July 1959. 8 pps. There are considered optimum laws for the electric drive control which provide maximum productivity when heat limitations are known. The optimum control laws are determined for different forms of dependence of the motor magnetic flow on the anchor current and of the resistance torque on the rotative speed. (U.S.S.R.)

Concerning Determination of Parameters of Feedback of Vibration Regulator of Electric Motor Rotation Speed, L. L. Rotkop. "Avto Tel." July 1959. 10 pps. The paper deals with the determination of parameters of the stabilizing feedback of the vibration regulator of electric motor rotation speed. (U.S.S.R.)

Nomograms for Analysis and Synthesis of Automatic Stabilization Systems, P. S. Matveew and V. N. Plotnikov. "Avto i Tel." July 1959. 5 pps. Desired log amplitude characteristic nomograms are given. The said nomograms can be used in analysis and synthesis of automatic control systems. (U.S.S.R.)

On Transfer Function of Induction Two-Phase Motor, V. G. Kutvinov. "Avto i Tel." July 1959. 11 pps. Peculiarities of determining the transfer function coefficients of the motor with amplitude and frequency modulation are considered. Engineering techniques of determining the transfer function are proposed. Influence of the motor controlling characteristic non-linearity on the transfer function is analyzed. (U.S.S.R.)

Use of Nonlinear Compensation Key-Type Devices to Improve the Quality of the Second-Order Automatic Control Systems, S. V. Emeljanov. "Avto i Tel." July 1959. 17 pps. The paper deals with the problem of stabilizing and improving the quality of the second-order automatic control systems by means of nonlinear compensation key-type devices. (U.S.S.R.)

Criterion of Control Inaccuracy, H. V. Ruubel. "Avto I Tel." July 1959. 4 pps. Criterion of control inaccuracy is theoretically well-grounded which makes it possible to objectively compare various automatic control systems. (U.S.S.R.)

Calculation of Saturable Reactor D-C Motor Characteristics, D. A. Alenchikov and F. X. Kulebakin. "Avto i Tel." July 1959. 10 pps. The method of calculation of saturable reactor d-c motor (1) is developed. The method is based both on use of current-voltage characteristics of the saturable reactor load current-voltage characteristic family. (U.S.S.R.)

Calculation of Periodic Operation Conditions in Automatic Control Relay Systems, Yu. J. Alimov. "Avto i Tel." July 1959. 7 pps. Accurate methods of analyzing periodic operation conditions are applied to automatic control systems which consist of relay part, linear units and of inertialess functional generators when latter are not included in additional feedbacks. (U.S.S.R.)

Equipment for Automatic Control of Thermal Processes, Hermann Ragnar Eggers. "AEG Prog." #3, 1958. 2 pps. Essential factors in the development and application of automatic control to thermal processes are discussed. (Germany.)

The Large Swing-Coil Regulator, Erwin Samal. "AEG Prog." #3, 1958. 12 pps. The large swing-coil regulator is a controller with continuous action for industrial process work. The controlled condition is sensed electrically; the output pneumatic or electric. The instrument can be set to have proportional, proportional-integral or proportional-integral with derivative action. Operation, construction and characteristics, and some applications, are described. (Germany.)

GENERAL

On Properties of Impulsive Responses of Varying-Parameter Systems, V. Borsky. "Avto i Tel." July 1959. 8 pp. A certain class of functions of two variables and the use of their properties to the determination of linear differential equation for a given impulsive response, and the problem inverse of that are discussed. (U.S.S.R.)

Reproduction of Sinusoidal Signals by the Restriction System, G. A. Nadzhafova. "Avto i Tel." July 1959. 6 pp. Conditions of partial and full non-reproducibility of the sinusoidal signal are considered, that is, limiting frequency characteristics of the typical second-order systems are determined. (U.S.S.R.)

Influence of Noise on Synchronous Filter-Generator Operation, A. M. Luchuk. "Avto i Tel." July 1959. 7 pp. Operation of a synchronous filter-generator with an input sinusoidal noise is analyzed. Results of the experimental treatment of noise-stability of the telecontrol device with synchronous filter-generators are described. (U.S.S.R.)

General Condition of Extremum of Given Function of Mean-Square Error and of Mathematical Expectation Square of Error of Dynamic System, N. J. Andreev. "Avto i Tel." July 1959. 6 pp. There is deduced the condition of the extremum, of the maximum or minimum values of a certain function f, of the mean-square error and of the mathematical expectation square of the error of approximating the random function. (U.S.S.R.)

Analysis of Pulse Signals, S. Judycki. "Roz. Elek." Vol. 5, No. 1. 50 pp. The paper discusses methods of calculating the quantities of signals for different combinations of arranging pulses in a signal with relation to the number of pulses in the signal and the number of pulses with specific qualities, on the basis of the permutation, variation and combination calculus. (Poland.)

The Submarine Telephone Cable Between Marseille and Algiers, M. R. Sueur et al. Bull. Fr. El. No. 96. Dec. 1958. 32 pp. A detailed description is provided by a number of authors of the problems associated with the design and construction of submarine cables. The final chapters are devoted to the problem of the cable laying from Board of ships. (France.)

Phenomena of Thermo-nuclear Fusion Which are of Particular Interest for Electronic and Vacuum Engineers, R. R. Warnecke. Vide, No. 75. May-June 1958. 24 pp. This article is a thorough treatise of thermo-nuclear fusion phenomena. (France.)

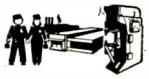
The Wind Driven Power Supply for the SHF Radio Relay Station Schoneberg (Eifel) and Experiences Made with This Supply, G. Rosseler. "Nach Z." July 1959. 9 pp. As a rule, mains supply with a Diesel-generator stand-by is used for supplying power for microwave relay stations. The installation and the maintenance of high voltage lines frequently causes excessive costs in regions with a mains supply network having wide meshes or in mountainous regions. For this reason the Federal German Post Office has made a test extending over several years in order to solve the question in how far the power supply for a decimetric radio repeater station can be ensured independent from the mains supply and with a minimum of use of the stand-by equipment. The means and the conditions for a successful result of the test are mentioned. (Germany.)

Stereophony on the Disc, H. Redlich. "El. Rund." Aug. 1959. 4 pp. The only systems suitable for stereophonic recording on discs are those which contain both stereo channels in a single groove. The internationally standardized two-component recording is such a system. The article deals with the principles of this technique as well as the design and operation of the stereo stylus and stereo pick up. (Germany.)

An Image Convertor Equipment for the Observation of Self-Luminous Gaseous Discharges, K. G. Beauchamp and A. J. Tyrrell. "El. Eng." July 1959. 6 pp. A high speed camera unit using a pulsed image convertor tube is described. Methods of gating this tube at potentials up to 20kV are detailed and the advantages of deflecting the electronic image across the tube face are discussed. A considerable reduction in the bulk and complexity of an image convertor equipment is made possible by using a permanent magnet for focusing the tube and the equipment described includes a focusing unit of this type. (England.)

Ultraharmonic and Subharmonic Resonance in an Oscillator, B. R. Nag. "J. BIRE." July 1959. 6 pp. Different order subharmonic and ultraharmonic resonance curves for an oscillator with a cubic non-linearity are obtained theoretically by van der Pol's method. Their distinctive features are discussed. Experimental results obtained with the help of an electronic differential analyser are compared with the theoretical curves. (England.)

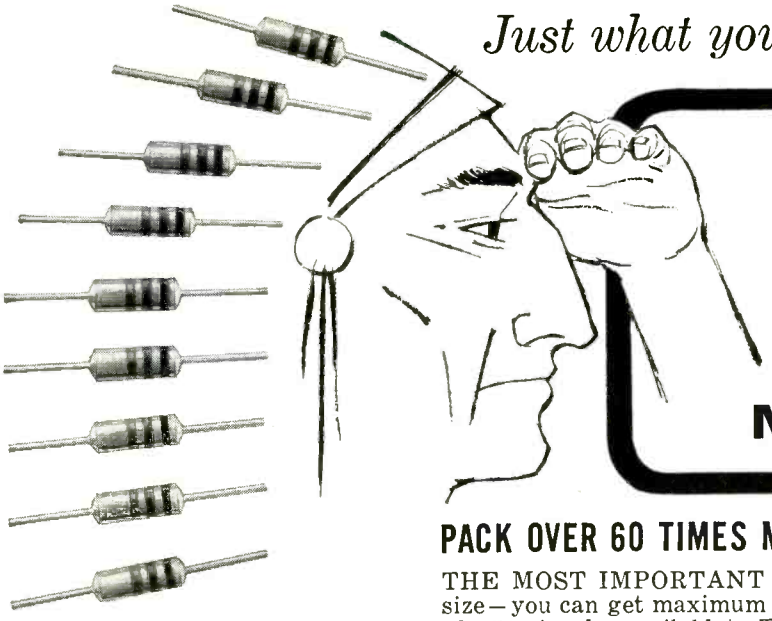
Photo-Electric Image Techniques in Astronomy, B. V. Somes-Charlton. "J. BIRE." July 1959. 19 pp. The underlying scientific principles of light detectors such as the human eye, photographic emulsion or photo-electric device, are explained and their quantum efficiencies compared in terms of signal/noise ratio. Television techniques can be applied to aid astronomical observations and help to overcome, in some measure, the fundamental problems in observing celestial objects through the semi-transparency of the Earth's atmosphere. The television techniques in the detection of threshold and extremely low light level stellar and planetary images are described. (England.)



INDUSTRIAL ELECTRONICS

Design Factors for Industrial Cold-Cathode Timers, J. F. Young. "El. Eng." July 1959. 4 pp. The accuracy of timers is determined by the stability of the components and by the variations of circuit voltages. An optimum design exists if a pre-ignition current is required by the cold-cathode trigger tube. A simpler timer can only be used to control heating loads accurately over a limited range

Just what you're looking for!



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MINIature! **STAB**le!

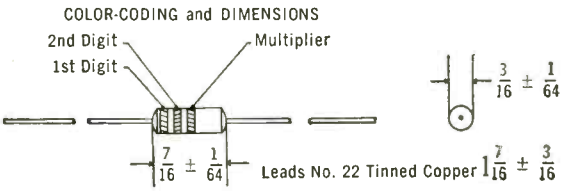
PACK OVER 60 TIMES MORE INDUCTANCE IN THE SAME SPACE!

THE MOST IMPORTANT ADVANCE IN DECADES! Now—in miniature size—you can get maximum inductance to 1000 μh *(more than 60 times the 15 μh previously available)*. The revolutionary MINI-STAB line supplements the Jeffers Type 101 Inductor line to provide you with *stable* inductance values from 0.15 to 1000 μh!

MINIATURIZATION WITHOUT LOSS OF STABILITY! Jeffers MINI-STAB inductors give you both stability and miniaturization.

Miniaturization is achieved through more efficient use of coil winding space.

Stability comes from using an open magnetic circuit as obtained with a conventional powdered iron coil form.



PART NUMBER	INDUCTANCE (Microhenries)	MEAS. FREQ. (MC)	Q MIN.	SRF MIN. (MC)	D.C. RES. MAX. at 25°C (OHMS)	CURRENT RATING (MA)	COLOR-CODING 1st	2nd	3rd
1311-1	18 ± 10%	2.5	50	25	1.8	315	BRN	GRY	BLK
1311-2	22 ± 10%	2.5	50	24	2.0	300	RED	RED	BLK
1311-3	27 ± 10%	2.5	50	20	2.8	255	RED	VLT	BLK
1321-1	33 ± 10%	2.5	50	19	2.5	270	ORG	ORG	BLK
1321-2	39 ± 10%	2.5	50	18	3.0	245	ORG	WHT	BLK
1321-3	47 ± 10%	2.5	50	17	3.5	225	YEL	VLT	BLK
1321-4	56 ± 10%	2.5	50	15	4.2	205	GRN	BLU	BLK
1321-5	68 ± 10%	2.5	50	14	5.0	190	BLU	GRY	BLK
1321-6	82 ± 10%	2.5	50	12	5.5	180	GRY	RED	BLK
1321-7	100 ± 10%	2.5	50	11	6.0	170	BRN	BLK	BRN
1321-8	120 ± 10%	0.79	50	9.0	7.0	160	BRN	RED	BRN
1321-9	150 ± 10%	0.79	50	8.6	8.0	150	BRN	GRN	BRN
1321-10	180 ± 10%	0.79	50	8.0	9.0	140	BRN	GRY	BRN
1321-11	220 ± 10%	0.79	50	6.6	10.0	130	RED	RED	BRN
1331-1	270 ± 10%	0.79	45	4.0	6.8	165	RED	VLT	BRN
1331-2	330 ± 10%	0.79	45	3.6	7.4	155	ORG	ORG	BRN
1331-3	390 ± 10%	0.79	45	3.4	10.6	130	ORG	WHT	BRN
1331-4	470 ± 10%	0.79	45	3.1	11.5	125	YEL	VLT	BRN
1331-5	560 ± 10%	0.79	55	2.9	15.2	110	GRN	BLU	BRN
1331-6	680 ± 10%	0.79	50	2.6	17.0	105	BLU	GRY	BRN
1331-7	820 ± 10%	0.79	50	2.4	19.0	100	GRY	RED	BRN
1331-8	1000 ± 10%	0.79	45	2.2	21.3	90	BRN	BLK	RED

TYPICAL CHARACTERISTICS OF INDUCTOR DESIGNS BASED ON 1000 UH VALUE

INDUCTOR CHARACTERISTICS	JEFFERS MINI-STAB DESIGN	CONVENTIONAL DESIGNS	
		MINIATURIZED*	NON-MINIATURIZED
MINIATURIZATION (WT. IN GRAMS)	1.0	0.5 to 2	2 to 10
STABILITY OF INDUCTANCE WITH TEMP. —55 to +125°C	± 2%	± 10%	± 2%
WITH APPLIED CURRENT (ZERO to 90 MA)	— 1%	— 30%	NIL
WITH APPLIED VOLTAGE (TEST OR SIGNAL)	GOOD	POOR	GOOD

*UTILIZING CLOSED MAGNETIC CIRCUITS SUCH AS TOROIDS, CUP-CORES, ETC.

The MINI-STAB design is in contrast to conventional inductor designs in which miniaturization is usually achieved at the sacrifice of stability (i.e., inductor designs of the closed magnetic circuit type such as toroids, cup cores, etc., tend to be inherently unstable). A comparison of these inductor characteristics is presented in the chart at the left.

MINI-STAB Inductors can be furnished as being capable of meeting requirements of MIL-C-15305A. (Details on request.)

JEFFERS ELECTRONICS DIVISION
SPEER CARBON COMPANY
Du Bois, Pennsylvania

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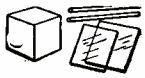
International ELECTRONIC SOURCES

of supply voltage, but by adding a step function to the timing wave, the range can be greatly increased. (England.)



MATERIALS

Temperature Coefficients of Mn-Zn Ferrites Permeability, A. Braginski, J. Kulikowski, and S. Makolagwa. "Prace. ITR." Vol. 3, No. 1 (7). 37 pp. The need has been discussed of elaborating new home-produced ferrite materials having small temperature coefficient of initial permeability. (Poland.)

MEASURE & TESTING

Non-Contact Method for Measuring Resistivity and Geometric Dimensions by Means of Eddy Currents, V. P. Grabovetsky. "Avto i Tel." July 1959. 9 pp. There is considered the non-contact method for measuring electric resistivity of non-magnetic materials and geometric dimensions of massive samples of such materials. (U.S.S.R.)

Inductive Transmitters for Flow, Pressure and Water Level, Johannes Strobel and Karl-Heinz Zeitz. "AEG Prog." #3, 1958. 5 pp. Construction, circuits and operation of inductive transmitters for remote indication of rotary and linear displacements, such as used in the measurement of pressure, flow and liquid level, are described. (Germany.)

Electronics as Basis of Automatic Analysis in Chemical Industry and Power Plants, H. Fuhrmann. "El. Rund." July 1959. 3 pp. Industrial analysis has moved more and more from laboratory conditions and is now applied at the final stage of the production process. The application of modern measuring methods in connection with electronics renders possible analysis in combination with registration and control. (Germany.)

Quasi-Logarithmic Pulse Indication with Transistors, T. Friese. "El. Rund." Aug. 1959. 3 pp. By the use of three simple monostable toggle circuits connected in series the quasi-logarithmic indication of an American ratemeter is ambiguous at several points. (Germany.)

Coding and Sequential Sampling Plan, J. A. Ville. "Cab. & Trans." July 1959. 8 pp. In this paper the author explains, by means of a simple example, the meaning of the term sequential sampling, by which a statistical sampling method is to be understood, in which examination of a lot of objects to be sampled is effected on successive samples of variable size, the full sampling plan being applied only when successive examination of the sampled objects does not first reveal such a number of defective ones as to justify the rejection of the whole lot. (France.)

A New Thermistance Vacuum Gauge, D. A. Degras and P. Andrieux. "Vide." March-April 1959. 14 pp. (France, in English.)

The Use of Pre-pulse Techniques in High-Speed Oscillography, F. E. Whiteway. "J. BIRE." July 1959. 11 pp. The recording of single transients of very short rise time and duration has necessitated the development of ultra-high-speed oscilloscopes. It is shown how the high-frequency range of conventional oscilloscopes and associated amplifiers can be extended by switching them into operating conditions of high current for only very short part of the duty cycle. (England.)

RADAR, NAVIGATION

Certain Theoretical Potentialities of an Automatic Direction Finder, Yu. A. Erukhimovich. "Radiotek." June 1959. 6 pp. The author proposes displaying the radiation pattern by developing its wave into even harmonics, which are scanned by the fundamental obtained from a nondirectional antenna. Owing to the method of scanning and connecting directional aerials adopted, gain equalization in the two directional channels is no longer required and it becomes possible to use a narrow frequency band thus improving the signal to noise ratio. The direction and the sense of the signal are obtained simultaneously, and the signal amplitude is maintained constant by means of a large automatic gain control. The new method of determining the sense of the signal can be applied to conventional two-channel direction finders. (U.S.S.R.)

SEMICONDUCTORS

Stability of Tuned Amplifiers with Junction Transistors in a Common Base and Common Emitter Connections, E. F. Vorob'eva. "Radiotek." June 1959. 7 pp. The object of this paper is to obtain conditions for avoiding self-oscillations and an expression for the mistuning when the negative input conductance is maximum in a more graphical and easily applicable form for design purposes. An expression for the stability of such an amplifier is obtained and in the case of a common emitter connection, confirmed experimentally. In the case of the common emitter connection above mentioned mistuning is negative and is above the transmission range of the loading circuit. In the case of the common base connection it is positive for the loading circuit and negative for the output circuit. (U.S.S.R.)

Design of Automatic Gain Control in Transistor Amplifiers, E. P. Dement'ev. "Radiotek." June 1959. 6 pp. General formulas providing the voltage gain of a stage and the limits of its variation are given for any transistor connection: with a common base, a common emitter or a common collector. Tables and graphs facilitating calculations are included. The design of multistage amplifier with automatic gain control is examined. (U.S.S.R.)

Transistor-Magnetic Amplifiers, O. A. Kossov. "Avto i Tel." July 1959. 4 pp. There is described a simple-transistor magnetic amplifier with switching transistors. (U.S.S.R.)

Transistors in Pulse Operation, T. Jankowski. "Roz. Elek." Vol. 5, No. 1. 42 pp. Problems connected with large signal driving of transistors working in digital computers are discussed in this paper. Time relations between input and output currents are given and compared with experimental results, as well as the dependences between voltages and currents resulting from the solution of the diffusion equation. (Poland.)

Lag in p-n Junction Diodes by Full Modulation with Sine Voltages, W. Heinlein. "Arc. El. Uber." No. 11, Issue 12. Nov. 1958. 4 pp. The two zones of a p-n junction diode in the conducting range as neutral emitters in the blocking range is stored in the path. The collection of the stored charges gives rise to a dynamic reverse current and causes the blocking lag. This concept was quantitatively confirmed. (Germany.)

Examination of Cross-Modulation Behavior of HF-Transistors, H. Lotsch. "El. Rund." Aug. 1959. 5 pp. The present article deals with the physical principles of cross-modulation and examines them especially relating to the transistor. After a description of different measuring methods transistor parameters important for the cross-modulation of the transistor are discussed and the influence of the internal resistance of the signal source is considered. (Germany.)

Semiconductor Diodes and Rectifiers Available in Great Britain. "Brit. C. & E." May 1959. 8 pp. This chart summarizes the main characteristics of the products of representative British manufacturers. Reference should always be made to the manufacturers' published data when diodes or rectifiers are chosen for particular applications: this chart is only intended to be a general guide to the range of types available. (England.)

Semiconductors — Some Fundamental, N. L. Harris. "Brit. C. & E." May 1959. 6 pp. (England.)

Semiconductors—The World Position 1, C. C. Gee. "Brit. C. & E." May 1959. 4 pp. (England.)

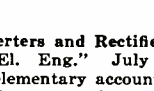
British Transistor Manufacture—A Report of Progress, A. R. Boothroyd. "Brit. C. & E." May 1959. 3 pp. (England.)

Transistors Available in Great Britain, "Brit. C. & E." May 1959. 8 pp. This chart summarizes the main characteristics of the products of representative British manufacturers. Reference should always be made to the manufacturers' published data when transistors are chosen for particular applications; this chart is only intended to be a general guide to the range of types available. (England.)

A Survey of Semiconductor Photo-Sensitive Devices, J. Tyndall. "Brit. C. & E." May 1959. 5 pp. Many of the newer semiconductor photocells that are now being produced are more than 20,000 times as sensitive as the earlier photo-emissive types. This article surveys the trends of development and lists the characteristics of the numerous photo-sensitive devices that are currently available in Great Britain. (England.)

Semiconductor Diodes, Report on the Present State of Development, R. W. A. Scarr. "Brit. C. & E." May 1959. 3 pp. During the last twelve years, technical developments have led to a much fuller understanding of how a diode works and, no less important, how to prepare and purify the materials from which it is made. This survey is concerned only with devices made from germanium and silicon, as progress with these materials has been most rapid during the period under review. (England.)

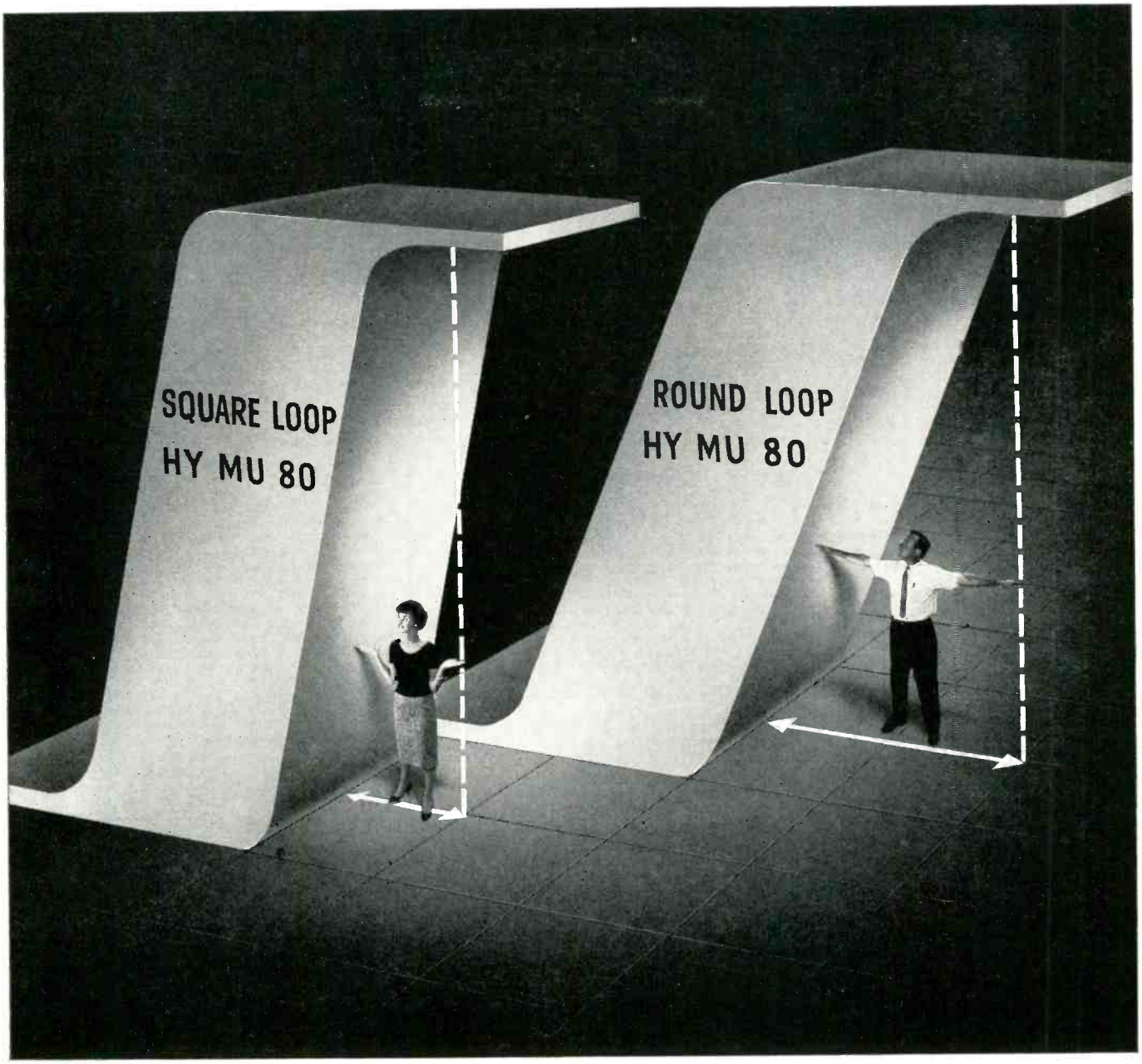
Transistor Inverters and Rectifier-Filter Units, F. Butler. "El. Eng." July 1959. 7 pp. Following an elementary account of the theory of transistor invertors, details are given of two practical designs suitable for operation from a 12-volt supply. One of these is a symmetrical push-pull circuit incorporating some refinements to improve the output waveform. The other employs four transistors in a bridge connection which is adaptable to give a very high output power. (England.)



TELEVISION

Transmission Problems of NTSC System, H. Schoenfelder. "Arc. El. Uber." No. 11, Issue 12, Nov. 1958. 13 pp. The paper discusses cross talk interferences between luminescence and chrominescence. An analysis is provided of those circuits which provide transfer and distribution of NTSC signals. The limitations of these circuits are studied. (Germany.)

Closed Circuit Television for Nuclear Applications, W. Jones. "El. & Comm." Aug. 1959. 3 pp. (Canada.)



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SOURCES

TRANSMISSION

Pulse Current Losses in Conductors, D. E. Bakman. "Radiotek." June 1959. 9 pp. The article provides general formulas with limited application for determining skin effect with any current wave shape. Equivalent resistances of conductor are calculated for rectangular and bell-shaped pulses and calculation of losses in pulse modulator shaping line coils are made. (U.S.S.R.)

Application of the Conformal Transformation Method to Problems of Radial Transition Between Two Rectangular Waveguides, N. P. Mar'in. "Radiotek." June 1959. 11 pp. The article deals with the problem of a flat transition between two homogeneous waveguides with different cross-sections. A conformal transformation of a heterogeneous wave guide into a strip is found by means of the Schwarz-Christoffel formula. Using Maxwell's equation in orthogonal curvilinear coordinates the problem of calculating the electromagnetic field inside the strip is investigated. Reflection factors and amplitudes of transmitted waves are given for various transition angles. (U.S.S.R.)

Behavior of Open-Wire Lines and Cables at Frequencies Above 150 kc. "El. & Comm." Aug. 1959. 4 pp. In this article the characteristics of open-wire lines and cables in the 150 kc to 350 kc region are discussed. (Canada.)

TUBES

Electron-Beam-Switching Valves for Distributing and Counting Purposes, R. F. Startz. "El. Rund." July 1959. 2 pp. In industrial electronics beam-switching valves are used for counting, storaging, and distributing purposes (e.g. measurement distribution for multi-telemetering equipments relating to an electronic collector-distribution principle.) After a short explanation of the operation of the different valve electrodes in connection with a constant magnetic field of force, circuit examples of the application of those valves are given. (Germany.)

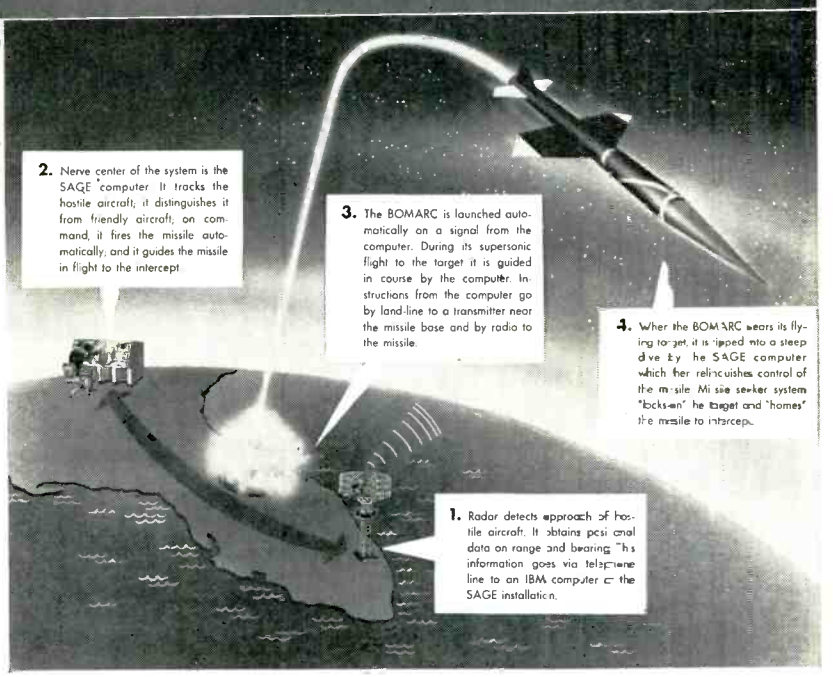
Important Characteristics of a New Type Getter-ion Pump, R. L. Jepsen. "Vide." March-April 1959. 15 pp. Following a brief review of the basic operation of the VacIon pump, some recent experimental results relative to speed as a function of voltage, magnetic field, pressure, and species of gas are presented. Important pump features and characteristics are summarized. (France, in English.)

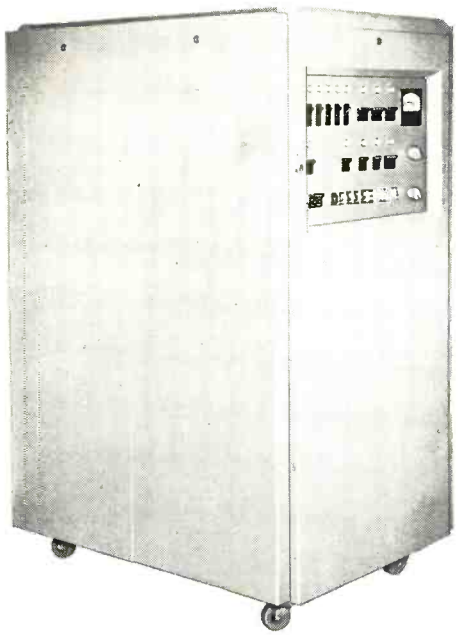
Ultra-High Frequency Tubes. "Toute R." No. 232. Jan. 1959. 2 pp. This article provides a very clear summary in graphical form of the various ultra-high frequency tubes manufactured in the United States and in Europe. Covered are klystrons, magnetrons, and traveling wave tubes. (France.)

Wide Range Tuning Cavities for Plug-In Reflex Klystrons, R. Mather and J. Sharpe. "El. Eng." July 1959. 4 pp. This article describes a range of external cavities, having a tuning range greater than 30 per cent in the frequency band from 5kMc/s to 12kMc/s, for use with plug-in X-band klystrons. The cavities are of modest dimensions and appear to have advantages over types previously described. Test results are of modest dimensions and appear to have advantages over types previously described. Test results are given and applications are suggested. (England.)

This Power Supply Provides Dependable Performance to the Magnetic Tape Units of the IBM SAGE COMPUTER

Computer Operating and Programming Room at one of the U. S. Air Force's SAGE Installations





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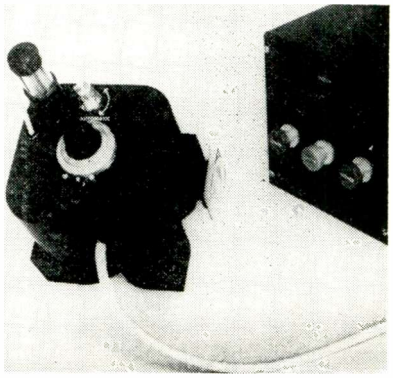

the filter to F_0, F_0+3 MC and F_0-3 MC. Configuration of the resonant cavity is cylindrical and the insertion loss is 2.5 db max. and max. VSWR is 1.5. Frequency Standards, Inc., P. O. Box 504, Asbury Park, N. J.

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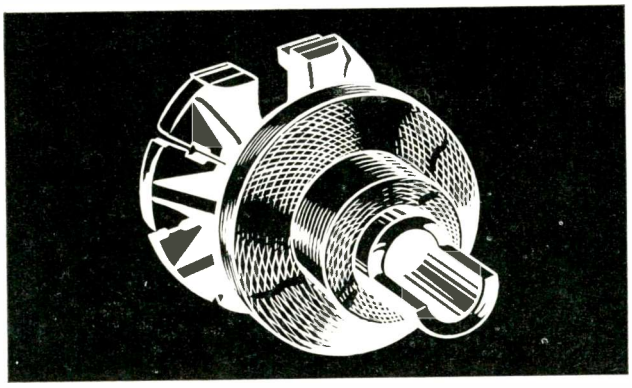

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SodALite is rated for 105°C. (Class A) operation. SodALite is superior to Formvar at its rated temperature and offers equivalent life to Formvar if maximum hot-spot temperatures do not exceed 120°C.

SodALite, bright red in color, has excellent handling, abrasion, physical, electrical, and chemical properties. Available in two grades, single and heavy, it can also be supplied with cement topcoat (for bonding), with matte surface, or with nylon overcoat. Any of these constructions can be produced in four additional colors for identification in winding.

SodALite is a member of the full Auto-Lite line of outstanding magnet wire—BondALite • DacALite • IsALite • LectALite • NyALite • SodALite

ANY WIRE PROBLEMS? Write, stating your wire problems, or mail coupon for the complete Auto-Lite Magnet Wire Catalog.

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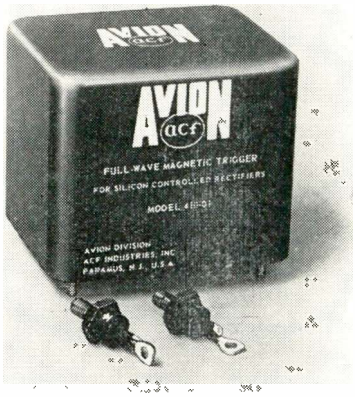
MAGNETIC TRIGGER

Model 410 series of Full-Wave Magnetic Triggers is designed especially for use with C35 or equivalent series of silicon controlled rectifiers. The transfer characteristic is largely independent of voltage and frequency of the primary power supply. The operating range extends from 50 through 400 cycles per sec. Output presents a steep wave-front to the gate circuit of the SCR, allowing precise determination of firing angle. The response of the unit is less than one half cycle of the supply frequency. Avion Div., ACF Industries, Inc., 11 Park Pl., Paramus, N. J.

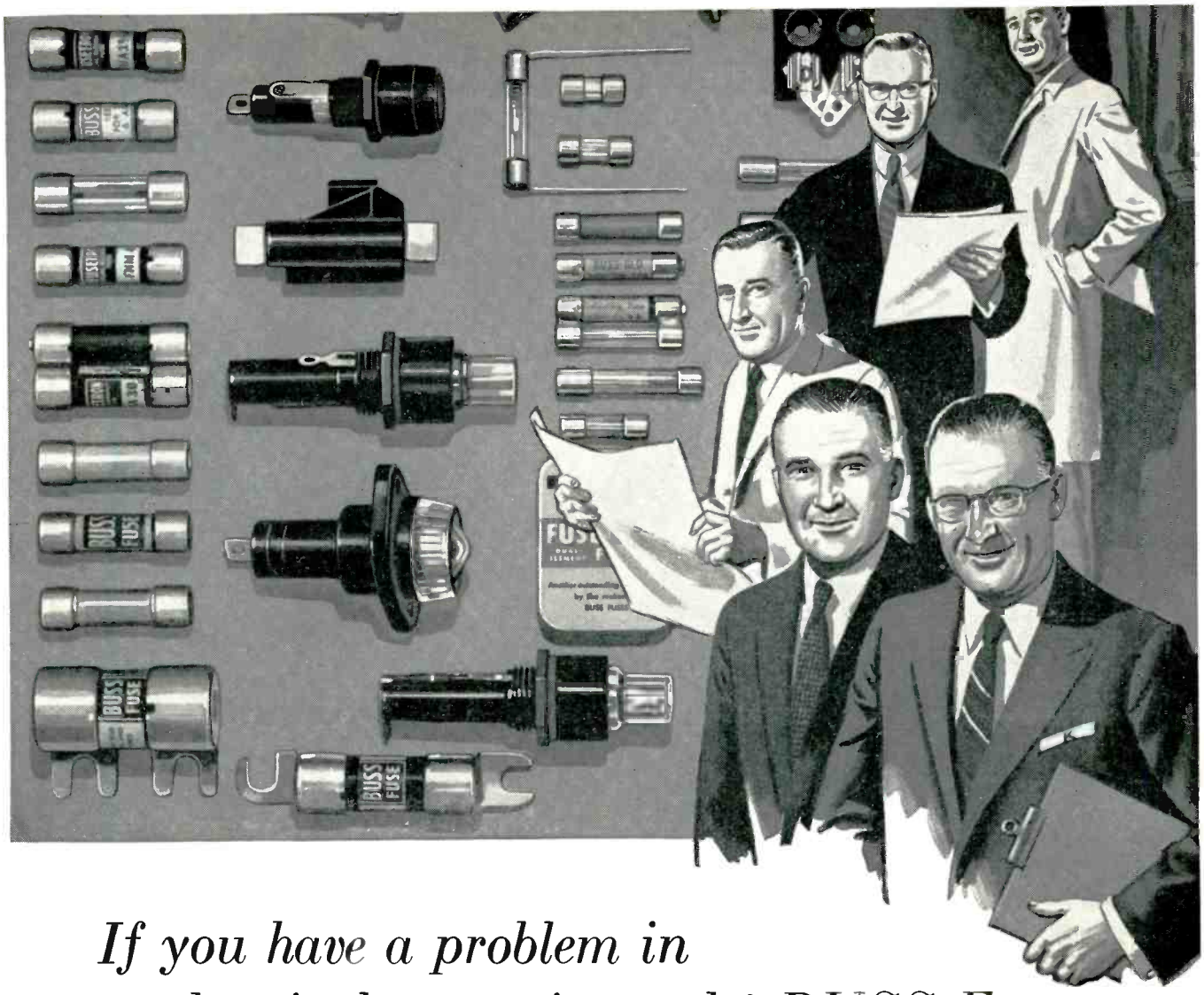


Circle 224 on Inquiry Card

BW OSCILLATORS

Wide-band voltage-tuned backward wave oscillators in 9 frequency ranges give coverage from 1.0 to 18.0 KMC. Precision hard glass and metal construction encapsulated in 1 in. OD x 14 in. anodized aluminum tubes. Weight 15 oz. min. power output 10 mw. A magnetic field of 800-1000 gauss required. May be operated with any element grounded. Dc voltage isolation is provided in the r-f output cable. A control grid is standard for amplitude modulation. Grid voltage of −15v stops oscillation over entire band. Maximum helix potential is 2500 v. Stewart Engineering Co., Soquel, Calif.

Circle 225 on Inquiry Card



If you have a problem in electrical protection — let BUSS Fuse Engineers Help You Solve It.

If you have an electrical protection problem, the BUSS fuse research laboratory, and its staff of engineers are *at your service.* Our engineers will work with yours to help you find a solution — and so save you engineering time.

It is quite possible a fuse already stocked by local wholesalers will be your answer, so that the right fuse is readily available if your equipment needs service.

The complete BUSS and FUSETRON fuse line includes:

Single-element fuses for circuits where quick-blowing is needed, such as for instrument protection.

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Dual-element, slow-blowing fuses for circuits where harmless current surges occur.

Indicating fuses where signal must be given when fuses open — or to activate an alarm.

BUSS and FUSETRON fuses range in size from 1/500 amperes up — and there's a companion BUSS line of fuse clips, blocks and holders.

Dependability Always

Every BUSS or FUSETRON fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

For a catalog on BUSS and FUSETRON small dimension fuses and fuseholders, — write for bulletin SFB. If you need special fuses or fuseholders, submit description or sketch, showing type of fuse to be used, number of circuits, type of terminal, etc.

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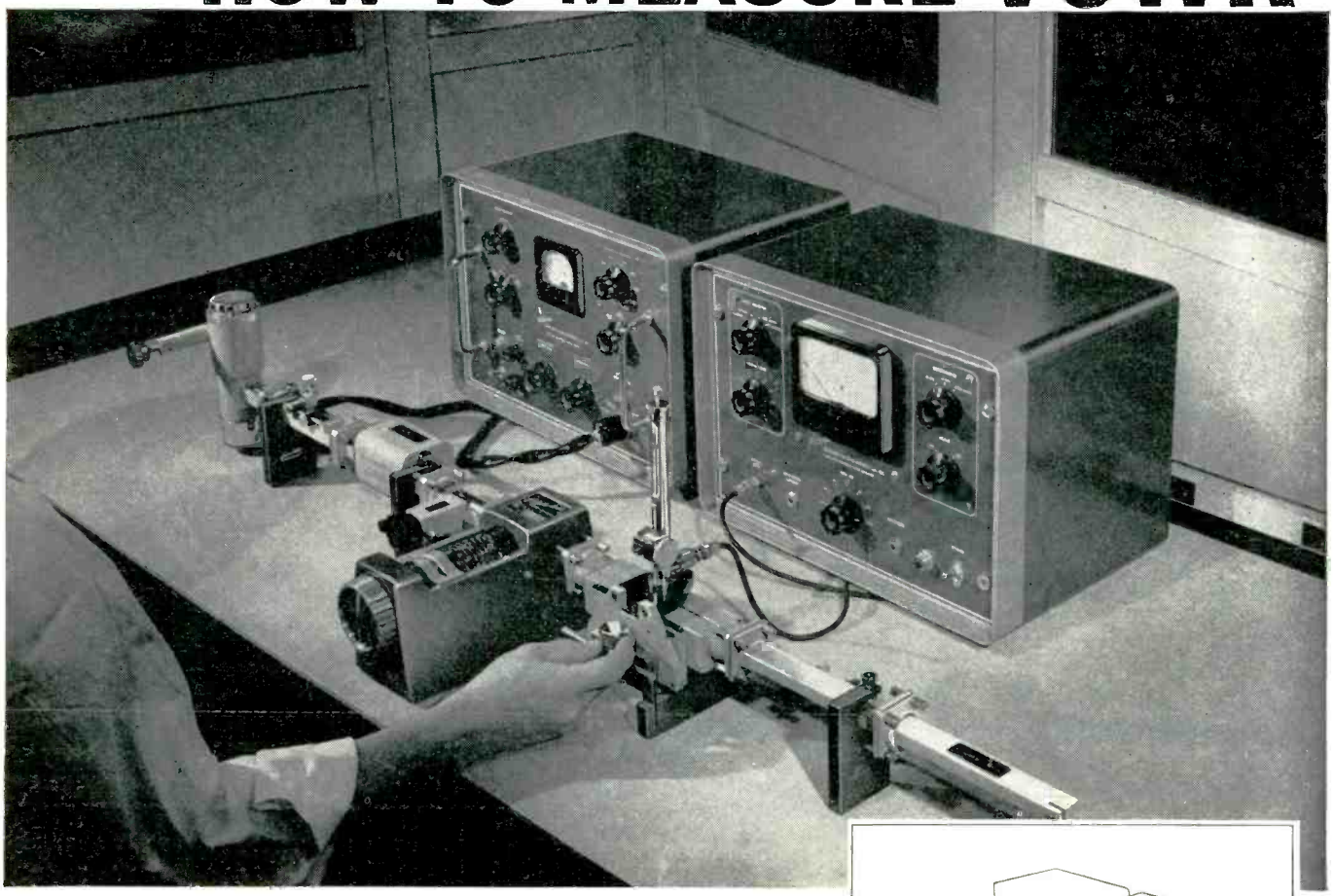
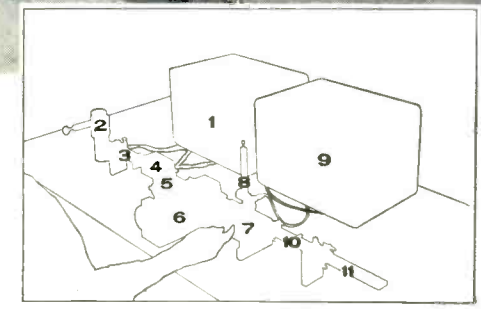
HOW TO MEASURE VSWR



This microwave measurement bench is for the determination of Voltage Standing Wave Ratio using the slotted-line technique. Other systems utilizing directional couplers or magic tees for measurement of VSWR are known, but the use of the Slotted Section assures maximum accuracy.

Regardless of the technique used, accurate readings depend on the precision of the test instruments involved. When it comes to microwave test instruments PRD produces the widest range of the most precise equipment available anywhere in the world.



You will notice in the measurement bench shown that there are four test components separating the klystron tube mount from the Slotted Section. These are: A Slide Screw Tuner, ferrite Isolator, Level Set Attenuator, and a broadband direct reading Frequency Meter. THE USE OF THESE FOUR COMPONENTS IN THE TEST LINE IS MANDATORY FOR PRECISE VSWR MEASUREMENTS!

The reason for this is clear when you consider the interrelationship between VSWR, power, and frequency.

The Slide Screw Tuner is used to match the klystron output to that of the tandem test line, thereby maximizing its output and increasing its stability.

The use of the ferrite Isolator assures klystron frequency and power stability by shielding the source generator from changes in impedance further down the line. It accomplishes this with negligible attenuation of the incident power. The Level Set Attenuator is used to adjust the amount of power feeding the remainder of the test line.

The reaction Frequency Meter accurately monitors the output of the klystron by a resonant dip on the Standing Wave Amplifier.

A Slotted Section, tuned Broadband Probe, Standing Wave Amplifier, and matched Termination complete the precision waveguide, X-band, VSWR bench. A Klystron Power Supply to provide the signal source with power and modulation and a Fixed Waveguide Attenuator to simulate the unknown are also shown.

Special problems in VSWR and other related measurements? — Contact our Applications Engineering Department.

We at PRD have pioneered the development of precision microwave test instruments . . . PRD is the only pioneer company today producing microwave test instruments exclusively. In fact, we're just about the largest microwave company in the world . . . our cable address is MICROWAVE, New York, USA.

For technical details and specifications covering products shown write:

TEST INSTRUMENTS USED IN THIS X-BAND VSWR BENCH

1—809 Klystron Power Supply, catalog page F-10
2—703 Shielded Tube Mount, catalog page F-8
3—303-A Slide Screw Tuner, catalog page B-14
4—1203 Isolator, catalog page A-21
5—159-A Level Set Attenuator, catalog page A-17
6—535 Frequency Meter, catalog page D-12
7—203-D Slotted Section, catalog page B-11
8—250-A Broadband Probe, catalog page B-12
9—277-A Standing Wave Amplifier, catalog page E-7
10—UNKNOWN—represented by a 140 Fixed Waveguide Attenuator, catalog page A-11
11—116-A Waveguide Termination, catalog page A-19

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45 Acoustica Associates, Inc. — Ultrasonic cleaning equipment
151 Alden Systems Company—Manufacturing systems engineering handbook
113 Allegheny Electronic Chemicals Co.—Silicon crystal slices
57 Allied Chemical Corp., General Chemical Div.—"Electronic grade" hydrofluoric acid
49 Allied Control Company, Inc.—Subminiature relays
18 Allied Radio—Electronic supply catalog
121 Amperex Electronic Corp. — Electronic tube
14 AMP Incorporated—Double throw program selector switch
34 Arco Electronics Inc. — MYLAR-paper capacitors
43 Audio Devices, Inc.—Recording tape
71 Audio Development Company — Transformers
107 Augat Bros., Inc.—Crystal holder socket assembly
82 Auto-Lite General Products Group—Magnet wire
37 Barker & Williamson, Inc.—Air-wound inductors
53 Beckman/Berkeley Division, Beckman Instruments, Inc. — Microwave frequency counter
94 Bendix Aviation Corp., Red Bank Division—Transistors
92 Birtcher Corporation, The — Transistor radiators
101 Biwax Corporation — Industrial sealing waxes
2 Bomac Laboratories, Inc., A Subsidiary of Varian Associates — Microwave tubes and components
88 Borg Equipment Div., Amphenol-Borg Electronics Corp.—Specialty engineering
90 Borg Equipment Div., Amphenol-Borg Electronics Corp.—Microdials
12 Bourns, Inc.—Trimmer potentiometers
97 Bourns, Inc.—Trimmer potentiometer
126 Bruno-New York Industries Corp.—Pigtailoring machine
39 Brush Instruments Division of Clevite Corporation—Recording systems
55 Bud Radio, Inc.—Inclined panel console
154 Burnell & Co., Inc.—Toroids, filters and related networks
85 Bussmann Mfg. Division, McGraw-Edison Co.—Fuses and fuseholders
95 Cambridge Thermionic Corporation — Miniaturized capacitors
23 CBS Electronics, Semiconductor Operations — NPN-PNP power transistor pairs
16 Centralab A Division of Globe-Union, Inc.—Printed circuit switch
130 Century Lighting, Inc.—Preset lighting system
81 Chicago Standard Transformer Corporation—Transformers
52 Chicago Telephone Supply Corporation—Variable resistor
48 Cinch Manufacturing Company Div. of United-Carr Fastener Corp.—Subminiature connectors
99 Clare & Co., C. P.—Relays
25 Clevite Transistor Products A Division of Clevite Corporation—Silicon junction diodes
118 Columbian Carbon Company—Synthetic iron oxides for ferrites
70 Continental Connector Corporation, DeJur-Amsco Corp.—Miniature power connectors
132 Conrac, Inc.—Television monitors
20 Corning Glass Works—Glass-enclosed resistor
15 Dale Products, Inc.—Precision resistors
76 Delco Radio Division of General Motors —Power transistors
28 Deutsch Company, The—Miniature connectors
65 Dialight Corporation — Ultra-miniature indicator lights
122 Du Pont de Nemours & Co., E. I., "Freon" Products Div.—Cleaning solvents
27 DuMont Laboratories, Allen B.,—Storage type cathode ray tube
98 Eastman Kodak Company—Semi-conductive resistor
128 Eisler Engineering Co., Inc.—Welding machines and accessories
56 Eitel-McCullough, Inc.—Klystron tubes
96 Elastic Stop Nut Corporation of America, AGA Division — Miniature time delay relays
24 Electra Manufacturing Co., Electronics Div.—Metal film resistor
153 Electronic Instrument Co. EICO—Electronics Catalog
31 Electro Motive Mfg. Co., Inc., The—Mica capacitors
512 Emerson Electric, Electronics & Avionics Div.—Engineering personnel
7 Engineered Electronics Company—Transistorized decades
26 Erie Resistor Corporation, Erie Electronics Div.—Trimmer capacitor
40 Fairchild Semiconductor Corporation—Silicon mesa transistor
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150 Freed Transformer Co., Inc. — Transformer, Magnetic amplifiers
66 FXR, Inc. — High voltage regulated power supplies
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32 General Electric Co., Power Tube Department—Voltage-tunable magnetron
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133 General Products Corporation — Taper pin terminal boards
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117 Gertsch Products, Inc.—Subminiature coaxial ratio transformer
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5 Hughes Aircraft Company, Vacuum Tube Products—Cathode ray tubes
6 Hughes Aircraft Company, Vacuum Tube Products—Direct-view storage tubes
4 Hughes Aircraft Company, Semiconductor Division—Computer diodes
87 Industro Transistor Corporation—Alloy junction germanium PNP transistors
36 ITT Industrial Products Division, IT & T Corp.—Power equipment
157 ITT Industrial Products Division, IT & T Corp.—Large screen oscilloscopes
137 International Rectifier Corp.—Zener diodes
138 International Rectifier Corp.—Miniature voltage reference
139 International Rectifier Corp.—Semiconductor substitution box
69 IMC Magnetics Corp.—Motors
77 Jeffers Electronics Division, Speer Carbon Company—Miniature inductors
148 Jerrold Electronics Corporation—Sweep generator
100 Jones Div., Harold B., Cinch Manufacturing Co.—Terminal panels
115 Keithley Instruments, Inc.—Decade isolation amplifier
156 Kester Solder Company — Resin-core solder
17 Keystone Carbon Company—Thermistors
89 Klein & Sons, Mathias—Long nose shear cutting plier
75 Kleinschmidt Division of Smith-Corona Marchant Inc.—Teleprinted communications equipment
108 Kulka Electric Corp.—Terminal connecting strips
140 Lenz Electric Company—Colored plastic jacket cables
102 Lifschultz Fast Freight — Freight forwarding service
63 Littelfuse—Indicating fuse posts
136 Lockheed Electronics & Avionics Division—Endless-loop tape recorders
78 Magnetics, Inc.—Tape wound cores
13 Manson Laboratories—Reference sources
129 Marconi Instruments—Q meter

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64 Motorola Semiconductors, Motorola, Inc. —Power transistors
119 Mueller Engineering Co., Inc., Heinz—Motors

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510 Garrett Corporation
507 General Electric, Communication Products Dept.
509 General Electric, Ordnance Department
504 General Electric, Heavy Military Electronics Dept.
513 General Electric, Heavy Military Electronics Dept.
508 Melpar, Inc.
511 Motorola, Inc.
502 National Cash Register Company, The
506 Norden Laboratories, Norden Div. of United Aircraft Corp.
505 Sylvania Electronic Systems, Waltham Laboratories
503 System Development Corporation

58 Muirhead & Co., Ltd.—Low frequency decade oscillator
111 Narda Ultrasonics Corporation, The—Ultrasonic cleaning equipment
35 National Ultrasonic Corp. — Ultrasonic cleaning equipment, solvents
21 New Departure Division, General Motors Corporation—Miniature & instrument ball bearings
116 Newark Electric Company — Electronic catalog
124 Newman Corporation, M. M.—Spiral-cut plastic tubing
135 Onan & Sons Inc., D. W.—Dual-purpose electric plant
59 Osborne Electronic Sales Corp.—Ratio transformer
19 Pacific Semiconductors, Inc. — Semiconductor products.
11 Philco Corp., Lansdale Tube Company Div.—High frequency silicon transistors
149 Plastic Capacitors, Inc.—Capacitors
86 Polytechnic Research and Development Co., Inc. — Microwave measurement bench
103 Pyramid Electric Co.—MYLAR or tantalum capacitors
84 Quan-Tech Laboratories—Power supplies
1 Radio Materials Company—Ceramic disc capacitors
158 Raytheon Company, Distributor Products Div. — Constant voltage power transformers
125 Reeves Soundcraft Corp.—Magnetic Tape Inspection kit
30 Reflectone Electronics, Inc.—Power supplies
114 Rohn Manufacturing Co.—Communication tower
41 Rucker Company, The—Small centrifuge
50 Sangamo Electric Company—Capacitor reference file
51 Sangamo Electric Company — MYLAR capacitor
47 Sarkes Tarzian Inc.—Silicon rectifiers
110 Segal, Edward — Automatic eyeletting machine
155 Servo Corporation of America — Servo system analyzer
61 Scintilla Division, Bendix Aviation Corp. —Rack and panel connector
134 Shoe Form Co., Inc.—Small plastic boxes
120 Shure Brothers, Incorporated—Communications microphone
147 Sickles Division, F. W., General Instrument Corp.—Delay line
62 Sperry Semiconductor Division—Switching diode
3 Sprague Electric Co.—Tantalum capacitors
146 Stanpat Co.—Adhesive drafting aid
112 Statham Instruments, Inc. — Pressure transducer
Superior Electric Company, The—Variable transformer
152 Technical Appliance Corporation, TACO —Telemetering antennas
54 Telechrome Manufacturing Corp.—Telemetering transmitters
9 Texas Instruments Incorporated—Silicon transistors
44 Tinnerman Products, Inc.—Speed nuts

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 203 of this issue.

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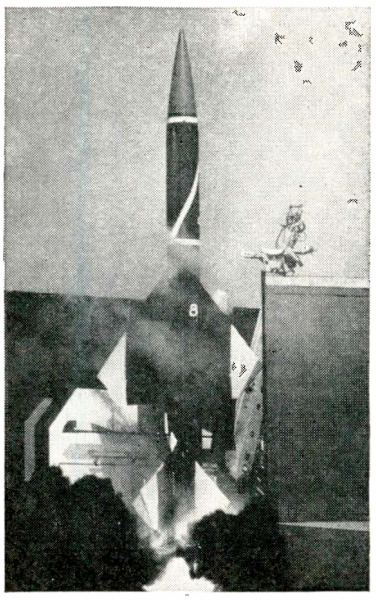
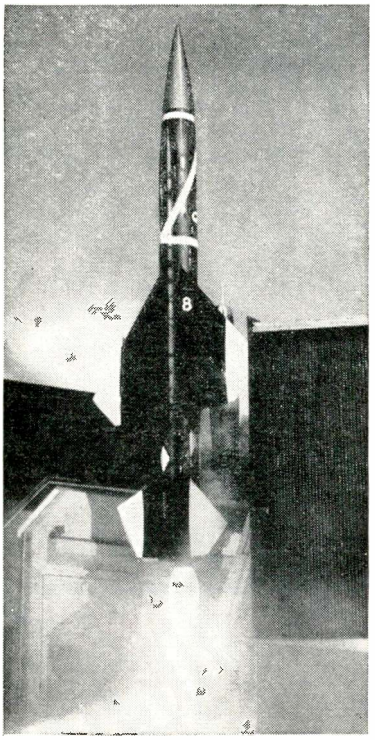
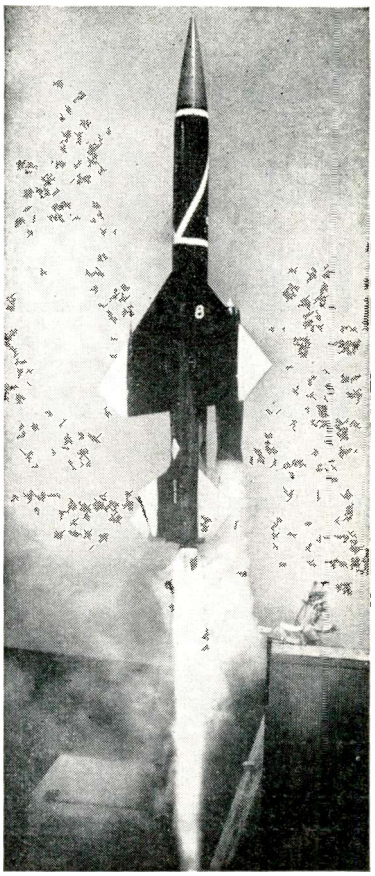
231 Amplifier, servo—Seneca Falls Machine Co.
243 Amplifier, servo—Control Technology Co.
161 Attenuator, oscillograph—Marduth Products, Inc.
222 Calibrator, digital force — Performance Measurements Co.
249 Circuit Breaker, thermal—Filtron Co., Inc.
252 Cleaner, ultrasonic—National Ultrasonic Corp.
244 Cores, tape wound—G-L Electronics, Inc.
172 Device, shock detection—Inertia Switch, Inc.
168 Disconnect, waveguide—Aircraft Armaments, Inc.
170 Etcher, printed circuit—Centre Circuits, Inc.
230 Fan, tube axial—American-Standard Industrial Div.
169 Filter, cavity—Adams-Russell Co., Inc.
223 Filter, microwave—Frequency Standards, Inc.
253 Gaussmeter—F. W. Bell, Inc.
255 Generator, square wave — The Hickok Electrical Instrument Co.
228 Generator, sweeping—Alfred Electronics
238 Grommet—Western Sky Industries
251 Head, mixing—The Martin Sweets Co., Inc.
248 Indicator—Electronic Tube Div., Burroughs Corp.
241 Indicator, digital—George L. Nankervis Co.
236 Line, delay—Deltime, Inc.
177 Microphone, condenser — B&K Instruments, Inc.
237 Motor—Western Gear Corp.
165 Multiplexer, high speed—Epsco, Inc.
247 Network, resistance—The Daven Co.
233 Oscillator, power—The Industrial Test Equipment Co.
225 Oscillators, BW—Stewart Engineering Co.
175 Oscilloscope — Waterman Products Co., Inc.
167 Perforator, tape—Data Instruments Div., Telecomputing Corp.
174 Photocells, readout—International Rectifier Corp.
254 Plotter, response—Southwestern Industrial Electronics Co.
242 Potentiometer—Aero Electronics Corp.
229 Potentiometer, rectilinear — Markite Products Corp.
235 Power Supply—Kepco Laboratories, Inc.
176 Power Supply, AC/DC — The Superior Electronic Co.
250 Probe, high voltage—Tektronix, Inc.
163 Rectifier, silicon—Audio Devices, Inc.
240 Rectifiers, silicon — International Telephone & Telegraph Corp.
171 Relays—Ohmite Mfg. Co.
166 Relays, time delay—Tempo Instruments, Inc.
162 Resistor, power—Dale Products, Inc.
178 Resistors, oxide films—Corning Glass Co.
239 Resistors, variable—Chicago Telephone Supply Corp.
227 Servoactuators — MOOG Servocontrols, Inc.
246 System, data processing—Hagan Chemicals & Controls, Inc.
234 Test set, transistor—Metronix, Inc.
232 Tester, environmental — Cincinnati Sub Zero Products, Inc.
224 Trigger, magnetic—ACF Industries, Inc.
245 Thermostat—Metals & Controls, Inc.
164 Trimmers—JFD Electronics Corp.

BORG ... a world of ideas ... *that work*







BOEING NEEDED SPECIALTY ENGINEERING...

AND GOT IT...FROM BORG

A FEW BORG DEVELOPMENTS

- FREQUENCY STANDARDS
- AIRCRAFT INSTRUMENTS
- PRECISION POTENTIOMETERS
- MULTI-TURN COUNTING DIALS
- FRACTIONAL H. P. MOTORS

Boeing Airplane Co. needed special potentiometers for the guidance systems of their deadly Bomarc surface-to-air missiles. The necessary potentiometers had to withstand severe vibration and shock and still retain uncanny accuracy within extreme tolerances.

The solution to this difficult reliability problem? The design, development and production facilities of the Borg Equipment Division of the Amphenol-Borg Electronics Corporation. The result? Specially designed potentiometers exceeding all required specifications.

Many industry leaders have found that they can depend on Borg engineering skill and cooperation. Call on Borg when you are faced with difficult design, development or production problems. Chances are you'll save a good deal of time and money and find it makes good sense to call on Borg. Write for our new facilities brochure.

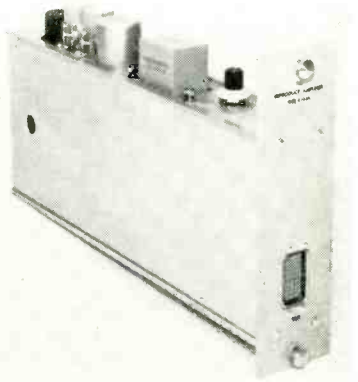
BORG

BORG EQUIPMENT DIVISION
AMPHENOL-BORG ELECTRONICS CORPORATION
JANESVILLE, WISCONSIN

New Products

FM REPRODUCE AMPLIFIER

FM reproduce amplifier, the 1-143A, is for use with magnetic tape recorders. Playback of any one of 6 tape speeds from 1⅞ to 60 in. per sec. in frequency response ranges

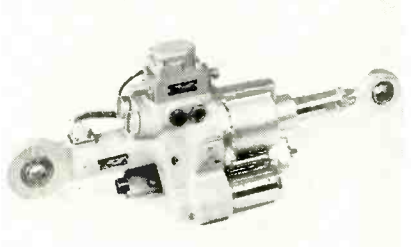


from 0-312.5 CPS to 0-10 KC is possible with plug-in generators and filters. A 7th filter extends the frequency range to 20 KC. Over-all system accuracy within ±0.5 db is realized from 0 to 10 KC. An output step attenuator with vernier and a coarse-and-fine zeroing control are accessible on top of the chassis. Signal output is 1 v RMS for ±40% deviation. Data Tape Div., Consolidated Electrodynamics Corp., Pasadena, Calif.

Circle 226 on Inquiry Card

SERVOACTUATORS

Line of electrohydraulic servoactuators for missile and aircraft controls, Series 17 Servoactuators, are integrated hydraulic packages which include an electrohydraulic servovalve, a cylinder-piston assembly and an electrical feedback device. They are designed for specific system applications and may include special auxiliary devices such as pressure limiters, snubbers, flow limiters, piston locks,



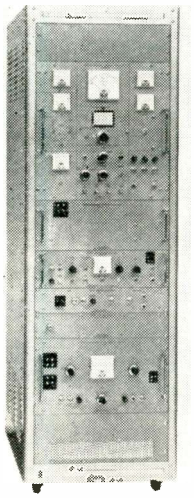
solenoids and/or integral filters to simplify systems installations. Typical models are operable to 350°F; special models can be designed for hydraulic control up to 600°F. MOOG Servocontrols, Inc., E. Aurora, N. Y.

Circle 227 on Inquiry Card

New Products

SWEEPING GENERATOR

Microwave sweeping generator provides electronically swept or precise CW, r-f power from 2 to 4 KMC. Model 6002A includes a backward wave oscillator, a 10 w TW amplifier, a microwave leveler, and a high-voltage

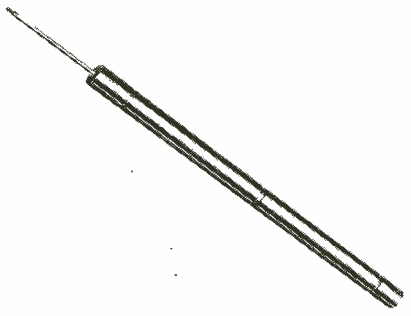


power supply. Power, adjustable from 10 mw to 1 w, is held to within ±½ db over the entire band. Frequency deviation is independent of the starting frequency, covering the entire range or any part of it. An internal 800 to 1200 CPS square wave generator may be selected to amplitude modulate r-f output. Alfred Electronics, 897 Commercial St., Palo Alto, Calif.

Circle 228 on Inquiry Card

RECTILINEAR POTENTIOMETER

A ¾ in. dia. cylindrical rectilinear potentiometer series, catalog numbers: 3091, 3090, 3080, 3258, 3257, 3254, and 3255, have single or dual elements and stroke ranging from 2½ to 10 in. The series display shock, acceleration, and vibration resistance in excess of 50g



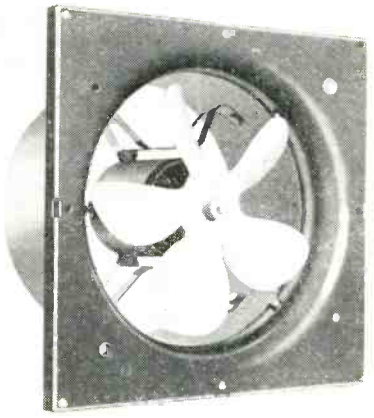
without opening or discontinuity. Other characteristics are: virtually infinite resolution and independent linearity in the order of ±0.2%. Markite Products Corp., 155 Waverly Place, New York 14, N. Y.

Circle 229 on Inquiry Card

New Products

TUBEAXIAL FAN

Tubeaxial fan, No. 89B222, is for ventilating cubicles, racks, and cabinets housing electronic equipment. It is recommended for use in stationary equipment where shock and vibration

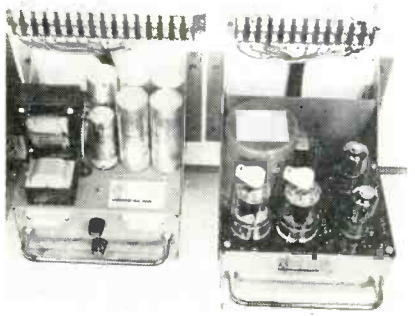


are negligible. Mounted in an open type enclosure, the unit is equipped with sleeve-type bearings and is powered by a 1.70-hp shaded pole electric motor operating on 115-v, single-phase, 60/50 CPS. At rated speed, it will deliver 450 CFM of air at 0 static pressure and 100 CFM of air at approximately 0.22 in. w.g. American-Standard Industrial Div., Detroit 32, Mich.

Circle 230 on Inquiry Card

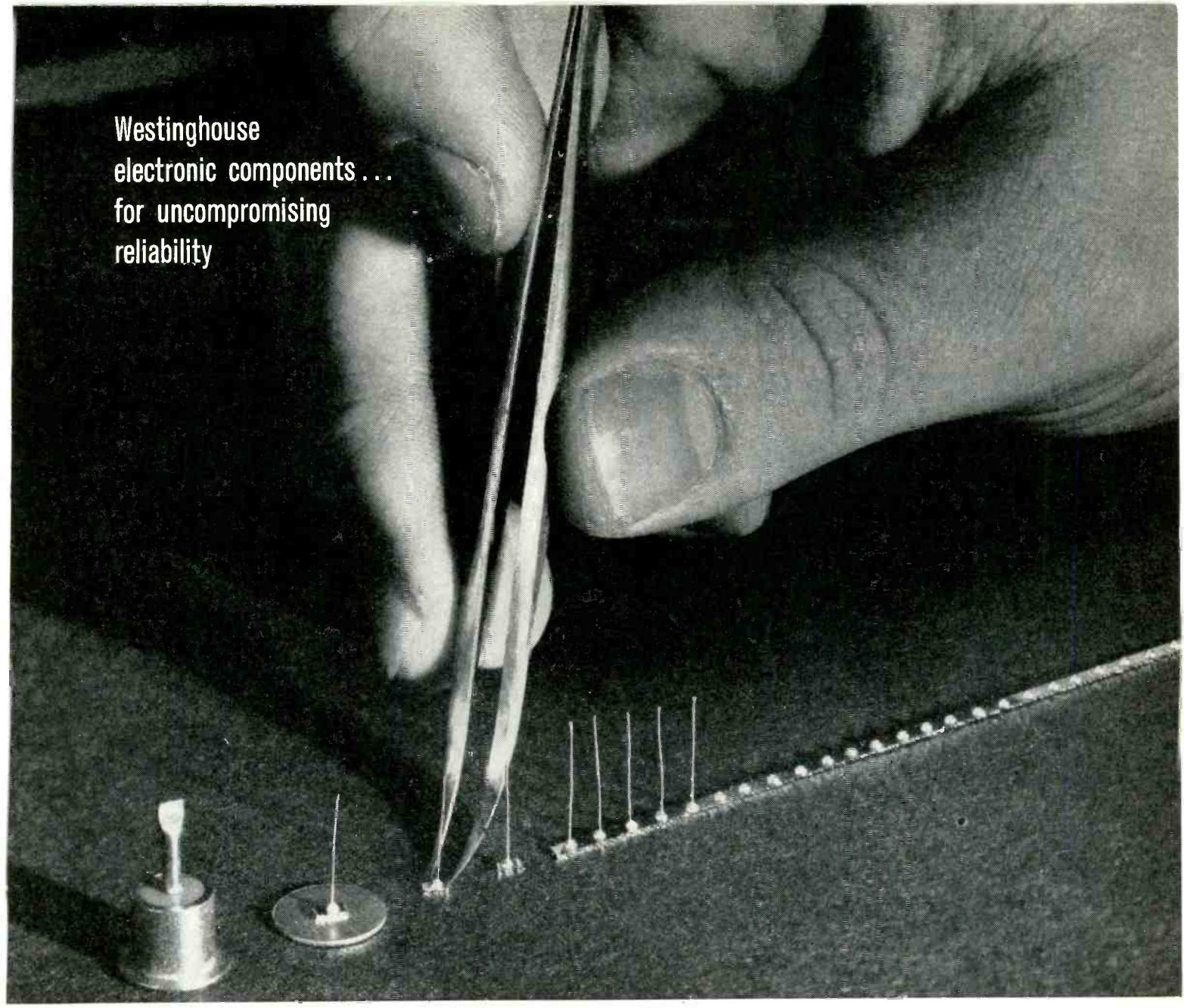
SERVO AMPLIFIER

Servo amplifier and power supply for instrument servo systems will control a range of ac servo motors with mechanical power outputs up to 10 w. The electronic amplifier will accept low level ac signals from a variety of existing transducers and from an ac feedback tachometer. The output power from the amplifier is available as various impedance levels via a combined matching and isolation



transformer. High sensitivity and stability of the electronic amplifier is achieved with feedback techniques and long-life tubes. Seneca Falls Machine Co., Electronics Div., 19 Fyfe Bldg., Seneca Falls, N. Y.

Circle 231 on Inquiry Card



1400% more reliability through research

Original research in electronics and related fields is constantly in progress at Westinghouse. Here, the latest development—molectronics—has reduced parts from 14 to 1, soldered connections from 15 to 2, in a light telemetry subsystem. The improvements in reliability when products like these reach automatic production are boundless.

You can take advantage of this kind of component research and development by specifying Westinghouse high-reliability components for all of your circuit designs. At Westinghouse, you can draw not only from a wealth of off-the-shelf components, but also from a vast stock pile of knowledge, experience, and research which makes "break-throughs" like molecular electronics a reality.

For all of your needs in ultramodern components, contact your local Westinghouse sales engineer or write: Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

Old and new—At left, a present semiconductor. At right, dendritically grown germanium crystals which perform the same function. Westinghouse expects to build several different electronic functions into single tiny slabs like these.

J-92028

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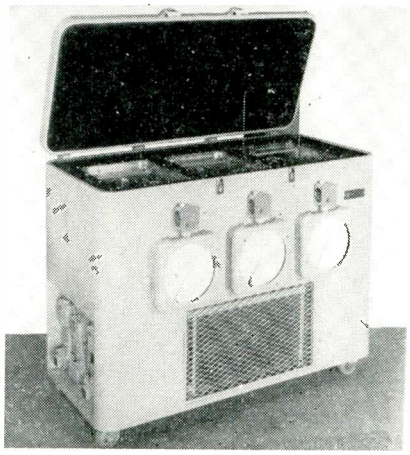
Circle 93 on Inquiry Card

New Products

ENVIRONMENTAL TESTER

Model SV3-75-5 is designed for multiple testing. Test Cell "A" provides a test temperature adjustable from 0 to −20°F; Test Cell "B" from −35° to −45°F; and Test Cell

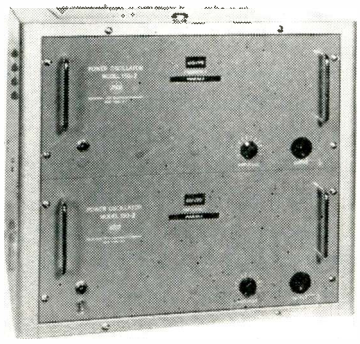


"C" from −60° to −75°F. Each compartment is individually controlled and operation is charted by individual recording thermometers. For minimum temp. variation, an 8 in. air circulator is provided for each area. Cincinnati Sub Zero Products, 3932 Reading Rd., Cincinnati 29, Ohio.

Circle 232 on Inquiry Card

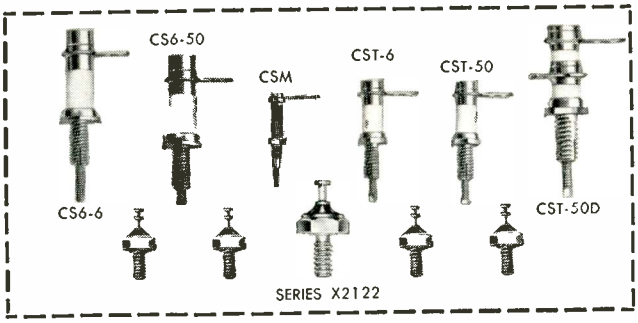
POWER OSCILLATOR

Model 150-2, power oscillator, supplies 320 va of power at a fixed frequency 400 CPS ±0.25%. Output voltage is continuously vraiable from 0-120 v. for each phase. The displacement between phases is maintained at 90° ±1°. Features include less than 1% dis-



tortion and better than 1% regulation from no load to full load. Silicon diodes in the plate supply reduce the heat dissipated. The Industrial Test Equipment Company, 55 East 11th Street, New York, N. Y.

Circle 233 on Inquiry Card



Shown ½ actual size

CAMBION® capacitors ...mighty midgets

CAMBION miniaturized capacitors outperform capacitors several times their size. Their unusual tuning elements practically eliminate losses due to air dielectric and result in wide capacity ranges. Among CAMBION Variable Ceramic Capacitors, Type CST-50 is only 1 3/32" high mounted, yet its capacity range is 1.5 to 12.5 MMFD's. Ranges of other CAMBION capacitors vary from 0.5 minimum to 25 maximum MMFD's.

CAMBION X2122 Stand-Off Capacitors with ceramic dielectric are exceptionally rugged RF by-pass capacitors for use in high quality electronic equipment. Encapsulating epoxy resin assures rigidity and durability under extreme shock, vibration and humidity. Available in 6 standard values; over-all mounted height under 3/8".

Supplied complete with mounting hardware, all CAMBION capacitors have single mounting studs with locking devices for securing tuning elements. Like all CAMBION components their quality is guaranteed in any quantity ordered. For further details, write to Cambridge Thermionic Corporation, 504 Concord Avenue, Cambridge 38, Massachusetts.

Circle 95 on Inquiry Card

GROW WITH AIRESEARCH IN ELECTRONICS

AiResearch expansion in electronics and electromechanical activity is creating outstanding positions at all levels for qualified engineers.

CONTROLS ANALYSIS

Work in preliminary design stage involves servomechanisms analysis and analog computer techniques.

Openings also exist in the following areas: Flight Systems Research ... Flight Data Components ... Data Systems Research ... Electromagnetic Development ... Instrument Design ... Airborne Instrumentation and Design.

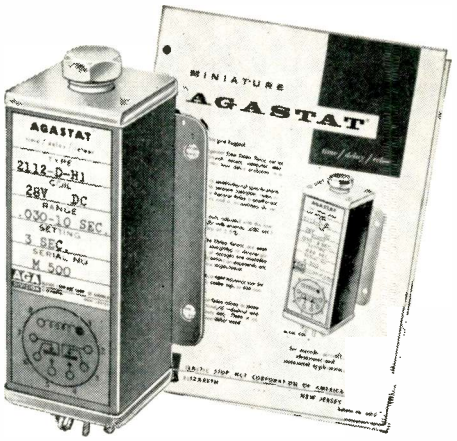
Send resume to: Mr. R. H. Horst

THE GARRETT CORPORATION

AiResearch Manufacturing Division

9851 So. Sepulveda Blvd., Los Angeles 45, Calif.

Circle 510 on "Opportunities" Inquiry Card



Now! get complete data on

MINIATURE AGASTAT® time/delay/relays

This free folder contains complete specs on 24 models of the miniature AGASTAT Time Delay Relay for missile, aircraft, computer, electronic and industrial applications. They're small as 1-13/16" x 4-7/16" x 1½", with adjustable timing ranges starting at .030 and as high as 120 seconds.

The folder gives operating and environmental specs, coil data, contact capacities, dimensions, diagrams of contact and wiring arrangements. *Write:* Dept. A-33-1032.

AGA DIVISION ELASTIC STOP NUT CORPORATION OF AMERICA

Elizabeth, New Jersey

Circle 96 on Inquiry Card

Kodak TRADE MARK

Q. What is a Kodak Ektron Detector?

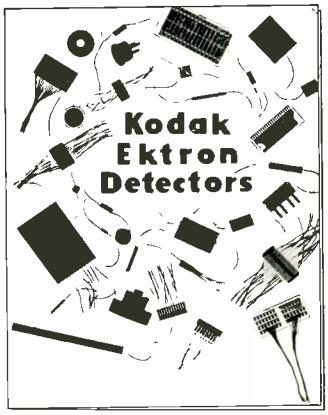
A: It is a semi-conductive resistor. The photosensitive area can be laid down in any pattern. Response extends to 3.5 microns in the infrared. Unaffected by vibration; high signal-to-noise ratio.

Q: What can it be used for?

A: For such applications as an infrared sensor in weapons systems, and in instrumentation for process control, analysis, and safety.

Q: How can I get the facts about spectral response, types, availabilities, and the like?

A: By writing for a new brochure called "Kodak Ektron Detectors."



Write to:

Apparatus and Optical Division

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

Circle 98 on Inquiry Card

A FULL LINE OF THE MOST RELIABLE, MOST DURABLE RELAYS EVER MADE

Never wear Out • Never Chatter or Bounce • Require no Maintenance

single form D

Type HG. Capable of up to 100 operations a second. Load-handling capacity to 5 amperes and up to 500 volts. (250 va max. with proper contact protection.)

single form D

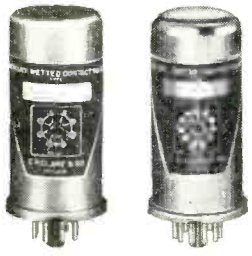
Type HGS. Biased with permanent magnets. Speed up to 200 cps. Sensitivity as low as ±2.5 milliwatts. Handles up to 2 amperes, up to 500 volts (100 va max. with proper contact protections.)

single form D

Type HGP. Can be factory adjusted to provide single side-stable, bi-stable or chopper characteristics.

four form D

Type HG4. Four form D switches enclosed in a single housing with coil. Plug in assembly (shown) is standard. Other mountings available.



two or three form D

Types HG2 and HG3. Two or three form D Switches enclosed in a single housing. HG2 has 8 or 11-pin octal style plug. An 11-pin base is standard for HG3.

six in-line flat pack

Type HG6F. Six switches mounted in line on printed circuit panel surrounded by single coil. Flat, compact assembly. Over-all dimensions: 3.640" x 3.125" x 1.046". Uses standard 32 or 36 terminal printed circuit socket.

For complete information on CLARE Mercury-Wetted Contact Relays or on the entire CLARE line of superior relays and electronic components address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Limited, P. O. Box 73, 2700 Jane Street, Downsview, Ontario. Cable Address: CLARELAY.

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CLARE RELAYS

FIRST in the industrial field

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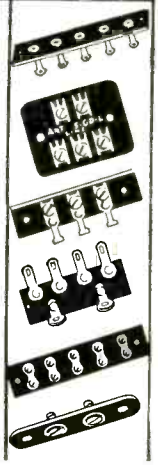
Complete Equipment FOR SPECIALS

Several pages of Jones Catalog No. 22 illustrate standard and special panels we are constantly producing. Latest special equipment enables us promptly to produce practically any panel required. Send print or description for prices, without obligation. Hundreds of standard terminal strips also listed. Send for Catalog with engineering drawings and data.

JONES MEANS *Proven Quality*



HOWARD B. JONES DIVISION
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CHICAGO 24, ILLINOIS
DIVISION OF UNITED-CARR FASTENER CORP.

Circle 100 on Inquiry Card

INDUSTRIAL SEALING WAXES

for sealing screw heads, sockets, switch bases, wiring devices, spotting, etc.

- Adhesion to ceramics, porcelain, plastics, metal and glass.
- Supplied in red, black, brown, and white.

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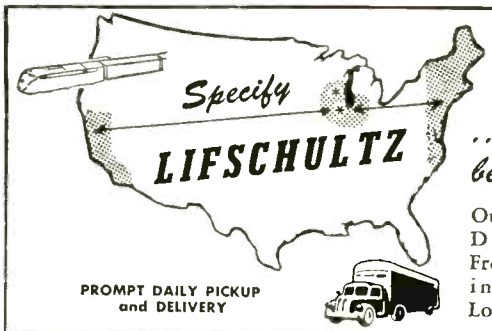

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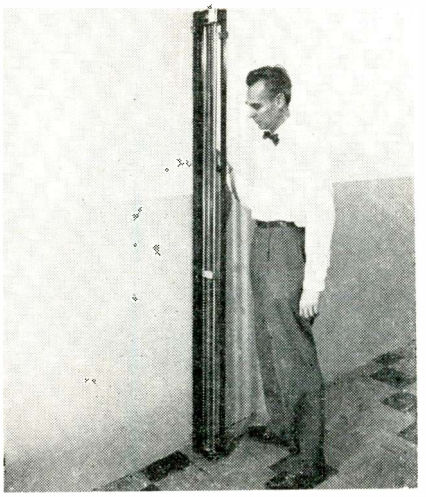
FASTEST TO BOTH COASTS!

Circle 102 on Inquiry Card

New Products

DELAY LINE

Servo-driven delay line offers a continuously adjustable range of from 3 μsec to over 400, is used in connection with missile tracking. Standing higher than a man, the narrow case contains the motor-driven worm-screw

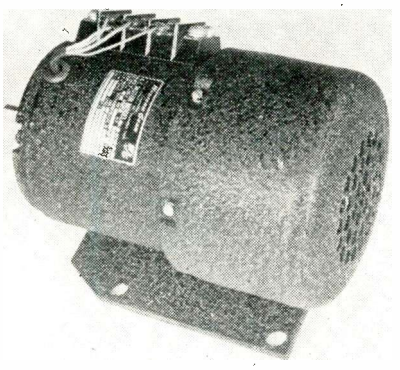


shaft that precisely moves and positions the output coil along the entire length of the magnetostrictive element in providing the time-delay constant. The linearity of delay, compared with the indicated position, is within 10 μsec of the actual delay. It can simulate the flight of a missile to outer space and its return to earth, in terms of time. Deltime, Inc., 139 Hoyt St., Mamaroneck, N. Y.

Circle 236 on Inquiry Card

MOTOR

Totally enclosed, self cooled, ¼ horsepower, 3300 rpm. electric motor, Model 33N29 is designed to conform to specifications CC-M-636. The motor operates from 115 vac, 60 CPS, single phase. It measures 4¼ inches in dia-



meter by 6¾ inches in length and weighs 10 pounds. Western Gear Corporation, Electro Products Division, 132 West Colorado Boulevard, Pasadena, California.

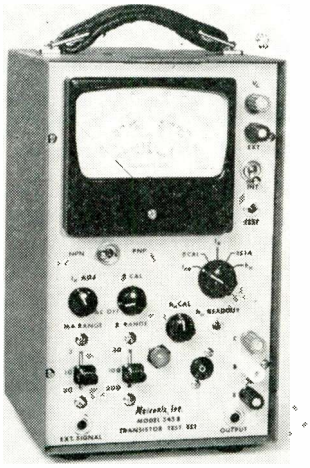
Circle 237 on Inquiry Card

Circle 103 on Inquiry Card

New Products

TRANSISTOR TEST SET

Transistor quality and performance may be determined through direct readout on a meter of 3 fundamental characteristics, with a portable transistor test set, Model 545-B, which

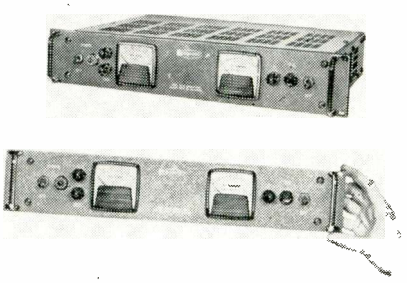


presents the hybrid parameter Beta (h_{21}, h_{fe}), the input impedance (h_{11}, h_{ie}), and the collector cut-off current (I_{co}). Measurement of these factors permits a rapid evaluation of whether a germanium or silicon transistor meets its stated specifications. The unit is designed for both production lines and laboratories. Metronix, Inc., Chesterland, Ohio.

Circle 234 on Inquiry Card

POWER SUPPLY

Models HB2, HB4 and HB6 deliver 200, 400, and 600 ma respectively—each with a dc incremental 4-band output voltage range from 125 to 325 v. with continuously variable output control within each band. Regulation for line or load is less than 0.1% or 0.2 v. Models available with 0.01% regulation. Ripple is less than 3 mv RMS; Recovery time less than 100 μsec.;



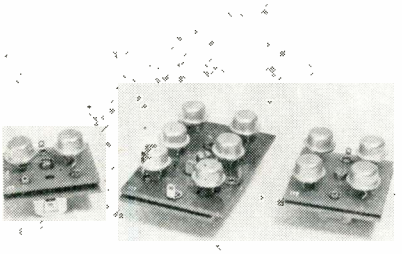
Stability for 8 hrs. less than 0.1%; Ambient operating temp. range from −20°C to +50°C; and the temp. coefficient is less than 0.05% per °C. Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y.

Circle 235 on Inquiry Card

New Products

SILICON RECTIFIERS

Series of silicon printed circuit rectifier assemblies can be mounted in any desired configuration on high temp. printed circuit boards. They are available for single and 3-phase

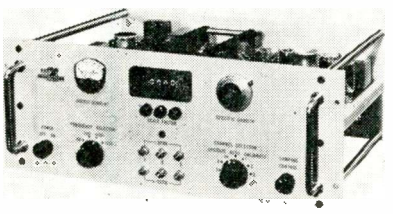


power supply applications, in half-wave, doubler, center tap and bridge circuits. They are hermetically sealed and will operate in adverse environments up to temperatures of 150°C. Basic ratings are available up to 3 adc and 800 v. in a single phase assembly, as well as 4.5 adc in three phase assemblies. International Telephone & Telegraph Corp., Components Div., Clifton, N. J.

Circle 240 on Inquiry Card

DIGITAL INDICATOR

Servo null-balance Digital Indicator, Type 6R, features high-accuracy multi-channel readout with pulse producing transducers. Accuracy is ±0.25%. Linearity is ±0.25% at any point over a 10 to 1 range. With 4 digit readout, it has a resolution of up to one part in 9,000. Ten scale ranges are available and it presents an analog numerical readout which continuously follows both increasing and decreasing transducer output. An



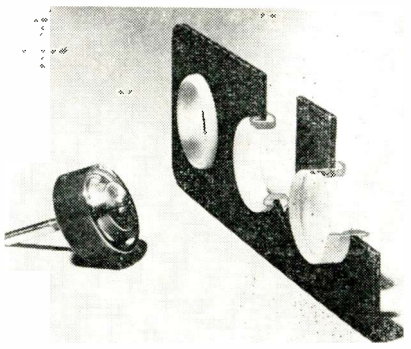
analog output voltage is provided for use with oscillographs and recorders for measuring transients and high-speed fluctuations. Cox Instruments Div., George L. Nankervis Co., 15300 Fullerton, Detroit 27, Mich.

Circle 241 on Inquiry Card

New Products

GROMMET

One-piece, solid grommet of Zytel 103 nylon fits snugly and cannot shake loose nor pop out. The nylon wears well and does not chafe material, such as electrical wire, which

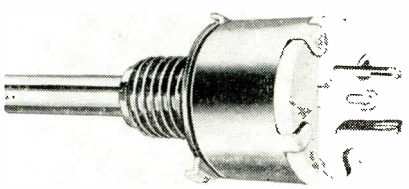


may pass through the grommet. In addition, it provides excellent electrical insulative properties. The grommet is used in the temp. range of −65° to 300°F. The grommet is inserted through the aperture and flanged over by a simple tool. The tool may be used in a common drill or arbor press or, in a hand pressure mechanism. Western Sky Industries, 21301 Cloud Way, Hayward, Calif.

Circle 238 on Inquiry Card

VARIABLE RESISTORS

High temp. variable resistor with infinite resolution, Series 600 Cera-Trols exceed Mil-R-94B. Power ratings are ¾ w @ 85°C, ½ w @ 125°C and zero load @ 175°C. Resistance range is 100 ohms thru 5 megs (linear taper), temp. range −63°C to +175°C, and temp. coefficient 250 to 500 PPM/°C. Load life 1000 hrs. ¾ w at 850°C or ½ w @ 125°C, 350 v max., av. change is ±4%, moisture resistance 1.3%,



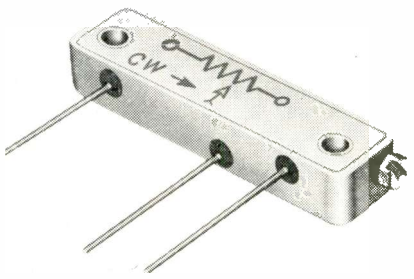
low temp. storage 0.5%, low temp. operation 1%, thermal cycling 2%, rotational life 7.5%, high frequency vibration 1%, and shock 1%. Chicago Telephone Supply Corp., Elkhart, Ind.

Circle 239 on Inquiry Card

New Products

POTENTIOMETER

High temperature miniature wirewound trimming potentiometer, Model 927, is set to give zero end play. Stability is 60 ppm to 190°C. Unit takes 3.5 w at 30°C, and will handle 0.35

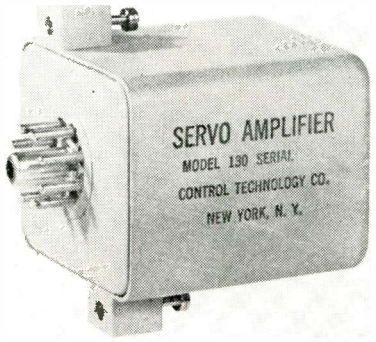


w at 175°C, and 30 g vibration at 2000 cps. It passes MIL-STD 202, Method 106, for moisture resistance, and meets many other Mil. Specs. Resistance range: 100 ohms to 100,000 ohms. Life at 190°C is 2000 hrs. min. (unlimited at 100°C). Aero Electronics Corp., 1745 W. 134th St., Gardena, Calif.

Circle 242 on Inquiry Card

SERVO AMPLIFIER

Amplifier will drive either 3.5 w or 6 w servo motors from low level 400 CPS signals. Max. gain is 2000, adjustable by external resistor. Gain stability is 3 db over temp. range. Input impedance min of 100K at all gains and isolated input makes the amplifier ideal for computing applications. Internal limiting prevents overdrive for high input signals. Op-



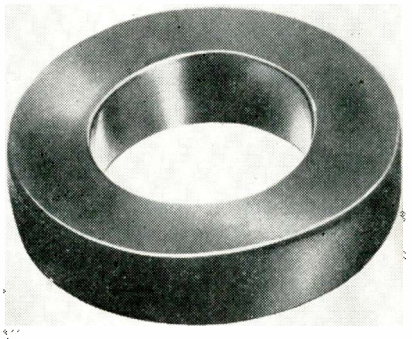
erates on 28 vdc with internal protection against dc line transients. Meets MIL E 5272. Control Technology Co., 1186 Broadway, N. Y., N. Y.

Circle 243 on Inquiry Card

New Products

TAPE WOUND CORES

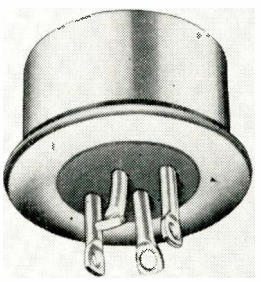
Nickel-iron tape wound cores Super Hymu "80" cores, are guaranteed to have an initial permeability greater than 55,000, tested at 20 gauss, 100 CPS. Its characteristics make it attractive when operating at low levels: it exhibits high gain in many types of amplifiers; has low hysteresis losses; and exhibits high permeability at low frequencies. Accidental contamination is eliminated by vacuum melting. G-L Electronics, Inc., 2921 Admiral Wilson Blvd., Camden 5, N. J.



Circle 244 on Inquiry Card

THERMOSTAT

Series of hermetically-sealed, 3-phase precision thermostats, the Klixon 2862 Series, for wye-connected circuits are actuated by snap-acting, bimetal discs, are fixed temp. set within a −65°F to +300°F range. Switch action is 3 circuit, single-pole, single-throw and can be made to either open or close on temperature rise. Other features: Operating temp. tolerance, open ±8°F, close ±5°F; Minimum normal temp. differential, 20°F; temp. exposure limits, −65°F to +325°F. Metals & Controls, 34 Forest St., Attleboro, Mass.

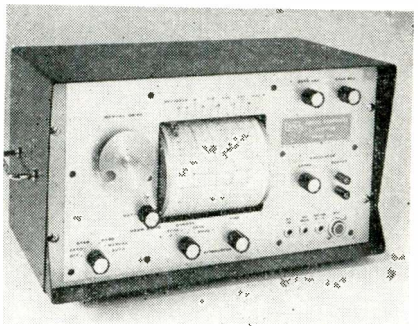


Circle 245 on Inquiry Card

New Products

RESPONSE PLOTTER

Model ARP-2, Audio Response Plotter, provides frequency response curves of audio range equipment. It will plot curves too complex to be drawn by hand—such as the response



of a loudspeaker in a live room. It can be used as a 0 to 1 vdc recording voltmeter. Input to the system under test is supplied by a continuous, single-sweep 20-20,000 CPS audio oscillator. Records are plotted automatically on a 40 db-range logarithmic chart. Southwestern Industrial Electronics Co., 10201 Westheimer Rd., Houston 19, Tex.

Circle 254 on Inquiry Card

SQUARE WAVE GENERATOR

Model 1715 is for production testing of audio and video amplifier response, oscilloscope operation, network, steady state and transient response measurement at audio, ultrasonic or low radio frequencies and for testing triggering, coding, or gating network and circuits. Rise time is 0.02 μsec. for pulse

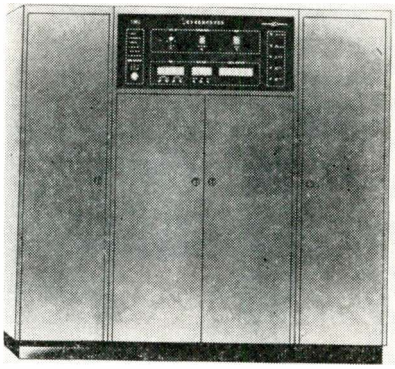
work and a frequency coverage from 1CPS to 1MC. Frequency range is in 6 decade bands. Frequency is variable throughout the entire range. The Hickok Electrical Instrument Co., 10606 Dupont Ave., Cleveland 8, Ohio.

Circle 255 on Inquiry Card

New Products

DATA PROCESSING SYSTEM

The Series 2000 Data Processing System, for processing industrial data, uses 4 basic modular chassis, plug-in housings, and a pin-board arrangement for function programming.

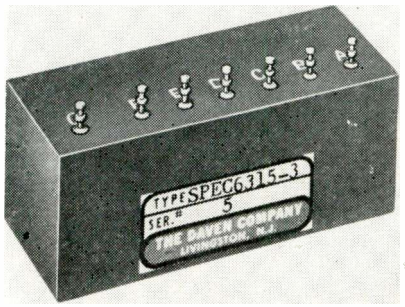


Solid state components have been incorporated for reliability. The basic logging unit which records process data, on a log sheet or other output device, can be expanded to provide scanning of an increased number of points and to perform a broad range of additional operations. Controls Div., Hagan Chemicals & Controls, Inc., Hagan Bldg., Pittsburgh 30, Pa.

Circle 246 on Inquiry Card

RESISTANCE NETWORK

High accuracy resistance network is for ac analog computer applications. A typical unit packages 6 ac matched resistors, up to 2.0 megs each, in less than 2½ cu. in. and weighs less than 2½ oz. Approximate equal value resistor can be matched to better than 0.005% over a temp. range of −15°C to +65°C. Wider tolerances are necessary for large ratio values and wider temp.



ranges. The reactive match at 400 cycles can be held as close as 20 microvolts per volt for a 6 resistor network. The Daven Co., Livingston, N. J.

Circle 247 on Inquiry Card

New Products

INDICATOR

Long Life Jumbo Nixie Indicator Tube, Type B7031 is 4th in a series capable of continuous operation over 30,000 hrs. The tube provides a numerical display of the digits zero through

nine in a common viewing area. The characters are 2 inches high and are visible over 150 feet. Featured is a side viewing design for close stacking of tubes. Burroughs Corp., Electronic Tube Div., P. O. Box 1226, Plainfield, N. J.

Circle 248 on Inquiry Card

THERMAL CIRCUIT BREAKER

Thermal circuit breakers eliminate danger of open-circuiting due to current-generated heat. The unit can safeguard equipment against overheating by detecting the ambient temp. and opening the critical circuit at a prescribed temp. "FIL-THERM" will interrupt line current to an equipment when the ambient temp. reaches a preselected level, independent of the current flowing through it.

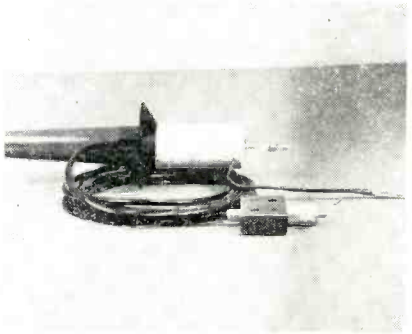
They can be supplied in temp. range, from 100°F to 2500°F, with a sensitivity of operation up to ±0.3% of the rated temp. Filtron Co. Inc., Flushing, N. Y.

Circle 249 on Inquiry Card

New Products

HIGH-VOLTAGE PROBE

The Type P1000 High-Voltage Probe for oscilloscopes is rated at 12 kv, dc or RMS, 25 kv peak. Attenuation ratio is 1000 to 1, rise time is 12 mμsec, frequency response is dc to

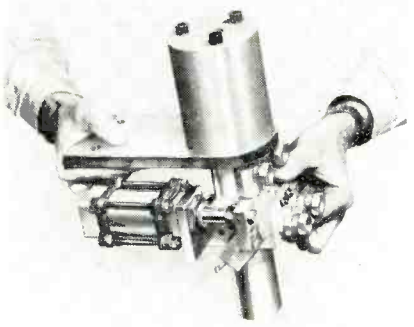


30 MC. Input impedance is 2.5 μμf paralleled by 100 megohms. A compensating network at the oscilloscope end of the probe cable permits adjustment to oscilloscope input capacitances from 20 μμf to 47 μμf. The probe is 12 inches long including handle, and has a 12 foot cable. Tektronix, Inc., P. O. Box 831, Portland 7, Ore.

Circle 250 on Inquiry Card

MIXING HEAD

Mixing head for valving, mixing and dispensing polyurethane foams controls 2 or 3 material streams with sharp cut-off for "on-off" operation. Designed for continuous recirculation of chemical components when mixing is not taking place, it allows for pressure balance of the "Mix" and "Recirculate" cycles, for accurately proportioned components throughout the foaming cycle. Snap-action of this



air-cylinder-actuated valve insures reproducibility of shots for accuracy of pours for filling cavities and molds. The Martin Sweets Co., Inc., 114 S. 1st St., Louisville 2, Ky.

Circle 251 on Inquiry Card

New Products

ULTRASONIC CLEANER

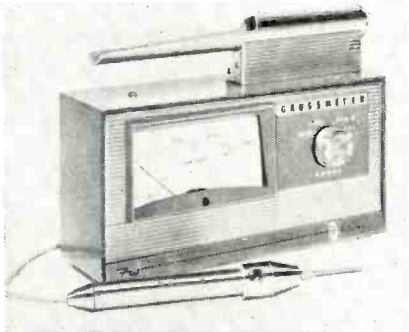
Model 250, ultrasonic cleaner, for use where high energy density ultrasonic cleaning is required, features a 5-gal. heavy-gauge polished stainless steel tank 12 x 12 x 9 in. Forty-four

and one-half per cent of the tank bottom is covered with driving elements. It delivers an av. power output of 250 w and produces peaks of 1000 w. Features include 0-60 min. timer, one tube oscillator, remote control, front panel switching which permits a choice of either of 2 transducers and circuit breaker, and 3-wire ground protection. The unit can be adjusted to available line voltage with a front panel switch. National Ultrasonic Corp., 111 Montgomery Ave., Irvington 11, N. J.

Circle 252 on Inquiry Card

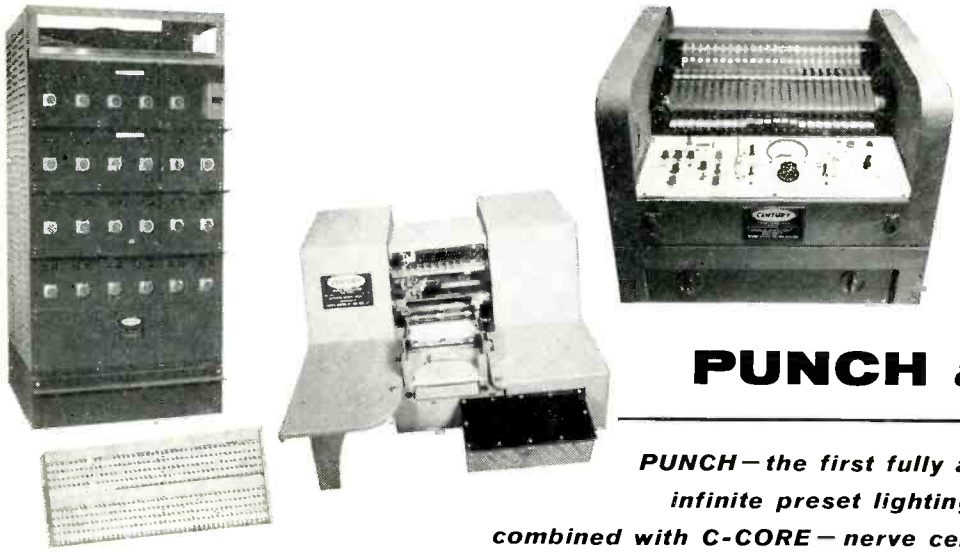
GAUSSMETER

Direct-reading gaussmeter measures direction and magnitude of flux density. Operating on the Hall Effect, Model 100 uses a thin wafer of high-purity indium arsenide with a temp. coefficient of 0.1%. The element (0.019 in. x 0.125 in.) permits insertion of the flat probe tip into narrow air gaps. Active area of the sensing element is equal to a circle of 0.0625 in. dia. Three scales give readings of: 0 to 300, 0 to 3,000 and



0 to 30,000 gauss. It will read dc flux in the presence of a strong ac field, rejecting the ac field and giving strong, continuous readings. F. W. Bell, Inc., 1356 Norten Ave., Columbus 8, Ohio.

Circle 253 on Inquiry Card



PUNCH *and* C-CORE

PUNCH—the first fully automatic instantaneous infinite preset lighting system in the world combined with C-CORE—nerve center of the dimmer control!

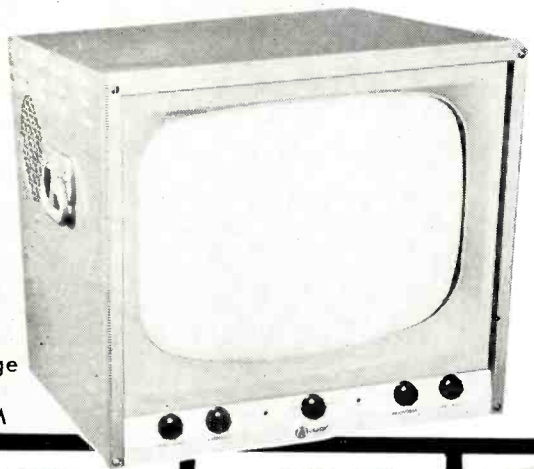
Conventional preset panels may be replaced by Century's electrically operated card punching and card reading machines. All scenes or cues are in card form and these cards are "read" at speeds up to 120 per minute. Another revolutionary development is the C-CORE Dimmer (silicon controlled rectifier) compatible with Century's infinite preset PUNCH system. Send for PUNCH and C-CORE brochures.

CENTURY

CENTURY LIGHTING, INC. *521 West 43rd St., N. Y. 36*

1820-40 Berkeley St., Santa Monica, Calif. / 1477 N.E. 129th St., N. Miami, Florida

Circle 130 on Inquiry Card



For Prices See Page 533 In EEM

WITH MORE UTILITY MONITORS IN BROADCAST THAN ANY OTHER MANUFACTURER

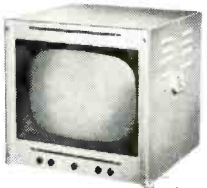
Now Our New "INSTRUMENTATION SERIES" Exceeds Broadcast Requirements—Resolution And Stability

- Designed for Critical Military Space Application
- Regulated Power Supplies
- Heavy Duty Metal Cabinet
- 800 Line Aluminized Kine
- Excellent Video Tape Sync Stability
- Single Chassis Or Plug-in Construction Optional

A Complete Line For Every Application, Broadcast, Closed-Circuit, Military

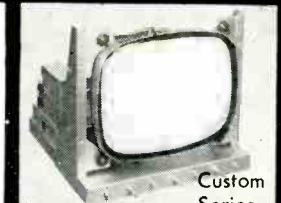
L59B/8"

L59B/17"



K59/21M

Rack Mounting



Custom Series

MIRATEL CONELRAD EQUIPMENT

1. Air Alert I Receiver
2. Air Alert II
3. Voice Operated Relay

1

2

3

Manufactured by MINNESOTA RADIO AND TELEVISION, INC.
1080 DIONNE ST., ST. PAUL, MINNESOTA

Miratel INCORPORATED

Circle 131 on Inquiry Card

Tele-Tech's ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • OCTOBER 1959

SYSTEMS—WISE . . .

▸ The Army has requested temporary use of the 144-148 MC amateur band from Oct. 17 to Nov. 10, 1959 to operate VHF radio relay equipment in the vicinity of Fort Bragg, N. C. A large-scale military air-ground training exercise, Operation Dragon Head, will require the use of a large number of frequencies for operation of military radio communication equipment which will be concentrated in the area. The request was subject to the condition that interference will not be caused to amateurs. In the event that it does occur, it is understood that the Army will take immediate remedial action.

▸ FCC reports that a sample of approximately 100 violations notices issued to licensees of Class D stations in the Citizens Radio Service shows a wide misunderstanding of the purpose of the service. Of the sample, 44 were for violation of the "short-distance" provision; 61, for violation of the rule which requires communications to be carried out in the minimum practicable time; 57 violations, off-frequency operation; and, 3 for overmodulation.

▸ The TV "booster" station bill introduced by Senator Frank E. Moss (D-Utah) to authorize the FCC to permit operation of these stations has been favorably reported by the Senate Committee on Interstate and Foreign Commerce. Features of the bill are: allow FCC to waive construction permit requirement for established booster stations; and, allow the Commission to permit operation of the stations without constant attendance by a licensed operator.

▸ Four-track stereo is believed to have been presented on radio for the first time over WQXR on September 1. The new series, "Stereo Tape Time," is sponsored by Ampex Audio, Inc.

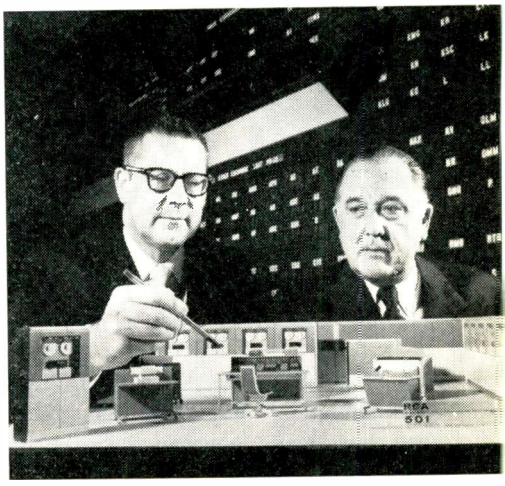
N. S. SAVANNAH SIMULATOR

This training simulator, responding exactly as does the atomic propulsion plant, plays an essential part in the practice drills for officers of the world's first nuclear-powered merchant ship, *N. S. Savannah.*

▸ "Snake batteries" which are strung on submarine communications cables to power repeaters have been developed for the U. S. Army Signal Corps. The flexible, zinc-silver chloride batteries, called electric eels, were developed by the Chemical Div., Aerojet-General Corp., Azusa, Calif., in cooperation with the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J. In use, a battery is placed next to each repeater. These are spliced into the cable every mile to boost voice or teletypewriter signals.

WALL STREET COMPUTER

Partners in E. F. Hutton & Co. discuss a layout model of RCA's Electronic Data Processing Center which will be installed in Wall Street this Fall. A member of the New York Stock Exchange, this investment firm was the first to sign up for the new Center's services.



▸ A Center for Instructional TV has been established by New York University in collaboration with the Radio Corporation of America. The Center's program, designed to develop and disseminate the most effective techniques for televised teaching in the nation's schools, will begin in September. RCA has provided some $100,000 in funds and TV equipment for the Center, located in the South Building at the University's Washington Square Center.

▸ The U. S. Navy has purchased a Dalto Visual Flight Simulator Attachment for evaluation by the Naval Training Device Center and the Airborne Early Warning Training Unit, Atlantic. The training aid has been delivered to the Naval Air Station, Patuxent River, for installation in connection with a WV-2 flight simulator. The closed circuit TV system will be evaluated in the extreme low visibility approach and landing phase of WV-2 aircraft instrument flight training. The WV-2 is an early warning radar version of the Lockheed Super Constellation.

▸ Applied Science Corp. of Princeton (ASCOP) has received a contract award of $794,000 for supplying digital data transmission systems for the Eglin Gulf Test Range, Eglin Air-Force Base, Florida. The 450-mile Eglin Gulf Test Range is a huge electronic "scoreboard" that will allow up to three missiles to be flown against three remotely controlled drones. All vehicles in flight will have flight-performance data monitored simultaneously.

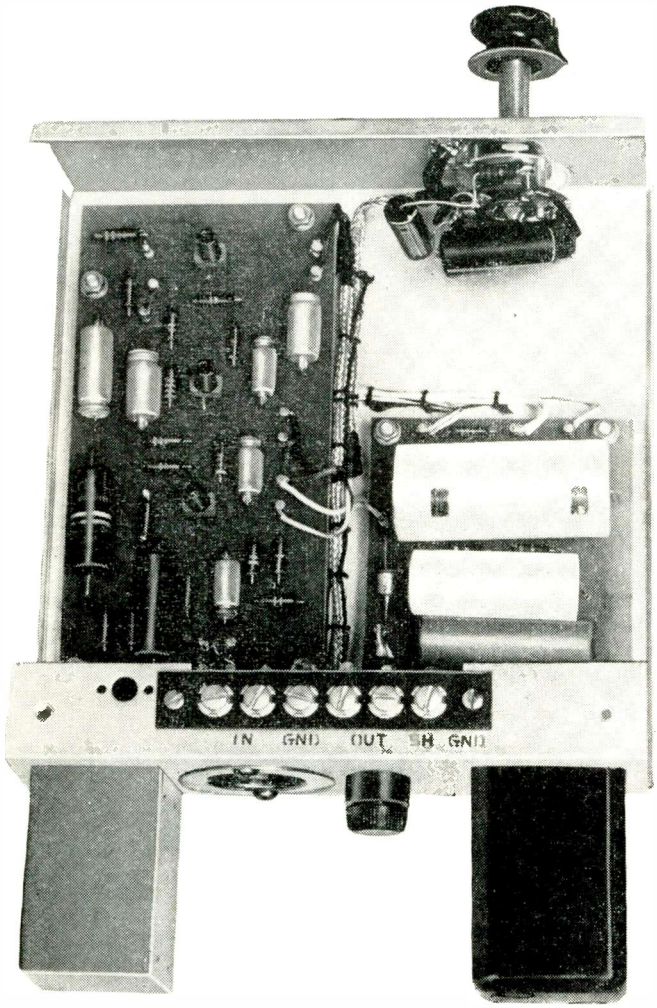


Fig. 1: Preamplifier with the cover removed

The design of a preamplifier equalizer for a magnetic pickup requires consideration of the normal recording level, pickup characteristics, and output level requirements. These design considerations are described in an easy to follow manner.

For Magnetic Pickups . . .

Transistorized Preamplifier Design

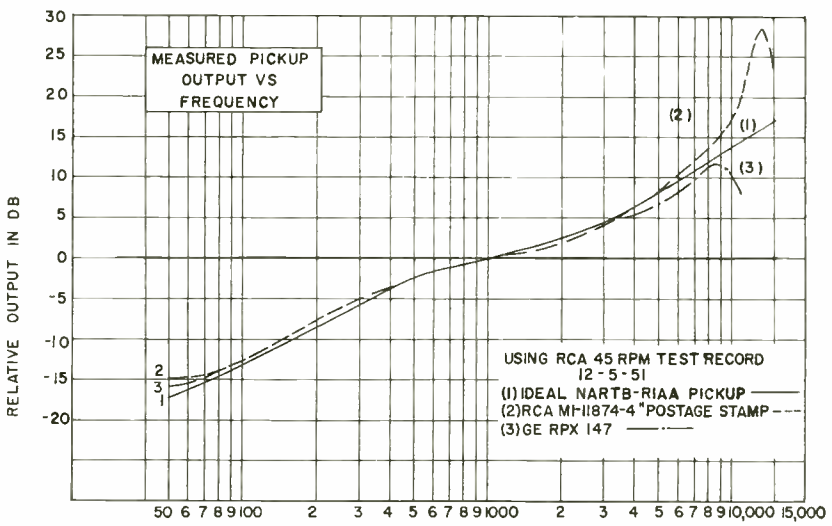
By HAROLD J. PAZ
Transistor Circuit Design Eng.
Surface Communications Dept.
Radio Corp. of America
Camden 2, N. J.

A TRANSISTOR preamplifier equalizer for magnetic pickups has been designed for use in broadcast studios. It can be used with low impedance magnetic or high impedance variable reluctance type cartridges.

The design of a preamplifier equalizer for a magnetic pickup requires consideration of the normal recording level, the characteristics of the pickup, and finally the output signal level required. The preamplifier is designed for the low impedance magnetic and the variable reluctance pickup similar to the "postage stamp" and G.E. RPX147 respectively.

The input level to the preamplifier is dependent upon the recording level and the transducer efficiency of the particular pickup. A 45 RPM test record RCA #12-5-51 has a normal recording level of 6.3 cm/sec at 1 KC. This level has found general acceptance and is used in this preamplifier design. Using the normal level test band of this record, the "postage stamp"

Fig. 2: Data was plotted using 1000 cps as the reference voltage point



pickup delivers an open circuit voltage of 12 mv.

The output level of −20 dbm was chosen, since this is a proper level at which to enter the mixing bus of a broadcast sutdio consolette. This level eliminates the requirement for a booster amplifier in the consolette, and simplifies the wiring and placement of turntables.

Pickup Frequency Response

Fig. 2 shows the frequency response characteristics of the pickups when the data is obtained from the test record which used the NAB-RIAA recording characteristics. The pickup under observation is played on this test record and the unloaded pickup is measured with a vacuum tube voltmeter. The data obtained is plotted in Fig. 2 using 1000 CPS as the reference voltage from which the increase or decrease in output voltage is measured. Curve 1, Fig. 2, shows the theoretical frequency response of an ideal pickup. This curve has a turnover frequency at 2120 CPS and a 6 db-per-octave boost up to 15 KC. The curve below 1000 cycles has a 6 db-per-octave cut starting with a turnover frequency of 500 CPS down to 50 CPS. Below 50 CPS the curve flattens out by cancelling out the 6 db-per-octave cut at 50 CPS by a 6 db-per-octave boost at a turnover frequency of 50 CPS. Curve 2 is a plot of the unloaded output voltage of the "postage stamp" pickup. Note the departure of this pickup from the ideal curve beyond 7 KC with a resonant peak around 13 KC. This 13-KC peak can be reduced by loading the pickup output terminals with a capacitor. This external capacitor combines with the internal inductance of the pickup to form a resonant L-C filter which tends to reduce the peak. Subsequently, an R-C filter is added to reduce the peak further, as will be seen later on. The pickup can be equalized by this method to within ±4 db from 50 to 15000 CPS. Curve 3 is the frequency response characteristics of an unloaded variable reluctance pickup.

Pickup Impedance

The input impedance of the transistor preamplifier equalizer should be high enough so that it does not load the magnetic pickup. It is generally known that the high frequency response of a variable reluctance pickup decreases at a rate of 6 db-per-octave when it is heavily loaded. Fig. 3 shows the measured source impedance of the magnetic pickup at any frequency between 50 to 15000 CPS. The "postage stamp" pickup has a dc resistance of 120 ohms and an internal inductance of 3 mh. The measured impedance of this pickup is shown by Curve 1. Note that the source impedance of this pickup is 120 ohms at 50 CPS and increases to 370 ohms at 15000 CPS. The variable reluctance pickup, however, has a much higher impedance at any frequency. Its source impedance at 15000 CPS will determine the required input impedance to the transistor preamplifier equalizer. The variable reluctance pickup has a measured impedance of 260 ohms at 50 CPS and increases to 14000 ohms at 15000 CPS. When this pickup is loaded by a preamplifier input impedance of over 28000 ohms, the loss in the output voltage at 15000 CPS is less than 1 db.

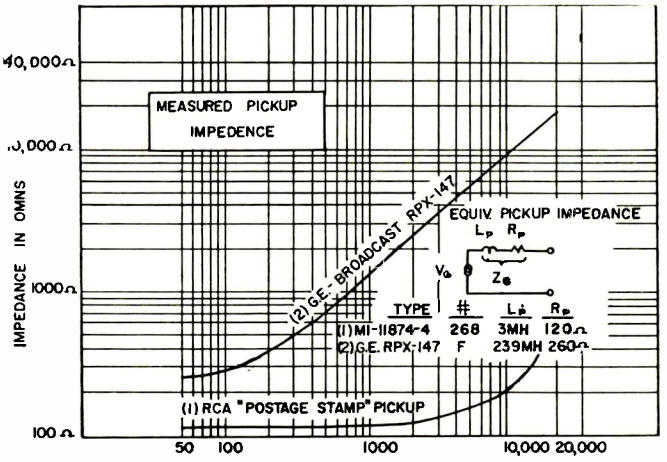
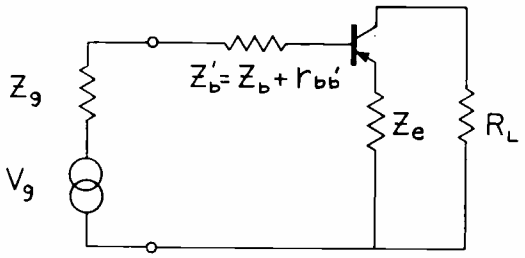


Fig. 3: Measured source impedance of the magnetic pickup

TYPE OF NOISE	AFFECTED BY
(1) WHITE NOISE	I_e, β_{dc}, $r_{bb'}$
(2) 1/f SURFACE NOISE	I_e^2
(3) 1/f LEAKAGE NOISE	I_{co}^2, V_c

Fig. 4A: Three internal transistor noise sources are listed

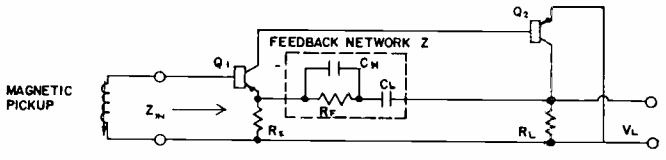


$$(1) \qquad \frac{S}{N} = \frac{V_g}{Z_T \left(\overline{I_{be}'^2}\right)^{1/2}}$$

WHERE $Z_T = Z_g + Z_e + Z_b'$

$\left(\overline{I_{be}'^2}\right)^{1/2}$ = "WHITE NOISE" CURRENT GENERATOR

Fig. 4B: Effect of external impedances on signal to noise ratio



TRANSISTOR FEEDBACK EQUALIZER CIRCUIT

DESIGN EQUATIONS:

(2) $Z_{IN} = B_1 B_2 R_E$

ASSUME FEEDBACK AT 50 CPS WHEN $Z \ll B_2 R_L$

VOLTAGE GAIN

(3) $V.G. = 1 + Z/R_E$

MIDBAND VOLTAGE GAIN

(4) $V.G._{MID} = 1 + R_F/R_E$

500 C.P.S. TURNOVER

(5) $C_L = 1/2\pi 500 R_F$

2120 CPS TURNOVER

(6) $C_H = 1/2\pi 2120 R_F$

Fig. 5: Transistor feedback equalizer with NAB compensation

Signal-To-Noise Ratio

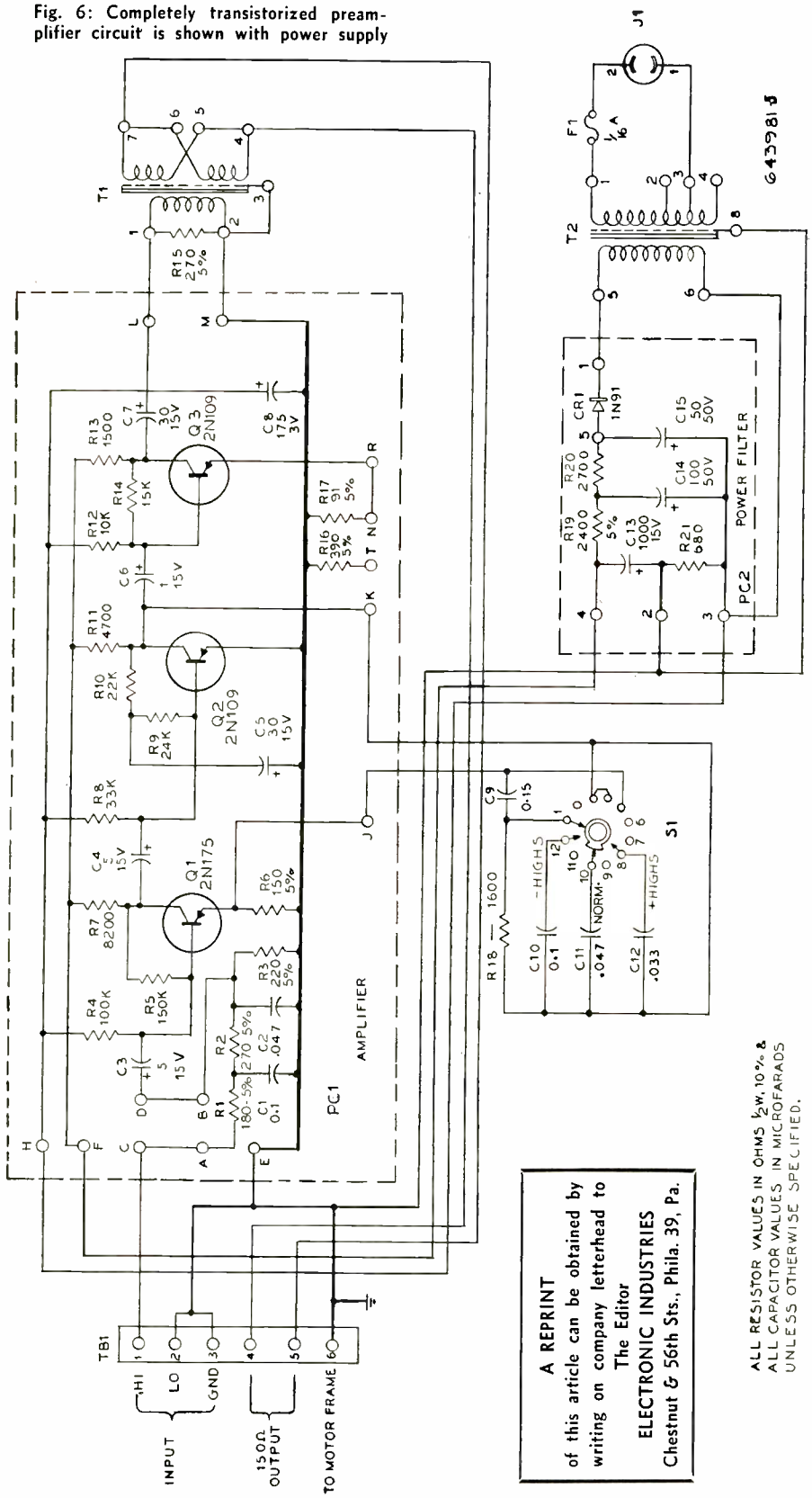
The signal-to-noise ratio is an important consideration in the design of a transistor preamplifier equalizer. The amplifier signal-to-noise ratio is dependent on the noise in the transistor used in the input stage of the preamplifier. Transistor noise is affected by the

Preamp Design

quiescent collector operating point and the external impedances of the transistor. A fundamental understanding of the effect of these external parameters on transistor noise will help in designing a low noise transistor preamplifier. The three sources of transistor noise which are affected by the quiescent collector operating point are shown in Fig. 4A.

"White noise" is directly proportional to the quiescent emitter current and is inversely proportional to the dc common emitter current gain, B_{DC} and the base lead resistance r_{bb}'. The second course of noise "surface noise," is proportional to the square of dc emitter current, I_E^2, and inversely proportional to the frequency. Lastly, the "leakage noise" is proportional both to the square of the leakage current, I_{CO}^2, and the collector to base voltage, and inversely proportional to frequency. White noise is much greater than leakage noise or surface noise when 5 volts and 0.5 ma are the quiescent collector operating point of a 2N175 low noise transistor.

Fig. 6: Completely transistorized preamplifier circuit is shown with power supply



ALL RESISTOR VALUES IN OHMS ½W. 10% &
ALL CAPACITOR VALUES IN MICROFARADS
UNLESS OTHERWISE SPECIFIED.

Lin[1] has derived an equation showing the effect that external impedances have on signal-to-noise ratio. This equation is shown in Fig. 4B. Signal-to-noise ratio is equal to the generator voltage, V_g, divided by the sum of all the external impedances Z_T and the equivalent white noise current generator $(I^2_{be})^{1/2}$. In this equation the signal-to-noise ratio is independent of the transistor current amplification factor, B. In general, negative feedback does not influence the signal-to-noise ratio but is useful in decreasing distortion and increasing the transistor input impedance. The total impedance Z_T is equal to the sum of the phonograph pickup impedance Z_E, and the impedance in series with the transistor base electrode including the internal base lead resistance r_{bb}' of the transistor.

For a good signal-to-noise ratio we need to follow two rules in the equalizer preamplifier design. First, select a low noise transistor and operate it, both at a low collector voltage V_c and low emitter current, I_e, since transistor noise is directly proportional to both these factors. Then, with a minimum internal transistor White noise, select the external parameters so that Z_T is low enough to give a high signal-to-noise ratio. The "spot" signal-to-noise ratio of the RCA "postage stamp" pickup if measured with a filter with 1-CPS bandwidth will not change more than 4db over the frequency bandwidth because its source impedance is only 350 ohms at 15000 CPS. If the emitter impedance Z_E is selected at 150 ohms, then Z_t,

[1] H. C. Lin, *J. Audio Eng. Soc.*, 4, 168 (1956).

(*Continued on page* 189)

CUES for Broadcasters

Transmitter Interlock Bypass

WILLIAM R. SHOOTS, Ch. Eng.
KHBM, Monticello, Ark.

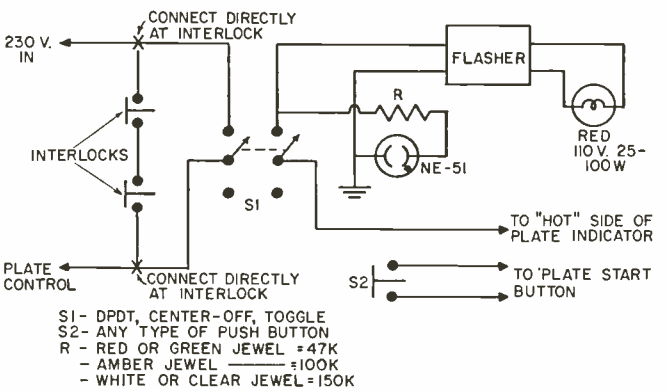
There are many stations with usually no more than one announcer or engineer on duty at a time, and for these stations the interlock and power control arrangement of the BC-1F, and similar transmitters, present a problem when it comes to troubleshooting and emergency operation. Temporary devices such as jumpers are to be avoided to prevent confusion and possible electrocution.

Here, at KHBM, I installed an interlock bypass (cheater) switch complete with a warning indicator in the BC-1F. The switch allows on-the-air operation with the rear door(s) open. It is a DPDT toggle unit with center-off. The panel indicator is a jeweled assembly with neon bulb. The warning indicator is a red bulb (up to 100 watt). It is screwed into a standard flanged receptacle which is mounted in the center of the bottom side of the dust catcher (this is near the top of the transmitter, inside). The flasher is a component from a store display-window sign. Most retail stores have many of these stuck away somewhere, and are available for just asking. The plug and receptacle are cut-off the cord, leaving the flasher with the desired amount of cord.

Connecting the indicators between 230 volts and ground applies 115v across them, when the high voltage is turned on. At this time (within a few seconds) the red bulb begins to flash, slowly, warning the operator of the presence of high voltage.

The auxiliary (remote) plate start button is any available push-button, even a door bell type. The high voltage is turned off by returning the bypass switch to Normal. The bypass switch and neon indicator are mounted on the rear, center column (outside) along with a 5 by 7 in. frame which encloses instructions and caution, all typed in red. Green and red squares are painted on either side of the bypass switch for "Normal" and "Bypass," respectively. The remote plate switch is sub-mounted behind the column, with a finger sized hole drilled in the column, so it can be pressed from outside without being exposed to danger.

This bypass facility allows the operator to locate simple trouble while waiting for the engineer to arrive, making for less lost air time. It also allows the engineer to trouble-shoot and "peak" the transmitter without assistance. WARNING: Look, but don't reach when the red light blinks!



Neon bulb is used as an extra indicator in case the flasher bulb should fail.

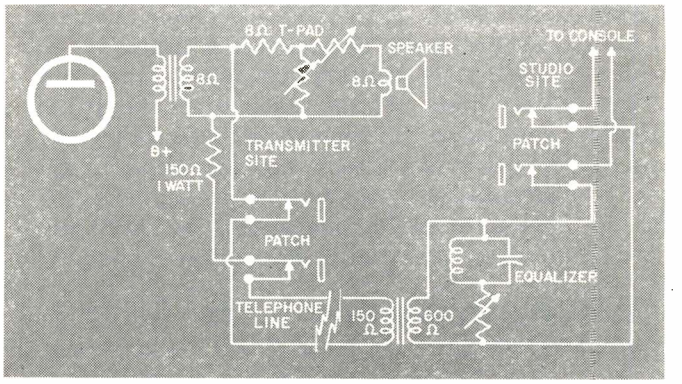
Off Air Monitor

C. R. MILLS, Ch. Engr.
WHYE, Roanoke, Va.

In some AM broadcast installations where the studio is some distance from the transmitter site, or there is considerable electrical disturbance, it may be desirable to use the modulation monitor located at the transmitter for off the air monitoring. This can readily be done using the Gates MO-2639 Monitor, a 150 ohm resistor, 8 ohm T-Pad, matching transformer and equalizer. The 150 ohm resistor serves to match the telephone line impedance and to keep the level within telephone co. specifications. It also eliminates the expense of an additional matching transformer.

The speaker level at the transmitter can be varied and not affect the monitor at the studio.

The frequency response and signal-to-noise ratio using this set up are very good. Also, in an emergency the monitoring line can be used as a broadcast line by bringing each end of the line to patch.



Speaker level may be varied at the transmitter without affecting the studio monitor.

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rate will be paid for material used.

WASHINGTON News Letter

RECORD OUTPUT—Factory output of electronics equipment and components, exclusive of R&D expenditures, is estimated to reach a record level of $8.5 billion in 1959, the Electronics Division of the Business & Defense Services Administration of the U. S. Department of Commerce recently forecast. This is $400,000,000 more than was attained for last year. Unlike 1958, when several sectors of the industry suffered reverses during the early part of last year, the BDSA division stated all sectors shared in the substantial rise in output during the first half of 1959.

MILITARY ELECTRONICS—Rising missile and military space activities, together with deferred military expenditures and the increasing electronics content of military hard good or weapon systems, is expected to push 1959 military electronic production to an all-time high. At the same time, the BDSA reported, commercial and industrial electronics output will maintain its steady upward trend to the year-end, stimulated by the nation's rising economic activity, increased capital investment by the industry and increased electronics output as a whole.

MICROWAVE STANDARDS—The FCC will be delayed until late this year or early in 1960 in promulgating final technical standards for private microwave systems. This resulted with the granting of an extension for comments by the Electronic Industries Association on the proposed standards until the last week in September. The Commission had issued, in mid-August, proposed technical rules which consisted in essence of a table showing frequency bands available for licensing of private microwave system, power tolerance, emission bandwidth, and maximum beamwidth of major lobe between 0.5 power points in horizontal plane.

INDEPENDENT PHONE OPPOSITION—Both the General Telephone & Electronics Corporation, the largest system of independent telephone companies, and the U. S. Independent Telephone Association are seeking reconsideration by the FCC of its policy decision to liberalize the use of private point-to-point microwave communications facilities. General Telephone & Electronics (the combination of the General Telephone Corp. and Sylvania Electric Products Inc.) is planning to seek a rehearing on the FCC's policy decision and promulgation of final technical standards. The U. S. Independent Telephone Association is challenging the FCC finding that the Bell System and Independent telephone companies restrict interconnection with private microwave systems and stated that both segments of the telephone industry "do and will provide circuits to connect private communications systems."

MORE FREQUENCY SPACE—One of the fastest growing mobile radio services, the Special Industrial Radio Service has petitioned the FCC for the return of frequency space to meet its increasing needs for exclusive spectrum bands. The SIRSA advised the Commission that, despite allocation of 13 frequencies from newly derived mobile radio "split" channels, other industrial services benefitted more and the special industrial service "was and is the most crowded." The SIRSA asked the return of the 49.51-49.60 MC band in view of the abandoning of a North Atlantic "scatter" system in favor of a new transatlantic telephone cable by the International Civil Aviation Organization. Bands in the 460-470 MC range which had been assigned to the Citizens Radio Service also were requested.

National Press Building
Washington 4

ROLAND C. DAVIES

MORE TRACKING STATIONS—The nation's civilian space agency has disclosed plans to establish a satellite tracking station in Minnesota. This will be the first of its kind in the Midwest. It is also the first of an undisclosed number of additional tracking stations that are being planned for various areas of the country for the space program. The U. S. now has ten minitrack stations in operation.

BIDS TOO LOW—A ruling by the U. S. Comptroller General's office says that when a company's bid is quite low on certain items, as compared to Government estimates and other competitive bids, the contracting agency should verify the low bid. This will give any company making an error a chance to withdraw their bid if a mistake has been made.

NEW TITAN SITE—The Air Force has picked Beale Air Force Base as the fifth Titan intercontinental ballistic missile site. The cost of this site will be $42,000,000. As yet there has been no announcement on when the Titan will become operational.

SPACEMAN WITHIN A YEAR—Within the next twelve months the U. S. hopes to place a man briefly into space and return him safely according to Dr. T. Keith Glennan, Administrator of NASA. He also said that at least twenty space shots will be used in preparation of this flight. Some of these shots will be manned with animals. The man is expected to ride in a capsule propelled by a Redstone booster missile.

Preamp Design

(*Continued from page* 186)

the total impedance, is equal to 690 ohms. The measured impedance of the variable reluctance pickup at 2000 CPS is 2500 ohms. This is very much greater than $Z_E + Z_B'$ and so the spot signal-to-noise ratio of the transistor preamplifier will decrease as the frequency increase as shown by the equation in Fig. 4B. If two phonograph pickups have the same value of output voltage V_g, then the pickup with the lowest internal impedance has the highest signal-to-noise ratio when used with a transistor amplifier.

Feedback Equalizer

A transistor feedback equalizer circuit with NAB compensation is shown in Fig. 5.

The amplifier consists of two common emitter transistor stages using R-C coupling with the output from the collector of the second transistor Q_2 fed back by a frequency selective network Z to the emitter electrode of transistor Q_1. In order to simplify the circuit, components that do not play an important role in the feedback equalizer have been omitted. This feedback circuit has two important features required for a preamplifier equalizer for use with the "postage stamp" pickup or the variable reluctance pickup. The circuit has a high input impedance, an excellent signal-to-noise ratio, and a great deal of negative feedback which results in low amplifier distortion. This two-stage feeback equalizer concept is not new in electronics; in 1952 G. E. Jones, Jr.[2] described an equivalent vacuum tube circuit. Transistors today have a wide variation in their parameters. The current gain, for example, may vary from unit to unit by as much as 4 to 1. An excellent way to control the shape of the frequency response and voltage gain if a transistor amplifier is to use negative feedback. The signal current flowing out the collector of transistor Q_2 (see Fig. 5), divides into two parts; one part flows into the load resistor R_L and

[2] G. E. Jones, Jr., *Audio Eng., 36,* 24 (1952).

(*Continued on page* 190)

(*Continued from page* 189)

the remaining signal current is fed back through the feedback network impedance Z to the emitter of transistor Q_1.

The following design equations are obtained by an analysis of the feedback equalizer circuit shown in Fig. 5.

To insure enough feedback current at 50 cycles, the feedback impedance:

$$Z \ll B_2 R_L. \qquad (1)$$

Where B_2 = current gain of transistor Q_2.

The approximate input impedance of the amplifier is

$$Z_{in} = B_1 B_2 R_E \qquad (2)$$

Where B_1 = current gain of transistor Q_1.

This equation for the input impedance, assumes that the current gain B_1 and B_2 is a constant in the passband. With present audio units the current gain drops to $1/\sqrt{2}$ of its dc value at about 10,000 CPS. Hence, if both transistor Q_1 and Q_2 have a beta cutoff at 10 KC, Z_{in} at this frequency will be ½ the maximum input impedance. By selecting R_E large enough, the input impedance at the upper frequency of the passband can be kept above the required value. A value of R_E = 150 ohms for this model had a measured total input impedance 45000 ohms at 15000 CPS.

The voltage gain at any frequency in the passband is

$$\text{V. G.} = 1 + \frac{Z}{R_E}. \qquad (3)$$

At 1000 CPS, the mid-band frequency, the value of Z is equal R_F so that the mid-band voltage gain

$$\text{V. G. MID} = 1 + \frac{R_F}{R_E}. \qquad (4)$$

Equations (5) and (6), (see Fig. 5), show the value of capacitance C_L and C_H required to satisfy the NAB equalization curve by a turnover frequency at 500 CPS and 2120 CPS respectively.

Circuit Description

The preamplifier equalizer circuit is shown in Fig. 6. The three stage amplifier used 3 pnp transistors with selective feedback to achieve the complementary NAB-RIAA equalizing curve. The ampli-

fier operates from its self-contained ac power supply. Etched wiring printed circuit boards PC1 and PC2 contain the components used in the amplifier and power supply filter respectively. A three-position tone switch S_1 is used to boost or cut the high-frequency response of the preamplifier.

Transistor Q_1 is R-C-coupled to Q_2 and the output is fed back through the frequency selective feedback network C_9, R_{18} and C_{11}, located on switch S_1, to the emitter electrode of Q_1.

The preamplifier etched circuit board PC1 is shown wired to operate from the "postage stamp" pickup. To connect a broadcast type variable reluctance pickup to this amplifier, jumpers across terminals A to C, B to D, and N to R must be removed. This disconnects the two-stage R-C filter R_1, C_1, R_2, C_2, and R_3 required to reduce the 13-KC peak in the "postage stamp" pickup. A jumper across terminals C to D connects the variable reluctance pickup directly into the high input impedance of transistor Q_1. The 2120 CPS turnover required when equalizing for the NAB curve is provided by R_{18}, a 1600 ohm resistor located on switch S_1 and capacitor C_{11}, a 0.047μf capacitor. The R-C time constant required for the 500 cycle turnover is provided by C_9, a 0.15μf capacitor and R_{18}. The calculated value required for C was 0.2μf but in practice a 0.15μf capacitor was shown experimentally to result in a better response with the magnetic pickup below frequencies of 1000 cycles. The dc blocking capacitors used in the three-stage amplifier result in a third turnover frequency below 50 cycles.

Output Level Adjustment

The output power level of −20 dbm is delivered to the load when either the "postage stamp" pickup or the variable reluctance pickup is used. The voltage that appears at the base input electrode of transistor Q_1 is much lower for the "postage stamp" pickup than it is for the variable reluctance pickup. The output voltage of the "postage stamp" pickup at low frequencies is attenuated by the voltage divider network consisting of R_3, R_2, R_1

(*Continued on page* 192)

Preamp Design

and the internal 120 ohm dc resistance of the pickup. The additional gain required for this pickup is obtained by changing the amount of negative feedback in the emitter electrode of transistor Q_3. When using a variable reluctance pickup, the output level must be readusted by disconnecting the jumpers across terminals R to N and rewiring it across terminals R to T.

Buffer Stage

Transistor Q_3 is a buffer amplifier stage which isolates the output transformer T_1 from feedback equalizer Q_2, whose output impedance is changing with frequency. If the transistor preamplifier is to operate directly into the mixing bus of a consolette, it must have a constant source impedance. The output impedance of transistor Q_3 is too high for the selected output transformer, so R_{15}, a 270 ohm resistor, provides the correct source impedance for the primary winding of the audio output transformer.

The output impedance of the amplifier can be 150 ohms or 600 ohms by connecting the two secondary coils of transformer T_1 in parallel or in series, respectively.

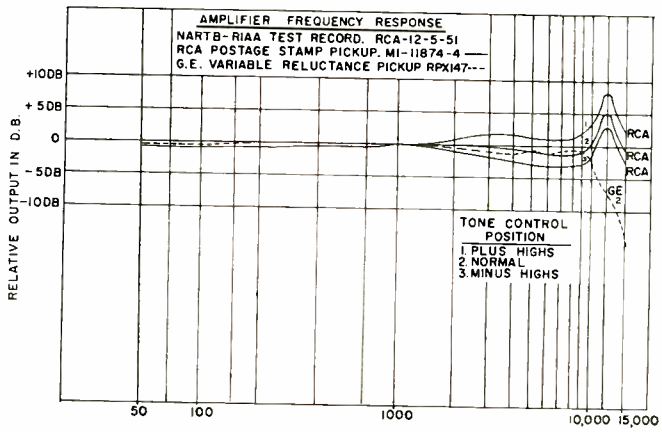


Fig. 7: Graphs show the frequency response of the transistor preamplifier equalizer

A small germanium 1N91 diode is used as a half wave rectifier. A three-section capacitor input filter is satisfactory for the small power requirements of this amplifier. Due to the low gain required for this application the need to use an R-C decoupling filter to isolate the output stage from the input stage is not critical. Resistor R_{21}, a 680 ohm resistor is used to develop a positive voltage that is required to bias the transistors. The ac ripple voltage across R_{21} is filtered by capacitor C_8. This capacitor is a 175μf capacitor located on the etched wiring printed board of the amplifier.

Performance

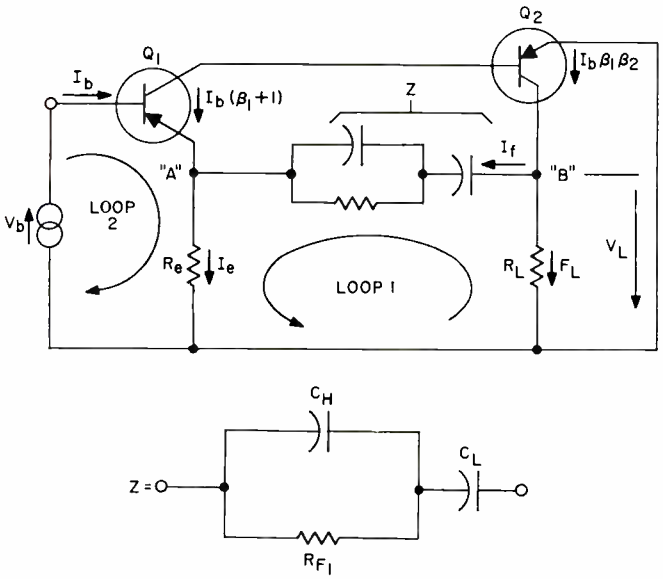
The frequency response of the transistor preamplifier equalizer is shown in Fig. 7 when the "postage stamp" or the variable reluctance pickup is used with the frequency test record. When using the tone control switch S_1 in position 3, the "postage stamp" pickup is equalized to ±4 db from 50 to 15000 CPS. The effect the tone control switch S_1 has on the high frequency response is shown by Curves 1 and 3 in Fig. 7.

The output power level is −20 dbm to a balanced 150 ohm load. The distortion at this output level is less than 1.0% over the frequency range of 50 to 15000 CPS.

The output signal-to-noise ratio is better than a comparable vacuum tube equivalent which measured 55 db compared to 65 db for the transistorized model.

APPENDIX

Transistor Preamplifier Equalizer Derivation of Basic Equations



Assume Q_1 Parameters are $B_1\ r_{e1}\ r_{b1}$

Assume Q_2 Parameters are B_2

Equation for node "A"

$$I_e = (B_1 + 1)\, I_b + I_f \qquad (1)$$

Equation for node "B"

$$I_L = B_1 B_2 I_b = I_f \qquad (2)$$

Equation for loop 1

$$V_L = I_L R_L = Z I_f + R_E I_e \qquad (3)$$

Equation for loop 2

$$V_b = I_b r_{b1} + I_b r_{e1} (B_1 + 1) R_E I_e \qquad (4)$$

Solving for I_f Sub (1) and (2) in (3)

$$I_f = I_b \left[\frac{B_1 B_2 R_L - (B_1 + 1) R_e}{Z + R_L + R_E} \right] \qquad (5)$$

Solving for I_L Sub (5) in (2)

$$I_L = \frac{I_b}{Z + R_L + R_E} \left[B_1 B_2 Z + R_E (B_1 B_2 + B_1 + 1) \right] \qquad (6)$$

Simplified equation for I_L

since $1 \gg \frac{1}{B_2} + \frac{1}{B_1 B_2}$ then

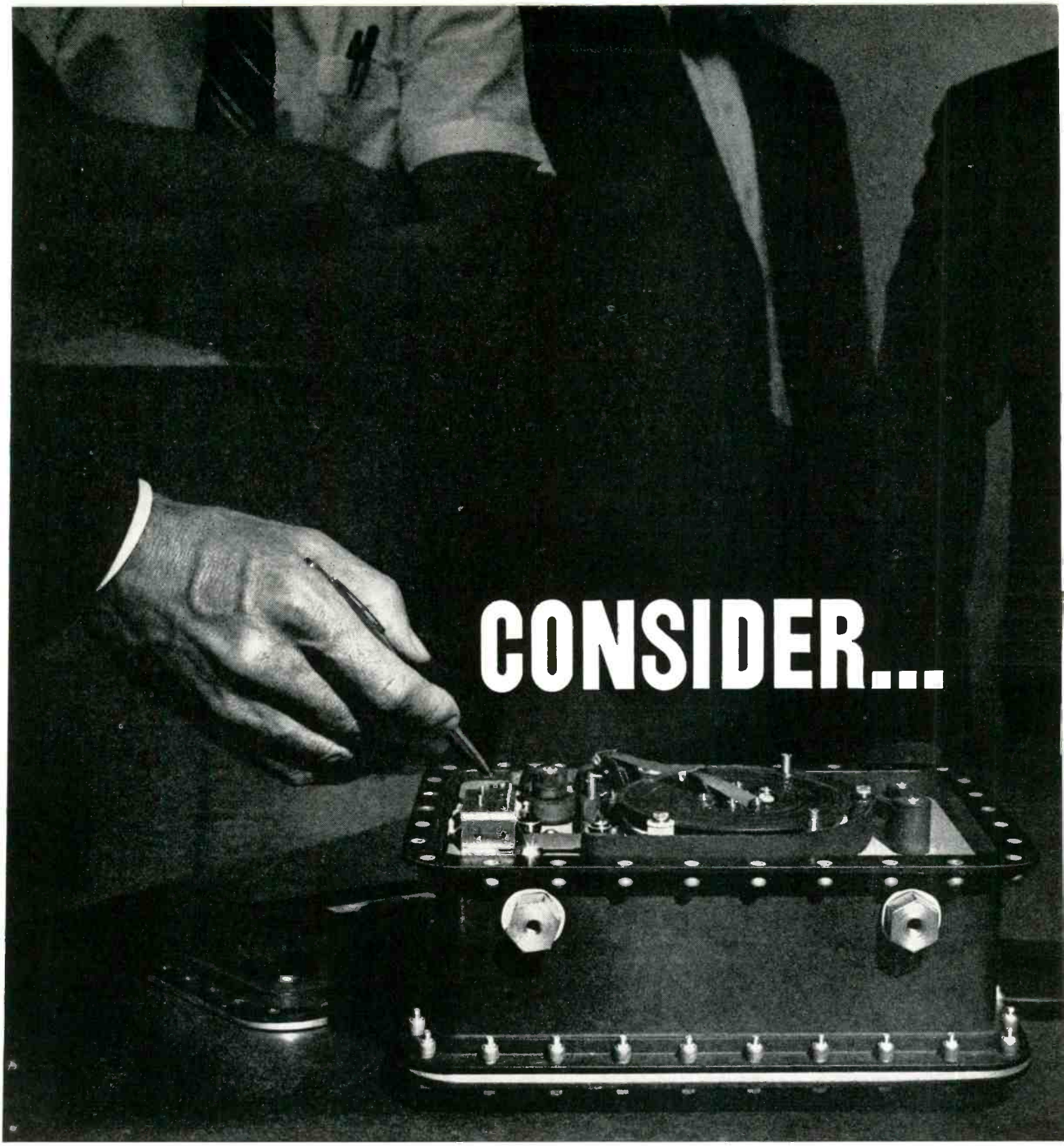
$$I_L = I_b B_1 B_2 \left[\frac{1}{1 + \frac{R_L}{Z + R_E}} \right] \qquad (7)$$

Solving for I_e Sub (5) in (1)

$$I_e = I_b \left[\frac{(B_1 + 1) Z + R_L B_1 B_2 \left(1 + \frac{1}{B_2} + \frac{1}{B_1 B_2} \right)}{Z + R_L + R_E} \right] \qquad (8)$$

Simplified Equation for I_e since $1 \gg \frac{1}{B_2} + \frac{1}{B_1 B_2}$ and $B_1 \gg 1$ then

(*Appendix continued on page 194*)



Lockheed's endless-loop tape recorders

DEVELOPED FOR SPACE COMMUNICATIONS, the recording capabilities of Lockheed's new endless-loop tape recorders are creating interest wherever the need exists for stored data in a critical environment. The original design is now operational in delayed and continuous recording and playback of stored data. Its endless-loop mechanism records and plays back in the same direction of tape travel . . . without rewind.

Variations of this lightweight, small size, low power consumption unit are available in a wide range of tape speeds and multiplicity of tracks. For more information on advanced recording techniques to meet your recording needs, write Marketing Branch, Lockheed Electronics and Avionics Division, 6201 East Randolph Street, Los Angeles 22, California.

Look to Lockheed for LEA*Dership in Electronics*

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REQUIREMENTS EXIST FOR STAFF AND SUPERVISORY ENGINEERS

Circle 136 on Inquiry Card

Transistorized Preamp Appendix

(*Continued from page* 192)

$$I_e = I_b B_1 \left[\frac{(Z + B_2 R_L)}{Z + R_L + R_E} \right] \tag{9}$$

Solving for V_b Sub (9) into (4)

$$V_b = I_b \left[\frac{r_{b1} + r_{e1}(B_1 + 1) + B_1 R_E (Z + B_2 R_L)}{Z + R_L + R_E} \right] \tag{10}$$

Input Impedance

$$Z_{in} = \frac{V_b}{I_b} = r_{b1} + r_{e1}(B_1 + 1) + \frac{R_E B_1 (Z + B_2 R_L)}{Z + R_L + R_E} \tag{11}$$

If $B_2 R_L \gg Z$ @ 2 KC then when $F > 2000$ cps

$$Z_{in} \approx r_{b1} + r_{e1}(B_1 + 1) + B_1 B_2 R_E \left[\frac{R_L}{Z + R_L + R_E} \right] \tag{12}$$

Max. Input Z If $f > 10$ KC

$$Z_{in} \approx r_{b1} + r_{e1}(B_1 + 1) + B_1 B_2 R_E \left(\frac{R_L}{R_L + R_E} \right) \tag{13}$$

Note that B_1 and B_2 are a function of frequency f.

Output Voltage

$$V_L = I_L R_L \tag{14}$$

Substitute (7) into (14)

$$V_L = I_b R_L B_1 B_2 \left[\frac{1}{1 + \frac{R_L}{Z + R_E}} \right] \tag{15}$$

Substitute (10) into (15)

$$V_L = V_b \left[\frac{1 + \frac{Z}{R_E}}{1 + Z \left(\frac{R_E + r_{e1} + \frac{r_{b1}}{B_1}}{B_2 R_L + R_E} \right)} \right] \tag{16}$$

Simplified equation for V_L, since $B_2 R_L \gg R_E$ and if $B_2 R_L \geqq 10Z \left(R_E + r_{e1} + \frac{r_{b1}}{B_1} \right)$

where Z has reached its maximum at $f = 50$ cps, then

$$V_L = V_b \left[1 + \frac{Z}{R_E} \right] \tag{17}$$

At low frequencies where 50 cps $> f >$ 500 cps the output voltage is a function of C_L only since

$$\left| X_{C_L} \right| = \left| \frac{1}{2\pi f C_L} \right| \gg \left| \frac{R_F (-X_{CH})}{R_F - X_{CH}} \right|$$

$Z \approx X_{CL}$ until at $f = 500$ cps where $\left| X_{C_L} \right| = R_F$. This is the first turnover frequency.

$$C_L = \frac{1}{2\pi 500 R_F} \tag{18}$$

Then the voltage V_L will remain constant as the frequency increases, until the shunt capacitor C_H has a shunt reactance that is small enough to change the value of (Z). The next turnover frequency is at $f = 2120$ cps.

$$C_H = \frac{1}{2\pi 2120 R_F} \tag{19}$$

$$\text{or } C_H \approx \frac{C_L}{4} \tag{19a}$$

The midband voltage gain at a frequency of 1,000 cycles per second is

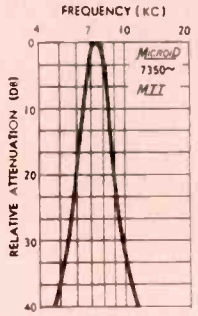
$$V_L = V_b \left[1 + \frac{R_F}{R_E} \right] \text{ when } Z = R_F. \tag{20}$$

SPACE SHRINKERS

MICROIDS AND MONKEYS—Burnell & Co. welcomes the assistance of their simian friends in the task of gathering data vital to space shrinking. By shrinking toroids, filters and related networks for guidance and communication systems, Burnell helps space vehicles carry bigger payloads — more instrumentation, animals — eventually man. Typical of our accomplishments is the *MTT MICROID*® telemetering band pass filter. Significantly, the combined weight of 23 *MICROIDS* — plus the monkey — is less than the single non-miniaturized telemetering band pass filter pictured here. *MICROID* band width is 15% at 3 db + 60% —40% at 40 db. Frequency coverage is from .4 kcs to 70 kcs.

Sizes	
Channels 1-6	2x27/32x1/2
Channels 7-10	1-5/16x11/16x11/16
Channels 11-18	15/16x19/32x1/2
Alternates A-E	15/16x19/32x1/2

Write for Filter Bulletin MTT 23.



2/3 actual size

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National Electronics Conf.

(Continued from page 102)

TECHNICAL PROGRAM

Monday Morning, October 12

ADAPTIVE SERVOMECHANISMS

Chairman: John A. Aseltine, Space Technology Laboratories

Trends in Adaptive Control Systems by John G. Truxal, Polytechnic Institute of Brooklyn
Multidimensional Adaptive Control by John E. Gibson, Purdue University
On the Philosophy of Adaptive Control for Plant Adaptive Systems by M. Margolis and C. T. Leondes, University of California
Use of Crosscorrelation in an Adaptive Control System by G. W. Anderson, R. N. Buland, and G. R. Cooper, Purdue University

PARAMETRIC AMPLIFICATION

Chairman: John Bell, Zenith Radio Corp.

Parametric Amplification With Solid-State Material and with Electronic Beams by Glen Wade, Stanford University
Recent Advances in Electron Beam Parametric Amplifiers by R. Adler, Zenith Radio Corporation
Magnetic Film Parametric Amplifiers by A. A. Read and A. V. Pohm, Iowa State College
Optimum Figures of Merit of Varactors by H. Gunther Rudenberg, Transitron Electronic Corporation
A Gold-Bonded Germanium Diode for Parametric Amplification by Warren P. Waters and Sverre T. Eng, Hughes Products

AUDIO

Chairman: William M. Ihde, General Radio Co.

Design and Use of RC Parallel-T Networks by Gifford White, White Instrument Laboratory
Free Field and Pressure Calibration of Microphones by the Reciprocity Method by R. W. Benson, Armour Research Foundation
A Transistorized Stereo Preamplifier and Tone Control for Magnetic Cartridges by A. B. Bereskin, University of Cincinnati
A Compatible Tape Cartridge by Marvin Camras, Armour Research Foundation
Hiss Reduction in Master Tape Machines by Abraham A. Goldberg and Emil Torick, CBS Laboratories

COMMUNICATIONS SYSTEMS

Chairman: Charles Wittkop, Motorola

Non-Synchronous Approach for Improved Communications Reliability by Clarence H. Stewart, II, and Charles E. Baker, Jr., Bell & Gossett Company
Performance Improvement in Single-Channel Voice Communication Radio System in Space by Leang P. Yeh, Page Communications Engineers, Inc.
Synchronous Reception in a PCM/PS Telemetry System by H. Raillard and H. N. Putschi, General Electric Company
Problems Encountered in Wide-Band Frequency Modulation by D. D. Wilcox, Ampex Corporation

NOON LUNCHEON

(Speaker to be announced.)

Monday Afternoon, October 12

COMPUTERS

Chairman: G. H. Leichner, University of Illinois

A High-Speed, Electronic, Analog-to-Digital Encoder by H. F. Lewis and J. J. Mielke, Autonetics
Elapsed Time Computation by H. W. Abbott and V. P. Mathis, General Electric Company
High-Frequency Magnetic Film Parametrons for Computer Logic by A. V. Pohm, A. A. Read, R. M. Stewart, Jr., and R. F. Schauer, Iowa State College
Millimicrosecond Diode Capacitor Memory by M M. Kaufman, Radio Corporation of America

ELECTRONIC DEVICES

Chairman: J. J. Hupert, DePaul University

The Solar Battery by Martin Wolf, Hoffman Semiconductor Division
Principles and Applications of Hall-Effect Devices by M. Epstein, L. J. Greenstein and H. M. Sachs, Armour Research Foundation

Sintered Cadmium Sulfide Photoconductive Cells by E. Fischer and C. P. Hadley, Radio Corp. of America
Coherent Optical Data Processing Techniques by L. J. Cutrona, E. N. Leith and L. J. Porcello. University of Michigan

AUTOMATIC CONTROL

Chairman: R. G. Brown, Iowa State College

Synthesis of Linear, Multivariable Feedback Control Systems by Isaac M. Horowitz, Hughes Aircraft Co.
Optimum Control Through Tuned Sampling by Julius T. Tou, Purdue Univ.
Extended Synthesis Techniques for Multipole Sampled Data Control Systems by E. B. Stear, Hughes Aircraft Co., Culver City, Cal., and UCLA, and C. T. Leondes, University of California, Los Angeles, Cal.
Three-Dimensional Phase Space Analysis by Lawrence P. Grayson and E. Mishkin, Polytechnic Institute of Brooklyn

PERCEPTION AND RECOGNITION

Chairman: R. K. Hellman, Hazeltine Corp.

Digital Simulation in Perceptual Research by E. E. David, Jr., Bell Telephone Laboratories
An Electronic Device to Measure the Intelligibility of Speech by J. C. R. Licklider, A. Bisberg and H. Schwartzlander, Bolt, Beranek and Newman, Inc., and General Electronic Laboratories, Inc.
Image Simulation and Interpretation by G. L. Meyers, Radio Corporation of America
A Review of the Perceptron Program by A. E Murray, Cornell Aeronautical Laboratory
Networks for Pattern Perception by Peter Greene. Univ. of Chicago

Monday Evening, October 12

RECRUITING OF SCIENTIFIC PERSONNEL

Moderator: John D. Ryder, Michigan State Univ.
Participants: Frank S. Endicott, Northwestern University; Edward Conley, Conley Associates; Harry Kentone, Argonne National Laboratories; Richard C. Swander, Cinch Mfg. Co.; Lowell H. Good, Radio Corp. of America, Camden, N. J.

PROBLEMS IN CIRCUIT THEORY

Moderator: George I. Cohn, Illinois Institute of Technology
Participants: T. J. Higgins, University of Wisconsin; Gail T. Flesher, Bendix Aviation Corp.; B. Saltzberg, Space Technology Laboratories

EDUCATION FOR LEADERSHIP

Moderator: Edward W. Ernst, University of Illinois.
Participants: A. D. Arsem, Wurlitzer Corp.; F. W. Braden, Illinois Bell Telephone Company; J. E. Gibson, Purdue University; and A. H. Waynick. National Science Foundation

Tuesday Morning, October 13

LOW NOISE DEVICES

Chairman: Ralph J. Schwarz, Columbia University

Ultra-Low Noise Measurements Using a Horn Reflector Antenna and a Travelling Wave Maser by R. W. DeGrasse, B. C. Hogg, E. A. Ohm, H. E. D. Scovil, Bell Telephone Laboratories
The Use of Radio Noise from the Sun for Calibrating Radio Receiving Systems by Myron E. Armstrong, George W. Swenson, Jr., Richard L. Sydnor and Harold D. Webb, University of Illinois
Reduction of Thermal Noise in Electron Beams by Carsten M. Haaland, Armour Research Foundation
An Electrostatically Focused Traveling-Wave Tube for Wide-Band Amplification in L- and S-Band by C. Cuccia and W. Johnson, Radio Corp. of America
Phase Shift Through Traveling-Wave Tubes by George I. Cohn and Paul Yuen, Illinois Institute of Technology

INFORMATION THEORY

Chairman: G. R. Cooper, Purdue University

Information Capacity of Communication Networks by L. S. Schwartz, New York University
A Probabilistic Model for Run-Length-Coding of Pictures by Jack Capon, Columbia University
Optimum Linear Least Square Smoothing and Prediction with Finite Data by R. Mittra, University of Illinois
Some Computations of Error Rates for Selectively Fading Multipath Channels by G. L. Turin, Hughes Research Laboratories
Transform-Ensemble Method for Analysis of Linear and Nonlinear Systems with Random Inputs by Yu Hsiu Ku, University of Pennsylvania, Philadelphia, and Alfred A. Wolf, Stromberg-Carlson Company

(Continued on page 198)

N.E.C. Technical Papers

(Continued from page 197)

NUMERICAL ANALYSIS AND SWITCHING THEORY

Chairman: L. W. Von Tersch, Michigan State University

A Digital Computer Program for Reducing Logical Statements to a Minimal Form by Kenneth J. Butler, Jr. and John N. Warfield, University of Kansas
Multivalued Switching Algebras and Their Application in Digital Systems by E. I. Muehldorf, Westinghouse Electric Corporation
On the Realizability of a Single-Contact Switching Function by Omar Wing, Columbia University
Application of Sylvester's Theorem to Some Engineering Problems by B. N. Garudachar, Marquette University
A Normalized Floating Point Significance Checking Program by G. P. Weeg and J. Eidson, Michigan State University

ENGINEERING MANAGEMENT

Chairman: Edward S. White, Warwick Manufacturing Company

The Individual Case in Research Management by E. H. Schulz, Armour Research Foundation
Project Selection in New Technical Fields by Albert H. Rubenstein, Northwestern University
Management of Product Development and Design Engineering by Winfield B. Heinz, Ampex Corp.
A Military-Political Advisor—An Upcoming Need for Electronic Company Managements by Casper M. Bower, Sealectro Corporation
Occupational Hazards of Engineers as Managers by J. R. Stovall, Jr., Remington Rand Univac

NOON LUNCHEON

(Speaker to be announced.)

Tuesday Afternoon, October 13

SOLID-STATE CIRCUITS

Chairman: J. J. Hupert, DePaul University

Nonlinear Analysis of a Transistor Harmonic Oscillator by D. O. Pederson and R. S. Pepper, University of California, Berkeley, Cal.
Thermal Response of Transistors in the Avalanche Mode by R. H. Beeson, I. Haas, and V. H. Grinich, Fairchild Semiconductor Corporation
The Influence of Nonlinear Junction Capacitance on Transistor Rise and Fall Times by R. P. Nanavati, Syracuse University
Semiconductor Diode Parametric Amplification by Earl L. Steele, Hughes Products
Electroluminescent Typewriter by Theodore Hamburger, Westinghouse Electric Corporation

COMMUNICATIONS SYSTEMS

Chairman: Ransom Slayton, Teletype Corp.

A Fully Electronic Private Automatic Telephone Switchboard by J. G. Van Bosse, General Telephone Laboratories
The Application of Digital Computer Techniques to Electronic Telephone Switching System by D. K. Melvin, General Telephone Laboratories
Message Protection in an Automatic Switching Center by A. S. Rettig and H. P. Gerber, Radio Corporation of America
RCA's Automatic Switching Center by J. L. Owings, T. L. Genetta and J. F. Page, Radio Corporation of America

MODERN PRODUCTION TECHNIQUES

Chairman: H. W. Farris, University of Michigan

A Survey of the Future of Microcircuitry by Willis A. Adcock, Texas Instruments Company
Microcircuitry Applications of Evaporated Materials by David William Moore, Servomechanisms, Inc.
A Light Telemetry Molecular System by G. Strull, Westinghouse Electric Corporation
Synthesis of Failure Indicating Modules by Donald H. Breslow, Raytheon Manufacturing Company

MAGNETIC AMPLIFIER APPLICATIONS

Choirman: R. A. Raber, General Electric Co.

Design for Manufacture of a Saturable Core Power Converter by C. M. Bailey, Bell Telephone Lab.
Transistor-Core Converter with High Input Voltages by R. P. Massey, Bell Telephone Laboratories
Controlled DC-to-DC Voltage Step-Up with a Single Transistor by R. E. Morgan, General Electric Co.

(Continued on page 200)

For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

FILTERS
All types for frequencies from .1 cycle to 400 MC.

400 ⎓ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ⎓, ⅝ x 1⅛ x 2"

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LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

Tuned DO-T servo amplifier transformer, 400 ⎓ .5% distortion.

Toroid for printed circuit, Q of 90 at 15 KC.

Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.

HVC tapped variable inductor for 3 KC oscillator.

HIGH Q COILS
Toroid, laminated, and cup structures from .1 cycle to 400 MC.

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Saturable reactors, reference transformers, magnetic amplifiers, combined units.

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Pulse current tansformer 100 Amp.

Pulse output to magnatron, bifilar filament.

Precise wave shape pulse output, 2500 V., 3 Amps.

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From miniature blocking oscillator to 10 megawatt.

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Standard and high temperature . . . hermetic, molded, and encapsulated.

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400 ⎓ scope transformer, 20 KV output.

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CABLES: "ARLAB" PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

N.E.C. Technical Papers

(Continued from page 198)

Analog Computer Design of Magnetic Amplifiers by L. A. Gregory, Magnetic Controls
Precise Control of High-Voltage DC Using Magnetic Controls by P. Convert, Magnetics, Inc., and M. Kramer, Aluminum Co. of America
Static Control for a Mechanical Regulated 40 K Volt Supply by H. J. Abrams and J. Brubaker, Westinghouse Electric Corporation

RADIO COMMUNICATIONS

(Paper titles to be announced.)

Tuesday Evening, October 13

NEC PARTY

6 p.m. Cocktails; 7:15 p.m. Dinner

Wednesday Morning, October 14

ACTIVE NETWORK THEORY

Chairman: J. B. Cruz, Jr., University of Illinois

Transformations of Active Networks by N DeClaris, Cornell University
Transistor Multiloop Feedback Amplifier Analysis by L. M. Vallese, Polytechnic Institute of Brooklyn
The Active Constant-Resistance Lattice by Roland E. Thomas, U. S. Air Force Academy
Synthesis of Three-Pole, Narrow-Band Interstages by J. J. Hubert, DePaul University, and Anthony Sances, American Machine and Foundry Co.
Transient Response as a Design Criterion for Stabilization of Feedback Amplifiers by J. H Mulligan, Jr., New York University

NAVIGATION AND GUIDANCE

Chairman: T. F. Jones, Jr., Purdue University

Modern Navigation—A Survey by C. S. Draper, Massachusetts Institute of Technology
A Glance at the Salient Points of Space Guidance by Bernard Lee, Emerson Electric Mfg. Company
The Synthesis of Velocity Inertial Navigation Systems by F. V. Johnson, General Electric Company
High-Speed Inertial Platform Stabilization and Control by Martin Finkel, Northrop Corp.
Heat Transfer and Fluid Flow for Airborne Navigation System by J. F. Culverwell, Northrop Corp.

RADAR

Chairman: D. L. Bitzer, University of Illinois

Multiple Target Resolution of Monopulse Versus Scanning Radars by Samuel F. George and Arthur S. Zamanakos, U. S. Naval Research Laboratory
Instrumentation for a Heat Budget Earth Satellite by R. J. Parent and Wayne B. Swift, University of Wisconsin
Radar Target Angular Scintillation in Tracking and Guidance Systems Based on Echo Signal Phase Front Distortion by Dean D. Howard, U. S. Naval Research Laboratory
The Statistics of Radar Video After Linear and Non-Linear Mixing by Peter R. Dax, Westinghouse Electric Corporation

INSTRUMENTATION

Chairman: S. A. Alessio, Bell & Gossett

Electric Timing Set (Time Encoder) by Joseph C. Brazda, The Hallicrafters Company
An Improved Transistorized Wave Analyzer by John Petrack, Hewlett-Packard Company
Some New Techniques in Airborne Data Acquisition by E. P. Brandeis and M. E. Harrison, Ampex Corp.
Technical Considerations for an Ultra-Sensitive Bridge to Measure RF Power and Voltage by L. J. Greenstein, R. B. Schulz and M. Epstein, Armour Research Foundation
Instrumentation Techniques for Shock Time-of-Arrival Measurements by R. J. Arndt, J. J Krstansky and H. M. Sachs, Armour Research Foundation

NOON LUNCHEON

(Speaker to be announced.)

Wednesday Afternoon, October 14

CIRCUIT THEORY

Chairman: D. O. Pederson, University of California

Problems in Time-Domain Equalization in Pulse

Transmission by F. F. Kuo, Bell Telephone Laboratories and Polytechnic Institute of Brooklyn
Transmission and Hybrid Parameters for n-Port Networks by L. P. Huelsman, University of California, Berkeley, Cal.
The Circuitry for Scattering Matrix Synthesis by Kendall L. Su, Georgia Institute of Technology
Transfer Function of RLC Grounded 2-Port with One Inductor by S. L. Hakimi, University of Illinois
The Effect of Element Tolerances on Cascaded Four-Terminal Networks by Edsel A. Worrell and Herman J. Yost, Westinghouse Electric Corp

ANTENNAS

Chairman: Morris Brodwin, , Northwestern University

An Investigation of the Feasibility of Obtaining a Constant Beamwidth Luneberg Lens by L. K. DeSize and B. A. Woodward, Airborne Instruments Laboratory
A Compact Dual-Beam S-Band Beacon Antenna by G. G. Chadwick and R. M. Phillips, Aero Geo Astro Corp.
A New Mathematical Approach for Linear Array Analysis by David K. Cheng and Mark T. Ma, Syracuse University
The Mutual Impedance of Perpendicular Half-Wave Antennas by D. R. Capps and D. L. Waidelich, University of Missouri
Far Field Antenna Pattern Calculations by Means of a General-Purpose Analog Computer by Arthur I. Rubin and J. Paul Landaver, Electronic Associates, Inc., Princeton, N. J., and Howard Q. Totten, General Electric Company

ENGINEERING WRITING AND SPEECH

Chairman: Robert B. MacAskil, Cook Research Laboratories

Patents and the Company Engineer by Len Nierman, Graf, Nierman & Burmeister
The Relationship Between Design Engineering and Engineering Publications by Louis H. Sprung Admiral Corp.
How to Save Money on Artwork by James P Davis, Nelson Technical Enterprises, Inc.

SYSTEM ANALYSIS

Chairman: B. R. Myers, University of Waterloo

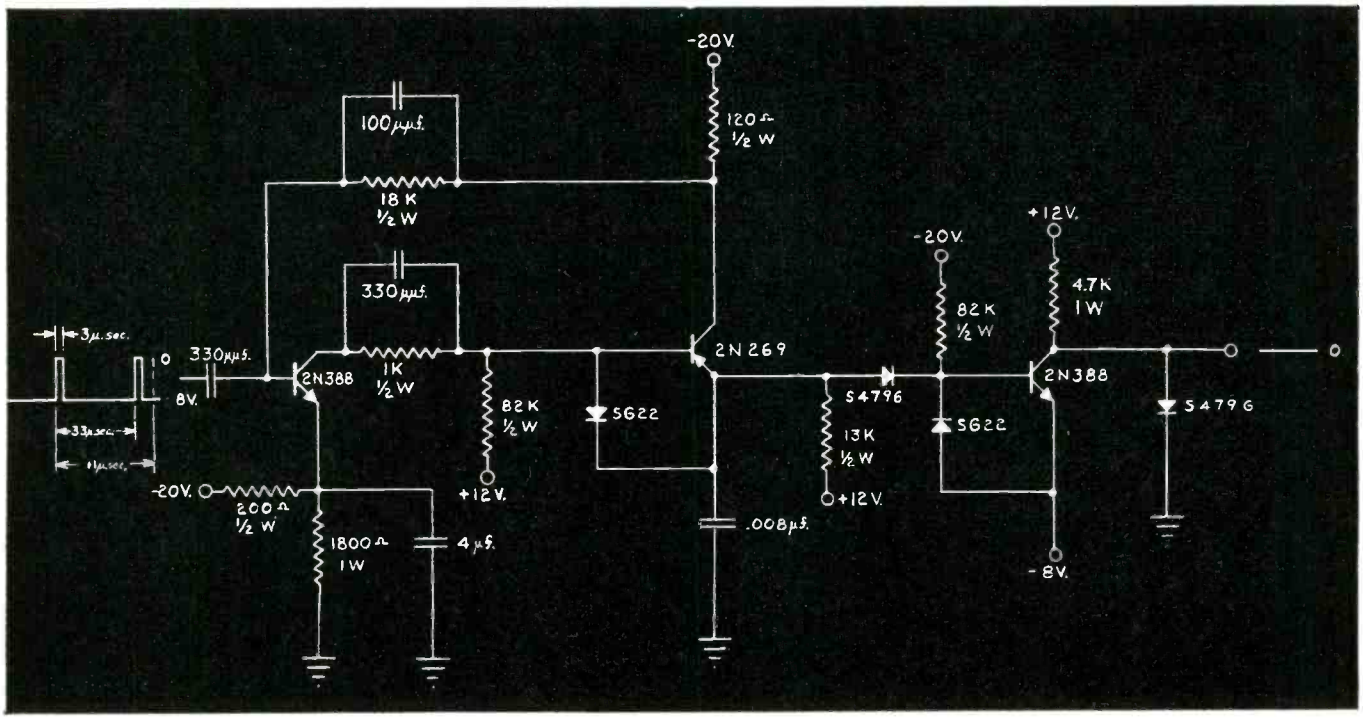
A Comparison of Methods for the Analysis of Pulsed Linear Systems by Herbert Freeman, Massachusetts Institute of Technology
Practical Applications of Signal Flow Graphs Using An Array of Non-Touching Loops by G. S. Axelby and R. H. Plath, Westinghouse Electric Corp.
The Analysis of Compensating Detectors for A-C Control Systems by Gordon J. Murphy and John F. Egan, Northwestern University
Improvement of Precision Control Using Open Loop Methods by L. J. Johnson and S. E Rauch, Hallamore Electronics Company, Anaheim, Cal. and University of California

Organizes PR Firm

Donald N. Martin, formerly Assistant to the President in Charge of Public Relations for the National Association of Broadcasters, has organized Donald N. Martin and Company, Public Relations. Offices are at 355 Lexington Ave., N. Y.

EI AT WESCON

While at WESCON EI's Bernie Osbahr and Bob McKenna made it a point to drop in on the impressive vacuum tube display at the ITT Components Div. booth. Left to right are Robert Deutsch, Sales Mgr. of ITT Components Div., Osbahr, McKenna, and Frank M. Viles Jr. vice-pres. and director of marketing for the division.



ATTENTION: COMPUTER AND DATA-PROCESSING ENGINEERS

HERE ARE THE TYPES OF MEN NCR NEEDS:

COMPUTER ENGINEERS:

SENIOR CIRCUIT & LOGICAL DESIGNER

experienced in the design, development and analysis of transistorized computer circuits, including application of magnetic cores to high-speed memories. Plus evaluating and debugging arithmetic and control areas of computer systems.

Your Work at NCR— design responsibilities in the areas noted above.

SENIOR MECHANICAL ANALYST

must be versed in dynamics, and familiar with analysis of, forces involved with bodies in motion, stress and strain with bodies of complex shape. Working knowledge of Laplace transforms, theory of complex variables, matrix algebra and vector or tensor analysis. Experienced in programming of digital or analog computers. Graduate degree required.

Your Work at NCR—perform mathematical analyses and relate to the design and development of high-speed input output devices.

CIRCUIT AND DEVICE ENGINEER

experienced in the design and development of solid state computer circuits. Strong background in solid state physics and magnetics is necessary.

Your Work at NCR—extend the knowledge of new research materials and components in circuits and seek new functions based on this knowledge.

DATA-PROCESSING ENGINEERS:

E.D.P. APPLICATIONS ANALYST

advanced degree in science with systems and/or materials experience in the field of electronic data processing. Should have special interests in pursuing the applications aspects of new technology.

Your Work at NCR—preparation of technical-economic evaluations of existing and proposed research projects for research management.

SENIOR ELECTRONIC DESIGN ENGINEER

experienced in the development of logical design using standard computer elements.

Your Work at NCR—to evaluate and design transistorized circuits including voltage regulated power supplies and circuitry related to decimal to binary coding.

HOW DO I APPLY?

Send your résumé to: T. F. Wade, Technical Placement Section A 109, The National Cash Register Company, Dayton 9, Ohio.

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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

Review Controversial NASA Patent Policies

The controversial patent policies of the National Aeronautics and Space Act of 1958 are examined and analyzed in a publication of the American Enterprise Association, Inc., 1012 Fourteenth St., N. W., Washington, D. C.

Briefly: the NASA act assigns *all* rights to the Government for inventions, discoveries, improvements, or innovations developed under contract with the NASA. The NASA Administrator may "waive" the Government's rights or he may make "monetary awards" as he deems warranted "for contributions to the space program."

In contrast, other Government contracting agencies (e.g. the Defense Dept.) have been left free to work out contract provisions to determine what the interest of the Government should be. Normally the Government retains a perpetual, royalty-free license to use the invention and to permit its use in supplying the government's needs. The contractor is usually permitted to retain commercial rights and title to the invention if he obtains a patent.

Critics of the NASA provisions claim they are detrimental since research contracts are rarely profitable to business except as they aid in the conception and development of inventions and ideas useful in commercial or Government production. They also claim the provisions are burdensome to small businesses whose only hope of competing with large concerns is in the protection provided by patent rights.

Supporters of the act take the position that inventions made in the course of performing such contracts are "paid for by the public" and that "the public interests requires that all rights to such inventions be assigned to the Government. . . ." They also say that "public ownership of such inventions" would be acceptable to a sufficient number of competent private and institutional laboratories to make it workable and would not diminish the efforts of the contractor's organization to perform the work competently.

AWARD WINNER

H. Leslie Hoffman (1) president of Hoffman Electronic Corp., receives first annual WEMA (Western Electronics Medal of Achievement) Award for outstanding industry leadership from John E. Chartz, president of Western Electronic Mfrs. Assoc.

Army Revises Technical Program

The Army's Scientific and Professional Personnel Program, established in 1948, is being revised under recently issued regulations. Over 30,000 have served under the program during the past ten years.

The new program "Scientific and Engineering Assistant's Program" (S&E) will apply higher standards of admission; positions filled by S&E personnel will "clearly require professional level performance in a scientific or engineering specialty" and frequency of interruption of professional-type duties will be reduced.

Semi-weekly Report on Bidding Opportunities

The General Services Administration will compile a master list of bidding opportunities offered by GSA's contracting offices throughout the U. S. The list will then be circulated to local business communities throughout trade and local press, chambers of commerce, trade associations, or any group that can and will apprise local communities of the opportunities to do business with the Federal Government.

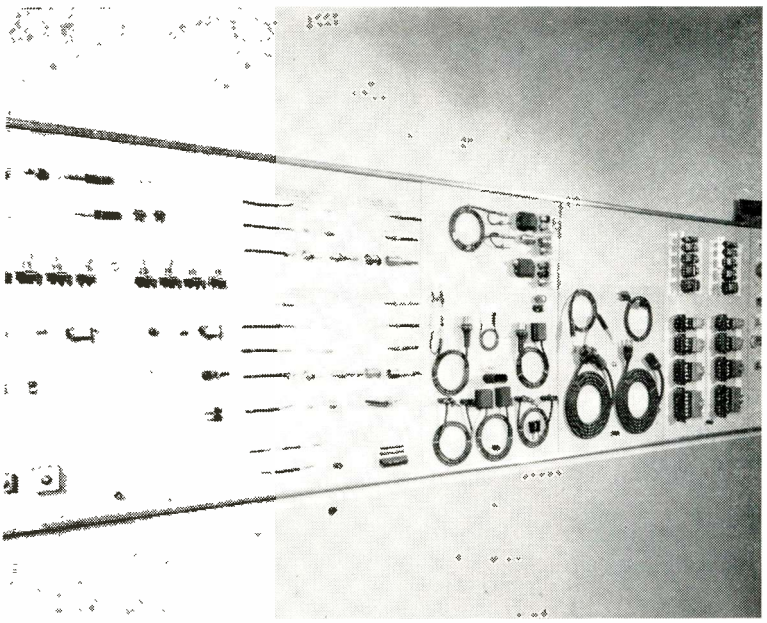
Intent is to increase participation by business, including small business, concerns in GSA bidding opportunities. The publication "Current Business Opportunities News Releases" will be published by GSA's Procurement and Business Services Div., Room 7206, GSA Building, Washington 25, D. C.

Circulating Science Library for 10-yr. Olds

The American Association for the Advancement of Science will make available to 100 selected schools an Elementary School Science Library. The library, 100 carefully selected books on science and mathematics for children, in the first 6 grades, will be circulated without charge.

Investigations carried on the Science Service indicate that the majority of the winners in the National Science Fairs and the Westinghouse Science Talent Search developed their interest in science by the time they entered the sixth grade. Conclusions reached by several agencies (to say nothing of observations by parents) indicate that lifetime reading habits are formed early in childhood.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 159.



Display boards showing the preferred stock items are located on the engineering department walls for quick reference

By HENRY C. LITTLEJOHN
Engineer
General Radio Co.
West Concord, Mass.

A Standards Program Cuts Costs

Companies with a working standardization program for materials and methods reduce their costs by having less paper work, fewer stock items, and engineering time saved. A manufacturer with a successful system tells how they set it up and what is required to keep it functioning.

A SUCCESSFUL standardization system for the materials and methods used in electronic designs can produce very tangible benefits for the manufacturing organization. Costs go down as a result of reduced paper work and fewer items stocked, engineering time is saved and service problems become fewer. Practically every manufacturer has, at some time, instituted such a program, but not all of them have been successful. A common complaint seems to be that the design engineer pays them, if anything, only lip service.

Like most companies, General Radio Company has always had a standardization program, and it has always worked well. Revised completely some six years ago, it has in its present form, been highly successful and has produced substantial dividends in lowered costs and increased efficiency.

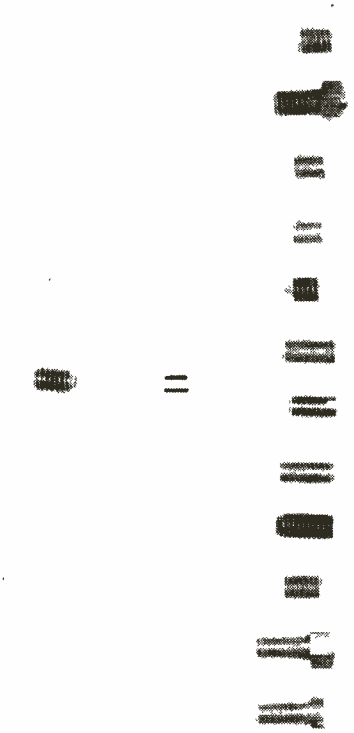
The General Radio standardization program is an integrated one, embracing material, component and design standardization. Material specifications cover things that are never used in the identical form in which they are purchased. Component specifications cover all items, either purchased or made internally, which are used as is. To complete the system, design standards have been established to guide the engineer in applying the components and materials in accordance with what is considered good design practice and in a manner compatible with the Company's manufacturing facilities and methods.

The program is not inflexible. A definite distinction is made between a standard item and a preferred item. The component and material lists are *preferred* lists.

An engineer may, when necessary or desirable, depart from the preferred list, although this is usually done only after consultation with the standards engineer. Similarly, the design standards are rec-

(*Continued on page* 208)

With a working standards program, the left hand screw is used in lieu of the twelve screws which are shown on the right



"AT SOME POINT IN HIS CAREER, every engineer critically evaluates himself in terms of his professional growth and progress. If your evaluation indicates that you have developed a depth of appreciation for the major problem areas in large complex electronic systems and the technical competence to contribute to the solution of such problems, you should seriously consider the next step in your professional career and explore the challenging opportunities the System Development Corporation has to offer.

"SDC has assumed major responsibilities for development and sustaining engineering and the implementation of engineering advances in the state of the art associated with the SAGE Air Defense System, the world-wide SAC Control System, and other major system development projects. Therefore, at SDC engineering is system-oriented and requires personnel with broad backgrounds and extensive experience in design, development and system engineering.

"The experience gained through intimate association with all of the elements of these large-scale systems and subsystems they control provides a most unusual opportunity for engineers to grow in technical competence and professional stature.

"I invite you to explore the opportunities offered by SDC at Santa Monica, California and Lodi, New Jersey, by writing or telephoning Mr. R. A. Frank, 2428 Colorado Avenue, Santa Monica, California, EXbrook 3-9411, or Mr. R. L. Obrey, Box 2651, Grand Central Station, New York 17, N.Y., ELdorado 5-2686, regarding our division at Lodi, New Jersey. Your correspondence will receive preferential treatment and its content will be handled in strict confidence."

V. J. Braun

V. J. BRAUN, ASSISTANT DIRECTOR FOR PLANNING, ENGINEERING DIRECTORATE

V. J. BRAUN

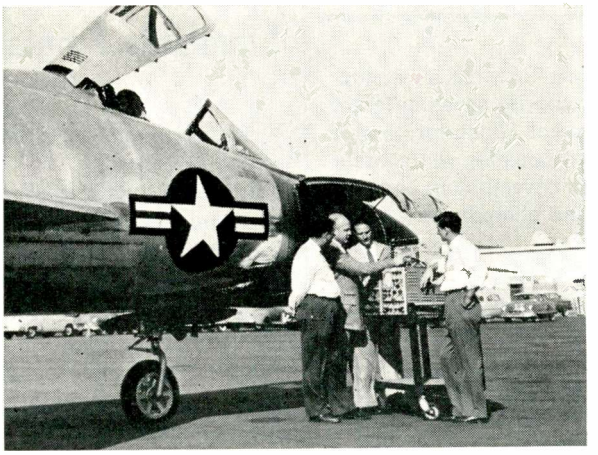
11-126

SDC

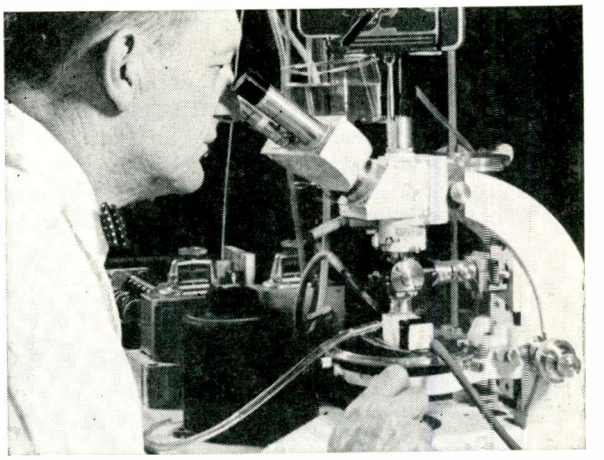
SYSTEM DEVELOPMENT CORPORATION

SANTA MONICA, CALIFORNIA • LODI, NEW JERSEY

creating controls



Everywhere Hughes systems and missiles *are employed, Hughes Field Engineers insure maximum utilization and field performance.*



Developing new semiconductor materials, *physicists at the Semiconductor Division of Hughes Products utilize highly advanced techniques.*

for the space age

Operating with accuracy at speeds far beyond man's ability to reason and act, the control systems produced by Hughes-El Segundo are blazing new trails in the state of the art.

Recognized as the leader in airborne control systems, Hughes is responsible for the controls in our most advanced weapons systems. And, today, Hughes engineers and scientists are expediting work on even more advanced systems which will help carry man on his first probes into space.

This work demands engineers of special ability, who are capable of translating theory into hardware of fantastic accuracy and dependability. A large share of engineering time at Hughes El Segundo is spent in the continuing development of these systems... and in the development of equipment and methods to support the program.

The systems philosophy is characteristic of all Hughes activities...covering the spectrum of electronic progress: space vehicles, plastics, nuclear electronics, infrared devices, advanced data processing and display systems, microwaves, global communications, ballistics missiles and many others. These activities provide stimulating outlets for creative engineering talents.

Hughes Products, the commercial activity of Hughes, has assignments for imaginative engineers in several areas of research in semiconductor materials and electron tubes.

The great variety of advanced projects...the stability stemming from a position of leadership ...and Hughes engineering-orientation creates an ideal environment for the engineer or scientist interested in advancing his professional status.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Logical Design	Communications
Digital Computers	Thin Films
Infrared	Microwave Tubes
Plasma Physics	Circuit Design & Evaluation
Field Engineering	Systems Design & Analysis
Quartz Crystal Filters	Semiconductor Circuit Des.

Write in confidence to Mr. Wally Peterson
Hughes General Offices, Bldg. 6-C 10, 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

Standards Program

(*Continued from page* 204)

ommended practices; not considered mandatory. *Very* frequently, however, the choice of a component or material is not extremely critical, and the engineer making the choice is glad to have a preferred list to choose from, rather than having to search at large with no particular basis for a choice.

Every type of component used in General Radio instruments has been standardized, from nuts, screws and lockwashers to the most sophisticated circuit elements. All the materials listed have been selected with great care. The lists of materials and components along with the design standards form a highly integrated system where, for example, a *preferred component* mounts with a *preferred fastener* in a *preferred size mounting hole* by a *preferred method.*

In general, the material and component lists are geometrical progressions of sizes, which have been shown by use to satisfy all the needs, without the inclusion of sizes which are almost identical. The design standards vary according to the component or material in question. The standard for application of a resistor gives pertinent electrical data supplied by the manufacturer, as well as the Company's own test data and ratings. A design standard for mounting a rubber foot simply gives the preferred size of mounting hole and preferred length of preferred rivet, eyelet or screw.

However well constituted a standardization program may be, it is only as useful as its application. First, this program attempts to remove as many obstacles as possible from the path of the engineer who is conscientiously trying to apply the standards. Note books listing in concise form the preferred components and materials, as well as the design standards, are not only supplied to the engineers, but are kept up-to-date by almost daily revisions of the sheets included. To facilitate locating what is in the books, but may not occur to the engineer as being there, a wall display of all the preferred

components is maintained in the engineering department. The display not only gives a three-dimensional sample of the component, but includes prices and affords the engineer an opportunity to browse while thinking-out a program. In addition, it is Company policy to maintain in stock, at least a minimum quantity for engineering use, every preferred component and material wherever it is practical to do so.

This triple combination of notebook listing, display board, and availability in the stockroom is fundamental to the success of the program. It is this combination that makes it work. Further, the engineer knows the program is devised and administered by engineers who know his problems and whose judgment he respects. This is a not-inconsiderable factor in enlisting his cooperation.

At the inception of this program a good deal of skepticism was evident on the part of engineers and draftsmen alike, but within two years the program had general support, and it now is severely criticized at times if it does not cover every contingency.

To maintain this program requires about half the time of an engineer and an engineering assistant along with several hundred man-hours of drafting time annually. It is estimated that latest designs consist 95% of preferred items applied according to recommended practices. This program has reduced the number of general-purpose components cataloged and stocked from 12,000 to about 2,500. For example, 10-32 machine screws were formerly stocked in seven head styles and 25 lengths; this has been reduced to one head style and 13 lengths. Electrolytic capacitors, formerly stocked in 60 types, have been reduced to 12 types, and 10-32 set screws are now stocked in one style and two lengths, replacing 12 styles and 12 lengths.

Equally important, however, is the fact that the engineering time necessary to select components and to solve simple design problems has been greatly reduced.

* * *

Industry News

Dr. Samuel B. Batdorf is now Director of Research at Lockheed Electronics and Avionics Div. He had been on leave to assist **Roy W. Johnson**, Director of the government's Advanced Research Projects Agency, in a special satellite assignment.

Robert F. Carleton has joined Servo Corp. of America as Sales Manager of the Instruments and Products Sales Div. He was formerly with Norden-Ketay Corp.

Pacific Semiconductors, Inc., announces the appointment of **Frank Steinbrey**, former PSI Developmental Engineer, as Program Director on an Air Force ultra high power transistor project.

Dr. Henry Marchman has been named Vice President and Manager of the Engineering Dept. of Rheem Semiconductor Corp. He was formerly Director of the Chemicals Development Div. of the Research Dept. of Standard Oil Co.

Dr. H. Marchman

F. H. Donnell

Election of **Franklin H. Donnell** as Sr. Vice President, Finance, Consolidated Electrodynamics Corp., has been announced.

Neil M. Blair has been elected Vice President and Assistant to the President of Intelex Systems, Inc., a subsidiary of IT&T Corp.

George Tinker is now Director of Sales for the Maryland Div., Litton Industries. He was promoted from the position of Marketing Consultant at the Maryland Div.

Robert A. Smith is now Technical Liaison Engineer for Buffalo Operations of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc.

(*Continued on page* 212)

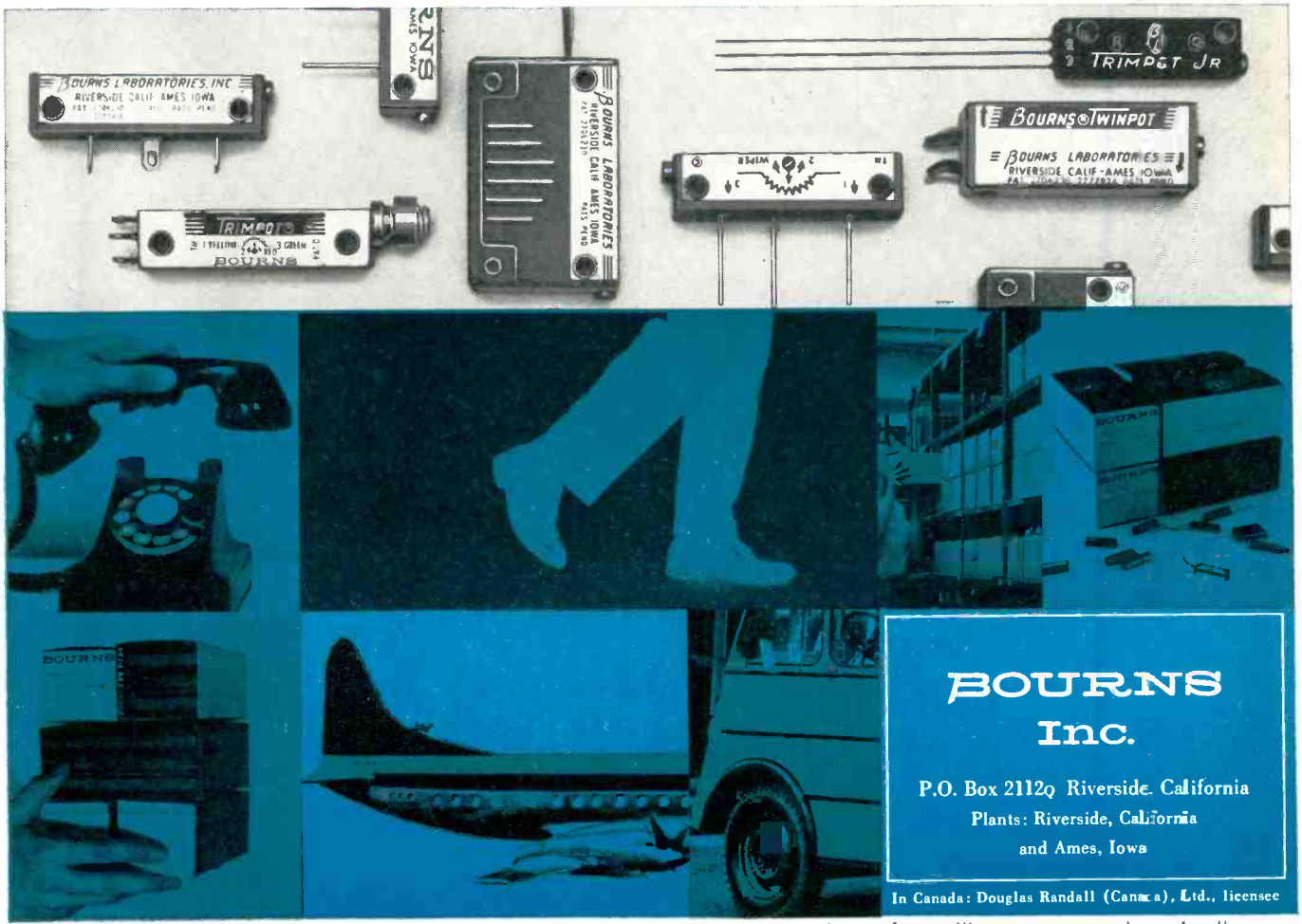
24 HOUR DELIVERY OF TRIMPOT® POTENTIOMETERS

500,000 STOCKED BY DISTRIBUTORS AND FACTORIES

Immediate "off-the-shelf" delivery is available of the entire line of standard Trimpot potentiometers — 20 basic models . . . 4 terminal types . . . 3 mounting styles! More than ½ million units are stocked by franchised distributors across the nation and at Bourns plants in Riverside, California and Ames, Iowa with distributors selling at factory prices in quantities to 2000 pieces. Wherever you are, whatever standard unit you need, there's a Trimpot source close at hand waiting to fill that rush order . . . no need to hold up your prototype or production projects.

This fast service is made possible by mechanized production processes, enlarged facilities, and greatly expanded engineering and production staffs. All this is part of our intent to provide the finest customer service program. It is another Bourns plus — in addition to the high quality, reliability, and performance that have won Trimpot potentiometers a place in major missile, aircraft and commercial electronic systems.

Write for price quotations and list of representatives and distributors — today. Let us assist you with your special requirements as well.



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

Circle 97 on Inquiry Card

Industry News

(*Continued from page* 210)

David G. Christie is now Director of Industrial Relations at Sylvania Electric Products, Inc., and **Robert F. Schulz** has been appointed Manager of Special Programs for Mountain View Operations of Sylvania Electronic Systems.

Dettmer H. Otto is now Sr. Engineer for the Semiconductor Mechanization Div., Texas Instruments Incorporated. He was formerly with Western Electric Co.

Dr. Finn J. Larsen has been named to the newly created post of Vice President in Charge of Research for Minneapolis-Honeywell Regulator Co. He has been Director of Research since 1953.

Dr. F. J. Larsen

E. W. Herold

Edward W. Herold is now Vice President for Research at Varian Associates. He was formerly Director of RCA Laboratories' Electronic Research Laboratory.

Microtan Co. has appointed **Richard Chaber** as Vice President in Charge of Engineering. He was formerly Chief Engineer.

Announcement has been made of the election by the Board of Directors of Litton Industries of **Charles R. Abrams, Jr., Dr. George Kozmetsky,** and **Harry J. Gray** as Vice Presidents and **William L. Reynolds** as Secretary of the corporation.

Walker C. Brownlee is now Administrative Vice President of The Garrett Corp.

Lt. Col. Kermit E. Beary, has been assigned to Republic Aviation Corp. as Air Force Plant Representative. Col. Beary, was previously Chief of the Airborne Early Warning and Controls Weapons System Project Office for the Air Materiel Command at Wright-Patterson Air Force Base, Dayton, Ohio.

(*Continued on page* 214)

ENGINEERS · SCIENTISTS

An Unprecedented Opportunity to Enter the Field of

LARGE SYSTEMS

with GENERAL ELECTRIC

Yesterday's systems must today be considered only "subsystems" to be integrated into a larger entity. The growing demand of the defense establishment for super-systems offers challenges of unprecedented scope to the engineering profession.

Now HMED offers able engineers an opportunity to get full exposure to this field of the future — to learn, grow and develop their capacities for systems thinking, by working with men who have been in-at-the-beginning of major systems design and integration programs.

Facts and Figures Behind Growth Opportunities Here:

At HMED you are joining an organization providing professional people with an outstanding combination of CAREER STABILITY plus INDIVIDUAL PROGRESS. In the last few years this G. E. department has *doubled* its dollar business volume; *tripled* its engineering laboratory and office space; *quadrupled* the number of its supervisors and managers, from 26 to 101, with 90% promoted from within; *quintupled* its professional engineering staff.

CUT COUPON ON DOTTED LINE

☐ **COMMUNICATIONS ENGINEERS** — To work with Propagation consultant in frequency choice versus sight configuration, and design of optimum communication and sight configuration. (BS in EE and 3 years' experience necessary)

☐ **RADAR SYSTEMS ENGINEERS**—To integrate varied data acquisition equipment into complex electronic control systems. (Advanced EE degree preferred with minimum 3 years' experience)

☐ **TELECOMMUNICATIONS ENGINEERS** — To design and develop advanced communications subsystems of ground electronic control system complex. (EE degree and 5 years' experience)

☐ **PROPAGATION CONSULTANTS**—To assist in the design, development and management of radar and communications subsystems as applicable to an air defense system. (Advanced degree in EE or Physics with 5 years' experience)

☐ **RADAR RECEIVER & VIDEO PROCESSING ENGINEERS** — To establish receiver design criteria for optimum system performance in varied environments, particularly ECM. (Advanced EE degree or equivalent and minimum 5 years' experience)

☐ **ECM SPECIALISTS** — To provide threat models and consultation to design and management engineers. (Advanced degree in EE and 3-5 years' experience)

☐ **ANTENNA AND MICROWAVE ENGINEERS** — To establish antenna design and sighting philosophies for optimised detection system performance. (Advanced EE degree and 5 years' experience)

☐ **RADAR DESIGN ENGINEERS** — To work on advanced designs and development of receivers utilizing parametric amplifiers. (BSEE and 2-4 years' experience)

☐ **PERSONNEL SELECTION AND TRAINING SPECIALISTS** — To prepare job evaluations, manning structures for complex military systems, and forecast training aid needs. (PhD or EdD required)

☐ **EQUIPMENT EVALUATION SPECIALISTS**—To solve man-machine problems, evaluate alternative components, displays, or techniques and devise simulators. (PhD in Experimental Psychology)

☐ **CABLING ENGINEERS** — To resolve varied problems in grounding and associated shielding problems of complex electronics equipments. (EE degree with minimum 2 years' experience)

☐ **LOGIC DESIGNERS** — To organize and perform logic designs of a high speed digital computer. (Degree in EE, Math or Physics with minimum 4 years' experience)

☐ **CIRCUIT DESIGN ENGINEERS (DISPLAY)** — To analyze equipment and circuit design requirements in data utilization and display subsystems. (Electrical Engineering degree with minimum 5 years' experience required)

☐ **SYSTEMS ANALYSTS** — To conduct system analysis programs and feasibility studies which lead to the conception and development of new systems, subsystems, and equipments of advanced design and function. (Advanced degree in EE, Math or Physics preferred with 3 years' previous experience)

☐ **TECHNICAL WRITERS** — To organize, write and publish progress and planning reports. (Engineering degree preferred with previous technical writing and editing experience in advanced electronics)

Dear Mr. Callender: Please send me an application form and additional information on the positions I have checked off above.

I am a graduate engineer with _____ *degree (s) and* _____ *years experience.*

NAME_____

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CITY_____ ZONE_____

STATE_____

Mr. George B. Callender, Div. 127-MJ
HEAVY MILITARY ELECTRONICS DEPT.

GENERAL ELECTRIC

Court Street, Syracuse, New York

Industry News

(*Continued from page* 212)

Dr. W. Crawford Dunlap, Raytheon Co. scientist, has been named Editor-in-Chief of Solid State Electronics, a new international publication dealing with transistors and other solid-state devices.

Robert L. Ford is now Manager of Technical Personnel at the Stromberg-Carlson Div. of General Dynamics Corp. He was formerly Assistant Director of Personnel Development for the Sperry Gyroscope Co.

R. L. Ford

H. R. Edwards

H. Robert Edwards has been appointed Sales Manager of The Zippertubing Co. Before joining Zippertubing, he was associated with Jefferson Electronic Products, Pacific Automation Products and Southern Engineering & Construction Co.

Rayford E. Nugent is now Vice President-Sales of the Consumer Products Div. of Philco Corp.

Eugene S. Goebel, former Vice President for Market Relations of Motorola Communications and Electronics, Inc., has joined Epsco, Inc., as Vice President in Charge of Marketing.

Election of **Harry B. Henshel** as President of Bulova Watch Co. has been announced.

Gerald E. Campbell has been appointed Vice President of Manufacturing at United Aircraft Products, Inc.

E. O. Vetter, an Assistant Vice President since 1958 has been elected Vice President of Texas Instruments Incorporated.

Gilbert N. Rosa has been elected a Member of the Board of Directors of Statham Instruments, Inc. He retains his post as Vice President for Marketing.

News of Reps

Spectrol Electronics Corp., has named **Stack Industrial Electronics, Inc.**, Syracuse, N. Y., as rep in the Syracuse area and **Seattle Radio Supply, Inc.**, Seattle, Wash., in the Seattle area.

Western Engineering Co., Phoenix, is now rep for Filtors, Inc., in Arizona, Colorado, eastern Idaho, eastern Montana, Utah, Wyoming, New Mexico, and El Paso, Texas.

LeeMark Assoc., St. Louis, Missouri, has been appointed rep for Scientific-Atlanta, Inc. in Kansas, Missouri, Nebraska, and southern Illinois.

The Heimann Co., Minneapolis, Minn., is now sales rep for the Birtcher Corp. in Minnesota, Iowa, North and South Dakota, Nebraska, Missouri, and Kansas.

The S. S. White Industrial Div. has appointed **Weightman and Assoc.**, Burbank, Calif., as rep in Arizona and California.

Walter H. Walczyk, Los Angeles, Calif., has been appointed Western Sales Rep by Sel-Rex Corp.

Ceramaseal, Inc., has appointed 4 new reps. **John Lazor** will cover central and northern New York State. **Harry Halinton** is assigned Chicago, northern Illinois and Wisconsin. **John Striker** will cover northern California, and **C. W. Saxon Assoc.** will handle southern California.

Electronic Assoc., Inc., Midland, Texas, has been named a Manufacturer's rep for Radio Corporation of America communications equipment. They will operate primarily in West Central Texas.

Gyra Electronics Corp. has appointed these reps. They are: in Metropolitan New York City, northern New Jersey and Firfield County, Conn., the **Herbert Shprentz Co.**, Scarsdale, New York, The **C. W. Reed Co.**, Los Angeles, Calif., in the eleven far western states, including El Paso County, Texas.

Avco Research and Advanced Development Div. has appointed the following reps: **Instruments for Measurements**, Hollywood, Calif.; **General Measurement Co.**, Newton Highlands, Mass.; **Kemco, Inc.**, Irving, Texas; **V. A. Snyder**, Union, N. J.; **Anger Assoc.**, Dearborn, Mich.; and **Concor International Corp.**, Long Beach, N. Y.

(*Continued on page* 216)

News of Reps

(*Continued from page* 215)

Engineering Service Co., Kansas City, Mo., is now rep for the Amerlay Corp. They will cover Missouri, Kansas, Nebraska, and southern Illinois.

Silicon Transistor Corp. has appointed the following reps: **R. C. Nordstrom & Co.**, Birmingham, Mich., Michigan; **Henry Lavin Assoc.**, Meridan, Conn., New England; and **Danco Corp.**, Fairview Village, Pa., for the Middle Atlantic States.

Ultradyne, Inc., announces the following rep appointments: **The Addelco Co.**, West Roxbury, Mass., for New England; **Holdsworth and Co.**, Lansdowne, Pa., for eastern Pennsylvania and southern New Jersey; **Memo, Inc.**, Hempstead, N. Y., for Metropolitan New York; and the **Charles A. Winick Co.**, Schenectady, N. Y., for northern New York.

Electronics Div., Elgin National Watch Co., has appointed **Murphy Assoc.**, Minneapolis, Minn., as sales rep in Minnesota, North Dakota, and areas of Iowa, Montana, Michigan, and Wisconsin.

The Communications Equipment Div., The Hallicrafters Co., has appointed **E. S. Gould Sales Co.**, Montreal, Canada, as rep in Canada.

Robert Boniface, Pres., Los Angeles Chapter of the Electronic Representatives Assoc., announces the appointment of 4 Trade Div. Chairmen. They are: (Audio) **Norman Marshank** of Marshank Sales Co., Los Angeles; (Distributor) **Jack Carter** of Bray & Carter, Los Angeles; (Industrial Components) **Jackson Edwards** of the Jackson Edwards Co., North Hollywood; and (Instruments) **Ed McCarthy** of McCarthy Assoc., Pasadena, Calif.

Land-C-Air Sales Co. has opened a branch office at 328 Springfield Ave., Summit, New Jersey.

Long & Associates, Redwood City, Calif., have been appointed rep for Tape Cable Corp., in northern California and western Nevada.

Waters Manufacturing, Inc., announces the appointment of **Farwest Agencies**, Seattle, Wash., as rep in Washington and Oregon.

Automatic Electric Sales Corp. has appointed **Paul J. Mozola, Jr.**, as sales rep for Colorado, Kansas, Missouri and parts of Illinois.

Shockley Transistor Corp., has appointed **Kenneth E. Hughes Co., Inc.**, as rep for Metropolitan New York, New Jersey, and eastern Pennsylvania.

News of Reps

The Industrial Div., Cubic Corp. has appointed Col-Ins-Co., Inc., Orlando, Fla., as rep in the southeastern U. S.

Weller - Rahe Co., Worthington, Ohio, has been named by Audio Devices, Inc., Rectifier Div., as rep in West Virginia and western Pennsylvania.

The R. W. Mitscher Co., Inc., has been appointed as Irish Tape rep for upstate New York by Orr Industries, Inc.

J. Douglas Martin is now rep for Commercial Plastics & Supply Corp. in northern New York State.

The appointment of Jack Berman Co., Inc., Los Angeles, as rep for National Radio Co., has been announced. The firm covers southern California, southern Nevada, and Arizona. The V. Avis McCorvey Co., Decatur, Ga., is rep in Alabama, Georgia, Mississippi, North and South Carolina, and Tennessee.

Freed Transformer Co., Inc., has appointed The Nelson Co., Denver, Colorado, as rep covering eastern Montana, Wyoming, Utah, South Dakota, and Colorado.

Brendan C. O'Hara, Philadelphia, Pa., is now rep for The R. T. Bozak Sales Co. His territory is Delaware, Maryland, and the District of Columbia.

Tally Register Corp. has appointed Rush S. Drake Assoc., Seattle, Wash., rep in Oregon, Washington, Idaho, and British Columbia.

Instrument Dynamics, Inc., Wakefield, Mass., has been appointed the New England sales rep for Amco Engineering Co.

Key Electronics, Inc., Hollywood, Calif., has been named sales rep for the southern California, Arizona, and lower Nevada area by Ohio Semiconductors, Inc.

Gordon Wade Davis, Houston, Texas, is now southwestern sales rep for Morse Twist Drill and Machine Co.

Stone Laboratories, Boston, is now sales and engineering rep in the New England area for the Electronics Div. of Clary Corp.

Pennon Electronics, Inc. has appointed Key Electronics, Inc., Hollywood, Calif., as sales rep in Southern California, Arizona, and Hawaii.

"Measurement Pinch"

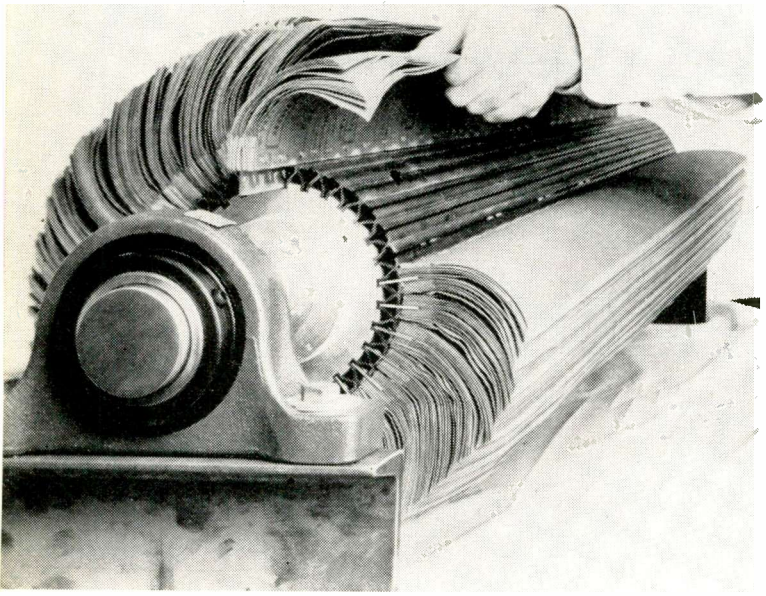
(Continued from page 7)

Also sorely needed is adequate training and education in the subject of calibration and standards. One of the aspects of this problem is the need to provide better methods for keeping workers in the field up-to-date on the state of the art, relative standards, calibration procedures, calibration equipment. This should be based on a good literature indexing and searching system, possibly one using coordinate indexing such as the Uniterm system. Design engineers should be trained in the relation of test specifications to overall system performance specs. Also, industry wide calibration procedure should be developed and disseminated. These last two projects should be undertaken by one or more of the professional engineering societies or by one of the industry trade associations in conjunction with NBS.

Also of extreme importance is traceability of calibration to the National Bureau of Standards. Basically, this involves establishing traceability which is as sure and as direct as possible. Operating practices should be developed with the proper use of transfer standards which are rugged, stable, and which have adequate coverage of the range of the quantity being standardized. Determination and publicizing of the traceability information should be done by NBS, possibly assisted by a professional engineering society.

TINY PARTS HANDLER

When we included in the "Snapshots" section last month a picture of a young lady holding a miniature component with a pair of tweezers the people at Carman Labs couldn't resist writing, pointing out that their equipment is much better suited for handling tiny parts. Here is the Carman Vac-U-Grip, which works on a vacuum principle. For more details write to P.O. Box 342, Bedford, Mass.



Construction of the drum sander consists of replaceable segments of abrasive cloth strips. Wheel can be reloaded within 15 minutes without removing it from arbors.

Machine Refinishing of Copper Sheets

ELECTROLYTIC copper foil of various weights is laminated under heat and pressure with multiple layers of epoxy resin impregnated glass fabric. This process yields a laminate that exhibits excellent electrical and structural properties and a very high copper-to-laminate bond strength. The copper bond withstands the high temperatures, 500°F, used for dip soldering without blistering or delaminating. The copper is bonded to either one or both sides of the laminate and the laminates are manufactured in standard thicknesses from 0.004 to 0.50 inch.

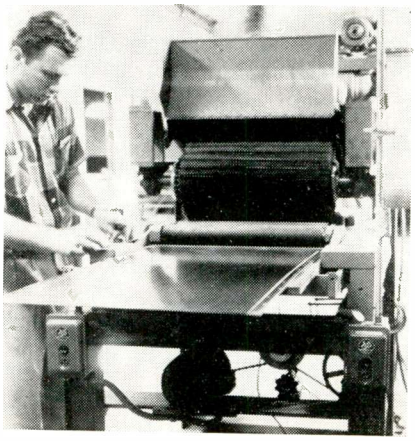
Particular care has been taken to maintain the original finish of the copper surfaces, which historically have required only normal processing before use. To provide a more pleasing appearance, a perfectly clean, "toothed" surface for subsequent solder-bonding, and to reduce the surface processing before use to a minimum, The Mica Corporation, Culver City, Calif., has installed a "refinishing" operation. The copper-clad laminates are put through a machine equipped with a special abrasive-leaf drum which revolves at 1200 rpm and oscillates from side to side enough to blend out any streaking as it makes a pass over the laminate. Finishes are uniform over the entire surface.

The amount of material removed, even with several passes, is so slight that it is impossible to measure the thickness change with ordinary micrometers. Regardless of the thickness of foil used, there is no danger of the abrasive cutting through. Owen Johnson, Director of Manufacturing at Mica Corporation, calls the operation a "surface phenomenon," rather than a material removing process.

Known commercially as the Merit Flex-Drum, this tool con-

(*Continued on page* 222)

Sander cleans and polishes copper-clad laminated panels used for printed circuits.



John A. Hickey, Industrial Products Manager, discusses new Raytheon PF Transformer line with William P. Sharpe, Product Planning Manager.

Now Locally Stocked...

RAYTHEON'S NEW PF LINE

New constant voltage plate-filament power transformers now available at Raytheon Distributors

These new Raytheon stabilizing transformers provide constant voltage better than ±3%. They prolong tube life and improve reliability and performance of electronic equipment. Often eliminate need for other voltage-regulating components. Also serve as effective "first-stage" regulators ahead of other voltage-stabilizing circuits. What's more, these new Raytheon-manufactured Transformers eliminate the need to match capacitors to the transformers when replacements are made.

Back-up Stock — Ask your nearest Raytheon Distributor to inventory your electronic components needs. He'll carry a complete back-up stock. Raytheon engineers are at his service to help solve your applications problems, too.

Single Source — Whatever electronic components you need, your local Raytheon Industrial Products Distributor can supply them. Electronic tubes, semiconductors, voltage regulators, knobs and hardware. And, A COMPLETE LINE OF STABILIZING PLATE AND FILAMENT TRANSFORMERS.

If you don't know your nearest Raytheon Industrial Electronics Distributor, write to John Hickey, Industrial Products Manager, who will be glad to give you his name or have him call you.

RAYTHEON COMPANY • DISTRIBUTOR PRODUCTS DIVISION

Circle 158 on Inquiry Card

(*Continued from page* 220)

sists of a series of "leaves" of abrasive cloth mounted horizontally to a cylindrical mandrel or wheel. As the mandrel rotates it wipes the leaves in rapid succession over the surface of the laminate. The mandrel itself is mounted on arbors so that a slight oscillating motion from side to side can be provided. Its construction consists of many horizontal key slots into each of which is inserted a steel ferrule holding several strips of coated abrasive. The abrasive loadings can be changed in a matter of minutes, using only a screwdriver. The wheel need not be removed from its mounting to load or change grit.

The one-piece design of the Merit Flex-Drum leaves no parting lines such as is the case when flap wheels are ganged on a single spindle. The abrasive of the Flex-Drum cleans itself by centrifugal force and will not clog or load up even when very soft metals are finished. The Flex-Drum is provided in a wide range of grits from #40 to #320 and in widths up to 60 inches. It has been particularly successful for satin finishing aluminum and stainless steel. Because of its flexibility, contoured parts can be handled equally as well as flat, broad surfaces. The wheels in smaller widths (up to 8 inches wide) may be had with "slashed" abrasive cloth for greater flexibility when used with irregular and odd-shaped parts.

The abrasive cloth wears evenly and a fresh cutting edge is always in contact with the work. Back-up pressure is furnished by the compactness of the flaps themselves. The Flex-Drum is particularly adaptable to long production runs and one abrasive loading will last for hundreds of hours of normal refinishing. This equipment is manufactured by Merit Products of Los Angeles, Calif.

Former methods of achieving a refinished surface included hand work with steel wool or scouring cleansers, and wet process machines. The Flex-Drum practically eliminates manual operations and cuts refinishing costs to a fraction.

ELECTRONIC INDUSTRIES Advertisers — October 1959

(Continued on page 224)

Advertisers Index —continued

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THE MOST COMPLETE LINE OF MICROWAVE TUBES AND COMPONENTS

Bomac offers you *the* widest choice of performance-proven microwave tubes and components from which to choose.

And when it comes to adaptations, or totally new designs, there's no substitute for Bomac's 12 years' experience in this specialized, complex, fast-changing field.

Whatever your problem in microwave, check Bomac *first*.

BOMAC laboratories, inc.

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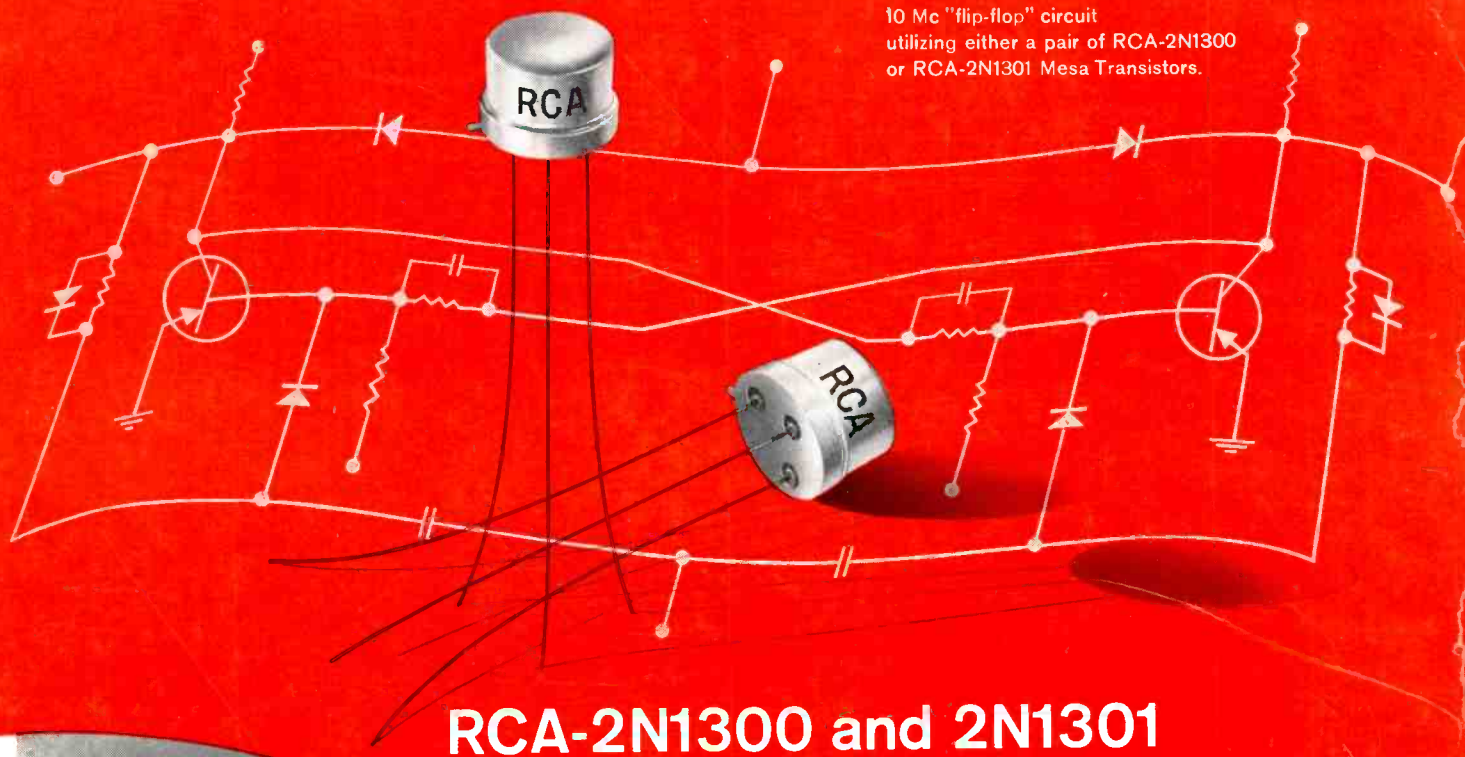
Circle 2 on Inquiry Card



10 Mc "flip-flop" circuit utilizing either a pair of RCA-2N1300 or RCA-2N1301 Mesa Transistors.

RCA-2N1300 and 2N1301

LOW-COST MESA COMPUTER TRANSISTORS

Now in quantity production . . . and available!

RCA-2N1300 and 2N1301 Germanium P-N-P Mesa Transistors offer these 10 major benefits to designers of switching circuits. And they're ready for you now!

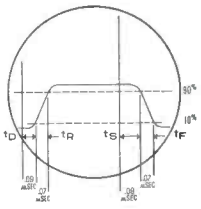
- rugged Mesa structure—permits extremely small base width to insure top performance at high frequencies
- fast switching times with low values of base input current—made possible by high frequency response and low total stored charge
- high current gain—permits high fan-out ratios (number of paralleled similar circuits per driver-stage output)
- high breakdown voltage and punch-through voltage ratings—the result of the diffusion process
- high power dissipation—150 milliwatts at 25°C—aids in the design of reliable circuits
- high current ratings—improve overall system speed
- rugged overall design—units have unusual capabilities to withstand severe drop tests and electrical overloads
- electrical uniformity—a result of the diffused-junction process used by RCA in the manufacture of Mesa Transistors
- especially well suited for use at pulse repetition rates up to 20 Mc
- exceptionally well suited to applications in saturation-type switching circuits

Information on RCA-2N1300 and 2N1301 Low-Cost Mesa Transistors is available from your RCA Field Representative. For technical data, write RCA Commercial Engineering, Section J-50-NN, Somerville, N. J.

RCA TYPE	Maximum Ratings▲ Absolute-Maximum Values						Characteristics: Common-Emitter Circuit, Base Input Ambient Temperature of 25° C		
	Collector-to-Base Volts	Emitter-to-Base Volts	Collector Milli-amperes	Transistor Dissipation—mw			Minimum DC Current Gain		Gain Bandwidth Product● Mc
				at 25°C	at 55°C	at 71°C	at collector ma = −10	at collector ma = −40	
2N1300	−13	−1	−100	150	75	35	30	–	40
2N1301	−13	−4	−100	150	75	35	30	40	60

▲Maximum collector-to-emitter voltage rating = −12 volts

● For collector ma = −10 and collector-to-emitter volts = −3.



Oscilloscope wave form shows typical delay, rise, storage, and fall times achieved with 10-ma inverter circuit utilizing the RCA-2N1301 MESA TRANSISTOR.

RCA Field Offices

EAST: 744 Broad St., Newark 2, N. J.
HUmboldt 5-3900

NORTHEAST: 64 "A" Street
Needham Heights 94, Mass.
HIllcrest 4-7200

EAST CENTRAL: 714 New Center Bldg.
Detroit 2, Mich.
TRinity 5-5600

CENTRAL: Suite 1154
Merchandise Mart Plaza
Chicago 54, Ill.
WHitehall 4-2900

WEST: 6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

GOV'T: 224 N. Wilkinson Street
Dayton, Ohio
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