SEPTEMBER 11, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 37 PRICE SEVENTY-FIVE CENTS

Special Instruments for Design and Production

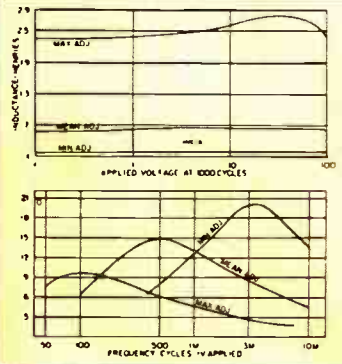
High-Q Inductors.... FROM STOCK

As largest producers in this field for over two decades, UTC inductors cover virtually every need for both fixed and variable units of exceptional stability. Hermetic units have been proved to MIL-T-27A, eliminating costs and delays of initial MIL-T-27A testing.

For complete listing of our 700 stock items (300 hermetic) write for catalog.

HVC Hermetic Variable Inductors

A step forward from our long established VIC series. Hermetically sealed to MIL-T-27A...extremely compact...wider inductance range...higher Q...lower and higher frequencies...superior voltage and temperature stability. Case 25/32 x 1⅛ x 1 7/32, 2 oz.

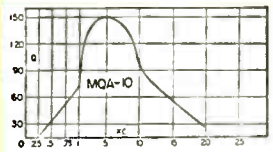


Type No.	Min. Hys.	Mean Hys.	Max. Hys.
HVC-1	.002	.006	.02
HVC-2	.005	.015	.05
HVC-3	.011	.040	.11
HVC-4	.03	.1	.3
HVC-5	.07	.25	.7
HVC-6	.2	.6	2
HVC-7	.5	1.5	5
HVC-8	1.1	4.0	11
HVC-9	3.0	10	30
HVC-10	7.0	25	70
HVC-11	20	60	200
HVC-12	50	150	500

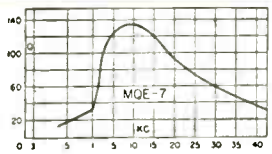
HVC

MQ drawn case structure

	Length	Width	Height	Oz.
MQE	1/2	1-1/16	1-7/32	1.5
MQA, MQD	11/16	1-9/32	1-23/32	4
MQB	1-5/16	2-9/16	2-13/16	14

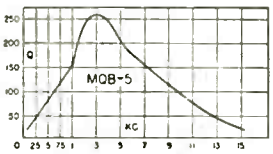


MQA
19 stock values from 7 Mhy. to 22 Hy.



MQE
15 stock values from 7 Mhy. to 2.8 Hy.

MQB
12 stock values from 10 Mhy. to 25 Hy.



MQD

New extreme stability inductors for 12KC to 130KC range. Typical Q is 170 @ 50KC. 6 stock values from 2 mhy. to 20 mhy.

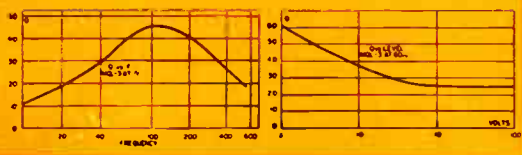
MQ Series Compact Hermetic Toroid Inductors

The MQ permalloy dust toroids combine the highest Q in their class with minimum size. Stability is excellent under varying voltage, temperature, frequency and vibration conditions. High permeability case plus uniform winding affords shielding of approximately 80 db.

MQL Low Frequency High Q Coils

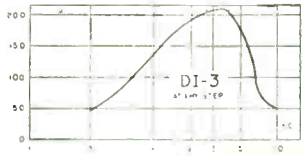
The MQL series of high Q coils employ special laminated Hipermalloy cores to provide very high Q at low frequencies with exceptional stability for changes of voltage, frequency and temperature. Two identical windings permit series, parallel, or transformer type conections. 1-13/16 dia. x 2½" H.

MQL-0	.25/1 Hys.
MQL-1	2.5/10 Hys.
MQL-2	5/20 Hys.
MQL-3	50/200 Hys.
MQL-4	100/400 Hys.
MQL-5	625/2500 Hys.



DI Inductance Decades

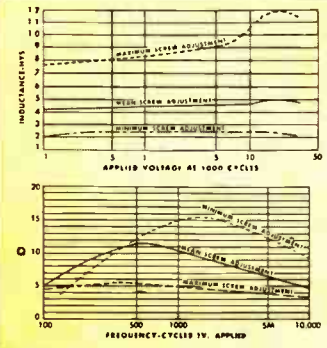
These decades set new standards of Q, stability, frequency range and convenience. Inductance values laboratory adjusted to better than 1%. Units housed in a compact die cast case with sloping panel ideal for laboratory use . . . 4½ x 4⅜ x 2⅜ high.



DI-1 Ten 10 Mhy. steps.
DI-2 Ten 100 Mhy. steps.
DI-3 Ten 1 Hy. steps.
DI-4 Ten 10 Hy. steps.

VIC case structure

Length	Width	Height	Oz.
1-1/4	1-11/32	1-7/16	5-1/2



Type	Mean Hys.	Type	Mean Hys.
VIC-1	.0085	VIC-12	1.3
VIC-2	.013	VIC-13	2.2
VIC-3	.021	VIC-14	3.4
VIC-4	.034	VIC-15	5.4
VIC-5	.053	VIC-16	8.5
VIC-6	.084	VIC-17	13.
VIC-7	.13	VIC-18	21.
VIC-8	.21	VIC-19	33.
VIC-9	.34	VIC-20	52.
VIC-10	.54	VIC-21	83.
VIC-11	.85	VIC-22	130.

VIC Variable Inductors

The VIC Inductors have represented an ideal solution to the problem of tuned audio circuits. A set screw in the side of the case permits adjustment of the inductance from +85% to −45% of the mean value. Setting is positive.

Curves shown indicate effective Q and L with varying frequency and applied AC voltage.

SPECIAL UNITS TO YOUR NEEDS
Send your specifications for prices.

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.

electronics

SEPTEMBER 11, 1959

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Vol. 32 No. 37

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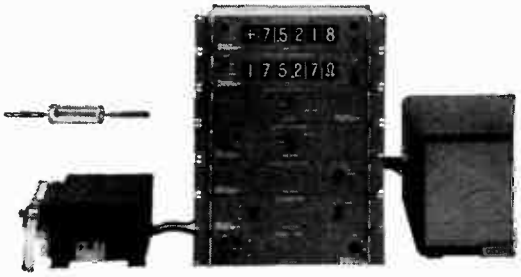
Low cost, versatile DIGITAL SYSTEMS

for automatic testing of transistors resistors diodes and capacitors



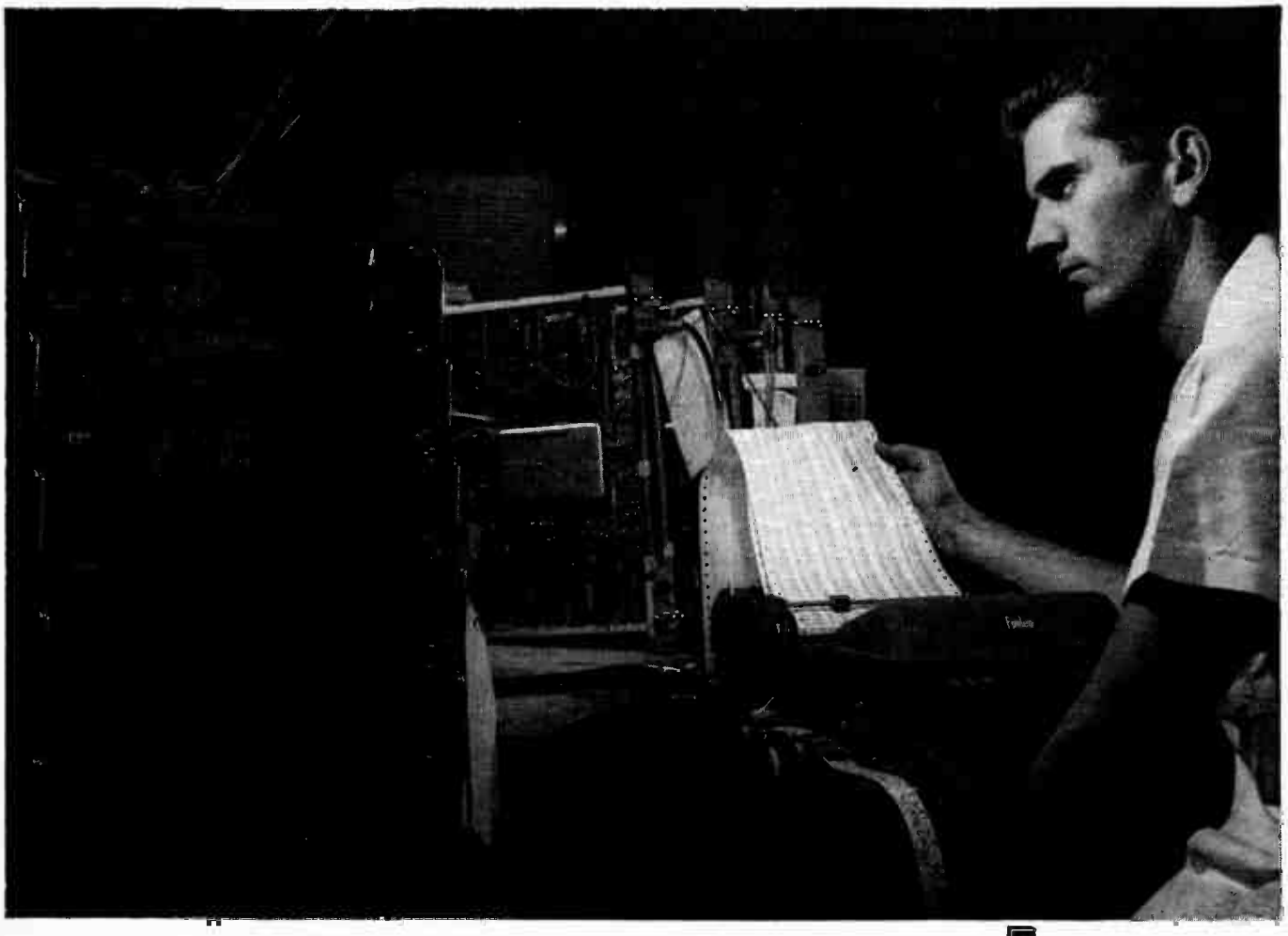
Typical E-I system for evaluating components—includes 100 channel input signal scanner. Can digitize DC voltage, resistance, AC voltage and DC/DC voltage ratio analogs. Digital equivalents are recorded on strip printer for "quick look" data and on punch paper tape for additional data reduction by digital computer.

Small E-I automatic digital systems provide many advantages. First, they cost less. This is primarily the result of large-quantity manufacture of modules which make up the E-I system. Cost is almost a linear function of performance capabilities desired in the system.

Second, they are exceptionally versatile. The E-I system can be expanded simply by adding appropriate modules. Typical systems presently in use measure resistance, capacitance, DC and AC voltages, DC/DC ratios, AC/DC ratios, AC/AC ratios and combinations of these. Measurements to four or five digits can be visually displayed and printed out at rates up to five readings per second. Operation can be semi- or totally automatic with go/no go comparison of values and programmed readout at periodic intervals. Scanners can be provided for scanning thousands of single and multi-wire input channels. In brief, the E-I system has an extensive scope of operating capability.

Third, E-I systems provide unmatched reliability. Where practicable, circuits are totally transistorized. The use of etched, plug-in circuit boards, and modular internal construction make maintenance checks and in-plant repairs easy.

Lower cost, maximum versatility and greater reliability—if you want these advantages in your component test system, contact your nearest E-I representative. He can give you complete information or answer any specific questions you may have.



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it's for the BIRDS*

THE KERNEL

... A New Microminiaturized Toroidal Inductor

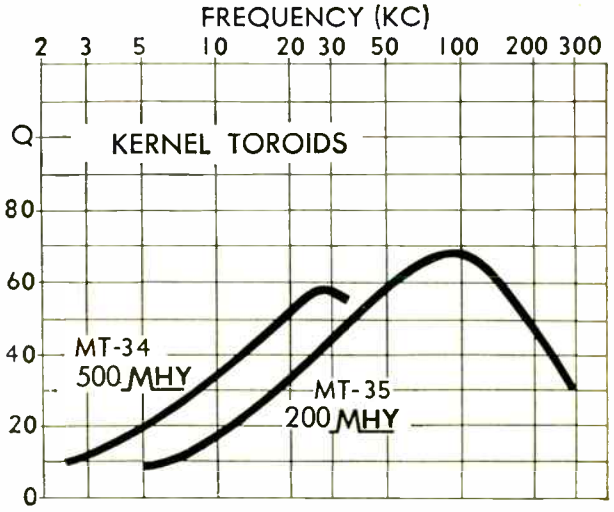
The new Burnell & Co. MT 34 and MT 35 microminiature Kernel toroidal inductors are made to order for the engineer who isn't content with outer husk solutions but gets right to the core of second generation missile communication problems.

MT 34 microminiature Kernels can be supplied with inductances up to 500 mhys and the Kernel MT 35 is available in inductances up to 200 mhys. MT 34 Kernels are recommended for frequencies to 30 kcs and the MT 35 is applicable to frequencies up to 200 kcs depending on inductance values. Q for the MT 34 is greater than 55 at 25 kc and for the MT 35 more than 60 at 100 kcs.

Size of the MT 34 and MT 35 is .117" OD x .215", spacing between leads .3" x 1" L with a weight of .06 ounces.

The new microminiature Burnell MT 34 and MT 35 Kernels provide maximum reliability as well as considerable economy in printed circuit use. Completely encapsulated, the Kernels will withstand unusually high acceleration, shock and vibration environments.

Write for special filter bulletin MTF to help solve your circuit problems.



*missiles

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TELETYPE: PASACAL 7578

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SHOPTALK . . . editorial

BYLINES. In the publishing world, a "byline" is a line of type displayed at the beginning of an article telling who wrote the article. Most publications put bylines on articles written by full-time staff members only when the article has singular merit. Among editors and writers, bylines are important milestones in their professional progress.

Our special report, "Instruments for Design and Production," which appears on p 89, carries the byline of Associate Editor Bushor. The report has been in preparation for almost one year. It is one of the most comprehensive rundowns yet to appear on new developments and future trends in test instruments.

Although they get no bylines, this report could not have been written without the help of many of our friends in industry. Gathering material for this report, Bushor visited dozens of instrument manufacturers, contacted additional hundreds by mail. Manufacturers proudly gave details on the latest innovations in their products and freely discussed future design and marketing plans.

This close cooperation between ELECTRONICS magazine and the electronics industry at large enables us each week to bring you, the reader, the latest business and engineering news—accurately, in depth and detail, and in true order of importance. Such a job can only be done by a publication that is truly part of the industry it serves.

OFF THE BEATEN TRACK. Our editors frequently unearth important business news stories by diverging from the hard-pan trail followed by most industrial editors.

At a recent "Press Open House" held at Fort Monmouth by the Army Signal Corps, Associate Editor Mason's deeply probing questions to his hosts earned him a fast ride by staff car to Deal, N. J. There he got a peek at the Army's satellite tracking center.

The tracking center is America's eye on the sky. Unlike many other tracking centers, the Deal center is not restricted to one frequency band. It can, and does, monitor frequencies from 15 kc to 1,000 mc, switching between a half dozen high-gain antennas.

The center locked onto Sputnik I only two hours after it was launched, and has tracked every satellite launched since then. It is our first line of defense against any potentially hostile orbiting vehicles. For details on equipment now being installed at Deal, plus Mason's exclusive photographs, see p 40

Coming In Our September 18 Issue . . .

INDUCTIVE COMPUTER CIRCUITS. In designing any switching circuit which requires a passive time-measuring or storage device, most engineers instinctively turn to using a capacitance. According to William Carey of Minneapolis-Honeywell's Datamatic Division, inductance is at least as versatile a reactive parameter as is capacitance in time-measuring circuits when transistors are used for amplification. Carey proceeds to show a number of circuit configurations which back up his claim that inductive elements are deserving wider use in multivibrators, scalers and similar computer uses.

MORTAR POSITION PINPOINTER. In recent wars, one of the leading producers of casualties has been the deadly mortar. The modern army's answer to this is a new tactical radar system for pinpointing the location of enemy mortars and directing more accurate counterfire to knock them out. M. S. Yaffee, W. F. Smith and J. B. Skully of General Electric Co. describe the new mortar locator which detects the mortar shell in flight and computes the location of the enemy position. The system has a maximum range of 10,000 meters and presents the target data in a form which minimizes the time between location and counterfire.

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, 35 Marshall Street, North Adams, Massachusetts.

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SPRAGUE COMPONENTS:
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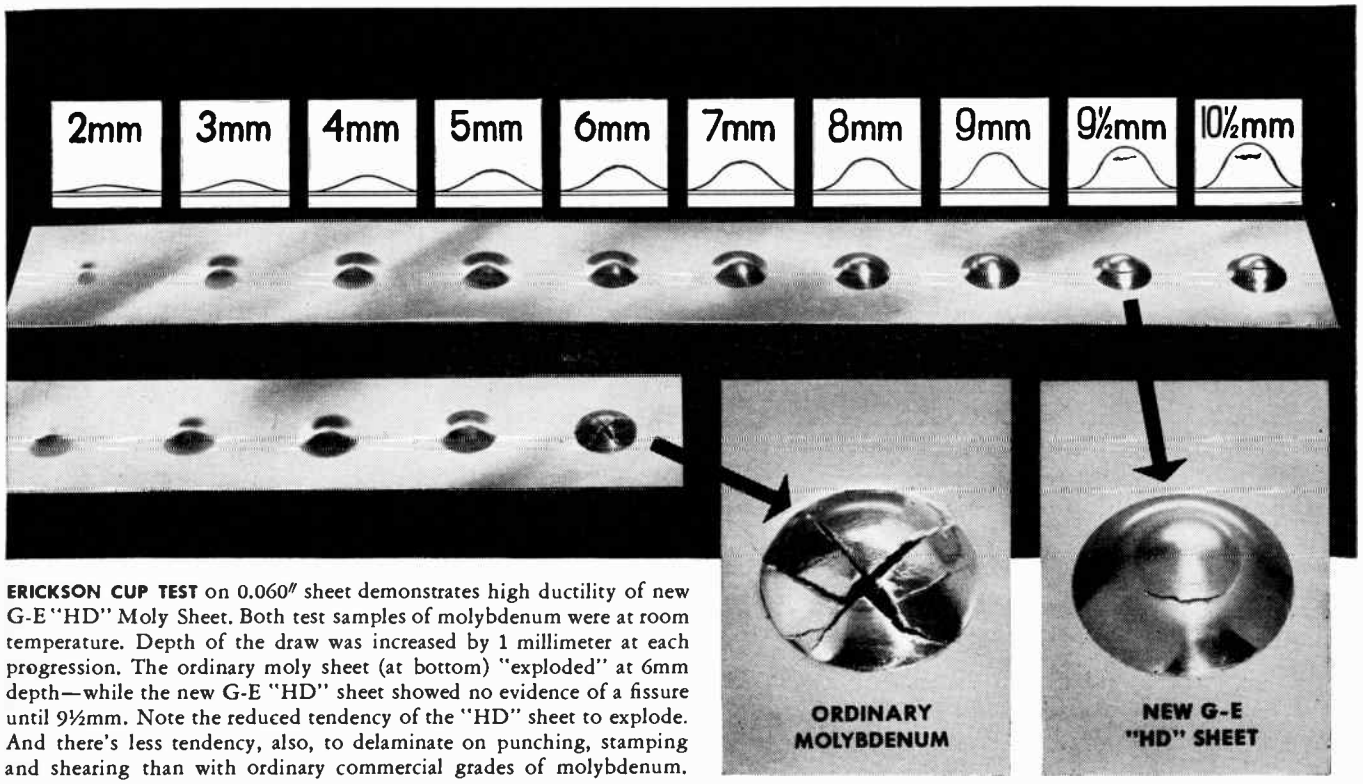
Now you can deep draw and bend molybdenum sheet at room temperature!

. . . with General Electric's new High-Ductility (HD) Molybdenum Sheet

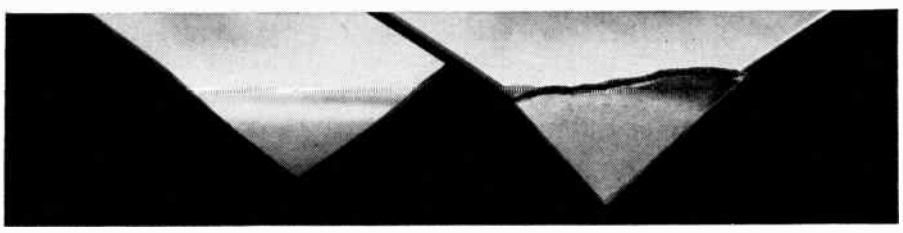


ERICKSON CUP TEST on 0.060″ sheet demonstrates high ductility of new G-E "HD" Moly Sheet. Both test samples of molybdenum were at room temperature. Depth of the draw was increased by 1 millimeter at each progression. The ordinary moly sheet (at bottom) "exploded" at 6mm depth—while the new G-E "HD" sheet showed no evidence of a fissure until 9½mm. Note the reduced tendency of the "HD" sheet to explode. And there's less tendency, also, to delaminate on punching, stamping and shearing than with ordinary commercial grades of molybdenum.

DRAW IT! FORM IT! PUNCH IT!—all without preheating! General Electric's new "HD" Moly Sheet can take it—and you can do all these operations in thicknesses previously impossible . . . or requiring up to 1000°F preheating. Even in cases where small amounts of heat may be needed, it's always less than with ordinary molybdenum sheet.

TIME SAVER, MONEY SAVER! The improved ductility of General Electric's new "HD" Molybdenum Sheet is of particular significance in sheet thicknesses of 0.020″ to 0.125″—as used in electronic tubes and semiconductor diodes, rectifiers and similar products. It has a high melting point (2622°C, 4752°F), low vapor pressure, and excellent strength at elevated temperatures. So it will be of great value to any company using refractory metals.

PLAN ON G-E "HD" SHEET Available in commercial quantities, so there's no better time than right now to get all the facts about this new kind of molybdenum. Write: General Electric Co., Lamp Metals and Components Dept. E-9, 21800 Tungsten Road, Cleveland 17, Ohio.



BENDS WITHOUT CRACKING . . . EVEN WITH NO PREHEATING!

Ordinary 0.060″ thick molybdenum broke at a 20° bend (see photo at left). The G-E "HD" sheet of same thickness shows no sign of cracking at 90°. Actually this new G-E Moly Sheet is so ductile you can bend it up to 180° without damage!

Progress Is Our Most Important Product

GENERAL ELECTRIC

READ

RADAR ECHO AUGMENTATION

Small in size but large in application, READ was designed and developed by Temco Electronics. Used in small target drones, READ makes the craft appear as large as a potential enemy bomber. The greatly augmented image permits very accurate long range tracking of aircraft and missiles. As an aid in traffic control, READ reduces the possibility of mid-air collision. READ is another example of Temco Electronics development of its own proprietary products, in addition to its participation in weapons systems development.

Many excellent engineering and scientific positions are now open in this and other Temco programs. We invite your inquiry.

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BROAD

with these convenient, precision

NEW AMPLIFIER!

Just clamp on probe and read current instantly!

hp 154A Voltage/Current Dual Channel Amplifier

SPECIFICATIONS

(When plugged into -hp- 150A/AR Oscilloscope)

CURRENT CHANNEL

Band Pass:	50 cps to 8 MC.
Sensitivity:	10 calibrated ranges, 1 to 1,000 ma/cm, 1, 2, 5, 10 sequence. Accuracy ± 5%. Vernier between steps (extends 1,000 ma/cm range to at least 2,500 ma/cm).
Max ac Current:	10 amperes rms 20 KC and above. Below 20 KC core saturation reduces current capability proportional to frequency.
Max dc Current:	Direct current to ½ amp has no appreciable effect.
Input Impedance:	Approx. 0.01 ohm shunted by 0.8 uh.

VOLTAGE CHANNEL

Band Pass:	dc coupled: dc to 10 MC, 0.035 μsec rise time. ac coupled: 2 cps to 10 MC, 0.035 μsec rise time.
Sensitivity:	9 calibrated ranges, 0.05 to 20 v/cm; 1, 2, 5, 10 sequence. Accuracy ± 5%. Vernier between steps.
Input Impedance:	1 megohm (nominal), 30 uuf shunt.

GENERAL

Vertical Presentation:	(1) Either voltage or current signal continuously or (2) voltage and current signals sampled at 100 KC or on alternate traces.
Vertical Position:	Each channel individually adjustable.
Price:	$430.00 (includes current probe).

The new hp 154A's exclusive "clamp-around" probe permits fast, direct measurement of current from 50 cps to 8 MC, 1 ma to 15 amperes (peak-to-peak) *without breaking into the circuit, loading, or voltage drop due to resistor insertion.* Here is a time-saving convenience feature of real significance in the investigation of transistors, logic circuits and other measurements where current information is of prime importance.

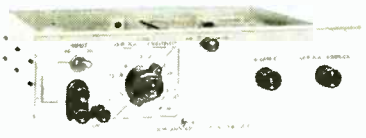
In addition, the 154A — actually two instruments in one—makes possible swift, simple and direct comparison between voltage and current waveforms. In this comparison service, one section of the 154A reads current while the other reads voltage in a manner identical with other hp voltage indicating instruments. Comparison is achieved by electronic channel switching—through alternate sweeps or 100 KC chopping. Either of the 154A's dual channels may also be used individually.

hp® now offers better-than-ever service

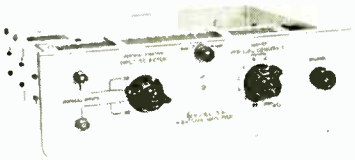
the utility of your 150 A/AR oscilloscopes

amplifiers and accessories

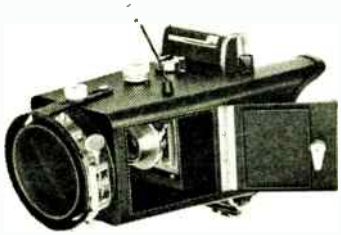
152B Dual Trace Differential Amplifier. New plug-in amplifier providing differential input and dual traces electronically switched between A and B channels at either 100 KC or on alternate sweeps. Sensitivity range 0.05 v/cm to 50 v/cm, input attenuator with 9 calibrated ranges in 1, 2, 5, 10 sequence and vernier. $250.00.



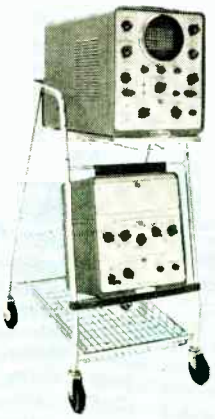
153A Very High Gain Amplifier. New plug-in permitting 150A to be used for many direct measurements from transducer without *preamplification*. Pass band dc to 500 KC, sensitivity 1 mv/cm to 125 v/cm, balanced input on all ranges. 15 calibrated ranges in 1, 2, 5, 10 sequence, 1 mv/cm to 50 v/cm; plus vernier. $125.00.



151B High Gain Amplifier. For 150A high gain unit with 5.0 mv/cm sensitivity, frequency response dc to 10 MC. 12 calibrated ranges on 1, 2, 5, 10 sequence, 5 mv/cm to 20 v/cm; accuracy ± 5%. Vernier adjustment. 1 megohm input impedance with 31 uuf shunt. Pass band rise time 0.035 μsec. Has 2 BNC terminals. $200.00.



196A Oscilloscope Camera. All new, most useful scope camera ever. Full-size, distortion free pictures; full picture area may be scaled. Simple multiple exposures; with one hand move lens through 11 detented positions. Pictures sharp, clear, compare to CRT resolution. Professional bellows prevents light leaks; easy tab pulling; set f-stop and shutter without removing camera from scope; mount on scope with one hand. Employs Polaroid® Land Camera back, new *flat* Wollensak 3" f/1.9 lens. Wt. 9 lbs. $425.00.



AC-115A Oscilloscope Testmobile. For 150 series oscilloscopes but fits others. 4" rubber tired wheels, heavy chrome tube construction, tilts 'scope to 30° in 7½° increments, folds for storage, shipping. $80.00 AC-116A Storage Unit fastens to AC-115A, holds 150A plug-ins or AC-117A Accessory Drawers. AC-116A, $22.50. AC-117A, $10.00.

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

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NOW! IN EUROPE!

In May, 1959, Hewlett-Packard S.A. was established in Geneva (a branch has since opened in Frankfurt am Main) offering technical sales and engineering help and information. Previously established relationships with representatives in other parts of Europe of course continue. In addition, there is a new - - warehouse in Basel stocking instruments and parts, and an - factory near Stuttgart will soon be producing - - instruments for customers throughout Europe.

to our customers in Europe!

NATO SELECTS EIMAC KLYSTRONS TO POWER EUROPE'S LARGEST TROPO-SCATTER NETWORK

One and ten kilowatt amplifiers in NATO's continent-spanning tropo-scatter system will be Eimac Amplifier Klystrons. Since Eimac Klystrons first made large-scale tropospheric communications possible in 1954, they've become famous for reliability in all major tropo-scatter networks: Pole Vault, Dew Line, Texas Towers, White Alice, Florida-Cuba TV. Individual Eimac Klystrons have logged more than 35,000 hours continuous air time in tropo-scatter service.

Exclusive design features make Eimac Klystrons outstanding for tropo-scatter. Extra-wide frequency tuning is achieved with one set of tuning cavities. Inductive tuning achieves uniform bandwidth plus greater broadbanding by external cavity loading. Eimac's external cavity design lowers original cost, and replacement cost is lower since tuning circuitry is purchased just once.

One wide range load coupler covers the entire frequency range. Eimac's series connected body magnets permit use of one power supply, one control for body magnets.

Eimac Klystrons will be used in NATO installations. Proved Eimac reliability will aid in safeguarding the security of all free European nations.

EITEL-McCULLOUGH, INC.

Eimac

San Carlos • California

ELECTRONICS NEWSLETTER

INSTRUMENT MAKERS in both military and commercial markets are making more and more of their own small components. Reason: They need better electrical characteristics plus reliability in quantities often too small for component manufacturers to produce at a low unit cost. Plant visits reveal that such specially made units include capacitors, wire-wound resistors and transformers. Meanwhile, GE disclosed that it is undertaking a two-year million-dollar effort, including an addition to its Columbia, S. C. plant, to produce a new family of capacitors for missile use that will have a failure rate of only one in 100,000. Current failure rate is about one in 1,000.

MIDAS SATELLITE will have infrared detectors to detect rockets or missiles at takeoff, says Herbert York, Pentagon director of research and engineering. DOD feels that this would be an improvement over ground-based detection system. York also said DOD is breaking down systems approach to military space programs, separating booster work from payload development. Such separation gives greater recognition to the work of electronics companies. Idea is to package what's best from electronics point of view and still get better integration with booster program.

Thermoelectric generators hold great promise as primary sources of power for aircraft and rockets of the future. This statement was not news when it was made recently to ELECTRONICS. But what was noteworthy was the fact that it came from a top engineer with an aircraft company who said his firm is pushing an R&D program.

TRANSISTORIZED SONAR TRAINING AID developed by ITT Laboratories teaches Navy sonar trainees to distinguish submarines from false targets. It reproduces exactly the echoes from different underwater objects. Gear records sonar searches by pulse amplitude modulation (pam) time division, f-m frequency division and a-m frequency division multiplexing onto 14-track magnetic tape. Stored data may be played back on 10 trainee-operated sets, each monitored by an instructor at master console. Equipment was produced under a $1.5-million contract from Naval Training Devices Center, Port Washington, N. Y., and has been installed at Key West, Fla., and San Diego, Calif., Navy training stations.

Minuteman guidance system is said by one source to involve 8,000 semiconductor diodes in the bird itself, 25,000 in ground-based gear.

NAVY THERMOELECTRIC EXPERIMENTS will be carried out with a new three-purpose device to be built by Westinghouse for BuShips. A thermoelectric air conditioner, space heater and refrigerator-freezer will be combined into one system. Purpose: to test the suitability of thermoelectricity for shipboard air conditioning and refrigeration. System's three components will be built up of identical thermoelectric elements, or modules; these can be individually removed and replaced, and can serve as building blocks for a larger system. Westinghouse research v-p S. W. Herwald says the Navy contract is "indicative of the rapid progress now being made in the whole broad field of thermoelectricity, both for refrigeration and for electric power generation."

Nearly 190 presentations have been scheduled for 60 sessions of the 14th and biggest Annual Instrument-Automation Conference and Exhibit of the Instrument Society of America in Chicago, Sept. 21-25.

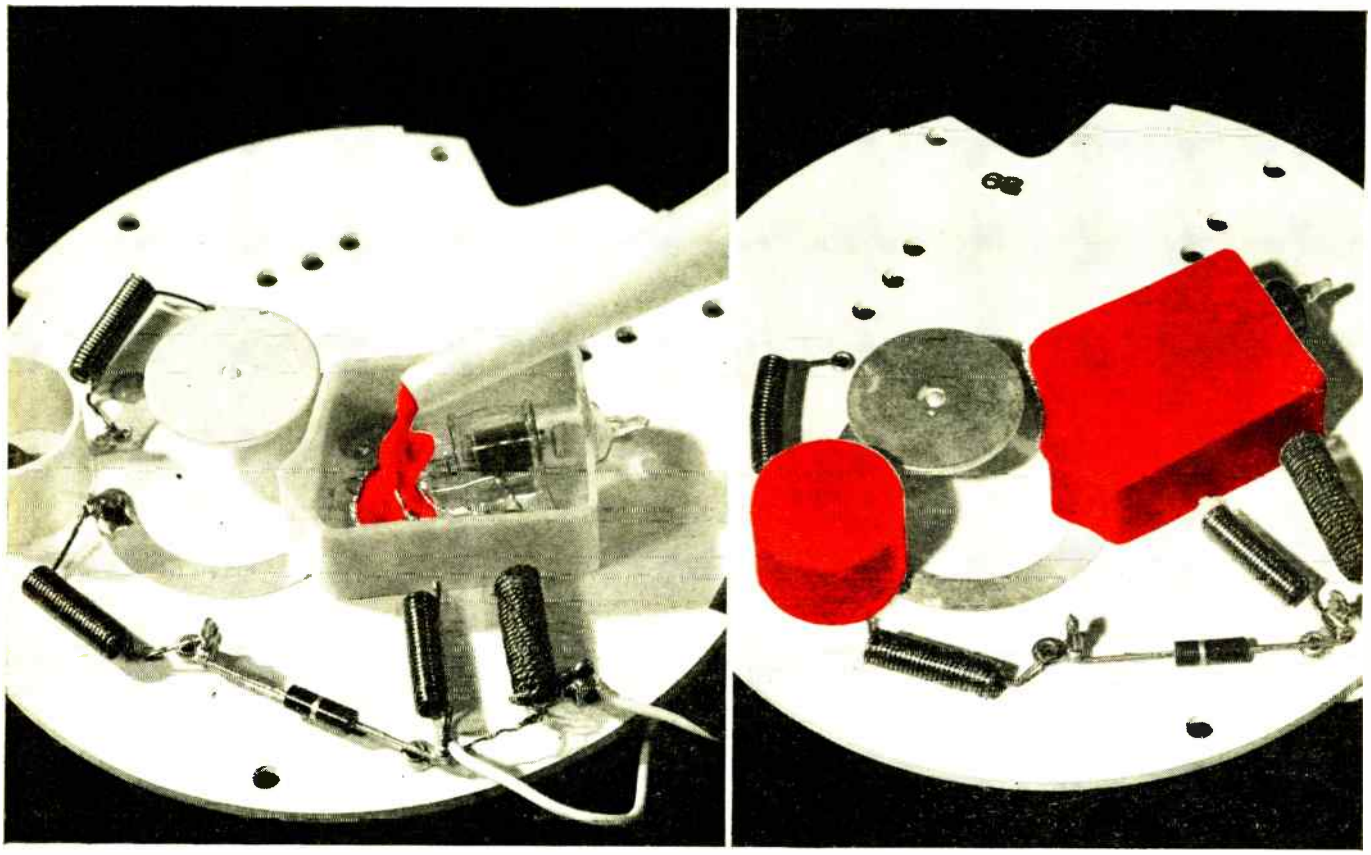
ELECTRONIC CONTROLS for machine tools are already important in the planning of European industry (ELECTRONICS, p 13, Oct. 31, '58). Now comes word that Britain's EMI Electronics, one of many firms in the growing market, this fall is taking a 25-ft trailer fitted out as a modern workshop to France, Belgium, Holland, West Germany, Switzerland and Italy, and hopes to take it to Moscow next year. Exhibit includes a Kearney and Trecker milling machine which can, with punched tapes, produce items from a two-dimensional template to a three-dimensional die. Meanwhile, Britain's Board of Trade released figures that indicate British automation progress: Deliveries by makers of instruments and industrial control gear increased 9 percent between 1956 and 1958. In the first five months of 1959 deliveries of control equipment, including computers, were up 5 percent over the previous year.

Third International Conference on Medical Electronics is being planned for late next year in London by the British Institution of Electrical Engineers. Exhibition is planned simultaneously.

SAGE-CONTROLLED AIR TRAFFIC is under study by The Mitre Corp., air defense engineering systems adviser. Idea is that Sage centers might be used simultaneously for military purposes and in civilian air traffic control, saving the cost of an entirely separate system. Technical feasibility of using CHARM (CAA High Altitude Remote Monitors) will soon be reported to government agencies. Second phase, dubbed Project SATIN (Sage Air Traffic Integration), used New England experimental Sage facilities for evaluation of air traffic control application. Meanwhile, Mitre's Boston area facilities are being augmented with an IBM 7090 and a solid-state experimental Sage computer.

SILICONE NEWS from Dow Corning

As Environments Grow Tougher



SILASTIC RTV
SILICONE RUBBER

Supplies Both Physical and Electrical Protection

The ideal encapsulating material should prevent mechanical damage to sub-assemblies and at the same time improve electrical properties. It should retain these protective qualities in all operating environments and put no stress on delicate parts. Just such a material is Silastic® RTV, the Dow Corning silicone rubber that vulcanizes at room temperature.

Take the case of the Radio Sondes manufactured by the General Instrument Corporation, Newark, N.J. These meteorological instruments linked to integral transmitters are designed to be launched from aircraft at altitudes up to 60,000 feet and speeds up to 565 knots. This means reduced air pressure and a definite hazard of arcing and corona due to the high potentials involved. It also means slipstream shock and vibration at launch.

As shown in the photos, critical areas of these Radio Sondes are encapsulated with Silastic RTV, applied with a calking gun into reusable retainer rings. By encapsulating the most vulnerable areas with Silastic RTV, excellent protection is achieved with no degradation of power factor.

Silastic RTV is easy to apply, has good dielectric and physical properties, and resists moisture, arcing, corona, and ozone. Rapidly changing ambients will not cause Silastic RTV to put excessive stress on fragile parts . . . it remains resilient and soaks up shock. Silastic RTV is available in different consistencies, set-up time can be varied from minutes to hours, depending upon the RTV system.

Typical Properties of Silastic RTV

- Temperature range . . (—70 to 260 C) —100 to 500 F
- Dielectric strength, volts mil . . . . . 300 to 500
- Surface resistivity at 50% relative humidity, ohms . . . . . 2.8×10^{13}
- Dielectric constant, 10^6 cycles per second 2.96
- Dissipation factor, 10^6 cycles per second . . . 0.003
- Moisture absorption after 7 days at room temperature, % . . . . 3 to 5

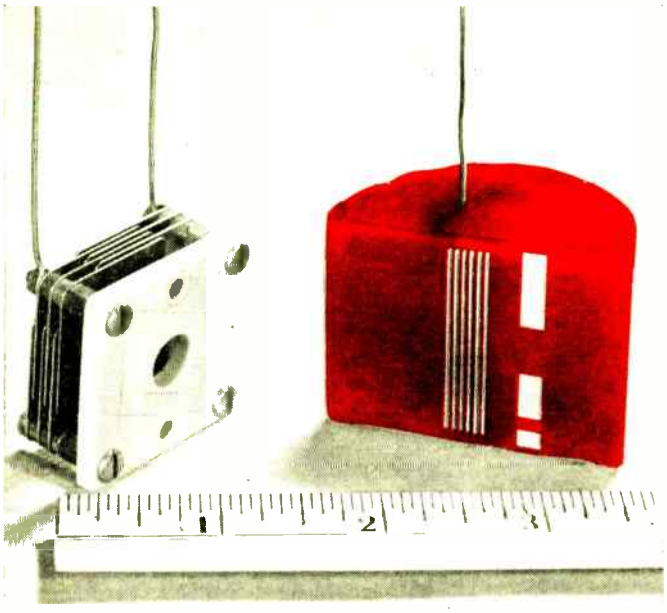
CIRCLE NO. 247 READER SERVICE CARD

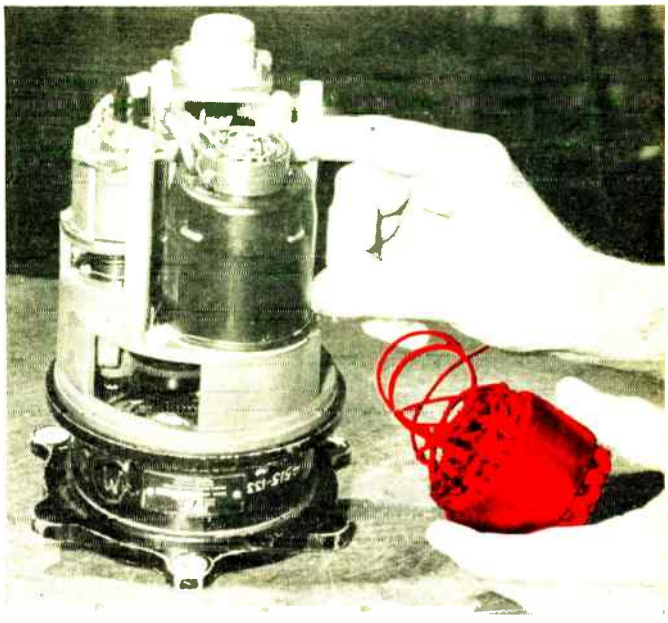
Your nearest Dow Corning office is the number one source for information and technical service on silicones.

first in silicones

Dow Corning

...silicones provide required service





Solventless Resin For Top Heat Stability

When you need a rigid potting or encapsulating material, make sure the resin you choose is one that will keep its properties under adverse conditions. Dow Corning solventless silicone resins will withstand temperatures above 260 C (500 F). With no solvent to evaporate, they set up to a continuous bubble-free mass. The capacitor in the picture is a good example. After potting with one of these thermoset materials, it was sawed in half . . . notice the excellent void-free fill between plates. Solventless silicone resins form clear, tough solids; they accept a variety of fillers. Catalyzed pot life is over 6 months.

CIRCLE NO. 248 READER SERVICE CARD

Highly Stable Diffusion Pump Fluids

Dow Corning silicone diffusion pump fluids resist oxidation even when exposed to air *at operating temperatures.* They won't decompose into gums and tars . . . can be cycled countless times. They recover far faster than organics and have very short pump-down times.

Silicone fluids produce vacua in the range of 10^{-5} to 10^{-7} mm. of mercury, are chemically inert, non-corrosive, non-toxic, free from impurities.

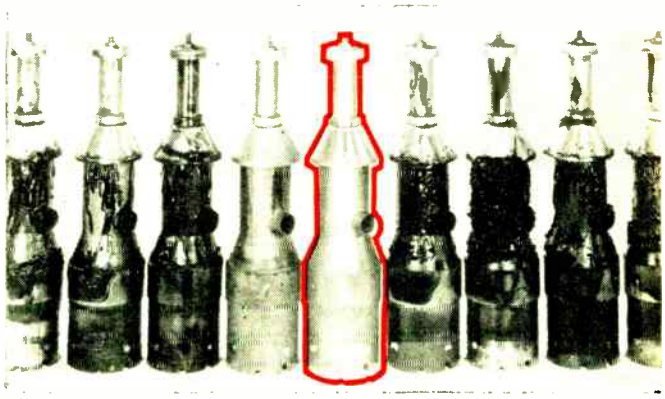
Shown are vacuum pump jet assemblies that were tested to breakdown on various pump fluids. The pump operating on Dow Corning fluids still had not broken down after 1,100 cycles, with exposure to air between cycles!

A Varnish With Greater Heat-Resistance

Dow Corning 997 Varnish permits operation at temperatures up to 250 C . . . gives electronic and electrical equipment protection against overloads, moisture, many chemicals, corrosive atmospheres and other hazards.

The unit pictured is a servo motor that actuates controls in aircraft automatic pilots. Insulated throughout with high temperature materials, and dipped in 997 Varnish, such motors have proven much more reliable operation in United Airlines planes . . . running as long as 5 years without need for replacement, as against scheduled replacement after 1000 hours for Class A insulated motors.

CIRCLE NO. 249 READER SERVICE CARD



CIRCLE NO. 250 READER SERVICE CARD

CORPORATION MIDLAND, MICHIGAN

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WASHINGTON OUTLOOK

WASHINGTON—THE ELECTRONICS INDUSTRY has won the first round in its battle against the aircraft industry's petition to the Labor Dept. that all electronics companies with missile and plane contracts be required to pay the same Walsh-Healey Act minimum wage as the aircraft makers.

In an upcoming survey of wages paid in aircraft and missile plants, the Labor Department has decided to exclude producers of airborne and ground electronic equipment designed for planes and missiles. But the survey will cover electronics companies which assemble missiles, build missile airframes and produce missile nose cones. Among such firms are Sperry, Hughes, Raytheon, Philco, GE and Avco. Labor Dept. officials stress that inclusion of such companies in the survey doesn't mean electronics firms with prime contracts for missile end-items will be covered by the same Walsh-Healey minimum wage as the aircraft industry.

The survey will be made under the aircraft unions' plea to boost the industry's nine-year-old $1.05 minimum pay rate. The unions and the Aerospace Industries Assn. had petitioned the department to include all electronics companies in missile and aircraft production in the survey.

Electronics Industries Assn., in opposing the AIA and aircraft unions, petition, claimed a wage differential of at least 50 cents between electronics plants and the higher-wage aircraft industry. The estimate included all types of electronics manufacturing. EIA conceded that the same differential does not prevail when nondefense electronics workers are excluded, argued that a "substantial wage differential" nevertheless exists between the two industries.

- **A separate Walsh-Healey minimum wage determination**—the first one ever—for the electronics industry as a whole will be considered in the near future. If electronics companies with prime contracts for missile end-items eventually escape Walsh-Healey coverage under the aircraft industry's wage rate, they will be covered by this survey.

  It will be at least another year before the missile wage rate issue is settled. The wage survey, which will begin shortly, must be followed by a public hearing at which AIA, EIA and the industries' unions will be heard prior to the final official decision.

  Meanwhile, the Labor Dept. is planning to meet with industry and union officials next month to discuss the makeup of the questionnaire to be sent to plants in the aircraft-missile wage survey.

- **Washington is making a reassessment** of the ambitious space exploration plans set up by NASA during its first year of existence. The purpose is to scale down the plans in view of what NASA administrator T. Keith Glennan calls "a full realization of the complexity of the technological problems facing us." The result is an indefinite postponement of the some 30 percent of the space-launching attempts scheduled for the year—notably interplanetary probes.

  From here on, the space agency will stress lunar probes. Glennan says NASA has "learned that we are not nearly as far advanced in space technology as we had thought or hoped." The ratio of successful launches to unsuccessful ones has not improved much in the past year.

  Major problem of the space explorers is still reliability. NASA is especially concerned about shortcomings in guidance, thrust control, telemetry and sensors of all types, will push hard on research in these fields.

OHMITE®

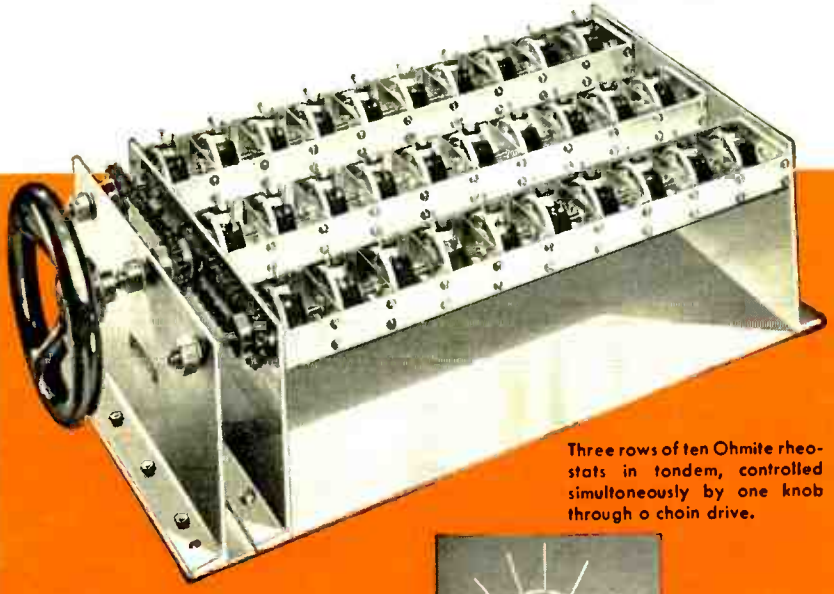
RHEOSTATS

WITH SPECIAL FEATURES

solve many difficult control problems

Ohmite offers not only industry's most complete line of *standard* rheostats but also rheostats with a wide variety of *special features*. Illustrated are only a few. All have the distinctive Ohmite design features: smoothly gliding metal-graphite brush; all-ceramic construction; insulated shaft and mounting; windings permanently locked in place by vitreous enamel. You will find the special rheostat feature you need in the dependable Ohmite line.

Two groups of four Ohmite taper-wound rheostats mounted in tandem, controlled by a single knob through a chain drive.



Three rows of ten Ohmite rheostats in tandem, controlled simultaneously by one knob through a chain drive.

Typical Ohmite motor-driven tandem rheostat assembly.

Locking type bushing with screwdriver slotted shaft.

Example of a 360° rotation rheostat with a wire lead tapped winding.

Ohmite rheostats can be mounted with two, three, or more in tandem for operation by one knob. Controls several circuits simultaneously. Model H and miniature Model E rheostats in tandem save panel space.

Rheostat with tapped winding and sensitive switch, arranged to operate at any preselected position of contact arm.

Ventilated cages prevent mechanical injury, or human contact with electrically "live" parts.

Call on Ohmite for APPLICATION ENGINEERING SERVICE

Save valuable engineering time. Team up with Ohmite to solve your resistance problems. Ohmite engineers are resistance specialists. They can quickly analyze your needs and recommend the correct rheostat to fit your application.

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Quality Components

RHEOSTATS RESISTORS TAP SWITCHES
RELAYS VARIABLE TRANSFORMERS DIODES
TANTALUM CAPACITORS R. F. CHOKES

DU PONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

NUMBER E-5 IN A SERIES:
ELECTRICAL DESIGN
Component Insulation

In the toughest environments, TFE resins offer the utmost in electrical insulation

To meet the stringent requirements imposed on electrical components in a variety of industrial and defense uses, TEFLON fluorocarbon resins offer an unmatched combination of electrical properties. In aircraft generators, for example, where weight and space savings are vital, insulation of TFE resins provides the high power and low weight necessary for extreme miniaturization. In motors and generators for use in locomotives, TFE resins provide superior resistance to arcing, as well as high dielectric strength and excellent heat resistance. In circuit breakers, interrupting orifices made of TFE resins have the necessary arcing resistance, plus chemical inertness and resistance to thermal shock. In capacitors, films of TFE resins offer excellent insulation resistance even at high ambient temperatures, exceptional stability of capacitance, and permit savings in space and weight. In computers, printed circuit laminates made of TEFLON fluorocarbon resins assure low dielectric losses over the broadest range of frequencies and temperatures.

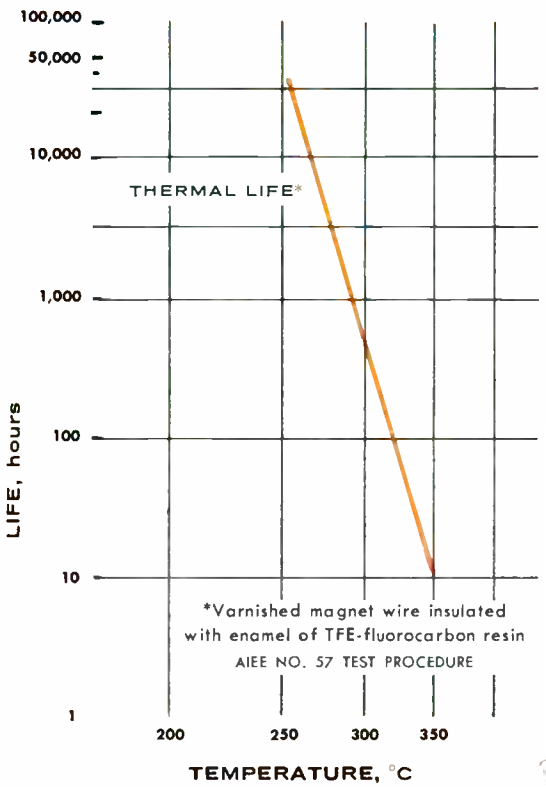
On the next three pages you will find more detailed information on some of the properties of TEFLON fluorocarbon resins and examples of how these unusual properties have been used to meet the most exacting design requirements.

OVER

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

DU PONT

Superior electrical and make possible design improvements



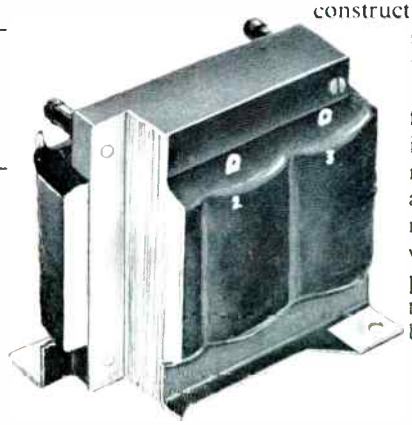
IN TRANSFORMERS

TFE resins offer exceptionally long insulation life at high temperatures

At their continuous service temperature of 260°C. (500°F.) the insulation life of TEFLON TFE resins is measured in years. The excellent heat-aging characteristics of TFE resins are the result of exceptionally low weight losses at elevated temperatures. Thermal-life tests on magnet wire (see chart at left) show that wire enameled with TFE resins had the highest thermal-stability rating of all insulation types tested. TFE resins can withstand elevated temperature conditions under which other plastic and elastomer insulations melt, char or disintegrate. The high thermal stability of TFE resins permits the construction of miniaturized components, with the resultant space and weight savings that are particularly important in air-borne applications.

The Class T transformer shown at left calls for 170°C. maximum operating temperature in an ambient of 100°C. To meet this requirement, layer insulation of TEFLON TFE resins and magnet wire enameled with TEFLON TFE resins are used. In addition, lead wire coated with TFE resins readily withstands the temperatures of encapsulation, eliminating costly rejects. The result is a reliable transformer for air-borne applications, small for its power rating.

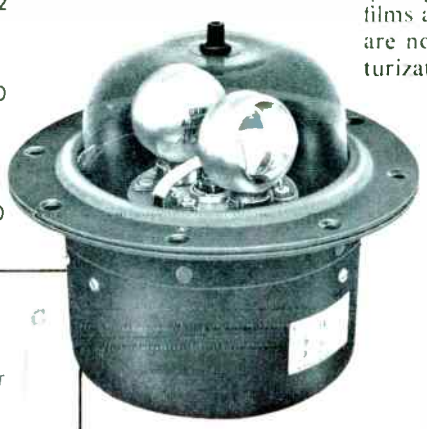
(PHOTO COURTESY OF CHICAGO STANDARD TRANSFORMER CORP.)

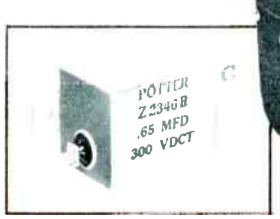


Properties of capacitors using dielectrics of TFE resins

Dissipation Factor (−40° to 250°C.; 0 to 10,000 mc)	.0002
Dielectric Constant (−40° to 250°C.; 0 to 10,000 mc)	2.1
Dielectric Absorption (% charge reappearing 30 sec. after discharge)	0.02
Temperature Coefficient of Capacitance (Parts/million/°C.; 0-200°C.)	−300
Insulation Resistance at 100°C. (Megohms x microfarads)	100,000

(ROTATING ANTI-COLLISION LIGHT BY GRIMES MFG. CO., URBANA, OHIO)





(CAPACITOR BY POTTER COMPANY, CHICAGO, ILL.)

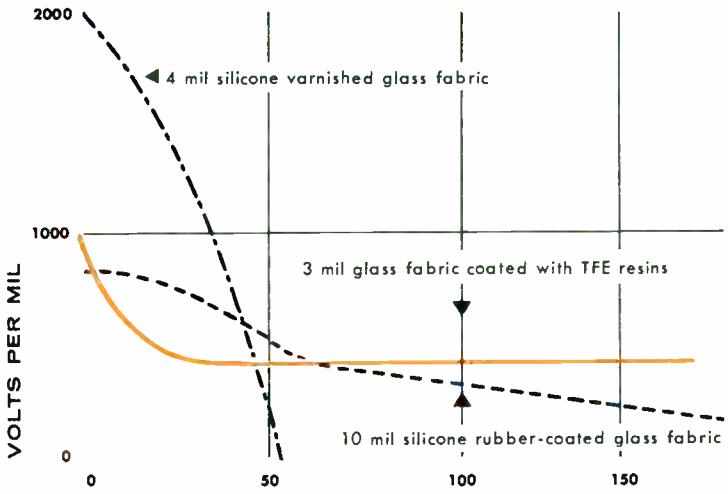
IN CAPACITORS

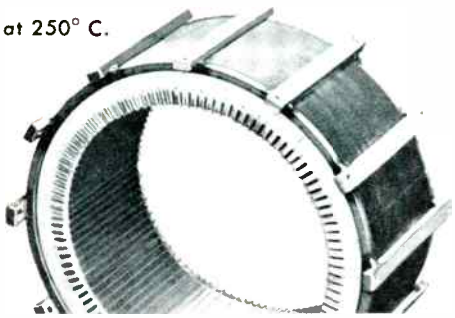
TFE resins used as high-temperature dielectrics provide outstanding stability...space, weight savings

Films of TFE resins used in capacitors offer unsurpassed insulation resistance at high temperatures, a low temperature coefficient of capacitance, a very low dissipation factor and outstanding capacitance stability on thermal cycling. The dielectric constant and dissipation factor of a TFE resin remain virtually unchanged over the broadest operating ranges of temperature and frequency (see table at left). Further, high-quality metalized films and flexible films of TFE resins as thin as ⅛ mil are now available, permitting a high degree of miniaturization . . . space and weight savings.

The motor of a rotating anti-collision landing light for the B-52 bomber required a phase-shifting capacitor (0.65 mfd. hermetically sealed), with a life of 500 hours at -65°F. followed by 500 hours at 300°F. ambient. Films of TEFLON TFE resins replaced another high-temperature dielectric with a resulting reduction of capacity drift from + 18% to -2%. At no increase in capacitor size, a 25°F. reduction in the mechanism operating temperature was thus achieved.

mechanical properties of TFE resins in wide variety of components



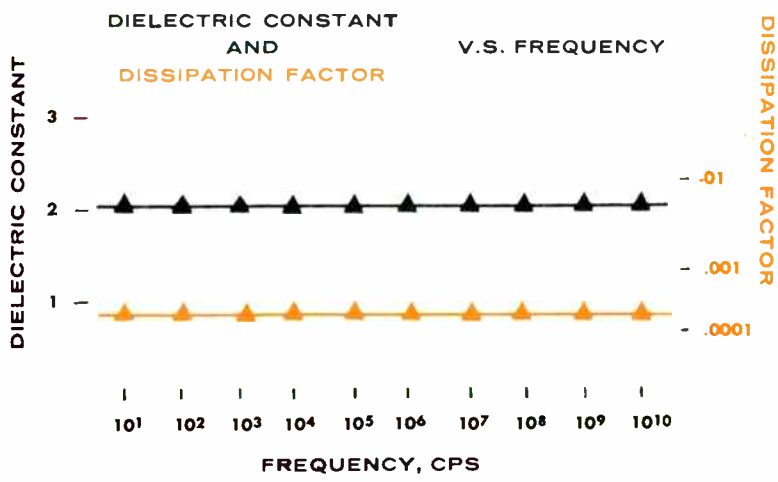


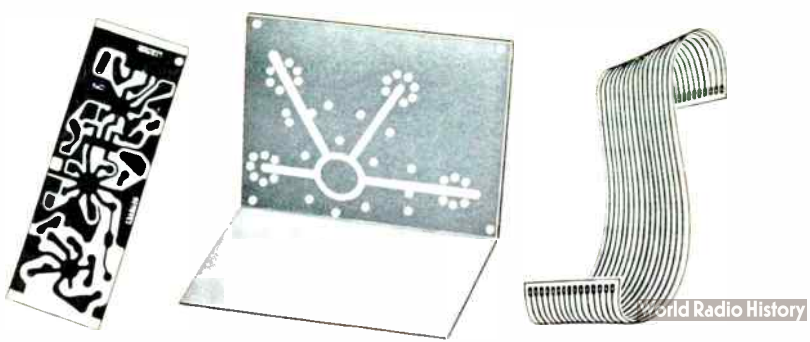
IN MOTORS AND GENERATORS

TFE resins provide mechanical ruggedness . . . maintain high dielectric strength after heat aging

Extreme miniaturization of aircraft alternators and generators, plus exposure to vibration and high temperatures, makes high demands on the insulation materials used. Slot liners of woven-glass fabric coated with TFE resins and magnet wire insulated with TFE resins offer the required mechanical ruggedness, heat resistance and dielectric properties after heat aging. The chart at left shows a comparison of dielectric strength vs. time aged at 250°C. (482°F.) for glass fabrics coated with TFE resins, against other commercially available Class H insulations. The low friction surface of slot liners made with TFE resins reduces rejects due to mechanical abuse of magnet wire in manufacturing and also reduces surface abrasion. The same properties—plus resistance to chlorinated cleaning solvents—are the reasons for the choice of TEFLON TFE-fluorocarbon resins for insulation in diesel electric generators.

The high-temperature aircraft alternator stator at left uses slot liners of glass fabric coated with TEFLON TFE resins. Superior dielectric and mechanical properties of TFE resins give windings maximum protection against vibration and the extreme heat generated at full load and high altitudes.





IN PRINTED CIRCUITS

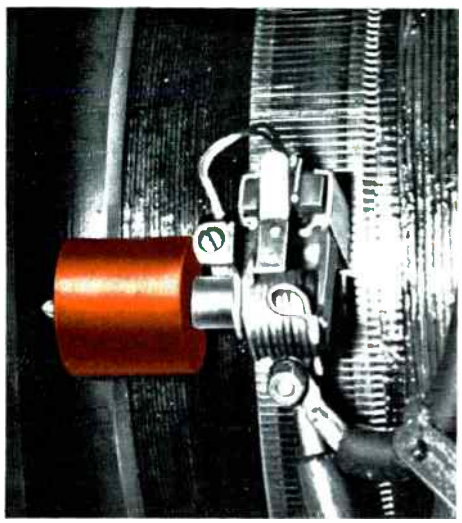
TEFLON fluorocarbon resins provide exceptionally low attenuation at high frequencies

Printed circuit laminates of TEFLON fluorocarbon resins offer superior performance in applications where low dielectric losses at high frequencies and high temperatures are essential. Design problems are considerably simplified by the fact that the dielectric constant and dissipation factor do not vary with frequency (see chart at left), or with temperature. In fact, these electrical characteristics of TFE resins are essentially invariant from low audio frequencies to the highest microwave frequencies and from below -100°C. to above 260°C.

Additional design improvements are made possible by the use of TEFLON FEP-fluorocarbon resin as a bonding medium. For example, in a "strip-line" circuit a double sandwich is used to provide a ground plane on both sides of the circuit. The use of FEP resin as a bonding medium between the copper and TFE glass-fabric base laminate permits a two-fold reduction of attenuation at 5000 mc, plus much better surface-resistivity and moisture-resistance properties. Since TFE resins are unaffected by solder temperatures, printed circuits can be easily dip-soldered.

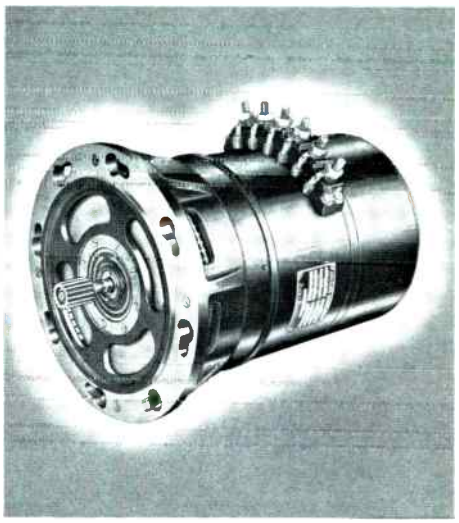
OVER

Insulation of TFE resins offers maximum reliability for reduced rejects . . . lower maintenance costs



BRUSH-HOLDER SLEEVES of TEFLON TFE resins provide superior arcing resistance on railroad-type motor generators. Repeated flashovers, unavoidable in railroad service, have little effect on TFE resins, while former insulators blistered. Protective sleeves also tend to be self-cleaning. Easier handling of generators in the shop, together with longer service life of each sleeve of TFE resin, has made maintenance simpler and less costly.

INTERRUPTING ORIFICES in this new 230-kv, 15,000 mva SF6 circuit breaker are made of a TEFLON TFE-fluorocarbon resin. Reasons for using this material involved a unique combination of properties offered by TFE-fluorocarbon resins; they are extremely resistant to arcing; produce negligible gas contamination; have high resistance to thermal shock; and are non-hygroscopic. (Photo courtesy of Westinghouse Electric Corporation)



AIRCRAFT GENERATOR above is designed to operate continuously with winding temperature of 550°F. for 1,000 hours. Insulation of a TFE resin is used because it is regarded as the only available material with the required combination of properties: high dielectric strength in reasonably thin and flexible sections, heat-aging resistance to the thermal exposures encountered and excellent chemical stability. (Photo courtesy of Jack & Heintz, Inc.)

Whenever design specifications call for reduced size and weight, high stability, broad operating ranges of frequency, operation at extremes of temperature or other severe environmental conditions, insulation of TEFLON TFE-fluorocarbon resins is rapidly becoming a design standard. TFE resins offer an unmatched combination of high dielectric strength, exceptional resistance to heat aging, low power losses, resistance to arcing, mechanical ruggedness, chemical inertness and low-friction surface. In addition, a melt-processable TEFLON FEP-fluorocarbon resin is now available for greater flexibility of design.

The combination of properties offered by TEFLON resins makes possible savings during the manufacture of components, reduced inspection costs, fewer rejects, fewer service failures and lower maintenance costs. The advantage of increased *reliability* applies to all applications of TEFLON resins in electrical components. Even when ambient conditions are not extreme, the non-aging characteristics of TEFLON resins make possible longer service and storage life of equipment.

The preceding issues of "Engineering facts about TEFLON fluorocarbon resins" cover other aspects of electrical applications. They are available by writing to the address below at left. Please state the issues you wish to receive.

1. RF Properties
2. Wiring Reliability
3. High Temperatures
4. Printing and Potting

FOR MORE INFORMATION

If you would like further design and end-use information about Du Pont TEFLON resins, contact your supplier of TEFLON fluorocarbon resins (listed in the Yellow Pages under "Plastics—Du Pont"). For any unanswered technical questions about these resins, write to: E. I. du Pont de Nemours & Co. (Inc.), Advertising Dept., Room T-148, Nemours Bldg., Wilmington 98, Delaware.

In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal Quebec.

TEFLON *is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.*

TEFLON®

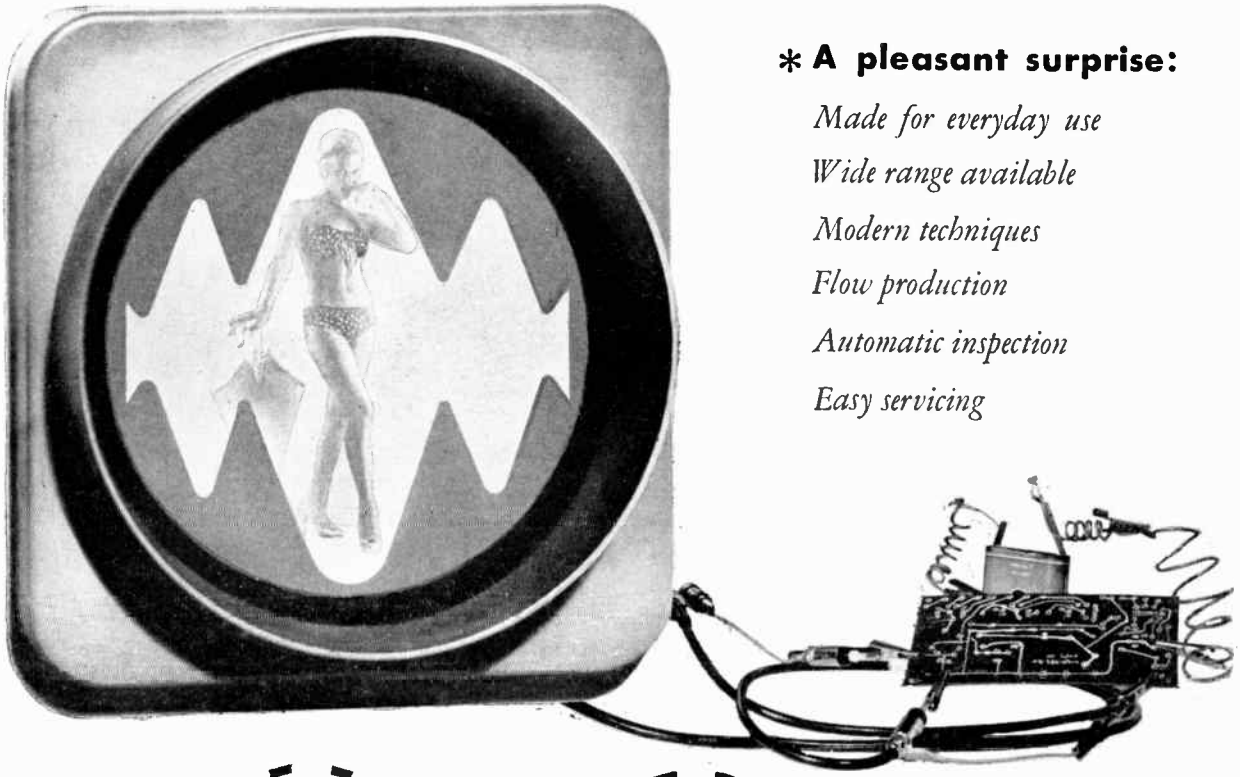
FLUOROCARBON RESINS

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

The new concept of electronic equipment manufacture



* A pleasant surprise:

Made for everyday use

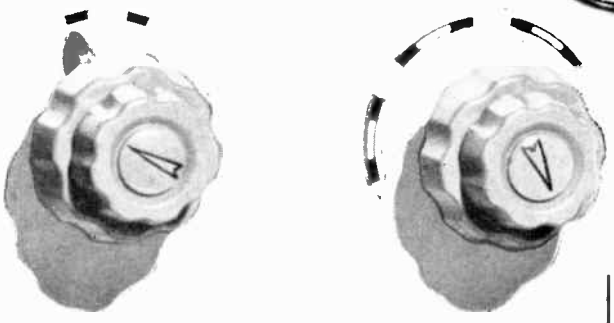
Wide range available

Modern techniques

Flow production

Automatic inspection

Easy servicing



* Philips manufacturing plants have been completely retooled so as to produce a new, wide range of relatively inexpensive electronic measuring equipment.
Each instrument is in fact an electronic tool for everyday use in factory or laboratory: accurate, robust and reliable, easily serviced throughout the world.
It is not too much to say that Philips have applied a new philosophy to the production of this type of equipment.
For users now benefit from the marriage of a highly specialised knowledge of these instruments and their applications with an unequalled experience in flow-line production. Here in fact is another substantial contribution by Philips to industry and to research.

Dependable **PHILIPS** *tools for the electronic industry*

Sold and serviced by Philips Organizations all over the world

Further information will gladly be supplied by:

N.V. Philips Gloeilampenfabrieken, Eindhoven, the Netherlands

Broadband mV-Meter GM 6012

Measuring range: from 1 mV (full scale deflection) in 12 steps up to 300 V; dB scale −80 dB up to +52 dB (0 dB = 1 mW into 600 Ω)
Frequency range: 2 c/s – 1 Mc/s
Input impedance: 4 – 10 MΩ//20·10 pF
Overall accuracy from 20 c/s to 100 kc/s: 2.5%; elsewhere 5%
Mains supply: 110-245 V, 40-100 c/s
Built-in calibration voltages
Amplifier can be used separately; gain 35 dB
5" linear scale with mirror reading

The price – a pleasant surprise

←CIRCLE NO. 20 READER SERVICE CARD

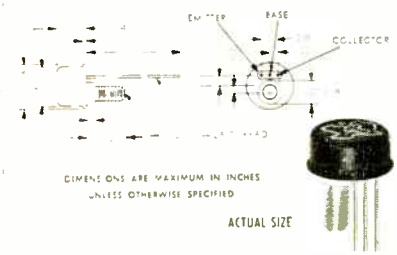
CIRCLE NO. 21 READER SERVICE CARD 21

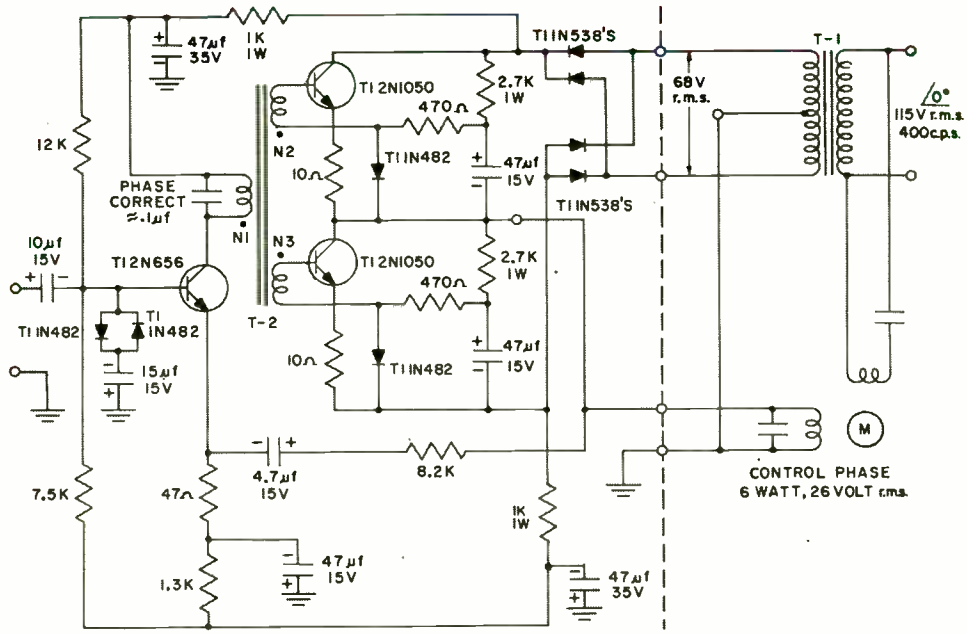
How to get 55% over-all efficiency in transistorized 6-watt servo amplifier

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
POST OFFICE BOX 312 • DALLAS, TEXAS

Mass., N. J. Companies Merge

MERGER between **Robinson Technical Products**, Teterboro, N. J., and **High Vacuum Equipment Corp.**, Hingham, Mass., has been announced. Robinson has acquired all outstanding shares of HVEC through an exchange of stock. The Massachusetts company will be operated as a wholly-owned subsidiary of the New Jersey firm and all assets will be retained. Robinson manufactures metal mesh vibration mountings for electronic equipment as a proprietary product and holds several contracts with major manufacturers for this aspect of reliability. HVEC manufactures high-vacuum furnaces and associated equipment including electron beam welders, metallizers and vacuum pumps.

• **Telectro Industries Corp.**, Long Island City, N. Y., and its wholly-owned subsidiary, **Telectrosonic Corp.**, report combined sales rise of 70 percent for the first six months of this year as compared with the same period of 1958. Volume for the two companies totaled about $2,027,000 as compared with $1,290,000.

• **Ling-Altec Electronics, Inc.**, Culver City, Calif., announces acquisition of all the outstanding stock of **Continental Electronics Manufacturing Corp.**, Dallas, Tex. Purchase price was $3,600,000, of which $3,250,000 was in cash, with the remainder consisting of 10,000 shares of Ling-Altec common stock and $125,000 in 5-percent notes. Ling-Altec officials say the acquisition will add about $8 million to their consolidated sales volume for the remainder of the current year. Continental makes high-power transmission gear.

• **Hewlett-Packard Co.**, Palo Alto, Calif., announces acquisition of all of the outstanding stock of **Boonton Radio Corp.**, Boonton, N. J. Terms of the arrangement call for transfer of H-P stock for Boonton stock. Boonton Radio employs about 150 persons and has an annual sales volume of $2.5 million. The firm manufactures signal generators and similar instruments. No personnel or management changes are contemplated for the New Jersey firm.

• Popularity poll by **New York Stock Exchange** shows that among the fifty most-wanted stocks for monthly investment plan members, 11 are stocks of electronics firms. Highest of these (in the number two spot) is General Electric, with Sperry Rand following in sixth place. Eighth place is held by AT&T, followed by RCA in ninth place. General Telephone & Electric runs 16th, General Dynamics 17th. The 27th spot is held by Westinghouse, 41st by ITT, 45th by Texas Instruments, and 46th by Raytheon.

25 MOST ACTIVE STOCKS

WEEK ENDING AUGUST 28

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Univ Control	974	19 3/8	17 5/8	18 1/4
Intl Tel & Tel	885	34 5/8	32 1/8	33 5/8
Gen Dynamics	751	50 3/8	46	50 1/8
Avco Corp	598	13 7/8	13 1/8	13 3/4
Sperry Rand	573	23 5/8	23	23
El-Tronics	462	1 5/8	1 3/8	1 5/8
Raytheon	437	48 3/4	45 1/8	48 1/8
Gen Tel & Elec	406	73 5/8	72 1/2	72 1/2
Gen Electric	384	82 1/8	79 7/8	82 1/8
Elec & Mus Ind	316	7 1/8	6 3/4	7
Texas Inst	286	142 5/8	133 1/8	142 1/2
RCA	269	62 3/4	61 5/8	62 1/8
Zenith	259	109	100 1/8	108 1/4
Admiral	255	21 1/8	19 1/8	20 1/2
Gen Transistor	222	36 1/2	33 5/8	36
Barnes Eng	187	28 3/8	23 1/4	27 3/8
Philco Corp	184	25 7/8	22 1/8	25 1/4
Ampex	180	83 1/4	80 1/2	82 1/4
Cons Elec Ind	166	50	44 3/4	50
Victoreen	164	15 7/8	14 1/4	15 3/8
Emerson	162	15 3/8	14 3/4	15 1/4
Intl Bus Mach	151	428	422	424
Lear	147	15 1/8	14 1/4	14 7/8
Beckman Instr	141	57	53 1/2	56 3/4
Cons Electrodnmcs	113	39 1/4	37 3/8	39 1/8

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co.

NEW PUBLIC ISSUES

	No. of Shares	Issues Price
Acme Missiles	150,000	6
Electro-Sonic Labs	100,000	3
Electronic Data Process.	17 000	10
Entron Inc.	200 000	3
Avco Electronic Intl.	142,800	2

STOCK PRICE AVERAGES

(Standard & Poor's)	Aug. 26 1959	July 29 1959	Change From One Year Ago
Electronic mfrs.	89.05	98.56	+54.6%
Radio & tv mfrs.	108.67	116.42	+104.1%
Broadcasters	97.41	103.36	+44.5%

FLEXIBILITY IN THE FIELD...

just one of the many useful features of

EMPIRE'S NOISE & FIELD INTENSITY METER MODEL NF-105

Model NF-105 remotely located from its antenna, for personnel safety.

- Measures 150 kilocycles to 1000 megacycles accurately and quickly with only one meter.
- Approval status: MIL-I-6181B, Class 1, MIL-I-6181C, Category A; MIL-I-26600 (USAF).
- Direct substitution measurements by means of broadband impulse calibrator, without charts, assure repeatability.
- Self-calibrating, for reliability and speed of operation.
- True peak indication by direct meter reading or aural slideback.
- Four interchangeable plug-in tuning units for extreme flexibility.
- Economical . . . avoids duplication.
- Safeguards personnel . . . ALL antennas can be remotely located from the instrument without affecting performance.
- Compact, built-in regulated A and B power supply, for stability.
- Minimum of maintenance required, proven by years of field experience.

Only the Model NF-105 is so simple to operate that one technician can take readings over the entire frequency range in less time than required by three engineers manning any other three separate instruments.

Send for our Catalog No. N-358

edp

EMPIRE DEVICES PRODUCTS CORP.

AMSTERDAM, NEW YORK

VICTOR 2-8400

MANUFACTURERS OF:

FIELD INTENSITY METERS • DISTORTION ANALYZERS • IMPULSE GENERATORS • COAXIAL ATTENUATORS • CRYSTAL MIXERS

SPACE
APPLICATIONS
OF

ELECTROLUMINESCENCE

In space things are either black or light. This almost total absence of degrees of intensity between light and black presents unique problems in illumination. Electroluminescence techniques applied in the initial systems considerations—of both space and airborne vehicles—are being studied. The resulting hardware represents significant developments in a new field.

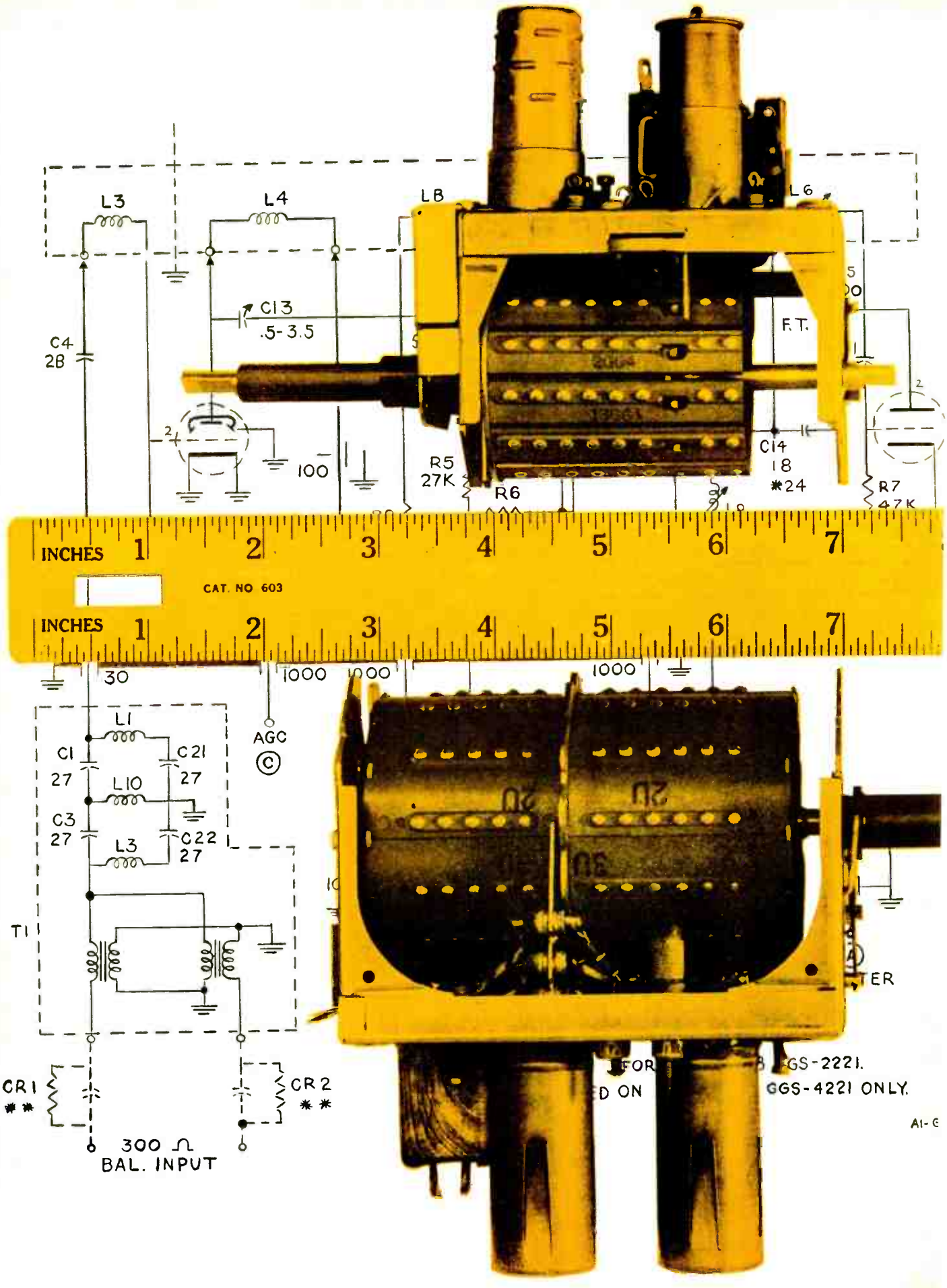
A larger staff is being organized to augment existing personnel and facilities. Senior and junior staff positions are open for scientists and engineers who have experience in the areas listed on the right.

Optics
Light Transmission
Basic Phosphor Chemistry
Electroluminescent Panels
Insulating Materials
Human Factors Engineering
Thin Dielectric Formulation
Electrical Measurements and Evaluation

Graduate scientists and engineers with applicable backgrounds are invited to submit a resume to:

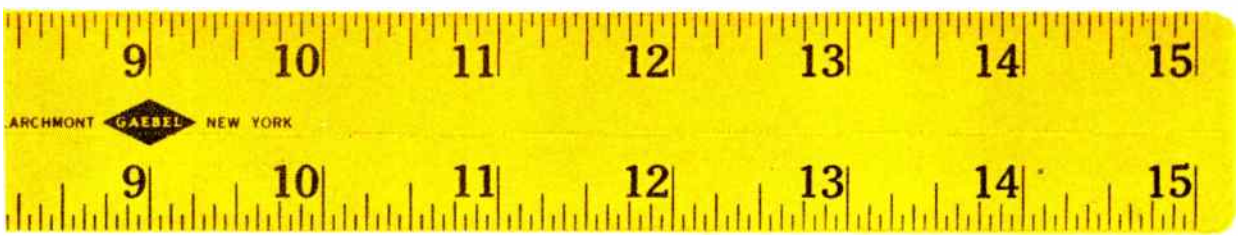
Mr. R. A. Martin, Supervisor
Professional Placement Staff
HUGHES RESEARCH AND DEVELOPMENT LABORATORIES
Culver City 60, California

HUGHES



Plaskon

ALKYD MAKES POSSIBLE SMALLER TV AUTOMATIC TUNER



Reliability of Alkyds permits miniaturization and improved performance

Automatic tuning for television that eliminates troublesome manual fine tuning has been achieved by Standard Coil Products in its new GG-4200 Automatic Tuner and Station Selector.

PLASKON Alkyd figured prominently in this development due to these *unusual electrical qualities:*

- Dielectric stability of tuner segments molded from PLASKON Alkyd gives a new high in VHF performance by reducing oscillator frequency drift.
- Changes in dielectric constant due to time and elevated temperatures are minimized.
- Dimensional stability of Alkyd maintains circuit constants. This prevents change in relationship between coils, contacts and other circuit elements—thus stabilizing circuit capacitance.

PLASKON Alkyd aided the molder Wilcox Plastics, with these *outstanding molding properties:*

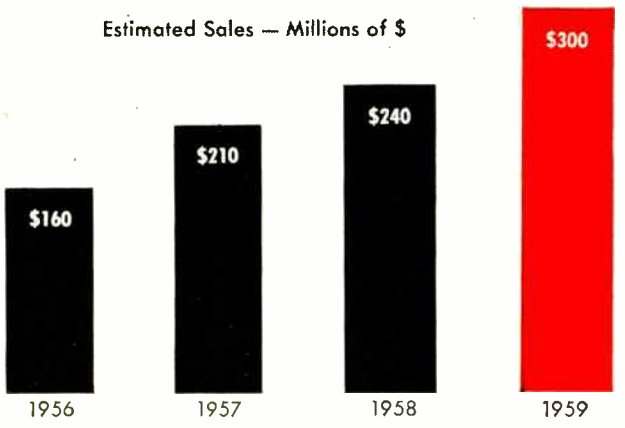
- Rapid molding cycles at low molding pressure permits mass production of intricate pieces.
- Uniformity of this Alkyd molding material provides unvarying precision of each molded part.
- The high mechanical strength of PLASKON Alkyd molded parts helps to accelerate separate staking operation for insertion of small contacts.

PLASKON Alkyd is outstanding for the qualities most necessary in molded parts for electronic and electrical applications. Competent Plaskon representatives will be glad to discuss material recommendations and fabricating techniques to fit your performance requirements.

PLASTICS AND COAL CHEMICALS DIVISION
40 Rector Street, New York 6, N. Y.

Basic to America's Progress

Allied Chemical



Sources — 1956: Dept. of Commerce
1957-1959: ELECTRONICS Estimates

Test-Instrument Sales Growing

SMALL LEGION of new product developers and investigators are currently busy studying the market for electronic test instruments. Reason: the rapid rate at which the test-instrument business is growing and resulting profit opportunities.

Test-instrument sales have been rising at an average rate of better than 20 percent since 1956. By end of 1959, sales are expected to total some $300 million, compared with about $240 million in 1958 and $210 million in 1957.

Figures for 1957-1959 are rough estimates, based on opinions of leading manufacturers and estimates of trade groups.

Department of Commerce survey of electronic instruments in 1956 disclosed that sales of general-purpose electronic test instruments were running at rate of $160 million annually.

Items included in the estimates are general-purpose instruments for testing and measuring electronic properties, sold to both military and nonmilitary users. For example, radio-frequency signal generators, audio oscillators and cathode-ray oscilloscopes are included. Electrical quantity- and characteristic-measuring instruments like panel voltmeters, ammeters and megohmeters are excluded. Special-purpose test equipment, designed solely for use in one system, are excluded.

Main factors behind the growth of test equipment sales, according to the Scientific Apparatus Manufacturers Association, are the steadily rising levels of research and development spending and the increasing importance of electronics in the military fields.

• **General Transistor** adds its voice to those manufacturers who are saying that 1959 semiconductor sales will be much higher than many expect. Herman Fialkov, GT president, looks for a minimum semiconductor sales total this year of $350 million. But, he thinks chances are good that sales will hit $400 million.

Transistor share of 1959 semiconductor business will be about $200 million, estimates Jerome Fishel, GT's vice president of marketing. He looks for an increase of 35-40 percent in 1960.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Aug. 21, 1959	July 24, 1959	Change From One Year Ago
Television sets	138,758	98,447	+6.28%
Radio sets, total	274,526	240,644	−4.23%
Auto sets	83,041	77,827	+2.56%

LATEST MONTHLY SALES TOTALS

(Add 000)	June 1959	May 1959	Change From One Year Ago
Rec. tubes, value	$33,099	$25,904	+5.26%
Rec. tubes, units	37,421	30,612	+3.17%
Pic. tubes, value	$15,137	$12,746	+6.57%
Pic. tubes, units	767	667	+5.61%

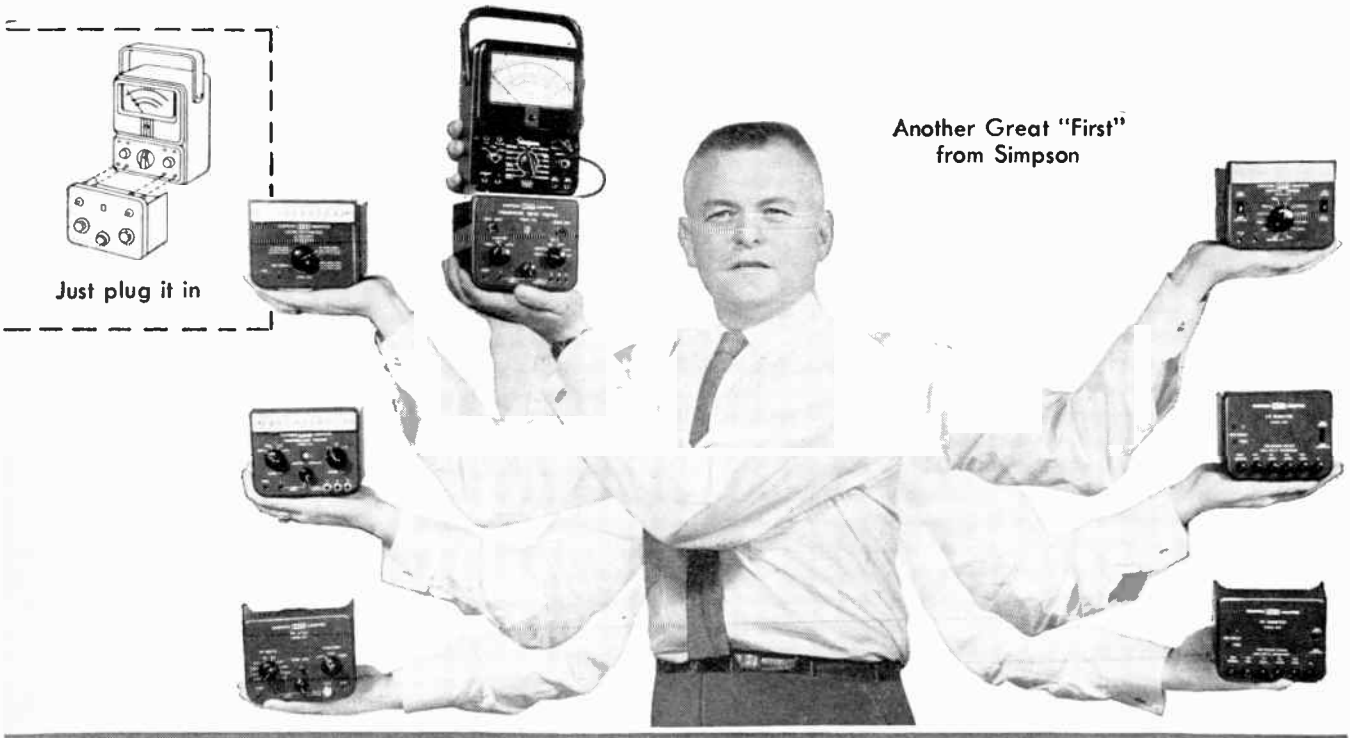
Air brake for a spaceliner

The earth's atmosphere, one of the biggest obstacles to getting into outer space, can be one of our biggest assets coming back. At Douglas we are investigating how we can use its braking effects on rockets returning from deep space trips at far faster than ICBM speeds. Success will allow us to increase payloads by reducing the weight of soft landing systems. This technique also will aid us in pinpointing landing areas. Current reports show real progress. Douglas is engaged in intensive research on every aspect of space planning, from environmental conditions on other planets to the destroyer-sized space ships necessary to get there. We invite qualified engineers and scientists to join us. Some of our immediate needs are listed in the column on the facing page. Please read it.

Arthur Shef, Chief, Advanced Design Section, Missiles and Space Systems, irons out a problem with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

New Simpson "Add-A-Testers"



Converts your 260* into seven different testers!

Think of it! A small investment turns your 260 VOM into a whole array of testers—equipment with a quality that is found only in individual pieces of test equipment at much higher prices. The secret lies in combining an adapter with the *top-notch meter and circuitry* of your 260.

Each combination of Add-A-Tester unit and 260 is self-contained, self-powered. Each adapter goes on and off in a jiffy. No gadgets, no complicated connections. Furthermore, Add-A-Tester units require only 1/2 to 1/3 the storage space of individual testers. By reducing bench clutter, this compactness makes jobs go faster, raises shop efficiency. Make your 260 do double duty. Stop in at your Electronics Parts Distributor or write the factory for further information.

*Trademark

TRANSISTOR TESTER, Model 650.....$26.95
Beta Ranges: 0-10, 0-50, 0-250, (F.S.)
Beta Accuracy: ±3%, with 260 ±5% nominal
Ico Range: 0-100 ua
Ico Accuracy: ±1%, with 260 ±3% (F.S.)

DC VTVM, Model 651.....$32.95
Voltage Ranges: 0-.5/1.0/2.5/5.0/10/25/50/100/250/500
Accuracy: ±1%, with 260 ±3% (F.S.)
Input Impedance: greater than 10 megs all ranges

TEMPERATURE TESTER, Model 652....$38.95
Temperature Ranges: −50°F to +100°F, +100°F to +250°F
Accuracy: with 260 ±2° (nominal)
Three lead positions provided
Sensing Element: thermistor

AC AMMETER, Model 653.....$18.95
Ranges: 0-0.25/1/2.5/12.5/25 amps
Accuracy: ±1%, with 260 ±3% nominal
Frequency Range: 50 cycles to 3000 cycles

AUDIO WATTMETER, Model 654.....$18.95
Load Ranges: 4,8,16,600 ohms
Wattage: Continuous 25 watts (8,600 ohms)
50 watts (4,16 ohms)
Intermittent 50 watts (8,600 ohms)
100 watts (4,16 ohms)
Accuracy: ±5%, with 260 ±10% nominal
Direct reading scale from 17 microwatts to 100 watts

MICROVOLT ATTENUATOR, Model 655..$18.95
Ranges: 2.5 microvolts to 250,000 microvolts continuously variable in decade steps
Frequency: DC to 20 KC
Accuracy: ±1db

BATTERY TESTER, Model 656.....$19.95
Checks all radio and hearing aid batteries up to 90 volts at the manufacturer's recommended load, or any external load.

Note: All Simpson 260 Adapters provide for normal 260 usage without disconnecting the adapter.

Simpson ELECTRIC COMPANY

5203 West Kinzie Street • Chicago 44, Illinois
Phone: EStebrook 9-1121
In Canada: Bach-Simpson Ltd., London, Ontario

WORLD'S LARGEST MANUFACTURER OF ELECTRONIC TEST EQUIPMENT

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

BASIC REQUIREMENTS

for outer space

The space/missile era has made it essential for today's components and systems to function precisely in environments that are literally out-of-this-world. Such stringent requirements can only be met by companies long experienced in component design and with proved records of imaginative engineering. Kearfott, long the leader in servo component design and production, has consistently looked into the future to anticipate the increased performance characteristics missile components must supply. As a result, it has not only developed an entirely new generation of precision components but established the ability to create radically new concepts in sensors and control elements.

THE PROBLEM: **HIGH ACCURACY**
THE SOLUTION: Synchros with maximum error from electrical zero of 20 seconds. Tachometers with linearity .05% over the speed and temperature range.

THE PROBLEM: **HIGH AND LOW TEMPERATURE**
THE SOLUTION: Servomotors, synchros and tachometers are now available for the temperature range of −54° C to 200° C with new developments soon to increase the range to 400° C.

THE PROBLEM: **RADIATION RESISTANCE**
THE SOLUTION: Kearfott servomotors, synchros and tachometers operate at 200° C and can withstand radiation of 10^8 through 10^{10} roentgens.

THE PROBLEM: **SHOCK AND VIBRATION**
THE SOLUTION: All Kearfott components can be supplied to function as required during or after 20 g's shock or 2000 cps vibration.

THE PROBLEM: **MINIATURIZATION**
THE SOLUTION: Size 5 synchros and servomotors. Size 8 components are outstanding examples of Kearfott's ability to combine miniaturization with precise performance.

THE PROBLEM: **LONG LIFE**
THE SOLUTION: Components are being developed which will operate continuously for 12 months in a total vacuum, the environment of outer space.

Representative of Kearfott's ability to look ahead are such current areas of development as Solid State Transducers and Control System Components. **You can take advantage of Kearfott's long-established know how in developing precision components for today — and tomorrow — by writing for details concerning your specific requirements.**

Engineers: Kearfott offers challenging opportunities in advanced component and system development.

Kearfott | A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation
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If you have an electronic component requirement, contact one of these three listed distributors for overnight delivery at factory prices from his complete line of TI stock.

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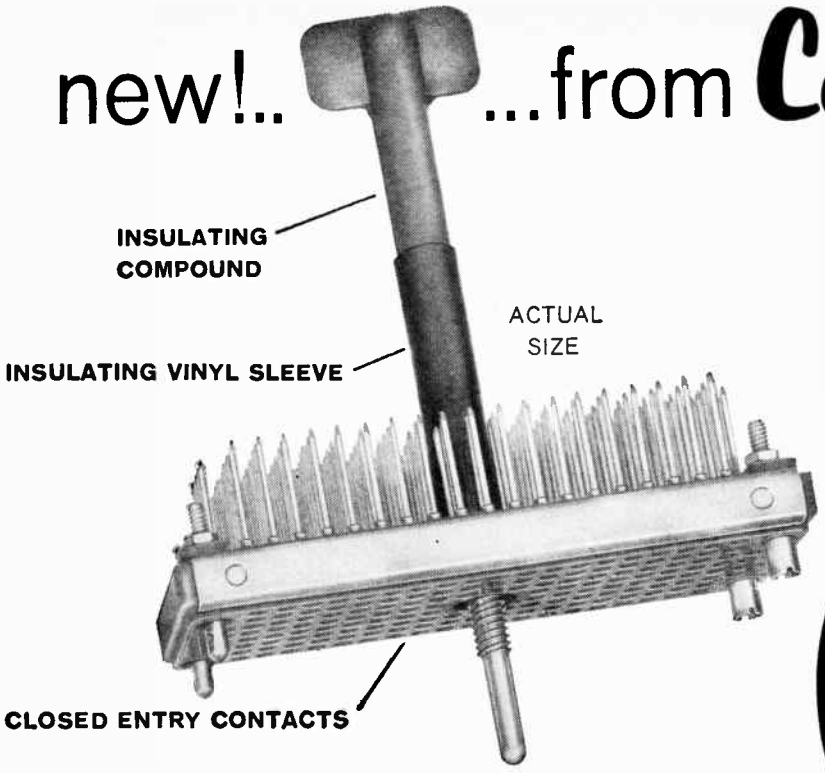
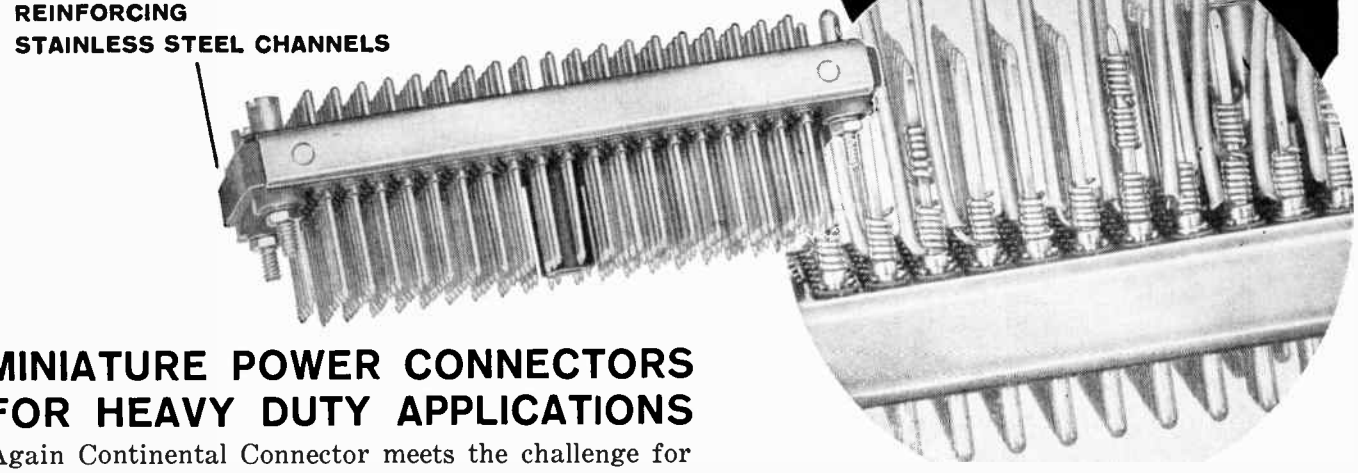
new!.. ...from Continental Connector



152 CONTACT

CENTER SCREWLOCK CONNECTOR WITH PROVEN RELIABILITY



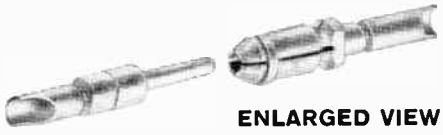
MINIATURE POWER CONNECTORS FOR HEAVY DUTY APPLICATIONS

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

POWER

handling capacity
of the new
Westinghouse
Silicon

POWER

transistor!

Greater than 99% efficiency when used to handle 1.5 kw of power in a low-frequency DC switch! Power loss is only 10-15 watts when handling 1.5 kw. That's just one of the impressive specifications established by a remarkable new semiconductor device—the Westinghouse Silicon Power Transistor.

This Power Transistor is remarkable in other ways, too . . .

- It is the first power transistor available in voltage ranges above 100 volts.
- It has power dissipation capability of 150 watts made possible by the low thermal resistance of .7°C/watt.
- It can operate at higher temperatures than germanium (150°C., compared to 85°C).
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- It is 100% power-tested under actual maximum rated specifications before leaving the plant.
- It is encapsulated in a rugged, all-welded case.

HERE ARE A FEW OF THE APPLICATIONS . . .

• Inverters and converters • Data processing circuits • Servo output circuits • Series regulated power supplies • As a low frequency switch • In class A amplifiers.

Available in 2 and 5 ampere collector ratings in production quantities now. For complete specifications and details, contact your local Westinghouse representative.

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Speeds office paper work, too Table-model Ozamatic has 16" width, turns out up to 1000 copies an hour. Used widely for "one-writing" business systems, general copying. Send for folder No. L-9-11 to Ozalid Division, General Aniline & Film Corp., Johnson City, N. Y.

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Division of General Aniline & Film Corp., In Canada: Hughes-Owens Co., Ltd., Montreal

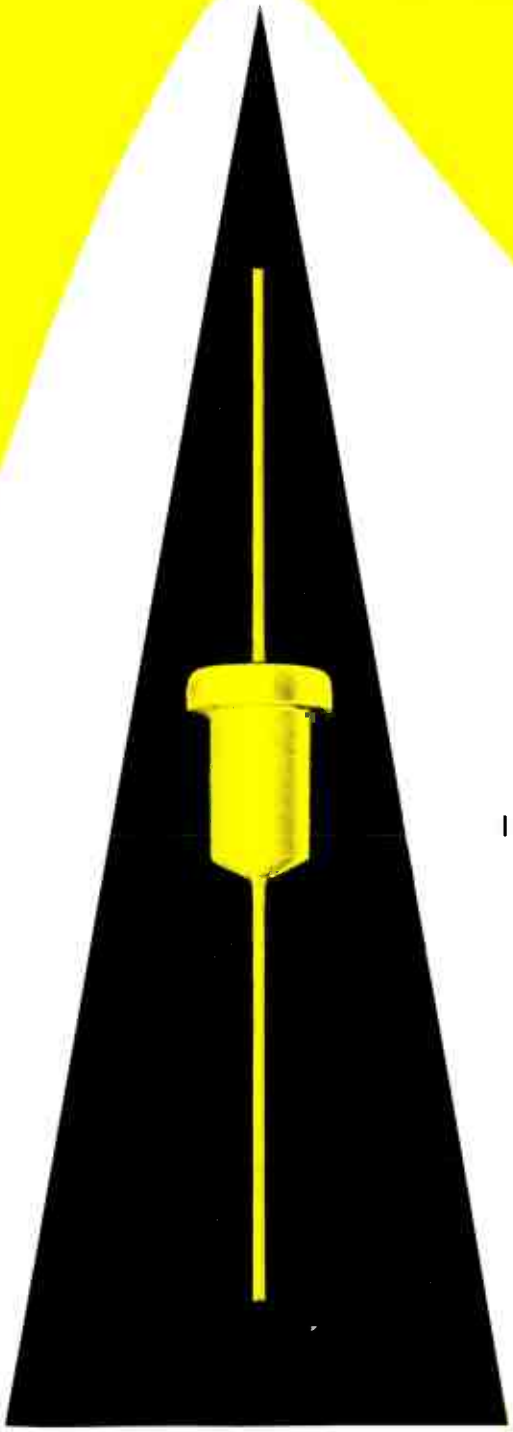
introducing the new Fansteel

GOLD-CAP

TRADE MARK

TANTALUM CAPACITOR

the world's most reliable capacitor



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

FANSTEEL RELIABILITY

only Fansteel dares offer

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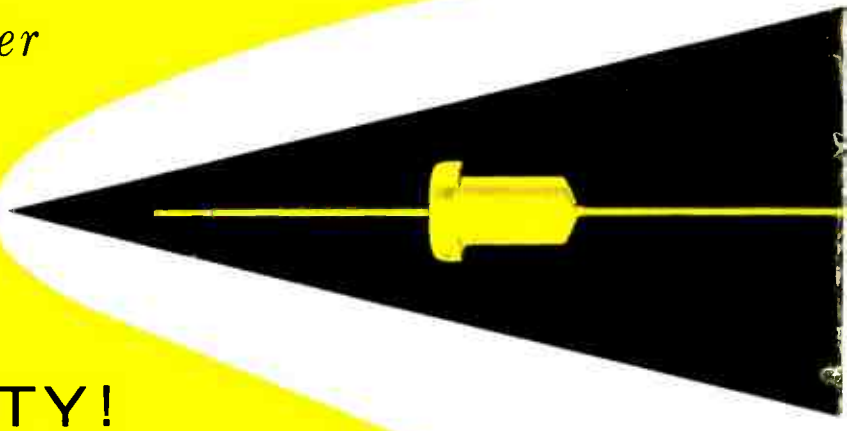


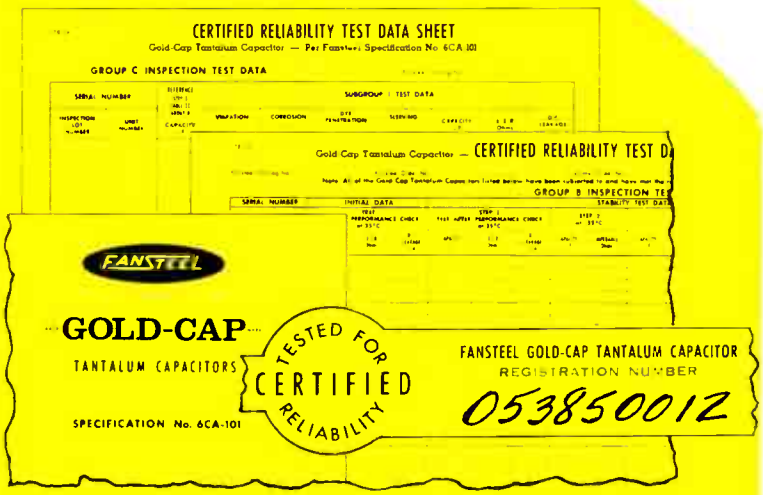
OF RELIABILITY!

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 the Gold-Cap Specification 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

FANSTEEL RELIABILITY

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 Specification No. 6CA-101

C-599

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

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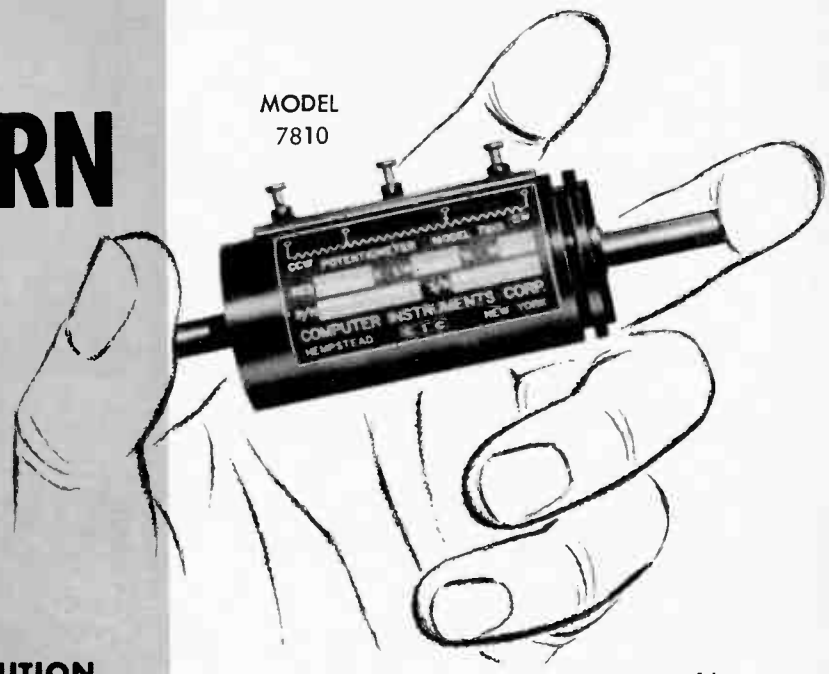
MINIATURE MULTI-TURN PRECISION FILM POTS



FEATURING:

- **VIRTUALLY INFINITE RESOLUTION**
  Eliminates servo hunting
- **LONG LIFE AT HIGH SPEEDS**
  10,000,000 revolutions—500 rpm

EXCLUSIVE FEATURES:

- **NON-LINEAR OUTPUTS**
  No Tapping and Shunting
- **DUAL GANG—SINGLE GANG**
  SAME CASE SIZE!
  SAME STARTING TORQUE!
  SAME INERTIA!
- **ONE PIECE THROUGH SHAFT**
  Pot fits *anywhere* in your gear train
- **ONE PIECE, ALL METAL CASE**
  Machined-in, Stay-Put Accuracy

This miniature multi-turn precision film pot is not just better than wire-wound types—it brings a new dimension of performance and flexibility to your system. With SuperCon Film pots you can forget about the obsolete concepts of wire resolution, clumsy tapping and shunting to produce non-linear outputs, bulkiness in ganging, and loose-wire, glued-assembly construction. The ball-bearing supported, one-piece through shaft permits you to locate your pot *anywhere* in the gear train, freeing you to select the optimum ratios with the minimum components, to transmit torque through the pot, to miniaturize even more. SuperCon Film pots have the inherent accuracy and reliability to easily meet your requirements.

CIC is the largest manufacturer of Precision Film Potentiometers, having pioneered in their development, with a 10-year record of supply to all branches of the Armed Services and throughout industry. Our staff of technical specialists is ready to assist you with your potentiometer needs.

Write for our catalog.

FIRST IN FILM POTS

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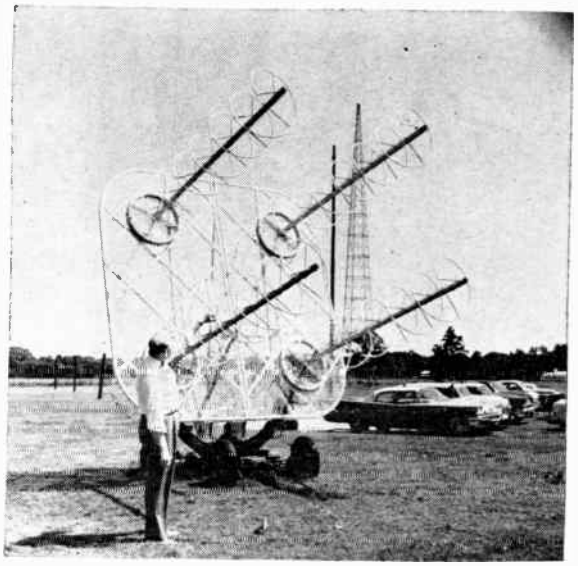
CIC COMPUTER INSTRUMENTS CORPORATION

SINGLE TURN POTS | **SINE-COSINE POTS** | **LINEAR MOTION POTS** | **PRESSURE TRANSDUCERS** | **COMMUTATORS**

←CIRCLE NO. 38 READER SERVICE CARD

CIRCLE NO. 39 READER SERVICE CARD



At Army Satelite Tracking Center near Ft. Monmouth, N. J., director Lloyd H. Manamon shows new Radiquad 4-helix tracking and telemetry antenna (left) and Dymec's digital data system, part of new gear enabling . . .

Army to Beef Up Sky Watch

New equipment going into Signal Corps' east coast satellite tracking center will make the station unique in range and flexibility

DEAL, N. J.—Our eastern seaboard sentry, Army's satellite tracking center here, listens 24 hours a day for radio signals from potentially hostile satellites or other orbiting vehicles—and is now completing an impressive buildup in its capabilities, ELECTRONICS learns.

With the old equipment, housed in one small room, the satellite tracking center was able to lock on to Sputnik I two hours after launch. New equipment now being installed will vastly increase the center's operational hearing range in distance as well as bandwidth.

Range is increased by switching from one to another of the six large conical-helix antennas in the facility. Wide band range—Doppler measurements can be made on any emission from 15 kc to 1,000 mc—will make the station unique in its flexibility, says center director Lloyd H. Manamon. Maximum frequency may be 3,000 mc next year.

Capabilities, Projects

Basic capabilities include routine recording of signal levels on 20, 40 and 108 mc, and monitoring of any frequency between 15 kc and 50 mc, 107 to 109 mc, 225 to 400 mc and 800 to 1,000 mc.

As part of U. S. Army Signal Research and Development Laboratory (USASRDL) at Fort Monmouth, N. J., the satellite tracking center here is engaged in several important projects:

About 80 percent of the effort involves satellite tracking and radio propagation studies. Remaining 20 percent goes into R&D of the center's long-range point-to-point communications receiving system, operating from 2 mc to 20 mc.

Satellite tracking work is broken down into two functions: operational tracking and use of the data obtained for R&D work on new tracking systems and space communication equipment.

Received signals are recorded and analyzed for frequency and signal characteristics. Doppler determines satellite's position and velocity.

Information is passed on by commercial wire to Army Ballistic Missile Agency (ABMA) in Huntsville, Ala., Jet Propulsion Laboratory, Pasadena, Calif., and the National Aeronautics and Space Administration's SpaceComm in Washington, D. C. A direct wire also sends data to Cape Canaveral, Fla.

Northeast launchings from Canaveral are picked up almost at once here and by the center's two portable tracking units in Maine and at Cape Hatteras, N. C. Called Operation Quick Look, this pre-orbital monitoring records signals 30 seconds before the third stage firing until 30 seconds afterwards. The Doppler equipment turns out information at the rate of 750 words a minute. This raw data is sent by wire to ABMA Evaluation Center where it is processed by computers.

Constantly Improving

Air Force launchings from Vandenberg, Calif.—usually toward the south—are not picked up here until about their 10th hour. Once detected, they, as well as Russian satellites, get the same thorough treatment as Army shots.

Deal has never missed a satellite—to date totaling 14. Three are currently transmitting; Vanguard I, Sputnik III, and Discoverer VI.

Constantly improving the system are new techniques, including new types of antennas, improved receiv-

ing equipment and faster and better ways of transmitting raw data to Army, Navy and Air Force computing centers.

In this connection, an entirely new digital data system has been developed as a result of the experience gained in monitoring techniques. This unit is known as the Dymec Digital Data System.

This automatic Doppler shift count-out mechanism provides high speed tape punch readout. It permits readout of real time versus Doppler shift frequency in steps of one second readout rates. The equipment is built by Dymec div. of Hewlett-Packard.

Equipment, Studies

The Radiquad antennas (see photo) built by Radiation, Inc., which are capable of rotating horizontally 360 degrees and vertically from 0 to 90 degrees, are used for tracking and taking telemetry data. American Electronics Laboratories' 60-ft tower antenna operates with VSWR (voltage standing wave ratio) no worse than three to one. Average gain is 5 db over the system's 50 mc to 1,000 mc range.

Other equipment includes Hallamore's 10-channel telemetry system, Sanborn's chart recorders, a 7-channel Ampex tape recorder, Nems-Clark receivers for general coverage (55 mc to 900 mc), and Nems-Clark telemetry receivers (225 mc to 260 mc). Interstate Electronics' tracking filters are used for taking Doppler information. The Yagi high-gain antenna is built by Telrex.

Studies being carried out include: effects of polarization and phase-front relationships of various types of tracking antenna arrays, including high-gain Yagis, stacked conical arrays and rotatable helices.

One as yet unexplainable phenomenon that occurred last December may be cleared up this December if it happens again. Vanguard I, Navy's grapefruit, still transmitting due to its solar converters which were designed and built at Ft. Monmouth, underwent a sudden decrease in the decay rate of its spin. One possible explanation: the particular angle of the earth's axis at this time may affect the earth's gravitational field.

GOOD-ALL CAPACITORS ASSURE

Circuit Stability

in ELECTRONIC ORGANS

GOOD-ALL 600UE, one of the types specified by leading manufacturers, excels in capacitance stability with life and has extremely high humidity resistance.

For these same reasons the 600UE has rapidly gained an excellent reputation for use in a wide range of fine instruments including oscilloscopes, professional quality recorders and closed circuit TV chains.

This premium capacitor costs surprisingly little more than conventional paper dielectric types.

SPECIFICATIONS

Construction . . . Mylar* dielectric molded in Epon** epoxy. Extended foil winding.

Stability with life . . . . . Less than 1% change after 10,000 hours under full rated conditions.

Insulation Resistance . . . Greater than 60,000 meg. x mfd. at 25° C, but need not exceed 180,000 megohms.

Temperature Range . . . Full rating —55° C to +85° C; to 125° C with 50% derating.

Voltage Ranges . . . 100, 200, 400 and 600 V.D.C.

Capacitance Tolerances . . . Standard tolerances ±20%; also available in ±10% and ±5%.

* DuPont's trade name for their space-saving polyester film.

** Shell's trade name for their epoxy resin plastic molding compound.

Write for detailed specifications.

Some of the well known Electronic and Electric Organ manufacturers who specify Good-All Capacitors.

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The 600UE and other popular Good-All Capacitors are now available at AUTHORIZED DISTRIBUTORS

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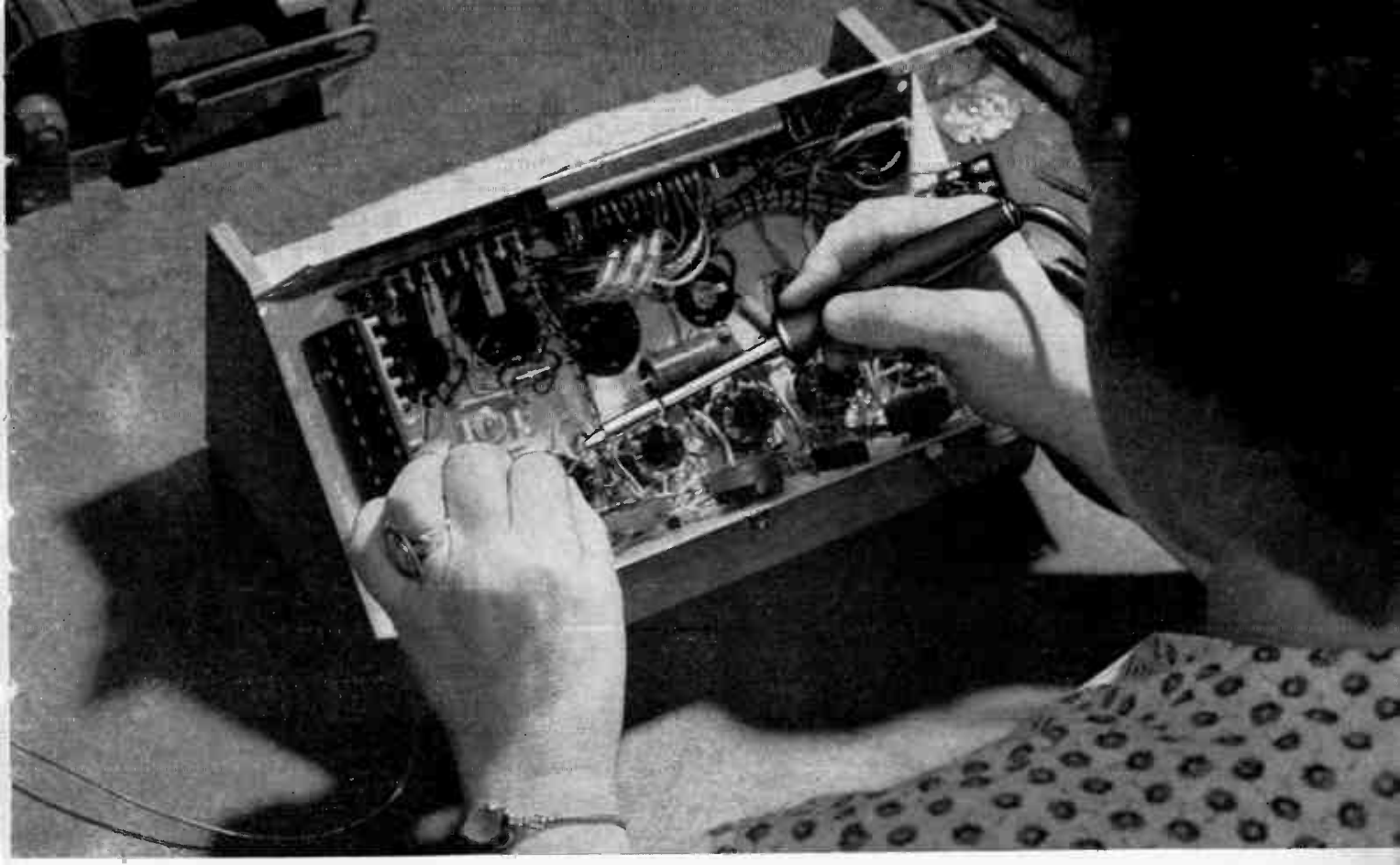
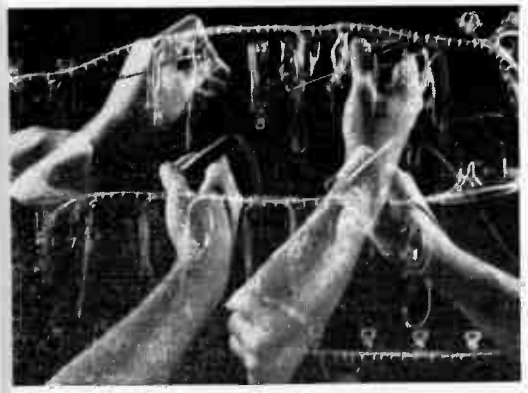
Good-All is a leading Manufacturer of Tubular, Subminiature Electrolytic and Ceramic Disc Capacitors.

GOOD-ALL ELECTRIC MFG. CO. OGALLALA, NEBRASKA



HARD-TO-REACH JOINTS in Sanborn Co.'s electro-cardiographs are soldered quickly with the fine-point G-E Midget iron—with no damage to adjacent parts. Weight of iron—less than 3 ounces—helped increase output by reducing operator fatigue. The Midget's ironclad-copper tip saves Sanborn ½ hour cleaning and tinning time daily, per operator station.

Sanborn speeds assembly 13% with G-E Midget iron, a small soldering iron with big-iron efficiency



FASTER HEAT RECOVERY and lower maintenance of G-E soldering irons have been proved by many manufacturers under their own production conditions—along with competitive soldering irons. If you would like to compare General Electric irons with the irons you are now using, call your G-E distributor.

DELIVERY TODAY is now possible on popular soldering irons and other General Electric heaters and devices from a local distributor near your plant. Your replacement inventory may be reduced. For the name of your nearest stocking distributor for G-E heaters and devices, call your General Electric Apparatus Sales Office.

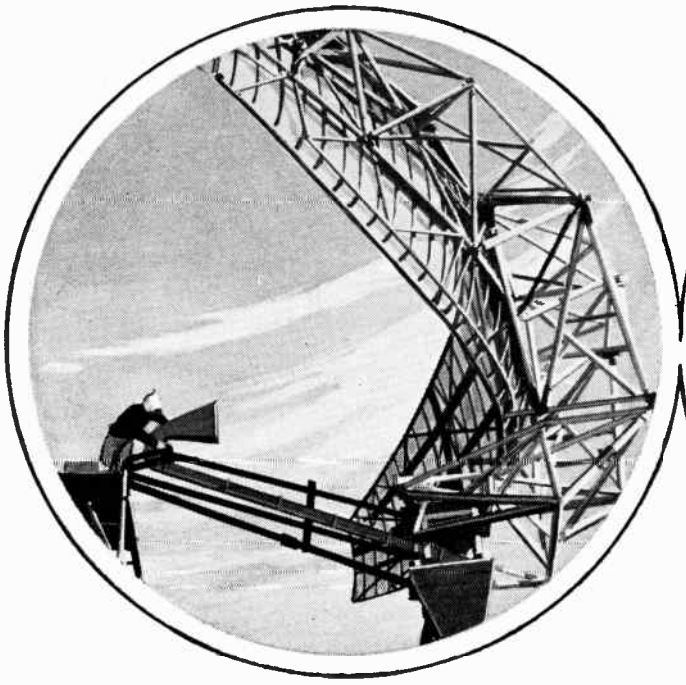
SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-9, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

CIRCLE NO. 43 READER SERVICE CARD

New from Superior Tube . . .

ALL-PURPOSE CATHODE ALLOY



. . . for pulse application

. . . or continuous signal

THIS IS X-3012* . . . first cathode alloy to do every job well. Use it where you want a passive alloy. It has greater emission capacity. Use it where you want an active alloy. It gives longer life. And look at these other characteristics:

1. Both sublimation and interface impedance reduced practically to the vanishing point
2. Has twice the hot strength of ordinary nickel alloys
3. Longer sustained life even under high current conditions and with overvoltage abuse
4. Good cathode coating adherence
5. Cathodes available from both air-melted and vacuum-melted material

Alloy X-3012 was developed in the electronic laboratories of Superior Tube. It is a combination of nickel, tungsten and zirconium . . . selected from a wide range of different heats as having the most effective proportions of these three metals. Available now in lockseam, lapseam, and Seamless/Weldrawn® cathodes. Write for a detailed technical report. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

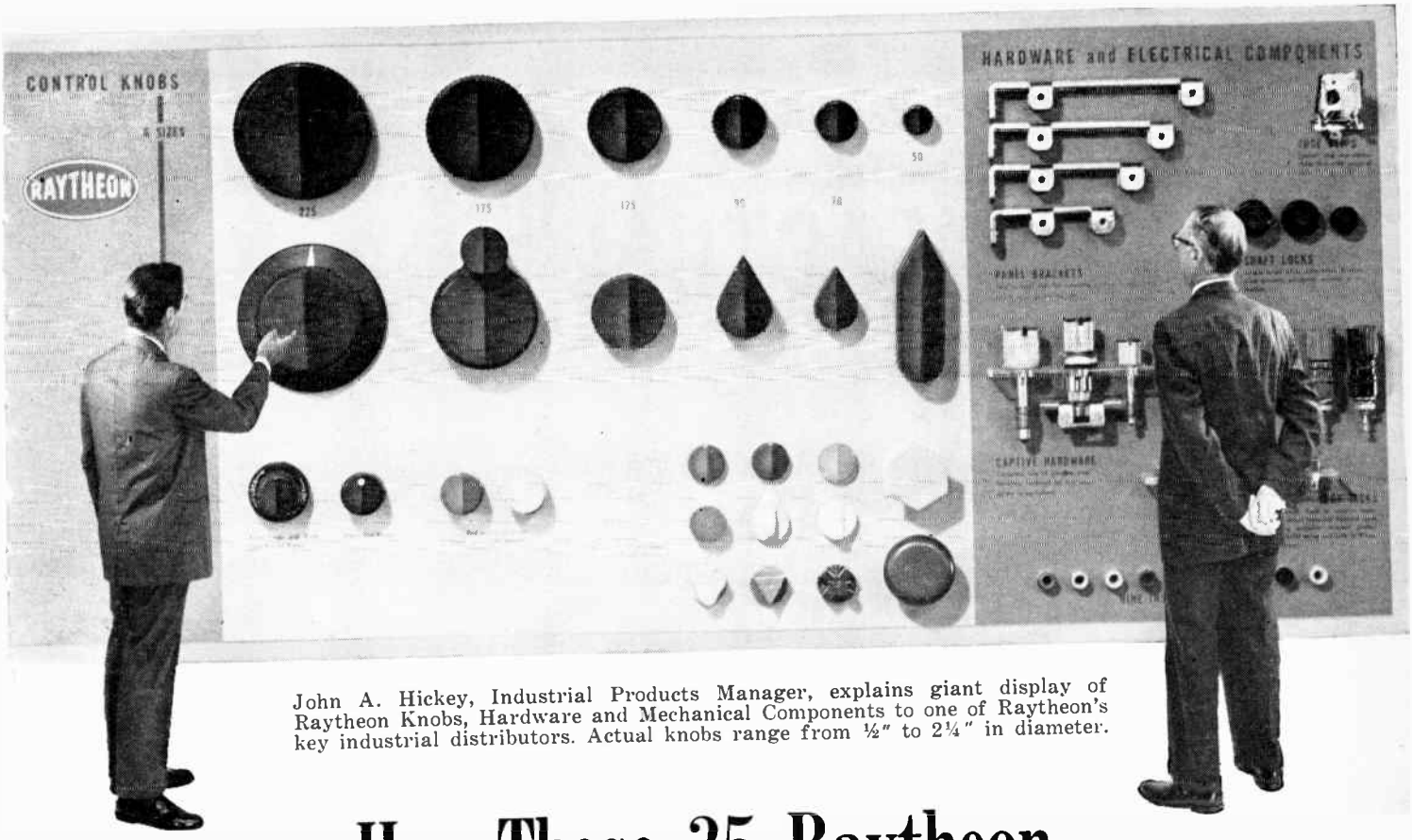
**U.S. Patent No. 2, 833, 647 (Superior Tube Co.)*

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

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



John A. Hickey, Industrial Products Manager, explains giant display of Raytheon Knobs, Hardware and Mechanical Components to one of Raytheon's key industrial distributors. Actual knobs range from ½" to 2¼" in diameter.

How These 35 Raytheon Knobs Solve 35 x 10^6 Control Problems

Raytheon offers the most complete line of knobs available to meet all requirements. Raytheon's knobs are handsomely styled to complement the finest electronic equipment. They are molded of Tenite II with inserts of anodized aluminum and two Allen head set screws. Raytheon knobs are designed to meet commercial and military applications. Colors are available and most knobs come in both mirror and matte finish.

One Source—These knobs plus a complete line of hardware and mechanical components are offered by Raytheon Industrial Distributors. In addition, Raytheon distributors offer complete availability on industrial tubes, voltage regulators, transistors and diodes, receiving tubes and cathode ray tubes. Whatever electronic components you need, your local Raytheon Industrial Products Distributor can supply them. You pay no penalty in price, and get faster service from complete local stocks on *all* Raytheon products they sell. If you don't know your nearest Raytheon Distributor, write to John Hickey, Industrial Products Manager, at the address below.

RAYTHEON COMPANY • DISTRIBUTOR PRODUCTS DIVISION

RAYTHEON

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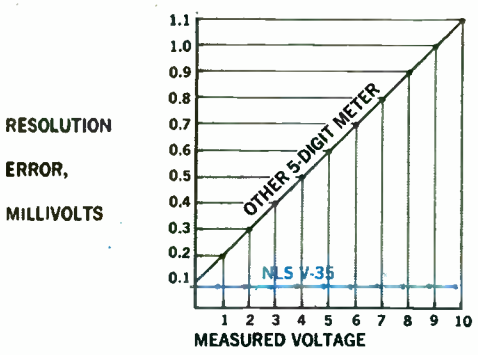
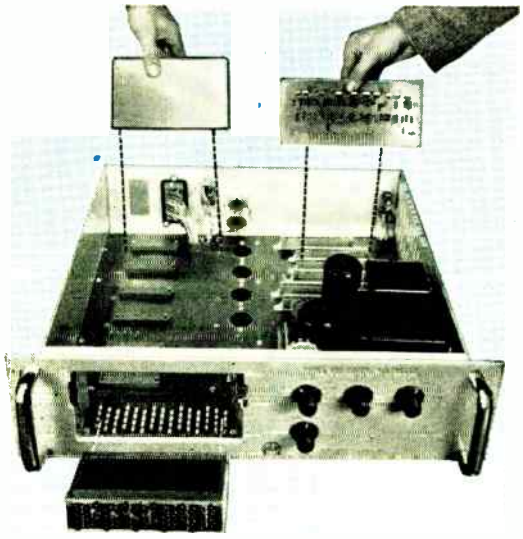
CIRCLE NO. 45 READER SERVICE CARD

FIRST DIGITAL VOLTMETER WITH THE FACTUAL FIFTH FIGURE

+96.438



This chart shows the significant resolution error that results in other five-digit meters as compared to the NLS V-35 with the *factual fifth figure.*



Compact, plug-in design of the NLS V-35

The All-Transistorized NLS V-35

Here for the first time is a *true* five-digit voltmeter with a factual fifth figure. Increased accuracy of *full* five-digit resolution — 0.001% — results from the new mathematically perfect logic of the NLS V-35.

Other five-digit digital voltmeters require "desensitizing" to prevent oscillation of the least significant digit. This results in a resolution error of three to nine digits in the upper portions of each range as graphically displayed in the chart to the left. This comparison clearly shows the increased accuracy of the NLS V-35, made possible by full five-digit resolution.

In new logic . . . in all-transistorized circuitry, including logic . . . in new simplified design with *plug-in* circuit boards, *plug-in* oil-bathed stepping switches, and *snap-in* readout . . . the NLS V-35 leads its field. Write today for complete information.

NLS V-35 Specifications

Measures Voltage from ±0.0001 to ±999.99, Ratio from ±.00001 to ±.99999 . . . 10 Megohm Input Impedance . . . 0.01% Accuracy . . . Automatic Selection of Range and Polarity . . . And Measures Three Times Faster Than Any Other Stepping Switch Instrument.

Originators of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (San Diego), California

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

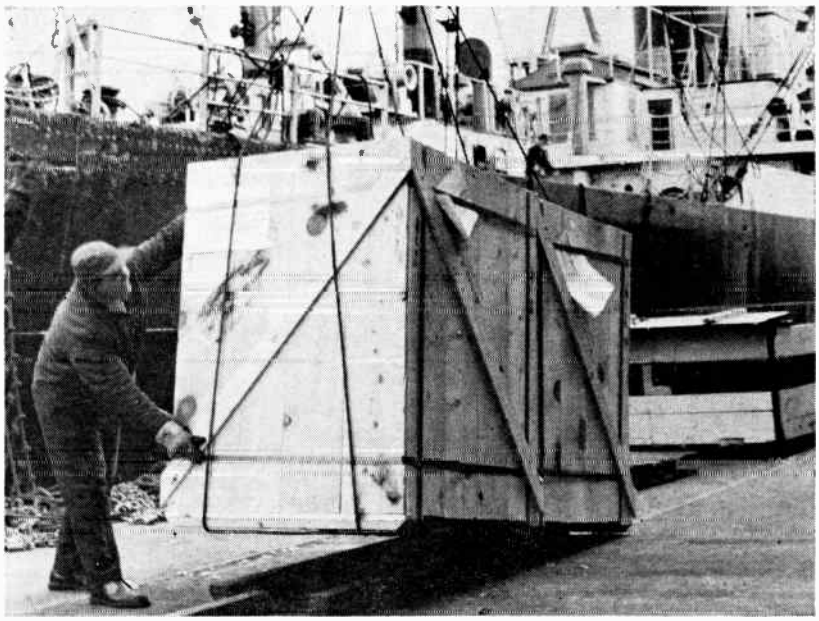
Training Men for Overseas

Language and custom studies are stressed for engineers going abroad. Companies say technical interests help to provide a common ground

AMERICAN ELECTRONICS FIRMS are doing a good job of training employees they send overseas—even though flurries in Washington this month concerning the image of U. S. people aboard tend to cloud the picture.

Spokesmen for a number of electronics manufacturers say the advance training given to men going to other countries is becoming increasingly important.

Anticipated growth of markets in Latin America, increasing competition from Europe's Common Market nations and the general "shrinking" of today's world provide ready incentives to educate overseas personnel, they say.



Foreign commerce means more than goods—it also means good will

Approaches Vary

ELECTRONICS interviews show that many firms, both large and small, have organized training programs for employees going abroad.

A series of short-duration trips with nationals of host nations is part of the Westinghouse approach to an overseas career.

In this way, the new man absorbs the ways of the country in small doses. Once the man and the country have proved they are compatible, a series of intensive language courses is started.

In addition, the man is encouraged to spend as much time as possible with people from the land he is going to. The firm prefers technically trained men who have been in its employ for some time. In seeking such men, the company feels the internationally-minded engineer will make his interest known.

Working overseas is considered a privilege—and care is taken to weed out the man who won't get along in the new environment.

The short, preliminary trip is also used by General Electric as a means of acquainting company personnel with overseas assignments.

The men also go to Berlitz language schools, receive intensive lectures, see films and read extensively about the place they're headed for. The company feels that the man going abroad must be the type who will add something to the country, rather than just live there in isolation.

Men chosen for overseas posts must demonstrate technical competence and an ability to get along with people. Lack of either quality usually disqualifies him, say company officials.

Wives Play a Part

Married men going abroad for RCA find that their wives can be a major factor in success or failure at the new assignment.

For this reason, the wife receives the same language courses and training her husband gets, with the company paying the bill. Preference is given to technically-proficient men capable of absorbing the language and customs of their future neighbors. Men sent abroad usually go in teams which include personnel already familiar with the country.

The Business Council for International Understanding, which urges greater participation by American businessmen in overseas training, has a dozen electronics firms as members. BCIU sets up courses and provides special aids to men going abroad.

In supporting the work of the council, Meade Brunet, RCA executive, points out companies can sustain losses due to inadequate preparation for overseas assignments. He also stresses that enrollment in training programs will not only benefit foreign operation, but will enable the U. S. business community to help its nation.

Universal Language

Managers of overseas divisions of electronics firms interviewed by ELECTRONICS were quick to point out that the electronics engineer has an edge over many other men going abroad to work.

"The language of our industry is a common one all over the world," said one major manufacturer. "Two competent men going over a schematic drawing are joined in reading an international language and sharing a common interest, no matter what nation they come from."

Protective packages for aircraft and missile instruments, computers, chemical glassware, and various guidance missile devices, are among custom-molded urethane foam containers developed by Standard Plastics, Inc., for new needs of industry.

"Lower cost is only one benefit of Urethane Foam packaging"

. . . says C. D. Snelling, president, Standard Plastics, Inc.

"Our custom-molded urethane foam packaging saves our clients as much as 30% in costs, reduces bulk by one-third and weight by 75%," states Mr. Snelling.

"We proved to our customers that urethane foam has a definite place in the packaging field," he adds, "and 1959 is proving to be the big year in this developing industry.

"The excellent energy absorption of urethane foam at low density and low compression set is supplemented by the economy of this material in terms of cost, space and weight savings. For example, our foam package for magnetron tubes replaced a wooden packing case with rubberized hair at a cost saving of 30%, a cube space reduction of 85% and a weight saving of 65%. This means a reduction of 55 cubic feet per tube package and 157 pounds per unit—pretty important figures to a shipper!

"The no-dust feature of urethane foam is also very important in packaging sensitive instruments and components," says Mr. Snelling. "And the low moisture content (.3%) makes urethane foam virtually chemically inert as well as affording corrosion resistance to silvered surfaces and the like."

Standard Plastics, Inc., was formed in 1954 to mold urethane foam products exclusively. Recently a new 16,000 square foot plant was opened in Fogelsville, Pa., which, incidentally, has urethane foam-lined office interiors for temperature and sound insulation.

Write Mobay for other examples of how urethane foam specialists are working with industry to improve the profits and potential of new products.

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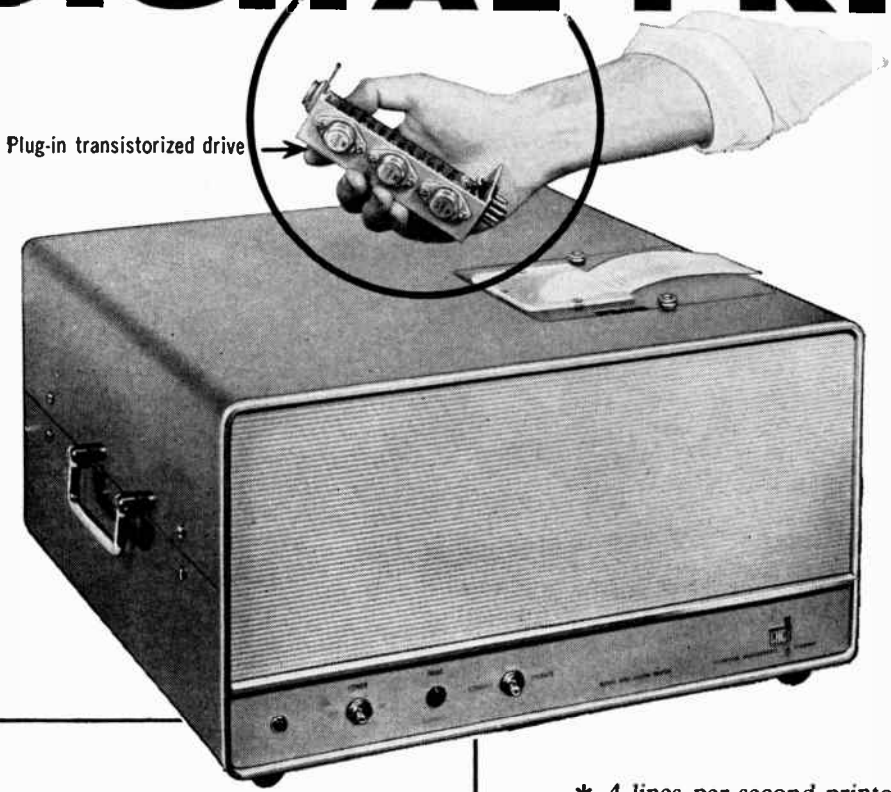

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The most versatile digital printer ever made

SPECIFICATIONS

Printout capacity	6 digits standard.
Accuracy	determined by basic counting instrument.
Display time	0.2 seconds minimum, maximum controlled by the counter.
Weight	60 lbs.
Power requirements	115 volts ±10%, 50-60 cps 25 watts
Dimensions	17" W x 8½" H x 16½" D. (Rack mounting available as option D.)
Warranty	One year on electronics; 1.5 million lines @ 4 lines per second on matrix; 10 million lines @ 4 lines per second on printer assembly, or 1 year, whichever occurs first.
Price	$1350.00. Add $10.00 for rack mount.

* 4 lines per second printout * Takes 1-2-2-4 or 1-2-4-8 four line code * No stepping switches * Operates from only 6 volt input * Parallel entry * Special options available including 10 line and analog output * 6 digit printout, up to 12 digits on special order * Rugged unitized construction * Completely compatible with CMC's new solid state frequency-period counters, and other types of transistorized counting equipment.

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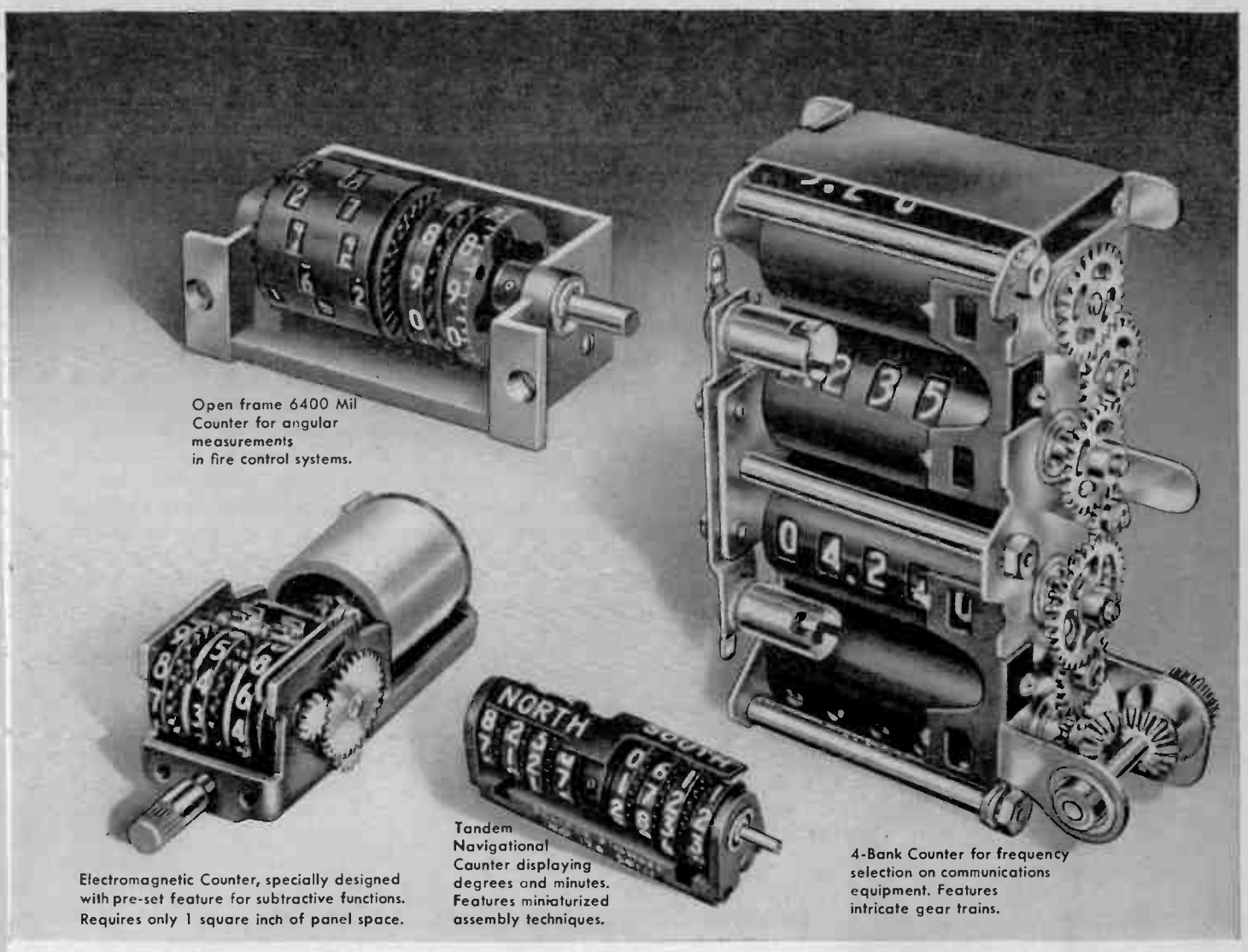

Open frame 6400 Mil Counter for angular measurements in fire control systems.

Electromagnetic Counter, specially designed with pre-set feature for subtractive functions. Requires only 1 square inch of panel space.

Tandem Navigational Counter displaying degrees and minutes. Features miniaturized assembly techniques.

4-Bank Counter for frequency selection on communications equipment. Features intricate gear trains.

Veeder-Root can provide the answer by supplying a single device or a complete counting "package" to fit your system.

The Veeder-Root Counters shown here are only a small selection of the specialized line of precision counters developed for instrument and military applications. Each demonstrates Veeder-Root's ability to design and produce to high precision, fine tolerances, and military specifications, and to satisfy severe environmental testing requirements.

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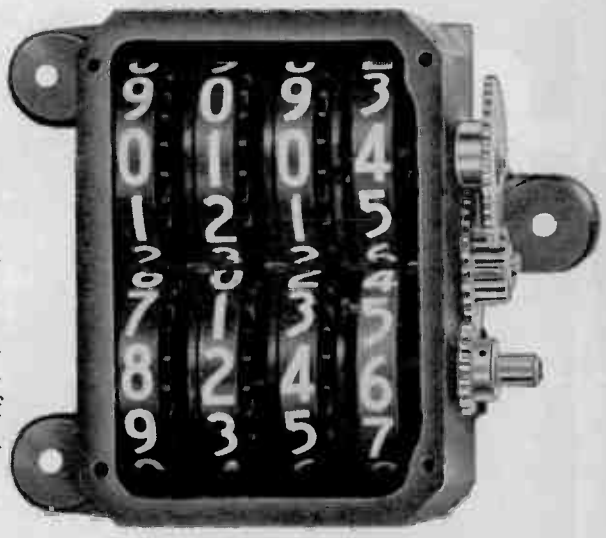

Dual Counter device for communications equipment. Features intricate assembly and gearing.

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Industry Grows In

Here's a report from Portland, Ore.—'City of Roses'—where electronics is blooming, too

PORTLAND, ORE.—THIS METROPOLITAN AREA of about 800,000 people will probably never become a giant Los Angeles-style center of our industry. But a post-Wescon visit to the "City of Roses" points up a few interesting things.

First of all, the flowers have been getting a run for their money from the growing electronics business, in the form of oscilloscopes, microminiature relays, gyros, potentiometers and precision transformers.

Growth Rate

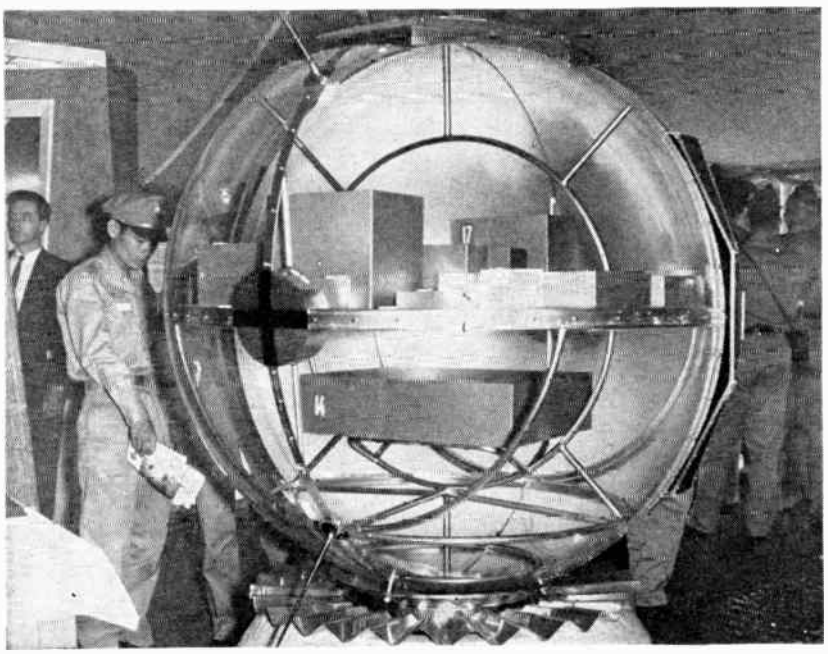
In the last two years, the growth rate of Portland's handful of small and medium-sized electronics companies has been prodigious. The Iron Fireman Mfg. Co.'s Electronics division has more than doubled its number of employees in the last year from 250 to 550, and is still hiring workers. The division's annual sales are around the $5-million mark, with prospects even brighter.

For example, its current sales of microminiature relays are running double last year's sales, which were themselves 50 percent higher than the previous year's levels.

Osborne Electronics Corp., with some 300 employees, about 100 more than last year, is currently doing business at an annual rate of $3 million. The firm reports its main problem now is "getting production out the door."

A large oscilloscope manufacturer, Tektronix, typifies Portland's

New Communications Satellite



Full-scale mockup of Signal Corps' Courier communications satellite was shown for the first time at Fort Monmouth's open house recently. Scheduled for a spring launching, the satellite will serve as a teletypewriter relay station in Army's worldwide communications network. Philco is building the payload—a mechanism for receiving, storing, and when instructed from the ground, transmitting messages. ITT is building the ground equipment which uses Radiation, Inc.'s antenna

Northwest

growth. The firm added 1,200 new people to its payroll last year, bringing the total to 3,000. Tektronix also built a new plant to house its employees, is now constructing a ceramic-parts processing plant, plans still more expansion.

Company employees' retirement fund owns 300 acres of land and an expandable warehouse, and fund trustees want to get in on the Rose City's growth by developing the land into an industrial park.

Keyed to Aircraft, Missiles

A second point apparent to an observer in Portland is that many small electronics plants here depend very heavily on the big aircraft and missile contractors along the West Coast for their component and instrument sales. This business is almost all military now, but commercial jet airliners are a new and promising market.

Emphasis by some firms on microminiature components seems to jibe with the thinking of top electronics men. For instance, Herbert York, Defense Department's director of research and engineering, told the closing Wescon luncheon that microminiaturization of equipment will be useful even if experts don't immediately know what for. "Intuition tells you some developments are a good thing," he said.

The right intuition and continued fat orders from big defense contractors should keep the fortunes of small firms in this part of the country moving up.

One company making sensitive advanced components for operational missiles is selling more advanced ones for developmental missiles, thinks its newest units will anticipate the sophistication of weapons systems now only being planned.

If such products also successfully anticipate demand for microminiaturization of commercial and industrial products, the lily will have been painted—Portland's roses notwithstanding.

Developed specially for the new "B" revision of MIL-I-7444, Resinite EP-93C is transparent and colorless (no amber tint). Here is a brand new material embodying all the superior characteristics of Resinite specification grade insulation sleevings – and more. Now there is a Resinite material for all Types (transparent, tinted or colored) and all Size Ranges of this important specification. Ask your Resinite Distributor for complete information or write for samples and performance data.

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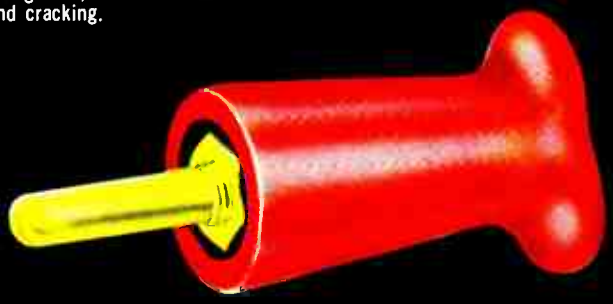
Pin plugs quickly assembled with a single nut after cable connection.

SOCKET RECEPTACLE



PIN PLUG

Receptacle caps and bodies are color-matched for quick circuit identification in front and back of panel.

Positive-grip, functionally designed plugs provide best handling ease and convenience.

Plugs can be connected to a range of cable sizes by fastening screws or by soldering.

PIN RECEPTACLE

SOCKET PLUG

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PIN PLUGS

Attach the cable to the pin plug with the two fastening screws or by soldering.

Slip the grip over the pin plug and tighten in place with the assembly nut.

SOCKET PLUGS

Slip the socket plug grip over the cable and attach the cable to the socket plug with the screws or by soldering.

Screw the socket plug shield and grip together securely.

RECEPTACLES

After opening the panel hole, screw the cap and the base together securely.

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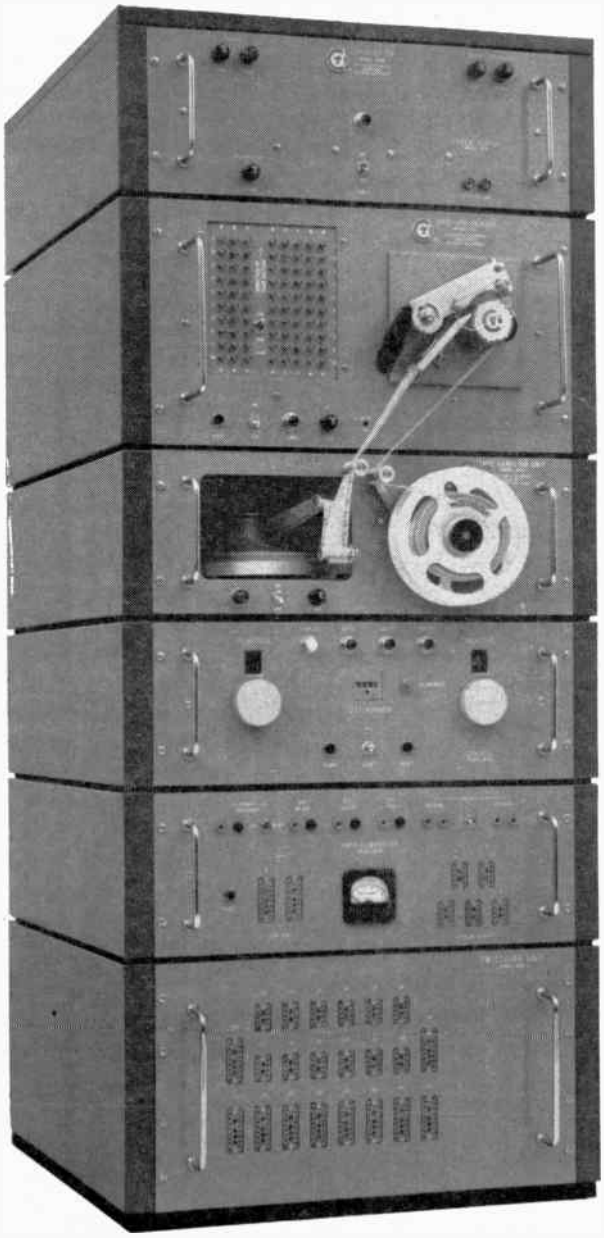

Drastically reduced test costs, increased equipment reliability and quality, incipient failures located during routine maintenance, decreased down time for vital equipment, production bottlenecks eliminated, no time wasted overhauling good units and needlessly replacing good components, exceedingly valuable in ground support—these are a few of the many reasons that CTI Supertesters are so widely used for all types of electronic and electrical testing from production to field maintenance. In making complete static and dynamic measurements on constituent circuits or in analyzing performance of entire systems, Supertesters have demonstrated time and again their advantages over other test methods.

Proved in over one year of use, the Model 180 Tape-Programmed Supertester is bringing a new versatility into automatic testing. With the accessory Tape Punch and Tape Duplicator, identical or revised copies of tapes can be made in seconds, an important feature where numerous design changes are of concern. Copies of tapes used by the original equipment manufacturer can be supplied for field use, always assuring that equipment is meeting the latest design specifications. In addition, lengthy test specifications are eliminated and the test instruments for a large variety of units are kept to a minimum —one CTI Supertester.

Write for complete specifications on the Model 180. A brief outline of your test requirements will enable us to advise you in more detail on the application of our testers to your needs. Related CTI products are the Model 165 Cable-Harness Analyzer, Model 176 card-programmed Component Tester, and Model 100 Supertester.

The new Model 180 Tape-Programmed Supertester has the same outstanding features that have made CTI automatic test equipment the leader in the field—high accuracy, go/no-go bridge measurements, widest scope of tests and auxiliary operations, and complete customer confidence in test results through fail-safe circuitry and self-testing ability.

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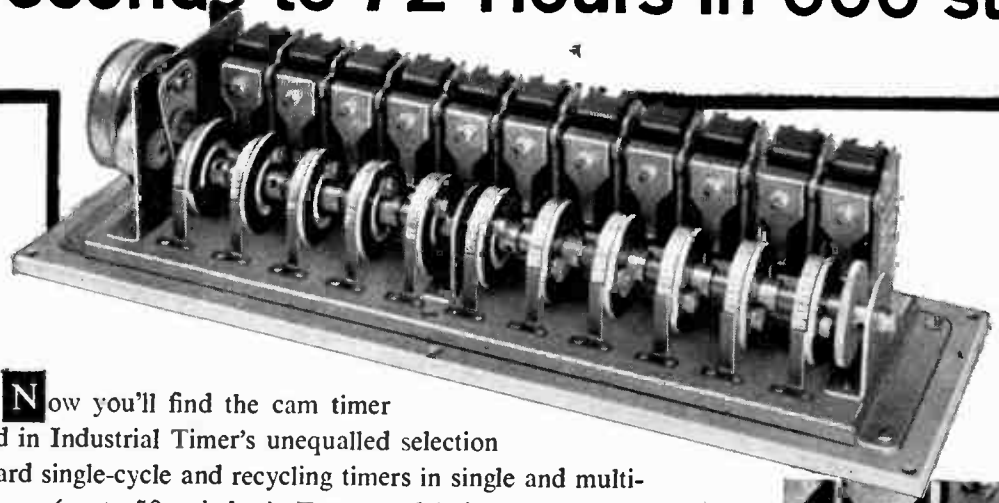

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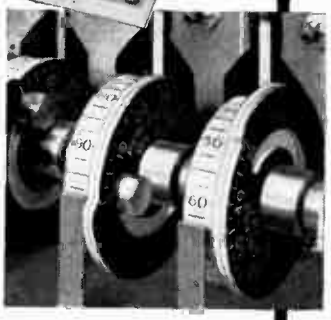

If you don't find the timer you want in this unmatched range (a highly unlikely possibility), Industrial Timer's unique Timer Kit will help provide the exact timer you need at low cost. With this kit you can design your own prototype, and since the kit components are standard in our line we can reproduce your prototype—in quantity—*at no extra cost.*

For fast delivery on a standard or special Cam Timer check first with Industrial Timer. For more information ask for *Bulletin 200* Synchronous Motor Driven Cam Timers, *Bulletin 201* Multi-Cam Timer Kit, *Bulletin 202* Multi-Cam Switching Devices.

Industrial Timer's complete line of timers also includes: Time Delay Timers, Interval Timers, Running Time Meters, and Programmers. Bulletins describing these are available on request.

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Explorer VI Transmitting Well

Satellite reveals a larger concentration of low-energy particles in space than expected

EXPLORER VI data is proving to be "better than satisfactory," in the words of George E. Mueller, vice-president of Space Technology Laboratories, which is responsible for scientific direction of the satellite project.

Mueller says the "telebit" telemetry system of Explorer VI has reported a larger concentration of low-energy particles in space than previously postulated. Data in higher energy density corroborates the Van Allen observation.

Energy level of the particles is 200,000 electron volts. He disclosed that the satellite's solar power level is slightly lower than anticipated but it's hoped that it will last a year. One dust particle has been counted for every 100 million cu ft of space during the satellite's orbit which carries from 134 mi perigee to 22,000 mi apogee.

The "telebit" digital unit aboard Explorer VI both stores and calculates before transmitting totalled data to earth on completion of a predetermined cycle. This data includes cosmic radiation, magnetic fields, radiowave propagation, solar corona density, ionization, micrometeorite flux and momentum.

Coded data picked up by a ground station is sent through a sensitive receiver before being demodulated, is then punched on teletypewriter tape to give an exact representation of the data recorded by the satellite's instruments. Taped information goes to a central computer which prints it out in chart or graphical form for evaluation by STL scientists.

Infrared Tracks Distant "Moons"

INFRARED SATELLITE TRACKER, above, developed by ITT, can detect artificial satellites thousands of miles above the earth.

The tracker uses a 19-in. concave mirror to collect the ir energy given off by satellites. This energy, caused partly by friction between a satellite and the thin atmosphere, or by rocket motor exhaust, is then focused on a sensitive detector, chilled to a temperature lower than −300 F.

The collector mirror oscillates and scans an area of the sky where the satellite is expected to pass. Shortly before the satellite is sighted, the tracker is set in motion and the satellite eventually catches up with the arc of the sky being scanned. A semiautomatic tracking device then keeps the tracker locked on the satellite.

"Distinct Improvements"

"If tests bear out our calculations," says F. H. Hall, Jr., ITT physicist, "the ir tracker will represent distinct improvements in reliability and production economy."

The tracker was developed for the Air Force to answer questions on the nature of ir radiation emitted by orbiting satellites. These questions are vital to space vehicle aerodynamics, atmospheric physics, space vehicle navigation and communication and space medicine.

The tracker also may have applications in missile-detection systems, if field tests show that missiles generate detectable ir radiation.

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

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

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

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

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

Write for Bulletins. TE-1353 and TE-1355

SILICON DIODES

FEATURES	Fast Switching and High Frequency Types Ratings @ 25°C				Military and High Conductance Types Ratings @ 150°C			
		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current, (ma)	Inverse Recovery Time (μsec)		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current (ma)	Max. Inverse Current (μa) @ V
• Recovery Times Under 15 μsec • High Conductance Combined With Fast Switching • Subminiature Size • High Inverse Resistance	1N808	100	100	.3	JAN 1N457	60	25	5 @ 60
	1N809	200	100	.3	JAN 1N458	125	25	5 @ 125
	1N658	120	200	.3	JAN 1N459	175	25	5 @ 175
	1N659	55	100	.3	1N485B	180	50	5 @ 175
	1N643	110	100	.3	1N488A	380	50	25 @ 380
	JAN 1N251	30	75	.15	1N464	175	40	30 @ 125

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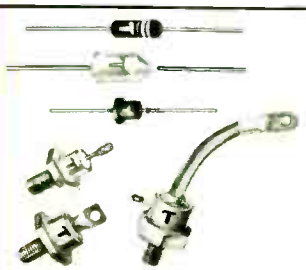
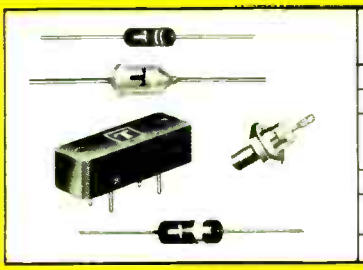
SILICON RECTIFIERS

Ratings @ 150°C Case Temperature			Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current (ma)	Maximum Inverse Current (ma)	FEATURES
	Subminiature Glass	1N689 1N649	600 600	150 150	0.2 0.2 (@ 25°C)	• Reliability at High Temperatures • High Efficiency • Rugged Construction • Hermetic Sealing • Low Thermal Resistance
	Miniature	TJ60A TJ30A	600 300	200 200	0.5 0.5	
	Axial Leads	SL715 1N547	1500 600	100 250	0.2 0.3	
	Military	JAN 1N256	570	200	0.25 (@ 135°C)	
	Stud Mounted	TM155 TM67	1500 600	400 3000	0.5 0.5	
	Medium Power	TR402 TR601	400 600	Amps 20 10	5 5	
	High Power	TH402B	400	50	15	

Write for Bulletin TE-1351

SILICON REGULATORS AND REFERENCES



	Voltage Range (Volts)	Maximum Dynamic Resistance (ohms)	Maximum Current @ 25°C (ma)	@ 125°C (ma)	FEATURES
Subminiature — SV-5	4.3-5.4	55	50	10	• Long-term stability • Operation up to 150°C • Small size, easy mounting • Hermetically sealed
Miniature — SV-815	13.5-18	120	40	8	
Power — SV-924	20-27	8	55°C (amps)* .4	(ma)* 100	
Stabistor — SG-22	.64	40	150	25	
Reference — SV-3176	8-8.8	15	Temp. Coefficient ±.001%/°C		
Ref-Amp — 3N44	8.3-9.8		±.002%/°C		

*Case temperature ratings

Write for Bulletin TE-1352

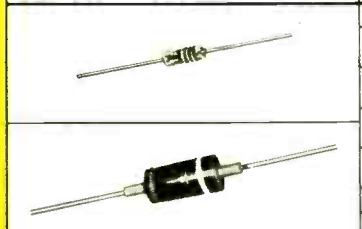
SILICON CAPACITORS

Ultra High Frequency Types — Ratings @ 25°C							FEATURES
	Cut-off Freq. (mc)	Capacity (μμf) @ V Max.	@ −0.1V	Q @ −4V @ 50Mc	@ 100Mc	Maximum Working Voltage	
SCH-51	5000	35	2	100	50	10	• Subminiature Size • High Q • High Temperature Operation
SCH-52	5000	8	4	100	50	7	

High Frequency Types						
				Q @ −4V At 5mc	At 50mc	
SC-1		4.4	24	350	35	22
SC-5		25	120	350	35	11
SC-15		120	360	350	35	6

Write for Bulletin PB-45

GERMANIUM DIODES

Specifications and Ratings at 25°C		Forward Current @ +1V (ma)	Inverse Current at Specified Voltage (μa @ V)	Max. Oper. Voltage (volts)	Description
	JAN-1N270	200	100 @ −50	80	JAN TYPES
	JAN-1N277	100	250 @ −50 @ 75°C 75 @ −10	100	
	JAN-1N281	40	500 @ −50 30 @ −50	60	
	JAN-1N126	5	500 @ −50 30 @ −10	60	
	JAN-1N198	5	250 @ −50 @ 75°C 75 @ −10	50	
	1N283	200	20 @ −10	20	COMPUTER TYPES
	T16G	40	100 @ −50	60	
FEATURES • Milli Microsecond Switching • Superior Forward Conductance • High Inverse Resistance • Uniformity and Stability • Gold Bonded Construction	1N278	20	125 @ −50 @ 75°C	50	HI-TEMPERATURE TYPES
	T22G	40	20 @ −10 @ 75°C	15	
	T9G	100	20 @ −50 2 @ −10	60	HI-RESISTANCE TYPES
	1N67A	5	50 @ −50 5 @ −5	80	
	T8G	100	20 @ −100 5 @ −10	100	
	S570G	10	30 @ 6	Recovery Time .002 (μsec)	MILLI-MICROSECOND SWITCHING

Write for Bulletin TE-1300 & TE-1319

GERMANIUM COMPUTER TRANSISTORS

	Minimum Current Gain (B)	Maximum Collector Voltage (volts)	Typical Cutoff Freq. (MC)	FEATURES
2N427	40	15	8	• High Frequency Switching • Low Saturation Resistance • Uniform Input Characteristics
2N428	60	12	13	

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

Transitron's TD series of rectifier stacks offer a wide range of ratings in seven standard circuit configurations. High voltage cartridges, quads, plug-in assemblies, and many other special encapsulations are also available. Your inquiries are invited.
Write for Bulletin TE-1342.

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electronic corporation • wakefield, massachusetts

CIRCLE NO. 61 READER SERVICE CARD

MEETINGS AHEAD

Sept. 7-12: Machine Searching and Translation, International Conf., Western Reserve Univ. and Rand Devel. Corp., Western Reserve Univ., Cleveland.

Sept. 14-16: Quantum Electronics Phenomena, Office of Naval Research, Shawanga Lodge, Bloomingburg, N. Y.

Sept. 15-17: Electronic Exposition, Twin Cities Electronic Wholesalers Assoc., Municipal Auditorium, Minneapolis.

Sept. 17-18: Engineering Writing & Speech, Dual National Symposia, PGEWS of IRE, Sheraton-Plaza Hotel, Boston; Ambassador Hotel, Los Angeles.

Sept. 17-18: Nuclear Radiation Effects in Semiconductors, USASRDL, Western Union Auditorium, New York City.

Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

Sept. 22-24: Industrial Nuclear Conf., Armour Research Foundation & NUCLEONICS (McGraw-Hill), Morrison Hotel, Chicago.

Sept. 23-25: Non-Linear Magnetics and Magnetic Amplifiers, AIEE, ISA, PGIE of IRE, Shoreham Hotel, Washington, D. C.

Sept. 23-25: Residual Gases in Electron Tubes and Related High-Vacuum Systems, International Symposium, Italian Society of Physics, Como, Italy.

Sept. 28-30: Telemetering, National Symposium, PGTRC of IRE, Civic Auditorium & Whitcomb Hotel, San Francisco.

Sept. 30-Oct. 1: Industrial Electronics Symposium, PGIE of IRE, AIEE, Mellon Inst., Pittsburgh, Pa.

Oct. 5-7: Communications Symposium, National Conf., PGCS of IRE, Hotel Utica, Utica, N. Y.

Oct. 12-14: National Electronics Conference, AIEE, EIA, IRE, SMPTE, Hotel Sherman, Chicago.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

There's more news in ON the MARKET, PLANTS and PEOPLE, and other departments beginning on p 136.

your electronic wire and cable problems end here

Fast moving electronic technology so often demands wire and cable construction to meet specific performance needs. As a "specialist in specials" Chester's engineering and production facilities are geared to meet both military and commercial requirements for plastic insulated wire and cable, while offering standard constructions for more general applications. The few types shown on this page are typical, high-quality Chester products, all of which may be varied to solve your electronic wire and cable problems.

SEND FOR THIS FREE CATALOG

The full story of Chester wires and cables for the electronic industry is in condensed catalog ELT-1.

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CHESTER, NEW YORK

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COAXIAL CABLES

RG types in both standard and special designs; military or commercial versions. Meet all MIL specs. Miniature designs, too.

MILITARY HOOK UP WIRES

A complete line for all military and commercial needs. Includes the new "Thrif-T-Bond"® bonded, tinned wire. Nylon, Teflon, braided jackets. Color-coded.

MULTI-CONDUCTOR CABLES

For computers and related equipment. Any number of color-coded conductors grouped to your requirements and sheathed.

MINIATURE WIRE & CABLE

Single or multi-conductor types in #18 to #30 AWG sizes with thin wall Plasticote® jacket. For radio, TV, electronic equipment.

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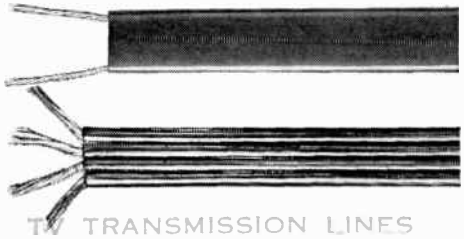
Microphone, phonograph, intercom, etc. An extensive selection of single and multi-conductor types for every audio application.

HI-V AND HI F WIRES

High frequency test lead, high frequency lead wire and flame-retardant high voltage wire. For use on flyback transformers, accelerating anodes, etc.

APPARATUS WIRES

Wire sizes from #16 to #27 AWG, solid or stranded, Plasticote insulated. Range: —40°C to 90°C, 600 volts, AC.



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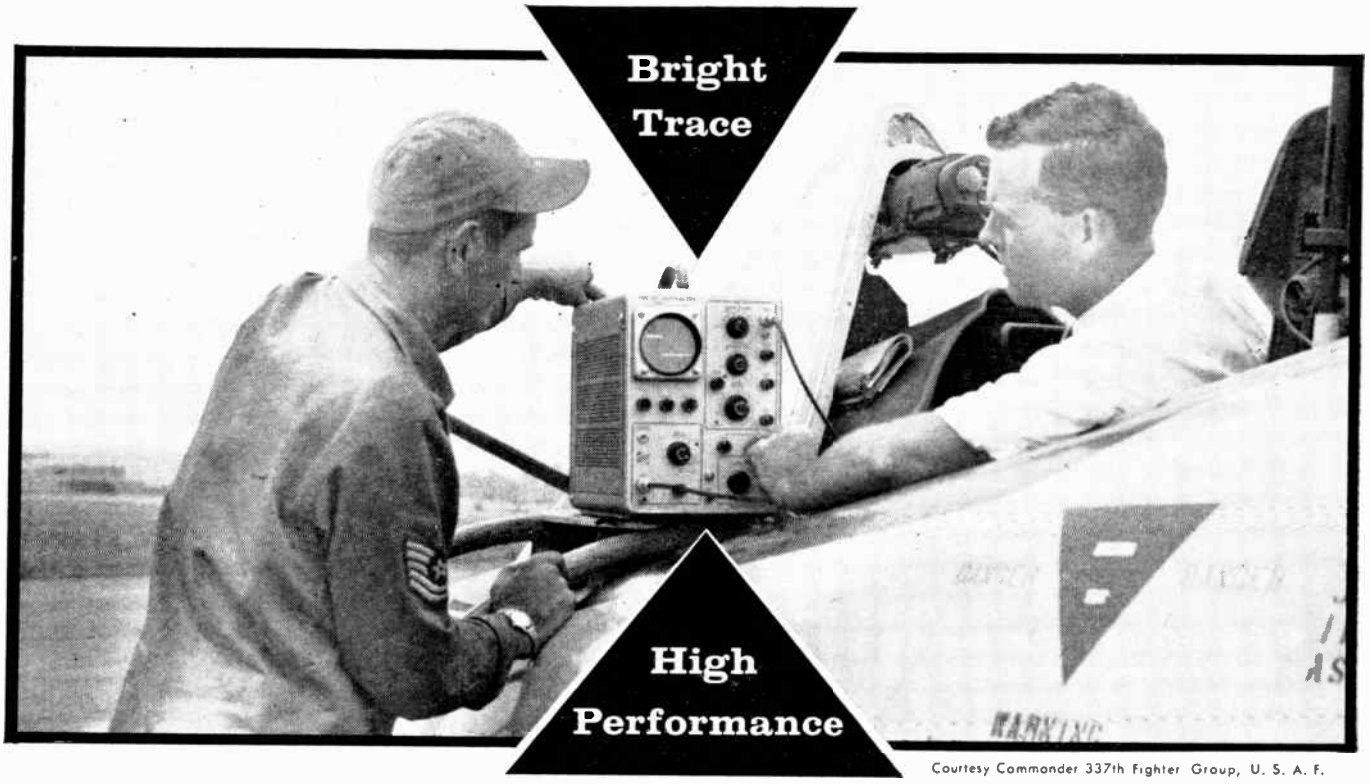
Covering the broad field of TV, including lead-in wire, TV rotor cable, primary and secondary lead-in coaxial cables.



Courtesy Commander 337th Fighter Group, U. S. A. F.

Low Cost DAYLIGHT OSCILLOSCOPE

TYPE 317—It's excellent for the daylight conditions often encountered in the field and at production test stations. The brilliant trace, provided by 9-KV accelerating potential on a new Tektronix 3-inch cathode-ray tube, is easily readable in bright areas, even at low sweep-repetition rates. And its DC-to-10 MC vertical response easily takes care of most of today's complex field applications.

The Type 317 is an excellent laboratory oscilloscope, too. Ask your Tektronix Field Engineer or Representative to arrange a demonstration in your most demanding applications.

TYPE 317 CHARACTERISTICS

VERTICAL RESPONSE

Passband—dc to 10 mc.
Risetime—0.035 μsec.
Sensitivity—0.1 v/div to 125 v/div, dc-coupled and ac-coupled—0.01 v/div to 0.1 v/div, ac-coupled only. Twelve calibrated sensitivity steps.

SWEEP RANGE

0.2 μsec/div to 6 sec/div. 22 calibrated steps from 0.2 μsec/div to 2 sec/div.
5-x magnifier increases calibrated sweep rate to 0.04 μsec/div.

TRIGGERING

Preset or manual stability control with amplitude-level selection, and fully-automatic triggering.

ACCELERATING POTENTIAL

9-KV on new Tektronix high-voltage 3-inch cathode-ray tube.

CALIBRATOR

Amplitude calibrator, 0.05 to 100 v in 11 steps, square-wave frequency about 1 kc.

OTHER FEATURES

Electronic power-supply regulation.
External input to horizontal amplifier.
Warning lights for uncalibrated sweep-rate and sensitivity settings.
Magnifier indicator light.
Size—8½" wide, 12" high, 19½" deep.
Weight—35 lbs.

Type 317 . . . . . **$800** (50 to 60 cycle supply).
Type 317 MOD101 . . . . . **$835** (50 to 800 cycle supply).
RACK MOUNTING MODEL—Some electrical specifications as Type 317. Dimensions: 7" high, 19" wide, 17 9/16" rack depth.
Type RM17 . . . . . **$875**
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ENGINEERS—Interested in furthering the advancement of the oscilloscope? We have openings for men with creative ability in circuit and instrument design, cathode-ray tube design, and semiconductor research. Please write Richard Ropiequet, V.P., Eng.

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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.

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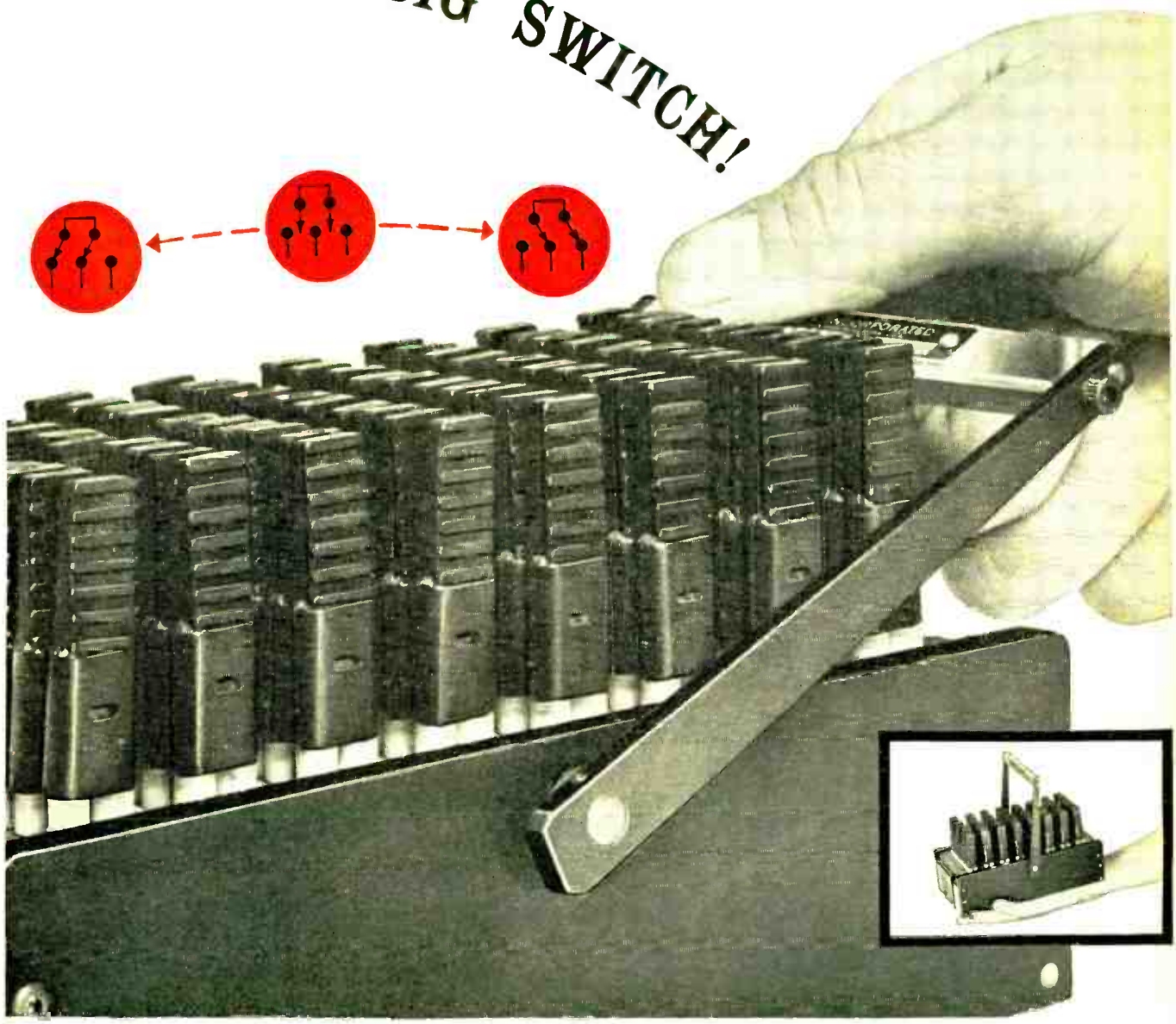
And—for flexibility, you can make a combination plug board and double throw switch with all throw positions independently patched.

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

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It takes Tough Testing to build Timing Performance

When you buy a Haydon Timing Motor or Timing Device, you buy high quality and superior performance, because every production model and every new design has *proved* itself by passing the toughest, most exhaustive series of tests that our engineers can devise.

Quality control at Haydon starts with a careful inspection of all in-coming materials. It continues throughout production — with all parts and assemblies gaged, inspected or physically tested after every operation that can affect the performance of the finished motor or device. Final step is an inspection of completed motors and timing devices. All units are performance tested for many hours under varying conditions and are checked for quiet operation. Percentage samples of each lot are checked for torque rating, timing accuracy, and accuracy and alignment of gears and shafts. In addition, all new designs and periodic samplings from production are subjected to special "life endurance" tests in which hundreds of units are run continuously under various load conditions. In some instances, units have now been running ceaselessly for more than 10 years . . . proving their ability to perform *millions of cycles without failure!*

When you submit your timing problems to Haydon, you can be certain that our teams of engineers and other Timing Specialists have the experience, knowledge and facilities to supply devices designed, produced *and* tested to meet your needs exactly and perform according to your specifications.

For further information, write now, outlining your timing requirements.

Haydon
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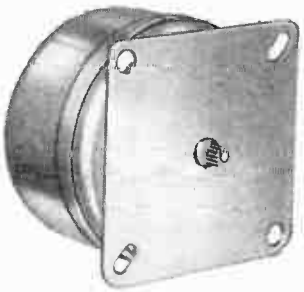
DIVISION OF GENERAL TIME CORPORATION

2433 EAST ELM STREET
TORRINGTON, CONNECTICUT

Headquarters for Timing

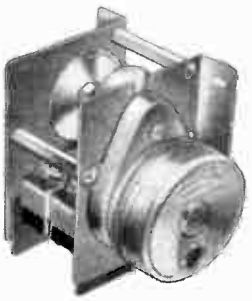
TIME DELAY TIMER

Provides time delay in ranges up to 9.5 minutes. Ideal for such applications as the protection of power tubes and/or operating preset operating cycles. Available in 120 or 240 volt, 50 or 60 cycle current.



400 CYCLE MOTOR

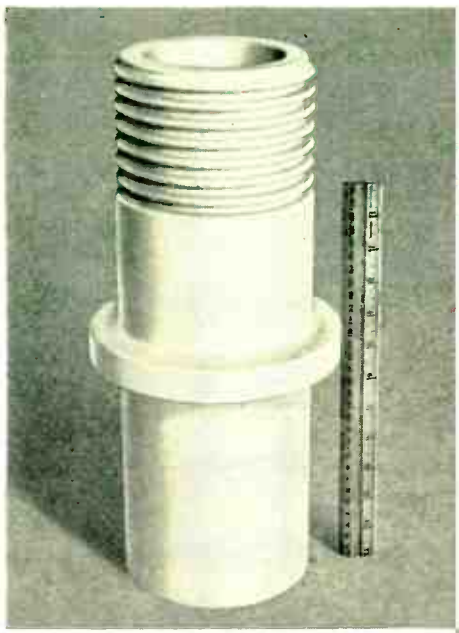
These split phase motors provide the military an accurate approach to timing control for military applications. Rotor speed is 3,000 RPM at 400 cycles, 115 volt normal. Two models are available — Heavy Duty with 18 gram millimeters torque at the rotor, and the Miniature with 5 gram millimeters at the rotor. These motors may be applied to Haydon gear trains if desired.



CYCLE TIMER

These units repeat a set cycle or sequence of operations as long as the motor is energized. Available in a wide choice of speeds, a broad range of timing intervals, and with a wide range of enclosed single pole, double throw switches for 120 and 240 volt operation, for 50 and 60 cycles.

COORS PRODUCES CERAMIC TO MEET YOUR REQUIREMENTS!



Eighteen years ago, this insulator was the answer to a need for a new ceramic for use on an early atomic project—Coors first production run of large ceramic parts using the isostatic technique.

New ceramic compositions, and new techniques have been introduced many times by Coors. Eighteen years ago Coors met the requirements of engineers in an early atomic project by supplying both a new ceramic composition and a new isostatic technique for forming ceramic components. The result—a new, mechanically strong, completely homogenous ceramic having excellent electrical properties.

Demands for better, stronger materials have been answered by Coors throughout the 47 years of their experience. Continuous research assures future developments. For example, Coors AD-99 is only one of several ceramic materials recently developed to meet the new needs of the electronic industry.

Parallel with the development of new ceramic compositions is the research for new and better techniques. For example, a completely new department for metalizing and brazing was installed and recently enlarged. Ceramic-to-metal assemblies can be furnished where brazing temperatures go as high as 1083° C —bonds have tensile strengths as high as 9,000 to 12,000 psi.

Coors precision finishing improves accuracy of electrical characteristics—this window for a traveling wave tube has thickness tolerances of ±.0005", and a flatness of 2 to 3 light bands.

Brazing temperatures of 1083° C were used in making this hermetic ceramic-to-metal assembly, permitting high operating temperatures in the final use of this design.

Ceramic compositions or production techniques are of little value without precise control. You need close tolerances—you obtain them from Coors in production runs, or experimental prototypes. Customary, careful work by over 600 skilled workers permits holding tolerances of 30 millionths of an inch on production runs.

To meet increased demands, additional engineers are being assigned to the field—Coors engineers in your neighborhood give you on-the-spot ceramic design service. They need only your invitation to help you with your ceramic problems.

For information concerning our facilities and for data about Coors high alumina ceramics, please write for bulletin 858.

Coors

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600 Ninth Street, Golden, Colorado

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Interior view of tracked vehicle above

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On the go...bouncing over bunker or beachhead ...Kleinschmidt teletypewriters accurately, efficiently send and receive printed messages. Developed in cooperation with the U. S. Army Signal Corps, these units instantly provide both sender and receiver with identical data...*printed on paper!* In recognition of its quality, Kleinschmidt equipment is manufactured for the U. S. Army under the Reduced Inspection Quality Assurance Plan. This kind of proved experience is now available for unlimited advances in electronic communications for business and industry.

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CLARE relays and stepping switches

One of five banks of Clare Type J Relays in P&W Numerical Control. At left, in cylindrical can, a Clare Type HG4 Mercury-wetted Contact Relay.

INSURE ACCURACY, INCREASE RELIABILITY, REDUCE SIZE *of*

PRATT & WHITNEY'S Numerical Control...

Pratt & Whitney's Numerical Control is a fully automatic, ultra-precise means of translating blueprint data into a series of machine positions. Applied to jig borers and other precision Pratt & Whitney machine tools, settings are made quickly, with high reliability to .0001" accuracy.

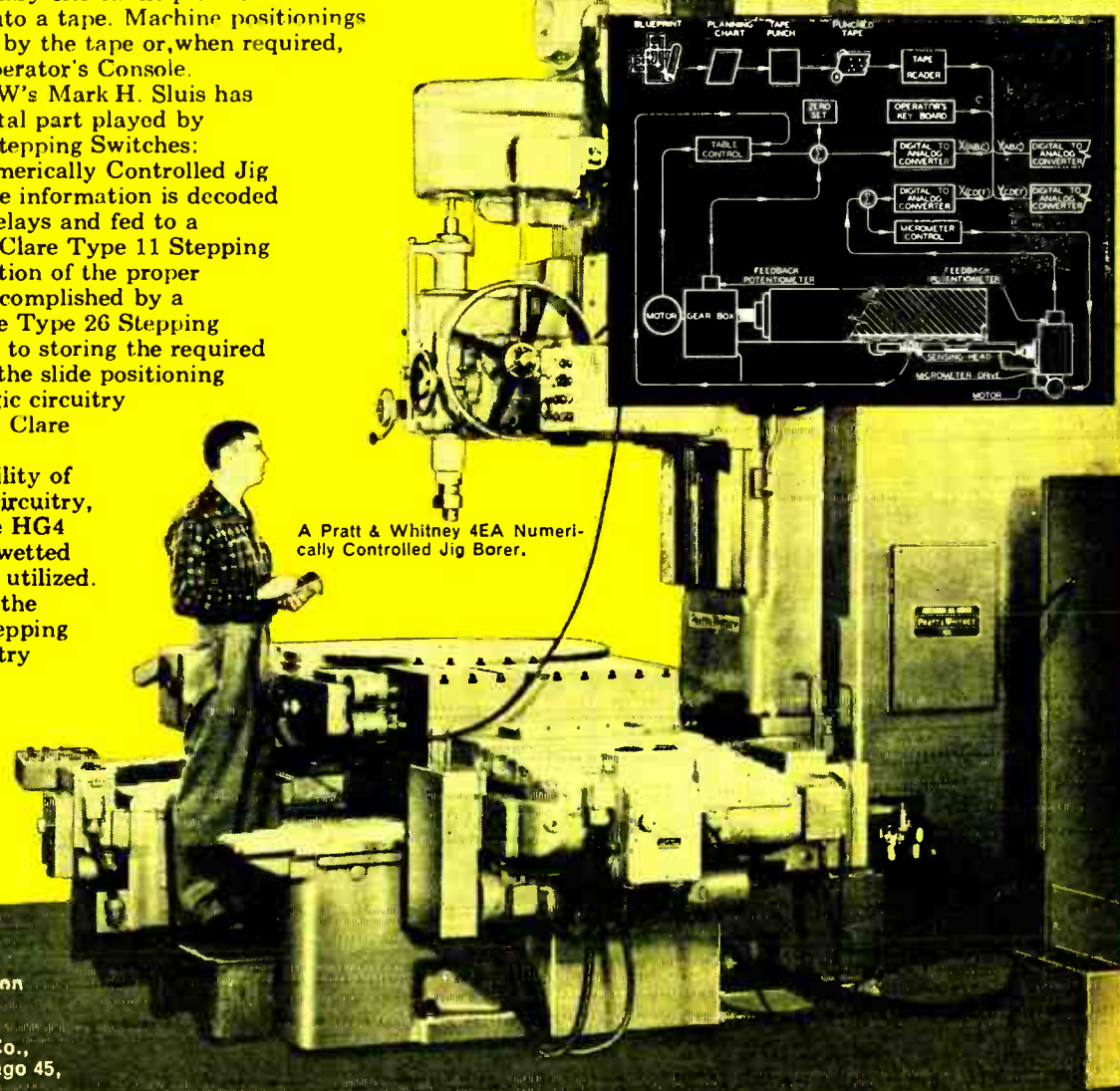
In operation, the Planning Engineer transfers to a Numerical Planning Chart all dimensional data from the blueprints which are necessary to determine the positions. Ordinary clerical help then punch these data into a tape. Machine positionings are then controlled by the tape or, when required, by a dial on the Operator's Console.

Here is what P&W's Mark H. Sluis has to say about the vital part played by Clare Relays and Stepping Switches:

"In the 4EA Numerically Controlled Jig Borer, punched-tape information is decoded by Clare Type J Relays and fed to a storage bank of 25 Clare Type 11 Stepping Switches. The selection of the proper storage switch is accomplished by a distributor—a Clare Type 26 Stepping Switch. In addition to storing the required command data for the slide positioning of this machine, logic circuitry comprises some 115 Clare Type J Relays.

"For ultra-reliability of the digit-selection circuitry, a dozen Clare Type HG4 four-pole Mercury-wetted Contact Relays are utilized.

"Through use of the Clare relays and stepping switches, our circuitry has increased in reliability, and a large contribution was made which enabled us to realize a 6:1 size reduction of the control system."



A Pratt & Whitney 4EA Numerically Controlled Jig Borer.

For complete information on Clare Relays and Stepping Switches contact C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., P.O. Box 134, Downsview, Ontario. Cable Address: CLARELAY

CLARE RELAYS *First in the Industrial Field*

B.F.Goodrich

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B.F.Goodrich ***microwave absorbents***

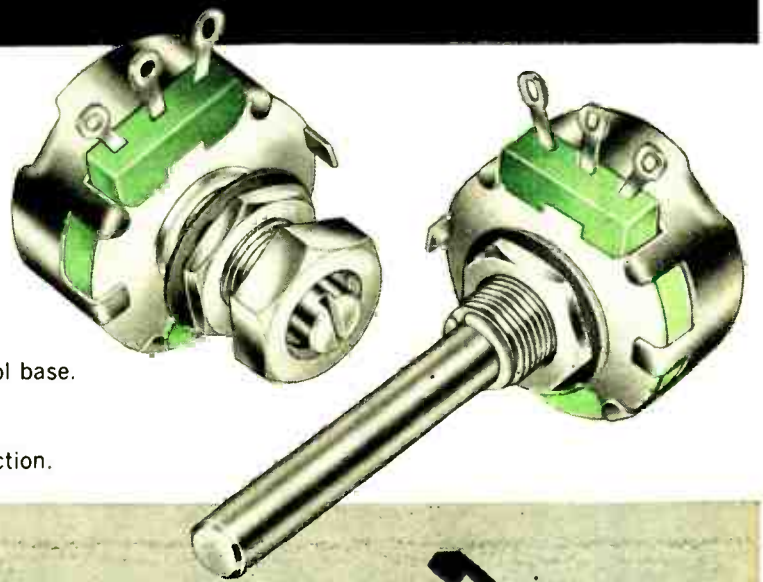
the extraordinary molded carbon potentiometer... CLAROSTAT SERIES 53

Used and proved superior in tens of thousands of installations, the Clarostat Series 53 molded carbon potentiometer is now available in quantity schedules to meet any production requirement.

The extraordinary performance and reliability of the Series 53 result from a Clarostat-conceived design that eliminates all metal-to-metal movable contacts, reducing noise, wear, and backlash.

For any application requiring the inherent superiorities of the molded carbon potentiometer, check the extraordinary features of the Clarostat Series 53 before settling for the ordinary . . .

- Pre-molded and pre-selected resistance element.
- One-piece carbon contact with simultaneous contact on resistance element and collector terminal.
- Zero backlash. Maximum stability.
- Gold-plated terminals for easiest soldering.
- Grease seal around shaft.
- Terminals molded in element and control base.
- Full 2-watt rating at 70°C.
- Available in completely encapsulated units for maximum environmental protection.



SPECIFICATIONS

POWER RATING: 2-watts at 70°C
RESISTANCE RANGE: Linear—50 to 10 meg. Tapered—250 to 5 meg. (Right or left-hand)
INSULATION BREAKDOWN: Between terminals and ground for 1 minute, 1000 v.d.c.
SWITCHES: SPST, SPDT, DPST
TORQUE: 1 to 6 oz. in. Up to 20 oz. in. with jam nut bushing.
EFFECTIVE ROTATION: 312° ± 3°
CONSTRUCTION: Meeting requirements of MIL-R-94 where applicable.

CLAROSTAT MFG. CO., INC.
DOVER, NEW HAMPSHIRE
In Canada:
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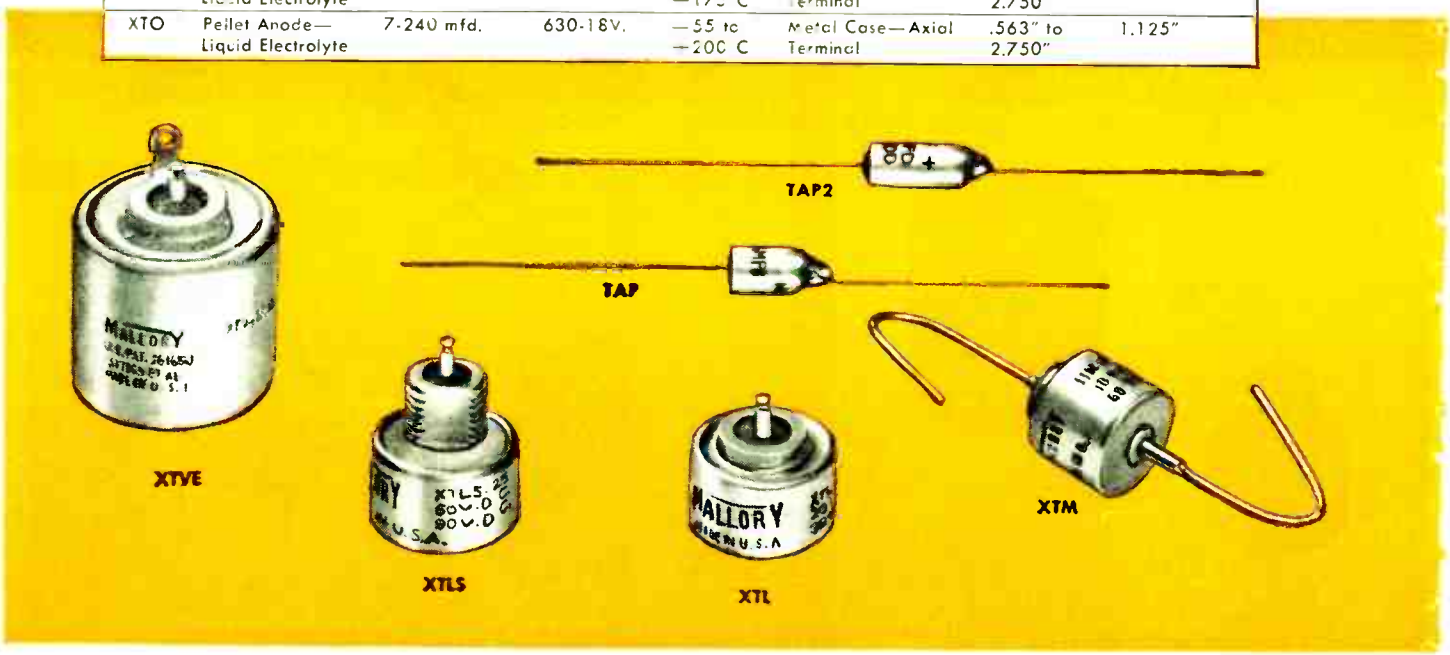
direct line service
IMMEDIATE DELIVERY!
Phone your local Clarostat Industrial Distributor for popular, standard Series 53 or military style RV-4 units...for fast delivery from local stock.

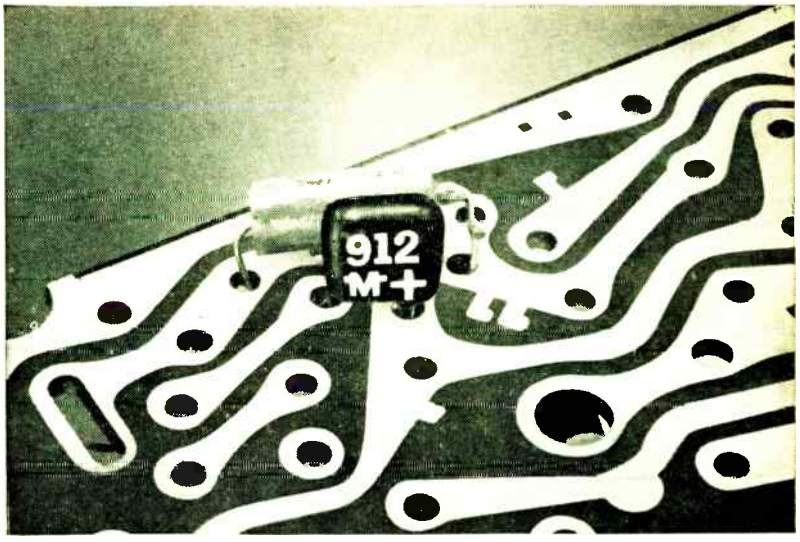
Need Tantalum Capacitors?

Choose From 15 Mallory Broadest Line on the

Type	Description	Capacity Range	W. Volts DC Rating at 85 C	Temperature Range	Case Style	Body Length	Body Diameter
HAT	Pellet Anode—Liquid Electrolyte	1-10 mfd.	16-1V.	—2[illegible] to —85 C	Metal Case—Axial Leads—Insulated Case	.210" max.	.075" max.
TAS	Pellet Anode—Solid Electrolyte	.33-330 mfd.	35-6V.	—8[illegible] to —85 C	Metal Case—Axial Leads	.25[illegible]" to .75[illegible]"	.125" to .341"
TAM	Pellet Anode—Solid Electrolyte	6.8-56 mfd.	25-6V.	—55 to —85 C	Dip Coated Resin—Upright Mounting	.175" thick	.313" square
TAF	Foil Anode—Semi-Liquid Electrolyte	.25-440 mfd.	150-3V.	—55 to —85 C	Metal Case—Axial Leads	.686" to 2.750"	.188" to .375"
STNT	Pellet Anode—Liquid Electrolyte	2-40 mfd.	50-3V.	—55 to —85 C	Metal Case—Axial Leads	.350"	.155"
TNT	Pellet Anode—Liquid Electrolyte	4-80 mfd.	50-3V.	—55 to —85 C	Metal Case—Axial Leads	.500"	.155"
TAP	Pellet Anode—Liquid Electrolyte	2-30 mfd.	90-6V.	—55 to —85 C	Metal Case—Axial Leads	.500"	.238"
TAP2	Pellet Anode—Liquid Electrolyte	11-140 mfd.	90-6V.	—55 to —85 C	Metal Case—Axial Leads	.660"	.238"
M2	Pellet Anode—Liquid Electrolyte	11-140 mfd.	90-6V.	—55 to —15[illegible] C	Metal Case—Axial Leads	.500"	.290" (Body) .484" (Flange)
XTK	Pellet Anode—Liquid Electrolyte	2-70 mfd.	340-8V.	—55 to —175 C	Metal Case—Axial Leads or Terminal	.438" to 1.313"	.650"
XTM	Pellet Anode—Liquid Electrolyte	4-140 mfd.	340-8V.	—55 to —175 C	Metal Case—Axial Leads or Terminal	.563" to 1.781"	.650"
XTL	Pellet Anode—Liquid Electrolyte	3.5-120 mfd.	630-18V.	—55 to —200 C	Metal Case—Axial Terminal	.500" to 2.595"	.875"
XTH	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	—55 to —200 C	Metal Case—Axial Terminal	.688" to 4.063	.875"
XTV	Pellet Anode—Liquid Electrolyte	18-1300 mfd.	630-30V.	—55 to —175 C	Metal Case—Axial Terminal	.563" to 2.750"	1.125"
XTO	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	—55 to —200 C	Metal Case—Axial Terminal	.563" to 2.750"	1.125"



Types... Market



Whenever you need tantalum capacitors for high reliability service in military or commercial electronics, you're sure to find the type you need and the performance you're looking for in the Mallory line.

Leader in tantalum capacitor technology, Mallory has developed models ranging from the micro-miniature Type HAT, scarcely larger than the head of a match, to the high-capacitance Type XTV, which can replace several conventional capacitors.

200°C ratings, pioneered by Mallory and available only from Mallory, can be obtained in several different capacitor designs.

In most of the types shown here, the unique sintered pellet anode construction gives life, stability and electrical properties that are unequaled in the industry. Refinements in hermetic sealing and in design for extreme shock and vibration further expand the utility of the line. Latest additions include a series of new space-saving encapsulated capacitors, and a line of tantalum foil units for applications requiring the special characteristics available from this construction.

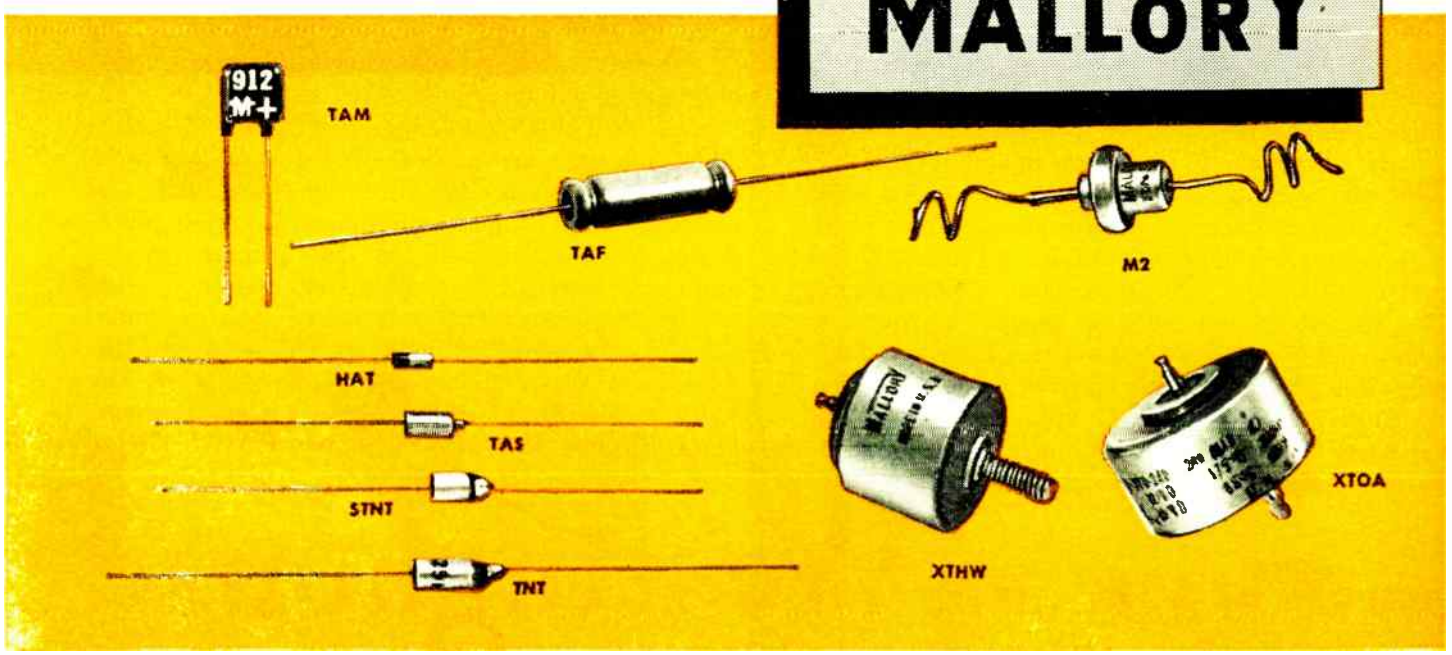
New Encapsulated Tantalum Capacitor Saves Space, Weight, Cost.

Another Mallory first . . . the new type TAM tantalum capacitor . . . is the first solid electrolyte tantalum capacitor without a metal case. Ideal for printed circuits. Takes only ⅓ the space of its metal counterpart, weighs 30% less; cost is substantially lower. Fully insulated. Grid-spaced leads dimensioned to EIA printed circuit standards. Protected against moisture by a specially developed encapsulation material. Size: 3/16" square, .175" thick. Ratings from 56 mfd., 6VDC to 15 mfd., 25VDC.

All models listed here are available for immediate delivery. Write today for technical data, and for experienced consultation on your circuit requirements by a Mallory capacitor specialist.

Mallory Capacitor Company
Indianapolis 6, Indiana
a division of
P.R. MALLORY & CO. Inc.

MALLORY



FOR ELECTRONICS PLANTS...
FOR AIRCRAFT AND MISSILE BASES...

NEW 400-CYCLE BUS DUCT

WITH ONLY 1.28 VOLTAGE DROP PER 100 FT!

High-frequency power distribution runs are, for the first time, really practical and economical. Now, a single, central high-frequency generator can completely power tens of thousands of square feet.

At 400 cycles and up, new Westinghouse high-frequency bus duct will deliver power with a maximum voltage drop of only 1.28 volts each 100 feet under full load of 800 amps. Here is performance that cannot economically be begged, borrowed or coaxed out of cable-conduit or other bus duct. Compare this efficiency with conventional systems in which drops of from 7 to 15 volts can normally be expected. Housing of duct is nonmagnetic aluminum . . . shields test equipment from radio frequencies originating in duct.

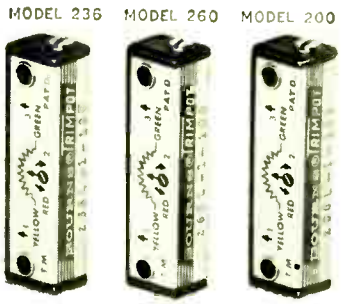
Here is an opportunity, too, to take advantage of all the inherent advantages of bus duct. Power taps every 60 inches over the entire length of duct . . . no splicing. No complex wire mazes. Infinitely more flexible and convenient to use. Duct is more quickly and easily installed than cable and conduit.

High-frequency bus duct is immediately available . . . and only from Westinghouse. Get in touch with your local Westinghouse sales representative. Or write or wire Standard Control Division, Westinghouse Electric Corporation, Beaver, Pa. J-30285

YOU CAN BE SURE...IF IT'S **Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

Trimpot® Trio



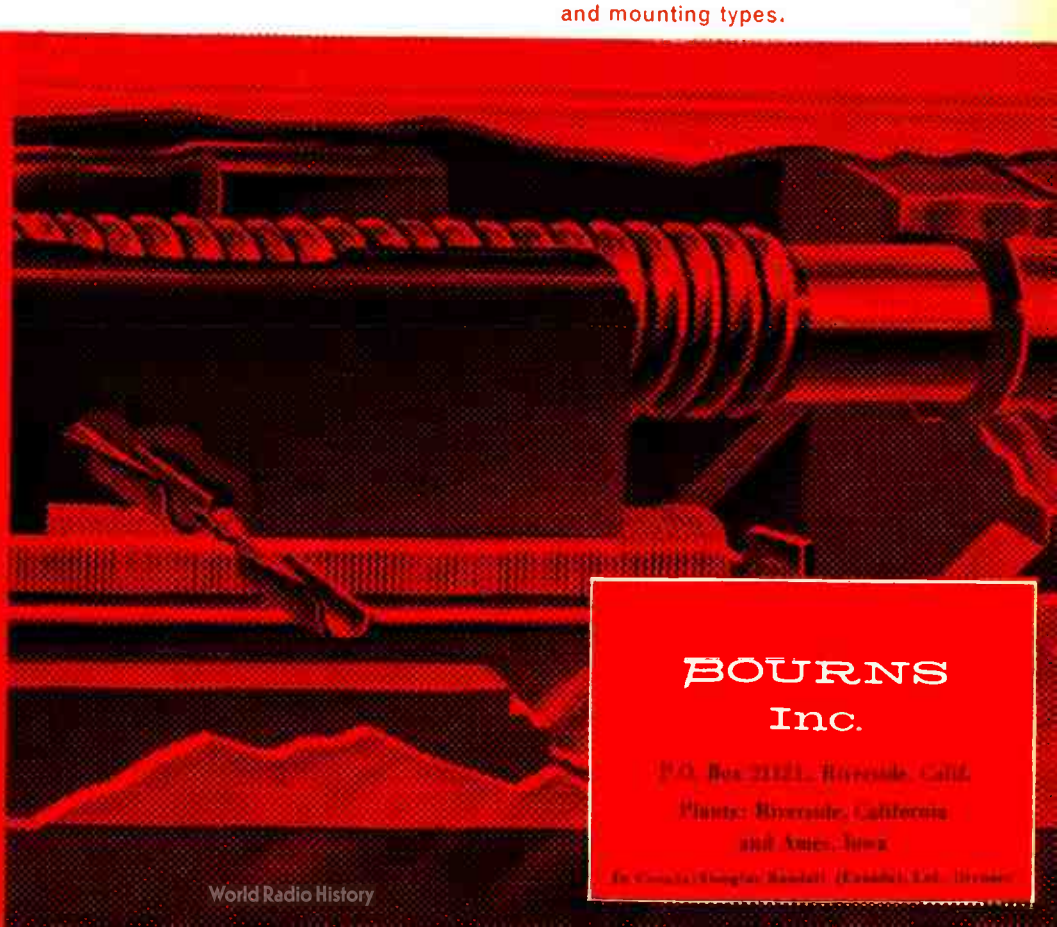
MODEL 236 HUMIDITY-PROOF TRIMPOT
Completely sealed to meet Mil Specs for humidity, sand, dust and salt spray, this proved wirewound potentiometer dissipates 0.8 watt at 70°C., operates reliably at temperatures up to 135°C. Resistances from 10Ω to 100K. Choice of terminals and mounting types.

MODEL 260 HIGH-TEMP, HIGH-POWER TRIMPOT
A favorite Mil Spec wirewound unit for hot spots. Use it where you need dependable, continuous operation from —65° C. to +175 C. Dissipates 1.0 watt at 70 C. Resistances from 10Ω to 100K. Choice of terminals and mounting types.

MODEL 200 GENERAL-PURPOSE TRIMPOT
Up-to-the-minute version of the original wirewound Trimpot—used in more military and commercial programs than any other leadscrew-actuated potentiometer. Maximum operating temperature is 105°C. Dissipates 0.25 watt at 70 C. Resistances from10Ω to 100K. Choice of terminals and mounting types.

The reliability of this well-known Trimpot trio has been proven repeatedly in America's toughest military programs. The Trimpot design has become the standard of the industry since Bourns introduced the leadscrew-actuated potentiometer seven years ago. Screwdriver settings are pinpoint sharp and virtually unaffected by vibration, acceleration and shock. Small size and space-saving shape permit installation of 12 units in one square inch.

For your wirewound or carbon potentiometer applications, Bourns offers you an inventory of 500,000 units—stocked by the factory and franchised electronic distributors across the nation. Besides the Trimpot Trio, there are 20 other basic models—each available in a variety of terminal and mounting types. *Terminals:* insulated stranded leads, solder lugs, printed circuit pins and bare wires. *Mounting types:* Panel, chassis and printed circuit. Write for new summary brochure no. 4.



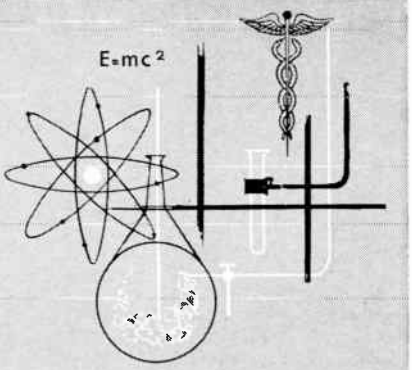
BOURNS Inc.

P.O. Box 2112[illegible], Riverside, Calif.
Plants: Riverside, California
and Ames, Iowa

140 KMC

ULTRAMICROWAVE* EQUIPMENT BY

–it works–it's accurate–it's available

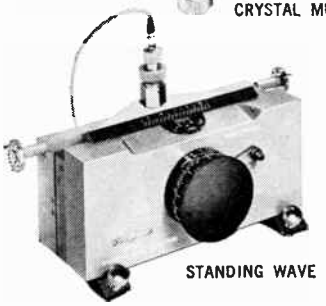


These millimeter wave units can greatly enlarge your scope of microwave activity. Research previously considered impractical at 140 KMC can now be carried on successfully.

De Mornay-Bonardi manufactures cavity wavemeters, crystal multipliers, crystal mounts, E-H tuners, and standing wave detectors specifically for use at 140 KMC. They work—we've been using these units effectively in our own laboratories for developing other items. These instruments are accurate—functionally as accurate as De Mornay-Bonardi equipment used at 90 KMC. You can order these units now—we're currently filling orders on 140 KMC instruments.

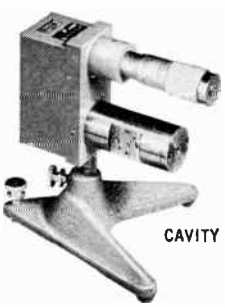
Write for complete data


CRYSTAL MULTIPLIERS


STANDING WAVE DETECTORS


CRYSTAL MOUNTS


E-H TUNERS


CAVITY WAVEMETERS

DE MORNAY-BONARDI®

DE MORNAY-BONARDI

780 SOUTH ARROYO PARKWAY • PASADENA, CALIF.

*TRADE MARK DE MORNAY-BONARDI

NEW

Low Cost Transistorized DC Power Supply (width: 8", height: 4½", depth: 14")

NJE answers the engineers' quest for a low cost transistorized power supply that is fully capable of remote sensing and remote programming—a power supply impervious to overloads or short circuits.

These compact, flexible NJE power supplies are designed in a new "half rack" modular concept suitable for laboratory bench use or in rack installations* as a component part of your equipment. They are also capable of series or parallel operation.

Component derating and construction conform to the highest commercial practices.

Check these specs!	MODEL TR-18-2	MODEL TR-36-1
Voltage Range	0-18 VDC	0-36 VDC
Current Range	0-2 amps	0-1 amp
Load Regulation (0-100%)	±0.05% or ±2 mv	±0.05% or ±2 mv
Line Regulation (±10%)	±0.1% or ±3 mv	±0.1% or ±3 mv
RMS Ripple	1 millivolt	1 millivolt
Internal Impedance (DC-20KC)	0.1 ohm max.	0.2 ohm max.

WRITE TODAY FOR COMPLETE TECHNICAL DATA

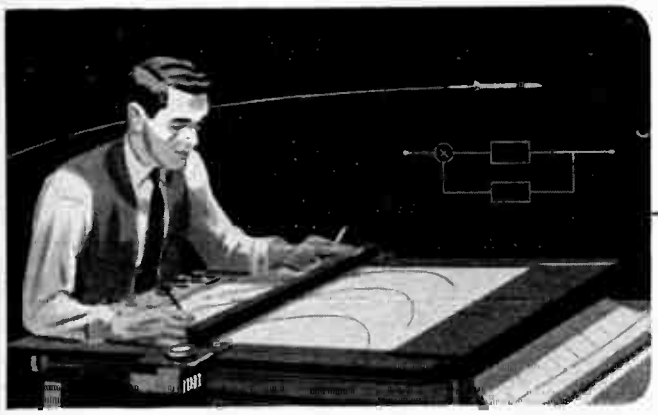
Models in stock subject to prior sale • **$250** each net; quantity discounts available • *Suitable front panels for rack mountings are available on order (single supply panel, Model RP1 $15 each net; dual supply panel, Model RP2 $15 each net)

NJE CORPORATION

20 Boright Avenue · Kenilworth, New Jersey

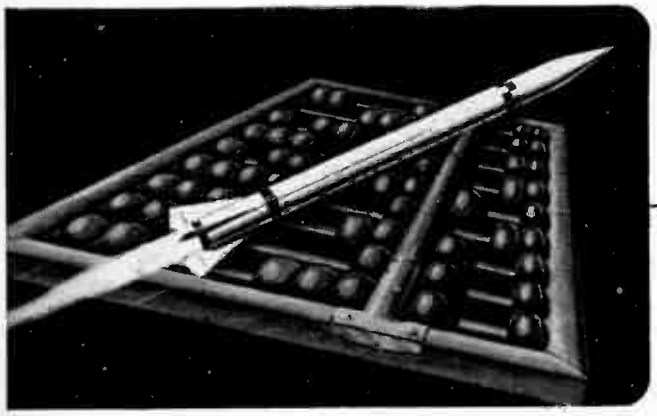
BR. 2-6000 · TWX Cranford, NJ 51 · FAX-FFP

Pioneering Achievements in Electronics at JPL

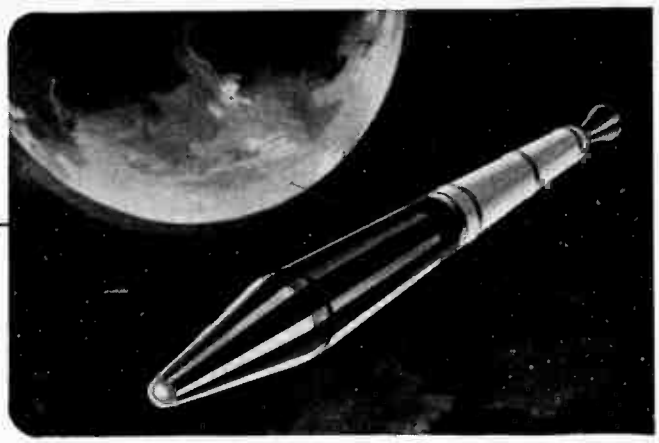


GUIDANCE RESEARCH . . . by JPL has led and advanced the field of missile guidance. Among these achievements are the application of Wiener RMS methods to multiple-input, multiple-loop servos, and matching missile trajectory to missile control transfer function for optimum accuracy.

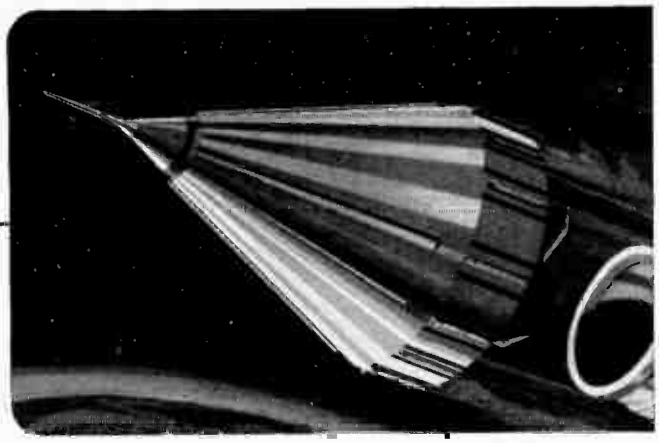
GUIDANCE SYSTEMS . . . both inertial and radio-command types employing new concepts of radar communication have been pioneered at JPL. This guidance system development activity is supported by basic research in all phases of electronics.



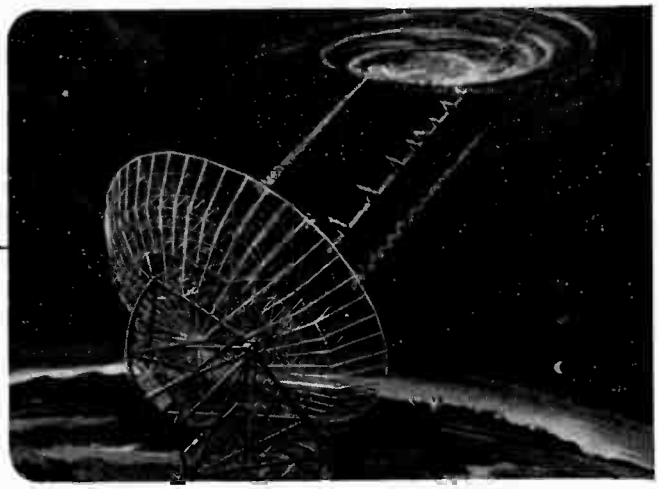
COMPUTERS . . . and the application of computing techniques to missile guidance systems have been pioneered by JPL. The Laboratory is now searching for new techniques that will further advance the state of the art in digital guidance components and computer systems.



DATA TRANSMISSION . . . brings news from space via the Explorer series. Explorer III used a tape recorder the size of a cigarette pack capable of transmitting two hours of information in 5 seconds. Electronic payload weight was approximately 11 lbs.



INSTRUMENTATION . . . of the moon probe provided measurement of radiation environment at distances far from the earth. Telemetered data revealed the existence of high intensity radiation. Miniaturization resulted in an instrument payload weighing only 10 lbs.



COMMUNICATIONS . . . pioneering in interplanetary communications resulted in this giant parabolic radio antenna, 85 feet in diameter, developed by the Laboratory which enables the tracking and reception of scientific data from great distances.

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY

JET PROPULSION LABORATORY

A Research Facility operated for the National Aeronautics and Space Administration

PASADENA, CALIFORNIA

Employment opportunities for Engineers and Scientists interested in basic and applied research in these fields:

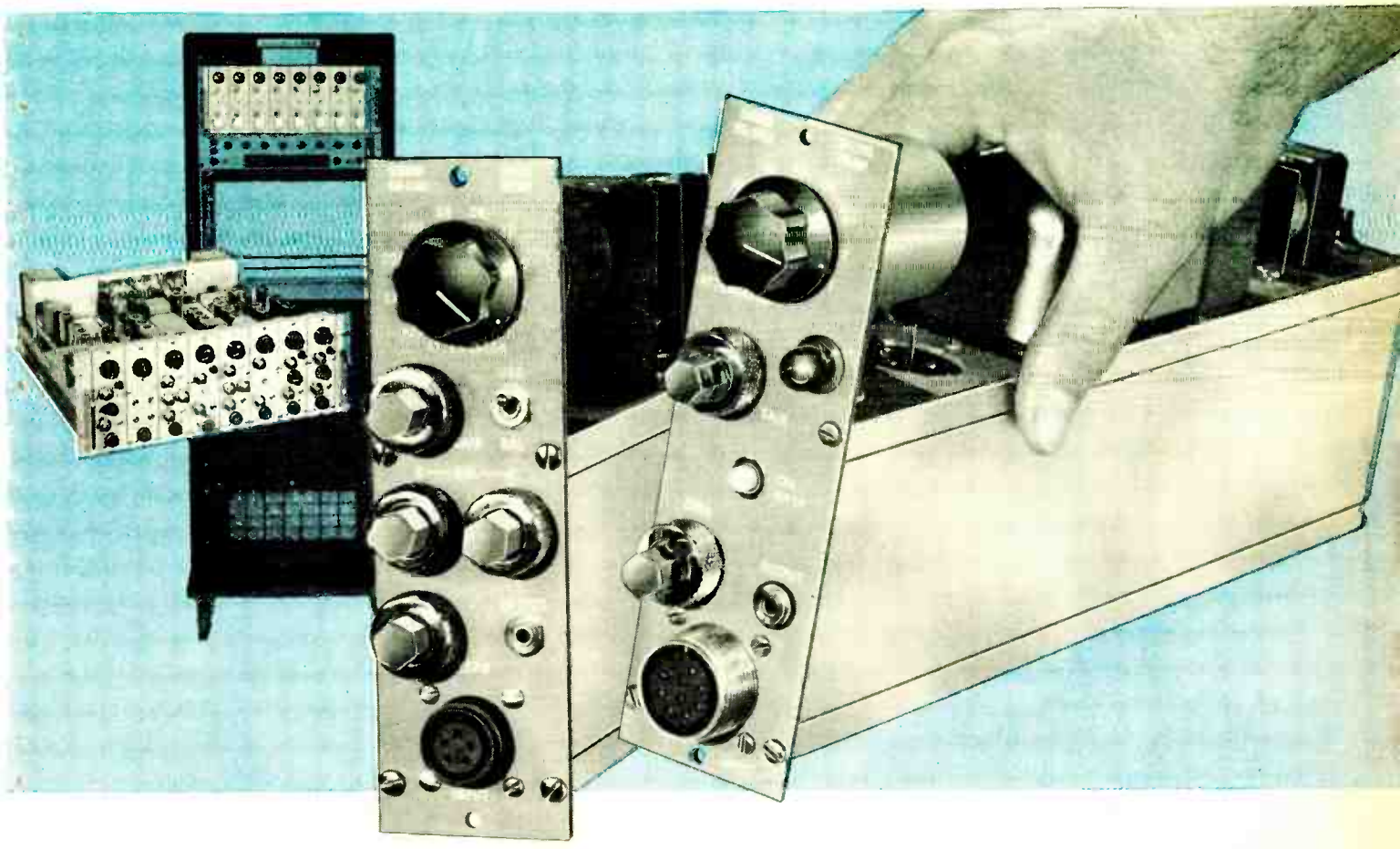
INFRA-RED, OPTICS, MICROWAVE, SERVOMECHANISMS, COMPUTERS, LIQUID AND SOLID PROPULSION, STRUCTURES, CHEMISTRY, INSTRUMENTATION, MATHEMATICS, AND SOLID STATE PHYSICS

Send professional resume, with full qualifications and experience, for our immediate consideration

NEW

CARRIER AND LOW LEVEL PREAMPS OFFER MORE RECORDING USEFULNESS

—per inch
—per dollar
—per channel



With the availability of these two new plug-in preamplifiers and associated MOPA, Sanborn 6- and 8-channel "850" oscillographic recording systems can now record an even *wider* variety of inputs — wherever *many channels* are needed in *minimum panel space*, with *no* sacrifice in system accuracy or reliability. The 850-1100A is a carrier amplifier-demodulator unit designed to work with resistance bridge, variable reluctance and differential transformer transducers. Attenuator, smooth gain, position and balancing controls are on the 2" x 7" front panel; input and output connections are provided at both front and rear. The 850-1500A is a chopper amplifier with floating input isolated from a floating output, capable of measuring low level DC-100 cps signals such as those from thermocouples and strain gage bridges. Design provides low noise operation, greater freedom from ground loop interference and high common mode rejection ratio. Required carrier excitation (2400 cps standard, 600, 1200 and 4800 cps optional) and chopper drive (440 cps) voltages are supplied by the 850-1900 MOPA, a dual-oscillator unit which can handle up to eight of each preamplifier.

SPECIFICATIONS

	850-1100A	850-1500A
Sensitivity	100 μv in gives 1 v at output	
Input impedance	approx. 2500 ohms	approx. 100,000 ohms
Output	±2.5v across 3300 ohms	±2.5 volts across 2500 ohms
Freq. response	−3 db at 20% of carrier freq.	0–100 cps, −3db
Linearity	±0.5% of full scale	±0.1% of full scale
Common mode performance		120 db for 60 cps, 160 db for DC with 5000 ohms unbalance in input
Noise		2 μv p-p over 100 cps bandwidth

(data subject to change without notice)

Ask your Sanborn Sales-Engineering representative for complete facts on all "850" system units — or write the main office in Waltham.

SANBORN COMPANY
Industrial Division
175 Wyman St., Waltham 54, Mass.

Proceed- OPERATION EXPANSION

September 1, 1959 — Raytheon Government Equipment Division today announced a major expansion into five operating subdivisions: Submarine Signal, Airborne Electronic, Systems Management, Heavy Electronic, and Santa Barbara.

Made necessary by expanding product activity, the decentralization has created managerial and technical staff positions in all areas.

Engineers and scientists of established technical competence are invited to investigate the several opportunities present in the area encompassing their particular interest.

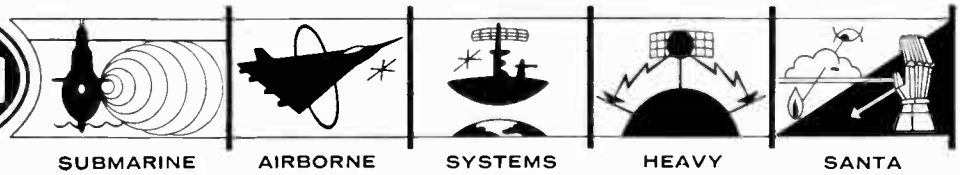
Inquiries should be forwarded to Mr. Donald Sweet, Engineering and Executive Placement, Government Equipment Division, Raytheon Company, 624F Worcester Road, Framingham, Mass.

H. R. OLDFIELD, JR.
Vice President & General Manager
Government Equipment Division

GOVERNMENT EQUIPMENT DIVISION

RAYTHEON

EXCELLENCE IN ELECTRONICS



SUBMARINE SIGNAL | AIRBORNE ELECTRONIC | SYSTEMS MANAGEMENT | HEAVY ELECTRONIC | SANTA BARBARA

SUBMARINE SIGNAL

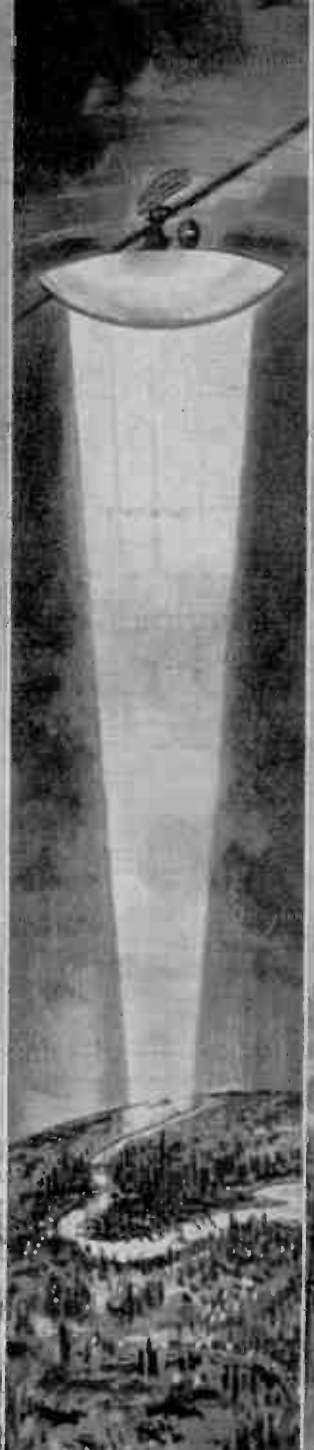
Newport, Rhode Island
W. Rogers Hamel,
General Manager

Engineering, Marketing, and Production of comprehensive anti-submarine warfare systems. Major products: underwater detection, navigation, communications and fire control equipment.

AIRBORNE ELECTRONIC EQUIPMENT

Maynard, Sudbury, Waltham, Massachusetts
Glenn R. Lord,
General Manager

Engineering, Marketing, and Production of advanced aerospace systems. Major products: navigation, search, and fire control apparatus for manned aircraft, unmanned aircraft, and space vehicles.



SYSTEMS MANAGEMENT

West Newton, Massachusetts
Harold M. Hart,
General Manager

Engineering, Marketing, and Management of major electronic system programs. Activities include systems synthesis, learning machines, weapons studies, microwave supported platform.

HEAVY ELECTRONIC EQUIPMENT

Wayland, North Dighton, Massachusetts
Fritz A. Gross,
General Manager

Engineering, Marketing, and Production of long range surface radars, ordnance and communications sytems. Products encompass 800-ton ground warning systems, missile fire control radars, 96-voice channel pulse code modulation equipment.

SANTA BARBARA

Santa Barbara, Californ
Gordon S. Humphrey,
General Manager

Engineering, Marketi and Production of inf red and countermeasu devices. Projects invo active and passive EC equipment for aircra missiles, and satellit infrared guidance, m ping, and fire cont components.

Why you can always depend on Asarco high purity elements

ASARCO examines every lot of material chemical, spectrographic, and other strumental techniques and reports all tectable impurities. This assures you of a iform quality of material from a pendable source of supply.

ASARCO supplies for you with each rchase an actual analysis of impurity ements detectable and the probable level which these impurities are present.

ASARCO has been a pioneer in the oduction of high purity elements for over years. ASARCO high purity elements ve been used for research in this country d abroad for fundamental studies in tal-physics and semi-conductor technology. e High Purity Metals Staff is always ailable to discuss your individual problems.

ASARCO

e above information is among the pertinent ta compiled by ASARCO's Central Research boratories in a catalogue, now available to users of gh purity elements. For copy, write on your terhead to American Smelting and Refining Company, 0 Broadway, New York 5, N. Y.

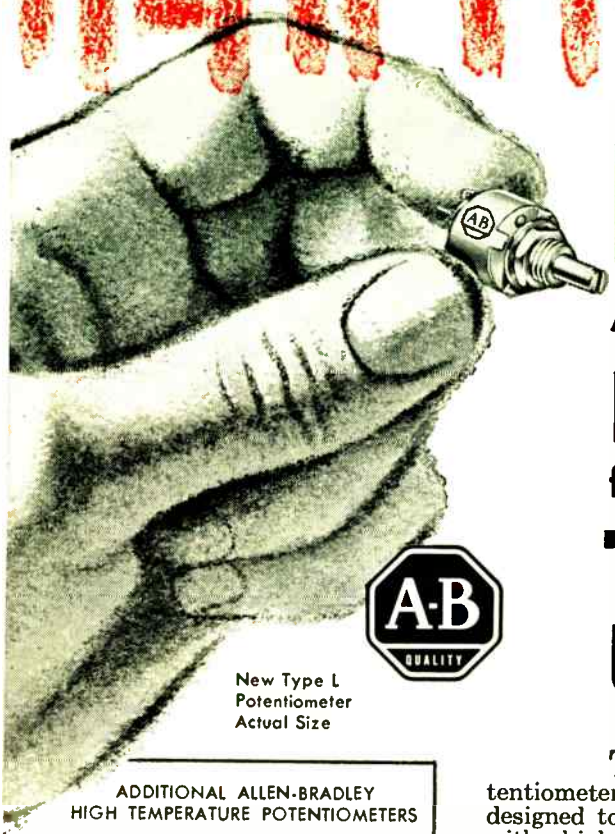
(If you use high purity elements, save this page as a current buying guide)

ASARCO HIGH PURITY ELEMENTS... ANALYSIS as of August 1, 1959

Impurities, sometimes found, at maximum levels, ppm (*less than ppm indicated)

ASARCO High Purity Element	Bi	Cu	Fe	As	Sb	Pb	Ag	Tl	Sn	Te	Au	Na	Cl	Cd
ANTIMONY	1	2	1	15										
ARSENIC		1*	1*											
ARSENIC TRIOXIDE		1*			1*									
BISMUTH		2	1			1	2						1*	
CADMIUM		1*				20								
COPPER														
INDIUM		1*				1		1*	1					
LEAD	1*	1*	1*				1*							
SELENIUM		1*		1*						1			1*	
SILVER		1*	1*			1*					1			
SULFUR												1	1	
TELLURIUM		1*	1*											
THALLIUM	1	3	1			1			1			2	1*	
ZINC		1*	1*			1*								1*

HEAT PROBLEMS?



New Type L Potentiometer Actual Size

NEW

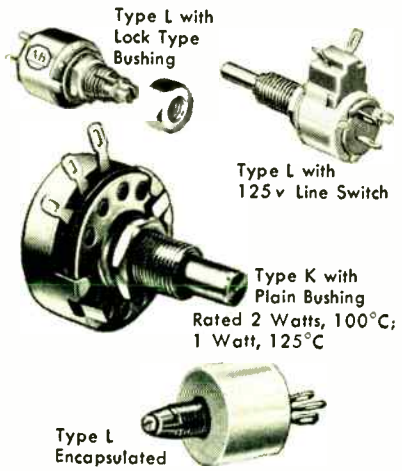
Allen-Bradley

POTENTIOMETERS

for use in

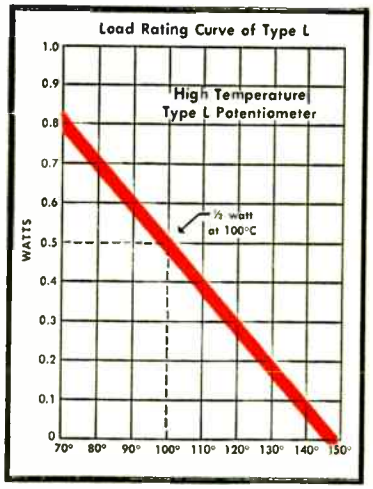
TEMPERATURES UP TO 150°C!

ADDITIONAL ALLEN-BRADLEY HIGH TEMPERATURE POTENTIOMETERS



This new Allen-Bradley potentiometer—the Type L—is especially designed to solve problems associated with high ambient temperatures—*and* space conservation. Although extremely compact—0.5 inch in diameter—the Type L control has a conservative rating of 0.5 watt when operating in an ambient temperature of 100°C. And, it provides reliable performance when operated at a temperature of 150°C—under "no load" conditions. (See graph at right.)

The new Type L control features the same solid, *hot molded* resistance element that has proved unequaled for long life, smooth operation, and low "noise" characteristic in Allen-Bradley's popular Type J, Type K, and Type G potentiometers. When temperature and space problems in your designs plague you, this new A-B "high temperature" potentiometer is a reliable answer. Please send for complete information, today.



Load Capabilities of Type L below the Critical Resistance Value. Type L Far Exceeds the Requirements of MIL-R-94B.

ALLEN-BRADLEY

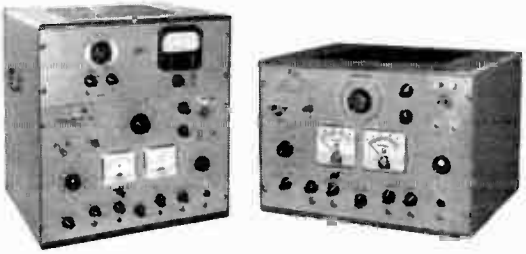
Quality Electronic Components

Allen-Bradley Co., 114 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradly Canada Ltd., Galt, Ont.

←CIRCLE NO. 82 READER SERVICE CARD

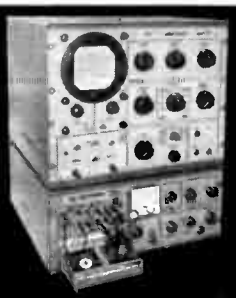
CIRCLE NO. 83 READER SERVICE CARD

COMPLETE LINE OF TRANSISTOR TEST EQUIPMENT



General Purpose Transistor Test Set, KP-2 Series

• Research and quality control with maximum reliability • Direct Precision Measurements • Up to 2 amps 200v. Based on h parameters using basic straight forward circuitry. Features common bases or emitter, direct measurement of h parameters plus α and β cutoff, Meter indication of DC parameters — I_{co}, I_{eo}, V_{cer}, V_{ebf}.



Curve Tracer, Model MW-1

• Newest, most Versatile on market Features Highest maximums in broad ranges (up to 30 amperes and 300 volts — 450 watts maximum). Lowest impedance. Positive overload protection. Unique tube adapter allows vacuum tube measurements by external provision of screen and filament supplies.

Transistor Test Set, Model GP4

• Standard of the Industry for low power transistors. Measures h parameters and equivalent T coefficients NPN and PNP junction and surface-barrier transistors, common base or emitter circuits α and β cutoff, and I_{co} and C_c. Measurement frequency from 100 cps to 1 mc.

Beta Tester, Model KT-1

• Lightweight • Portable • Easy to use. Measures Betas h_{ie} and I_{co}. This completely self-contained unit features a transistorized 1 kc oscillator and batteries, printed-circuit construction and meter overload protection.

Minority Carrier Lifetime Test Set, Model JJ

**Basic Tool for the Industry . . . Provides a reproducible measure of minority carrier lifetime of both germanium and silicon. Evaluates performance characteristics.

Semiconductor Resistivity Test Set

• Precise. • Easy to operate . . . Features exclusive FOUR-POINT-PROBE. Reliable applications for both production quality control and R&D. Measurement accuracy ±5%.

Component Selector Model NA-1

Designed primarily for incoming inspection or quality control testing a large number of 2 or 3-terminal components. • Capacity, 50 at one time. • Manual or foot switch operation. • Safety switching. • Manual reset.

Write today for further technical information on B/A test instruments to:

Baird-Atomic, Inc.

33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

Baird® Atomic

STACKPOLE

Coldite 70+®

fixed composition RESISTORS

Today's slickest looking resistors . . . and every bit as good as they look! Unmatched for load life and moisture resistance. They're approved resistors—direct from a MIL-R-11 approved manufacturer. And now, for the first time, you can get such resistors in a full line of RC-42 (2-watt); RC-32 (1-watt) and RC-20 (½-watt) types IMMEDIATELY from distributors' stocks at rock-bottom prices!

Now! PICK 'EM OFF DISTRIBUTORS' SHELVES!

. . . for military prototypes, small runs, production emergencies or "hurry-up" projects

. . . in any standard value or tolerance

. . . at lowest prices in lots up to 1,000 resistors of a value

Complete stocks — and we mean *complete*—in the hands of the 28 selected Stackpole distributors listed below help you handle every job with highest quality resistors, fully proved and accepted for critical applications. Equally important, you actually get them at less than factory prices in lots up to 1,000 of a value!

These selected STACKPOLE distributors have them!

BALTIMORE, MD.
Kann-Ellert Electronics, Inc.

BATTLE CREEK, MICH.
Electronic Supply Corp.

BIRMINGHAM, ALA.
MC Electrical Supply Co.

BOSTON, MASS.
Sager Electrical Supply

BROOKLYN, N. Y.
Electronic Equipment Corp.

CLEVELAND, OHIO
Pioneer Electronic Supply Co.

DALLAS, TEXAS
Wholesale Electronics Supply Co.

DAYTON, OHIO
Srepco, Inc.

DENVER, COLO.
Denver Electronics Supply Co.

GLENDALE, CALIF.
R. V. Weatherford Company

INDIANAPOLIS, INDIANA
Radio Distg. Co.

KANSAS CITY, MO.
Burstein-Applebee Co.

MELBOURNE, FLORIDA
Electronic Supply

MIAMI, FLORIDA
Electronic Supply

NEW YORK, N. Y.
Harvey Radio Co.

PHILADELPHIA, PA.
Almo Radio Co.

SAN DIEGO, CALIF.
Radio Parts Co.

SCRANTON, PA.
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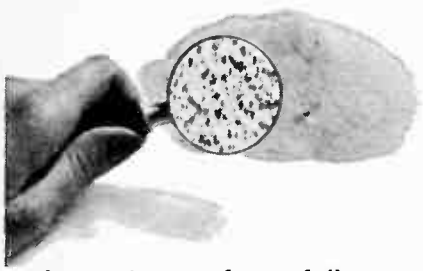

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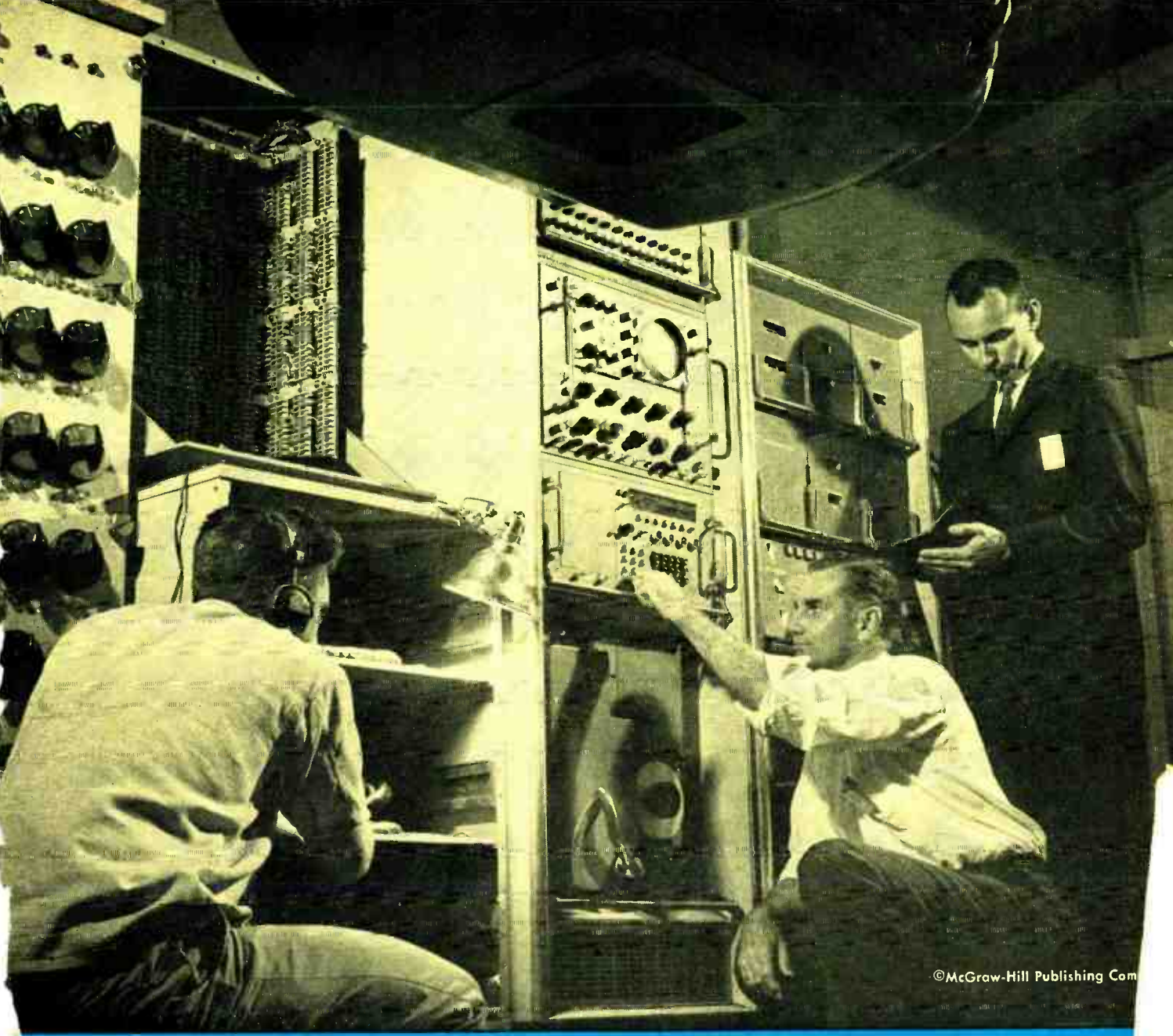


Engineers in simulated Polaris test installation at Sperry's Marine Division check out inertial guidance system made by North American Aviation's Autonetics Division

INSTRUMENTS
for Design and Production

By **WILLIAM E. BUSHOR**, Associate Editor, ELECTRONICS

VOLTAGE, CURRENT AND POWER MEASUREMENT
IMPEDANCE MEASUREMENT FREQUENCY MEASUREMENT WAVEFORM MEASUREMENT TUBE AND SEMICONDUCTOR TESTING AUTOMATIC TESTING

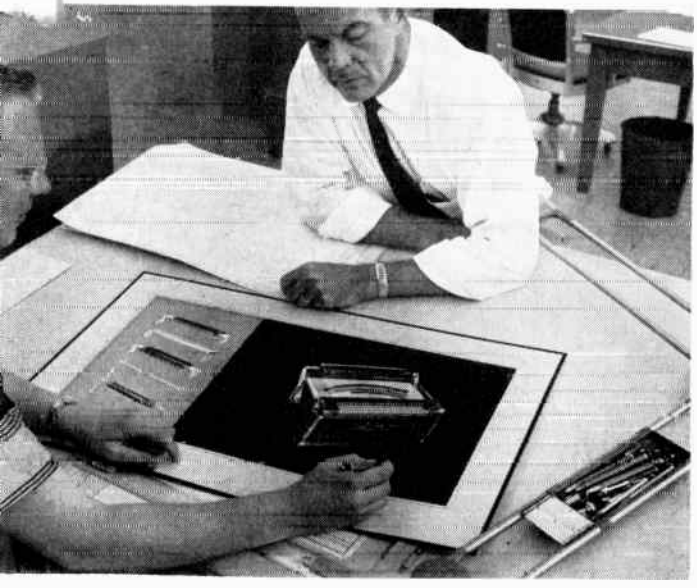
exact information is the greatest aid to sound decision.....

TECHNICAL PROGRESS IN THE ELECTRONICS INDUSTRY depends to a large extent on the ability of the engineer to measure basic electrical parameters. Instruments capable of translating these invisible phenomena into quantities the physical senses can perceive are his tools.

ACCURACY—Demands of military and space programs have pushed the state of the electronics art to the point where even the Bureau of Standards routine accuracies of primary standards are inadequate in some measurement areas and nonexistent in others. Since design and production instruments are calibrated from secondary standards, they are necessarily an order of magnitude or more less accurate than the primary standard.

RANGE—Increasing need for measuring across wider ranges of parameters is bringing about a change in instrument design philosophy. Instead of using many instruments each of which covers a portion of the desired range, future instruments will cover a major portion of the useful range.

TRANSISTORIZATION—Transistors take up little space and generate little heat. This heat-reducing property is also possessed by cold-cathode vacuum tubes which are becoming more widely used in instruments. In terms of future design trends, it is anticipated that an increasing number of transistorized circuits will be utilized where economics permit and where instrument performance is comparable to that of electron-tube counterparts.



Packaging and human engineering are important aspects of Hewlett-Packard's design effort

DATA DISPLAY—Increasing use of test instruments by relatively unskilled operators means that test data must be presented simply and clearly. Use of digital presentation not only reduces reading time but also minimizes the chance of error.

AUTOMATIC OPERATION—The constant drive to reduce operating time and chance of human error indicates that many future instruments will be automatic or semiautomatic. Some manufacturers report that customers often require automatic testers since nontechnical operators are to use the equipment.

PACKAGING—Most manufacturers consider packaging an essential point in good instrument marketing, thus much design effort is channeled in this direction. Human-engineered controls and intelligently arranged scales are appearing on modern instruments instead of indiscriminately distributed switches and knobs, and hard-to-read scales.

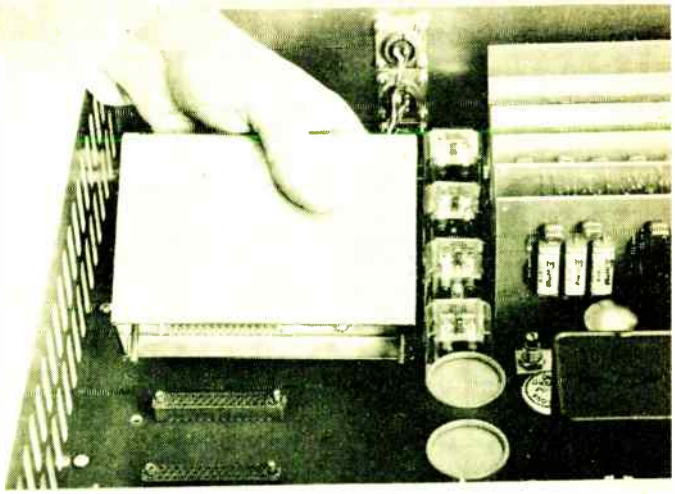
MODULAR CONCEPT—Use of plug-in units and other interchangeable parts to increase an instrument's versatility is developing rapidly. This design trend is particularly important since many operators are neither engineers nor highly skilled electronic technicians. Modular construction permits servicing of instruments by replacing individual modules.

MINIATURIZATION—There is a continuing trend toward obtaining more instrument function per unit volume. Since instruments are required to perform an increasing number of functions, control-panel space is becoming precious. Operators of test equipment want the control knobs and buttons close together and handy to use, thereby reducing unnecessary and time-consuming motion. Miniaturization is particularly important where instruments are to be incorporated in panels of larger equipment.

SELF-CONTAINED CONCEPT—Many manufacturers are concentrating on the development and production of instruments requiring no external power or auxiliary equipment. Instruments capable of both bench and portable operation are becoming more common. Instrument makers report users are asking for bench instrument capabilities in portable equipment.

Test instruments are defined in the following pages to be those used to scale, record or measure one or more electrical parameters of a signal. Sources and modifiers used with these instruments are outside the scope of this report.

Digital techniques promise great accuracies for routine voltage measurements, also better readability. Present accuracy requirements for r-f power measurement often exceed capabilities of available instruments. Direct-reading noise-figure meters are in demand



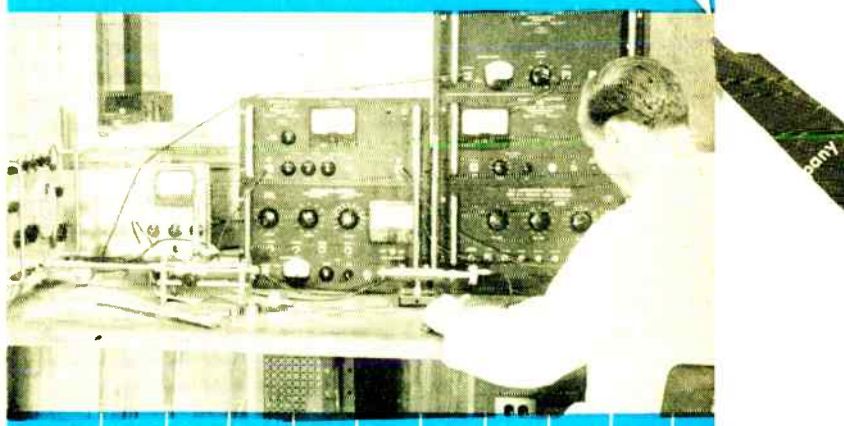
Plug-in stepping switches used in Non-Linear Systems' digital voltmeter are oil-bathed to increase life and eliminate periodic lubrication

Voltage, Current and Power Measurement

ALTHOUGH INSTRUMENTS for measuring electrical voltage, current and power have been with us for many years, there is a virtual revolution going on in meter design and packaging. Overall trend toward miniaturization, portability and high accuracy compatible with simplicity of operation is evident. Ruggedness, compactness and adaptability to bench and panel use are important design considerations.

VOLTAGE MEASUREMENT—Manufacturers feel there could be a real breakthrough in meter accuracy limitations if more convenient production standards were available. One company reports that production of meters with ¼-percent accuracy over temperature range of —55 to +71 C requires production standards of 0.02-percent accuracy or better. Some standards laboratories claim they can do better than 0.02 percent but will not certify any better. Thus 0.02-percent accuracy is the limit that can be achieved in practice using presently available standards. See Tables I and II.

In general, trends in voltmeter design are toward greater sensitivity, higher stability, faster response time and simplified field maintenance.



Development of broadband attenuators at Weinschel Engineering, using combination dual and single-channel audio-substitution-type insertion-loss set, is shown above plot

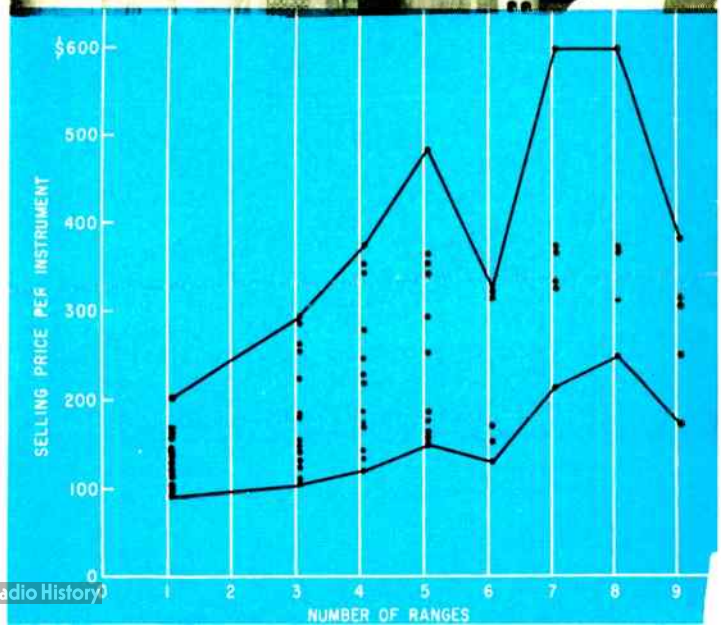


FIG. 1—Selling price goes up as number of ranges available on typical nonelectronic voltmeters with 0.5-percent accuracy is increased

Engineer makes adjustments necessary to optimize noise figure within a system using Hewlett-Packard's noise-figure meter

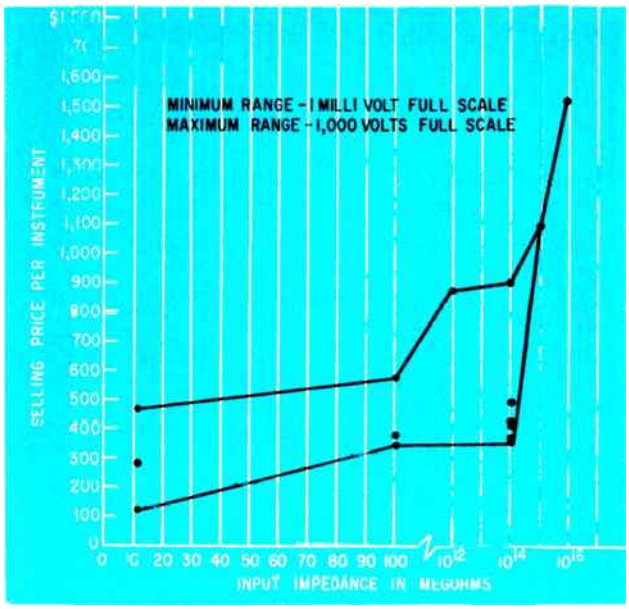


FIG. 2—Selling price as a function of input impedance for vtvm's with one to three-percent accuracy

ANALOG VOLTMETERS—For some applications, it is felt that reading accuracy of analog voltmeters can be enhanced by using a suspension movement carrying a mirror which reflects a beam of light on the scale. Since this technique eliminates the conventional pointer, it is particularly useful in measuring minute voltages.

Other significant advances are the development of taut-band suspension and expanded-scale techniques.

There is a need for instruments with wide voltage ranges, for example 100 microvolts to 10,000 volts; however, the upper and lower extremes are not universally useful. Selling price as a function of number of ranges for nonelectronic voltmeters is shown in Fig. 1.

There has been a continuous demand for higher and higher input impedances in vacuum-tube voltmeters. Often these instruments are selected largely because of their input impedance characteristic. Sell-

Measurement Accuracies

A survey completed early this year determined the measurement accuracies desired by manufacturers in various categories and compared them with the best routine accuracies of the National Bureau of Standards. NBS' best routine accuracy is used because the best obtainable accuracy is often difficult to determine and usually depends on amount of time, effort and money available. (Detailed tabulations of the survey results bearing on electrical measurement are given in appropriate sections of this report.)

The survey was undertaken by the Quality Control Committee of the Aerospace Industries Association at the suggestion of the Air Materiel Command, and was sponsored by Sperry Gyroscope Company. A general summary of results was given earlier (ELECTRONICS, p 16, Aug. 21, 1959)

Table I—Desired Accuracies in D-C Measurements

Category	Are Existing Accuracies Sufficient? (No. of Firms that Replied)		Desired Accuracy		Nat'l Bureau of Stds	
	Yes	No	%	No. of Firms	Range	Routine Accuracy %
CURRENT						
1 μamp to 1 amp	41	2	0.001 0.01	1 1	1 μamp to 1 amp	0.05
1 amp to 100 amp	38	5	0.001 0.01	2 3	1 amp to 100 amp	0.05
VOLTAGE						
Saturated Standard Cells	13	1	10^{-6} 10^{-5} 0.0004 ±1 μv	1 1 1 1	.....	0.0002
Unsaturated Standard Cells	27	6	0.00004 0.005 0.002 0.001 0.1	1 1 2 1 1	.....	0.01
Potentiometers	29	5	0.005 0.002 0.001 0.01 0.1	1 1 1 1 1	.....	0.01
Digital Voltmeters	26	10	10^{-5} 0.005 0.05 0.01	2 1 6 1	.....	0.05
Ratio—Standard Voltage Dividers	32	11	10^{-6} 10^{-5} 0.05 0.01 0.001	2 2 3 3 1	1.5 to 1,500 v	0.01

Table II—Desired Accuracies in A-C Measurements

Category	Are Existing Accuracies Sufficient? (No. of Firms that Replied)		Desired Accuracy		National Bureau of Standards		
					Range		Routine Accuracy %
	Yes	No	%	No. of Firms	Freq	Magnitude	
CURRENT							
15 ma to 20 amp	22	4	1 0.25 0.01	1 1 2	60 cps to 30 kc	15 ma to 20 amp	0.05
Ratio of Current Transformers	19	3	0.04 0.05	1 2	60 cps	0.25 to to 4,000 amp	0.1% ratio 3' phase angle
VOLTAGE							
1 to 300 v 20 cps to 10 kc	39	16	0.1 0.01 0.02 0.05 0.001	2 4 3 4 3	.....	0.01 to 1,000 v	0.05
Other Voltage and Frequency Ranges	28	7	0.01 0.05 0.1	1 3 3	30 kc	600 v	0.05
Standard Ratio Transformers	27	2	0.0001 0.05	1 1	60 cps to 10 kc	.....	0.01
Pulse	16	5	0.1 0.5 1	2 2 1	.....	High voltage	1
Pulse Dividing Ratio	4	1	1	1	.....	High voltage	1
C-W on Balanced Line	12	3	5 1	1 2	No measurement		
C-W on Unbalanced Line	18	10	5 1 0.5 0.1	2 4 3 1	30 kc to 100 mc 100 to 400 mc	0.2 to 300 v 0.2 to 100 v	2 3
R-F Pulse	2	5	5 1 0.5	2 2 1	No measurement		
R-F Potentiometers	2	1	1	1	30 kc to 500 mc	1 mv to 0.1 v	3
Signal Generators (sine wave)	18	7	5 1 0.5 0.1 10	1 2 2 1 1	500 to 1,000 mc	100 μv to 0.1 v	5
Impulse Generators	7	1	5	1	No measurement		

FIG. 4—Selling price as function of frequency range for typical field-strength meters. Instruments are portable unless otherwise indicated

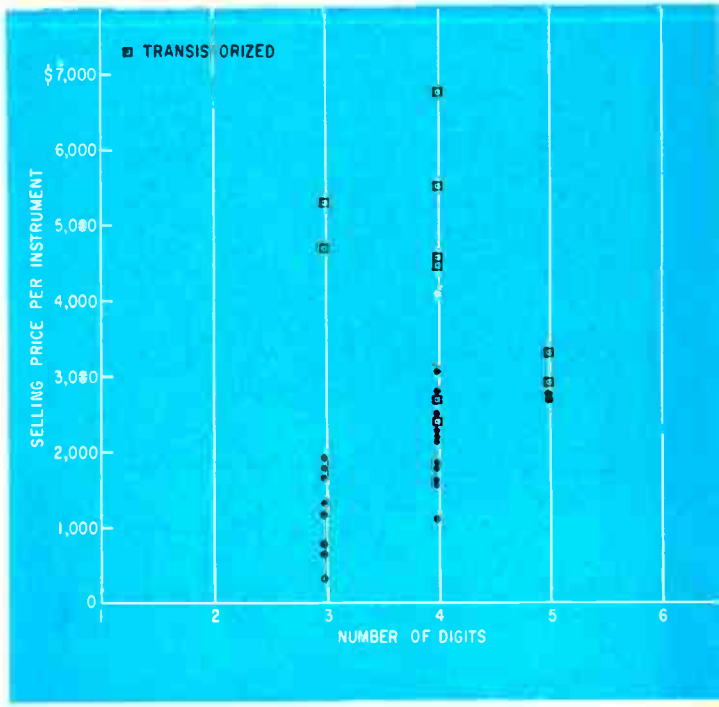


FIG. 3—Selling price of both vacuum tube and transistor d-c digital voltmeters rises as number of digits displayed increases

ing price of vtvm's as a function of input impedance is shown in Fig. 2.

DIGITAL VOLTMETERS—Since digital voltmeters usually operate on the potentiometer principle of measurement, they promise accuracies comparable with the movements available in analog meters—but at a somewhat higher cost. Compatibility with data processing and computer equipment together with readout speed make digital voltmeters extremely useful. Selling price as a function of number of digits is shown in Fig. 3.

Miniaturization of digital voltmeters is a recent design trend. As a result, measuring equipment will take up less space—a particularly valuable feature for instruments used in aircraft.

Meters which are capable of converting measurement into a verbal readout promise even greater

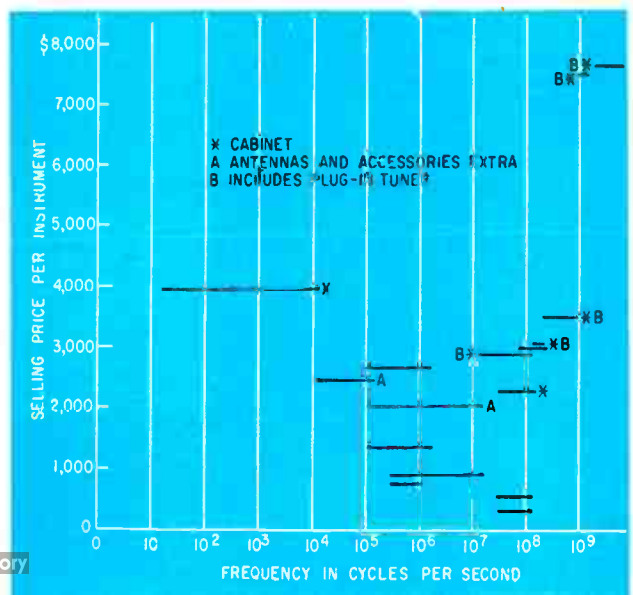


Table III—Desired Accuracies in Power Measurements

Category	Accuracies Sufficient? (No. of Firms Replying)		Desired Accuracy		National Bureau of Standards		
					Range		Routine Accuracy
	Yes	No	%	No. of Firms	Freq	Magnitude	%
Power	30	6	0.01	1	d-c to	0.1 to	0.05 to
			0.1	1	1 kc	100 amp	0.1
			0.05	2		30 to	
			0.25	2		1,000 v	
R-F POWER							
Balanced Lines	6	1	1	1	No measurement		
Unbalanced Lines	12	8	5	1	1 to	1 to	1
			3	1	100 mc	10 mw	
			2	1			
			1	2	100 to	1 to	
			0.5	1	300 mc	100 mw	
			0.1	1			
			0.01	1			
Interference Radiated	16	2	5	1			
			3 db	1			
Interference Conducted	16	2	5	1	No measurement		
			3 db	1			
MICROWAVE							
Unmodulated Power with Calorimeters	14	9	2	4	No measurement		
			1.5	3			
			1	2			
Unmodulated Power with Bolometer Bridges	21	13	10	3	8.2 to	1 to	1
			5	2	12.4 kmc	10 mw	
			2	3			
			1	1			
			0.5	2			
			0.1	1			
			2 db	1			
Unmodulated Power with Directional Couplers and Bolometer Bridges	11	14	10	2	8.2 to	1 to	1
			5	2	12.4 kmc	10 mw	
			3	1			
			2	3			
			1	4			
			0.1	2			
Pulsed Power, Peak (Calorimeters)	7	4	2	2			
			5	2			
					No measurement		
Pulsed Power, Peak (Couplers and Bridges)	9	4	10	1			
			5	1			
			3	1			
			2	1			
Attenuation on Unbalanced Lines	10	6	0.05	1	30 to	0.1 to	0.05 db
			0.8	1	300 mc	70 db	+0.1%
			1	1			of attenuation in db
			0.1	1			
			0.01	2			
Attenuation Below 0.1 db	7	4	1.5	2			
			10	1	No measurement		
			1	1			
Attenuation 0.1 db to 45 db	16	9	1.5	1	300 mc	.....	0.1 db waveguide
			1	1			
			0.2	1			
			0.1	2			
			0.05 db	1	12.4 mc		0.2 db coax or 1%
			2	1			
			0.8	1			
			0.01	1			
Attenuation Above 75 db	7	5	5	1	No measurement		
			2	1			
			1.5	1			
			1	1			
			0.05	1			

convenience and safety in some applications.

CURRENT MEASUREMENT—Since the principle upon which ammeters and voltmeters operate is the same, the comments on voltage measuring instruments apply equally well to ammeters. An additional trend, however, is the development of ammeters which externally measure the alternating or direct current flowing through a wire by sensing the strength of the magnetic field produced.

POWER MEASUREMENT—Trend in wattmeter design is not only toward higher accuracies, but also the use of linear a-c scales. Many present square-law scales emphasize readability during overload conditions at the expense of readability under normal conditions. Linear scales give equal emphasis.

One of the problems in power measurement is the fact that the measuring instrument itself consumes power. This problem has been resolved somewhat by recently announced commercially available wattmeters which consume only milliwatts of power.

In the field of r-f power measurement, the state of the art is being pushed with regard to accuracy. See Table III.

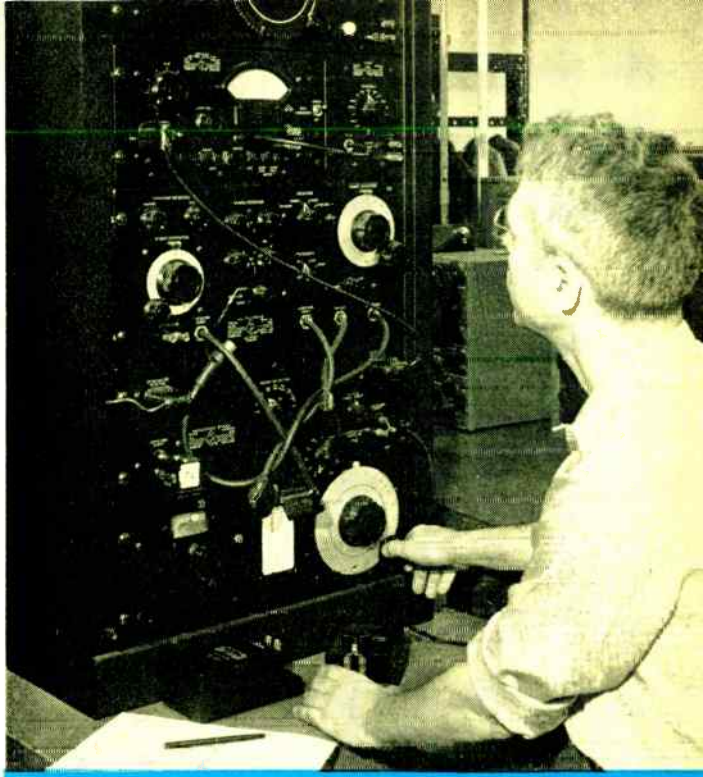
NOISE-FIGURE METERS — Conventional techniques of measuring noise figure which involve many pieces of apparatus are being supplemented by meters capable of dynamic, continuous display of noise figure. Not only do these devices eliminate time-consuming setup and adjustment, but they overcome the necessity of determining the effective power gain-bandwidth product and the difficulty of measuring the available signal power at the low levels involved. Design effort is being expended to assure reliable performance by improving ease of alignment to automatize the instrument and to eliminate periodic recalibration. Automatic operation has already been obtained for 0- to 36-db noise figure over a 12-mc to 40-kmc range.

POWER RATIOMETERS—Determination of antenna patterns, amplifier gains and r-f attenuation requires measurement of relative r-f power levels over a wide dynamic range. The problem in this area is to design instruments capable of accurately measuring minute power levels. At present a dynamic range of —15 dbm to —87 dbm can be measured with a precision of 0.01 db and an accuracy of 0.02 db/10 db over frequency range of 100 to 4,000 mc.

FIELD-STRENGTH METERS — Radio-frequency energy received at an antenna associated with a field-strength meter is converted to a voltage which is a function of field strength. Since a wide range of field strength is normally encountered, the readout is scaled logarithmically; however, the trend is toward use of linear scales for easier reading. Continuous effort is being made to make portable instruments more compact and lighter. Selling price of field-strength meters as a function of frequency range is shown in Fig. 4.

Accuse not nature, she hath done her part; do thou but thine . . .

Emphasis is on less complicated measurement of resistance, inductance and capacitance. Direct-reading instruments for measuring standing-wave ratio are coming into wide use

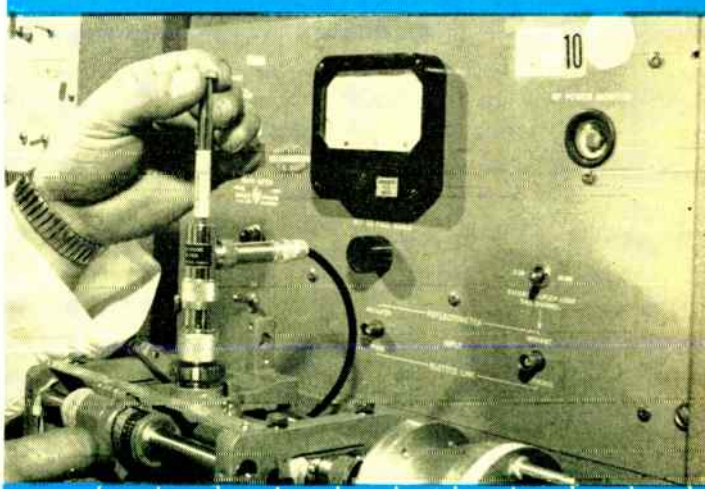


Calibrating capacitance test assembly against standard capacitor at Goodyear Aircraft's standards laboratory

Impedance Measurement

IMPEDANCE MEASUREMENT is probably the most important measurement made in design and production of electronic equipment. Trend in impedance measuring instruments is toward shorter setup time, greater simplicity, foolproof readout, in-line digital presentation, automatic decimal-point indication and automatic display of units of measurement next to the answer. Trends in design of impedance measuring equipment have been largely influenced by the development of closer tolerance components. See Table IV. This condition can be expected to continue.

RESISTANCE MEASUREMENTS—When considering measurement of resistance, it is necessary to separate the d-c from the a-c methods. For d-c measurement, the Wheatstone bridge is generally used. In the case of low resistances, a Kelvin double bridge is required. Measurement of high resistances is ordinarily done with a vacuum-tube detector used in conjunction with the bridge. Direct deflection methods are also used; examples being the megohmmeter and ohmmeter. For still higher resistances, up to 10^{16} ohms, an electrometer is required. Selling price of



Performing functional acceptance test on an antenna from a Polaris test missile at Lockheed Missiles and Space Division, using slotted-line set to measure vswr, is shown above plot

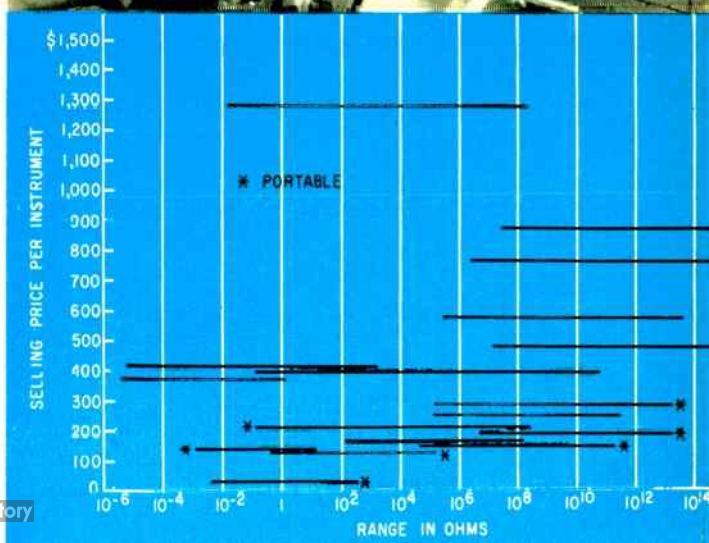


FIG. 5—Selling price as a function of range for typical ohmmeters. Combination volt ohmmeters are not included

Table IV—Desired Accuracies in Impedance Measurements

Category	Are Existing Accuracies Sufficient? (No. of Firms that Replied)		Desired Accuracy		National Bureau of Standards		
					Range		Routine Accuracy
	Yes	No	%	No. of Firms	Freq	Amplitude	%
D-C Resistance of Standard Resistors	32	10	0.0002 0.0001 0.002 0.001 0.01	1 2 2 3 2	.....	1 ohm 0.001 to 100,000 ohm 0.0001 ohm	0.0005 0.002 0.01
Inductance	39	6	0.05 0.01 0.2 0.1	1 2 2 1	60 cps 100 cps 400 cps 1 kc	100 μh to 10 h	0.03 to 0.1
Inductance of Search Coils	15	1	5	1	.....	.....	0.25
Capacitance of Fixed Standards	29	11	0.1 0.05 0.02 0.01 0.002	1 2 3 3 2	60 cps 100 cps 400 cps 1 kc	100 μμf to 1 μf	0.03 to 0.1
Capacitance of Variable Standards	24	6	1.0 0.1 0.05 0.01 0.001	1 1 2 1 1	60 cps 100 cps 400 cps 1 kc	100 μμf to 1 μf	0.03 to 0.1
Q of Standard Coils	22	4	1.0 0.05	2 2	No measurement		
Loaded Q of Fixed Resonant Cavity	2	4	5 3 1	1 2 1	No measurement		
Loaded Q of Tunable Frequency Meter	1	4	5 3	2 2			
R-F Impedance	9	6	2 1 0.5	2 3 1	30 kc to 300 mc	1 ohm to $\frac{1\times10^6 \text{ (ohms)}}{2\pi f \text{(mc)}}$	1 (including Q)
Vswr with Slotted Lines	15	7	2 0.02 0.005 0.001	2 3 1 1	No measurement		
Vswr with Reflectometers	12	1	5	1			
Vswr of Standard Mismatches	9	3	0.001 0.005 0.02	1 1 1	8.2 to 12.4 kmc	1.01 to 1.5 vswr	±0.1

ohmmeters as a function of range covered is shown in Fig. 5.

Measurements of a-c resistance at low frequencies can be made with an a-c form of the Wheatstone bridge. Bridge measurements are also used at frequencies as high as 150 mc; over this frequency instruments with distributed capacitance, usually coaxial lines, are used. Among distributed capacitance instruments are the slotted line and the admittance meter, both of which can be used up to a few hundred megacycles; beyond this frequency, slotted sections of waveguide are required. In addition to the direct measurement of resistance, the low resistance of reactive elements is measured in terms of dissipation factor, in the case of capacitances, or of Q, in the case of inductors.

Digital ohmmeters are coming into wide use because they are capable of being used as general-purpose instruments alone or in conjunction with input scanners and digital data recorders. These instruments are valuable because of their completely automatic operation and range switching, high speed, high accuracy, presentation of data in easily read numerical form, ruggedness, ease of use by untrained personnel and wide measuring ranges.

INDUCTANCE AND CAPACITANCE MEASUREMENTS—Inductance and capacitance are measured at power-line, audio and radio frequencies with impedance bridges. Other instruments, such as the Q meter, are also used in the radio-frequency range. Simple capacitance meters which are, in effect, a-c ohmmeters are used in some applications. Coaxial-line instruments such as slotted lines, admittance meters, transfer function and impedance/admittance bridges are used at frequencies between a few hundred and a few thousand megacycles; at still higher frequencies, the slotted sections of waveguide take over.

Capacitance measuring equipment is now available in one integrated assembly. Self-balancing feature is presently being incorporated in many types of impedance-measuring equipment to speed up test procedures. In addition to extended range, instruments of the future will include rack-mounting accommodations, variable oscillator-detectors, and reduced residual error and null drift resulting from temperature changes.

Self-powered portable instruments are in demand and will be produced in greater quantity and variety in the next few years.

Inductance bridges are now on the market having built-in oscillator-detectors for measurement of 0.002 microhenry to 1.1 henrys of inductance. These instruments are capable of measuring inductances that vary appreciably with frequency, such as those wound on powdered iron or iron-alloy cores. Trend is toward design of bridges with improved ability to pass d-c current for incremental inductance measurements, extended frequency range and reduced residual errors.

VSWR MEASUREMENT—Ratiometers for measuring voltage standing wave ratio are becoming widely accepted. When used in conjunction with oscillographic recording equipment, instantaneous plots of vswr as a function of frequency can be produced. These devices can be used as continually tunable, direct-reading laboratory instruments or as production line go, no-go testers.

Accuracy requirements are approaching standards capability. Frequency counters are supplementing frequency meters in many applications

Engineer calibrates frequency-measuring equipment against frequency standard at General Radio's plant

Frequency Measurement

"Just the minute you get satisfied with what you've got, the concrete has begun to set in your head" . . . Kettering

FREQUENCY is the electrical parameter that can be measured most accurately. Some commercially available instruments attain accuracies of 1 part in 10^{11} thereby approaching the limit of the art with their routine performance. This condition has been achieved because electronic circuits are capable of adding, subtracting, multiplying and dividing with great precision frequencies generated by a high-quality standard. See Table V.

Manufacturers of frequency-measuring equipment report they are constantly asked to extend the frequency range of their instruments to higher and lower ranges and also improve their power-handling capacity. An example of changing requirements which drastically affects the instrument industry is single-sideband communications equipment which requires oscillator stabilities of 5 parts in 10^{9} per week where previously 2 parts in 10^{6} per week was acceptable.

A definite range of parameters has been established for frequency-measuring instruments since, under the new FCC regulations, many tolerances must be held to 0.0005 percent. Some instrument manufacturers are planning to announce next year relatively inexpensive instruments which will meet these FCC requirements.

In view of anticipated tightening of tolerances and

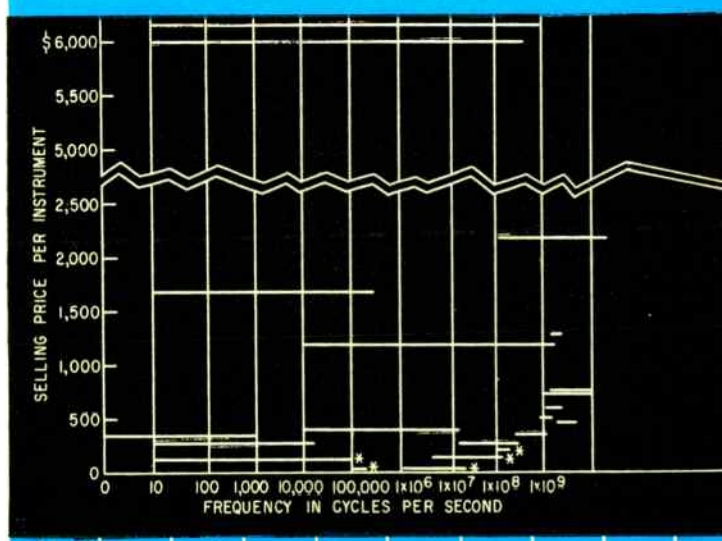


FIG. 6—Selling price as a function of range for frequency meters requiring no external power

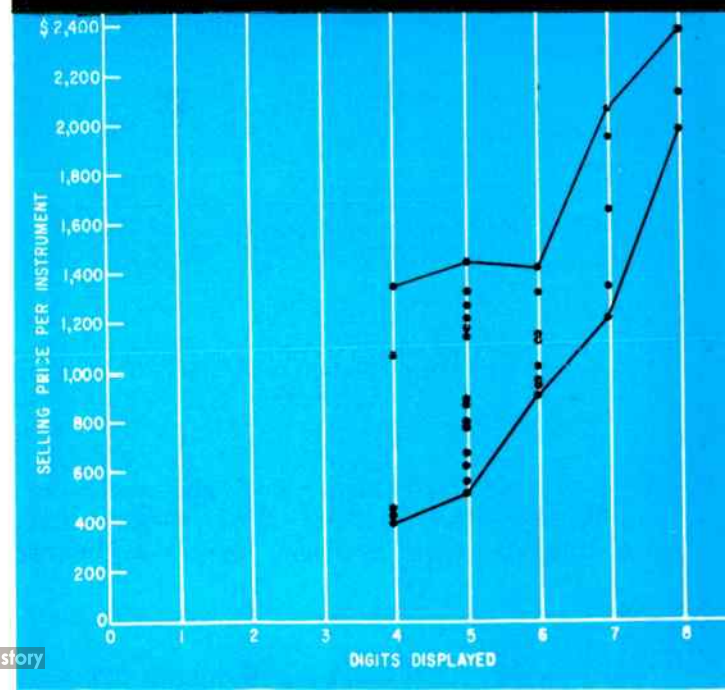
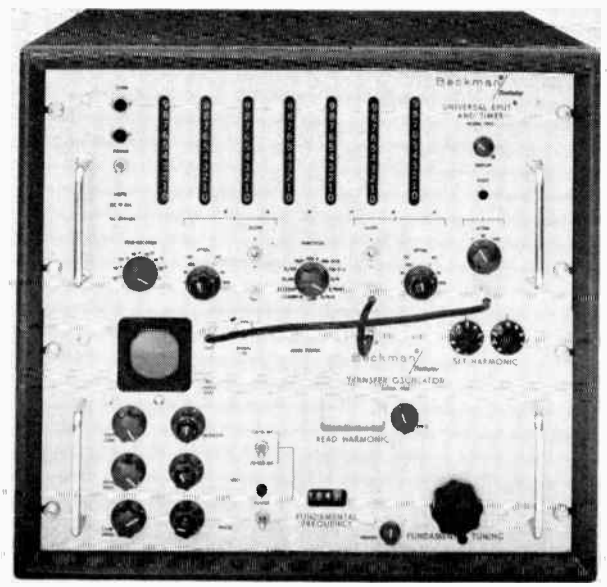


FIG. 7—Selling price of digital frequency counters as function of number of digits displayed

Table V—Desired Accuracies in Frequency Measurements

Category	Are Existing Accuracies Sufficient? (No. of Firms that Replied)		Desired Accuracy		National Bureau of Standards		
					Range		Routine Accuracy %
	Yes	No	%	No. of Firms	Freq	Amplitude	
R-F of Crystal Oscillators	26	5	0.001 10^{-10} 10^{-9} 5×10^{-9}	1 2 1 1	100 kc to 100 mc	1 to 10 v	1×10^{-9}
R-F of Multiplied Signal from Crystal Oscillator	16	5	0.01 0.01 10^{-7} 10^{-9}	1 1 2 1	100 kc to 10 mc	1 to 10 v	1×10^{-9}
Resonant Cavity (fixed)	16	4	0.01 2 mc 2×10^{-6} 10^{-9}	1 1 1 1	to 75 kmc	.....	Determined by stability and resettability of instrument
Maser meter (tunable)	0	2	10^{-7} 10^{-8}	1 1	No measurement		



Frequency counter made by Beckman's Berkeley division

increasing of band spread and spectrum coverage, instruments presently on the drawing board will be designed to satisfy future requirements on a long term basis. These instruments will also have extended range facility.

FREQUENCY METERS—For commercial power-line frequencies, direct-indicating instruments are available and frequency meters of the vibrating-reed type are common. At frequencies up to a few megacycles, direct-indicating frequency meters, usually of the pulse control type, can be used. Selling price of frequency meters as a function of range covered is shown in Fig. 6.

At audio frequencies, most measurements are based on frequency standards of the quartz crystal or atomic types. These basic frequency standards, with their auxiliary frequency multiplying and dividing equipment, can also produce a harmonic series of standard frequencies throughout the radio-frequency spectrum. Other auxiliary equipment is available that enables the operator to interpolate between any two of these harmonics to identify exactly any unknown frequency.

Absorption-type wavemeters are mostly used now for approximate measurements. Instruments in wide use now include heterodyne frequency meters and grid-dip meters.

One design trend is the use of cast aluminum in fabrication of frequency-meter chassis. This method of construction permits casting of a cellular-type chassis which, besides providing excellent r-f shielding, eliminates the more intricate mechanical fabrication found in conventional chassis. By cantilever-mounting a number of these chassis to an extra thick front panel, assembly and test procedures can be simplified.

Design of frequency standards is tending toward reduction of physical size and weight while meeting tougher military requirements. In the last few years, the size of frequency standards has been reduced to one fifth of their former size with a commensurate reduction in weight.

FREQUENCY COUNTERS—A widely used frequency-measuring device for routine measurement is the digital counter. This device counts the number of cycles of the unknown frequency in a predetermined time interval. A crystal oscillator is used as an internal frequency reference for these instruments. Such instruments are supplementing conventional high-accuracy frequency measuring equipment at a rapid rate. Selling price of frequency counters as a function of the number of digits displayed is shown in Fig. 7.

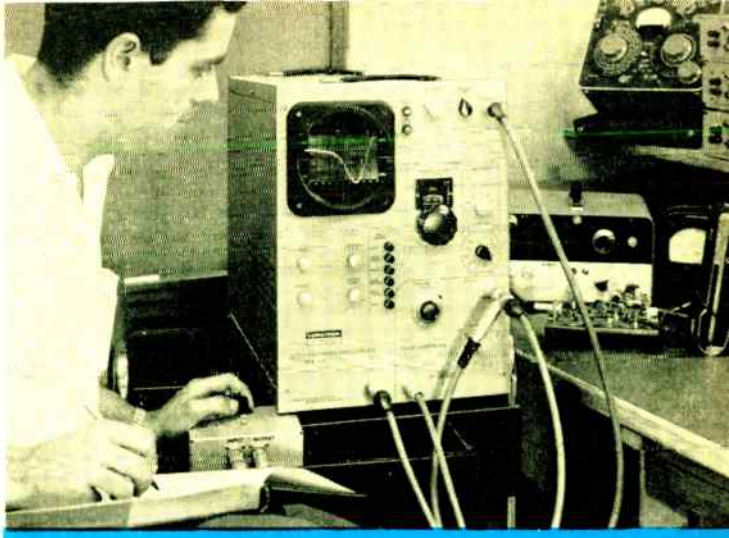
Because counter-type frequency-measuring instruments generally give readings automatically in direct numerical form, they can be used effectively by nontechnical personnel.

MODULATION METERS—Modulation measurement is becoming increasingly more important. It is of primary significance in power generating units driven by gasoline engines or Sunstrand drives. Servo systems give a good deal of trouble when the voltage or frequency modulation introduced by the prime power source exceeds certain low limits. Instrumentation for these measurements is still rapidly developing, but the trend seems to be toward instruments which can measure accurately smaller and smaller percentages of modulation over a wider and wider frequency band.

To hold, as t'were, the mirror up to nature

Semiconductor testing requirements are promoting development of ultrahigh-speed oscilloscopes. Distortion measuring instruments are now essential for quality control of electronic equipment

Waveform Measurement



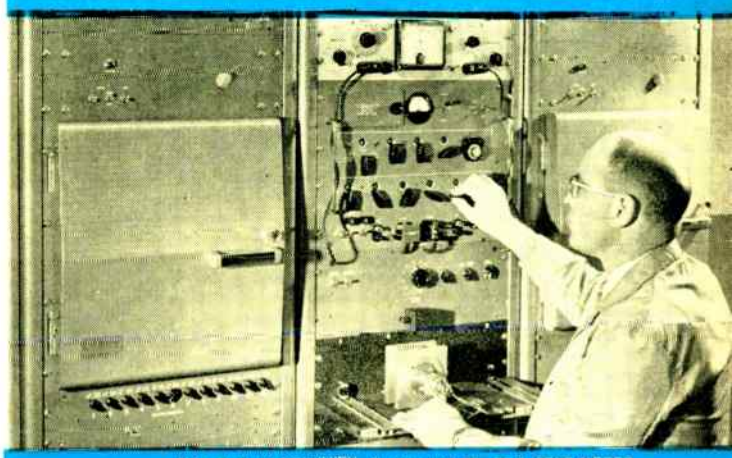
Engineer evaluates performance of high-speed switching transistor with Lumatron Electronics sampling oscilloscope

BASIC INSTRUMENTS for analyzing waveforms or measuring phase are the oscilloscope and oscillograph. Components of a complex waveform are often identified and measured using a wave analyzer or tuned voltmeter. When overall evaluation of the total harmonic content is wanted, a distortion meter can be used. Since wave analyzers and distortion meters operate primarily in the audio-frequency range, it is necessary to use spectrum or phase analyzers at higher frequencies.

OSCILLOSCOPES—Two oscilloscope parameters—sensitivity and bandwidth—are receiving a considerable amount of attention and will continue to do so. By increasing sensitivity and expanding bandwidths to accommodate higher frequencies, heretofore unobservable waveshapes can be investigated.

Need for instruments capable of measuring outputs of ultrahigh-speed switching devices on the production line has recently been fulfilled by sampling and traveling wave tube oscilloscopes. Because of convenience of operation and sensitivity, the sampling types will have much wider general purpose use. Since traveling-wave-tube oscilloscopes can display 0.2 millimicrosecond pulse with rise times they are all fitted for specialized applications, such as display of single transient pulses. Selling price of oscilloscopes as a function of rise time and sensitivity is shown in Fig. 8.

Switching devices currently under development will have 0.1 millimicrosecond rise times and pulse widths of one millimicrosecond or less. For this



Operator at John Oster Manufacturing Co. measures phase angle and transfer voltage characteristic of tachometer using North Atlantic phase angle voltmeter

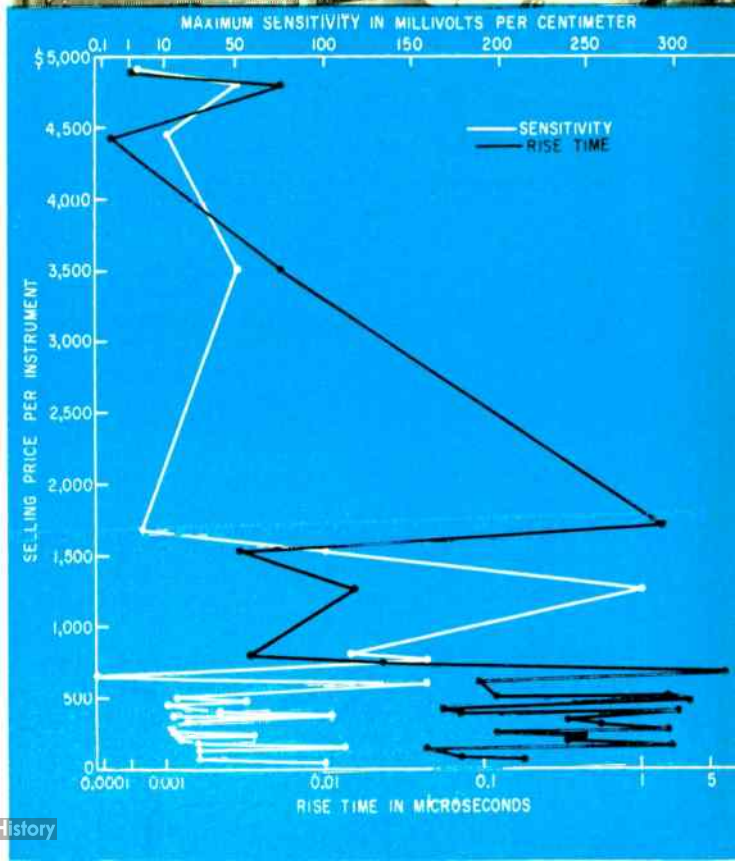


FIG. 8—Selling price of oscilloscopes as a function of rise time and maximum vertical sensitivity. Dual and multichannel types are not included

Table VI—Desired Accuracies in Waveform Measurements

Category	Are Existing Accuracies Sufficient? (No. of Firms that Replied)		Desired Accuracy		National Bureau of Standards		
					Range		Routine Accuracy
	Yes	No	%	No. of Firms	Freq	Amplitude	%
Phase Angle with Phase Meters	31	3	0.5 deg 0.1 deg 0.01 deg	1 1 1	400 cps	360 deg	0.1 deg
			Could be improved if justifiable				
Phase Angle of Phase Signal Generators	9	1	0.01 deg	1			
R-F Phase Angle	7	4	1 0.5 0.1	1 1 2			
Phase with Slotted Lines	5	3	2 1 0.1	1 1 1	No measurement		
Phase of Phase Shifters	3	1	2 0.5 0.1	1 1 2			
Pulse width	19	3	1 mμsec 0.01 μsec	1 2			
Delay on Delay lines	12	2	1 mμsec 0.01 μsec	1 1			

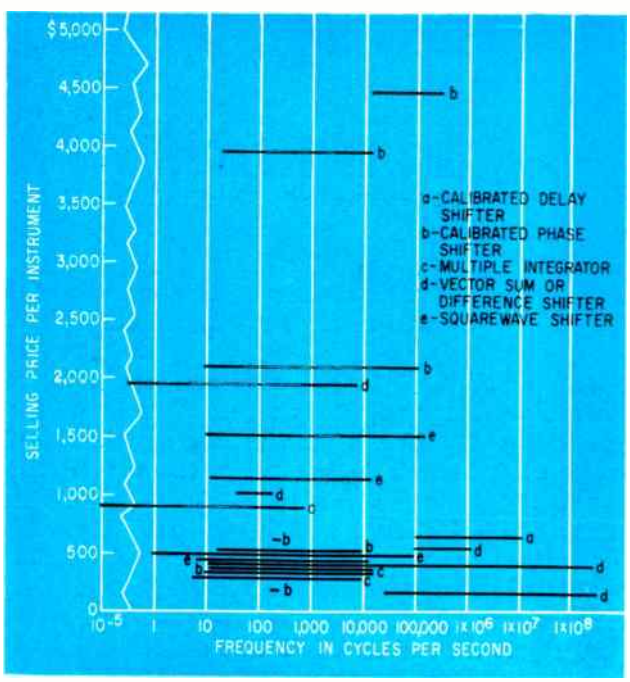


FIG. 9—Selling price of phase meters as a function of frequency range

reason, there is a trend toward development of even faster oscilloscopes for the millimicrosecond field.

Trend is toward using swept r-f and marker generators to provide instantaneous graphs of r-f voltage as a function of frequency. Several test equipment manufacturers are producing instruments that include high-quality generators of this type. Various ranges of frequencies are covered, particularly below 1,000 mc. Soon-to-be-announced generators will feature watts of power rather than milliwatts, sweep widths as wide as 500 mc, ranges extending to 2,300 mc, plug-in marker units, and variable sweep rates providing continuous control from 1 cycle per 2 or 3 minutes to 60 cycles per second.

OSCILLOGRAPHS—These instruments cover a broad spectrum of frequency response, from a few cycles in the case of the chopper type recording ammeter to over 100 kc in the case of multiple crt types. Usefulness of these devices will be enhanced when more writing channels are made available to handle the multitudinous outputs currently being tested. Current design trends are towards improvement of pen function in ink writing oscillographs, reduction in cost of paper and easier maintainability of jets in liquid ink stylii.

PHASE METERS—Measurement of phase shift has become important in recent years because of the development of computing transformers, computing amplifiers and resolver systems. Although many devices for measuring phase and phase shift are available, in many critical applications the capability of the instruments is approaching the limit of the art. See Table VI. Presently available vector sum or difference and calibrated delay phase meters are operable to 200 or 300 mc, but industry is already demanding the range be extended to one kmc. High accuracy below one cycle and up to one kc can presently be obtained with phase counters, thus no immediate measurement problem exists in lower frequency ranges. Selling price of phase meters as a function of frequency range is shown in Fig. 9.

DISTORTION METERS—Demand for simple harmonic distortion measuring devices is increasing in design, test and production work. Design emphasis is toward avoiding introduction of distortion by the instrument itself and assuring inclusion of high-order harmonics in the voltmeter readings.

WAVE ANALYZERS—Important characteristics of the wave analyzer, or tuned voltmeter, are its frequency range, sensitivity, amplitude range and bandwidth or selectivity. Since this device consists essentially of a bandpass filter whose center frequency can be varied continuously over the frequency range and a voltmeter which measures every component of a complex wave, limitations of voltmeters affect the ultimate usefulness of the wave analyzer. Design emphasis is on making tuning easier and on stabilizing the tuning adjustment.

Noise-figure measurement is taking on increasing significance in testing vacuum tubes. Trend is also towards evaluating semiconductors on dynamic rather than static parameters

Operator checks out traveling-wave tube using automatic production tester built by Sperry Microwave Electronics

Tube and Semiconductor Testing

GO, NO-GO MEASUREMENTS using the ordinary vacuum-tube tester are satisfactory for many routine purposes, as are those of its transistor-testing counterpart. For more precise measurements, a vacuum-tube bridge-type tester is used by many vacuum-tube manufacturers. This bridge technique of measuring tube characteristics can also be used to measure transistor parameters, but most of the important parameters are more accurately measured on a transfer-function and impedance/admittance type bridge.

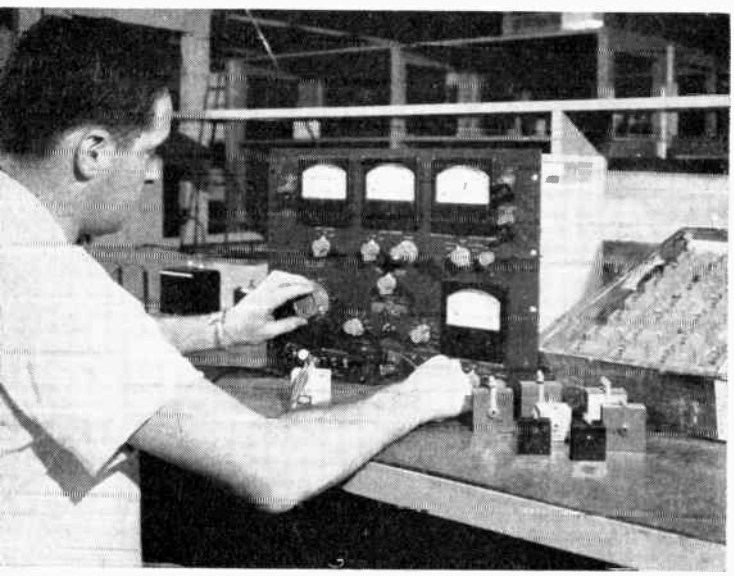
TUBE TESTERS—Trend is toward use of noise figure test sets for the standardization of noise measurements among the various receiving tube manufacturers. These test sets probably will be adopted ultimately as standard for measurement of noise produced by receiving and special purpose tubes at 200 mc.

A tester designed to check S-band and X-band traveling-wave tubes automatically on a production line basis has recently been announced. The instrument permits a technician to make all measurements necessary to determine if the tube meets production specifications. A permanent record of all measurements can be made and a self-calibrating feature is included in the instrument. Traveling wave tube parameters measured are power gain, power output, vswr and stability.

SEMICONDUCTOR TESTERS—Manufacturers of this equipment are struggling to keep up with the variety of new semiconductor devices being produced and with the almost daily change in type and accuracies of measurements required. Object is to show

Engineer makes voltage check on Ford Instrument's sequential analyzer used to test transistors and print out results

High-frequency transistor parameters are measured using Wayne Kerr r-f bridge



Technician checks silicon diodes on General Radio semiconductor tester

a measured parameter without using external instruments, switching in and out of other apparatus, or computation.

Techniques have been devised for obtaining readings on an instantaneous basis by pushing a button or throwing a switch once the bias values corresponding to the measurement desired have been set in.

A trend in semiconductor testing is to measure dynamic rather than static parameters. Conventional techniques measure the d-c ratios of transistors or, in the few cases where a-c measurements are made, the a-c ratios are taken at a single test frequency.

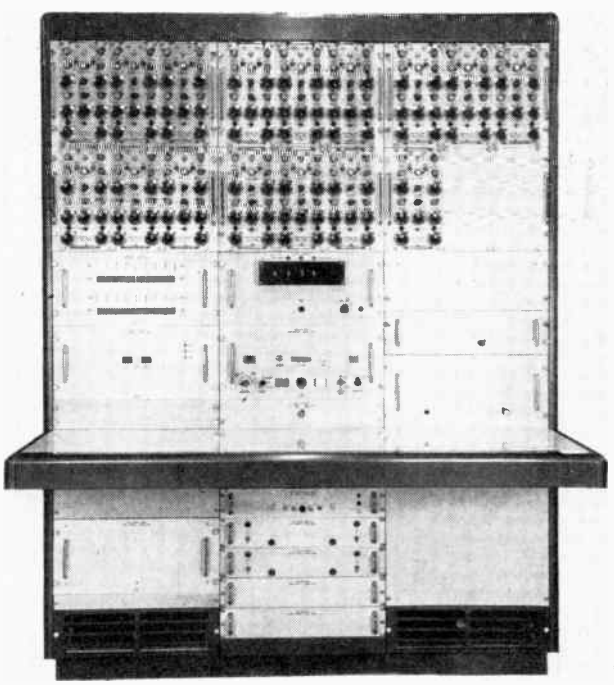
At least one available tester permits semiconductor measurements to be made over a band of frequencies and presents the summation of all the a-c ratios directly on a meter scale. This method of measurement accurately delineates the transistor characteristics and shows up any points within the amplification band which might be missed by more conventional testing methods.

Radio-frequency voltmeters have been used extensively by producers of transistors for low-level testing. Advantage of this measurement technique is the high sensitivity over a wide frequency range. Capacitance bridges are being used for measuring capacitance of diodes under different bias conditions. This approach is particularly useful in testing voltage-variable diodes.

Most of the parameter testing in the transistor field has been in the low or intermediate frequency ranges. With the rapid increase in the frequency bands over which transistors can operate, it has been necessary to expand measuring ranges into the video frequency range. It is expected that a further extension into still higher frequency ranges will be required. Requests have already been made for transistor testers capable of measuring in the microwave region.

The packaging trend for these testers is toward compact desk or bench mounting with controls and meters arranged in a logical manner. Also, sloping front panels giving maximum visibility of presentation are popular.

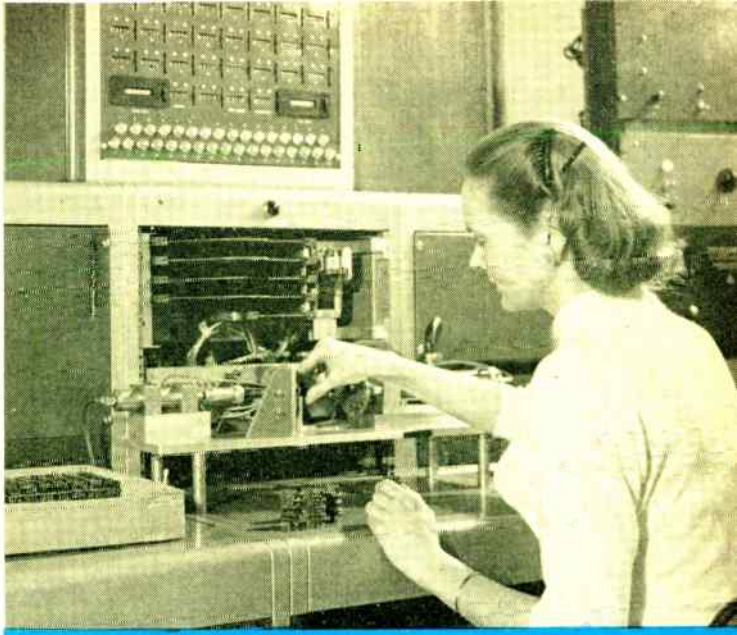
As in tube testing, the best method of testing a semiconductor is to test it in the type of circuit in which it will be used. For example, it is most useful to test transistor performance at the end points, or tolerance limits, of their operating voltages and currents.



Sequential mechanism for automatic recording and testing has been designed by Texas Instruments for incoming inspection of transistors by volume users

Many things difficult to design prove easy to performance....

Limit-type go, no-go production testers using meter relays or precision comparators are now widely used. Systems testers are still largely custom-made by user



Automatic module tester developed by ACF Electronics tests all types of mounted components including capacitors, resistors and inductors

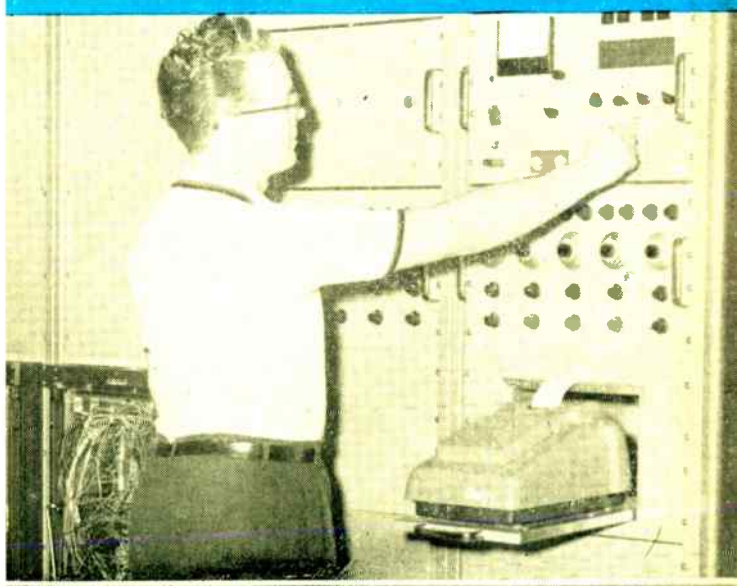
Automatic Testing

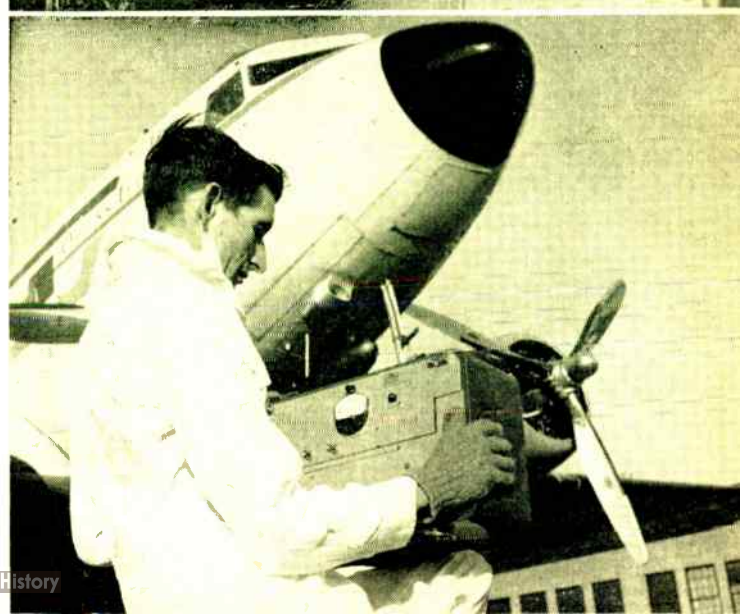
DECISIONS formerly made by human operators are now being made in many cases by automatic test equipment. In addition to relieving man of this often times routine and arduous chore, integrated instrument systems are usually able to perform the function faster, more accurately and with a flexibility denied ordinary mortals. This section dwells on the instrument complexes used for lot-acceptance or system testing.

QUANTITY TESTING—A growing trend in production testing is to make more and more measurements automatically. This testing philosophy is applied particularly in current and voltage measurements, and in tube and transistor testing. These items involve relatively simple measurements which must be made a large number of times on a repetitive basis.

Go, no-go testing of devices judged on current and voltage parameters is already accepted on many production lines. Tubes and semiconductors, when produced in quantity or undergoing purchase inspections, are also ideally suited to automatic testing procedures.

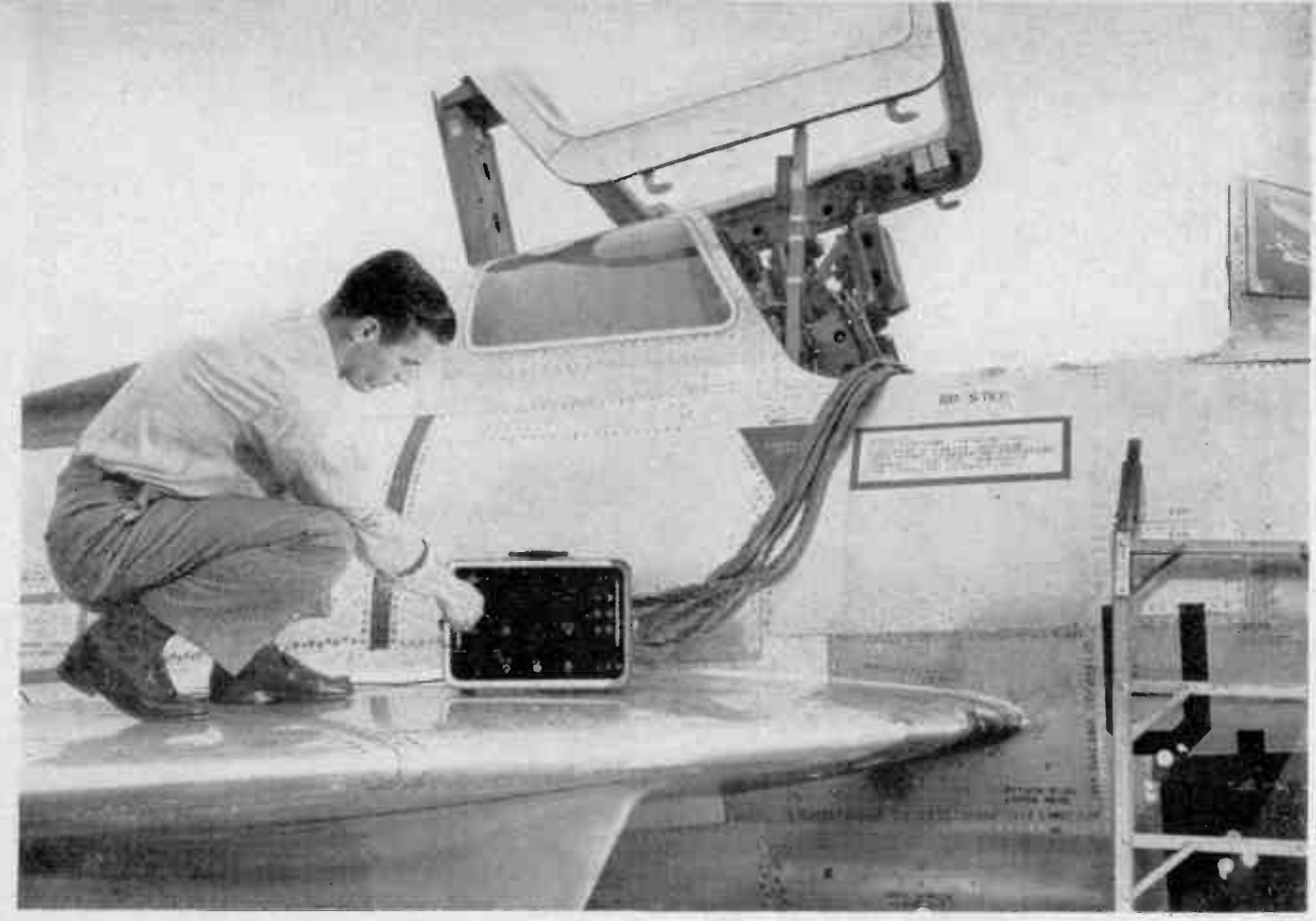
Evidence of increasing automatizing is shown by the large number of meter relays presently being sold. The relays are substituted for the indicating meters in instruments and are used to actuate various types of selection or rejection mechanisms. By adjustment of relay sensitivity, end point tolerances





Production checkout of cables at GE's Light Military Electronics Department is done with Consolidated Avionics automatic multiple circuit analyzer in center photo

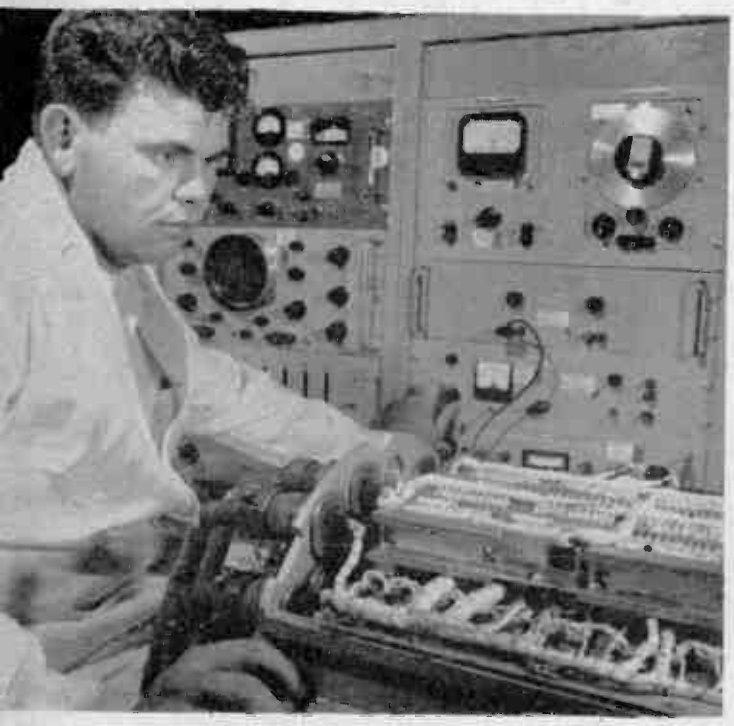
Checking operational status of airborne radar immediately before takeoff with go, no-go pushbutton tester built by Sperry Microwave Electronics



Checking cabling in Republic Aviation aircraft using portable circuit analyzer

can be preset. Devices such as resistance bridges have been designed to function in this manner. Precision comparators are coming into wide use in go, no-go testing because of their great reliability and high sensitivity.

Automatic component testers are particularly advantageous for manufacturers receiving small quantities of a variety of types of electronic components. These test instruments usually are programmed for testing any of the common components by inserting a punched card into the instrument. Obviously, such an instrument usually contains more facility than normally required by component manufacturers who are interested in large volume testing of a single component type. Commercial circuit testers must provide test-setup flexibility at reasonable cost.



Instrument complex used to check out telemetering package of Polaris test vehicles at Lockheed's Missiles and Space Division

Satisfying the needs of a wide variety of customers without making the purchase price prohibitive for most seems to be the biggest problem faced by circuit and component tester manufacturers. Requests for unusual measurements or extended ranges must often be ignored for the sake of practicality and economy. Provisions are being made in automatic testing instruments for use of auxiliary apparatus such as oscilloscopes and oscillators by customers with specialized requirements.

SYSTEMS TESTING—Much of the automatic equipment designed to test complex electronic systems is custom-built by the systems manufacturers themselves. Usually this procedure involves purchasing a variety of commercial instruments and incorporating them into a tester containing special test sequence control units or programmers. Some testers are available commercially for checking out radar systems and cabling.

The author wishes to acknowledge the assistance of the many individuals who helped make this report possible.

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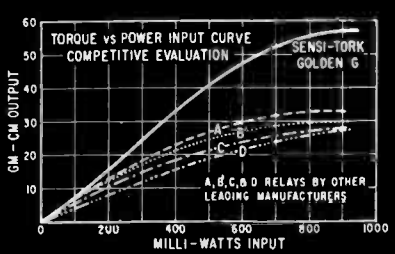

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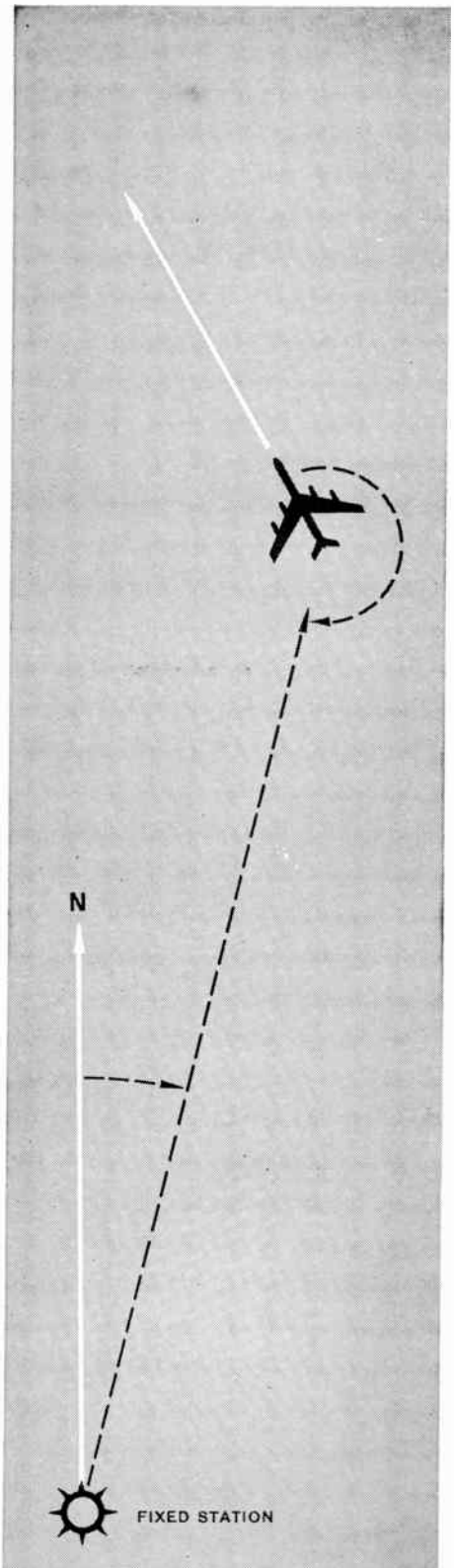

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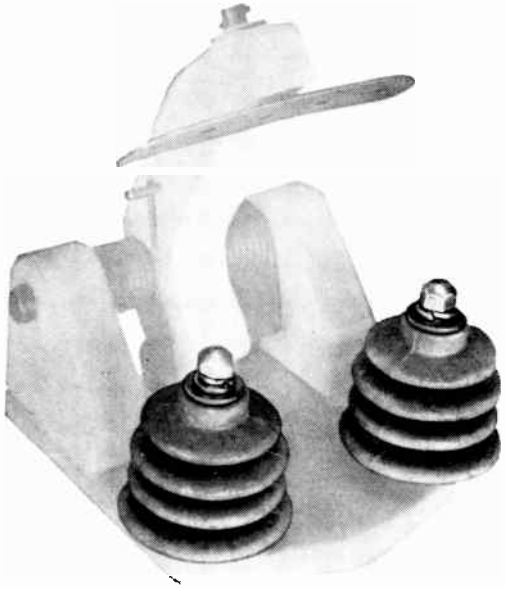

"gives high impact strength . . . superior insulating value," in ITT's TACAN beacon

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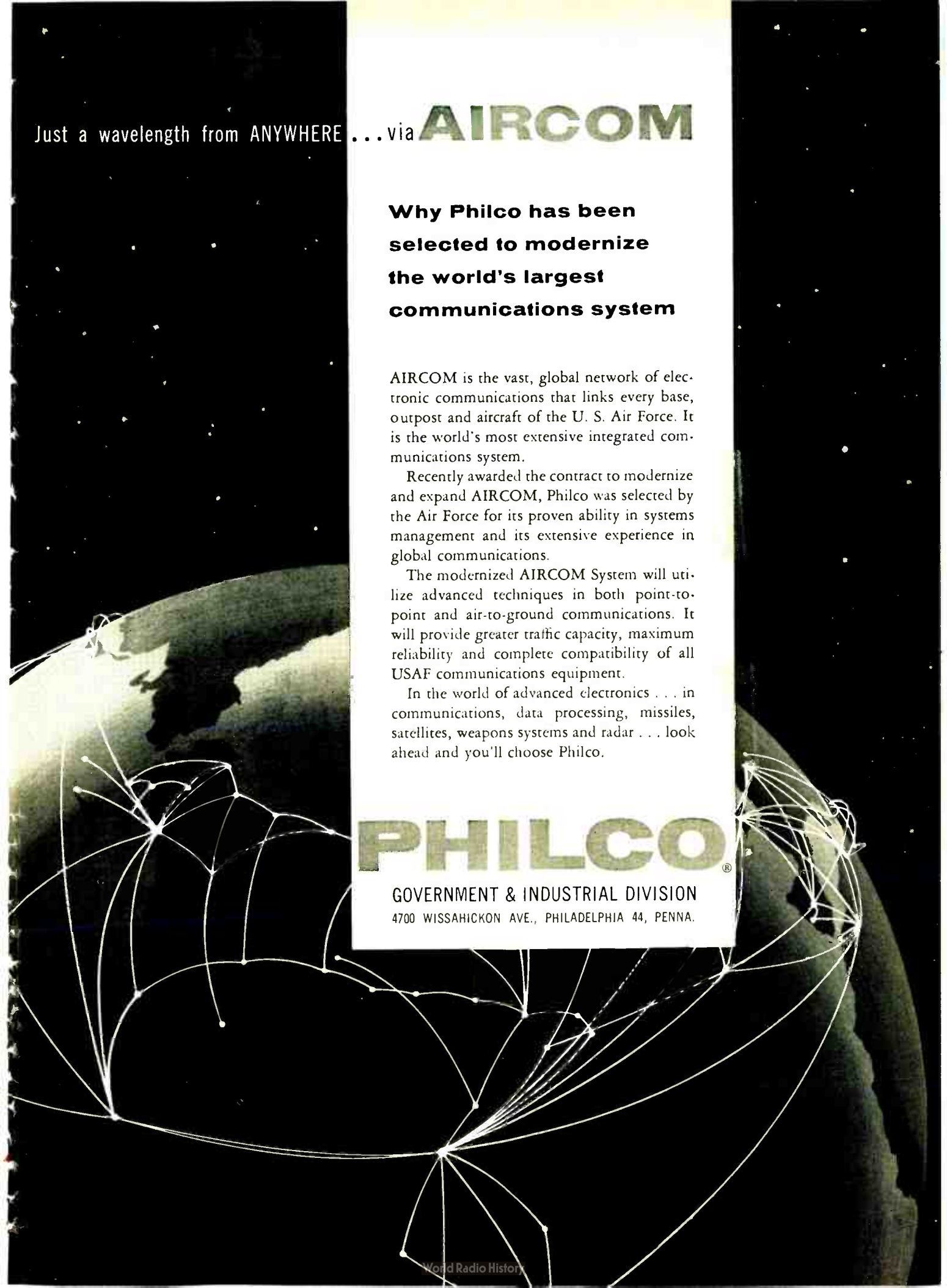

Why Philco has been selected to modernize the world's largest communications system

AIRCOM is the vast, global network of electronic communications that links every base, outpost and aircraft of the U. S. Air Force. It is the world's most extensive integrated communications system.

Recently awarded the contract to modernize and expand AIRCOM, Philco was selected by the Air Force for its proven ability in systems management and its extensive experience in global communications.

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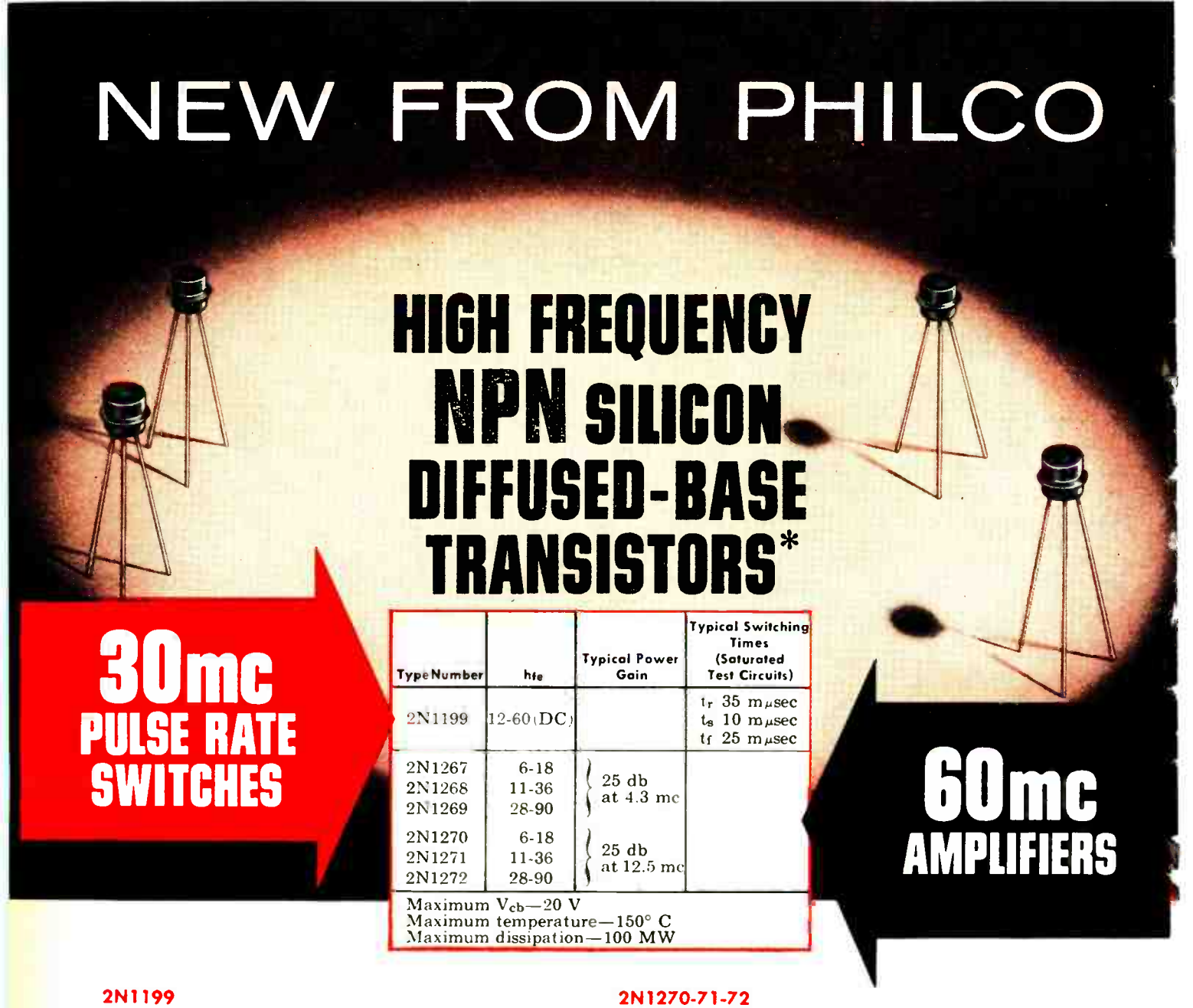

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30mc PULSE RATE SWITCHES

Type Number	h_{fe}	Typical Power Gain	Typical Switching Times (Saturated Test Circuits)
2N1199	12-60 (DC)		t_r 35 mμsec t_s 10 mμsec t_f 25 mμsec
2N1267	6-18	25 db at 4.3 mc	
2N1268	11-36		
2N1269	28-90		
2N1270	6-18	25 db at 12.5 mc	
2N1271	11-36		
2N1272	28-90		

Maximum V_{cb}—20 V
Maximum temperature—150° C
Maximum dissipation—100 MW

60mc AMPLIFIERS

2N1199

This high speed switch has exceptionally low saturation voltage (typically 0.125 V), permitting *practical* design of 5 mc pulse circuits, using conventional saturated switching configurations. 30 mc pulse rates are obtainable in *practical* circuits using non-saturating techniques.

2N1267-68-69

The high gain characteristics of these units make possible the design of high efficiency IF amplifier circuits for communications equipment. These devices have unusually low collector capacitance . . . typically 1.5 $\mu\mu$f . . . and are available with restricted beta ranges to simplify design problems.

2N1270-71-72

The excellent high frequency response of these transistors makes practical the design of high performance communications systems at frequencies up to 60 mc. They have the same low collector capacitance and are available with restricted beta ranges.

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LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

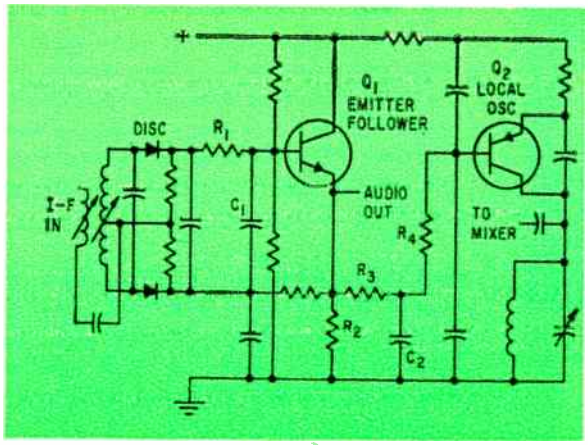


FIG. 1. Controlled oscillator current afc used in 15-transistor radio

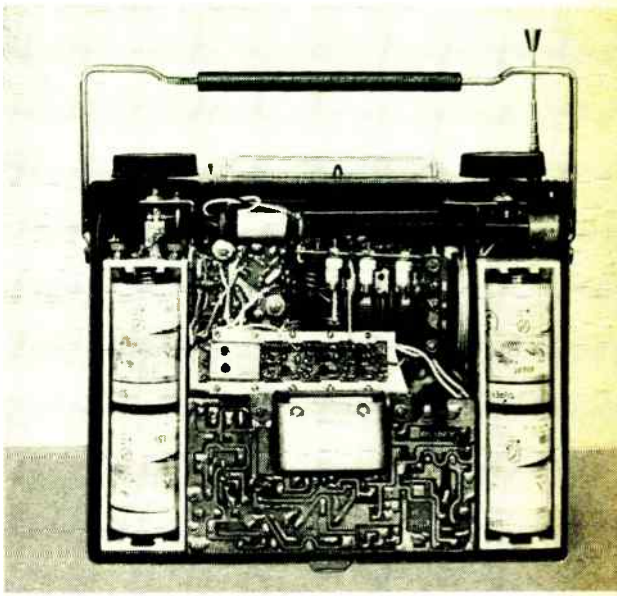


FIG. 2. Rear view of 15-transistor radio showing use of printed boards

Survey of Japanese Electronic Devices

Besides run-of-the-mill transistor radios, Japanese engineers are coming up with novel ideas. A talking book, a pair of a-m/f-m portables, a half-dollar sized rechargeable cell and industrial-scientific devices are some of the items

By LESLIE SOLOMON, Associate Editor

SINCE ENTERING the transistorized radio field (ELECTRONICS, July, 1956), and having found it profitable (ELECTRONICS, June 26, 1959), Japanese electronics manufacturers are venturing deeper into the market. Several new devices are to be offered in the near future.

A-M/F-M PORTABLES—One development is the Sony model TFM-151 transistorized a-m/f-m portable. This set uses 15 transistors, 4 germanium diodes and one varistor. The receiver is divided into three basic sections: f-m detection, a-m detection and audio amplification.

The f-m portion uses 8 transistors and two diodes. These are used as r-f amplifier, mixer, local oscillator, four stages of i-f, discriminator (two diodes) and emitter follower. The controlled-oscillator current automatic-frequency-control circuit is shown in Fig. 1. The 10.7 mc i-f signal is detected by a conventional discriminator and the output passed through de-emphasis network R_1 and C_1 to emitter follower Q_1. The audio output and afc are taken from emitter load R_2. The afc voltage is derived from averaging circuit R_3 and C_2 then applied through R_4 to the base of local oscillator Q_2. There are no provisions for disabling the afc.

The a-m portion uses 3 transistors and two diodes. The circuit consists of a conventional converter and

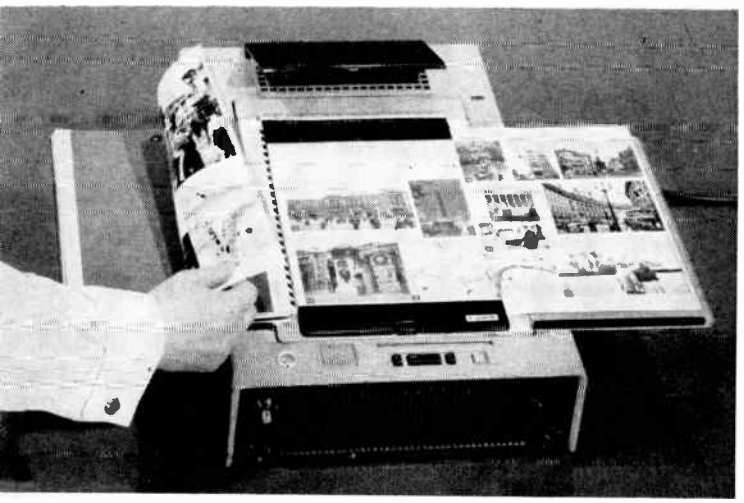


FIG. 3. Talking book is supported on shelf. Page being read is under plastic pressure plate. Book in picture has fold-out pages. Dark surface, left, is magnetic-film coating

two i-f stages. One diode is used as the second detector and the other is used in a shunted-diode agc circuit. The output of either the f-m or a-m portions is chosen by a switch.

Four transistors terminating in a push-pull output stage are used in the common audio section. It produces approximately 180 mw output power. Figure 2 shows the rear of the set and Table I lists the characteristics.

Another a-m/f-m model by the same manufacturer is the TFM-121. This 12 transistor set is smaller and lighter than its predecessor. At the time of writing, schematics were not available. This model is provided with a multiplex output jack and has an extension dipole within its carrying handle.

TALKING BOOK—One Japanese innovation is the talking book or Synchroreader shown in Fig. 3. The recording media for this device is a thin coating of magnetic film (similar to conventional tapes) applied to one side of a sheet of paper. The recorded message may then be illustrated on the opposite or viewing side. Up to ten-minutes playing time is available and provisions are made to enable playback to start at any point on the sheet. The machine can also make recordings.

The basic mechanical operation of the talking book is shown in Fig. 6. The paper to be recorded is placed on the machine, magnetic film down, and held in place with a clear plastic pressure plate. The turntable mounts three equally-spaced parallel-connected magnetic recording/playback heads. In operation, the turntable rotates so that the three heads sequentially sweep the magnetic film. The sweep is moved down the paper by a feedscrew driven by the turntable motor. A separate high-speed motor is provided for fast turntable return.

A built-in microphone and amplifier produce the currents required for the three heads during recording. For playback, the three heads operate in the same mechanical way as when recording and the same amplifier is used. While either recording or listening, the viewing side of the paper is motionless. As shown in Fig. 3, the recorded sheets may be bound book style.

To prevent accidental erasure of prerecorded sheets, punched-coded holes on the sheets will automatically open the erase circuit. Among the auxiliary components used with the device is a magnetic sound printer that can make up to 15 copies simultaneously from one prerecorded sheet and a quantity of thin magnetic film that may be applied to the back of any sheet of paper to make it usable by the machine. The magnetic film has been applied to a newspaper sheet which was then run through conventional printing presses.

RECHARGEABLE CELLS—To supply power to transistor radios or other low-power devices, a miniature rechargeable cell has been developed. This alkaline cell is enclosed in an air-tight metal case whose size ranges from approximately $\frac{1}{2}$-in. to 2-in. in diameter and between $\frac{1}{4}$-in. and $\frac{1}{2}$-in. thick. The cells deliver between 3 and 1,000 milliampere hours at 1.25 v.

To recharge the cells, a small plastic-cased plug-in charger is used. The charger can hold a pair of cells and plugs directly into a wall socket. A neon-lamp indicator glows when the charger is in operation. Approximately 8 hours is required to charge the cells.

TRANSISTORIZED TV SETS—Two working experimental models of transistorized tv sets have been developed. The Toshiba set uses a 70-degree 14-in. cathode ray tube, 34 transistors and 12 diodes. The set is 11-in. high, 17-in. long, 15-in. wide and weighs about 40 lb. This developmental model uses external rechargeable batteries. The crt uses 11 kv generated by a vacuum tube circuit and total power consumption is 30 watts. Figure 5 shows one experimental model using an 8-in. crt.

The Hitachi set uses a 90-degree 14-in. crt, 32 transistors and 3 diodes. The set is 13-in. high, 15-in. long, 15-in. wide and weighs 40 lb including rechargeable batteries.

There are still several problems to be solved in transistor tv. What is needed includes: new type crt to fully exploit the advantages of transistor compact-

Table I—Fifteen-Transistor Radio Characteristics

	A-M	F-M
Frequency range	535–1,605 kc	88–108 mc
Intermediate frequency	455 kc	10.7 mc
Sensitivity	approx 70 μv	approx 20 μv
Selectivity	20 db (10 kc off)	3 db (150 kc off)
Antenna	built-in ferrite bar	rod antenna (75 ohms)
Output power	180 mw (max)	
Dimensions	3 × 8¼ × 9 in.)	
Weight	5.5 lb	

FIG. 4—(Left) Transistorized a-m/f-m portable showing extension antenna mounted in handle

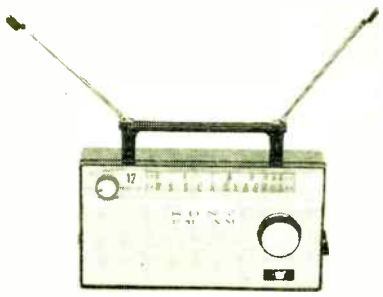
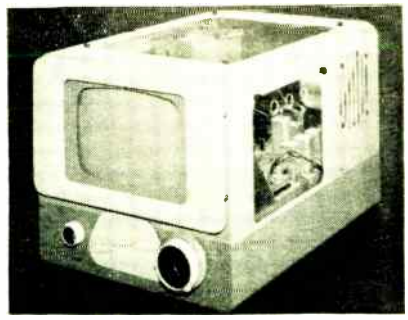


FIG. 5. (Right) Experimental model of transistorized tv set using an 8-in crt



ness; more compact and efficient batteries; and lower priced transistors.

OTHER EQUIPMENT — A number of Japanese manufacturers are now making industrial and scientific devices of excellent quality and performance.

A portable industrial 15-mev betatron having a ray focus of 0.1 x 0.1 mm making it useful for magnified radiographs.

A newly developed photoelectric colorimeter allows accurate and direct reading of required value of x, y, (chromaticity coordinates) and Y (luminance) by control of a photovoltaic cell. The colorimeter uses 3 filters instead of the 4 usually used to satisfy Luther conditions. The device is equipped with a luminance fluctuation compensator so that the chromaticity coordinates of flickering light can be directly measured.

A hand-foot radiation monitor incorporates alpha, beta and gamma detectors; also has an extension detector for checking clothes. The detector takes 10 seconds to operate and indicates the presence of contamination by indicator lamps.

Transistorized remote control and measuring equipment has selection signals binary coded with a parity check bit. The received code is sent back to be compared with the original code. Both selection and operation codes are frequency-shift modulated and transmitted over a control cable. The maximum number of controlled machines is 100. Measuring equipment is housed in an unmanned station and transmits information by vhf to the recorder station. One recorder station handles 10 unmanned stations. The recording stations report to the main station.

A three-axis numerically controlled milling machine has its axes controlled by a digital servo at a speed of 0-5.12 mm/sec. The tolerance is less than 0.05 mm at a speed of 3 mm/sec. The playback speed is 10 mm/sec.

An automatic curve tracer features a photodiode and transistorized head. The unit analyzes pulses in two axes. With ±0.05 mm to tolerance, the machine can trace a diagram as large as 1,600 x 1,250 mm at speeds up to 5 mm/sec and can enlarge up to 10 times the original diagram size.

A transistorized carrier telephone system provides 12 telephone channels over foamed polyethylene or paper-insulated cables on a two-wire basis. The unit uses frequencies from 6 to 54 kc in one direction and 60 to 108 kc in the other direction.

A multiplex communication system operating at

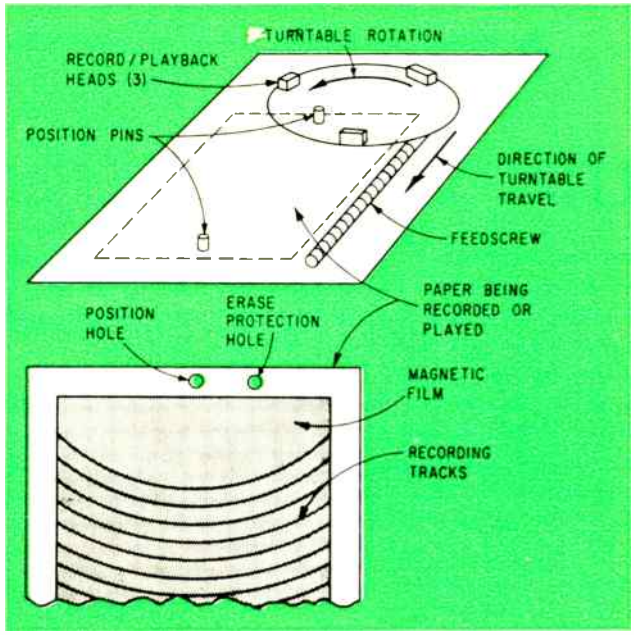


FIG. 6. Mechanical details of the talking book

14,000 mc is completely transistorized except for the klystron. The system can handle 6 single-sideband or 4 double-sideband channels. Provisions are made to expand the system so that it can accept up to 12 single-sideband channels.

SPECIAL-PURPOSE TUBES — The Japanese are also active in the special-tube field. One company makes heavy-duty rectifiers that have outputs up to 15 amperes at voltages of 200 v, counting tubes with speeds of 20 kc, current regulators that regulate up to 1.75 amperes and mercury-pool rectifiers with up to 100 amperes output at 250 v.

Many other special-purpose-tube types such as Geiger-Muller counters, multiplier phototubes, single- and double-beam cathode ray tubes, camera and monoscope tubes are also being developed and manufactured.

Another company is concentrating on the design and manufacture of microwave tubes. Such tubes as glass-to-metal and ceramic-to-metal disk-seal triodes delivering 15 w at 2,500 mc, reflex klystrons with output up to 500 mw at frequencies ranging to 7,060 mc, traveling-wave tubes operating at 10.7 and 11.7 kmc having a small signal gain of 30 db with an output of 0.7 w.

Increasing Counting

Use of transistors in this glow-tube counter results in a cost reduction of one-half and an increase in reliability. Units can be cascaded to read as high as 10^5 and are used in nuclear instrumentation

By **HENRY A. KAMPF,** Consulting Engineer, Packard Instrument Co., Inc., La Grange, Illinois

USING A COMBINATION of transistors and glow-transfer counting tubes results in an inexpensive approach to reliability for counting systems. The absence of vacuum tubes and the use of transistors that are either cut off or saturated results in a nearly ideal counter which is unaffected by power supply variations as large as 20 percent and temperatures as high as 60 C. A single low-speed decade complete with decimal readout can be produced at less than one-half the cost of conventional decimal counting units.

Glow-transfer counting tubes perform the function of counting and simultaneously provide visual readout by the position of the glow of the tube. Each glow tube requires two negative pulses to advance the glow from one cathode to the next. One of these pulses is fed to the first guide which advances the glow one-third of the way. The second pulse is fed to the second guide which advances the glow the second one-third of the distance from cathode to cathode. The glow finally advances the last one-third of the distance as the pulse driving the second guide falls to zero.[1, 2]

Pulse Timing

The negative pulses driving the guides are timed so that the second-guide pulse is nearly at full amplitude before the pulse at the first guide begins to fall as shown in Fig. 1A. Pulse amplitudes of at least 80 v are required to drive the tubes reliably.

Larger pulses produce faster glow transfer, giving faster counting rates. However, 80 v pulses will drive a GC10B glow tube at a rate of 1000 counts per second.

The pulse width also affects the counting rate. It is not possible to start glow transfer before the glow is resting on a cathode, and a finite time is required to transfer the glow from cathode to guide to guide to cathode; therefore a minimum period exists below which input pulses will not be resolved. Driving pulse width T_1 at one-half amplitude must not be wider than about 80 percent of T to allow for adequate glow-transfer time.

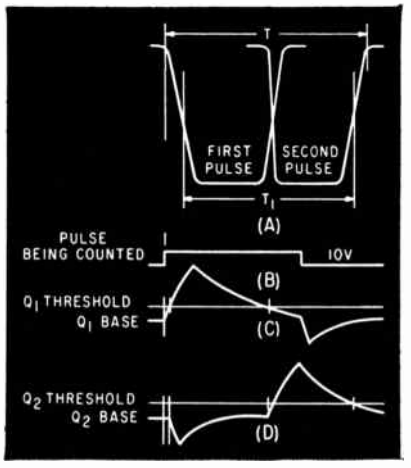
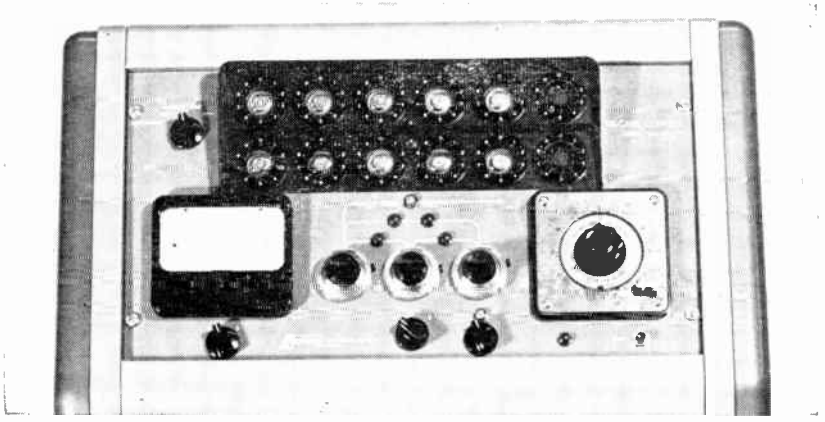


FIG. 1—Waveshape of pulses at the guides (A), input (B), transistor Q_1 (C) and transistor Q_2 (D) are shown

The circuit shown in Fig. 2 is a simple reliable circuit capable of 1-kc operation. It provides driving pulses of about 100 v. Since this driving-pulse amplitude is smaller than that usually used with the glow-transfer tube, it is necessary to make the output pulse widths wider than just described in order to accommodate the slower glow-transfer times. This circuit is essentially two amplifiers in cascade; both are saturated when no signals are present.

Circuit Operation

The positive input pulse is differentiated by the coupling capaci-



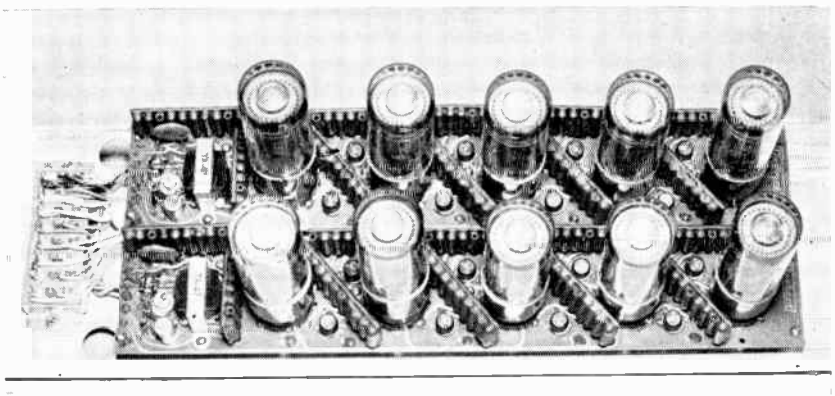
Reliable counter uses glow tubes and transistors

tor C_1 and R_1, the input resistor of transistor Q_1. The portion of this differentiated pulse that exceeds the cut-off threshold of Q_1, produces a large negative pulse at the collector of Q_1 as it is cut off. This pulse is fed to the first guide of the glow tube and also fed to transistor Q_2 to develop the second pulse. The pulse is differentiated by capacitor C_2 and R_2, the input resistor of Q_2.

Negative excursion of the signal at the base of Q_2 has no effect since Q_2 is already saturated. However, the positive part of this signal which exceeds the cut-off threshold of Q_2 causes the pulse output that is used to drive the second guide.

The time constant at the base of Q_1 controls the pulse width of the first pulse and the delay time of the second pulse. The time constant at the base of Q_2 controls the pulse width of the second pulse.

These 1-kc circuits are cascaded by connecting the input of one to the output of another. Registers as high as 10^7 have been obtained by using this method.



Printed circuit layout of 1-kc and 4-kc scaler aids in assembly and packaging

4-Kc Scaler

The circuit shown in Fig. 3 drives the glow tube at its maximum possible rate. It uses a single-shot multivibrator and step-up transformer T_1 to obtain the 300 v pulses necessary to drive the tube at its maximum rate of 4-kc. In this circuit the single driving pulse is fed to both guides at the same time.

The pulse arrives at the first guide after passing through differentiating network R_1 and C_1 while the pulse arriving at the second guide charges up capacitor C_2 of the pulse-stretching network. Therefore, as the pulse at the first guide is decaying the second guide-pulse voltage is still at a high value, and the glow is transferred as previously described.

The main-driving pulse width is determined by the multivibrator time constant and the pulse amplitude is determined by the loading on the step-up transformer. Pulse amplitudes as large as 300 v are obtained and, with a half-amplitude width of only 60 microseconds, are capable of driving the glow tube at a 4-kc rate. Some of the GC10B tubes have counted as fast as 6 kc with this circuit.

These circuits are quite tolerant of component variations in production and are used in the counting system of liquid scintillation spectrometers and other nuclear instrumentation.

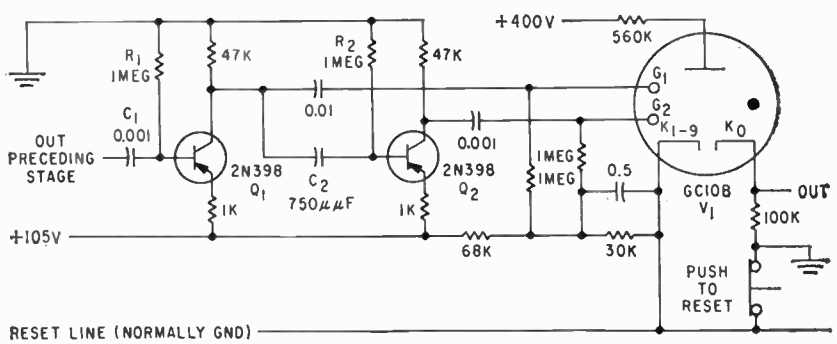


FIG. 2—Circuit for 1-kc scaler uses 5-percent tolerance resistors and 10-percent tolerance capacitors

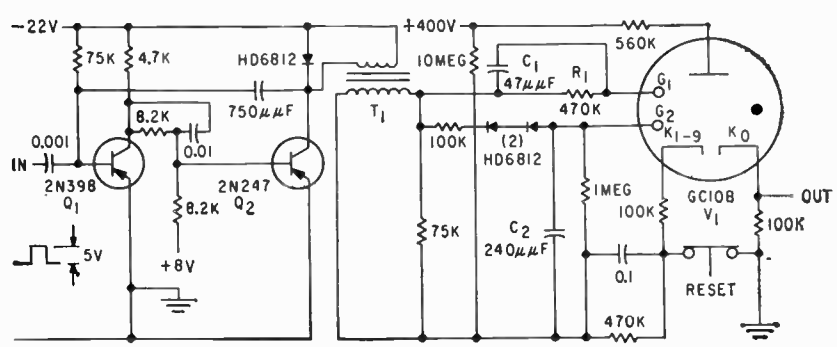


FIG. 3—All capacitors and resistors of 4-kc scaler have tolerance of 5-percent

References

(1) J. H. L. McAsulan and K. J. Brimley, Polycathode Counter Tube Application, ELECTRONICS, p 138, Nov. 1953.

(2) R. C. Bacon and J. R. Pollard, The Dekatron, *Electronic Engineering*, p 173, May 1950.

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Staff Member, MIT, Lincoln Laboratory, Lexington, Mass.

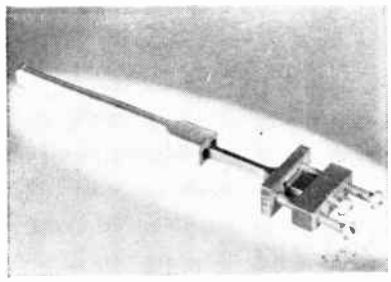

FIG. 1—Electroforming of transition piece eliminates problems of machining and assembling

Electroforming of Intricate

Because electroforming permits intricate and complex shapes to be produced accurately and economically, it provides a valuable tool for the engineer concerned with the design, development and production of quality components

ELECTRONICS ENGINEERS working on microwave transmission systems often require a knowledge of production techniques to design equipment properly. Electroforming, a refinement of electroplating, has found extensive application in the manufacture of microwave hardware.[1] Its applications are limited only by its users.

Electroforming is a process by which metal parts can be made accurately by electrochemical deposition of metal onto a mandrel or into a mold. Parts that are impossible or costly to make by standard machine shop practices can frequently be produced economically by electroforming methods. This plating technique provides close control of tolerances of intricate shapes and produces smooth interior finishes of high quality.

Electroforming Process

There are four basic steps in the electroforming process: preparation of electroplating bath, preparation of the mandrel and its placement in the electrochemical bath, metal build-up and removal of the component from mandrel or mold without damage to the shell of deposited metal.

The preparation of the electroplating bath follows usual procedures in electrochemistry. The nature of the bath depends upon the metal to be deposited.

Mandrels or molds are made of stainless steel, aluminum, plastic and other materials. The manner in which mandrels are treated for the electroforming process depends upon the material of which they are made. Details of a reliable procedure for treating plastic mandrels are given in the box.

After treatment, the mandrel is placed in the electroplating bath as the cathode and receives positive metal ions from the electrolyte. The applied voltage is usually from 1 to 3 v d-c and, in general, current densities of 40 amp per sq ft of plating area are used.

For a given current density, the thickness of the deposited metal is a function of plating time. As long as the current flows in the same direction and the mandrel is the cathode, thickness of plated metal is directly proportional to plating time. This linear relation does not apply if the direction of current is periodically reversed. Periodic reversal of current improves the smoothness of deposit and surface finish. With periodic current reversal and current densities of 40 amp per sq ft, metal deposition rate is about 0.0015 in. per hr. When the deposited metal has been built up to the desired thickness (preferably 0.040 in. or more) the mandrel and plated shell are removed from the electroplating bath.

Finally, the electroform is removed from the mandrel. A plastic mandrel shrinks upon cooling and can be removed from the electroform by subjecting both to a decrease in temperature. Aluminum mandrels are removed from copper electroforms by dissolving or etching the aluminum with solutions that do not attack copper. Stainless steel mandrels may be pushed away from the electroform at ambient temperatures, or rapid heating, making use of the differential thermal conductivity between steel and copper, can be used.

Mandrels

Stainless steel mandrels are used for electroforms that can be separated physically. In other words, the mandrel should not have any negative or reverse drafts. A stainless steel mandrel is quite durable and can be used repeatedly. Accidental nicks and scratches are the usual reasons for retiring a stainless steel mandrel.

If the mandrel is of such complex geometry that it cannot be separated, it must be dissolved. Alumi-

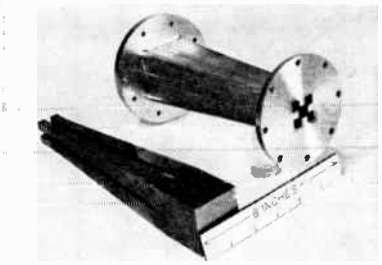

FIG. 2—Waveguide is built using a combination of electroforming and machining techniques

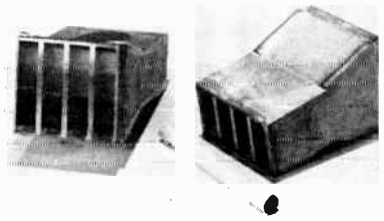

FIG. 3—Four-cavity waveguide transition uses aluminum mandrel which is dissolved out

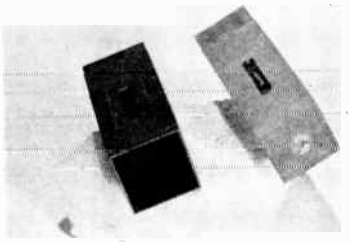

FIG. 4—Plastic mandrel for guide is chemically silvered using process outlined in box on next page

Electronic Components

num mandrels etch-out readily in sodium hydroxide (lye or caustic soda). Considering machining tolerances, aluminum mandrels are excellent but unfortunately can be used only once.

When using aluminum, there is a slight sacrifice of finish as compared to an equally finished stainless steel product because of the zincate step in the aluminum mandrel processing. The zincate coating leaves a matte finish compared to a mirror-like result from the direct copper plating on the equally finished stainless steel mandrel. In practically all radar plumbing applications this difference is of no significance.

As has been indicated stainless steel and aluminum mandrels are sufficiently versatile to perform almost all standard electroform requirements. However, a plastic mandrel can be effectively utilized when one-shot job with tolerances of ± 0.003 in. or looser is involved. Plastics are subject to cold-flow internal stresses and exhibit some dimensional hystereses on cooling, thereby limiting their reuse because of dimensional changes.

Plastic mandrels are also useful when economy and ease of machining are paramount and where the bulk of the mandrel introduces a size and weight problem.

An example of a precision part produced on a stainless steel mandrel is the h-f transition piece shown in Fig 1. The finished inner dimensions of the guide measure 0.074×0.080 in. at one end with a one-inch taper section to 0.034×0.020 in. A tolerance better than $\pm$ 0.5 mil is held throughout. The fixture end of the mandrel is enlarged to 0.234×0.148 in. to facilitate the removal of the jig.

Figure 2 shows another waveguide built up on a stainless steel mandrel. The orientation of the waveguide and mandrel are inverted to show the intricacies of the transition more clearly. Feathering of the brass inserts can be noted from the mandrel groove pattern. The flanges are soldered in place but the brass inserts are fastened by electroplating. This is accomplished by holding the four brass inserts closely to the stainless steel mandrel until a 5 to 6 mil thickness of metal is deposited. Then the clamps are removed and the electroforming continued. No machining is done on the body proper, which is over $\frac{1}{4}$ in. thick.

The slotted four-cavity waveguide transition shown in Fig. 3 is made by sandwiching four aluminum plates with three brass separators. The assembly is bolted together beyond the usable waveguide portion. The mandrel is machined and the bolt area stopped off. After electroforming with copper, the aluminum is dissolved out with caustic soda. Soldering and annoying solder residues are eliminated by using this approach. Tolerances are easily maintained and alignment of plates is not a problem.

A dimensionally stable and easily machined plastic is Rexolite, a styrene copolymer. A Rexolite step mandrel and electroformed guide are shown in Fig. 4. The center cut-

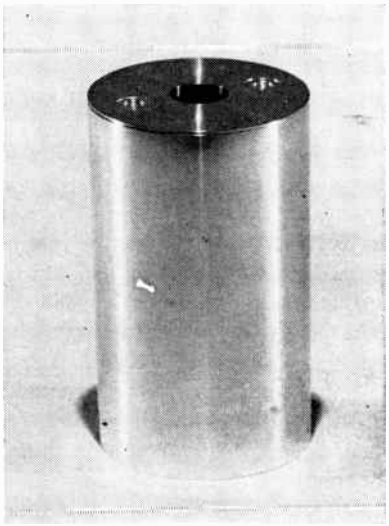

FIG. 5—Lead is used as inside lining of this radar-frequency tuner

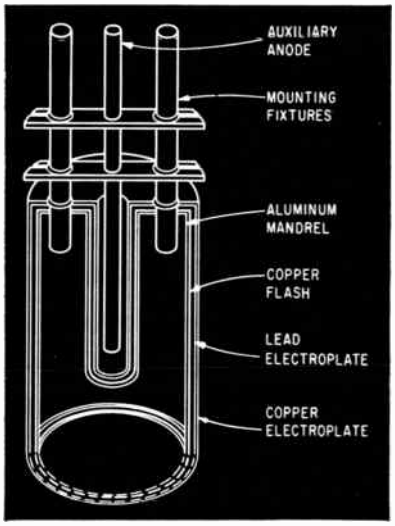

FIG. 6—Cross-section of tuner shows method of obtaining lead lining

out is electroformed in place. This is done by placing an unmetallized plastic spacer on the chemically silvered mandrel.

The mandrel for making a radar-frequency tuner in which no foreign metal is present other than lead as an inside lining is shown in Fig. 5. This mandrel is made by press fitting various aluminum parts into the assembly shown.

A series of metal deposits are made as indicated in Fig. 6. After electrodeposition, the mounting fixtures and auxiliary anode are removed and the holes enlarged. The bottom of the inside tube is opened, permitting easy solution etching of the aluminum mandrel. Copper flash coating over the aluminum is removed with a sulphuric-chromic acid solution and lead chromates that form on the lead are removed by a chelating cleaner. Figure 7 shows the resultant product after final chemical treatment but before any electrical adapters have been mounted. Preliminary tests have yielded good results.

A variation from the usual electroforming is the making of maser traveling waveguides. These components are electroplated with the mandrel becoming an integral part of the guide. Since they operate at liquid-helium temperatures, it is desirable to limit the copper wall thickness to a minimum because of the different coefficients of expansion of the materials involved. A prototype with a wall thickness of 10-15 mils has been made.

The guides are usually filled with crystalline-like materials that have been precision cut at particular orientations. One section of the guide may require a different dielectric than the other for matching electromagnetic field requirements. The alignment jig and dielectric crystal mandrel are shown in Fig. 8. Note the nine sections which include two triple-layer, sandwich-like sections. Eight joints must be made intact.

Initially, the exposed areas of the guide are metallized with silver by the silver mirror technique (see box). The silver is about 10 millionth inch thick. Copper electroplating deposits a strap around all the joints, and, after this 5 to 6 mil deposit, the unit is usually physically sound and may be handled with care. The maser guide is removed from the jig. The areas that were in intimate contact with the jig are remetallized with copper after a copper oxide treatment. The last innovation insures the bonding of the chemically-deposited copper to the already present copper plate[2].

Although alternative fabrication techniques are possible, they usually leave undesirable air gaps between the dielectric and the waveguide that this electroplating eliminates completely.

Mandrel Removal

One of the most fundamental requirements in electroforming is to be able to remove the mandrel from the electroform. This is not a problem with plastic mandrels because of the large difference in the expansion coefficients between plastic and copper. Separation of this composite is the easiest of the mandrels being discussed. Because the plastic has an expansion coefficient six times greater than copper, cooling in dry ice shrinks the plastic so that it practically falls out.

When dealing with stainless steel mandrels two properties should be considered. Although the coefficients of expansion of copper and stainless steel are quite similar, there is a significant difference in their heat conductivity with copper able to conduct heat about 100 times faster than steel. Therefore, on troublesome separations quick heating of the electroform will facilitate removal.

On properly treated mandrels it is rarely necessary to introduce this rapid heating step. The force necessary to remove a new mandrel is in the order of 60 psi of intimate surface contact area. Once the mandrel has been broken in the release force can be as low as 30 psi.

Tests have been run on sample guides and compressive forces recorded. It was convenient and informative to separate most of the small electroforms with the tensile jaws of the tester and record the tensile force pattern.

Treatment for Plastics

The dielectric is made conducting by using the popular silver mirror process.[1] Of the innumerable formulations available, the following has proved reliable.

1. The plastic mandrel should be capable of being wet, indicating a high degree of cleanliness.

2. Immerse the dielectric to be silvered in the sensitizer solution for one minute and follow with a thorough water rinsing (distilled or demineralized water is used in this process.

Sensitizer Solution

Stannous chloride	100 g
Hydrochloric acid	400 cc
Nonionic wetting agent	
Aerosol OS (by weight)	0.1%
Water to moke 4 liters	

3. Immerse in a silvering solution made up of the following solutions:

Solution 1

Silver nitrate	100 g
Water	1,000 cc

Solution 2

Sodium hydroxide	100 g
Water	1,000 cc

Solution 3

Ammonium hydroxide	400 cc
Water	600 cc

Silvering solution

50 parts solution 2
40 parts solution 3
1,250 parts water

Reducer Solution

Cane sugar	90 g
Nitric acid	4 ml
Ethyl alcohol	175 ml
Water to make 1 liter	
Age for one week	

To the silvering solution of 2 and 3, add approximately 150 parts of solution 1. Balance solution 3 and 1 until a light brown colloidal dispersion results. Use enough solution to cover the article or mandrel to be coated, and add 1 cc of reducer solution for every 20 cc of silvering solution. It is convenient to use graduated cylinders where possible, so that the volume of solution and additions are readily discernible.

4. Silvering takes place immediately, but the process is permitted to continue for 5 minutes. There should be no skips evident. However, after an initial flash of electroplate, it is sometimes possible to touch up a skip carefully with a conducting silver paint. Resilvering without stripping is sometimes practical. Cleanliness is essential. If the plastic specimen does not water wet initially, it is a good indication that the entire silvering operation will also be unsuccessful

Some experiments have been performed to evaluate brass mandrels. It would be advantageous to substitute the more machinable brass mandrel for stainless steel.

The brass treatment procedure involves the deposition of a silver immersion film on the brass followed by the conversion of this film to silver iodide. A film of graphite is then applied. This lowers the release force from 700 psi of surface area to 300 psi when separating the electroform from the brass mandrel. Heating offers no assistance in separating. The separation force is about 5 to 10 times greater than that for stainless steel mandrels.

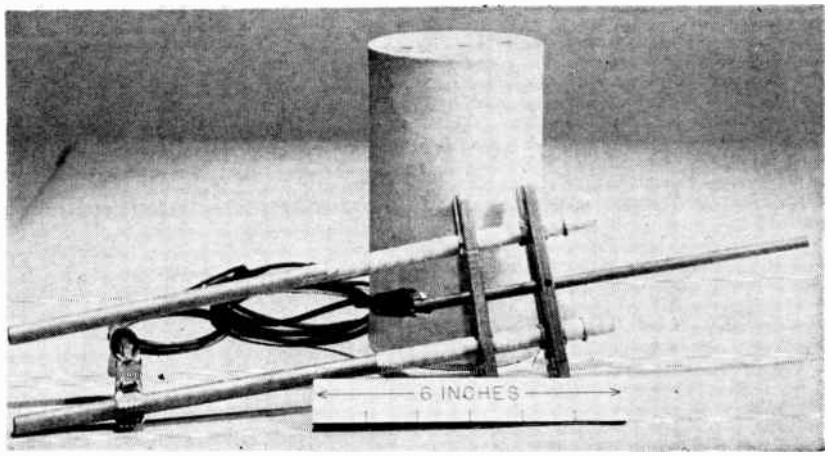

FIG. 7—Preliminary tests of tuner indicate satisfactory operation

Stress

Electrolytically deposited metal can be highly stressed both in tension and compression. Additions agents, temperature of deposition, current density, periodic reverse and solution concentration all seem to influence stress level.

Forces involved in acid copper electroplating were measured.[3] Unfortunately the results have not been sufficiently consistent to yield definite conclusions. However, if a relatively large amount of addition agent is used, large stresses can result. Actual stress cracks have occurred on certain shape objects (spheres), where the geometry would be weak under tension stresses. The remedy is to limit the amount of addition agent. There appears to be little difference in stress level between straight plating and periodic-reverse plating.

Strain experiments to correlate the data are being conducted to determine the mode of distortion that could take place in electroform sections. Additional stress measurements are planned for the above copper electrolyte. Initial results indicate that compression forces are involved when the addition agent is omitted but that periodic reversal of the current direction lessens these forces.

Periodic Reverse

Periodically reversing the direction of the electrolysis results in good leveling. Without this periodic reversal, metal deposition is usually excessively nodular and irregular at high current density points such as projections, outside corners and ridges.

The Russians have reported similar findings[4]. They report that their results indicate that the mechanism of periodic reversal is as follows: The first cathode impulse deposits copper crystals of a definite orientation controlled by the mandrel surface. The anode film impulses formed a transparent film of cuprous oxide or cuprous hydroxide. The next impulses deposit copper crystals and the same type of film. The orientation of the copper crystal in the second layer is the same as in the first. This continues in every cycle until the end. Orientation of the final copper crystal is the same as the first, regardless of the thickness of the deposit.

A simple example of the results of periodic reversal would be to illustrate the deposition pattern on a brass metal plate 4 × 2.5 × 0.040 in. After a 15-hour periodic reversal deposit, the corners and edges of this brass plate would be 30 percent less nodular than the straight plated sample. Experiments have not clearly indicated the exact period for optimum leveling, but have shown the decided advantage over straight plating.

In these experiments a 20-sec cathodic interval and a 5-sec anodic plate interval were used. It has been reported[5] that optimum conditions for copper electrode-position with periodic reversal are: Total period of 15, 25 or 40 seconds with a ratio of cathodic time to anodic time of 7.

The work reported here was performed by Lincoln Laboratory, a center for research, operated by MIT with the joint support of the U. S. Army, Navy and Air Force.

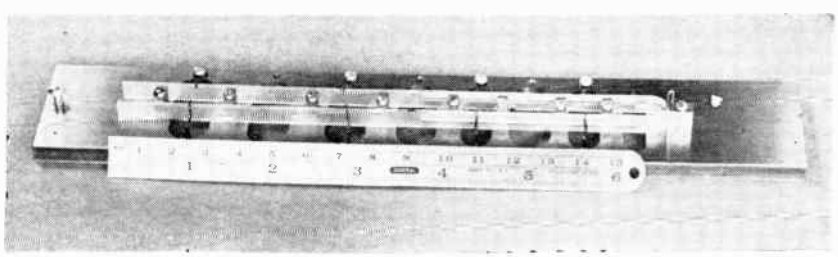

FIG. 8—Use of electroforming to make maser traveling waveguides eliminates air gaps

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Low-Distortion Transistor

Monitor amplifier for broadcast duty uses production lot power transistors for high fidelity and low distortion. Technique has other applications

By **HAROLD J. PAZ,** Radio Corporation of America, Camden, New Jersey

POWER TRANSISTORS are used in this monitor amplifier to eliminate the problems of hum, microphonics and heat. In addition, a reduction of size is obtained which is of value in many presently cramped studios.

The design objective was to produce a low-distortion, high-fidelity all-transistor power amplifier that does not require laboratory adjustment and selection of power transistors. Most present amplifiers require a power transistor with a beta cutoff of 30 kc for low distortion at 15 kc. But presently available power transistors have beta cutoffs of about 6 to 9 kc.

Distortion

There are a number of reasons for distortion at midband frequencies with presently available power transistors. In a class-B amplifier, beta mismatch distortion will cause one-half of the output signal to be larger than the other. There is, of course, a wide variation in the current gain, beta, of most types of power transistors.

The input impedance of a transistor has an effect on the gain and distortion of the driver and output stage. The common-emitter input impedance is $z_{in} = r_b + (\beta + 1)\, r_e$, where r_b is the base resistance, r_e is the emitter resistance and β is the current gain. But r_b, r_e and β are all inversely proportional to the current flow in the emitter. Typically, the input impedance can change from 2,000 ohms at an emitter current of 1 ma to 15 ohms at 1 amp.

Changes in the large signal current transfer ratio with the input base current drive is another reason for distortion in a high-power transistor amplifier. Figure 1 shows how rapidly the current transfer ratio of a power transistor decreases with collector current. The current transfer ratio is 140 at 100 ma but decreases to 60 at 1 amp.

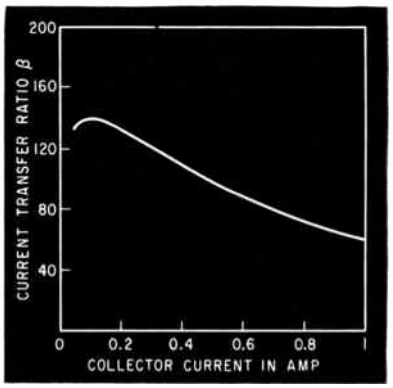
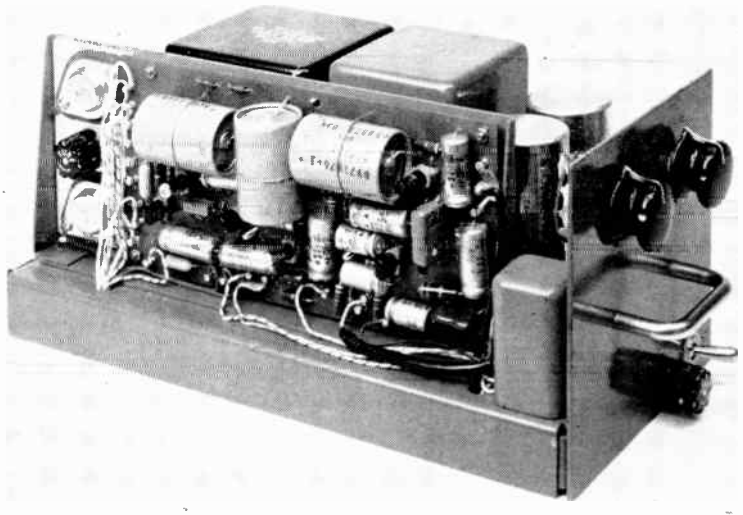


FIG. 1—Current transfer ratio, beta, of a 2N301 or 2N301A power transistor varies with collector current

Local Negative Feedback

A new approach to the problem uses negative feedback to shift the dependence for ultralinear amplification from the critical selection of the power transistor to the circuit design. Negative feedback may be used to improve frequency response and reduce distortion. However, in a transistor amplifier using four or five stages, too much loop feedback can result in oscillation. The phase shift in each stage of a transistor amplifier is great. Therefore, the total phase shift of the amplifier greatly limits the maximum amount of loop feedback. Hence, loop feedback is not as successful in reducing distortion in a transistor power amplifier as local feedback.

An unbypassed emitter resistor provides local negative feedback. This external emitter resistor must be larger than the internal transistor emitter resistance. Low dis-



Transistorized monitor amplifier is 5 in. wide, 4¾ in. high and 12 in. long

Monitor Amplifier

tortion in a transistor amplifier is obtained when the transistor is driven by a low impedance source. Since the input impedance of a transistor operating in class B varies considerably with emitter current, a shunt resistor at the base input terminal will control this impedance variation. When using the 2N301A power transistor, a shunt base resistor 15 to 18 times the unbypassed emitter resistor will provide enough local feedback to control the effective current gain as well as the input impedance. This local feedback also compensates for beta mismatch, beta variation with base current drive and phase shift, and boosts the beta cutoff frequency from 9,000 to 30,000 cps.

Hybrid Transistor Amplifier

The new approach is a hybrid of the series[1] and the quasicomplementary[2] transistor amplifiers and is shown in Fig. 2. The input stage, Q_1, is a low-level class-A stage.

The complementary symmetry pair of transistors, Q_2 and Q_3, is used as a class-B direct-coupled phase inverter. Transistors Q_2 and Q_3 are directly connected to Q_4 and Q_5 which are two *pnp* transistors operating in class B and are used to drive the output pair of transistors, Q_6 and Q_7. Transistors Q_4 and Q_5 are coupled to Q_6 and Q_7 in a way similar to that used in the series power amplifier.

Local feedback has an important effect on the high-frequency response and distortion. By careful selection of resistors R_2 through R_7, local negative feedback is introduced. Surprisingly low distortion is measured when the ratio of R_4 to R_6 and R_5 to R_7 is 15 and the ratio R_2 to R_4 and R_3 to R_5 is 18.

Circuit Operation

In Fig. 2A, the collector voltage of Q_4 is one-half the supply voltage, V_{cc}, at zero input signal. The complementary symmetry phase inverter, Q_2 and Q_3, does not have a potential across the base to emitter junction because the output capac-

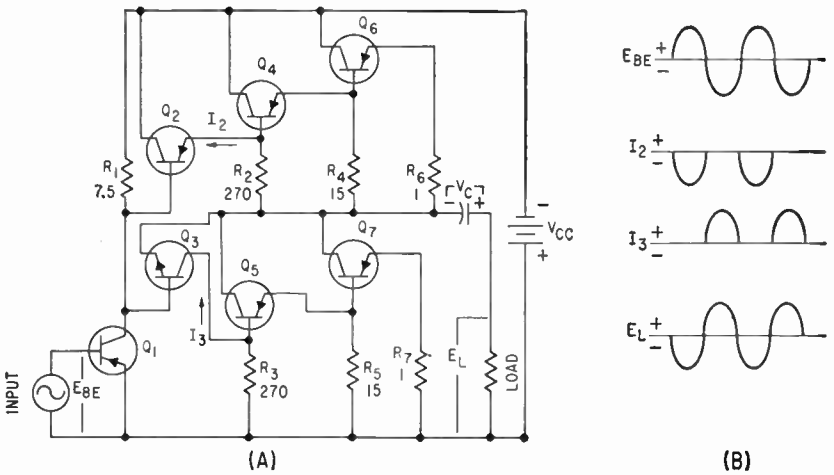
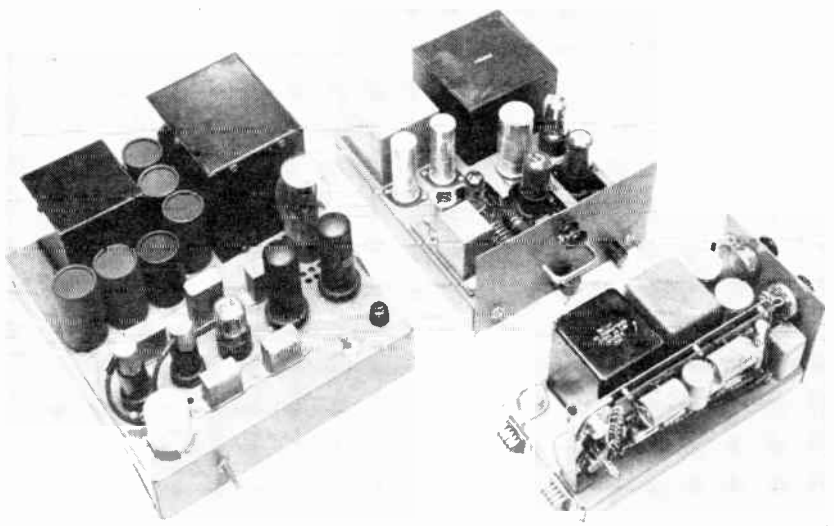


FIG. 2—The basic circuit of the hybrid power amplifier (A); and circuit waveforms (B)



Obsolete monitor amplifier is shown at left. New transistorized unit is shown at lower right and unit it replaces is in the center

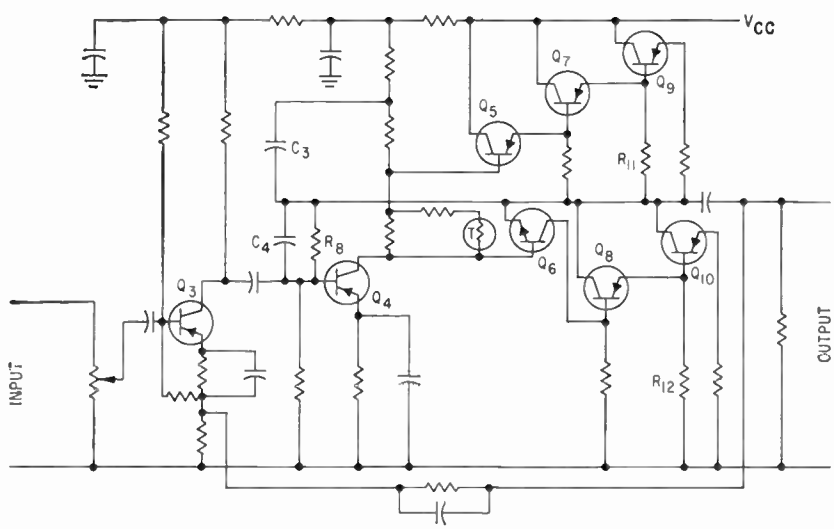


FIG. 3—Practical circuit of the hybrid complementary symmetry amplifier. Output at 10 w has less than 0.25-percent distortion

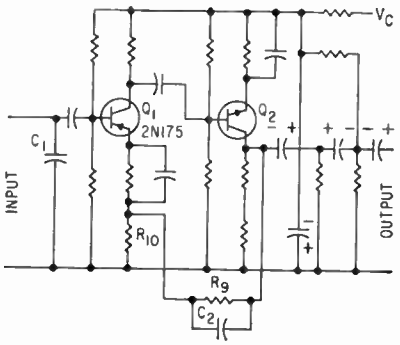


FIG. 4—Low-noise preamplifier has loop feedback and low-frequency noise filter at output

itor voltage V_c is equal to the collector voltage of Q_1.

If the collector voltage of Q_1 becomes more negative, then the base of Q_2 will be more negative than the emitter. This will turn on Q_2 and a voltage drop will appear across R_3. This voltage drop causes Q_4 and Q_6 to conduct. The base voltage that causes Q_2 to conduct is also applied to Q_5. This puts a reverse bias on Q_3 which prevents conduction. Since Q_3 is cutoff, Q_5 and Q_7 are also cutoff.

Thus the top half of the circuit, Q_2, Q_4 and Q_6, conducts only when the collector voltage of Q_1 is greater than $V_{cc}/2$, or when the base to emitter signal voltage E_{BE} of Q_1 is positive. When E_{BE} is negative, the collector voltage of Q_1 becomes less negative than the capacitor voltage V_c. This makes the emitter of the *npn* transistor Q_3 more negative than the base, and starts conduction in the transistor. However, this potential prevents conduction in *pnp* transistor Q_2.

As the *npn* transistor conducts, it produces a voltage drop across R_3 which puts Q_5 and Q_7 into conduction. Fig. 2B shows the relationship between input voltage E_{BE} and the current flow in Q_2 and Q_3. Notice

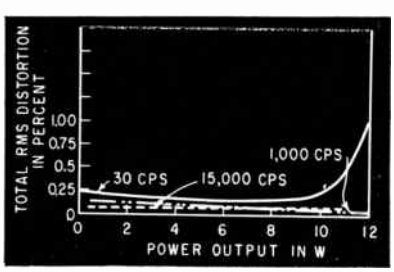


FIG. 5—Distortion of hybrid amplifier is less than 0.25 percent over frequency range from 30 to 15,000 cps

that the voltage across the load, E_L, is 180 deg out of phase with the input signal E_{BE}.

The practical hybrid complementary symmetry circuit shown in Fig. 3 is part of a transistor monitor amplifier which is designed for use in broadcast studios. Used with a two transistor preamp, the circuit provides 104 db of gain. This gain is enough to permit a microphone to drive 10 w of power into a loud speaker.

The input impedance of Q_3 should be high to prevent loading of the transistor noise filter used in the preamplifier. Capacitor C_3 provides positive feedback to the driver stage Q_4. The output stage operates at full power efficiently because the positive feedback reduces the drive

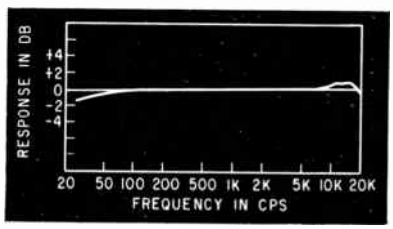


FIG. 6—Frequency response is within ±2db from 30 to 20,000 cps

voltage requirement. To reduce phase shift in Q_3, a drift transistor, type 2N247 was selected. The network R_3C_1 provides a third internal feedback loop from the output to the base of Q_1. High-frequency stability is improved by this loop.

Preamplifier

A two stage preamplifier is shown in Fig. 4. Transistor Q_1 is a low-noise element which can handle a high-input level without distortion because of loop negative feedback. Resistor R_3 feeds back some of the collector current to the emitter of Q_1. To keep low-frequency phase shift at a minimum, a series capacitor is not used in the feedback loop. The emitter feedback increases the input impedance of Q_1 and decreases the loading on the signal source. For good low-frequency response from a ribbon type microphone, the input impedance of the transistor amplifier should be over 4,000 ohms. Resistors R_9 and R_{10} should be 1-percent carbon film resistors to control preamplifier noise and gain. The preamplifier does not like to see an inductive load at the input terminals so capacitor C_1 is used. Capacitor C_2 is used to limit the preamplifier bandwidth.

A three-section R-C filter is used to cutoff the low-frequency response of the preamplifier. This network will filter out the low-frenquency transistor noise content. Transistor noise is also called flicker noise and is quite large below 30 cps.

Temperature Stability

Since the hybrid complementary symmetry amplifier (Fig. 3) uses direct coupling, control of the d-c collector current of Q_1 is important for temperature stability. Any drift here is amplified by the three direct-coupled class-B stages. Since the transistors operate in the class-B mode, the resistance of R_{11} and R_{12} is kept low enough to shunt most of the temperature sensitive leakage current, I_{co}, thus preventing its amplification. The thermal change in collector current of the class-B stage is mostly caused by a change in the transconductance of the transistor. To compensate for this, a thermistor is used to stabilize the quiescent operating point.

Distortion of the 10-w amplifier is shown in Fig. 5. At 10-w output, distortion is less than 0.25 percent over the complete frequency range. At 30 cps, distortion begins to rise at 10 watts because the filtering action of the power supply decreases with signal frequency.

Frequency response of the monitor amplifier is shown in Fig. 6 for an output of 1 w. When terminated with the recommended impedance the response is within ±2 db from 20 to 20,000 cps.

A model of the hybrid power amplifier is shown in the photographs. A metering switch is provided to measure transistor voltages. Input and output transformers are used to provide circuit isolation, with input impedances of 37.5, 150 or 600 ohms. The output transformer can handle loads of 4, 8, 16, 150 or 600 ohms.

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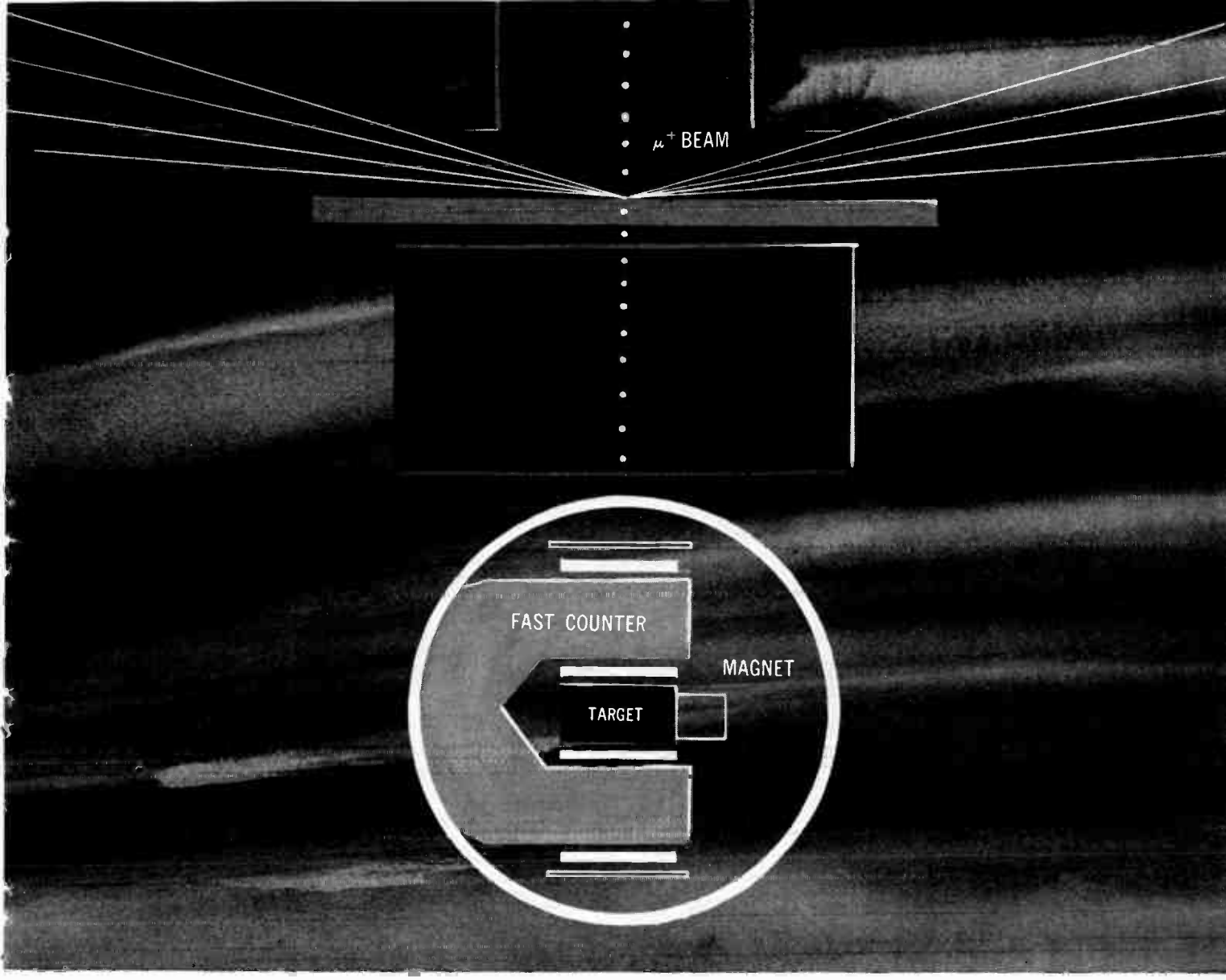


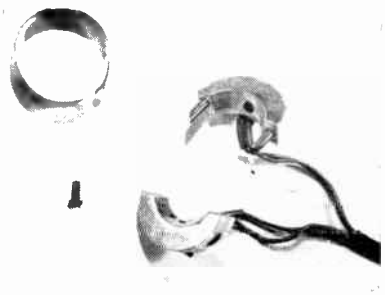
Report from IBM *Yorktown Research Center, New York*

THE IMPORT OF POLARIZED MESON BEAMS

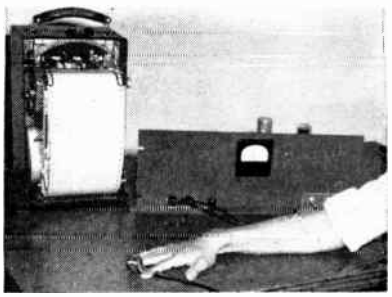
Study of meson decay has led to further confirmation of parity nonconservation in "weak" interactions of high-energy particles by a group of scientists of the Columbia University Physics Department and the IBM Watson Laboratory at Columbia. Their work has also uncovered important new knowledge of the meson particle itself.

When T. D. Lee and C. N. Yang first proposed their now famous hypothesis of parity nonconservation, they pointed out that it implied a polarization of the spin of the μ meson emitted from stopped π mesons. About two years ago, precise experiments by R. L. Garwin and L. M. Lederman verified this predicted polarization with meson beams extracted from the Columbia University Nevis Cyclotron. More recently, polarized meson beams were used to measure accurately the magnetic moment of the μ meson. This experiment required apparatus for measuring time to 2/10,000 of a microsecond.

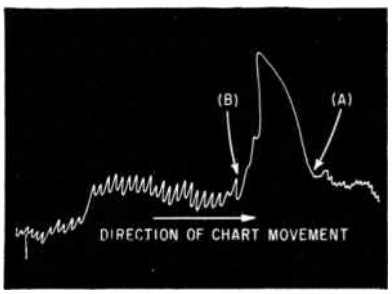
As a result of these studies and other independent investigations, the meson is now probably better understood than any particle except the electron. In fact, polarized meson beams have become a powerful tool for exploring magnetic fields in nuclei, atoms and interatomic regions.



Plethysmagraph consists of two sections that mate with guide pins and are held together with spring clip band



Digital plethysmagraph is placed on finger. Spring clip insures tight but comfortable fit



Recording shows where subject took a deep breath at (A). Expiration of breath is followed by regression of baseline at (B)

Miniature Photocell Measures Blood Volume

Compact finger plethysmograph features ease of application, negligible lag and insensitivity to minor muscular movements

By **HENRY E. GUTTMANN,** Department of Psychology, University of Washington, Seattle, Wash.

CERTAIN MEDICAL diagnosis often requires knowledge of the amount of blood occurring in a limb or organ of the body.

With the availability of miniature photosensitive components, a device has been constructed that measures the amount of blood and the pulse rate occurring within a finger. Such a device is called a digital plethysmograph.

Construction

The device consists essentially of a split-ring assembly that is adjustable for different finger sizes as shown in the photo. One part of the split ring has guide pins which mate with corresponding holes in the other half. A spring clip bands the entire assembly and maintains a comfortable fit around the finger.

One of the halves is drilled to hold a miniature lamp while the mating half houses a miniature photocell with its sensitive surface opposing the light source. The amount of blood in the tissues at any instant determines the amount of light reaching the photocell. When a d-c amplifier is used, the slow changes due to relaxation or dilation of blood vessels or the more rapid pulse changes may be recorded. The photocell is connected in a conventional bridge circuit, and output is amplified and applied to a recording device.

Operation

The plethysmograph is placed on the subject's finger and the bridge is balanced to zero the recording device. Amplifier gain is adjusted until a suitable indication of the recording device occurs with the pulse beat. As ambient light may cause noise in the recording, an opaque cloth is placed over the hand and plethysmograph.

The device is relatively insensitive to minor muscle movements making it superior to the conventional hydraulic plethysmograph. In one study, it was required that the subject receive a mild electrical shock at intervals. The hydraulic unit was found unsuitable because of its sensitivity to the mild flinching that occurred. The photoelectric unit produces an essentially uncontaminated output.

Output of the photocell used was reasonably high. With 45 v applied to the bridge, an output of over 50 mv was obtained with the average pulse. The amplifier uses two tubes and a silicon chopper. Inexpensive germanium diodes have been used in the chopper with excellent results.

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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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Ultrasonic Camera Supplements X-rays

PROTOTYPE tv camera works from sound instead of light waves. It can display internal structures of materials and of biological specimens. The system was described at The Institution of Electrical Engineers, London. It was built by C. N. Smyth and J. F. Sayers with support of R. W. Paul Instrument Fund Committee at Northampton College of Advanced Technology, London.

Internal flaws in blocks of aluminum immersed in a tank of water reveal their shape and size clearly. Electroplating that poorly adheres to the base metal shows as dark patches. Internal parts of goldfish and of some medical specimens can also be seen clearly. Sound intensities used are too small to have adverse biological effects, an important factor in examination of body regions sensitive to X-rays.

Ultrasonic Camera

The ultrasonic tv camera differs from ordinary tv cameras in that the light-sensitive surface is replaced by a sound-sensitive (piezoelectric) image-receiving surface. The quartz surface, under impact of sound waves, develops on each point of its surface a voltage proportional to sound intensity. The value of this voltage is detected, point-by-point, by electronic scanning. After amplification, the signal voltage controls brightness of a tv receiver to produce a visible image of the invisible internal structure under examination.

The equipment takes advantage of the fact that sound waves can be focused with lenses, and images of objects exposed to sound can be formed and reproduced at a distance. At frequencies from 1 to 20 mc, sound wavelengths in water or oil are only fractions of a millimeter and sound lenses 10 cm across are very efficient.

In operation, the object is immersed in a c-w ultrasonic field. The resulting image is formed on the piezoelectric plate, which is the end wall of the scanning tube.

Tube Operation

The ultrasonic illumination is switched on for alternate frames only. During the frame in which the ultrasonic source is on, electrons arrive at the insulating surface during positive half cycles of the piezoelectric alternating potential. The surface becomes negatively charged to its peak value. The outer surface of the quartz plate rests against a conducting electrode, transparent to sound, and is grounded at sound frequency (4 mc) but not at the output signal range of frequencies (0 to 2 mc). Current flow to this electrode is the output signal from the camera.

The static charge produced on the quartz must be removed before the camera can rescan the picture. The tube contains residual gas at a pressure of about 10^{-6} mm Hg. The scanning beam consists of mixed ions and electrons. An ion trap mesh is placed about 1 cm from the quartz, and only ions produced in this space are able to reach the quartz. When the surface of the quartz is positively charged, it collects negative charge predominantly from the electrons; when it is negatively charged, it collects positively charged ions only. The mixed beam therefore stabilizes the surface at cathode potential. To make times of charging and discharging frames equal, beam current is increased during alternate frames to provide enough ion current in the time available.

Construction

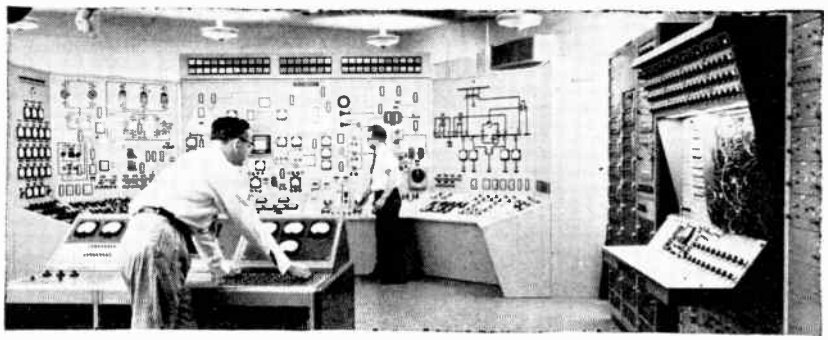
The camera comprises a 4.5-cm diameter glass envelope, fitted at one end with a crt gun and zirconium getter wire. At the other end is the ion trap screen and the quartz plate with an intervening annulus of nonmagnetic steel to maintain an orthogonal electric field in the decelerating space.

The possibility that a single piece of piezoelectric material would, if damped by a liquid, sustain a varying vibration intensity distribution over its surface in synchronism with the driving force distribution, rather than resonate as a whole, was first suggested by Sokolov.

Quartz has a good piezoelectric sensitivity, producing at 4 mc a camera face voltage of 150 mv for an incident sound intensity of 1 $\mu w/cm^2$. In the absence of interfering effects from the scanning system, sensitivity would be limited by noise at about 10^{-7} w/cm^2. At these low sound levels there is no damage to biological tissues.

The Q of quartz damped on one surface by a liquid is reduced to about 18, under which conditions there is little loss of image resolving power due to the multiple internal reflections. The first interference fringe or halo is more that 20 db below the main signal. Resolution is about 0.5 mm at 4 mc. Cameras are operated in or near resonance to produce strain in the quartz, one surface of which is free.

Simulator for Nuclear Ship Crew



Analog computer is heart of Westinghouse simulator for training crew of nuclear ship N.S. Savonnah. In addition to orders from the bridge, instructors can simulate malfunctions. Strip charts record crew's reactions

Computer Design May Foster New Parts

DEVELOPMENT of microscopic parts for a small but complex computer

Tubes are built for rugged service – at **SPERRY**

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New high-power S-Band Traveling Wave Amplifier

2.0-4.0 kmc with 300 watts nominal output power

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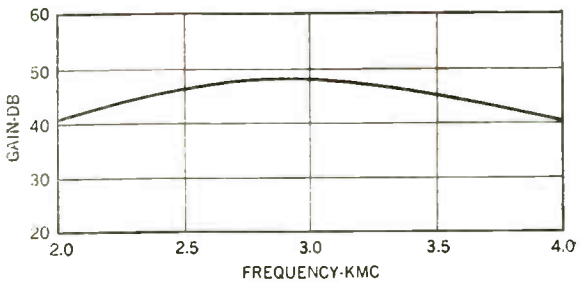
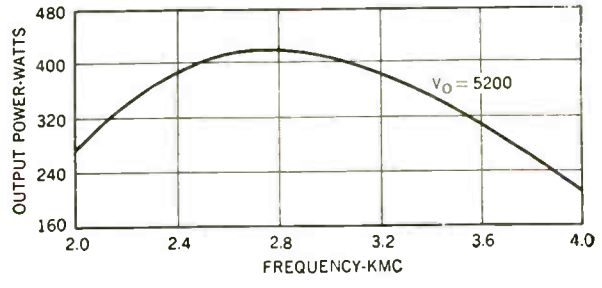
SPECIFICATIONS

Frequency Range	2.0-4.0 kmc
Small-Signal Gain	40 db
Output Power	300w (nom)
Saturated Gain	35 db
Beam Voltage	5.2-5.6 kv
Beam Current	380 ma
Heater Voltage	6.3 v
Heater Current	2.6 a
Helix Current (full)	8 ma

Small-Signal Gain vs Frequency



Saturated Power vs Frequency



This new broadband, high gain cw traveling wave amplifier is the only tube in S-band – delivering 300 watts nominal – for service in microwave systems, high performance tracking radars, high frequency communications networks and other applications where high power and high gain in the 2.0 to 4.0 kmc frequency range are desirable. This tube features rugged, all metal-ceramic construction for high performance aircraft environments and is short-circuit stable.

The STS-101 may well be suited to projects or problems you are working with now. Write for data regarding your application.

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ELECTRONIC TUBE DIVISION, *SPERRY GYROSCOPE COMPANY, GREAT NECK, NEW YORK, DIVISION OF SPERRY RAND CORPORATION*

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is one objective of an extensive research program under way at California Institute of Technology. The program could result in new components and techniques that would have a major effect on many areas of electronics.

Investigators are studying microscopic bits of material whose electrical properties differ from larger pieces. They are also developing alloys with new electrical properties—all with the aim of miniaturizing electronic devices.

Electrical properties being studied are the semiconducting properties of materials such as silicon and germanium, the magnetic properties of ferromagnetic materials such as nickel-iron alloys and the superconducting properties at cryogenic temperatures of such materials as tin and lead. The latter two electrical properties can be used for memories and logic circuits.

Miniature Computer

A major application of the tiny components—some comparable in size to a single neuron—will be a compact computer able to work hundreds of times faster than existing large computers and with a much larger memory.

Speed will be increased because switches only a few millionths of an inch in size will work faster than the larger ones now in use. Also, the electricity will travel much shorter distances. Speed of electricity is becoming a limiting factor in computers.

One phase of the program is concerned with developing a memory device that will permit an information storage density of the order of 100 million bits per cubic inch. The program is also concerned with creation of new electrical and energy conversion properties of materials. Electrical energy has been and probably will continue to be the most convenient medium for instrumentation and data processing. Therefore new and more efficient methods of converting other forms of energy into electrical energy are being studied.

The engineers are using developing techniques to obtain the microscopic amounts of substances. One method is to heat the substance in a vacuum so that molecules of it will vaporize and collect as a thin

film on a glass slide. They are especially interested in the switching ability of the substances. The very thin films of naturally magnetic materials are capable of extremely high-speed switching.

It is believed that memory devices can be made even smaller with superconductive techniques. Superconducting metals could make excellent memory units and also switching devices requiring very small amounts of electrical energy to operate.

The researchers are also investigating paramagnetism, in which garnets and certain rare earth combinations show slight increases in magnetism under some conditions.

Circuit Problems

Developing microscopic electronic components brings up a new problem: making circuits small enough to link them. One process is photoetching, in which a thin layer of copper is deposited on a glass plate or other insulating material. A photographic process is used to project a picture of the desired circuit on the copper, and acid eats away the copper not coated with an acid-resistant film. The electronic components are then attached to the copper lines.

Slices of miniature circuits can be sandwiched atop each other, separated by an insulation coat only a few millionths of an inch thick. Each layer can be linked with the others.

The group may experiment with an electron beam circuit tracer. The beam would be one twenty-millionth of an inch in diameter. It would be used in a vacuum in which there is a vapor of silicon. The beam would fix a tiny line of silicon onto a thin copper sheet. The rest of the copper would be etched away. Sometime the group may be able to write down circuits in microscopic amounts of the materials comprising the electronic components.

Such problems of circuitry and those of getting information in and out of a small computer (possibly by signals from a photoelectric cell) are among the many that will require solving. As problems are resolved in this field, discoveries will probably be made that will have applications even beyond those imagined by the investigators.

Developments in Composite Laminates

RECENT TECHNICAL advances in bonding various metallic and nonmetallic materials to laminated plastics have opened up new design opportunities using combination laminates, reports Taylor Fibre Co., Norristown, Pa., manufacturer of laminated plastics and vulcanized fibre.

It is now possible to bond virtually any compatible material with a laminate to form a composite combining the advantages of both.

Becomes Standard

One of the first combination materials was copper-clad laminates used for etched printing circuits. With the rapidly increasing use of printed circuits, copper-clad laminate has become a standard engineering material in our industry.

More recent composite laminates are usually manufactured to customer specifications. Among those which Taylor has produced are:

Vulcanized fibre-clad laminates. These combine the high strength of laminated plastics with the superior hot arc resistance of vulcanized fibre. They have been used in switch gears for both low and high voltage applications. Other applications are suggested where the high impact strength of vulcanized fibre may prove advantageous.

Rubber-Clad Laminates. Almost any type of natural or synthetic rubber, including Buna N and Buna S, may be used as the cladding material. The composite laminates are widely used to protect the laminate against highly alkaline electrolytes. They have application where sealing or chemical resistance is needed, as in battery tops; and for isolating vibration, as in shock absorbers.

Asbestos-Clad Laminates. Laminated plastic clad with untreated asbestos paper has high heat resistance and arc resistance.

Laminate-Clad Lead. Lead sheets bonded between Grade XX paper-base laminates have been used for x-ray shields. The laminate provides strength and also contributes to lead's high shielding properties.

Aluminum-Clad Laminate. Laminated plastics with aluminum cladding have been used extensively for engraving stock. The laminate base is black in color, providing a good contrast with the aluminum when the design is etched away. Aluminum-clad laminates also offer possibilities as a printed circuit material, but soldering problems remain to be solved. Another application is for plate holders for x-ray machines where the aluminum not only acts as a shield, but also resists abrasion.

Beryllium-Copper Clad Laminates. Beryllium copper is nonmagnetic and a good conductor. The composite material has possibilities for printed circuit applications.

Stainless Steel-Clad Laminates. This material also has application where nonmagnetic properties are required. Other applications are in certain corrosive environments where stainless steel's resistance to attack is an asset.

Reduces Weight

Magnesium - Clad Laminates. Long sheets of this material are used as a screen for x-ray operators. The lightness of the magnesium greatly reduces weight.

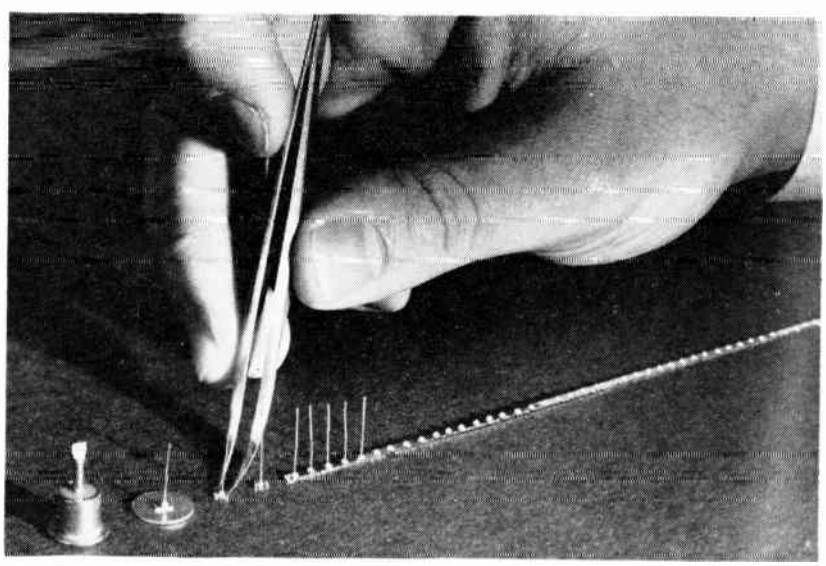
Silver and Gold-Faced Laminates. The extremely high electrical conductivity of silver and gold indicates possible use of the composite materials for electrical contacts. The laminate provides strength and insulation properties.

Metal cladding can be bonded to almost any grade of laminate. It is usually necessary, however, to treat the metal before bonding to eliminate oxides.

A variety of materials may be bonded to vulcanized rubber. Aluminum-clad fibre has been investigated as a possible material for capacitors.

Combination laminates and vulcanized fibre can be specified in sheet, rod or tube. Available sizes are same as for the base material.

Automatic Transistor Production



Successful growth of long, flat ribbons of high-quality semiconductor materials may be a major step towards automatic manufacture of transistors and diodes. Here a hand-built version shows how semiconductor units are formed as a series of dots along the mirror-flat surface of a germanium strip. Crystalline dendrites form rapidly into strips about an eighth inch wide and a few thousandths of an inch thick. Individual functioning units have been prepared by the Westinghouse semiconductor department at Youngwood, Pa.

Growing High-Purity Silicon Carbide

ABOUT TWO YEARS ago, William Shockley theorized that growing silicon carbide crystals from solution in alloy melts might solve the present problem of producing high-purity crystals.

Silicon and germanium crystals are usually grown by slow crystallization of the melted compound

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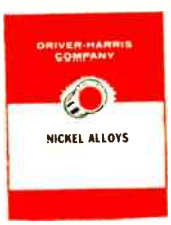

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onto a seed crystal. However, silicon carbide does not melt at ordinary pressures, but rather vaporizes and decomposes.

The Shockley theory was put into practice at the Stanford Research Institute's ceramics technology group under a subcontract from the Bureau of Ships and the Shockley Transistor Corporation. At Stanford, Frank A. Halden and coworkers melted pure silicon in a carbon receptacle. The carbon of the crucible diffused into the molten silicon and saturated the solution. A cool spot was produced in one area of the solution by careful temperature control. This resulted in a localized area of supersaturated solution from which silicon carbide crystals can be grown.

At present the SiC crystals are too small for commercial use. But the process shows enough promise for the Electronic Warfare and Parts Branch of BuShips to extend the research another year, giving Halden time to come up with methods of growing large crystals.

This project may be a promise to raise the temperature limits for transistors and diode operation up to 1,800 F. At the present time, transistors of germanium and silicon are limited to operate only up to 190 F to 450 F.

Casting Pure Silicon For Infrared Optics

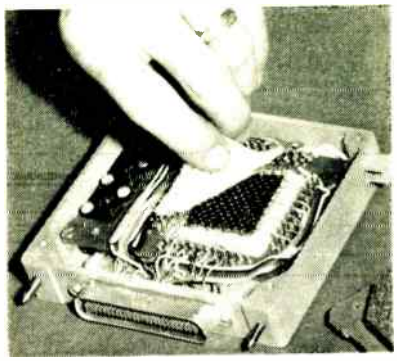
SILICON INFRARED optics can be designed with greater economy through the perfection of a new technique for casting pure polycrystalline silicon of the highest optical quality, developed by the Semiconductor Division of Hughes Aircraft, Newport Beach, California. Repeated tests demonstrate conclusively that there is no significant difference between transmission and emmisivity of cast polycrystalline silicon and grown single crystal silicon.

Scattering characteristics of polycrystalline silicon are closely similar to those of a single crystal, and are not affected by wide variations in grain size. Density is the same as that of the single crystal material. Cast silicon has about 80 percent of the breaking stress and modulus of

elasticity properties of the single crystal material.

The casting method calls for the use of vacuum metallurgy. Vacuum induction furnaces, purchased by Hughes in this connection, were made by Consolidated Electrodynamics Corp., of Rochester, New York.

Insulating Ferrite Memory Cores



Polyurethane pad insulator

A SERIES OF temperature controlled memory planes, designed to function efficiently in adverse environments, is under development by the Applied Logics Division, General Ceramics Corporation, Keasbey, New Jersey.

The new unit solves the problem of insulating ferrite memories. Because the ferrite cores are sensitive to mechanical pressure, selection of a suitable thermal insulating material was a problem. A pad of polyurethane placed on either side of the memory plane, proved to be a satisfactory solution.

First in the series is a 16 x 16-core array, together with its temperature controlled assembly, enclosed in a 4 x 5 x 1-in. magnesium case. For airborne applications, the present design functions at 85 C ±7 deg in an ambient from −55 C to +85 C. It maintains its temperature at 60,000 feet. Warm-up time is less than five minutes.

Daniel Haagens of General Ceramics, manager of the division, announced that they were working on other units for an ambient of 100 C and for applications in ground equipment.

The device shown meets the specs of MIL-E-005272B, USAF.

Overall view of transistor assembly machine. Controls, water and etchant supplies are not shown

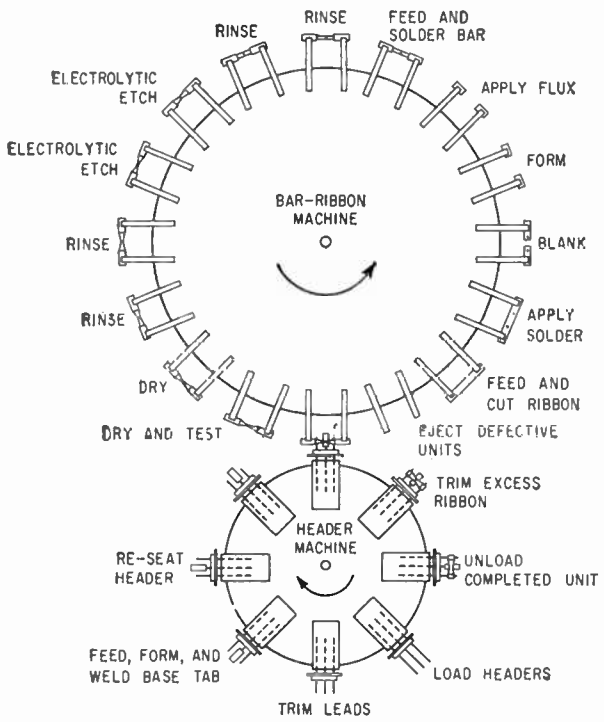


FIG. 2—Sequence of operations performed on bar-ribbon and header assembly rotary index tables

Mechanized Transistor Assembly

By R. C. SHAFER, Engineering Department Chief, Western Electric Co., Inc., Allentown, Pa.

FIRST STEP in the development of an automatic assembly machine for grown junction transistors was redesigning the transistor to facilitate automatic handling (Fig. 1).

The machine is built around two commercial, clutch-actuated rotary index tables mounted on a single rigid base. The bar-ribbon assembly and the header, the two major subassemblies of the transistor, are prepared on 16-station and 8-station index tables, respectively, and are joined at a common weld station. Fig. 2 depicts the sequence of machine operations.

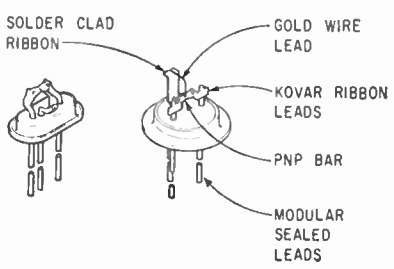
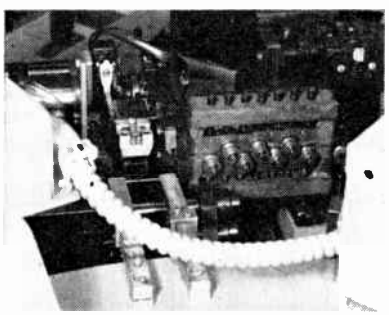


FIG. 1—Old transistor design at left, mechanized assembly design at right

An endless roller chain encircles each table and drives all of the work stations associated with that table. Work stations requiring only vertical movement are operated from face cams driven from the roller chain through a sprocket. Work stations requiring a multiplicity of movements have their own cam shafts which are driven from the roller chain through helical gears and sprockets.

Although most station movements are cam controlled, air cylinders are used on the trimming, forming and welding stations. Solenoid valves are used to control the flow of deionized water, etchant, air and nitrogen, which is used for drying the etched and rinsed bar-ribbon assembly.

Over-all machine timing is controlled by a sequential cam timer in the control set. Individual work stations are synchronized by the roller chains which are driven by ratio motors through single revolution clutches.



Ribbon feed station. Rollers at right straighten ribbon

The control cabinet also houses 4 separate power supplies for electrolytic etching, 3 capacitor discharge welding supplies, power supplies for soldering, interlock control circuits and a test circuit. This test circuit checks the completed bar-ribbon assembly before it is welded to the prepared header. If the bar assembly is defective, the

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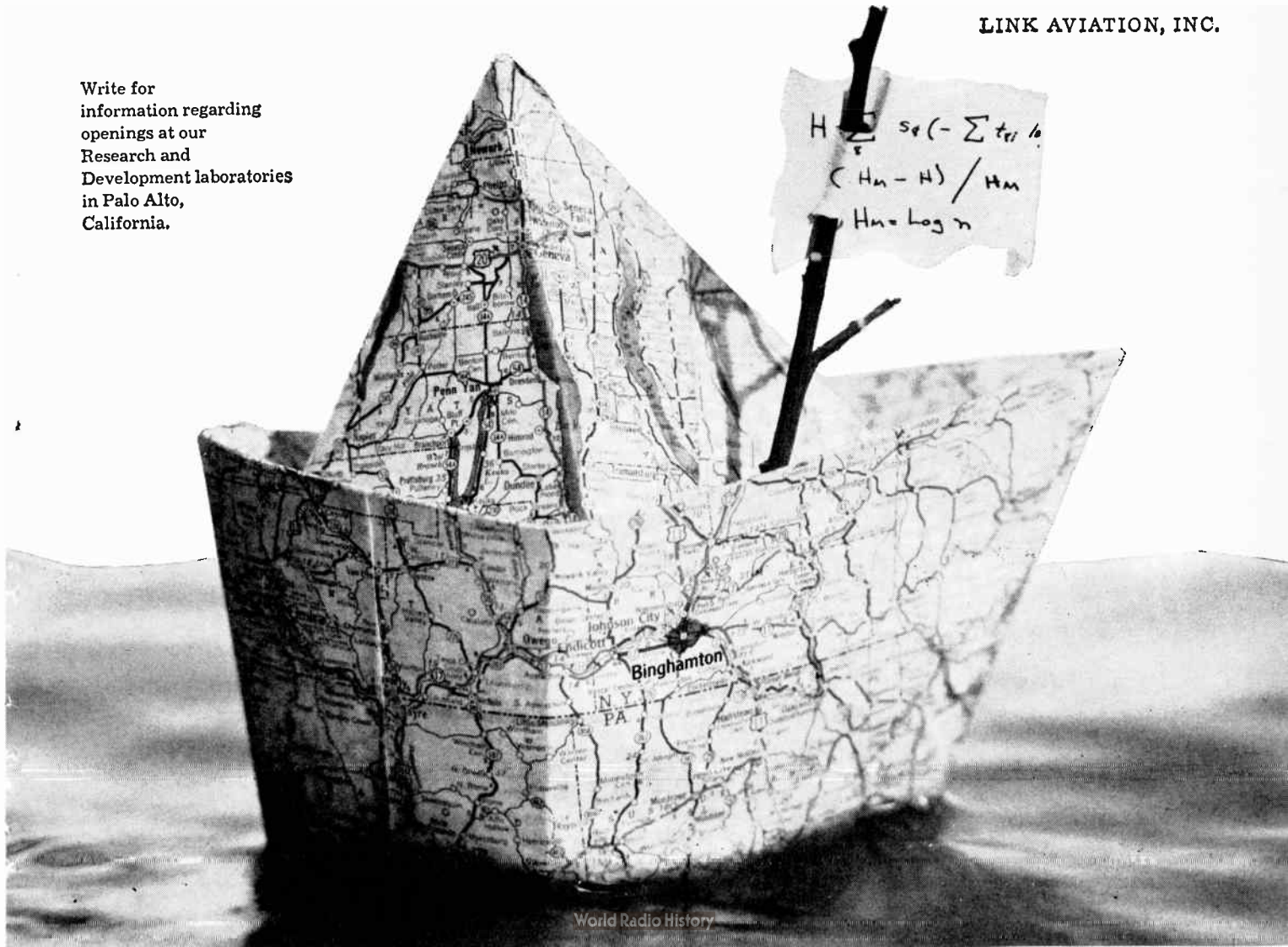


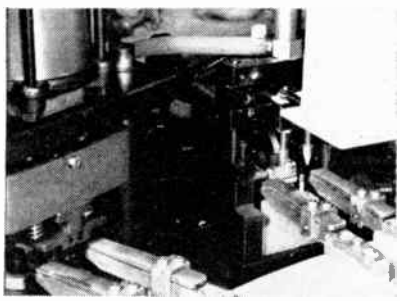
test circuit prevents the header table from welding it to a header.

In preparing the bar-ribbon assembly on the 16-station table, Kovar ribbon is fed from a supply spool, straightened by rollers, cut and loaded into insulated carrying fingers.

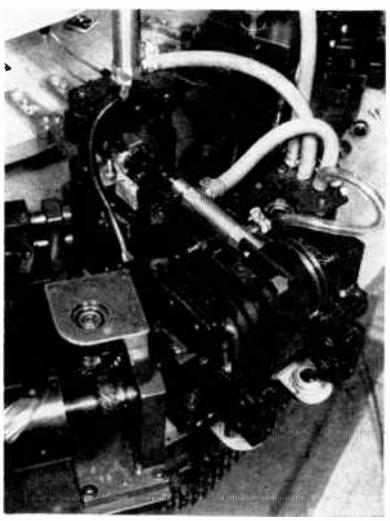
Two small spots of solder are applied to the Kovar ribbon by utilizing the ribbon as a resistance heater. The Kovar ribbon, previously fluxed in the desired spots, melts off small portions from 2 ribbons of solder which are fed across the Kovar ribbon.

The ribbon is then cut, formed and refluxed for soldering to the ends of the germanium bar. The *npn* bars are manually oriented and loaded into the magazine, but are fed, transferred and soldered to the leads automatically.

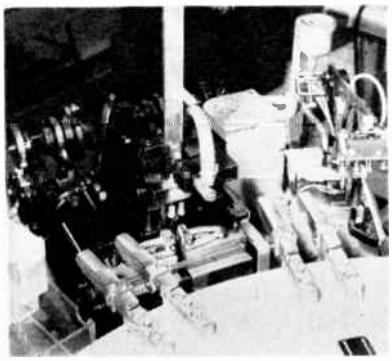
Flux residue is removed by a water rinse. An electrolytic etch removes about 0.005 inch from each face of the *npn* bar (0.025 x 0.025 x 0.125 inches). The etchant is 0.1 percent potassium hydroxide at 300 milliamperes constant current and



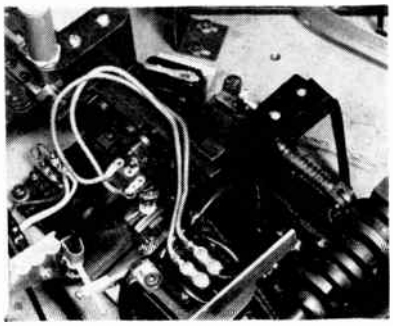
Solder application (right) and ribbon blanking stations (left)



Other side of solder application station. Solder spools are at right of horizontal air cylinder



Lead fluxing, npn bar feed and rinse stations (right to left). Heated slides are below bar magazine



Header loading station. Header carrier is at top left

250 volts. Etching is followed by a rinse of ultrapure water (less than 0.4 microhms conductivity).

The test circuit which controls the operation of the header table measures the current passed by the photosensitive etched bar, under constant illumination. The current is proportional to alpha or gain.

Headers are processed on the 8-station table. An electromagnetic chuck inserts the headers into the carrying fixtures after picking them off a vibrating track. Modular spaced leads keep the headers oriented on the track. After the internal header leads are trimmed to length, a piece of solder-clad ribbon is fed, formed, welded to the header base lead and cut off.

Unless a defective bar-ribbon is detected by the test circuit, both subassemblies are joined together at the common weld station. The bar assembly is released by its carrying fingers and the transistor assembly retracts with the header carriage. Excess ribbon leads are trimmed off.

Considerations which led to the development of the machine and redesign of the transistor are reported in the July, 1958, Western Electric *Engineer*.

On The Market

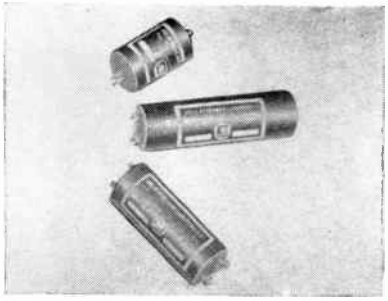
Transformer encapsulated

UNIVERSAL TOROID COIL WINDING, INC., 171 Coit St., Irvington 11, N. J., has developed a new low cost subminiature variable differential transformer for use as a displacement transducer. Among the features of the DT-401 are interchangeable cores, magnetic shielding and Teflon insulated leads for added strength. Overall length is 0.468 in.; finished o-d, 0.313 in. The unit shown guarantees a null of less than 100 μv with an input of 3 v at 400 cycles. Sensitivity is 2.7 mv/mil deflection with this input and linear range is $\pm$0.005 in.

CIRCLE NO. 300 READER SERVICE CARD

Standard Resistors and ratio sets

JULIE RESEARCH LABORATORIES, INC., 556 W. 168th St., New York 32, N. Y., has available a complete line of laboratory-standard resistors and ratio sets to 0.0015 percent absolute accuracy and 0.0005 percent relative (ratio) accuracy, with comparable stability. The NB-1 style oil-immersed, hermetically-sealed units have application in production gear, laboratory and field instruments, analog computer networks, and operational amplifier summing networks, as well as in laboratories as reference and calibration standards.

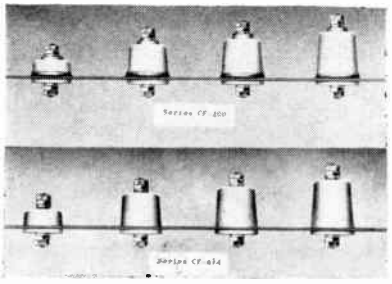


CIRCLE NO. 301 READER SERVICE CARD

Teflon Insulators feed-through type

FLUOROCARBON PRODUCTS INC., Camden 1, N. J., has introduced a versatile family of Teflon feed-through insulators especially designed for permanent and demountable applications. The permanent type, known as the Chemelec series CF-400 insulator, incorporates a hermetic solder seal. The semipermanent, or demountable seal, designated Chemelec series CF-414, utilizes silicone rubber "O" rings to establish seal between the insulator body and the bed plate and between the feed-through terminal and the insulator body.

CIRCLE NO. 302 READER SERVICE CARD



Tachometer highly sensitive

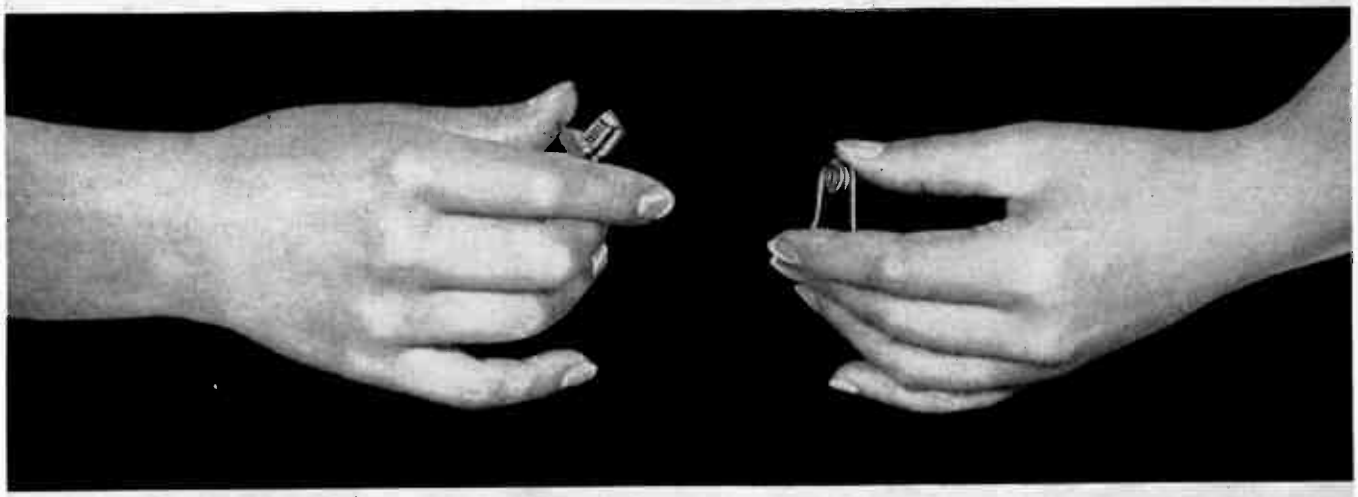
AIRPAX ELECTRONICS, INC., Seminole Division, Ft. Lauderdale, Fla. The new Tach-Pak makes possible the accurate measurement (0.25 percent) of the speed of any rotating, reciprocating or oscillating shaft or mechanism. The units require input signals no greater than 5 mv. Employing a magnetic pickup, no mechanical or electrical connection to the moving component is necessary. The 0 to 5 v output of standard Tach-Paks drives loads as high as 3,000 ohms. Output voltage is proportional to speed or rpm of the device measured.

CIRCLE NO. 303 READER SERVICE CARD

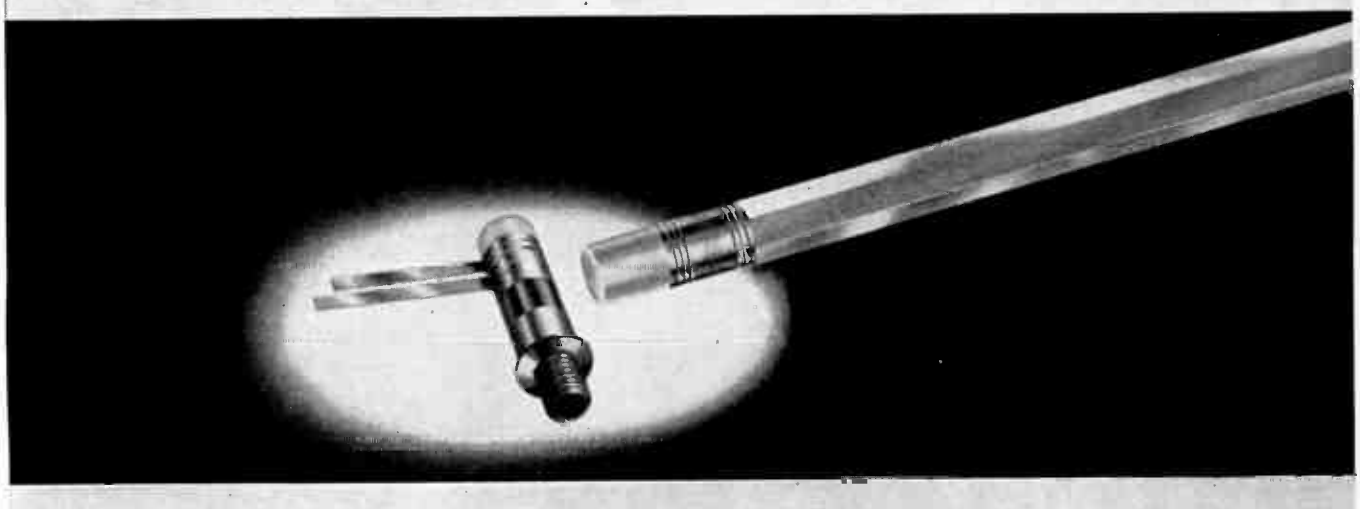
A-C Voltmeter transistorized

MOTOROLA COMMUNICATIONS & ELECTRONICS, INC., 4501 W. Augusta Blvd., Chicago 51, Ill. A new all-transistorized battery-operated a-c voltmeter provides laboratory performance and range combined with easy portability. It has full scale readings of 1 mv to 300 v in 12 ranges with an essentially flat frequency response of 20 cps to 1.5 mc. High input impedance of 10 megohms shunted by 15 $\mu\mu$f is provided in the 1-300 v range, and in-

WHY USE TWO?



WHEN ONE JFD LC TUNER WILL DO!



The versatile new JFD LC Tuner combines the characteristics of a precision variable capacitor and a metallized inductor. Its unique miniaturized construction helps effect compact electronic packaging to meet space challenging demands . . . affords higher reliability, faster assembly, and greater economy in prototype design or production.

A wide selection of 12 LC Tuners (in panel and printed circuit mounting types), each offering a large range of resonating frequencies, meet most circuitry requirements. If our standard line does not meet your needs, our engineering staff will be glad to design LC Tuners that suit your individual circuit specifications.

Typical LC Tuners Now Available

Model	Self Resonating Frequency Range	Length Above Panel	Diameter
LC303	450–700 MC	.635	5/16"
LC304	300–500 MC	.845	5/16"
LC306	200–450 MC	1.104	5/16"
LC309	125–200 MC	1.691	5/16"

Write for Bulletin 216 for further facts. Include your current design or performance problems for specific recommendations.

JFD

Pioneers in electronics since 1929

PHONE DEWEY 1-1000

ELECTRONICS CORPORATION

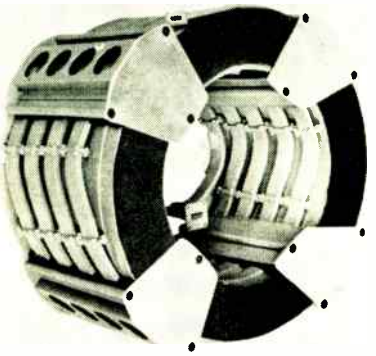
1462 62nd Street, Brooklyn, New York

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

JFD International
15 Moore Street
New York, New York

put impedance of 1 megohm shunted by 25 $\mu\mu$f is provided in the 1-300 mv range. Accuracy is within ±5 percent up to 1 mc and the unit is useable as an indicator up to 5 mc.

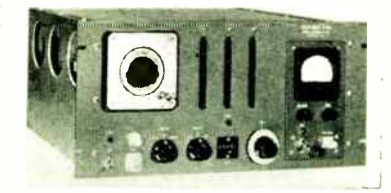
CIRCLE NO. 304 READER SERVICE CARD



X-Band Delay Line
spiral waveguide

TURBO MACHINE CO., Lansdale, Pa. Cylindrical assemblies of spiral waveguide delay lines, in single coils up to 78 ft in length, and multiple interconnected systems of any length are now being built. Typical input vswr measurements of the compact, light weight and rugged units are less than 1.20 at any X-band frequency. Insertion loss is less than 0.1 db per ft of length. The X-band delay line is constructed from 1.000 in. by 0.300 in. o-d aluminum waveguide with brazed flanges.

CIRCLE NO. 305 READER SERVICE CARD



Decade Scalers
versatile units

HAMNER ELECTRONICS CO., INC., Princeton, N. J. The N-220 is a low-cost, fast-counting device using three in-line decades and a 4-digit electromechanical register. Time resolution is 1 μsec. Preset count is

CIRCLE NO. 139 READER SERVICE CARD→

recti/riter® systems offer you the widest recording ranges available

Versatile "recti/riter" recorders, both Single and Dual channel, have established new standards for *reading ease, full-scale accuracy*, and *up-front operator conveniences*. Now, the applicability of the "recti/riter," or other graphic recorders of one-milliampere sensitivity, is extended to the widest practical limits by the use of Series 300 accessories, which presently include models:

301 DC AMPLIFIER	353 LINE VOLTAGE MONITOR
350 MULTI-VOLTAGE MONITOR	354 LINE CURRENT MONITOR
351 AC MULTI-CURRENT MONITOR	333 LINE SERVICE MONITOR
352 LINE FREQUENCY MONITOR	(a single-package combination of 352, 353, and 354)

Only the "recti/riter" systems, recorders and matching accessories, offer these wide ranges for recording electrical parameters:

10 millivolts to 1000 volts . . .
500 microamperes to 1000 amperes . . .
Monitor standard frequencies—40, 60, 400 cps.

FULL SCALE RANGES—Accessory scales give quantities per division equal to decimal multiples or sub-multiples of 1, 2, and 5 in keeping with standard 50-division chart of recorders.

ACCURACY—Combined recorder-accessory response departs from true value at any point not more than 2 per cent of the full scale value.

POWER REQUIREMENTS—No auxiliary power required for transducer accessories . . . a 45-volt battery or optional AC supply is used with the DC Amplifier.

SIZE—Aluminum cases 2½" H., 7½" W., 10" D. (Monitors may be mounted inside as integral part of recorders.) Mountings are available for relay racks, flush mounting, portable, or desk use.

To select the "recti/riter" recorder-accessory system that meets your exact measurement requirements, let TI give you complete technical assistance . . . write or call today!

TEXAS INSTRUMENTS
INCORPORATED
GEOSCIENCES AND INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON, TEXAS • CABLE: TEXIN$

OTHER TI/IID PRODUCTS

- Complete Geophysical Instrumentation
- Measurement and Control Systems
- Automatic Test Equipment

10, 100, 1,000. Accessories include l-f timer, plug-in r-f power supply and amplifier. Discriminator range is from −50 to +100 v with an alternate choice of low-level discrimination of from −10 to −0.25 v for G-M use, and increased sensitivity of 1 mv is available with the addition of a plug-in amplifier.

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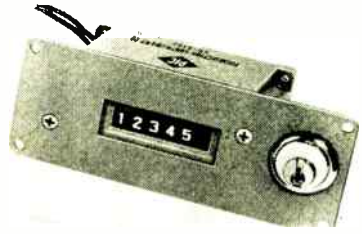

Electric Counters
pulse grouping

PIC AUTOMATION CONTROLS DIV. of General Controls Co., 8070 McCormick Blvd., Skokie, Ill. Counting pairs, quads, and other group quantities without pulse divider circuits, is achieved by new pulse grouping electric counters. In operation, a pulse grouping counter designed to count pairs (one count for two pulses) for example, accumulates one pulse and then registers one unit count on the second pulse. Five number wheels are provided to register unit counts. A sixth number wheel can be arranged to register accumulated partial counts.

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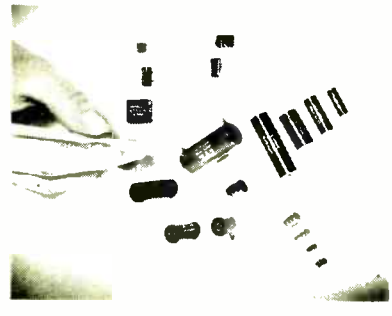
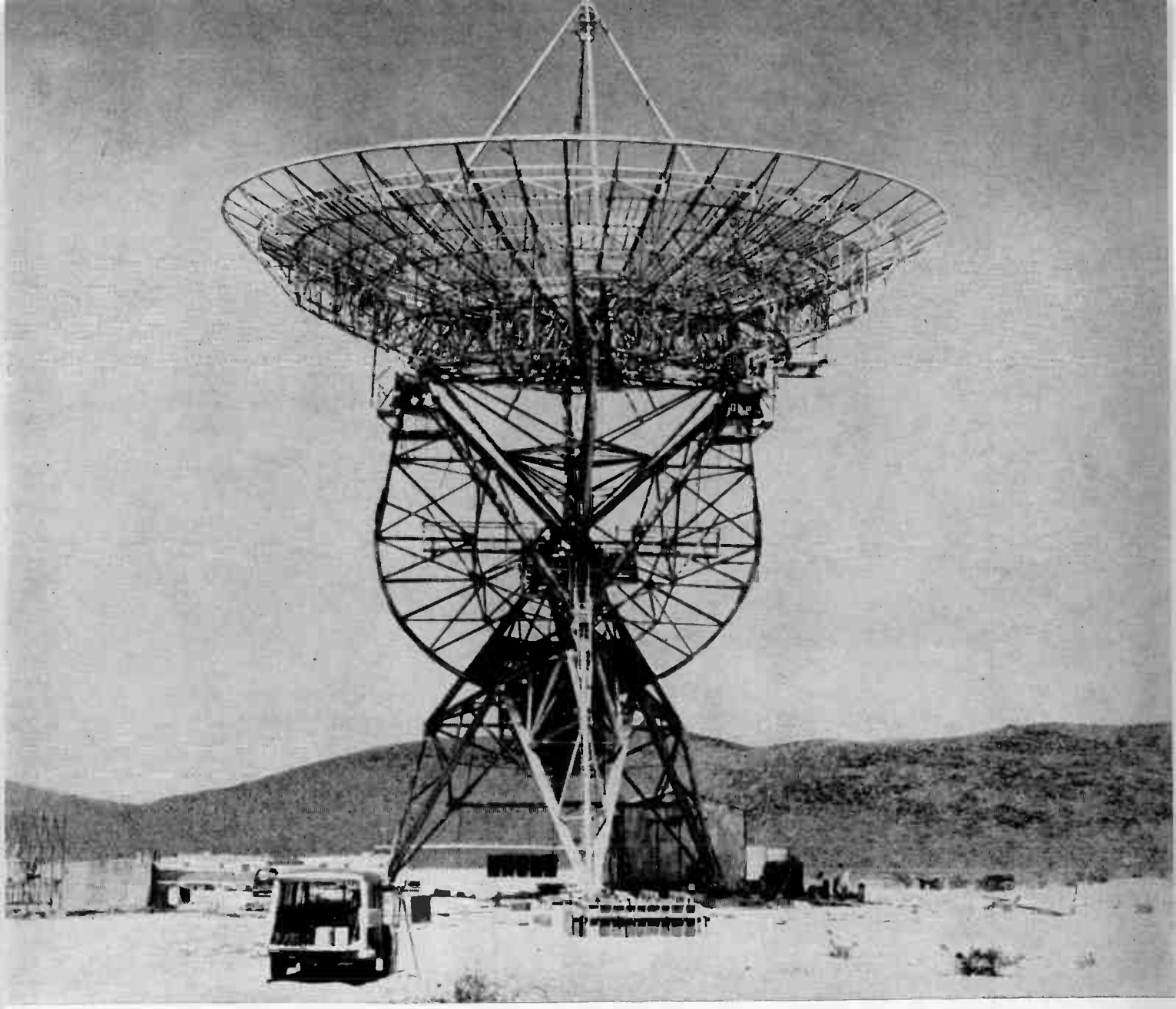


Precision Resistors
variety of leads

ULTRONIX, INC., 111 E. 20th Ave., San Mateo, Calif. Special precision wirewound resistors with any specified temperature coefficient between −25 and +6,000 parts per million per deg C in



85′ diameter tracking antenna, shown under construction. Reflector face surface is fabricated from aluminum. Pedestal, Polar Cage, Declination Cage and back up structure are of galvanized steel.

New BLAW-KNOX 85′ diameter tracking antenna for U.S. Lunar Probe Project

This newest Blaw-Knox 85′ Tracking Antenna is part of the Space Probe Project of the Jet Propulsion Laboratory at Pasadena, Calif. It will be used to maintain communications with space vehicles at ranges up to 250,000 miles.

Its design is fully determinate. All structural members of the assembly are analyzed for stress and deflection before fabrication. Coupled with shop fabrication and field erection to rigidly accurate tolerances, it is capable of the highest gain, with a minimum of distortions or aberrations.

The entire drive system embodies such critical design requirements as infinitely variable movement with negligible creep or overrun for tracking. The slewing drives are capable of the extremely rapid acceleration and deceleration necessary to focus on targets.

Pioneering like this is the latest step in a long series of Blaw-Knox developments. Such milestones as the Guyed Vertical Radiator design in AM radio, the first radar antenna used to bounce signals off the moon, and the Tropospheric Scatter Antenna for over-the-horizon television have marked Blaw-Knox as a world leader in advanced design, fabrication and erection techniques.

Blaw-Knox welcomes the opportunity to translate your most advanced concepts into highly reliable operating equipment. Contact the Antenna Group.

Antennas—Rotating, Radio Telescopes, Radar, Tropospheric Scatter, and Ionospheric Scatter.

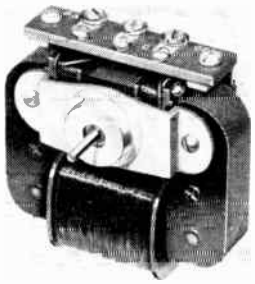
BLAW-KNOX

BLAW-KNOX COMPANY
Blaw-Knox Equipment Division
Pittsburgh 30, Pennsylvania

CIRCLE NO. 141 READER SERVICE CARD

values of 10 ohms to 3 megohms are now available. They have application in telemetering, Zener diode and other circuits requiring positive temperature compensation. In bridge circuits high temperature coefficient resistors can be used to accurately measure temperature. Units are characterized by close tolerance and compression molding in an alkyd resin. They meet or exceed all applicable military specifications.

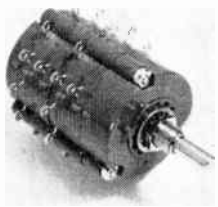
CIRCLE NO. 308 READER SERVICE CARD



Shaded-Pole Motor
reversible

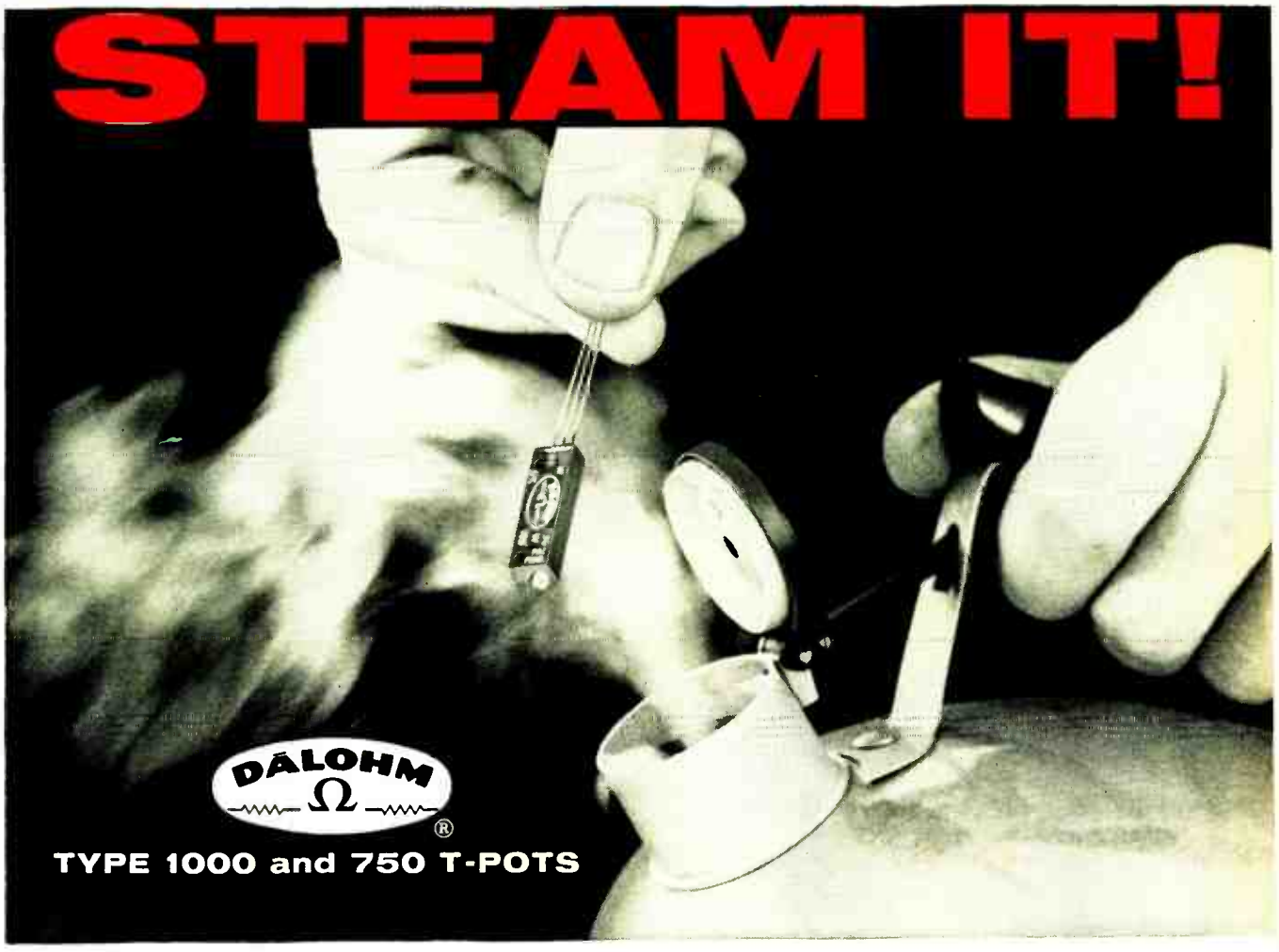
BARBER-COLMAN CO., Rockford, Ill., announces a reversible shaded-pole motor that fulfills the requirements of an a-c tachometer or rate generator. With rated a-c voltage applied to the main winding, a voltage is generated in the shaded windings which is proportional to the speed at which the rotor is driven. Voltage is nearly linear from 1,000 to 3,000 rpm. Generated voltage from a typical AYAE rate generator with low impedance shading coils (150 ohms) is 2 v per 1,000 rpm and can be increased to 10 v per 1,000 using shading coils of higher impedance.

CIRCLE NO. 309 READER SERVICE CARD



Rotary Switch
multiposition

INDUSTRIAL DEVICES INC., 982 River Road, Edgewater, N. J., has developed a 12-position instrument-quality rotary switch with contact



INHERENT STABILITY

Assured in a DALOHM 750 or 1000 Trimmer Potentiometer

The ability to perform reliably under extreme conditions of heat and humidity is only one mark of the inherent stability that is standard in Dalohm trimmer potentiometers.

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

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

WIRE WOUND • SEALED • HIGH POWER • DALOHM TYPE 750 and 1000 TRIMMER POTENTIOMETERS

Miniature and standard sizes with completely sealed cases. Three terminal configurations provide the solutions for demanding design problems.

	750	1000
Rated at	...2 watts	2.5 watts
Resistance range	.....10 ohms to 30K ohms	10 ohms to 50K ohms
Standard tolerance	... ± 5%	± 5%
Size	.....180" x .300" x 1.000"	.180" x .300" x 1.25"
Screw adjustment	..17 ± 2 revolutions	25 ± 2 revolutions
Weight	.....2 grams	2.5 grams

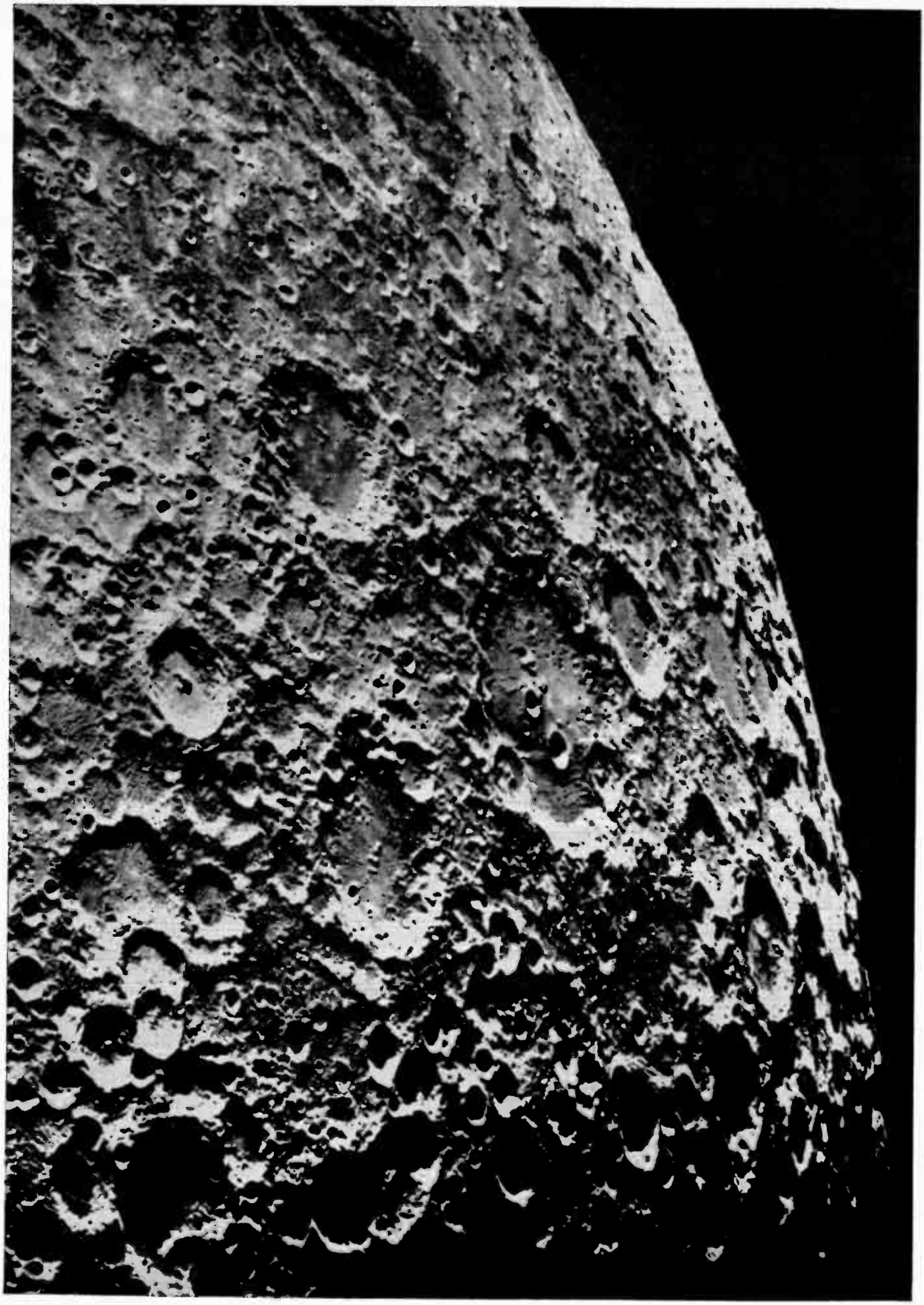
- Completely sealed
- Meets humidity requirements of MIL-STD-202A, Method 106A or MIL-E-5272A, Procedure 1
- End resistance is 3%, maximum
- Nominal resolution is from 0.1% to 1.2%
- Temperature coefficient is 50 PPM/° C.
- Meets load life requirements of MIL-R-19A
- Surpasses applicable paragraphs of MIL-R-12934A

Write for Bulletins R-41A and R-44, with handy cross-reference file cards.

SPECIAL PROBLEMS?

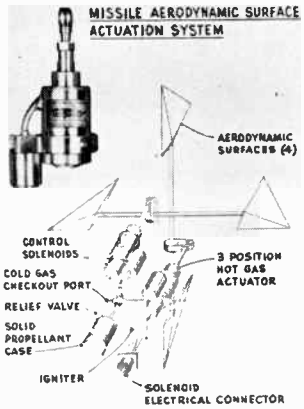
You can depend on DALOHM, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks;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

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1300 28th Ave., Columbus, Nebr.



resistance less than one milliohm. It is available in six models, one to six poles, offering a voltage breakdown rating of better than 1,000 v rms. It features a nylon detent and hardened beryllium copper detent spring to promote unusually smooth detent action for the full life of the switch. Switch has been designed for use exceeding 250,000 cycles of rotation, either continuous or limited as desired.

CIRCLE NO. 310 READER SERVICE CARD



Actuation System
for missiles

BENDIX PRODUCTS DIVISION, Bendix Aviation Corp., South Bend 20, Ind. Missile aerodynamic surface actuation system includes two 3-position actuators, solid propellant and igniter. It eliminates gear train or levers since all differential action is obtained within actuators. Actuators can be designed for various loads and travel. System weighs 5 lb and exerts 50 in./lb surface force.

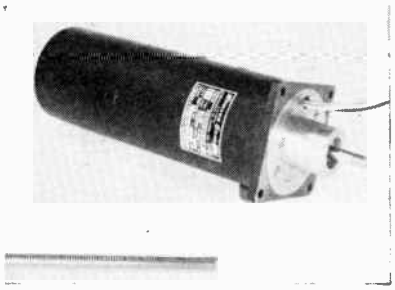
CIRCLE NO. 311 READER SERVICE CARD

Tiny Relay
current sensitive

FILTORS, INC., 30 Sagamore Hill Drive, Port Washington, N. Y. S type current sensitive Powrmite relay meets shock tests of 100 g's for 11 millisec and vibration tests

of 10-55 cps at 0.06 double amplitude, 55-2,000 cps at 30 g's. Contact arrangement is 2 C (dpdt); ambient temperature range, —65 C to 125 C; dielectric test (at sea level), 1,000 v (750 v between open contacts); contact rating, 2 amperes resistive. Coil resistances from 185 to 10,000 ohms are available.

CIRCLE NO. 312 READER SERVICE CARD



Gear Motor three-speed

WESTERN GEAR CORP., 132 W. Colorado St., Pasadena, Calif., announces a 24 v d-c centrifugally governed controlled three-speed gear motor. The motor is rated at 0.1 hp at 1,920, 1,440 and 960 rpm with ±1 percent variation. It is a totally enclosed explosion proof motor designed for 500 hr life and built to meet the latest military specifications for camera and tape applications. It measures 6½ in. in length by 2$\frac{5}{16}$ in. in diameter.

CIRCLE NO. 313 READER SERVICE CARD

Single-Turn Pot subminiature

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif. Model 304 subminiature single-turn pot offers linearity to 0.3 percent and a 500,000-cycle life in a package that is only ½ in. in diameter and ⅜ in. in case length. This is said to be 25 percent to 40 percent smaller than previously available pots of comparable performance. Use of cylindrical mandrel,

The way to know – An ominous shadow over ocean or wasteland... an unidentified "blip" on a radar scope! A challenge from an airborne AN/APX-7 interrogating unit spurts into the ether. In microseconds a reply identifies the potential marauder as friendly. The absence of such a reply alerts the protective and retaliatory might of the nation.

ENGINEERING BEYOND THE EXPECTED

Packard Bell's reputation as a leading designer and foremost producer of IFF (identification, friend or foe) equipment is indicated by the fact that both the AN/APX-7 and the AN/APX-6, which returns the reply, are products of our Technical Products Division. Advanced development, company-sponsored, has recently produced miniaturized IFF modules which operate up to 200°C.

PACKARD BELL ELECTRONICS

Technical Products Division

12333 W. Olympic Blvd.

Los Angeles 64, Calif. • BR 2-5141

C '59 PB

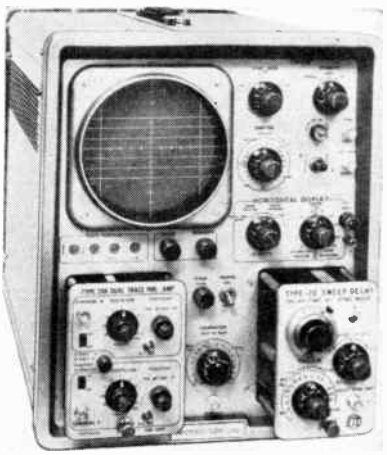
instead of the conventional card, permits a significant shortening of the case and more precise winding techniques. Environmental characteristics: 2.0 w at 50 C, operates to 125 C, withstands 20 g vibration and 30 g shock.

CIRCLE NO. 314 READER SERVICE CARD

Log Electrometer for reactor control

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio, announces model LE-1 log electrometer for precision measurement of small currents over a wide dynamic range. It is particularly well suited for use as a reactor control instrument. In addition to being stable and reliable, the unit provides an inexpensive method of measuring 8 decades of current in the range of 10^{-5} to 10^{-13} amperes. Trip circuits can be incorporated on special order.

CIRCLE NO. 315 READER SERVICE CARD



Oscilloscope wide-band

ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 18, Pa. An accurate sweep delay with 18 calibrated ranges from 2 μsec to 1 sec per cm is available as an optional plug-in accessory in a single-channel oscilloscope. Model K-120

Improved performance plus production economies Your job . . . and Centralab's

with High Alumina Ceramic to Metal Precision Assemblies

Take full advantage of the superior electrical and physical properties of High Alumina and Steatite ceramics. Let CENTRALAB provide you with complete assemblies.

The specialized techniques of close tolerance ceramic-to-metal fabrication are daily routine at CENTRALAB. You can eliminate production assembly problems and at the same time achieve superior products by relying on years of expert knowledge and unequalled facilities for engineering ceramics.

CENTRALAB can handle intricate, precision assemblies involving machining of ceramics or metals to ±.00025, metalizing of ceramics, cementing, riveting, soldering, plating, and stamping. Such assemblies are regularly produced in their entirety—from raw stock—in the CENTRALAB plant.

Write for your free copy of CENTRALAB'S Ceramic Design Handbook giving your detailed design data and complete electrical and physical specifications on High Alumina and Steatite ceramics.

PUMP PLUNGER

Length 11⅞", diameter ground to .0002" Total Indicator Reading. Surface finish of 10 micro-inches. Stainless steel epoxy bonded to high alumina. Similar units up to 18" long and 4" diameter can be made.

VARIABLE CONDENSER SHAFT

Precision 95% High Alumina shaft and silver plated brass hardware assembled and machined to a Total Indicator Reading requirement of less than .002".

TUNER COUPLING ARM

To hold center dimensions between riveted brass pivot and cemented phosphor bronze bushing, bushing is machined to a tolerance of ±.0005" or less. O-ring groove on pivot machined to .012" wide, —.000" + .002". Machined ceramic screw.

NON-FLOATING VALVE SEAT

Comprised of ceramic cone with surface finish of 3-5 helium light bands brazed to machined and copper plated bushing. After assembly, Total Indicator Reading of ceramic cone is less than .005".

CONTACT ROTOR ASSEMBLY

With riveted and soldered contact arm. Nickel plated brass bushing soldered to metalized ceramic. Tolerance —.000" + .001". on I.D. of bushing after slotting.

Centralab

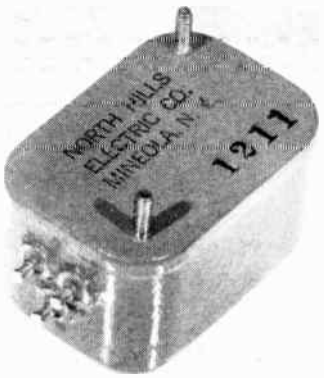
X-5967 ®

A Division of Globe-Union Inc.
9141 E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 804 Mt. Pleasant Rd., Toronto 12, Ont.

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

oscilloscope includes features such as a wide-band vertical amplifier with 0.017 μsec rise time, sweep lock-out, beam position indicators, single knob calibrator and sweep controls, and others that simplify operation and waveform analysis. Unit is a general purpose laboratory instrument for fast circuit work in pulse applications such as radar, guidance systems, and nuclear work.

CIRCLE NO. 316 READER SERVICE CARD



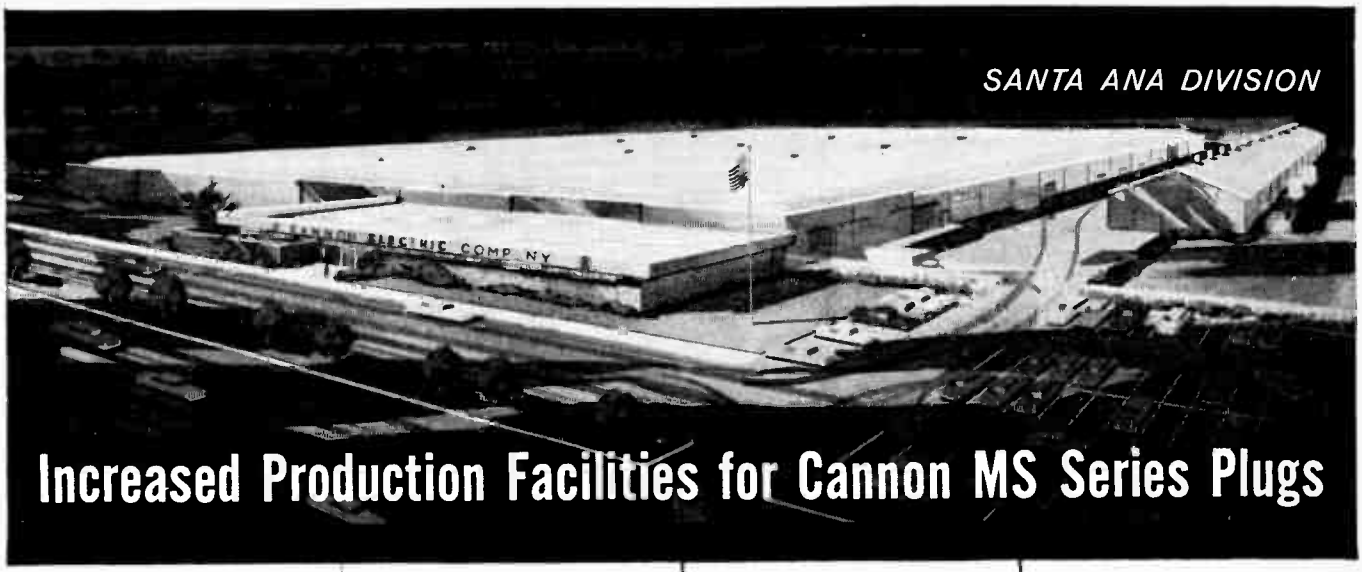
R-F Transformers wide-band

NORTH HILLS ELECTRIC CO., INC., 402 Sagamore Ave., Mineola, N. Y. Two types of r-f transformers are available in a hermetically sealed package 1⅛ by 1⅝ by 1¼ in. Type 1211A covers 200 kc to 40 mc; 1211B, 3 to 100 mc. Impedance ratio is 600 ohms to 75 ohms. Applications include antenna matching, receiver and low power transmitter coupling, and pulse circuits.

CIRCLE NO. 317 READER SERVICE CARD

Signal Sampler for coax systems

T.E.M., INC., 71 Okner Parkway, Livingston, N. J., announces a group of signal samplers for monitoring the signals present in co-



Increased Production Facilities for Cannon MS Series Plugs

MODERN PRODUCTION FACILITIES — The new modern Cannon factory building in Santa Ana has over 110,000 square feet of floor space, equipped with the latest automatic and semi-automatic processes. This increased production capability has been organized especially for the production of the Cannon MS line of plugs.

QUALITY CONTROL — The Santa Ana Division utilizes the most modern methods of quality control to insure conformance to MIL-Q-5923, MIL-C-5015, and related specifications as presented in the latest QPL Lists.

SPECIAL ENGINEERING A complete engineering staff is maintained at Santa Ana to handle all special modification requirements on the MS Series, and to serve customers with unusual needs.

FASTER DELIVERY — This new facility further increases the ability of Cannon Electric Company to provide fast deliveries of Cannon Plugs, without sacrificing quality or reliability.

STOCKED BY DISTRIBUTORS — Cannon Distributors, located throughout the country, stock the standard types of MS Plugs and can arrange for immediate shipment.

NEW MS-R SERIES
All Cannon MS Series Plugs conform to Military Specification MIL-C-5015D (ASG)

CLASS R — environmental resisting (Lightweight) Cannon Plugs are a new addition to the MS Line. Class R Plugs are intended for use where the plug will be subject to heavy condensation, rapid changes in temperature or pressure, and to high vibrations.

Cannon is the only qualified source for the complete line of the new Class MS-R Plugs. MIL-C-5015D specifies that Class R Plugs shall have the "wire sealing grommets in firm contact against the rear face of the insert." This requirement, now written into the specification, has always been a Cannon design criterion for all MS environmental resistant designs.

MS — MS-A, MS-B, MS-E

■ 260 Shell Styles ■ Lightweight ■ 1 to 100 Contacts ■ 15 different Diameters

All Cannon MS Plugs Conform to Military Specification MIL-C-5015D (ASG)

OTHER MS PLUGS AVAILABLE FROM CANNON

MINIATURES • POWER • RACK/PANEL • BATTERY • PRINTED CIRCUIT • MS ACCESSORIES • MS MODIFICATIONS TO MEET SPECIAL NEEDS

For further information write for the new MS-R Catalog, MS Nomenclature Guide, and Catalog on MS Insert Arrangements to:

CANNON ELECTRIC COMPANY —
3208 Humbolt Street, Los Angeles, California · Please refer to Dept. 120

LARGEST FACILITIES IN THE WORLD FOR RESEARCH-DEVELOPMENT-MANUFACTURE

CANNON PLUGS

Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne and Tokyo. Distributors and Representatives in the principal cities of the world.

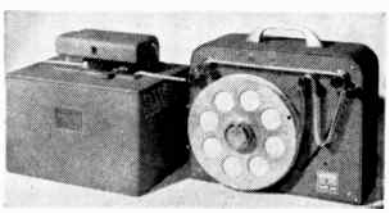
axial systems. They consist of a section of 50-ohm transmission line, fitted at either end with type N, BNC, TNC, C or HN fittings and with an additional arm added at the center. In this arm is mounted a probe, either loop or electrostatic, whose insertion depth can be adjusted to provide a coupling variation range of at least 60 db. Thus, a means is provided for taking from a coaxial line a small amount of signal for monitoring, coupling wavemeters, etc., without adding any appreciable discontinuity to the line.

CIRCLE NO. 318 READER SERVICE CARD

Diode Tester
extended range

TELETRONICS LABORATORY, INC., 54 Kinkel St., Westbury, L. I., N. Y. Model MA-259 millimicroammeter (at right in rack adapter) has been developed to extend the range of the model DT-257 diode tester from 50 μa to 0.01 μa to measure the low reverse current characteristics of silicon diodes. Used as a millimicroammeter the instrument covers the range from 0.01 μa to 1,000 μa and is completely self contained and battery powered.

CIRCLE NO. 319 READER SERVICE CARD



Tape Reader
transistorized

FERRANTI ELECTRIC INC., 95 Madison Ave., Hempstead, L. I., N. Y. Type TR5 fully transistorized, self-contained photoelectric tape reader operates at any speed up to 330 characters/sec and stops on the stop

An achievement in defense electronics

HALF CUBIC INCH 90 DB AMPLIFIERS FEATURE NEW CERAMIC TRANSFORMERS

New 455 kc three-stage amplifiers developed by the U.S. Army Signal Corps utilizing the facilities and competence of General Electric provide as much as 90 db gain with 5 kc bandwidth in a volume of one-half cubic inch. This degree of miniaturization evolved from sustained research and development in solid state filters, delay lines and transformers at the Electronics Laboratory, Electronics Park.

The unique bar-shaped transformers developed for these amplifiers, combined with improvements in existing ferro-electric ceramics, permits the most compact packaging with extreme gain. This achievement in research and development is indicative of General Electric's technical competence in defense electronics.

227-2

Progress Is Our Most Important Product

GENERAL ELECTRIC

Defense Electronics Division
Heavy Military Electronics Department
Syracuse, New York

character. It accepts 5, 7 or 8 hole tape widths, provision being made for reading all tracks. Simple adjustment of a slide instantly adapts the reader for the required width of tape. Where spooling is required, the type A11 spooler can be used for either feed or take-up or both at any rate on demand by the reader.

CIRCLE NO. 320 READER SERVICE CARD

Precision Pot rugged, long-lived

NEW ENGLAND INSTRUMENT CO., 320 Main St., Woonsocket, R. I. Model 55 wirewound pot has been vibration-tested for up to 24 g at 500 cps, and up to 10 g at 1,000 cps, and is available in servo-mounting packaging or standard bushing mount. Maximum resistance is 100,000 ohms, with a tolerance of ±5 percent on standard units or ±1 percent on special types. The pot is rated at 2 w at 65 C and will operate over an ambient temperature range of −55 C to +105 C for the standard design. Insulation resistance is 100,000 megohms for standard units.

CIRCLE NO. 321 READER SERVICE CARD

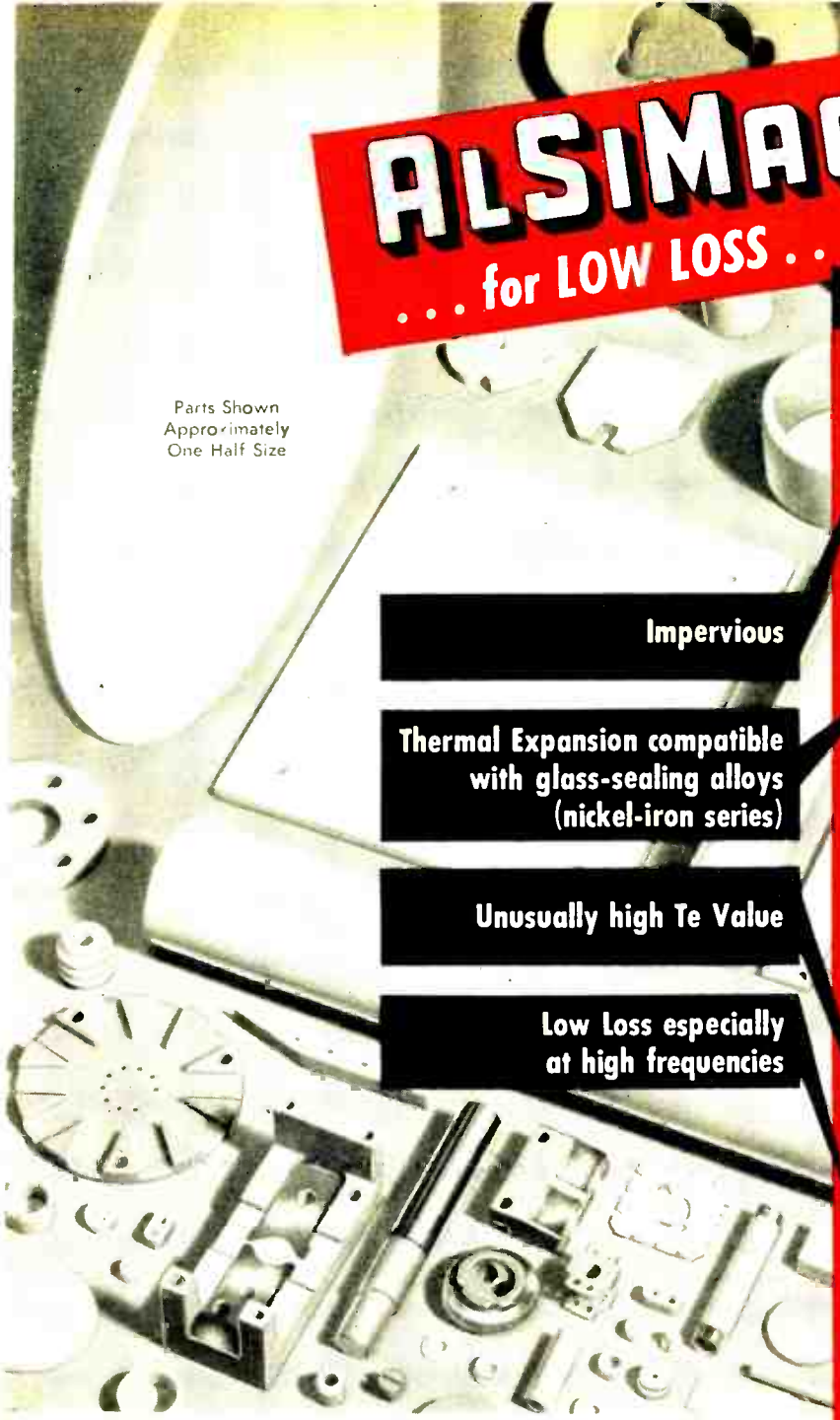
Analyzer gages thickness

DELSEN CORP., 719 W. Broadway, Glendale 4, Calif. The successful adaptation of the D-K analyzer as a gage for nonmetallic thickness

CIRCLE NO. 154 READER SERVICE CARD
CIRCLE NO. 155 READER SERVICE CARD →

ALSiMAG® 243

. . . for LOW LOSS . . . for HERMETIC SEALING



Parts Shown Approximately One Half Size

Impervious

Thermal Expansion compatible with glass-sealing alloys (nickel-iron series)

Unusually high Te Value

Low Loss especially at high frequencies

Note These Advantageous Properties

PROPERTY	UNIT	AlSiMag 243
Water Absorption	%	0 to .02 Impervious
Specific Gravity	———	2.8
Density	Lbs. per cu. in.	.101
Standard Body Colors[a]	———	Buff
Softening Temperature	°C. °F.	1 440 2 624
Safe Temperature at Continuous Heat	°C. °F.	1 000 1 832
Hardness	Mohs' Scale[b]	7.5
Thermal Expansion Linear Coefficient	Per °C. 25-300°C. 25-700°C.	10.0×10^{-6} 11.2×10^{-6}
Tensile Strength	Lbs. per sq. in.	10 000
Compressive Strength	Lbs. per sq. in.	85 000
Flexural Strength	Lbs. per sq. in.	20 000
Resistance to Impact (½" rod)	Inch-Lbs.	4.0
Thermal Conductivity[c] (Approximate Values)	g. cal. x cm. thick / cm² x sec. x deg. C.	.008
Dielectric Strength (step 60 cycles) Test discs ¼" thick	Volts per mil	240
Volume Resistivity at Various Temperatures: 25°C.	Ohms per centimeter cube	$>10^{14}$
100°C.		5.0×10^{13}
300°C.		7.0×10^{11}
500°C.		1.2×10^{10}
700°C.		1.0×10^{8}
900°C.		3.0×10^{6}
Te Value[d]	°C. °F.	>1 000 >1 832
Dielectric Constant[e]: 60 Cycles	———	6.3
1 MC.		6.2
100 MC.		6.1
10,000 MC.		5.8
Power Factor[e]: 60 Cycles	———	.0014
1 MC.		.0004
100 MC.		.0003
10,000 MC.		.0010
Loss Factor[e]: 60 Cycles	———	.009
1 MC.		.002
100 MC.		.002
10,000 MC.		.0058

The low loss, Te value and thermal expansion characteristics of Forsterite ceramics are not equalled by any other impervious ceramic. This is especially important when high frequencies or sealing to metals or glasses is involved.

These properties have created a steadily increasing demand for AlSiMag 243. In the past two years major improvements have been made on this material and its fabrication. We are now producing components formerly unattainable in this material and the number of applications is constantly increasing.

If your application requires the favorable characteristics of AlSiMag 243, why not send us your blue prints and outline your operating conditions? If it is possible that your requirements can be met, we will be glad to work with you at reasonable cost on prototypes for your practical tests. Test discs approximately 1/2" x 3/32" are available with our compliments.

A Subsidiary of Minnesota Mining and Manufacturing Company

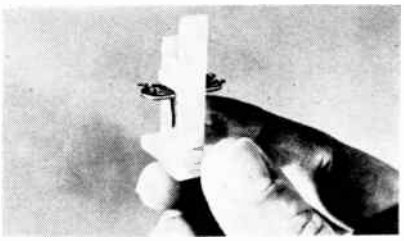
AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
58TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

measurements has uncovered major applications. It is currently being used to scan and determine electrical flaws in insulating materials for missile, aircraft, and insulation manufacturers. The portable instrument measures 12½ in. by 9½ in. by 10½ in., and weighs approximately 15 lb. Power can be supplied by either a plug-in battery power supply or by an interchangeable 115 v a-c bench power supply. Total power dissipation is only 15 w.

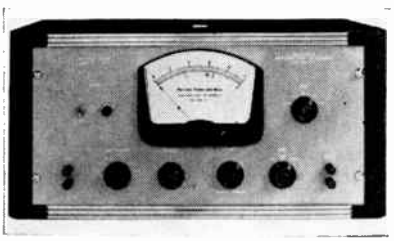
CIRCLE NO. 322 READER SERVICE CARD



Low Power Contacts for multipole relays

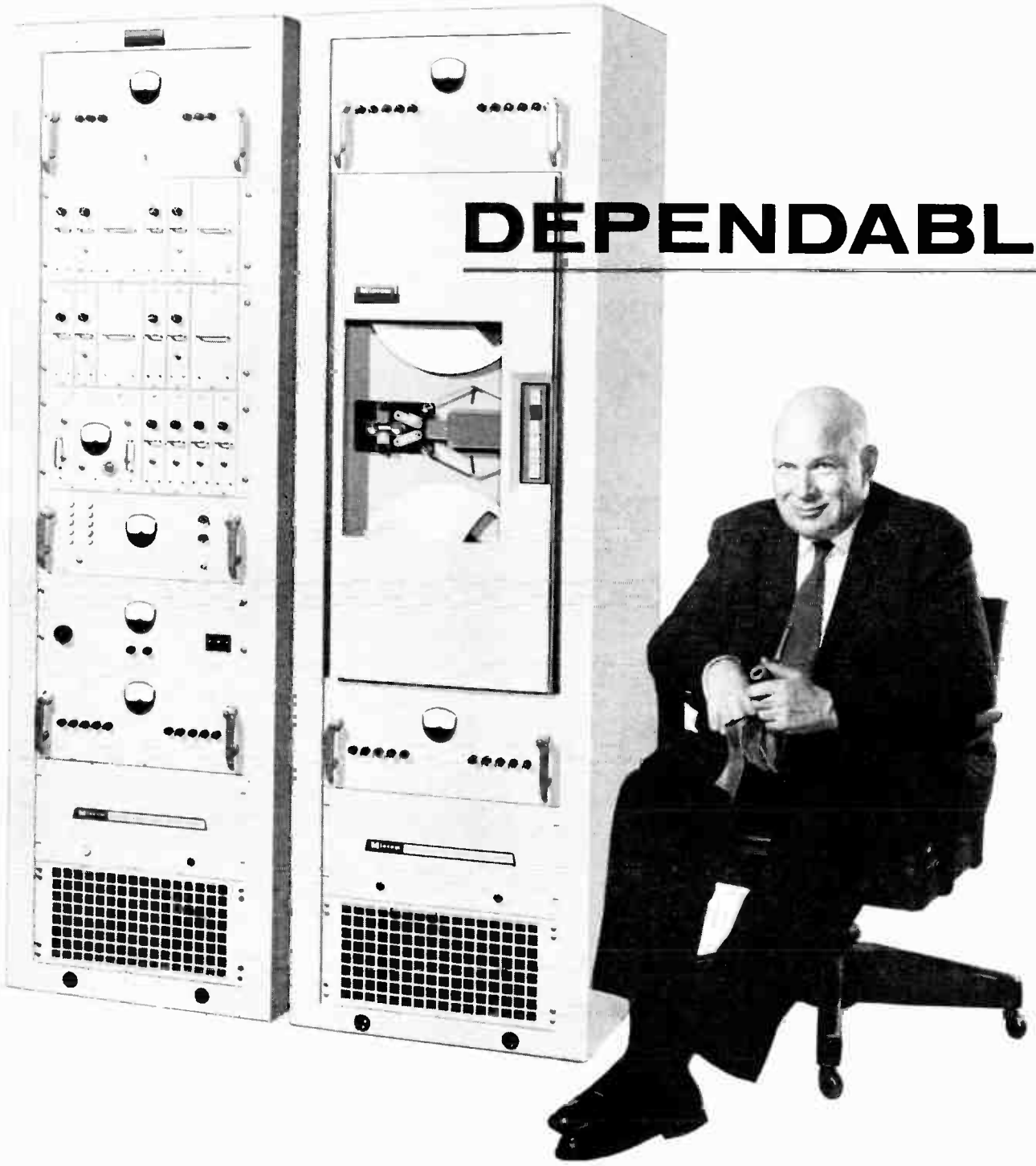
WARD LEONARD ELECTRIC CO., 115 MacQuesten Parkway South, Mt. Vernon, N. Y., has available low power contacts for its new line of type HR multipole relays. Low power contacts are engineered for use in exceptionally low power (low voltage, in milliamperes) circuitry where high electrical and mechanical reliability are vital. Interchangeable with standard double break contacts, the low power (palladium alloy) contacts are totally enclosed by individual molded hoods supplying protection against accumulations of foreign particles.

CIRCLE NO. 323 READER SERVICE CARD



Flutter Meter sensitive device

AMPLIFIER CORP. OF AMERICA, 398 Broadway, New York 13, N. Y. The new flutter meter is designed to fill the need for a sensitive, rapid and accurate method of visual indication of wow and flutter content of



DEPENDABLE

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

3M COMPANY ... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

2049 SOUTH BARRINGTON AVENUE • LOS ANGELES 25, CALIFORNIA

all types of tape recorders and playback equipment including 33⅓, 45 and 78 rpm disks and 16 and 35 mm sound film mechanisms. A built-in preamplifier and input attenuator will accept voltages ranging from 1 mv to 100 v. Connection may be made directly across magnetic tape playback heads, or across high-level circuits delivering up to 100 v. A built-in 3,000 cycle oscillator is incorporated for recording purposes.

CIRCLE NO. 324 READER SERVICE CARD

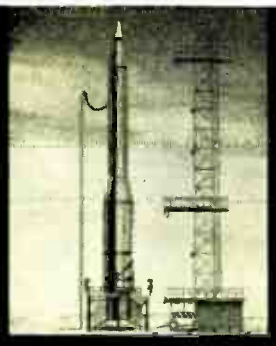
Drum Head
low inductances

GENERAL TRANSISTOR WESTERN CORP., 6110 Venice Blvd., Los Angeles 34, Calif. Model MHDM-35-328 miniature drum head is designed for installation where many tracks are required or where a large number of recirculating registers are necessary. The heads can be mounted so that the gaps of two adjacent heads are only 0.150 apart circumferentially, making the head ideal for close recirculating registers. Heads are low inductance for efficient transistor driving. Diameter of the head is only 0.216 with an overall length of 1.062.

CIRCLE NO. 325 READER SERVICE CARD

Electrical Drives
variable speed

APPLIED TECHNOLOGY CORP., 475 Fifth Ave., New York 17, N. Y. Model SC-31 series covers the 1/50 to ½ hp range. These electrical drives use no tubes, have wide speed ranges with stepless adjustment from zero to full speed; and utilize



FOR RADAR AND
MISSILE TRACKING

ANOTHER VARIAN FIRST

INTERNAL CAVITY PULSE AMPLIFIER
KLYSTRON with 75 KILOWATTS
average output

- RUGGED
- NON CRITICAL
- HIGH PERFORMANCE
- SINGLE PUSH-BUTTON OPERATION

1.25 MEGAWATTS PEAK POWER

Varian's VA-842 is the world's largest internal cavity Klystron. It produces the tremendously high average power of 75 kilowatts for long pulse radar and missile tracking. Features include a pulse duration time of 20000 microseconds, tunable frequency range of 400 to 450 megacycles, 40 db stable RF power gain.

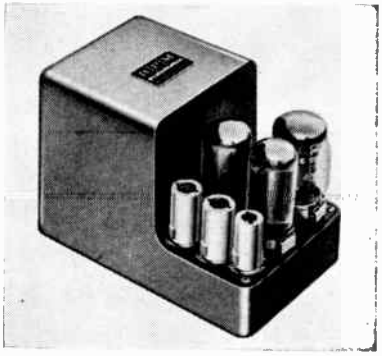
Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Test and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy — address Tube Division.

VARIAN associates
PALO ALTO 1, CALIFORNIA

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, HIGH VACUUM PUMPS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, N. E. SPECTROMETERS, MAGNETS, MAGNETOMETERS, KLYSTRONS, POWER AMPLIFIERS, DIGITAL RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

circuit breakers for armature protection. The remote control is small, light and compact. Its sturdy construction utilizes components rated well in excess of normal operation for maximum dependability.

CIRCLE NO. 326 READER SERVICE CARD



Power Supplies
modular type

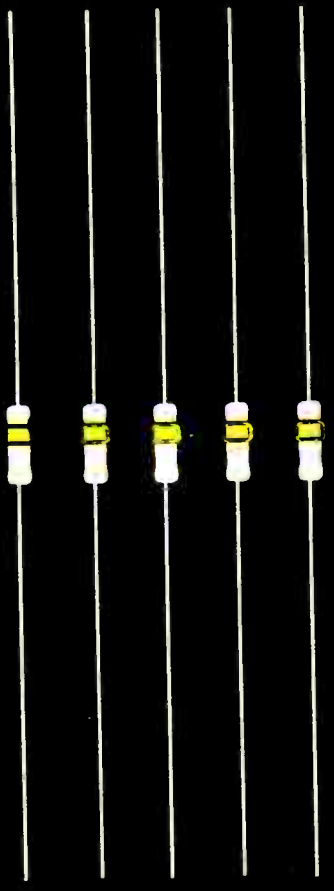
NYT ELECTRONICS, INC., 2979 Ontario St., Burbank, Calif., announces a line of extremely well regulated power supplies designed as modules for original equipment. Compact and efficient, the units mount like a component in small spaces, on conventional chassis cutouts. A wide choice of overlapping current and voltage ranges is furnished in 16 models—from 125 v at 50 ma to 425 v at 400 ma. Regulation for the entire line is 0.05 percent. Ripple is less than 1 mv rms, and transient response less than 25 μsec.

CIRCLE NO. 327 READER SERVICE CARD

Capacitors
photoflash type

ILLINOIS CONDENSER CO., 1616 N. Throop St., Chicago 22, Ill., announces a new series of smaller case dimension photoflash capacitors for energy storage, welding, time delay, high current filtering, etc. They have guaranteed low leakage (no greater than 1 ma) at full rated working voltage. They also feature

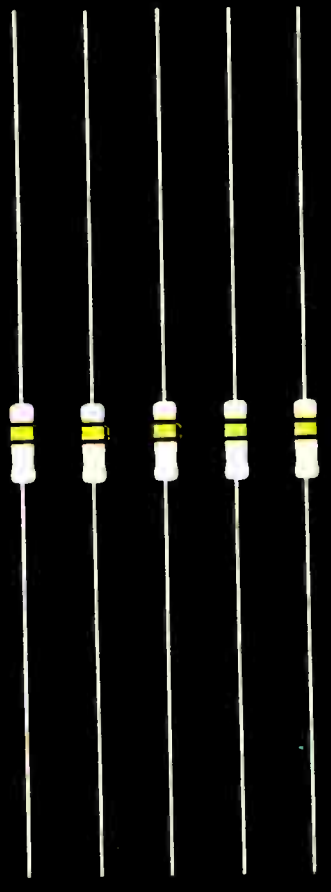
GENERAL INSTRUMENT SEMICONDUCTOR DIVISION



JAN TYPE

RADIO RECEPTOR SILICON DIODES

IN457
IN458
IN459



When JAN type diodes are required, you can be certain that General Instrument's engineering skills and manufacturing facilities will enable us to deliver them at prices that reflect years of volume production experience.

The Radio Receptor line of silicon *and* germanium diodes is the most complete available to the industry — with the widest possible range of characteristics. You'll find them at authorized distributors across the country. Complete information and data sheets are available upon request.

Code No.	Min. Fwd. DC Cur. @ +1V	Max. Rev. DC Cur. @ Test V.		Test Voltage	Max. Inv. Voltage	Min. Breakdown Voltage*	Avg. Fwd. DC Cur. (Max.)
		25° C.	150° C.				
1N457	20 mA	.025 μA	5 μA	60V	60V	70V	75 mA
1N458	7 mA	.025 μA	5 μA	125V	125V	150V	55 mA
1N459	3 mA	.025 μA	5 μA	175V	175V	200V	40 mA

*Reverse voltage at which a reverse current of 100 uA flows.
All ratings and characteristics are at 25° C. unless otherwise noted.
Operating temperature range −80° C. to +200° C.

Semiconductor Division

GENERAL INSTRUMENT CORPORATION

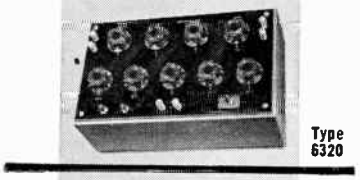
65 Gouverneur Street, Newark 4, N. J.

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

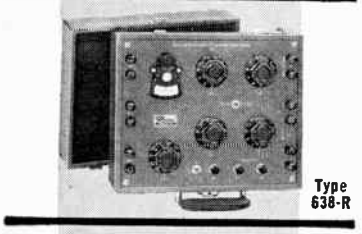
GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Los Angeles: Valley Electronics Supply Co., Burbank • Milwaukee: Radio Parts Co., Inc. • New York City: Hudson Radio & Television Corp., Sun Radio & Electronic Co. • Philadelphia: Herbach & Rademan, Inc. • San Diego: Shanks & Wright Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capitol Electronics

Shallcross BRIDGES

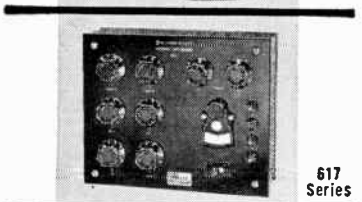
Types 6100 and 6101



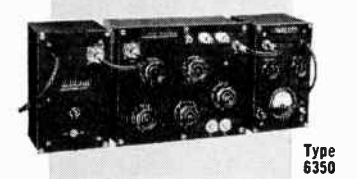
Type 6320



Type 638-R



617 Series



Type 6350

ACCURATE dc RESISTANCE MEASUREMENTS

. . . 1 micro-ohm to 10^6 megohms

Among the many bridges manufactured by Shallcross, these six have become virtually "standards" for general-purpose resistance measurements. Each is easy to operate and ruggedly constructed to maintain accuracy and stability in every kind of field and laboratory service. Switch decks are inside the case for minimum maintenance.

Of special interest are the 617 Series Limit Bridges. These provide direct "GO-NO GO" production line resistor testing for any percent tolerance spread from ±0.1% to ±20%.

NEW BULLETIN L-19B contains full specifications for each instrument. For your copy write to: SHALLCROSS MANUFACTURING COMPANY, 2 Preston Street, Selma, North Carolina.

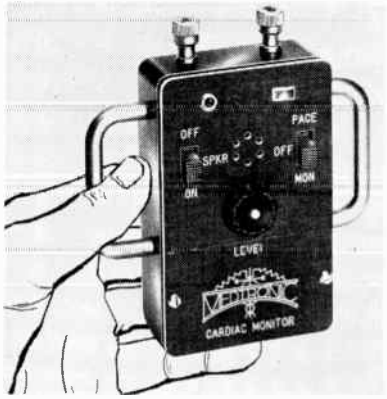
Model Number	Measurement Accuracy	Maximum Setting	Minimum Setting	Circuit	Special Features
6100	±0.1% +0.01Ω (.1Ω to 1.011 MegΩ)	1.011 MegΩ	0.001Ω	Fault Location—Wheatstone	Fault Location by Murray, Varley, Hilborn & Fisher Loop Tests.
6101	±0.1% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	0.001Ω	Wheatstone	Four dial rheostat usable as decade box.
6320	±0.02% +0.01Ω (1Ω to 11.11 MegΩ)	111.11 MegΩ	0.00001Ω	Wheatstone	Most accurate five dial Shallcross bridge for direct resistance measurement.
	±0.05% to ±20% on separate "+" and "—" percent selectors. (1Ω to 10 MegΩ)	11.111 MegΩ	0.0001Ω	Percent Limit	Rapid "GO-NO GO" percent limit testing. Built-in adjustable comparison standard.
638-R	±0.75% or better (.001Ω to 1Ω)	11.11Ω	0.000001Ω	Kelvin	Overlapping Kelvin and Wheatstone ranges selected with single ratio dial.
	±0.2% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	.001Ω	Wheatstone	
6350	±1%, (10Ω to 10 MegΩ) ±2%, (10 MegΩ to 10,000 MegΩ) ±5%, (above 10,000 MegΩ)	1.111 x 10^6 MegΩ	0.01Ω	Wheatstone with d-c Amplifier	Modular construction dual range power supply, null indicator-amplifier, for 115V. 60 cycle operation.
617 Series	±0.1% to ±20% on separate "+" and "—" selectors from a minimum resistance consistent with number of dials in use to the maximum settings.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Percent Limit	For rapid "GO-NO GO" percent limit testing. Hand or foot operated for production testing. All models also usable for direct resistance measurements. Binding post for external d-c power supply.
	†±0.2% +0.01Ω from a minimum consistent with number of dials in use to the maximum setting.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Wheatstone	

† Except 617B and 617J ±0.1% ±0.01Ω.

* Except 617G, 0.01Ω.

excellent shelf life, are designed for minimum inductance, and allow greater discharge currents with more useful watt seconds available. Units may be stacked for space savings.

CIRCLE NO. 328 READER SERVICE CARD



Cardiac Monitor transistorized

MEDTRONIC INC., 818 19th Ave. N.E., Minneapolis 18, Minn. A new cardiac monitor provides both visual and audible indications of: the ventricular "R" wave from external chest electrodes; the ventricular "R" wave through internal heart wires or, the Medtronic Pacemaker pulse, passing through the patient's heart, indicating a complete circuit. Instrument is fully transistorized and quite sensitive (½ mv). It is operated by self-contained batteries and does not present interference problems.

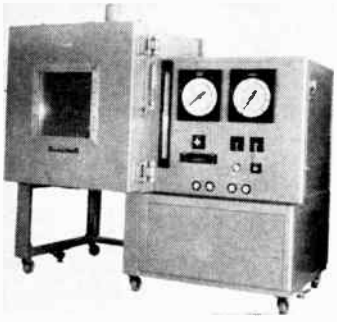
CIRCLE NO. 329 READER SERVICE CARD

Coax Terminations d-c to 3,000 mc

STODDART AIRCRAFT RADIO CO., INC., 6644 Santa Monica Blvd., Hollywood 38, Calif., has improved a line of coaxial line terminations to permit proper function of the units within temperature extremes of −450 F to +440 F. Resistive elements of these units are made of thin platinum films fired at high

temperatures on ceramic forms and treated with a protective coating of silicone varnish. These elements do not become superconductors at temperatures at least as low as 4.2 deg Kelvin. Units' vswr is less than 1.2 to 3,000 mc and average power dissipation is 1 w.

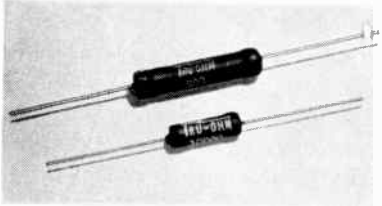
CIRCLE NO. 330 READER SERVICE CARD



Test Chamber self-contained

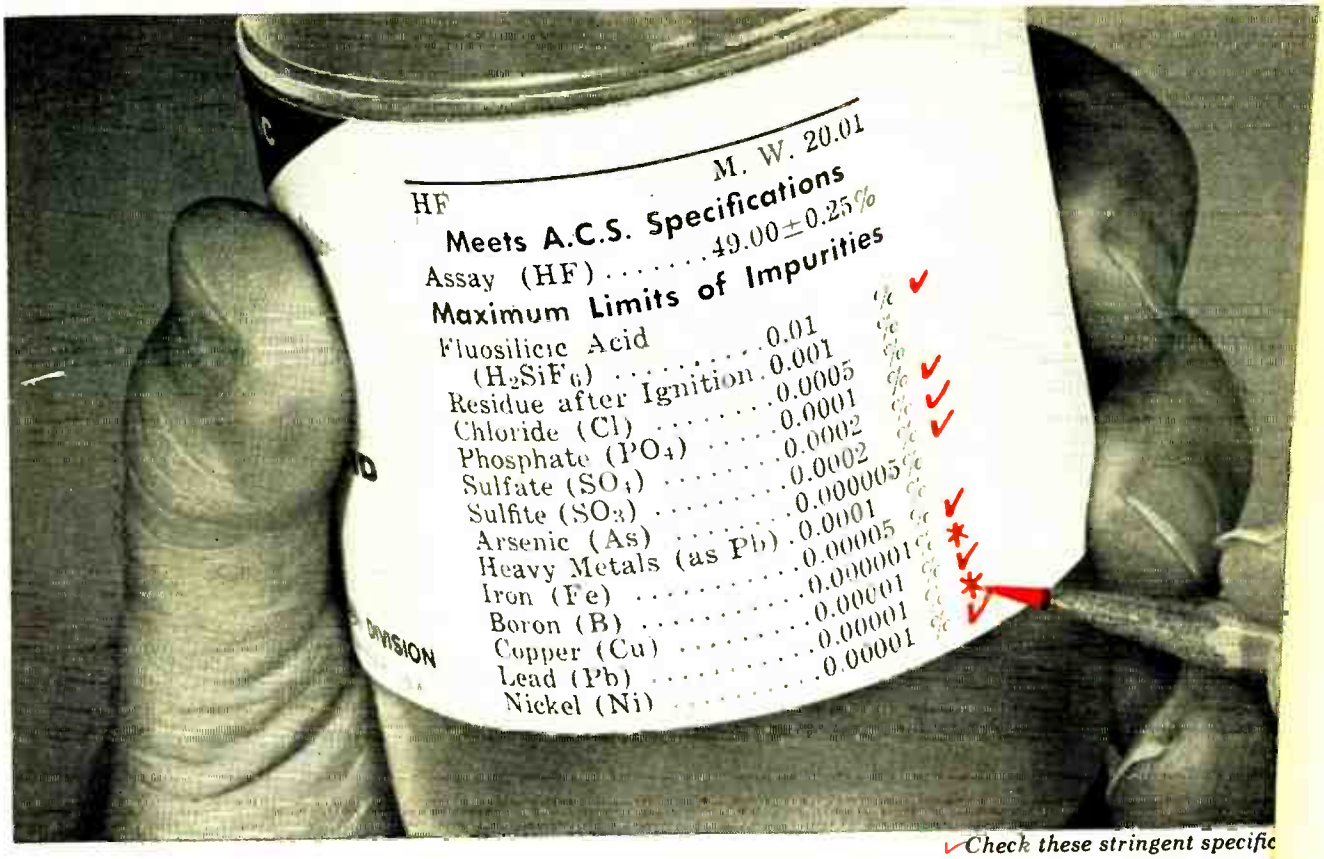
CONRAD, INC., 141 Jefferson St., Holland, Mich. The Chemosphere test chamber model FHV-27-5-5 is designed for high altitude testing in the Centigrade range between 100,000 ft and 260,000 ft altitude. A major feature is that the chamber combines altitude with temperature and vibration and permits the vibration machine to be coupled through a bellows arrangement permitting test items within the chamber being bolted directly to the vibration machine table. Standard temperature range is +300 F to −100 F. Altitude can be simulated up to 200,000 ft in 20 minutes; 50,000 ft altitude can be attained at the rate of climb equal to 25,000 ft per minute.

CIRCLE NO. 331 READER SERVICE CARD



Resistors vitreous enamel

TRU-OHM PRODUCTS, 2800 N. Milwaukee Ave., Chicago 18, Ill., announces its new fixed wire wound vitreous enameled resistors, now available in 3 w, 5 w, 10 w and 20 w



✓ *Check these stringent specific*
* *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 returnable plastic jug, 10 lb returnable polyethylene bott 6½ gal. polyethylene carbo member . . . for the finest in ele chemicals—specify B&A!

Quality specifications have also improved for B&A Reagent Hydroflu Acid, 48% A.C.S. The new rea grade promises greater reliabilit research . . . fewer variables in lab tory control work . . . better analyt control . . . more reproducible res

BAKER & ADAMSON®
"Electronic Grade" Chemicals

Allied Chemical

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

CIRCLE NO. 163 READER SERVICE CARD

SYNTHETIC SAPPHIRE FOR HELIX SUPPORTS

The bifilar helix and electron gun structure of this backward wave oscillator tube are supported by sapphire rods. The tube was developed and built at the Electronics Research Laboratory, Stanford University, and operates from 500 to 1000 megacycles at 100 watts.

Single crystal synthetic sapphire rods are being used as support members for TWT helices and electron gun structures.

Sapphire offers flexural strength at elevated temperatures, excellent dielectric properties, small-diameter rigidity, strength at elevated temperatures, low-loss characteristics, zero porosity, and economy.

In addition to rods, single crystal sapphire is available in the form of windows and domes for microwave and infra-red systems. Special sapphire shapes for custom applications can be obtained.

Other single crystals, such as ruby and doped titania for maser amplifiers are available. LINDE also supplies single crystal yttrium iron garnet, for solid-state devices.

For further data, write to Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited. Address Department E-92

Linde TRADE MARK

UNION CARBIDE

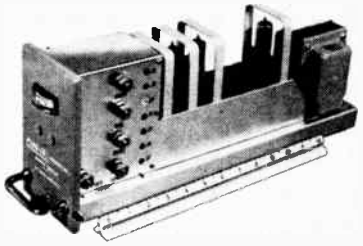
types. These resistors have steatite type cores, continuous operating temperature of 134 deg maximum at 40 C ambient; are resistant to humidity; are furnished in 5 percent and 10 percent tolerances; have axial leads which make them simple to mount.

CIRCLE NO. 332 READER SERVICE CARD

Inverter
high frequency

POWER SOURCES, INC., Burlington, Mass. Model SV2C1200 Sineverter is a general purpose inverter for use in missiles, aircraft and other applications where the primary a-c power frequency is 2,000 cps. It employs the Sineverter technique which provides sine-wave power from any d-c source without filtering. Input voltage is 22 v d-c with transients per MIL-E-5894A. Output voltage is 115 v ±5 percent, 2,000 cps ±1 percent, single-phase, 0-50 va. Waveshape is sinusoidal with less than 5 percent total harmonic distortion.

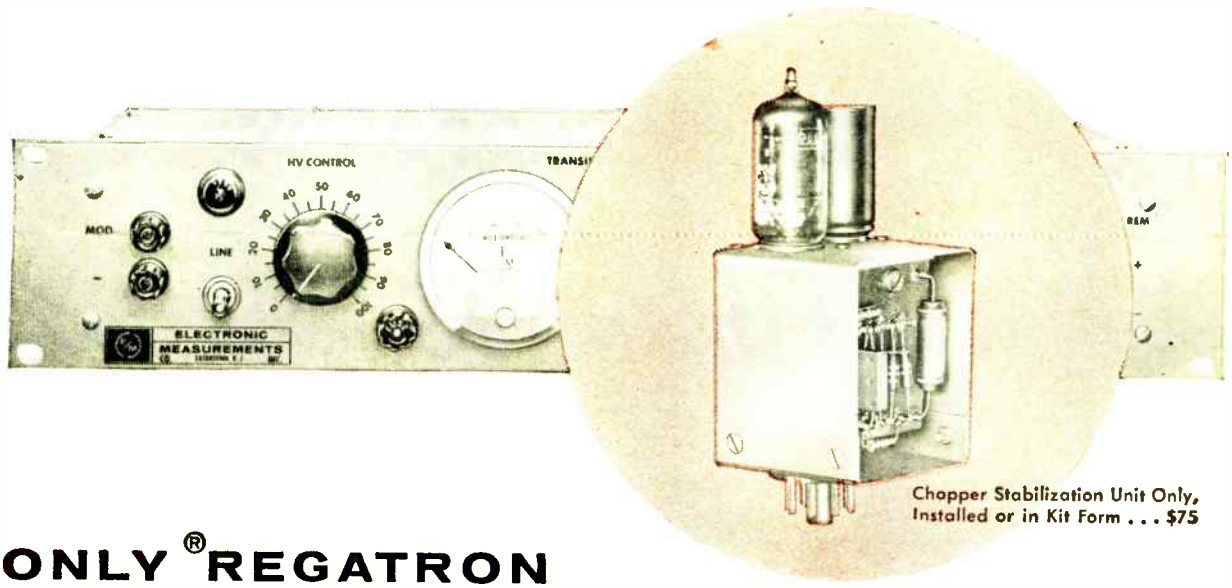
CIRCLE NO. 333 READER SERVICE CARD



Servo Amplifier
modular unit

PLUG-IN INSTRUMENTS, INC., 1416 Lebanon Rd., Nashville, Tenn. Model SA-2002-P d-c servo ampli-

Optional Chopper Stabilization



Chopper Stabilization Unit Only, Installed or in Kit Form . . . $75

ONLY ®REGATRON PROGRAMMABLE POWER SUPPLIES HAVE IT!

0.01% or 0.003 V from no load to full load . . . this is the conservative regulation specification for Regatron Programmable Power Supplies equipped with chopper stabilization. And just as important, chopper stabilization assures a higher order of regulation and stability at every output voltage, even at fractions of one volt.

There are other advantages too: Chopper stabilization provides for exceptionally high repeatability of voltage control settings . . . enhances remote control operation.

And chopper stabilization can be specified at any time. The compact plug-in unit can be installed at the factory as an original accessory, or it can be installed in the field. A complete kit is available for field installations. Instructions and all hardware are included.

Ask your local E/M representative for more information, or write . . .

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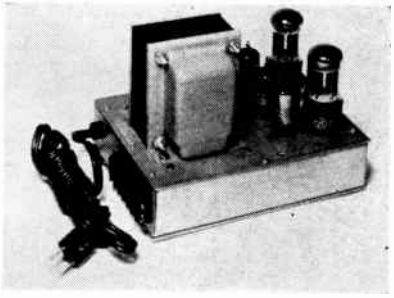
ELECTRONIC MEASUREMENTS COMPANY, INCORPORATED
EATONTOWN · NEW JERSEY

fier is designed for electro-hydraulic control system applications and features overall modular construction. Installed in its matching mounting frame, the amplifier may be partially withdrawn from the panel under full power for adjustments and checks. Further withdrawal disengages the unit for complete removal. There are adjustments for gain, zero, balance, dither and feedback potentiometer excitation. Internal gain of the unit is greater than 60 ma/v. The quiescent current for the differential output is 15 ma for loads up to 3 K.

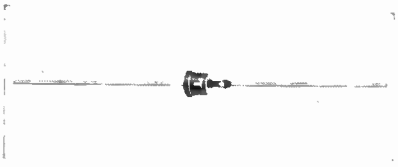
CIRCLE NO. 334 READER SERVICE CARD



Power Supply modular type

TRANS ELECTRONICS, INC., 7349 Canoga Ave., Canoga Park, Calif., has added model RS-210 to its economical modular line of d-c power supplies for use in laboratory, test bench or original equipment. The new module is designed with silicon rectifiers and besides being available in the time-saving chassis or subchassis construction illustrated, can be purchased rackmounted with and without meters.

CIRCLE NO. 335 READER SERVICE CARD



Silicon Rectifiers JAN approved

TRANSITRON ELECTRONIC CORP., Wakefield, Mass., announces a series of axial lead JAN silicon rectifiers designed for use in applications that demand reliable operation at high temperatures and under severe

universal transistor tester

$59.50

MEASURES Ico, ALPHA

•

MEASURES DIODE FORWARD AND REVERSE CURRENTS

•

TESTS FOR SHORT CIRCUITS

Battery-operated, portable model TT-1 provides quick, reliable measurements on both PNP and NPN transistor types of low, medium and high power. Universal panel receptacle and test leads accommodate all standard and special types. Dual scale on precision 50- microamp ammeter indicates transistor leakage and gain, diode forward and reverse currents. Ideal for laboratory, production or field test. Strong, shock-resistant case.

Write for complete specifications.

REFLECTONE

THE REFLECTONE CORP. • STAMFORD, CONN.

CIRCLE NO. 238 READER SERVICE CARD

specify...

G-E KSR* TANTALYTIC* CAPACITORS

for computer, missile, radar, and airborne electronic equipment.

- Provide high microfarad ratings in cases of nominal size and weight without loss of quality or reliability.
- Offer voltage ratings to 150 volts d-c from −55C to +85C; to 100 volts for 125C operation.
- Are up to 50% lighter, 30% smaller compared with lower microfarad units rated for 125C.

SPECIFYING INFORMATION on G.E.'s complete Tantalytic line is available from your nearest Apparatus Sales Office, or write for GEA-6766A, to General Electric, Section 449-11, Schenectady 5, N. Y.

*Registered Trademark of General Electric Co.

GENERAL ELECTRIC

CIRCLE NO. 239 READER SERVICE CARD

here's a complete element of your block diagram...

now readily available

R P M*

*REGULATED POWER MODULE

All design, development and production work has been completed for you in these RPM power modules. Buy them as catalog items, and get these advantages:

Wide choice of overlapping adjustable voltage and current ranges—125 to 425 volts...50 to 400 milliamps.

Excellent regulation—0.05% NL to FL, or 10% line change.

Compactness—RPM units are custom designed and built with our own transformers for most efficient use of space.

Super-rugged construction includes one-piece, cast aluminum housings and JAN hardware. RPM modules can be mounted in any position.

High reliability—achieved by use of top quality components throughout, and rigid inspection during production.

Request ACDC Bulletin 400.

ACDC ELECTRONICS, INC.

2979 N. Ontario St., Burbank, Calif.
Formerly NYT ELECTRONICS, INC.

CIRCLE NO. 169 READER SERVICE CARD

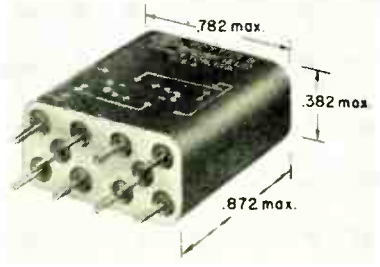
environmental conditions. The JAN types 1N538, 1N540, and 1N547 offer high efficiency and ease of mounting in new and existing rectifier applications. Maximum ratings are 200 v, 400 v, and 600 v respectively at 250 ma, 150 C ambient temperature.

CIRCLE NO. 336 READER SERVICE CARD

Tantalum Capacitor micromodule type

P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis 6, Ind. The micromodule tantalum capacitor was developed in two thicknesses, 0.028 in. in ratings up to 15 μf X volts, and 0.035 in. in ratings up to 30 μf X volts. Three different ratings and five terminal arrangements were developed in each thickness. The units have an effective operating temperature range of −65 to 85 C.

CIRCLE NO. 337 READER SERVICE CARD



Tiny Relays for p-c boards

POTTER & BRUMFIELD, INC., Princeton, Ind., announces relays with terminals located on 0.2 in. by 0.2 in. coordinates to permit mounting on printed circuit boards by automatic assembly techniques. The new terminal layouts are available on both dual coil magnetic latching and on single coil action relays. Both relays operate under 100 g shocks and 30 g vibrations to 2,000 cps with no

contact openings in either armature position. Relays with single coil action pull-in at 260 mw at 25 C; dual coil latching relays at 230 mw. All coil connections are polarized to take advantage of permanent magnet forces in the relay.

CIRCLE NO. 338 READER SERVICE CARD

Klystrons
7,500-hr service life

RAYTHEON MFG. CO., Waltham 54, Mass., has increased the life warranty of its line of low-power communication klystrons to 7,500 hr by advanced manufacturing techniques and rigorous quality control. Designed primarily for microwave communications equipment, the mechanically tuned, reflex-type klystrons cover government, studio link and common carrier frequency bands. Two tubes are used in each relay unit; one in the transmitter; one in the receiver as local oscillator. This makes it unnecessary to maintain a constant relationship between outgoing and incoming frequencies. Tubes can be driven in parallel from a single receiver-type power supply.

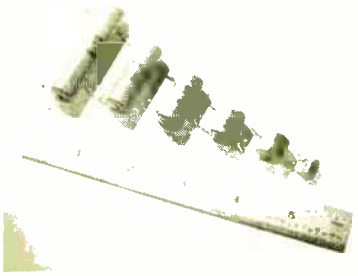
CIRCLE NO. 339 READER SERVICE CARD

A-C Potentiometer
high linearity

PERKIN-ELMER CORP., Norwalk, Conn. A 40-ohm output impedance with a linearity of only ±0.01 per-

cent is obtained in the Vernistat model 3-B a-c potentiometer. It substantially eliminates loading error problems. Unit also features high resolution and minimal phase shift in a small lightweight package. Quadrature at 400 cps is less than 0.1 mv per v. Minimum input impedance at 400 cps is 50,000 ohms (constant); maximum input voltage at 400 cps is 35 v.

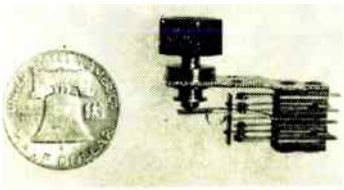
CIRCLE NO. 340 READER SERVICE CARD



Resistors wire-wound

LEONARD ELECTRONICS, INC., 1209 Olympic Blvd., Montebello, Calif. A new line of Delta Ohm precision wire-wound resistors, with resistance tolerance to 0.005 percent if desired and operating temperature range from — 65 C to + 135 C has been announced. Available in approximately 40 sizes and wattages at present, the line surpasses the requirements of both MIL-R-93B and MIL-R-9444. Size range is from ¼ in. by ⅜ in. to ½ in. by 2 in., with wattages from 0.1 w to 2.0 w.

CIRCLE NO. 341 READER SERVICE CARD

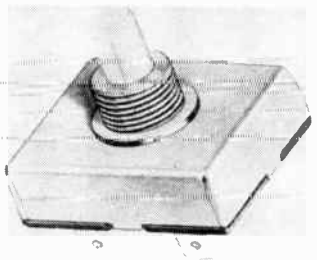


Push-Button Switch open blade

ROBERTSHAW - FULTON CONTROLS. Co., P. O. Box 449, Columbus 16, Ohio. A push-button switch designed for mounting through a panel features dpdt circuitry and performs the functions of two separate switches with resulting savings in cost and space. It has

combination side and tail solder terminals for easy wiring and is mounted with two No. 4-40 machine screws. It is rated at 10 amperes, 125 v a-c and has gold flashed contacts. Switch has 0.015 in. minimum overtravel. Operating force on the button is 8 oz maximum, and release force, also measured on the push button, is 2 oz minimum.

CIRCLE NO. 342 READER SERVICE CARD



Rotary Switch
compact unit

CONTROLS CO. OF AMERICA, 9555 Soreng Ave., Schiller Park, Ill. A selection of eight different combinations of 1, 2 or 3 spst switch positions are offered in series 777 rotary switch. The versatile unit features ¼-in. wide spade terminals with holes for solder connections, positive indexing, metal cover and a molded nylon shaft and cam. It is rated at 10 amperes, 125 v a-c; ½ h-p, 125/250 v a-c.

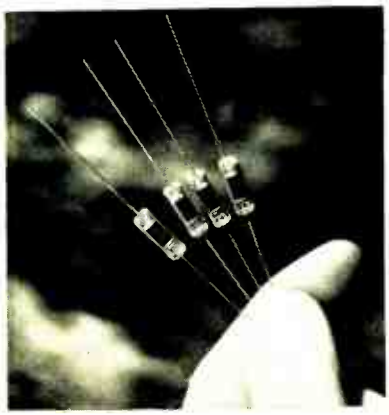
CIRCLE NO. 343 READER SERVICE CARD

Accelerometer
potentiometer-type

PACIFIC SCIENTIFIC CO., 6280 Chalet Dr., Los Angeles, Calif. Model 4205 Potentiometer-type accelerometer measures only 1.1 in. wide, 1.5 in. long, and 0.8 in. deep. It delivers 2 percent accuracy over a −10 to +30 g range, and is designed as an inexpensive instrument for tele-

metering and control. Silicon fluid damping is utilized for exceptional shock and vibration immunity. Temperature range is from −55 C to +82 C.

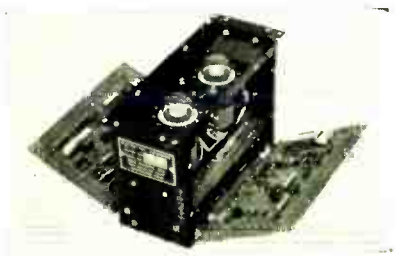
CIRCLE NO. 344 READER SERVICE CARD



Film Resistor
glass enclosed

CORNING GLASS WORKS, Corning, N. Y., announces a glass-enclosed resistor completely impervious to moisture, and designed to meet requirements of MIL-R-10509C, Characteristic B. It has Dumet leads which are sealed to the thermally compatible glass case, creating an hermetic seal. The leads are welded inside the case to Kovar metal disks, which are fused to the resistance element. Resistance range of the ¼ w unit is 10 ohms to 0.5 megohm at 300 v and 70 C, with derating to 150 C.

CIRCLE NO. 345 READER SERVICE CARD

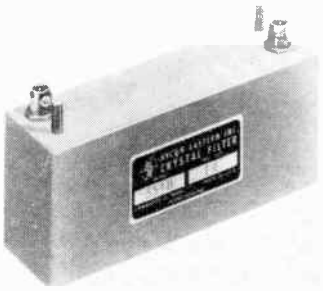


Interval Timer
digital unit

ERIE-PACIFIC, 12932 S. Weber Way, Hawthorne, Calif. Model 2202TL is a compact, rugged, digital interval timer designed especially for airborne or ground support operation under extreme environmental conditions. Silicon solid-state devices are employed to meet military tem-

perature specifications. No vacuum tubes are used other than the counting decades which are efficient, reliable and long-lived cold cathode gas tube devices. Pluggable glass epoxy printed circuit boards, one on either side of the unit, swing outward for easy access to board components and the equipment interior.

CIRCLE NO. 346 READER SERVICE CARD



Crystal Filters in the 37-mc range

HYCON EASTERN, INC., 75 Cambridge Parkway, Cambridge 42, Mass. Model 354 series crystal filters are designed to be directly paralleled with no isolation padding networks in order to minimize r-f losses. System selectivity is achieved at the r-f frequency. Therefore, false triggering due to undesired adjacent signals is eliminated. Operating temperature range is −40 C to +85 C. Vibration is 5 g to 100 cps, 2 g to 1,000 cps. Size is 3⅜ in. long by ¾ in. wide by 1½ in. high.

CIRCLE NO. 347 READER SERVICE CARD

Beacon Transmitter for space vehicles

APPLIED SCIENCE CORP. OF PRINCETON, P. O. Box 44, Princeton, N. J. A miniature, low-power combination subcarrier oscillator transmitter, designed for use in satellite or space-vehicle tracking systems, is now available. Carrier frequency of

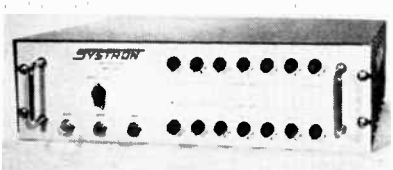
the transmitter can be chosen from any crystal controlled frequency in the range of 100 to 150 mc. The output power of 30 to 100 mw achieves line-of-sight operation from 150 to 1,000 miles in normal satellite applications. The transmitter is intended to be amplitude modulated although phase modulation at subcarrier frequencies up to 22 kc can be used.

CIRCLE NO. 348 READER SERVICE CARD

Scaler transistorized

RADIATION INSTRUMENT DEVELOPMENT LABORATORY, INC., 5737 S. Halsted St., Chicago 21, Ill. Model 49-22 offers both preset time and preset count. The digital readout system used is fully transistorized and allows the displayed numbers to be read at wide angles and in direct sunlight. Resolving time is $\frac{1}{2}$ μsec with maximum counting rate of 2 mc. Count capacity of 10^7 is included with time capacity to 1,000 minutes. Amplifier sensitivity is $\frac{1}{2}$ mv and gain, 1,000. Printed circuitry and modular construction are used throughout.

CIRCLE NO. 349 READER SERVICE CARD

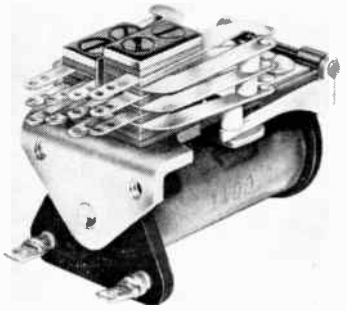


Limit Detector digital unit

SYSTRON CORP., 950 Galindo St., Concord, Calif. Absolute accuracy is achieved with the model 1470 digital limit detector. Low-go-high indication to an exact number of counts is made possible by two banks of presettable switches. Unit can be integrated with any Systron

counter to provide alarm, digital control, or classification of basic measurements. Reliability is increased by the use of solid-state circuitry throughout. A front panel light indicates high-within-low as the unit monitors each counting cycle. Contact closure outputs provide classification or control for each of these conditions.

CIRCLE NO. 350 READER SERVICE CARD



D-C Relay telephone-type

OHMITE MFG. CO., 3665 Howard St., Skokie, Ill. Model TO medium size, telephone-type d-c relay provides increased operating sensitivity, as compared to certain miniature telephone types, because of its longer coil. The terminals project at the mounting and for through-panel connections. Hinge pin armature construction is employed, and a staked-in polepiece eliminates the air gap between the polepiece and frame for increased operating sensitivity. A wide range of operating voltages—up to 220 v d-c—is available.

CIRCLE NO. 351 READER SERVICE CARD

Miniature Tetrode for tv receivers

RADIO CORP. OF AMERICA, Harrison, N. J. The 6FV6 is a new sharp-cutoff tetrode of the 7-pin miniature type designed for use as an r-f amplifier tube in vhf tuners of tv

receivers. This tube has a high transconductance (8,000 μmhos) and a high ratio of plate current to grid-No. 2 current (7 to 1). The high transconductance provides for high gain per stage with corresponding reduction in equivalent noise resistance. The high ratio of plate current to grid-No. 2 current provides good signal-to-noise ratio.

CIRCLE NO. 352 READER SERVICE CARD

Building Block dual flip-flop

DIGITAL EQUIPMENT CORP., Maynard, Mass. A dual flip-flop containing two identical flip-flops with built-in output amplifiers is part of a new line of 5 mc transistorized system building blocks. The dual flip-flop is designed to provide savings over the cost of separate flip-flops in buffer and control registers and other non-counting applications. The system building blocks are used in making permanent or semipermanent digital computer-type systems and in other data handling applications.

CIRCLE NO. 353 READER SERVICE CARD

Snap-Acting Switch subminiature

UNIMAX SWITCH DIVISION, The W. L. Maxson Corp., Ives Road, Wallingford, Conn. Type USM4 snap-acting switch withstands continued use at temperatures up to 400 F. It measures only 25/32 in. long by ¼ in. wide by ½ in. high. Small size permits the switches to be gang-mounted, four to the inch, for multiple-circuit control in miniaturized

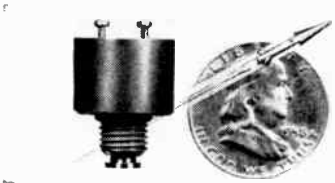
apparatus. Electrical ratings of the spdt switch are: 2.5 amperes, 30 v d-c, inductive; 5 amperes, 30 v d-c, resistive; and 5 amperes, 125/250 v a-c.

CIRCLE NO. 354 READER SERVICE CARD

A-C Voltmeter
suppressed zero

ERA PACIFIC, INC., 1760 Stanford St., Santa Monica, Calif. Model SZV-125 voltmeter provides expanded scale reading accuracy without sacrificing valuable scale space for compression at the low end. Full scale deflection is accomplished for the voltage range of 100 v a-c to 125 v a-c, thus providing adequate coverage for the normal range of 115 v ±10 percent. Reading accuracies of ±0.2 v and meter accuracies of better than 1 percent are obtainable. A time constant of less than 0.5 sec provides faster readings and closer monitoring of line conditions. Unit may be used on frequencies between 50 and 450 cps.

CIRCLE NO. 355 READER SERVICE CARD

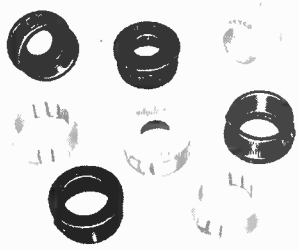


Pressure Switch
for missile use

FREBANK CO., 711 W. Broadway, Glendale 4, Calif., has developed a miniature pressure switch for missile and similar space applications. Model 3486 is designed for use with

both hydraulic fluids and gases, and for 400 psi to 3,000 psi systems. Its snap action design is such that it is extremely resistant to acceleration, shock and vibration. Bearing a maximum weight of only ¾ oz, the switch has a temperature range from −65 F to +275 F, a proof pressure of 4,500 psi and a burst pressure of 7,500 psi. It can be supplied in spst, spdt or dpst.

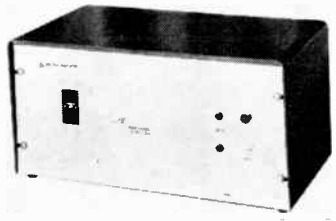
CIRCLE NO. 356 READER SERVICE CARD



Snap Bushing variety of i.d.'s

HEYMAN MFG. CO., Kenilworth, N. J. A new Heyco nylon bushing snaps into a ¾ in. diameter chassis hole and locks under finger pressure. No threated holes or nuts are required to hold it in place. It cannot be removed unless the nylon step-clips are compressed. Wire, cable, hoses or tubing can then be run through the bushing, which, being nylon, provides a neat appearing and smooth unbreakable insulation protection. The bushing is available with various inside diameters, and requires no tools to install.

CIRCLE NO. 357 READER SERVICE CARD

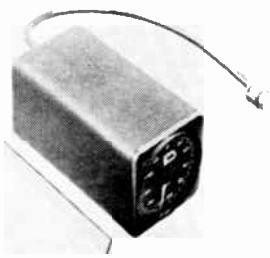


Voltage Regulator broad band

ARMOUR ELECTRONICS, 4201 Redwood Ave., Los Angeles 66, Calif. The PoweRite broad band line voltage regulators extend equipment life as much as 50 percent and assure optimum performance for all types of electronic devices operat-

ing on a-c voltage. The new, fully transistorized regulators provide 4 kva of power regulated to within ±0.5 percent and operate equally well at any frequency between 45 cps and 400 cps. They display response rates of better than 60 v/sec, are power factor insensitive and show less than 0.01 percent total harmonic distortion.

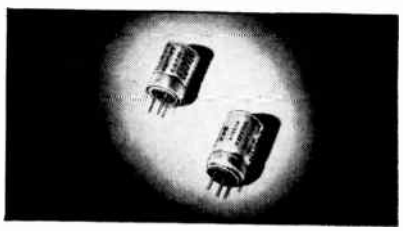
CIRCLE NO. 358 READER SERVICE CARD



Self-Balancing Pot miniaturized

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif., announces a highly versatile, miniature flight test instrument, Autopot series EMP-NS2, with dimensions of 3⅝ by 3⅝ by 7 in. This self-balancing potentiometer is designed to accept outputs from thermocouples or other transducers used in flight test programs. It converts temperature, pressure, stress, flow or acceleration signals into direct-reading indications. Plug-in construction permits simple conversion of basic model for either millivoltmeter or pyrometer applications. Operation is completely automatic due to new servo design.

CIRCLE NO. 359 READER SERVICE CARD

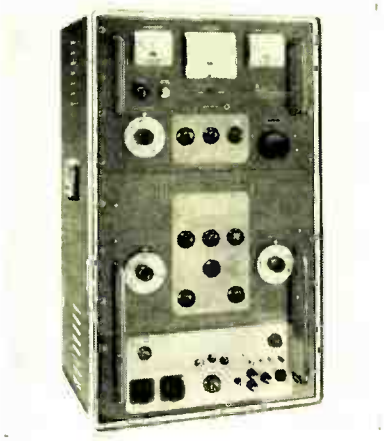


Capacitors common anode

ILLINOIS CONDENSER CO., 1616 N. Throop St., Chicago 22, Ill., announces type SMTUCP common anode miniature electrolytic capacitors. They are dual capacitors in

one case, and their common anode construction with isolated cathodes allows economy and space savings in modern transistor electronic circuitry. Isolation between cathodes allows the electronic designer to use individual capacitors for dual filtering, by-pass, or coupling where two or more individual capacitors were previously needed.

CIRCLE NO. 360 READER SERVICE CARD



Power Supply
bwo/twt

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. The PRD type 813 universal bwo/twt power supply is designed for use with a wide variety of microwave tubes. Among its features are individual adjustment of delay time, collector, anode grid and heater elements; provisions for both internal and external sweep and amplitude modulation; automatic gain control at the grid when used with external detectors; counter type readout for delay line supply; and dual output jacks for parallel tube operation or external metering.

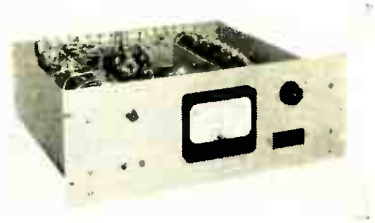
CIRCLE NO. 361 READER SERVICE CARD

Magnetic Shield
multisectional

MAGNETIC SHIELD DIVISION, Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill., has developed a

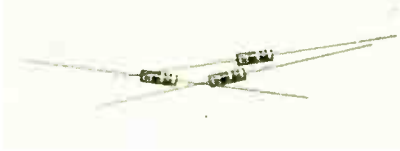
new multisectional Netic Co-Netic magnetic shielding assembly which facilitates installation in existing equipment without dismantling the structure. It is particularly suited for assembled sensing or guidance devices that display an unanticipated sensitivity to magnetic fields. The unique overlapping multisectional assembly is designed to provide effective shielding without modifying the initial structure or dismantling a complex electronic set-up. Design flexibility permits effectively enclosing virtually any configuration.

CIRCLE NO. 362 READER SERVICE CARD



D-C Power Supply for lab use

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., has developed a new 400-cycle a-c input d-c power supply utilizing a combination of magnetic amplifiers, transistors, silicon power rectifiers, and a silicon Zener diode which provides extremely reliable long life and excellent dynamic load regulation. Model M-1201 has a transient regulation of ±10 percent with a step change of no load to full load or vice versa and recovers to within 1 percent of the output voltage setting in less than 0.1 sec. Ripple is less than 0.05 v rms. A-c input is 115/200 to 126/220 v and d-c output is 24/32 v at 25 amperes.

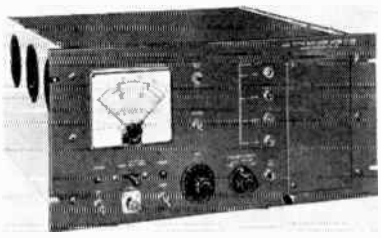


Silicon Diodes stable, reliable

CONTINENTAL DEVICE CORP., 12911 Cerise Ave., Hawthorne, Calif. A new series of silicon diodes is manufactured by the controlled fusion

technique which effects precise control over the junction formation and geometry and leads to very uniform characteristics in production. Types CD1111 through CD-1116 have working voltages through 300 v and forward currents in excess of ¦ ampere at 1 v. Reverse currents are below 5 millimicroamperes at the maximum working voltage.

CIRCLE NO. 364 READER SERVICE CARD



Count Rate Meter rack-mounted

HAMNER ELECTRONICS CO., INC., Princeton, N. J. The N-701C log count rate meter is designed specifically for direct counting of pulses resulting from nuclear disintegrations. It is used with scintillation detectors, G-M counters, BF_3 counters and reactor instrumentation. There is a maximum-count limit switch that may be used to activate an alarm system or other external device that will signal the presence of excessive radiation. Scale expansion allows any three adjacent decades to be selected by a front panel switch.

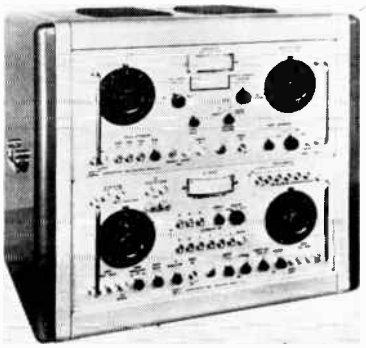
CIRCLE NO. 365 READER SERVICE CARD

A-C Voltage Divider ultralinear

ELECTRO-MEASUREMENTS, INC., 7524 S.W. Macadam Ave., Portland 1, Oregon, announces a new a-c voltage divider, the model DT-72 Dekatran. A laboratory standard is now available to measure voltage ratios with a linearity accuracy of better than 0.0001 percent (1 ppm). Specially

constructed toroidal transformers are combined to provide seven decades of accurate voltage division. Accuracy is maintained over a wide range of audio frequencies, input voltages and ambient temperatures.

CIRCLE NO. 366 READER SERVICE CARD



I-F Test Set
multifunction unit

TELONIC INDUSTRIES, INC., Beech Grove, Ind. The SSX-2/PAM-2 combines in one instrument the following functions: r-f sweep signal, c-w signal source, variable marker, video pulse, c-w pulse, audio modulated c-w, and high level audio voltage. Simplified procedures are incorporated for complete testing of i-f amplifiers and similar equipment. Accuracy is ±0.25 percent.

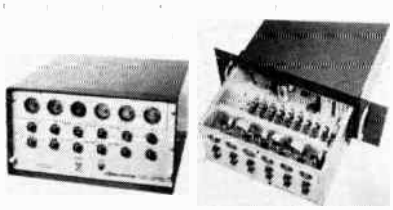
CIRCLE NO. 367 READER SERVICE CARD

Comparator
high precision

WAYNE KERR CORP., 2920 N. 4th St., Philadelphia 33, Pa., announces the B-821 low impedance comparator for accurate comparison of an unknown impedance. It compares impedances in the order of 1,000 ohms against a known standard with an accuracy of 0.001 percent, and covers ratios between standard and unknown of 0.8:1 and 1.2:1 in steps of 0.00001. An external a-f source and detector are required. The maximum effective impedance, look-

ing back into the bridge, is a few milliohms; measurement frequency can be between 500 cps and 5 kc.

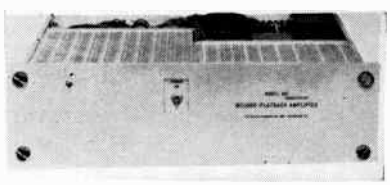
CIRCLE NO. 368 READER SERVICE CARD



Preset Controller for industrial use

DYNAPAR CORP., 5150 Church St., Skokie, Ill., has developed a transistorized preset controller series designed specifically for heavy duty industrial production applications, such as counting, measuring and control for automatic cutting-to-length, batch counting and sequencing, automatic machine tool positioning, and many other measuring and control functions. Units operate directly from all types of sensing devices, and have provision for a wide range of optional outputs. Preset range is 0 to 180,000 counts per minute, with instantaneous reset (optional: to 75,000 counts per sec). Numerical readout consists of either glow counter tubes or Nixie in-line indicators.

CIRCLE NO. 369 READER SERVICE CARD

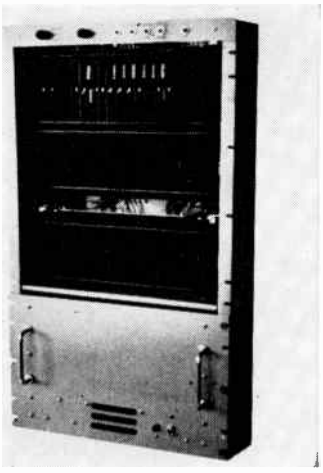


Amplifier record-playback

POTTER INSTRUMENT CO., INC., Sunnyside Blvd,. Plainview, N. Y. Model 921 family of write/read amplifiers affords users of digital magnetic tape transports a wide choice of characteristics for virtually any current or advanced application. Tape speeds from 1 in./sec to 150 in./sec can be accommodated, with a response to minimum signal levels as low as 150 μv. Designed for compatibility with existing return to zero and non-return to zero recording systems, this

amplifier equipment offers a choice of d-c level or preselected pulse width for output use. D-c level or pulse is also acceptable for input to write amplifier.

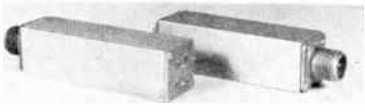
CIRCLE NO. 370 READER SERVICE CARD



Buffer Storages flexible/control

DI/AN CONTROLS, INC., 40 Leon St., Boston 15, Mass. A new line of sequential-to-sequential buffer storages are based on coincident-current magnetic storage elements. The buffers are designed to implement digital data transfer between systems or equipments that are asynchronous, or have different data rates, for collection of regular or aperiodic data from tapes, analog-to-digital converters, and other digital sources. The exceptional flexibility of the buffers is attributed to a unique modular control-system design. Units feature a wide range of standard control options.

CIRCLE NO. 371 READER SERVICE CARD

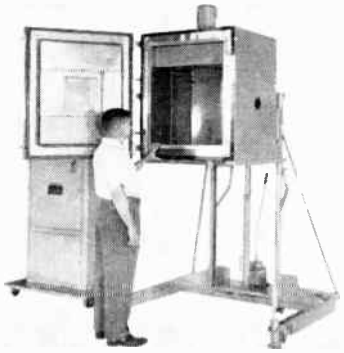


Coaxial Relay high speed

ELECTRONIC COMPUTER CO., 618 Maple St., Conshohocken, Pa. Hermetically-sealed coax relay for input applications in data system and other uses. Features are: coiled impedances, to 6,000 ohms; low contact resistance; operating rate, up to 500 closures per sec; pull-in and

release time, less than 1 millisec; operating currents, to 0.5 ampere resistive also can be used on inductive devices with contact protection; contact capacitance, less than 1 $\mu\mu$f.

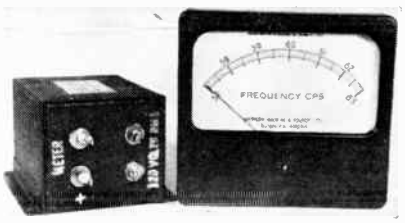
CIRCLE NO. 372 READER SERVICE CARD



Portable Chamber
heat, cold, vibration

CONRAD, INC., 141 Jefferson St., Holland, Mich. Model FBV-8 temperature vibration chamber features a hydraulic lift for raising or lowering the chamber to accommodate a vibration exciter lead through the bottom of the chamber or with an accessory adapter diaphragm through the side of the chamber. Temperature range is +800 F to ambient temperature or with liquid CO_2 cooling to approximately −100 F. Instrumentation is available with several options from indicating controllers to strip chart potentiometer recording controllers.

CIRCLE NO. 373 READER SERVICE CARD



Frequency Meters
expanded scale

AMERICAN MACHINE & FOUNDRY Co., 1025 North Royal St., Alexandria, Va. The commercial model direct reading frequency meter uses a square 4½ in. meter face. It has a 0.25 percent accuracy and a range from 380 to 420 cps. A separate

sensor may be mounted independent of the indicating meter to minimize panel space. The sensor unit weighs 2 lb, is compact (approximately 10 cu in.) and is potted for ruggedization. The meter has been temperature-compensated and needs no calibration in the field.

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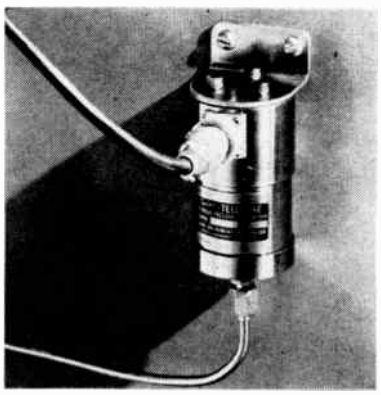

Pressure Transducer low range

TABER INSTRUMENT CORP., North Tonadanda, N. Y. A new low range pressure transducer measures corrosive gas and liquid pressures up to 200 psi. Fast accurate responses (1 millsec) to dynamic pressures result from the small pressure cavity and bonded strain gage construction. Measuring element is a bonded strain gage-proving ring. Pressure on the proving ring sets up strains in the ring which are transmitted to the strain gages. This produces a linear electrical output signal proportional to the pressure. Such signal may be used for either control or measurement in the most precise of systems. The measurement system is relatively insensitive to spurious responses.

CIRCLE NO. 375 READER SERVICE CARD

Frequency Standard encapsulated

ARKAY ENGINEERING, INC., 225 Santa Monica Blvd., Santa Monica, Calif. Series RK200 encapsulated

solid state standards use a new circuit principle to provide any single pulse rate and/or square wave frequency. An external tuned amplifier can produce a sinusoid. Pulse rate is 120 cps to 100 kc; square wave, 60 cps to 50 kc. Pulse output is +1.0 v minimum into 5 K; square wave, 5 v peak into 50 K.

CIRCLE NO. 376 READER SERVICE CARD

Enclosure System
modular frame

AMCO ENGINEERING CO., 7333 W. Ainslie St., Chicago 31, Ill. The new aluminum modular frame system has many advantages in versatility, stocking programs, environmental, antimagnetic, airborne, weatherproofing and unusual size enclosure applications. Members are available from 7 in. to 20 ft in width, height or depth. A complete range of standard ½ in. aluminum panels, plain or painted, conforming to EIA mounting standards is available as well as side, top and bottom panels. Special panel sizes on request.

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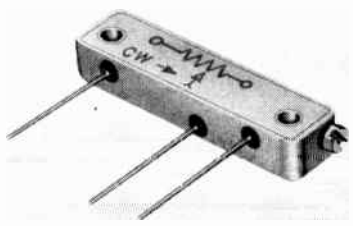

Trimming Pot
highly stable

AERO ELECTRONICS CORP., 1745 W. 134th St., Gardena, Calif. Model 927 miniature wirewound trimming pot has a stability of 60 ppm to 190

C. Unit takes 3.5 w at 30 C, and will handle 0.35 w at 175 C; withstands 30 g vibration at 2,000 cps; passes MIL-STD 202, method 106, for moisture resistance; resistance range, 100 ohms to 100,000 ohms; size, 1.25 in. long by 0.24 in. wide by 0.33 in. high.

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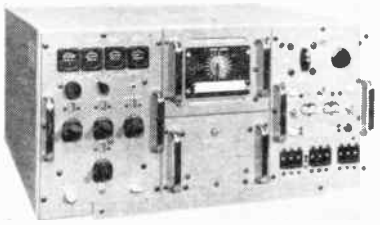


UHF Transmitter small and light

ELECTRONIC COMMUNICATIONS, INC., St. Petersburg, Fla. Model 28 is a 1 kw uhf (225-400 mc) transmitter for airborne communications and other applications. It is 15 in. high, 30 in. wide, 27 in. deep and weighs less than 200 lb. Unit is self-contained, operates from a primary power source of 380 to 1,200 cycles and is shielded against radiated and conducted r-f noise.

CIRCLE NO. 379 READER SERVICE CARD

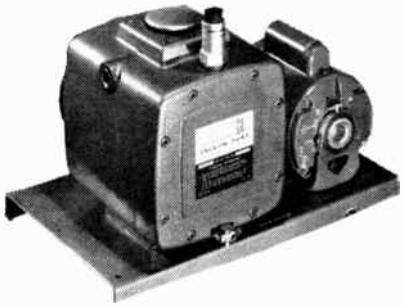
Fact Finding Lab simple to use

ALDEN SYSTEMS Co., Alden Research Center, P. O. Box 125, Westboro, Mass., announces the new fact finding laboratory. It contains all the tools necessary to get the facts, backed up with permanent recording on any physical motion, action or change. The lab is a

NEW

Precision Scientific Model 75 • Model 150 VACUUM PUMPS

. . . now available with GAS BALLAST



Allowing you to evacuate systems containing moisture or other condensible vapors without need of a cold trap or other complete setup.

How It Works

A check valve on compression side of exhaust stage admits controlled amount of air at atmospheric pressure to exhaust undesirable vapors and prevent pump oil contamination.

New Versatility

Use closed with normal vacuum systems and open with contaminated systems. Ultimate vacuum closed is 0.1 microns. Ultimate vacuum open is 5 microns (depending on contaminant present).

All Precision Advantages

Modern design provides greater pumping efficiency at low pressures, more capacity for your investment, compact design and quiet operation.

See For Yourself

For a demonstration without cost or obligation, call your distributor or Precision district office.

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CIRCLE NO. 251 READER SERVICE CARD

complete package with the Alden 30 channel recorder, paper take-up, indicating power supply, 2 channel recorder with extra magazines, direct reading time and money device, Alfax paper, motion switches, extension cords, mobile work center, detecting floor cushion, detecting seat mats, mercury switches, electric photocells, and other accessories. It can be operated by nontechnical personnel.

CIRCLE NO. 380 READER SERVICE CARD

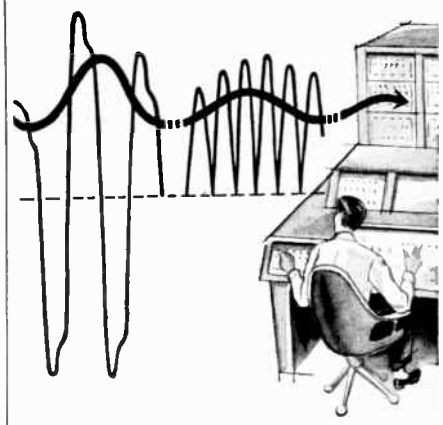
Variable Capacitor many applications

PLASTIC CAPACITORS, INC., 2620 N. Clybourn Ave., Chicago 14, Ill. The Brad-Cap variable capacitor has a maximum capacitance of as much as 4.4 μf. It is ideal for many applications, including wide range R-C or L-C circuits; adjustable capacity standards; integrating circuits; ferroresonance circuits; low and high pass filters. Temperature range for operating and storage is −20 C to 100 C; voltage range, 200 v a-c/400 v d-c.

CIRCLE NO. 381 READER SERVICE CARD

Thermostat for missiles

VALVERDE LABORATORIES, 252 Lafayette St., New York 12, N. Y. Now serving in missile and other vital airborne components, the new VAL90 miniature snap action, pre-



NOW— AC TO DC CONVERSION UNAFFECTED BY HARMONICS

IN PRODUCTION, LABORATORY OR IN THE FIELD

North Atlantic Phase Sensitive AC to DC Converter

makes available, for the first time, the precision and flexibility that permits DC instruments to be used for measurement of complex AC signals. Freedom from harmonic effects, plus variable phasing control, allow **accurate DC readout of total, fundamental, in-phase and quadrature** component of any signal.

Broad dynamic response, excellent linearity and choice of single- or double-ended output make the Model 401 readily applicable to digital voltmeters, DC ratiometers, electronic analog to digital converters and data handling systems. Available for specified frequencies from 30 to 5000 cps, in portable, bench or rack-mount models—or as a module for automated checkout systems. **For full specs, write for Bulletin 401.**

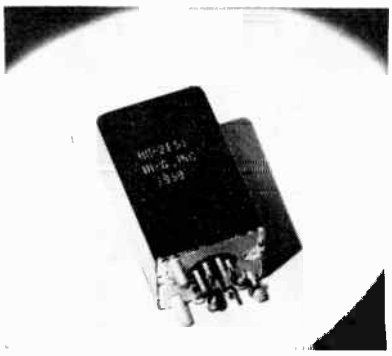
Model 401
5¼" x 19" x 8½"

NORTH ATLANTIC *industries, inc.*
603 Main Street, Westbury, N.Y.
EDgewood 4-1122

CIRCLE NO. 193 READER SERVICE CARD

cision set, sealed thermostat has been designed for reliability under vibration and shock even after months of shelf life. Normally preset up to 350 F with a differential of 3 F or better and a setting tolerance of ±3 F the capacity is 40 w 30 v and 100 w 120 v a-c/d-c noninductive and for dry circuits. Weight is under 0.2 oz.

CIRCLE NO. 382 READER SERVICE CARD



Sealed Relay
1 in. sq, 1½ in. high

HI-G, INC., Bradley Field, Windsor Locks, Conn. ESS series hermetically sealed relay meets vibration of 20 v to 2,000 cps with a sensitivity of 80 mw in a 2pdt unit. Coil resistances as high as 36,000 ohms are available, and a-c units using full wave or half wave rectifiers may be obtained. Contacts are rated at 2 amperes resistive for a life of 100,000 cycles. Relay is suitable for use at ambient temperatures up to +125 C.

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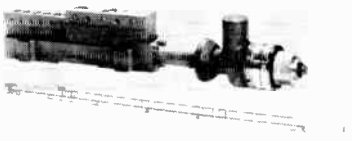

Video Detector Mount
filter and crystal

AMERICAN ELECTRONIC LABORATORIES, INC., 116 N. Seventh St., Philadelphia 6, Pa. Filter and crystal video detector mount has a pass band of 2.6 to 3.25 kmc with insertion loss of less than 1.4 db within the band. Combination weighs approximately 3 oz, with tangential sensitivity—57 dbm measured with a 2 mc video band-

width using an MA408B crystal. Input is matched to a 50 ohm line and both input and output utilize Microdot miniature coax connectors.

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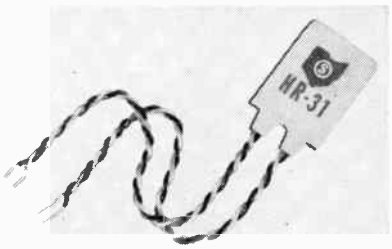

Hall-Effect Device
high resolution

OHIO SEMICONDUCTORS, INC., 1035 W. Third Ave., Columbus 8, Ohio. Halltron type HR-31 utilizes a thin wafer of indium arsenide to provide a high output voltage over a wide temperature range. Output decrease is 10 percent when the element temperature is changed from 0 deg C to + 100 C. Temperature coefficient is essentially constant at 0.1 percent per deg in this range. Use of the HR-31 is recommended in flux measuring equipment, analog multipliers, power meters and many other applications where very low temperature dependence is a necessity.

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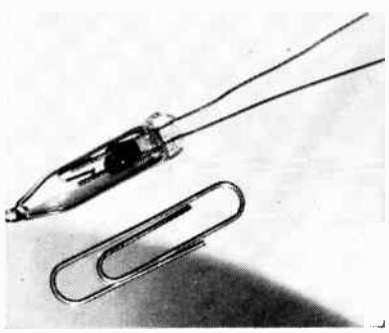

Circuit Breaker
subminiature

SYLVANIA ELECTRIC PRODUCTS INC., Salem, Mass., has developed a subminiature electrical circuit breaker that is vacuum sealed in a glass envelope. Called the Mite T Breaker, the low-cost device provides circuit protection by interrupting current flow when excessive

current or external heating occurs. As temperature decreases or the overload is removed, the current path is automatically reset. A wide variety of potential uses include the diversified control systems of today's highly automated industries.

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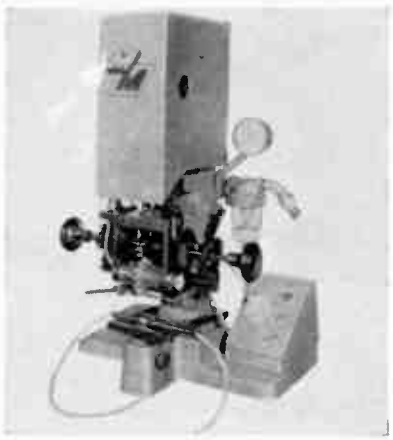


Marking Machine
air-operated

MARKEM MACHINE CO., Keene 75, N. H. Tubing from size No. 12 up to ½ in. in diameter can be marked on the new model 1002 marking machine. Unit has a specially designed work table with a tubing guide to assure proper location of the tubing for imprinting. Tubing is pulled through the guide and cut off manually. Engraved type-wheels make imprints up to 22 characters wide or 2⅛ in. maximum length; imprint changes are made almost instantly by rotating the type-wheels with turning pinions to select the desired imprint. Heated type and ink make imprints that become part of the material when marked and will not scrape or rub off.

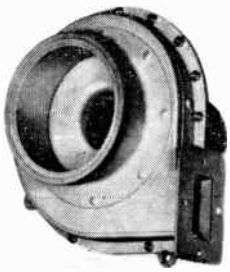
CIRCLE NO. 387 READER SERVICE CARD

Power Supply
semiconductor type

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. Model ME36-5EM power supply

features a magnetic line voltage regulator and a transistorized regulator circuit. The line voltage regulator causes the voltage across the transistors to drop to zero when the output is shorted, thus minimizing the amount of power the transistors must dissipate. The transistorized regulator permits a recovery time of less than 50 μsec with overshoot less than 1.0 percent of the voltage setting. Output voltage is 0 to 36 v continuously variable, with vernier control, at 0 to 5 amperes d-c.

CIRCLE NO. 388 READER SERVICE CARD



Aircraft Blower meets MIL-E-5272A

THE TORRINGTON MFG. CO., Torrington, Conn. MSA-10569 cooling blower is being applied in complex ground support facilities for calibrating critical aircraft equipment. Unit will deliver 25 cfm of air against a static pressure of 8 in. of water. It is provided with a 115-v single-phase 400-cps aircraft motor and weighs about 4 lb.

CIRCLE NO. 389 READER SERVICE CARD

Floated Rate Gyros high-accuracy

KEARFOTT CO., INC., 1500 Main Ave., Clifton, N. J. Series 2500 miniature floated rate integrating gyros, designed for use in missiles or other severe environments, are 2 in. in diameter and 2¾ in. long.

measure down to 0.03 μv

The Keithley 150 sets a new standard of sensitivity for dc voltmeters. Typical uses include output measurements from strain gages, thermopiles and ion chambers, as well as Hall effect studies, corrosion work and molecular weight analysis.

Functions and measurement spans of the 150 are: dc voltmeter, 1 microvolt to 1 volt full scale; ammeter, 10^{-3} to 10^{-10} ampere full scale; dc amplifier, gains of 10 to 10^{7}; and null detector, with 0.5 to 2 second response. Features include:

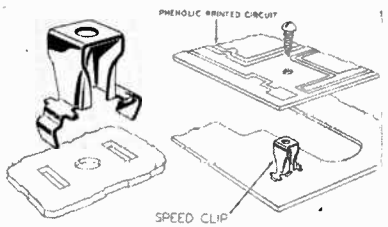
- **zero stability** as a voltmeter within 0.1 microvolt per day; as an ammeter, within 2 x 10^{-11} ampere per day.
- **zero suppression** up to 100 times full scale.
- **optional** floating or grounded input.
- **short term noise** within 0.03 microvolt peak to peak (0.006 microvolt RMS).
- **rugged construction,** relative insensitivity to vibration, 60-cycle fields, or thermal EMF's.

Write today for your copy of Keithley Engineering Notes, Vol. 7 No. 1 describing the Model 150.

KEITHLEY INSTRUMENTS, INC.
12415 Euclid Ave., Cleveland 6, Ohio

Design combines torque motor and signal generator in single unit "torsyn" with restraint-trimming tertiary winding. A variety of performance characteristics are available. Units operate at any altitude. Standard deviation (short term): azimuth, 0.05 deg/hr; vertical, 0.03 deg/hr. Max. drift rate: 0.015 deg/hr/g^2 steady accel.; 0.008 deg/hr/g^2 vibratory accel.; warmup time: 10 minutes from −60 F; weight: 0.7 lb; life: 1,000 hr.

CIRCLE NO. 390 READER SERVICE CARD



Speed Clip
fastens p-c board

TINNERMAN PRODUCTS, INC., Cleveland, Ohio. One-piece speed clip to space and fasten printed circuit boards to chassis. Made of spring steel, it is self-retained in fastening position by bowed spring legs which snap into place and lock on the underside of the chassis. When clips are in place, circuit board is positioned, screws are inserted through board and between clip legs into chassis. Clips provide more than half-inch clearance between circuit board and chassis.

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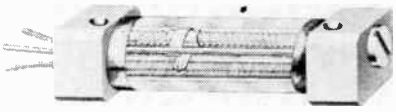
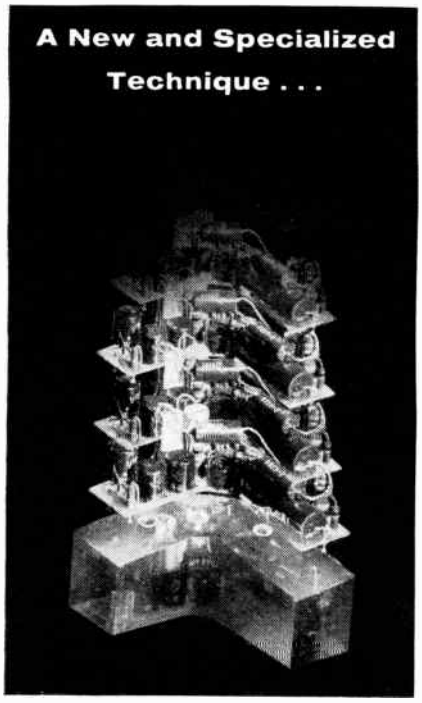


Miniature Pot
humidity proof

NETWORKS ELECTRONIC CORP., 14806 Oxnard St., Van Nuys, Calif. Nec-Pot miniature wirewound pot is 100 percent humidity proof. Hermetically sealed all-glass case provides visual inspection and adjustment of wiper. Units are supplied with resistances of 100 ohms



CUSTOM PACKAGING
by General Electric

Specialized defense requirements necessitate new packaging techniques for electronic circuit modules. Working from schematics or performing the entire design task from customer requirements, General Electric creates small lightweight, high-density components. Engineering and production staffs skilled in new packaging techniques deliver tested prototypes in four to six weeks.

With *maximum environmental stability*, *lower noise* and *higher signal levels*, applications for such electronic packages as inverters, flip-flops, encoders, amplifiers, exist throughout the military market. Where the advantages of *modular replacement* over technical field repair are of the utmost importance, the high-density volume efficiency of these circuit modules is the answer to extreme space limitation.

For more information on Custom Packaging, write to Defense Industries Sales, Section 227-27D

DEFENSE ELECTRONICS DIVISION
HEAVY MILITARY ELECTRONICS DEPARTMENT
GENERAL ELECTRIC
SYRACUSE, N. Y.

CIRCLE NO. 254 READER SERVICE CARD

to 30 K ohms, ±2 percent. Linear range is 5 to 95 percent of total resistance; and resistance, 1 percent; insulation resistance, 500 megohms minimum; operates from −55 C to +225 C.

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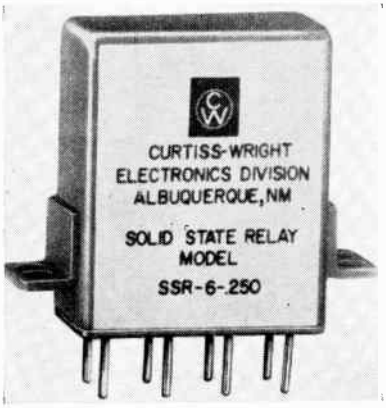

Solid State Relay
spst device

CURTISS-WRIGHT CORP., Inter Mountain Instruments Division, P. O. Box 8324, Albuquerque, N. M. Model SSR-6-250 is a 6 v, ½ ampere, spst solid state relay for aircraft, missile and other high environment d-c power switching applications. It has no moving parts. Pickup time is 2 μsec and dropout, 5 μsec. It can withstand shocks of 1,000 g. Price is $55.

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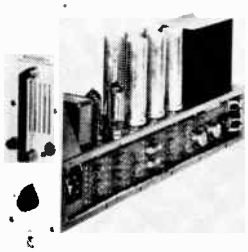

A-C Amplifier
all-transistor

DYNAMICS INSTRUMENTATION CO., 1118 Mission St., South Pasadena, Calif. Model 1634 linear instrument amplifier with integral power supply. Voltage gains are 1 to 100 with 100,000 ohm input impedance in a low-noise all-transistor design. Frequency response of 2 cps to 100,000 cps (±0.5 db) is compatible with other elements of modern instru-

mentation systems such as wide-band magnetic tape recorders. Cables up to 2,000 $\mu\mu$f can be driven without signal distortion up to 50,000 cps.

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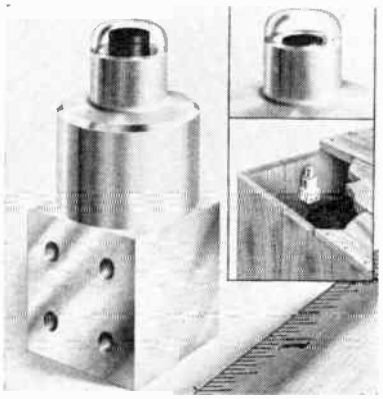

V-Dot Indicators
reusable devices

INERTIA SWITCH, INC., 311 W. 43 St., New York 36, N. Y. Designed primarily for use in shipping missiles, electronic parts and other delicate instruments, V-dot indicators determine if rough or careless handling has caused a shock to the shipment. They give visible indication when shock has exceeded a predetermined permissible limit. Devices have complete spherical sensitivity. Units are also available having one or two plane sensitivity with an accuracy of 5 percent of preset value; available from 5 g to 75 g, in standard models; meet typical military environmental specs.

CIRCLE NO. 395 READER SERVICE CARD

Battery Holders
insulation pretested

ACME MODEL ENGINEERING CO., 6224-15th Ave., Brooklyn 19, N. Y. Over 140 different sizes of battery holders feature impregnated fibre washer insulation, spring tempered aircraft aluminum, standard mounting holes, nickel plated brass

contacts, preadjusted tension for total contact and solder coated copper terminals.

CIRCLE NO. 396 READER SERVICE CARD

V-R Power Supplies
all-semiconductor

TRANSISTOR DEVICES INC., 11 Hamburg Turnpike, Riverdale, N. J. A line of voltage-regulated power supplies feature regulation of 0.1 percent line or load; ripple, 2.5 mv maximum; multiple frequencies, usable from 60 to 400 cps. They are self-protected (short circuit proof), repairable (not sealed), and competitive in price.

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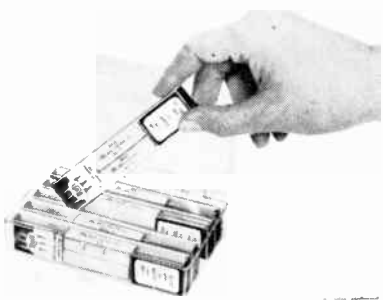

Resistor Kit
multirange

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa. Multirange resistor kit with five basic units delivers 200 fixed resistance values. Each has four separate 10-w wirewound resistors, encased in a common steatite housing. Resistors are of either two or four different values, each with its own pair of axial leads. Connection of leads in series, parallel, and series-parallel arrangements, provide up to 47 different values in a

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covering a frequency range of 30 cps to 1000 mc

NM-40A (AN/URM-41)

30 cps to 15 kc

SELECTIVE OPERATION/Specifications

Sensitivity: For a one-to-one signal-to-noise ratio, the sensitivity of the NM-40A is better than 0.15 microvolt from 1000 to 15,000 cps, 0.25 microvolt from 300 to 1000 cps and 1.0 microvolt from 30 to 300 cps, when used as a selective two-terminal voltmeter with its narrowest bandwidth and an input impedance of 100,000 ohms.

Spurious Responses:

$2\ F_0' >$ 60db down from F_0
$3\ F_0' >$ 55db down from F_0
All others > 75 db down

} where F_0 is any input signal using selective operation

WIDEBAND OPERATION/Specifications

Frequency Response: 30 cps to 15 kcs, ±0.5 db.

Sensitivity: 15 microvolts sensitivity at input impedance of 100,000 ohms.
Input Impedance: 50, 600, 10,000 and 100,000 ohms.
The NM-40A may also be used as an ultra-sensitive AUDIO frequency WAVE ANALYZER.

NM-10A (AN/URM-6B)

14 kc to 250 kc

GENERAL SPECIFICATIONS:

Sensitivity: Electrostatic pickup using rod antennas, one microvolt-per-meter to 2 volts-per-meter. Elect.o-magnetic pickup using shielded loop antennas, 10 microvolts-per-meter to 100 volts-per-meter. As a two-terminal voltmeter, either balanced or unbalanced, one microvolt to one volt.

Effective Random Noise Bandwidth: Varies from approximately 55 cps to 400 cps over the frequency range. Calibration charts give exact figures for each frequency.

Image Rejection: Better than 50 db.

I.F. Rejection: Greater than 60 db.

The equipment is of sturdy drip-proof construction and may be operated for prolonged periods in driving rain or snow with no deleterious effects.

NM-20B (AN/PRM-1A)

150 kc to 25 mc

GENERAL SPECIFICATIONS:

Sensitivity: As a two-terminal voltmeter, either balanced or unbalanced, one μv to one volt. Electrostatic pick-up using rod antenna, 2 μv/meter to 2 volts-per-meter. Electromagnetic pick-up using shielded loop antenna: SMALL LOOP, 10 to 30 μv/meter min. to 10,000 to 30,000 μv/meter max.; LARGE LOOP, 2 to 6 μv/meter min. to 20,000 to 60,000 μv/meter max.

Image Rejection: Better than 50 db.

I.F. Rejection: >45 db.

BFO is provided for C. W. reception.

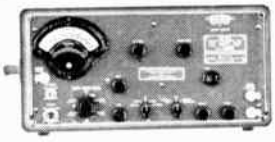
NM-30A (AN-URM-47)

20 mc to 400 mc

Sensitivity: Radiated pick-up using a calibrated, tuned dipole (without reflector), 0.6 to 60 μv/meter, depending on frequency. Conducted pick-up via 50-ohm matched coaxial line, 0.5 to 1 μv from 20 to 240 mc, less than 6 μv from 240 to 400 mc.

Spurious Response Rejection: Better than 40 db.

I.F. Rejection: >60 db.



NM-50A (AN/URM-17)

375 mc to 1000 mc

Sensitivity: Radiated pick-up using a calibrated, tuned dipole (without reflector) 35 to 160 μv/meter, depending on frequency. Conducted pick-up via 50-ohm matched coaxial line, 2 to 5 μv.

Impulse Bandwidth: Approximately 600 kc over frequency range.

Image Rejection: Better than 40 db.

Spurious Response Rejection: Better than 40 db.

I.F. Rejection: >80 db.

APPROVAL DATA CHART

STODDART & MILITARY TYPE	FREQUENCY	MIL-I-16910A (Ships) Amend. #2	MIL-I-26600* (U.S.A.F.) & MIL-I-6181B	MIL-I-11748B (Sig. C.)	S.A.E.	A.S.A.	C.I.S.P.R.
NM-40A (AN/URM-41)	30cps-15Kc	CLASS "1"	Not Req'd	Not Req'd	Not Req'd	Not Req'd	Not Req'd
NM-10A (AN/URM-6B)	14Kc-250Kc	CLASS "1"	Not Req'd	APPROVED	Not Req'd	C63.2 (Proposed)	Not Req'd
NM-20B (AN/PRM-1A)	150Kc-25Mc	CLASS "1"	CLASS "1" "CATEGORY "A"		Not Req'd	C63.2 (Proposed)	**
NM-30A (AN/URM-47)	20Mc-400Mc	CLASS "1"	CLASS "1" "CATEGORY "A"	APPROVED	APPROVED	C63.3 (Proposed)	APPROVED
NM-50A (AN/URM-17)	375Mc-1000Mc	CLASS "1"	CLASS "1" "CATEGORY "A"	APPROVED	Not Req'd	C63.3 (Proposed)	Not Req'd

** Can be supplied with C.I.S.P.R. Recommended detector time constants.
S.A.E. (Society of Automotive Engineers)
A.S.A. (American Standards Association)
C.I.S.P.R (Comite International Special des Perturbations Radioelectriques)
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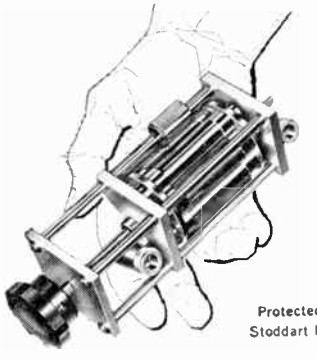
made with exclusive Stoddart Filmistors for highly accurate and stable resistive values from dc to 3000 mc.



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WITH SIMPLE "PULL-TURN-PUSH" OPERATION, SMALL AND RUGGED

ATTENUATOR PADS

Available in any conceivable combination of male and female Type C and Type N connectors. Maximum length of 3" for any attenuation value.

GENERAL SPECIFICATIONS:
VSWR: <1.2 to 3000 mc for values from 10 to 60 db; as value decreases below 10 db, VSWR increases to not over 1.5.
Characteristic Impedance: 50 ohms.
Attenuation Value: Any value from 0 db to 60 db including fractional values.
Accuracy: ±0.5 db; values above 50 db have rated accuracy of attenuation through 1000 mc only.
Power Rating: 1.0 watt sine wave.

COAXIAL TERMINATIONS

Small-stable-50 or 70 ohms

½-Watt: 50 ohms impedance, TNC or BNC connectors, dc to 1000 mc, VSWR less than 1.2.

1-Watt: 50 ohms impedance, dc to 3000 mc or dc to 7000 mc, Type N or Type C connectors, male or female; VSWR less than 1.2, 70 ohm, Type N, male or female terminations available.

Fast delivery on all items/Send for complete literature

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single unit. Simple circuit diagrams and complete instructions for interconnection are included in each Handy-Pak of two units.

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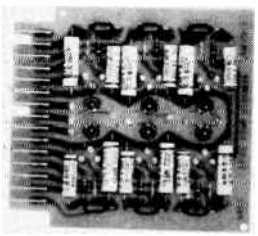

Digital Modules
magnetic type

PACKARD BELL COMPUTER CORP., 1905 S. Armacost Ave., Los Angeles 25, Calif. Magnetic digital modules increase system reliability by reducing number of active circuit elements and permit operation of up to 50 core stages from one drive transistor. System design time can be minimized by core and solid state core driver modules. Modules can be used in digital systems such as computers, automatic control systems, test equipment, telephone circuitry, switching circuitry and shift registers.

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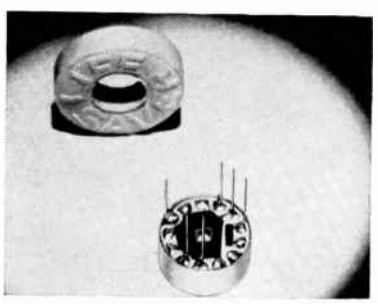

Tiny Amplifier
4-stage

CENTRALAB, A Division of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. TA-12 4-stage amplifier measures 0.531 in. in diameter and 0.228 in. in height, including the hermetically sealed case; contains 12 resistors, 5 capacitors, and 4 transistors. Gain is 73 to 78 db at 1 kc with 1,000 ohm load; nominal input impedance, 2,000 ohms; signal to noise ratio,

42 db below 1 v; supply voltage, from a 1.3 v mercury cell; current drain, 2.1 ma maximum.

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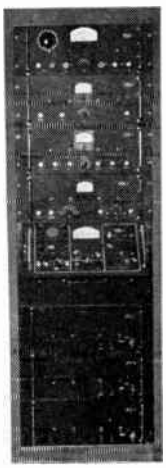

Adapter System for high power ssb

KAHN RESEARCH LABORATORIES, INC., 22 Pine St., Freeport, L. I., N. Y. Model SSB-58-1A adapter system is a practical solution to high power and super power ssb communications. It also permits standard h-f, high level a-m transmitters to be converted to ssb operations without engineering modifications. Principal advantages are: two-to-one or more reduction in equipment costs, greater undesired sideband rejection, lower tube costs, and less sensitivity to overloads and tuning errors. It is specifically tailored for h-f voice, facsimile and multichannel FSK teleprinter operation from 10 kw to 1 megawatt.

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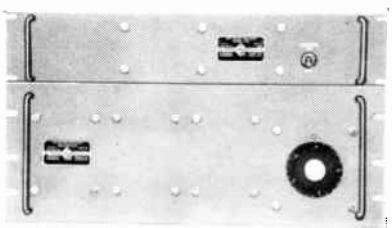

Voltage Regulator militarized

GENERAL RADIO CO., West Concord, Mass. Type 1570-AS25 militarized line-voltage regulator—designed to meet and exceed military environmental requirements of shock, vi-

CIRCLE NO. 207 READER SERVICE CARD

bration, temperature and humidity —is servo-controlled and gives 3-phase service. All 3 phases are controlled together. Average value of output voltage is held constant regardless of harmonic distortion in power line. It can be used with 50 or 60 cycle lines and is available in 115 v or 230 v models (±10 percent). Maximum kva in wye connection is 8.6.

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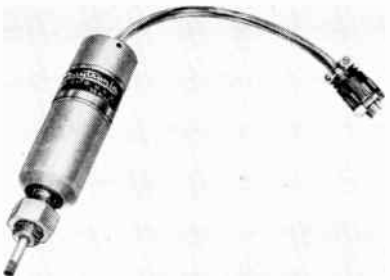

Transducer linear motion

DAYTRONIC CORP., 216 S. Main St., Dayton 2, Ohio. Linear motion measurement or gaging with accuracy to 0.0001 in. in ranges up to 0.120 in. is accomplished using model 102A-120 displacement transmitter which provides an electrical output proportional to displacement of its spring loaded plunger. An inductance device, it has no sliding electrical contacts, maintains calibration indefinitely and is relatively unaffected by mechanical shock, temperature or atmospheric pollution.

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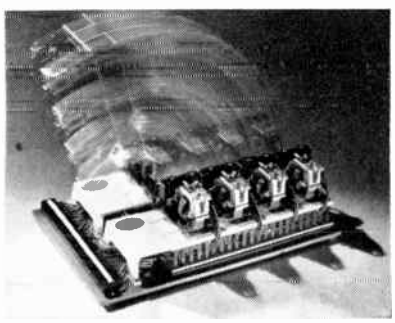

Wiring System for control panels

WYR-WAY, INC., 250 Mt. Hope Ave., Rochester 3, N. Y. A structural wiring system permits compact mounting of relays and results in

the use of considerably smaller panel enclosures. Units are of hinged aluminum modular construction with built-in wiring compartments. Relays are mounted on the top surface and control wires are contained under the devices. Each module swings out so control wires can be snapped into place behind flexible vinyl retaining fingers. Units provide for containing both horizontal and vertical wiring.

CIRCLE NO. 404 READER SERVICE CARD

Power Supply
dual-range

MODEL RECTIFIER CORP., 1675 Utica Ave., Brooklyn 34, N. Y. The DV-III transistor power supply provides these continuously variable outputs: 0-6 v d-c at 1 ampere, or 0-30 v d-c at 2 amperes, or 0-115 v a-c at 1.2 amperes. It features continuously variable autotransformer; 2-section choke input filter; 2-range voltmeter and 2-range ammeter, accurate to 2 percent; 5-way output binding posts; magnetic circuit breaker and range-indicating pilot lights.

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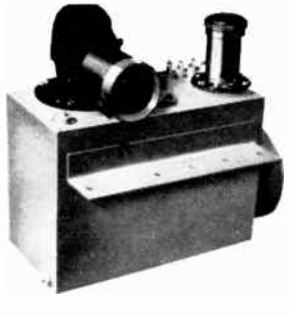
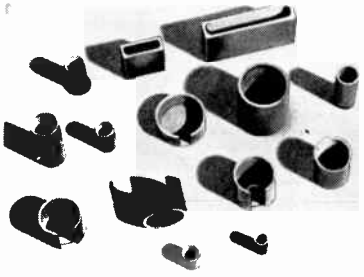


Pulse Transformer
high-power

STAVID ENGINEERING, INC., Plainfield, N. J. High-power pulse transformer features plug-in magnetron receptacle and pulse cable connection. Transformer compartment in case is completely sealed, with ex-

ternal expansion bellows and guard. Case contains two trigger windings to actuate external circuits. Power output is 1.3 megawatts at 28 kv; step-up ratio, 1:3.5; primary impedance, 50 ohms; pulse duration, 0.9 μsec; pulse repetition frequency, 1300 pps; filament supply, 3.5 amperes.

CIRCLE NO. 406 READER SERVICE CARD



Epoxy Shells for encapsulation

THOR CERAMICS, INC., 225 Belleville Ave., Bloomfield, N. J. Epoxide resin shells in many shapes for encapsulation of all types of components with liquid epoxy resin. Low water absorption qualities protects enclosed components from water and atmosphere. Shells have a high tensile strength, withstand 150 C. At 60 cycles, dielectric constant is 3.70, loss factor is 0.009.

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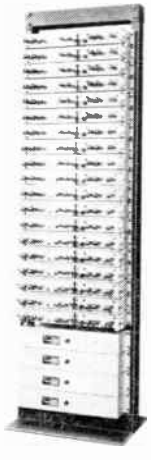
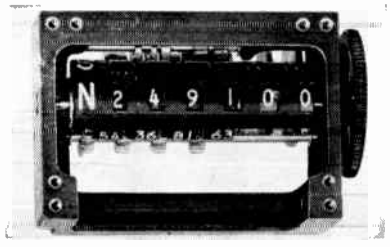


F-M Carrier System 24-channel

RAYTHEON CO., 103 River St., Waltham 54, Mass. B-640 multiplex carrier features transmitter crystal-control, miniaturized plug-in assembly and compatibility with telephone transmission standards.

It provides voice channels over f-m subcarriers in the 40 to 420 kc base band. Carrier equipment may be separated from associated r-f equipment by several miles of wire line or cable. System design includes optional transistorized repeaters.

CIRCLE NO. 408 READER SERVICE CARD



Mechanical Counter
high precision

CHICAGO DYNAMIC INDUSTRIES, INC., 1725 Diversey Parkway, Chicago 14, Ill. Series 2500 mechanical counter is designed for indicating temperatures, pressures, positions, distances and time for ground support equipment, telemetering, fire control and other computers. Counter has operating speeds up to 1,350 rpm; operating temperature range, − 65 F to + 160 F; starting torque from 0.5 oz in. over full operational range. Unit withstands vibration along each principal axis through a total excursion of 0.06 in. for 1 hr at 10 to 55 cps.

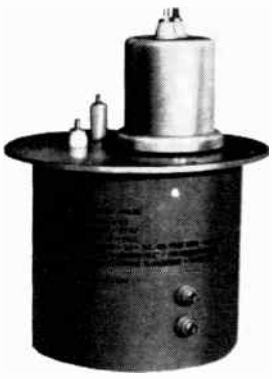
CIRCLE NO. 409 READER SERVICE CARD

Automatic Furnace
utility size

THERMO ELECTRIC MFG. CO., Dubuque, Iowa. Type 200 Thermolyne electric laboratory furnace fea-

tures a fully automatic electronic controller, spotlight temperature readings, long life heating elements, safety door that swings out and up (keeping the hot side away from the operator), and durable construction.

CIRCLE NO. 410 READER SERVICE CARD



Pulse Transformer high temperature

STAVID ENGINEERING, INC., Plainfield, N. J. High power pulse transformer is designed for ambient of 85 C, will withstand 135 C operating temperature and 150 C nonoperating. Unit uses high-temperature insulated wire, Teflon pads between windings, silicone oil vacuum-impregnation, gaskets and seals of silicone rubber or Teflon, recessed expansion bellows, and a small, lightweight package.

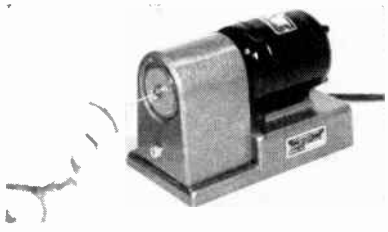
CIRCLE NO. 411 READER SERVICE CARD

Miniature Fan quick-mounting

ROTRON MFG. CO., Woodstock, N. Y. Designed for tightly packaged airborne black boxes where size and weight must be held to a minimum, where reliability is critical and where high heat loads must be dissipated with cooling air, the Aximax 1 is 1½ in. in diameter by 1½

in. in length and weighs 4 oz. The constant 22,500 rpm design will deliver 23 cfm free delivery or 19 cfm at 1 in. static pressure. Available motor designs include 115 or 200 v a-c, 1 phase or 3 phase, 400 cps for either pressurized or non-pressurized applications and for sine or square wave.

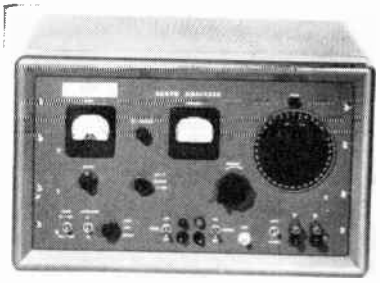
CIRCLE NO. 412 READER SERVICE CARD



Rotary Wire Stripper
no nicking

CARPENTER MFG. CO., INC., Highbridge Road, DeWitt 14, N. Y. Model 78 swingblade rotary wire stripper is designed for production twist-stripping of Teflon, nylon, PVC and all similar insulations from solid, stranded and shielded wire, cable or coax up to ⅜ in. diameter over the insulation. Inserting the wire opens the blade. Withdrawal automatically closes the blade, simultaneously twist-stripping the slug off the end of the lead with a wringing action that leaves a stranded conductor tightly twisted for further handling.

CIRCLE NO. 413 READER SERVICE CARD



Servo Analyzer
versatile unit

AETNA ELECTRONICS CORP., Readington Rd., North Branch, N. J. Servo analyzer features a mechanical integrator which allows wide frequency coverage. Frequencies are indicated on a 4-in. dial. A special circuit design for generating

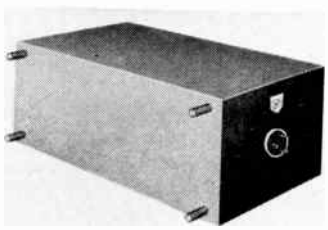
square waves provides transient-free wave forms even at lowest frequencies. A 100 to 1 attenuator is provided. Analyzer will accept carrier frequencies from 5 to 5,000 cps and has an internal carrier source of 5,000 cps. Unit is particularly useful for testing servo, missile, geophysical and medical equipment.

CIRCLE NO. 414 READER SERVICE CARD

Video Detector Mount
lightweight unit

AMERICAN ELECTRONIC LABORATORIES, INC., 116 N. Seventh St., Philadelphia 6, Pa. An all-aluminum broadband coaxial crystal video detector mount weighs less than 1.2 oz. Recommended for aircraft applications, the mount is made with a choice of type N or TNC male input connectors and either TNC or miniature female video connectors. Mount covers the band from 1 to 11 kmc with tangential sensitivities better than −50 dbm over the entire band, measured with a 2 mc video bandwidth using an MA408B crystal.

CIRCLE NO. 415 READER SERVICE CARD

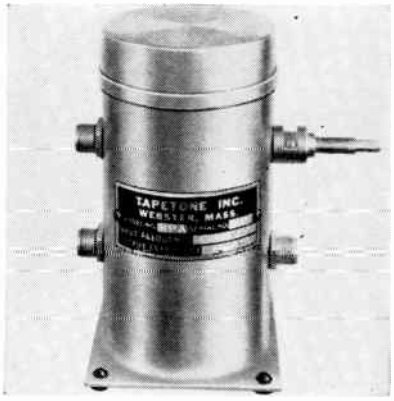


Delay Network
for analog computers

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. Analog computer delay network has a delay time of 700 μsec ± 7 μsec, tapped at 70 μsec

intervals ± 1 percent; characteristic impedance, 3,000 ohms ± 5 percent; delay linearity, ± 1.0 percent, 300 cps to 25 kc; ripple, ± 1.0 percent; insertion loss, 1.0 db maximum; frequency response, ± 1.0 db, 300 cps to 10 kc; dimensions, 9 in. by 5¾ in. by 4¾ in.

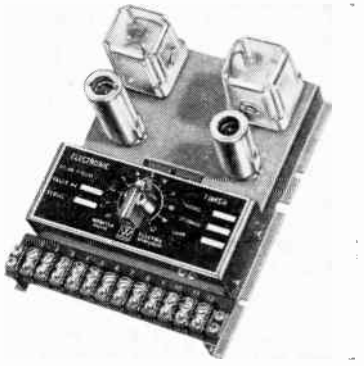
CIRCLE NO. 416 READER SERVICE CARD



Parametric Amplifier
pretuned unit

TAPETONE, INC., Webster, Mass. Parametric amplifier cavity series HPA operates at fixed frequencies at 400-500 mc. Bandwidth is about 1 percent; gain, approximately 15 db with proper pump amplitude and frequency; permits 3-10 db improvement in most receiving systems in this frequency range.

CIRCLE NO. 417 READER SERVICE CARD



Electronic Timers
two types

WEBSTER ELECTRIC CO., Racine, Wisc. Types T-1 and T-3 electronic timers were designed for on-off timing in life tests of products, proportioning controls, and repeat timing of a variety of processes and machines. They are for continuous

cycle operations which are turned on or off for a given period, with the cycle continuous until the initiating switch is opened. The T-1 has a single relay and one time control knob; the T-3, two relays and two knobs.

CIRCLE NO. 418 READER SERVICE CARD

High Speed Relay
semiconductor type

RIXON ELECTRONICS, INC., 2414 Reedie Drive, Silver Spring, Md. Semiconductor relay with keying speed up to 2,000 band (bits/sec) for telegraphic or teletypewriter applications will accept either polar or neutral inputs. It has all electronic parts, can operate at high speeds without mechanical delay or failure. It operates as a spst relay with input coil and output contact isolation.

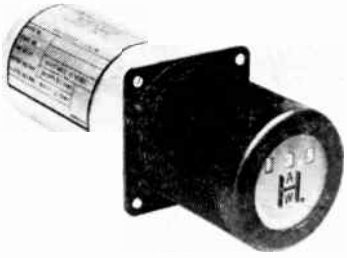
CIRCLE NO. 419 READER SERVICE CARD

Double-Ended Relay
4pdt

HI-G INC., Bradley Field, Windsor Locks, Conn. The HG4DM relay, approximately ⅜ in. diameter, may be used as an in-cable assembly, with the coil leads being connected

both ends internally. It uses two parallel, magnetically isolated structures and one common coil. The two armatures are of the balanced rotary type, making the relay suitable for use under vibration of 20 g to 2,000 cps. Contacts are rated at 2 amperes resistive at 28 v d-c or 115 v a-c for a life of 100,000 cycles.

CIRCLE NO. 420 READER SERVICE CARD



Time Delay Relays for military uses

THE A. W. HAYDON CO., Waterbury, Conn. Special digital time delay relays for military applications where adjustable, accurate and legible time delay settings are required. Housing is 2¼ in. round, extending less than 4½ in. behind panel mounting flange with only setting knob exposed. Delays of $\frac{1}{10}$ sec to 30 sec, in $\frac{1}{10}$ sec increments, are set by rotating full diameter knob containing setting and switching mechanism.

CIRCLE NO. 421 READER SERVICE CARD

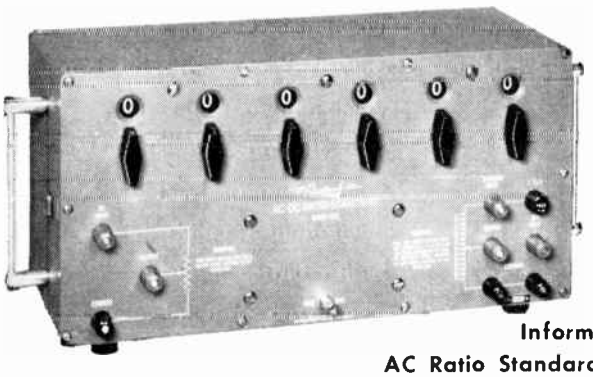
Servo Amplifier transistorized

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. Model 412 series subminiature transistorized, sealed, self-contained low-power servo amplifier. It will drive a 3.5-w servomotor, such as the 40-v, center-tapped, size

AC/DC RATIO STANDARD

For those who require an AC/DC RATIO STANDARD in a single package, Gertsch offers its Models 1001 and 1002. Like all GERTSCH RATIO STANDARDS (1000 Series), these units feature: heavy duty instrument switches, transient suppression, AC Ratios up to 1.11111, bold in-line readout and extra-heavy mechanical construction to insure TRUE STANDARDS PERFORMANCE.

	AC	DC
Linearity:	1 part per million (0.0001%)	10 parts per million (0.001%)
Resolution:	6 Place (0.0001%)	6 Place (0.0001%)



Information on AC Ratio Standards in the GERTSCH RATIO STANDARDS SERIES, Models 1000, 1003 and 1004, is also available.

GERTSCH PRODUCTS, Inc.

3211 South La Cienega Boulevard, Los Angeles 16, California
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- Our line includes terminals and printed circuit hardware in loose or in chain form for automatic insertion.

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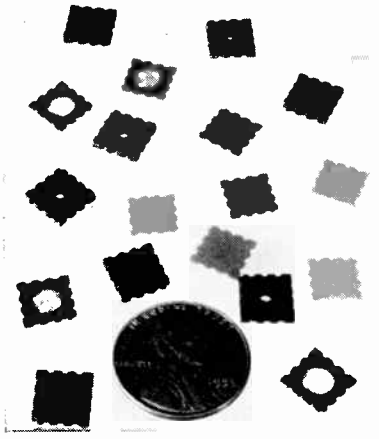
10 and 11 servomotors from low-level a-c signals. Gain is 2,500 ±5 percent with 10-v output; excitation, 28-v d-c; size, 1 cu in.; temperature range. −55 C to +100 C.

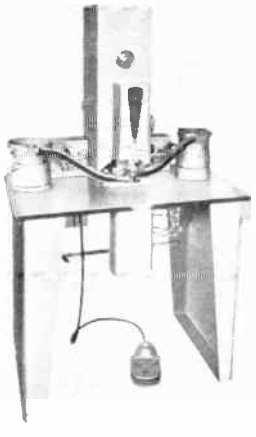
CIRCLE NO. 422 READER SERVICE CARD



Tiny Wafers high-temperature

CORNING GLASS WORKS, Corning, N. Y. Wafers of Fotoceram, a rugged, high-temperature glass-ceramic, enable production of micro-module circuit assemblies. The wafers serve as resistor, transistor, capacitor and diode bases.

CIRCLE NO. 423 READER SERVICE CARD

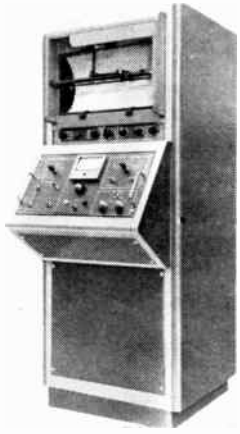


Inserting Machine for small parts

HILL MACHINE CO., 1301 Eddy Ave., Rockford, Ill. Sertomat automatic machine feeds and inserts a wide variety of small parts such as the newly-developed two-piece Teflon bushing and feed-through type circuit board terminals. Parts fed from two hoppers through chutes are pressed into place by cam-oper-

ated ram adjustable for pressing force, speed, and stroke. A lower unit has retracting pin to facilitate accurate positioning of small parts. Insertion of 3,000 pieces per hr is feasible.

CIRCLE NO. 424 READER SERVICE CARD



Servo Plotter
5 ft high, 2 ft sq

REPUBLIC AVIATION CORP., Farmingdale, L. I., N. Y. Plotter automatically checks out servo systems and reproduces test results in graphic form. It produces a selection of 40-point curves within 12 minutes from beginning of test. It detects and plots phase and amplitude relationships in the data-frequency range from 0.3 to 30 cycles. Harmonic distortions are compensated for automatically.

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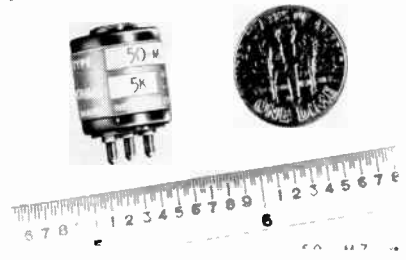


P-C Trimmer Pot
½ in. in diameter

MAUREY INSTRUMENT CORP., 7924 S. Exchange Ave., Chicago 17, Ill. The 50-M7 miniature trimmer pot. One terminal is polarized for quick assembly, needs no shaft-locking device, available from 25 to 10,000 ohms, sealed construction. Pots are built to applicable requirements of MIL-R-19A, MIL-E-5272A, MIL-R-19518, MIL-R-12934B, NAS 710.

CIRCLE NO. 426 READER SERVICE CARD

Literature of

MATERIALS

Protective Surface Coatings. Columbia Technical Corp., 61-05 Thirty-First Ave., Woodside 77, N. Y., has available a chart providing thermal, physical, chemical and electrical characteristics of HumiSeal protective surface coatings for electronics applications.
CIRCLE NO. 450 READER SERVICE CARD

COMPONENTS

Switching Transistor. Texas Instruments Inc., P. O. Box 312, Dallas, Texas. A 6-page folder describes the type 2N705 *pnp* diffused-base mesa germanium transistor.
CIRCLE NO. 451 READER SERVICE CARD

Precision Stock Gears. U. S. Gear Corp., 81 Bay State Road, Wakefield, Mass. A complete line of precision stock gears, 48 through 200 pitch, is covered in a 96-page catalog.
CIRCLE NO. 452 READER SERVICE CARD

Tantalum Slug Capacitors. Ohmite Mfg. Co., 3639 Howard St., Skokie, Ill. Bulletin 159C covers high temperature vibration-shock resistant tantalum slug capacitors.
CIRCLE NO. 453 READER SERVICE CARD

Selenium Rectifiers. Syntron Co., Homer City, Pa., announces a revised catalog on "Selenium Slims" high voltage, cartridge-type rectifiers.
CIRCLE NO. 454 READER SERVICE CARD

EQUIPMENT

Modular Enclosures. Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill. Catalog 106 covers the complete line of basic frames and components of the Emcor modular enclosure system.
CIRCLE NO. 455 READER SERVICE CARD

Packaged Modular Control Systems. Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5,

the Week

N. J. A bulletin describes new packaged modular control systems which are built or assembled entirely from standard units, assemblies and subassemblies. The matched systems are suitable for use in the aircraft, missile, electronic control and related fields.

CIRCLE NO. 456 READER SERVICE CARD

Linear Actuator. Lear, Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich. Product Data 102-11 describes model 320 linear actuator, a compact unit especially suited to applications requiring a high degree of positioning accuracy.

CIRCLE NO. 457 READER SERVICE CARD

Basic Noise Source. Kay Electric Co., Maple Ave., Pine Brook, N. J. A recent mailing piece fully describes the Therma-Node, a commercial portable noise generator covering a frequency range of 0.5-1,000 mc.

CIRCLE NO. 458 READER SERVICE CARD

Electronic Generator. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y. A single-page bulletin gives a description and specifications for model 150 precision 160 va electronic generator.

CIRCLE NO. 459 READER SERVICE CARD

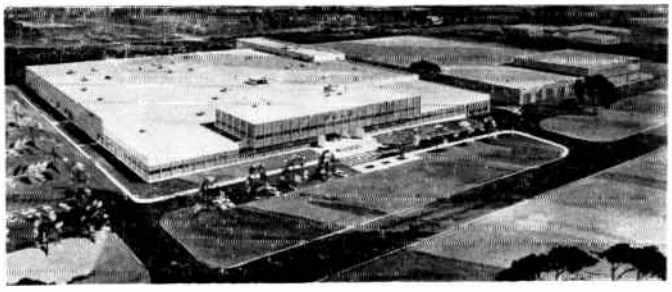
FACILITIES

Industrial Rubber Products. Irving B. Moore Corp., 65 High St., Boston, Mass. Purpose of a recent brochure is to acquaint the reader with the company and its facilities for the research, development and manufacture of rubber products for industry.

CIRCLE NO. 460 READER SERVICE CARD

Drawn Metal Shell Production. Cly-Del Mfg. Co., Waterbury, Conn., has available technical and reference material on single multiple-step operations in drawn shell manufacture.

CIRCLE NO. 461 READER SERVICE CARD



Sola Building New Plant

THE SOLA ELECTRIC CO. of Chicago, manufacturer of precision electronic and electric products and components, has begun construction of a 200,000 sq ft plant in Elk Grove Village just northwest of Chicago.

The new building will approximately double Sola's present facilities and enable the firm to effect a production increase of, says company president Joseph G. Sola, "at least 50 percent within the next five years."

Sola Electric, a division of Basic Products Corp. of Milwaukee, will sell its present plant when it shifts operations to Elk Grove Village sometime next summer. Company officials said the new building, equipment and moving would cost about $2 million.

The firm was founded in 1930 as an engineering laboratory. Since then it has grown to become one of the leading designers and producers of specialty dry-type transformers. Its accounts include manufacturers of computers and radar and missile guidance systems.

Office space of approximately 50,000 sq ft in the new building will be air-conditioned. The 150,000 sq ft production area will be thoroughly ventilated and air-filtered for comfort and dirt control.

Arthur L. Myers, Sola vice president-manufacturing, said the new plant, in addition to greater space, will have a more efficient production layout, faster material flow and handling. The plant will also be convenient to railroad, highway and air transportation.

Joins EECO as Head Engineer

KENNETH GOODMAN has been named chief engineer of Engineered Electronics Co., Santa Ana, Calif. He leaves a post of chief customer engineer at Helipot Division of Beckman Instruments, Fullerton, Calif. Prior to that he was engaged as engineering manager of Aerovox Corp., Monrovia, Calif.

Goodman comes to EECO with a complete background in engineering design work, having done such work at AiResearch Mfg. Co., Bardwell and McAlister, Inc., and Logistics Research, Inc., before going to Aerovox.

Engineered Electronics is a subsidiary of Electronic Engineering Co. of California, also located in Santa Ana, which pioneered the use of plug-in electronic circuits for missile and industrial instrumentation control and data handling systems.

Sylvania Sets Up Second N. H. Plant

SYLVANIA'S Semiconductor Division will begin transistor production early next year in Manchester, N. H., planning employment build-up to nearly 1000 people within two years in its second Granite State location.

Company purchased one-story building containing 25,000 sq. ft. on one-acre site. It was formerly occupied by the Arrow Needle Co. Manchester plant will be strictly a production facility, with engineering and other operations continuing at the Woburn, Mass., headquarters of the Semiconductor Division.

At Hillsboro, N. H., Sylvania manufactures diodes.

Hi-G, Inc. Hires Chief Engineer

J. A. GARRATT recently joined Hi-G, Inc., Bradley Field, Windsor Locks, Conn., as chief engineer. He was formerly with Thomas A. Edison Co., having served there as chief product engineer of the instrument division.

Approve License For Sandynamics

SANDYNAMICS, INC., Ramsey, N. J., has been licensed to produce the Markite precision conductive plastic potentiometers. The new facility has been approved by the Dept. of Defense and Dept. of Commerce as a dispersed production source.

Markite Products Corp., New York City, has been formed to handle all sales, and provide extensive technical service for both Markite Corp. and Sandynamics, Inc.

Epsco Appoints Production Mgr.

PHILIP HOOD has been named production manager by Epsco, Inc., Cambridge, Mass. He was formerly with the AC Spark Plug Division of the General Motors Corp., where he held managerial positions in the production and engineering departments.

In his new post, Hood will work closely with the managers of the three Epsco Boston divisions—the

Systems Division, the Instruments and Equipment Division, and the Components Division—to insure efficient manufacturing operations.

Wilson Directs New Division

BRUSH INSTRUMENTS has appointed Gardner P. Wilson as manager of its newly formed Western Engineering Division in Pasadena, Calif.

Most recently Wilson was with the Electro-Data Division of Burroughs Corp. as manager of the company's Western Engineering Branch. Earlier he served as chief development engineer for Consolidated Electrodynamics Corp.

News of Reps

Lee Mark Associates of St. Louis and Kansas City, Mo., will cover Kansas, Missouri, Nebraska and southern Illinois for Scientific-Atlanta, Inc., Atlanta, Ga., manufacturer of antenna pattern range equipment and related accessories.

Perkin Engineering Corp. Electronic Division, El Segundo, Calif., has named Law Instruments of Angola, Ind., its sales rep for Indiana.

Mechtron Laboratories, Peekskill, N. Y., manufacturer of miniature Teflon film insulated magnet wire has appointed several new sales representatives. Reps and their territories are:

W. H. Hicks of Roslyn, N. Y.—New York City and Long Island;

Samuel A. Jeffries, Inc., of Harbeth, Pa.—southern New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia and Washington, D. C.; **Barrett Border** of Tenafly, N. J.—northern New Jersey; **W. K. Hile** of Charlotte, N. C.—North Carolina, South Carolina, Georgia and Florida; **Roger E. Schlemmer** of Cincinnati, Ohio—Ohio, Indiana and Kentucky; **Lawrence Sales Co.** of Dallas, Texas—Texas, Oklahoma and New Mexico.

Consolidated Avionics Corp., Westbury, N. Y., recently appointed additional reps for its line of transistorized power supplies for electronic equipment. They are: **Roland Olander and Co.** of Los Angeles, for California and Arizona; **J. Y. Schoonmaker** of Dallas, for Texas, Oklahoma, Arkansas and Louisiana; **J. Neal and Co.** of Miami, for Florida, Alabama, Tennessee, Georgia and South Carolina; and **Lowry Dietrich Co.** of Pittsburgh, Cleveland and Dayton, for western Pennsylvania, Ohio, West Virginia and Kentucky.

Electrosources, Inc. of Palo Alto, Calif., was recently named as sales rep for the northern California-Nevada territory by Aircom, Inc., a Winthrop, Mass., firm engaged in design, development and fabrication of microwave components and equipment.

Jim Hastin has acquired sole ownership of Hastin & Browne, manufacturers' rep firm in Honolulu, Hawaii, from Burton Browne. The firm is now known as **Jim Hastin Sales Co.** Browne remains available as a consultant when ever needed.

Bob Gibson has joined **E. V. Roberts and Associates,** Los Angeles electronic engineering reps, as electronics sales engineer.

The United Transformer Corp., New York, N. Y., names **Comtronic Associates** of Mineola, N. Y., as its rep in the New York metropolitan area, servicing industrial accounts.

COMMENT

Temperature Chart

In attempting to use your Temperature Rise Chart (p 106, Oct. 10 '58) we uncover an apparent error. It is that the extreme right-hand scale marking on the upper scale is omitted. In assuming that this marking was 20 C rise, as indicated by comparison of the rest of the scale and lack of any marks indicating a break or discontinuity, then the temperature rise of the example in the next-to-last paragraph would be 26 C instead of the indicated answer of 20 C.

On the other hand, examination of slopes of the lines below 30 C and the slopes above 30 C indicates a change in the scale and that the scale mark should be 0 C. If this modified scale is accounted for, then the rise of the example would be 20 C as indicated. It is obvious, therefore, that the chart was modified at 30 C in order to fit the available space, and that the extreme right-hand scale marking was omitted.

Another problem encountered in attempting to use this information is that it is unwise to assume that the material being tested is copper of 100-percent conductivity. Therefore the use of the constant 234.5 as referenced, without experimental proof for the particular material, is not recommended. The determination of a factor K to replace your value of 234.5 by measurement of resistance variation during a known temperature change is suggested in order to make your information more universal.

BERNARD C. BARNES

NORTH AMERICAN AVIATION
COLUMBUS, O.

More on Diode Terms

The editorial comment on the use of the words *diode* and *rectifier* (p 95, July 3) is well put, but reader Rogers' remarks on symbol polarity are unfortunate.

A diode—whether detecting, conducting, blocking or rectifying—is always a sink, and as such its positive terminal is the anode. A d-c power supply employing one or

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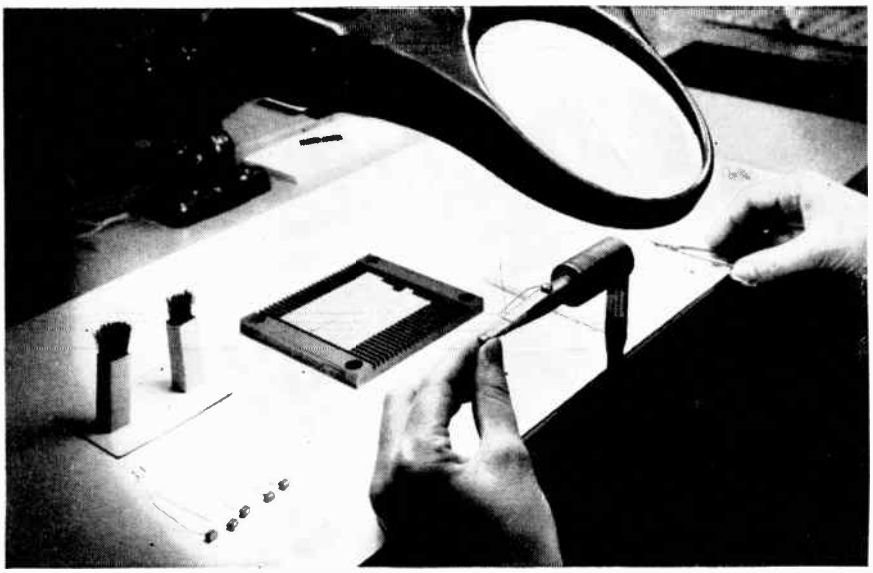

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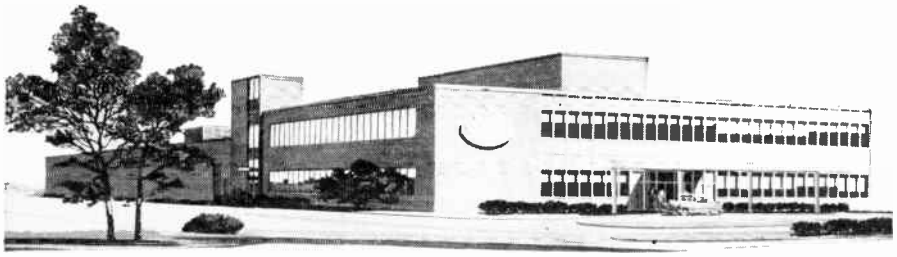

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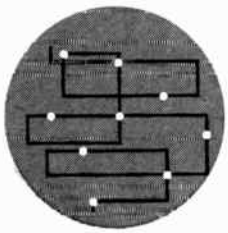

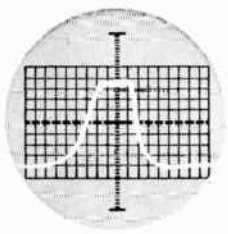

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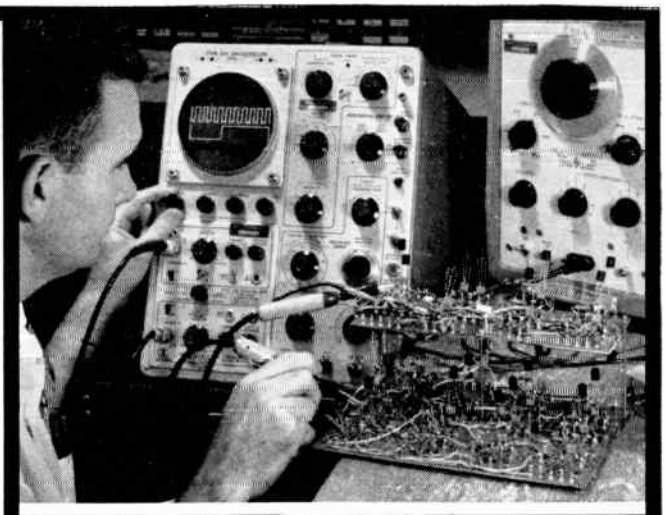

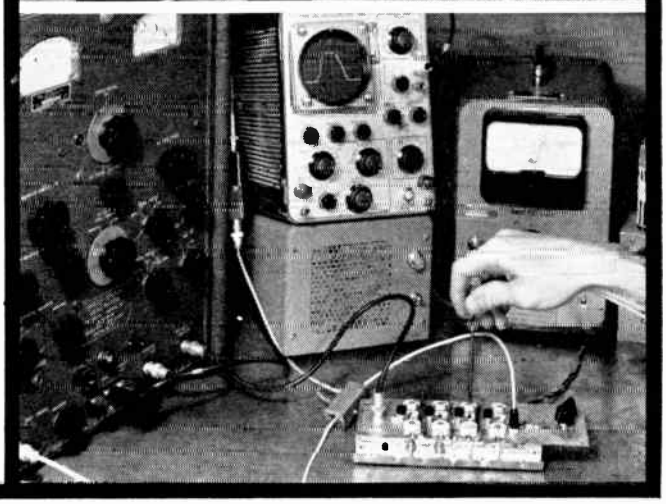

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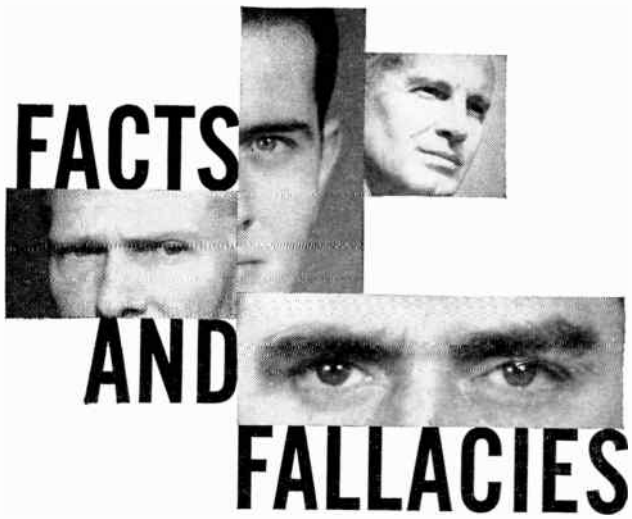

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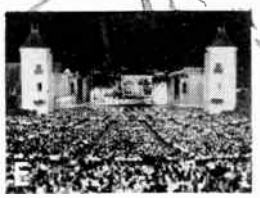

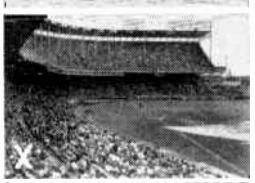

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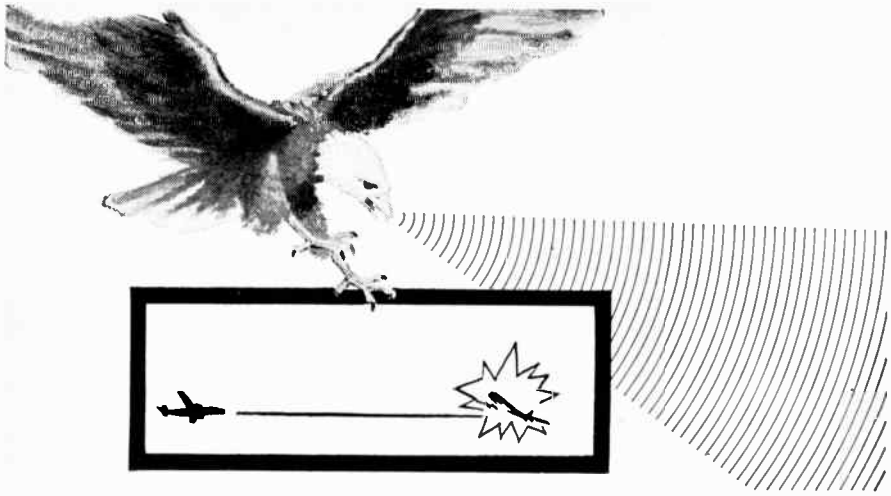

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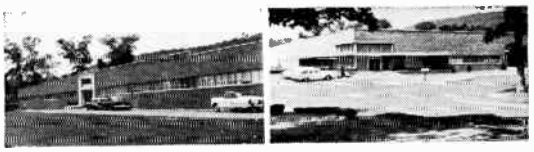

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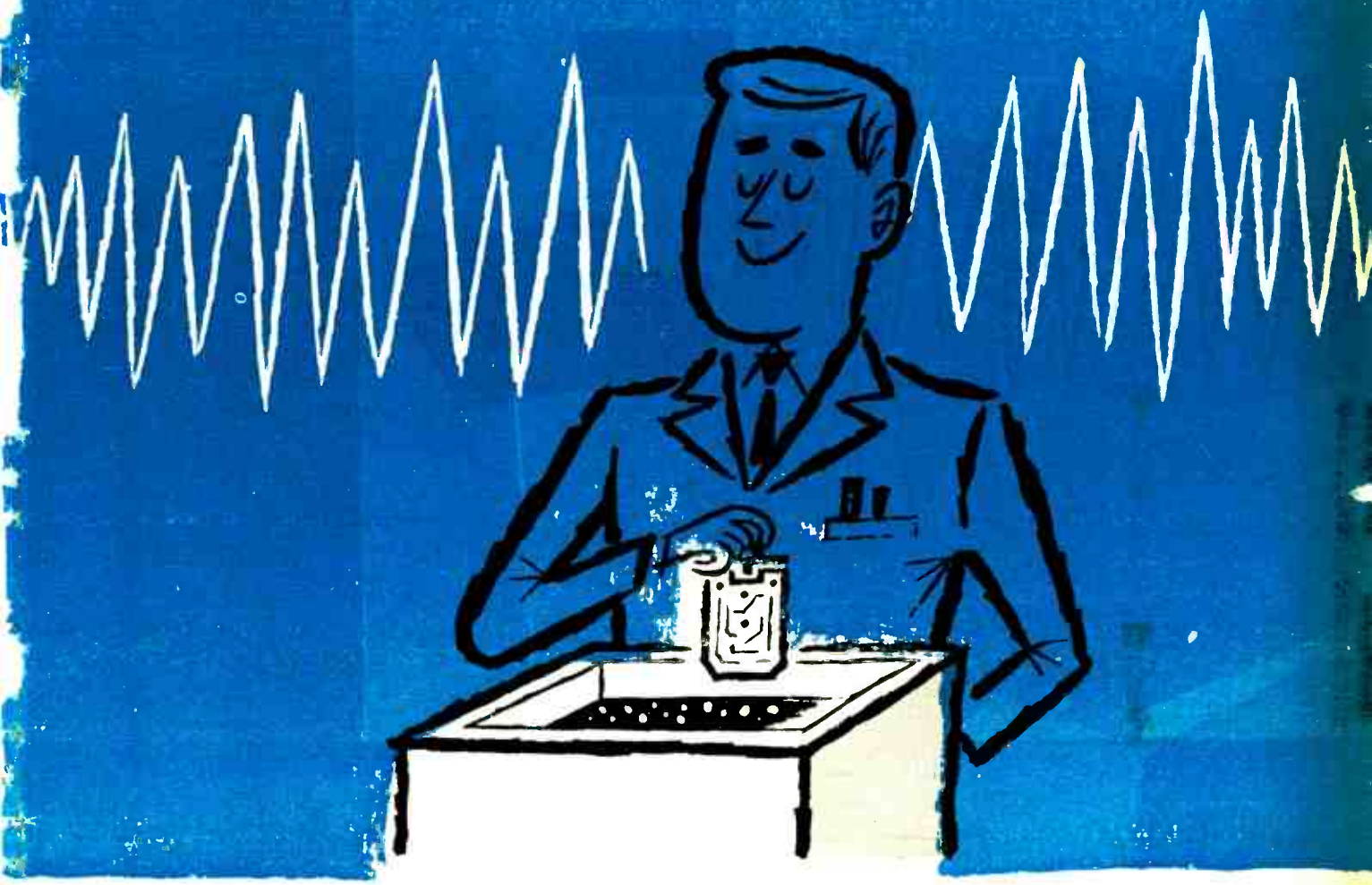

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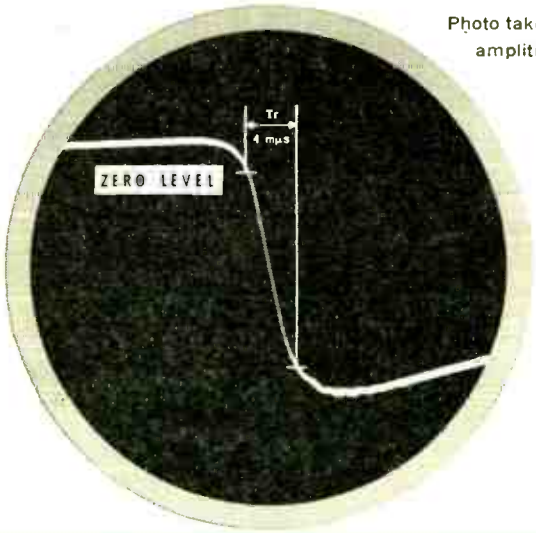
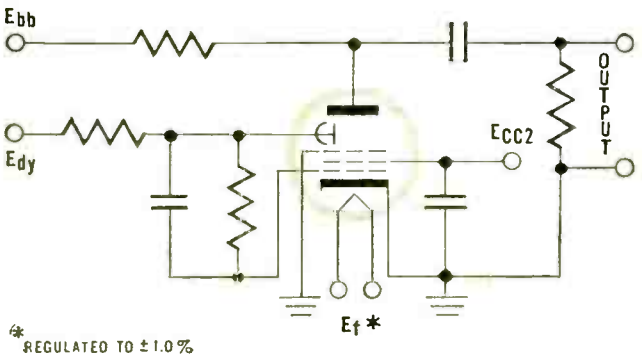


Photo taken with direct coupling to CRT. (T_r 1.5mμs): amplitude 1 amp., rep. rate 100kc.



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Pulse output current	1 amp max
Rise time	4 mμs (N.S.)
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Screen voltage	200 vdc
Plate dissipation	4 w
Dynode dissipation	3 w
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