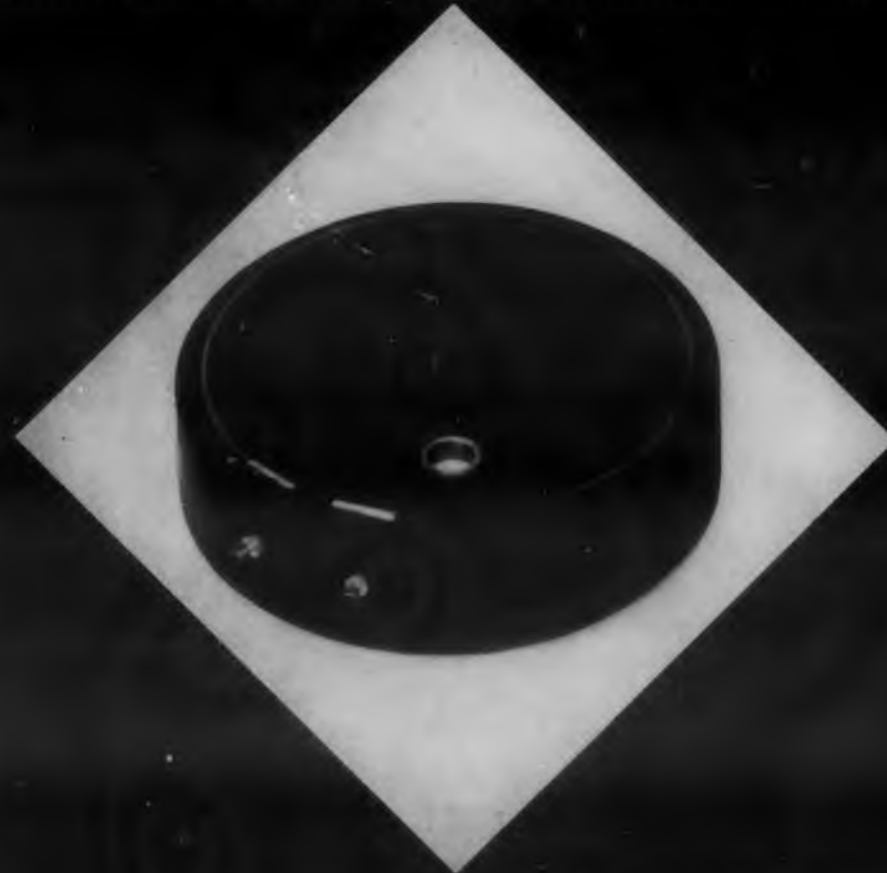


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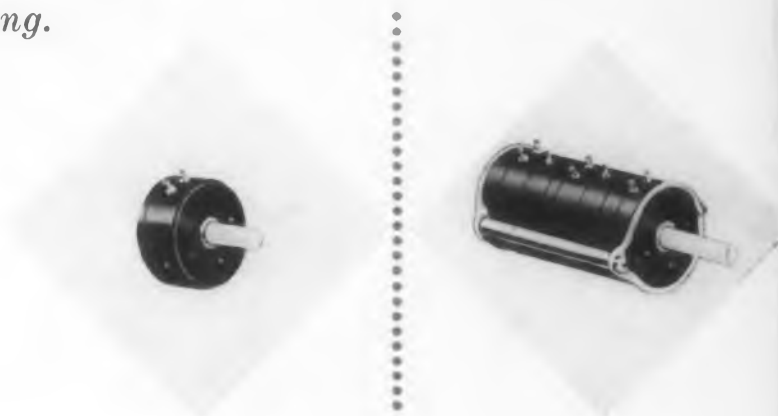
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**S***implicity of construction makes for low cost and good design in this line of precision potentiometers. They have two parts held together by a screw which also serves as a stop for the wiper assembly. The units can be ganged to provide any desired phasing.*



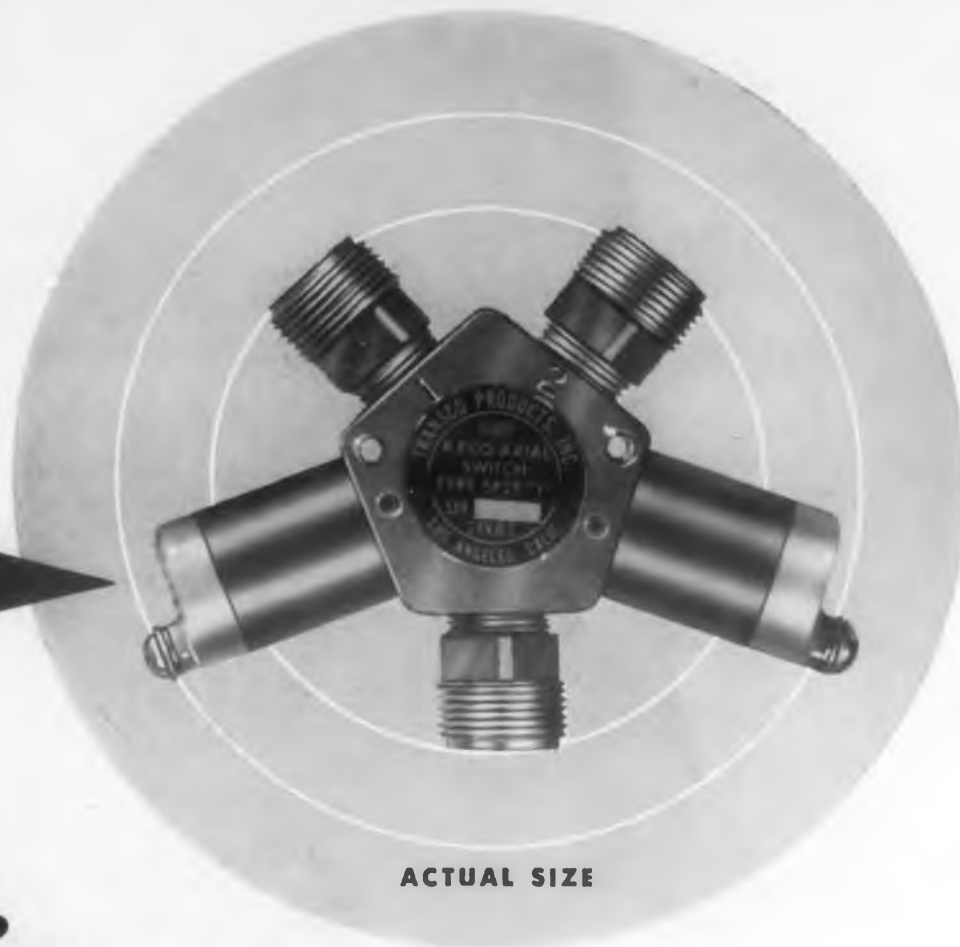
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**THE NEW MINIATURE**

**TRANSCO**

## R. F. CO-AXIAL SWITCH



ACTUAL SIZE

### DESIGNED TO MEET REQUIREMENTS OF MIL-E-5272

Are space, weight and mounting savings vital? Here's how you get them with these performance-proved, rugged, compact, lightweight units specifically designed to meet miniaturization demands under tough environmental conditions.

A new TRANSCO design concept that brings even greater performance and versatility to meet the exacting requirements of modern microwave components and accessories.

### CHARACTERISTICS

FREQUENCY RANGE: 0 to 8000 MC.  
VSWR: 1.3 MAX. WITH TYPE "N" CONNECTORS.  
INSERTION LOSS: 0.2 MAX.  
CROSS TALK: 50 DB MIN.  
LIFE DURATION: 500,000 OPERATIONS MIN.  
ACTUATOR POWER RATING: 18-30 VDC at 0.18 Amps, MAX. PER COIL.  
WEIGHT: 4.8 OUNCES APPROX.  
AMBIENT OPERATING TEMP. RANGE: -65° F. TO +225° F.  
ACTUATING TIME: 1/200 SECOND MAX.  
R. F. POWER RATING OF CO-AXIAL SWITCH EQUAL TO THAT OF IMPROVED TYPE "N" CONNECTORS.  
SWITCH CAN BE OPERATED WITH R. F. POSITIONS 1 OR 2 BOTH "ON," OR "OFF," SIMULTANEOUSLY.  
STACKING DIMENSIONS: .850" x 2.48"  
R. F. POSITIONS MAY BE OPERATED AS "MAKE BEFORE BREAK" OR "BREAK BEFORE MAKE"

This new addition to the famous TRANSCO line of remotely and manually controlled Co-Axial Switches is designed to supply economical, reliable and compact units for frequencies to 8000 MC. The 1460 series is available for more critical applications and frequencies to 11,000 MC. You will find a combination of exclusive features in TRANSCO Switches which will make your selection a confident one.

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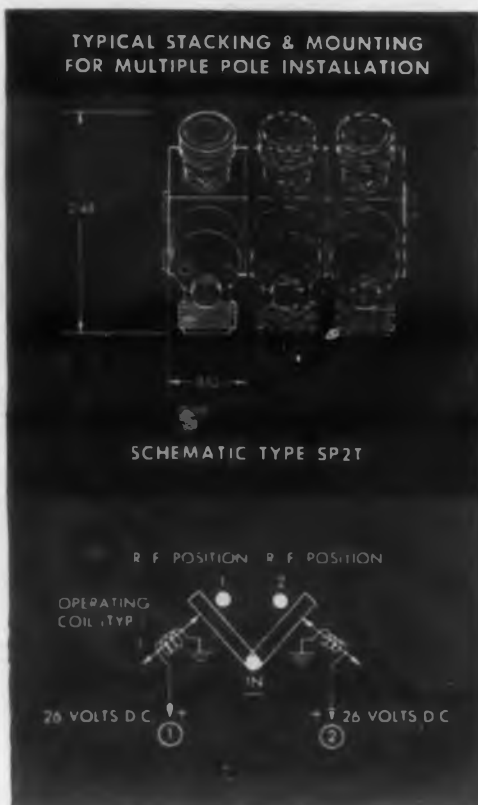
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# ELECTRONIC *design*

Vol. 2  
No. 12  
December 1954

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*Advanced  
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... with performance features never before possible

More and more engineers are finding other uses for these precise and rugged units—jobs which thermal relays of the usual bi-metal design often cannot do... such as:

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Greatly expanded production facilities assure prompt deliveries.

Only G-V offers complete technical data and helpful engineering cooperation on THERMAL TIME DELAY RELAYS.

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# Compare Machlett High Vacuum Rectifier Tubes with any other make



ML-102A  
ML-5575/100  
ML-5576/200  
ML-199\*

ML-5575/100 operates at 100% of current rating with 300% safety factor for anode dissipation. Competitive high vacuum rectifier tube operating at 65% of peak anode current is at limit of anode dissipation.

**Machlett High Vacuum Rectifier Tubes** give maximum rectification efficiency and high working load capacity with no increase in anode dissipation requirements, because . . . unique Machlett catenary type filament, eliminating need for electrostatic shielding, gives . . .

**Highest Operating Efficiency**

**Coollest Running Anode**

**Highest Working Power Level**

**Highest Overload Capacity**

**Longest Life**

For particle precipitation, chemical recovery, hold-off diode application and general high voltage requirements, a broad range of Machlett High Vacuum Rectifier Tubes are available. Included among the higher power tubes are:

75 PKV, 0.75 max anode amps; 750 watts anode dissipation.  
100 PKV, 1.00 max anode amps; 750 watts anode dissipation.  
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\*Thoriated Tungsten Filament.

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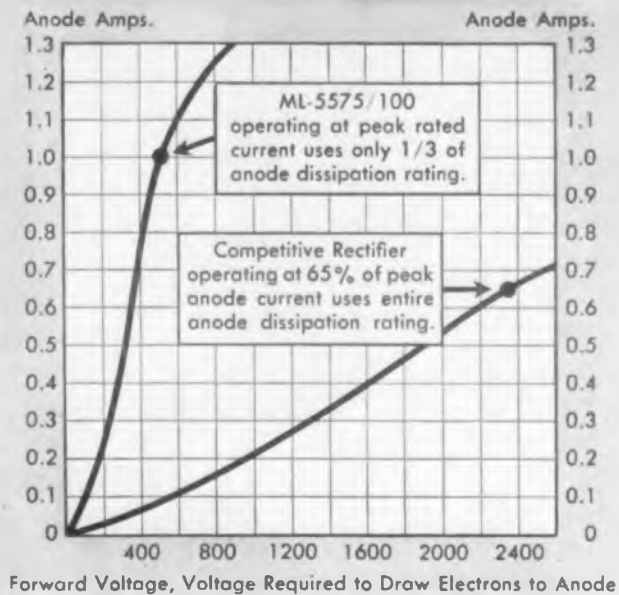
ML-5575/100 compared with competitive high vacuum rectifiers having conventional design features and identical peak ratings.

Conditions: Bridge-type rectifier circuit.

Waveform: Square, where

Anode Dissipation =  $\frac{\text{Forward Volts} \times \text{Amperes}}{2}$

Filament Volts, each tube: 20.



## Editorial

### Sharing the Burden

We noted with great interest and satisfaction a report in the *New York Times* of a new plan to provide more funds for American colleges and universities. The General Electric Company has proposed to match contributions that college graduates employed by the company make to their alma mater in 1955. The company's Educational and Charitable Fund would match such contributions up to \$1000.

This action deserves commendation for several reasons. First of all, schools will get additional, badly needed income. If other companies are stimulated to embark on similar programs, this income can be greatly increased. These two reasons above are more than enough to justify our enthusiasm for the idea. But the most important reason why we like the plan is because it could go a long way towards stimulating more college graduates to support their alma maters.

We feel that support of our colleges is everyone's responsibility—not just that of the Government or a few wealthy philanthropists. With more individuals participating in this support, the need for increasing tuition fees, putting off improvement of facilities, and seeking Government support diminishes. At the same time those individuals and organizations who profit most directly from the work of the colleges assume their fair share of the responsibility of financial support.

We can't think of a more stimulating piece of news at the close of the old year. It certainly is a note of encouragement for 1955 that promises to strengthen these institutions which are so vital to our national well being.

# Engineering Review . . .

*For more information on developments described in "Engineering Review", write directly to the address given in the individual item.*

**Billion-Calculation Computer Unveiled . . .** Capable of 15,000 complete arithmetic calculations per second, the newly completed "NORC" digital computer is one of the fastest computers in existence. It was designed to aid the Navy in solving ordnance problems of the

greatest complexity that would take too long to solve on existing computers.

The \$2,500,000 "Naval Ordnance Research Calculator" was built at the Watson Laboratory at Columbia University in New York City by International Business Machines Corp., 590 Madison Ave., New York 22, N. Y. Under construction and testing since 1951, the multi-unit computer will shortly be moved to the Naval Proving Ground, Dahlgren, Va.

One of the complex puzzlers the machines will at-

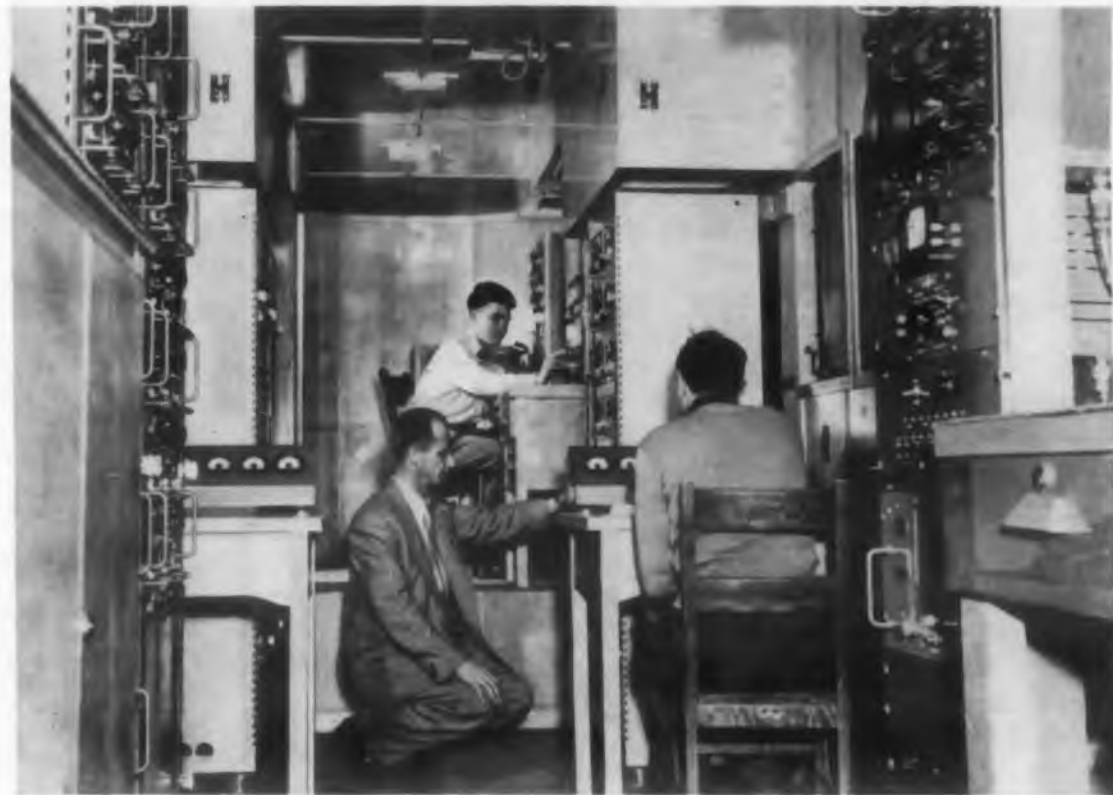
tack is known as the "cavitation" problem. This problem involves the size and shape of the cavity or envelope of comparatively empty space that forms around an object moving underwater. In the case of an underwater weapon, if the cavity is so large that fin and rudder surfaces do not touch the water, control is lost. The mathematics of the cavitation problem have been known, but the solution was beyond the practical capacity of existing computers. NORC can count at the rate of one million digits per second.

Input to the new computer is by magnetic tapes, which are loaded from punched cards on separate equipment. The eight magnetic tape units feed data into the instrument at the rate of 70,000 decimal digits per second. The tape units also act as large-scale storages of intermediate results during the calculations. Digits stored in the calculator's cathode-ray-tube memory can be recalled from any of 2000 locations in 8microsec.

The computer's printers are so arranged that calculation continues during printing, and the speed of calculation is reduced less than 3% while the printers are in operation. Provision is also made for automatically using the same set of instructions to perform successive sets of arithmetic operations on a series of numbers. This feature is called "automatic address modification". B. L. Havens of IBM supervised construction of NORC.

## Trailer "Follows" Jets

Inside the trailer shown below, these test engineers are following the performance of a far-distant jet aircraft by means of some five tons of electronic telemetering equipment. Sixty-seven separate items of data per second are recorded by means of f-m signals from the plane. Employed by A. V. Roe Canada, Ltd., to check their jets, the gear is mounted in a Fruehauf trailer.



# SENIOR STAFF

at Ramo-Wooldridge



The Senior Staff of The Ramo-Wooldridge Corporation, shown above, is comprised of scientists, engineers, and science administrators with outstanding records of past performance in positions of responsibility. By means of meetings of the entire group, supplemented by frequent smaller sessions, these key men participate actively in the establishment of company plans and policies.

Existing project commitments require that the current rapid rate of expansion of the company continue throughout the coming year. Unusual opportunities, encompassing a wide variety of challenging research and development problems, exist for *additional* scientists and engineers who would like to participate in the development of a company in which, from the outset, all features of the organization and of the operational procedures are designed to be as appropriate as possible to their special needs.

## The Ramo-Wooldridge Corporation

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**Solar-Powered Transmitter . . .** An experimental solar-powered radio transmitter employing two transistors has been developed. Five commercial selenium cells are used to convert sunlight into electricity to power the self-contained unit. It was developed by Edward Keonjian, Electronics Laboratory, General Electric Co., Syracuse, N. Y.

The two commercial germanium junction transistors are a n-p-n type used as an oscillator and a p-n-p type employed as a modulator. The transmitter is fixed-tuned, but is capable of operation throughout the broadcast band. It has been operated as high as 2300kc. Its output is 50 to 100microwatt depending on the intensity of sunlight, and its range is 100 ft.

A special oscillator circuit is employed to give the unit great stability. No frequency shift can be noticed over a long period of time and under varying operating conditions.

Five type B2M selenium cells, made by International Rectifier Co., 1521 E. Grand Ave., El Segundo, Calif., are used in series. They deliver 300microwatt to the transmitter over an ambient temperature range of  $-60^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ . More power could be obtained from germanium or silicon cells.

### "Cradled" Relays

Sensitively calibrated relays are protected from possible damage during shipment by these containers, developed by RBM Div., Essex Wire Corp., Logansport, Ind. Each relay is individually nested between two sheets of clear polyethylene plastic. Twenty-five relays are packaged in each container and three to five containers are placed in a shipping carton.





The solar-powered transmitter is being operated by its inventor, Edward Keonjian. The unit is 3" high x 2-1/2" wide x 5/8" thick, weighs 3-1/2 oz.

**TV Around the World . . .** An airplane circling over the Caribbean Sea between Key West, Fla., and Cuba provided the TV relay for the "live" reception in Cuba of the televised World Series baseball games, according to "Du Mont Dispatch", published by Allen B. Du Mont Laboratories, Inc., International Div., Empire State Bldg., New York, N. Y. A TV link between Florida and Cuba has been proposed by the American Telephone and Telegraph Co. It has asked the FCC for authority to establish such a link to permit experimentation in an international broadcasting-telecasting service.

It was reported too, that experimental color TV transmissions are scheduled to start before the end of this year within the Soviet Union. The Russians also are constructing a new TV station at Baku in the Caucasus to supplement the existing stations at Moscow, Leningrad, and Kiev.

**Huge Duplicating Lathe . . .** An electronically controlled duplicating lathe capable of turning and redressing steel mill rolls up to 48" diam and 18' long is being built for a mill under construction at the Indiana Harbor plant of the Inland Steel Co. Operating from a stylus following a flat master template, the cutting tool on the lathe will accurately machine structural-shape contours in the rolls.

The automatic roll contouring lathe, made by Macintosh-Hemphill Co., 901 Bingham St., Pittsburgh, Pa., is another step in the trend toward greater automation in steel mills. It will be capable of machining the most complex roll shapes with only supervision from the operator. It uses principally carbide tools. Electronic contouring equipment incorporated in the lathe will be supplied by Raytheon Manufacturing Co., 138 River St., Waltham 54, Mass.

# NEW *Uniline* MODELS RUGGEDIZED

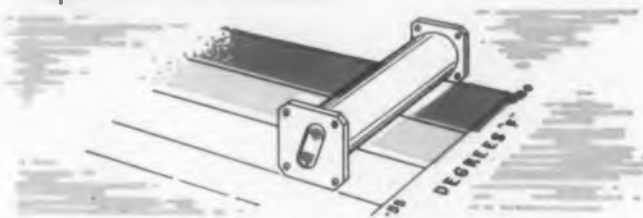


Now, completely new design extends the field of utility to applications where severe shock and vibration are prevalent.



## WIDER RANGE OF OPERATING TEMPERATURES

Range from  $-55^{\circ}\text{F}$  to  $+180^{\circ}\text{F}$  permits use in high temperature environments.

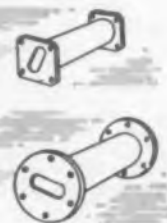


## PERFORMANCE CHARACTERISTICS SAME AS STANDARD MODELS

All new ruggedized models retain the desirable performance characteristics of their standard, equivalent frequency range, counterparts.

## SEVEN FREQUENCY RANGES

- Model R96-104: 9.6 to 10.4 kmcs.
- Model R88-96: 8.8 to 9.6 kmcs.
- Model R80-88: 8.0 to 8.8 kmcs.
- Model R69-74: 6.9 to 7.4 kmcs.
- Model R64-69: 6.4 to 6.9 kmcs.
- Model R59-64: 5.9 to 6.4 kmcs.
- Model R54-59: 5.4 to 5.9 kmcs.

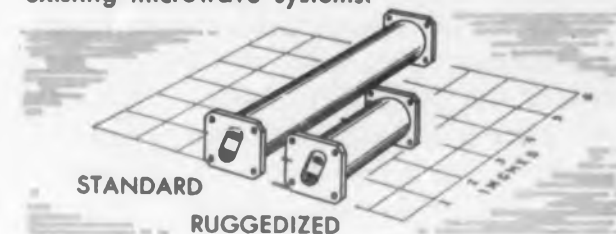


## \**Uniline* MICROWAVE LOAD ISOLATOR

A practical application of the Faraday rotation properties of ferrites at microwave frequencies. By its use, highly effective isolation is provided between source and load without the requirement of external power source or supplementary equipment and with negligible loss of transmitted microwave power.

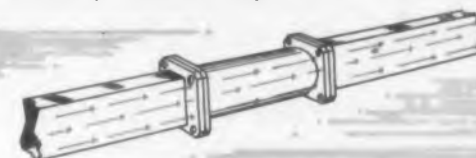
## SMALLER...

Substantial reduction in physical size compared to standard models . . . readily installed in existing microwave systems.



## AVAILABLE FOR USE IN PRESSURIZED SYSTEMS

These new models can be supplied, modified, for use in pressurized systems.



## GREATLY EXTENDED FIELD OF APPLICATION

For use in aircraft and missiles, for mobile and fixed microwave communications equipment.

## OTHER CASCADE FERRITE DEVICES

Other CASCADE microwave ferrite devices include: UNILINES for other frequency ranges, and for high power applications..GYRALINE, the microwave amplitude modulator. Complete information on request.

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**Radiation Consultants . . .** A group of atomic scientists and engineers have formed a new organization to act as consultants to industry on applying radiation. Known as Radiation Applications Inc., the group maintains that the primary and greatest commercial uses of radioactive materials provided by the Government will be in applying the effects of radiation in research and production lines rather than in atomic power.

Located at 342 Madison Ave., New York 17, N. Y., the group includes physicists, chemical engineers, and geneticists. They will act as consultants to the food-processing and packaging, drug, plastics, metal working, chemical and oil industries and agriculture. Radiation from comparatively inexpensive sources such as radioactive cobalt can be used as a catalyst in chemical processing and oil refining, to breed new plants and flowers, and to sterilize or prevent spoilage in food. The group does not have its own radioactive source as yet, but will rent various sources throughout the nation as required and aid industry in acquiring such sources.

It was also revealed that one member of the group, Bernard Manowitz, who is also engineer-in-charge of the Fission Products Utilization Project at Brookhaven National Laboratory, is constructing a mobile radioactive source at the laboratory to irradiate food for long-time storage. Weighing about 25 tons, the truck-mounted source will be able to process hundreds of bushels of potatoes a day.

Any wide-spread application of radiation in industry should provide a large market for electronic instrumentation and safety devices, as well as furnishing new materials for incorporation in components and equipment.

**Engineers' Penmanship . . .** Electrical and civil engineers rated high in a handwriting poll conducted by the Norma Pencil Corp. The survey, which asked secretaries to rate their bosses' handwriting, revealed that the engineers scored 71% legibility. The overall average for all types of employers was 59% legibility.

**Molecular Weight Tester . . .** A fast, accurate check of the molecular weight of thermoplastic high polymers can be obtained during fabrication with a newly developed device. High molecular weight in these materials must be maintained during fabrication to insure best results in the finished parts in tensile strength, elongation, toughness, and resistance to embrittlement upon aging.

The tester consists of an automatic temperature control furnace and components providing for semi-automatic indication of zero strength time. Semi-automatic controls and circuitry are installed in replaceable sub-chassis assemblies. Known as the "ZST Tester", it was developed by M. W. Kellogg Co., Danforth Ave., Jersey City 3, N. J.



**BASIC 10 CONNECTOR TAPER-BLOK WITH DUAL CONTACTS**

Photo shows TAPER-BLOK with A-MP TAPER PINS in place. Strip measures only .610" x 2". Blocks, made of NYLON 10001, can also be stacked to accommodate hundreds of circuits.



**TAPER PINS FOR MULTIPLE CONNECTORS, AN AND OTHER TYPES**

Amphenol, Cannon, Continental and Winchester Connectors now are available with tapered receptacles for A-MP self-locking TAPER PINS. Saves over 80% of your wire assembly time and provides uniformly higher quality connections at lower cost.



**TAPER TAB RECEPTACLE APPLICATIONS**

More and more flat tabs on relays, switches and other components are being tapered to receive A-MP TAPER TAB RECEPTACLES. Fast easy assembly reduces costs and provides higher quality connections.

# NEW **AMP** MINIATURE

## TAPER-BLOK For AMP Taper Pins

(Wire Ranges: #26 to #18)

**NEW TAPER-BLOK FOR A-MP'S TAPER PINS HELPS YOU SAVE SPACE AND WEIGHT, SPEEDS UP WIRING ASSEMBLY, SIMPLIFIES DESIGN, AND REDUCES COST!**

The TAPER-BLOK shown full size at the right has receptacles for 1000 connections, yet measures only 4" x 5" x 5/8"! Receptacles are designed to receive A-MP self-locking Taper Pins which can be easily pushed in place with A-MP's CERTI-LOK measured energy insertion tool.

Extremely high contact pressure assures dependable, uniform, low resistance connections for electric and electronic circuits.

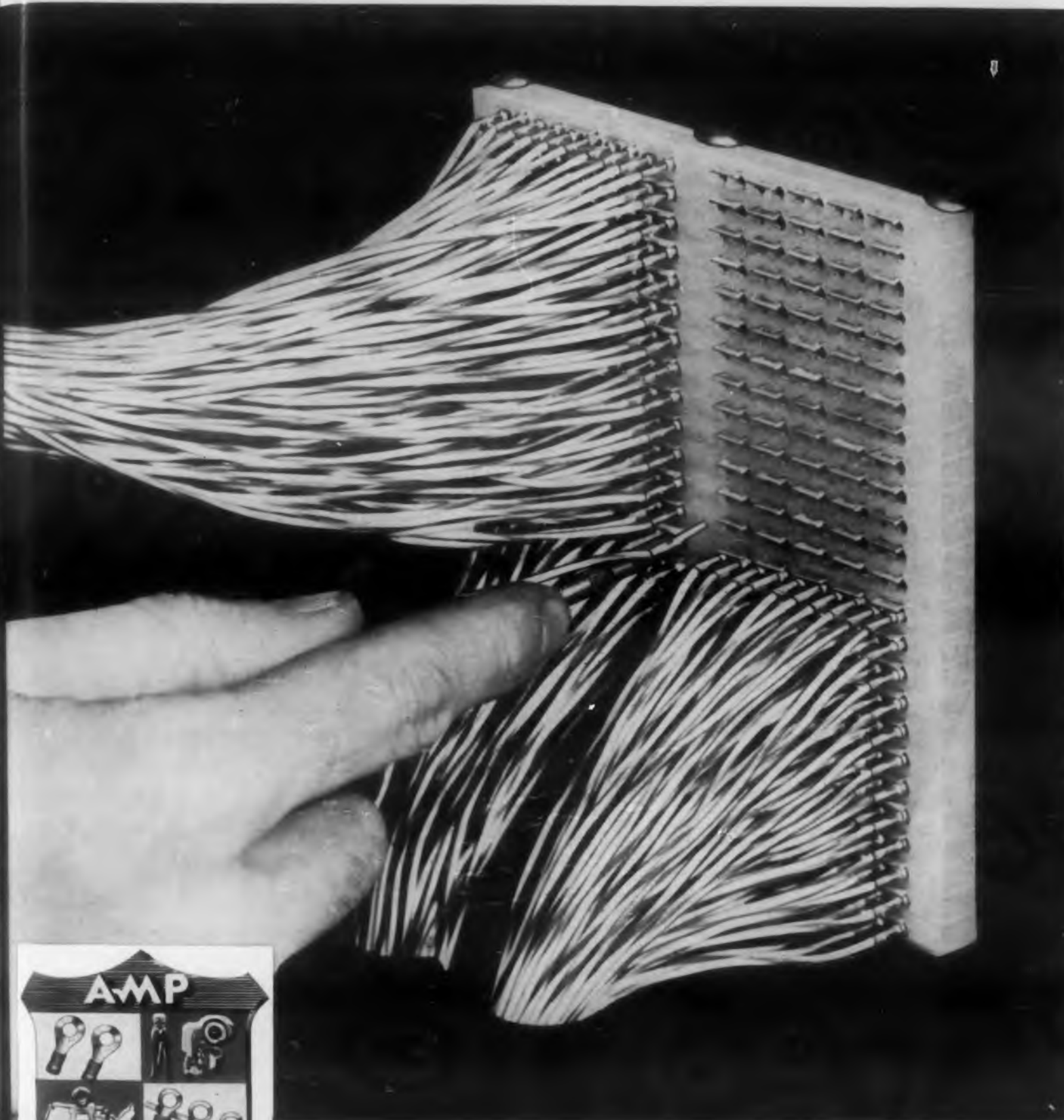
Assembled TAPER-BLOKS are available in 10 and 20 connector sizes with single or dual receptacles. TAPER-BLOK strips can be assembled by stacking to provide the number of connections required for your design. Write for specific information and latest prints.

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**Cosmic Ray Investigations . . .** The earth's magnetic field has been used as a particle analyzer for investigating cosmic rays. The studies may have far-reaching effects on radio communications and other fields, according to a report by Dr. J. A. Simpson, professor of physics, University of Chicago, to the American Rocket Society. These studies could lead to explanations of why radios break down at some frequencies. They reveal that a small portion of cosmic radiations originate in this solar system, although most of them come from elsewhere in the galaxy.

The principal problem in cosmic ray investigations he defined as ". . . the interpretation of high-energy heavy nuclei that shoot into our atmosphere just short of the speed of light. Recent discoveries made with the analyzer indicate that the solar system now may be used as a model for cosmic ray studies of the rest of the universe."

The analyzers use the earth's magnetic field to sort out cosmic ray particles for comparable studies at different latitudes on the earth's surface, Dr. Simpson explained. The instruments are located in five stations that operate continuously from the Peruvian Andes to Colorado. Farther north, mobile laboratories are set up within aircraft in co-operation with the United States Air Force.

**Ultrasonic Delay Lines . . .** Two 20" diam folded-path delay lines with a delay of  $3,333\mu\text{sec}$ , among the largest ultrasonic delay lines ever built, have been made by Corning Glass Works, Corning, N. Y., for the Lincoln Laboratories at Massachusetts Institute of Technology. They will be used in the development of prototype radar equipment.

Disc-like in appearance, each line consists of a thin polygon sheet of fused silica. The sheets were cut and ground by precision methods to meet tolerances up to  $\pm 0.0003"$ . Fused silica, which transmits an ultrasonic signal almost 100,000 times slower than an electrical signal in wire, is similar to fused quartz, but is purer and has a more homogeneous structure. Lines made of this material are relatively small in size and weight compared with mercury lines.

Among the outstanding properties of fused silica are the lack of cavitation under shock conditions, operational stability over a wide temperature range, and wide bandwidth.

**Magamps in Temperature Monitor . . .** Magnetic amplifiers are used for amplifying the outputs of thermocouples in a bearing temperature monitor developed by Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson 3, N. J. The bearing temperature monitor consists of thermocouples installed at the points at which the temperature is to be checked and a bank of magnetic amplifiers to magnify the electrical output of the thermocouples to a level sufficient to actuate an indicator and the alarm system. The instrument operates automatically and features "fail-safe" operation.

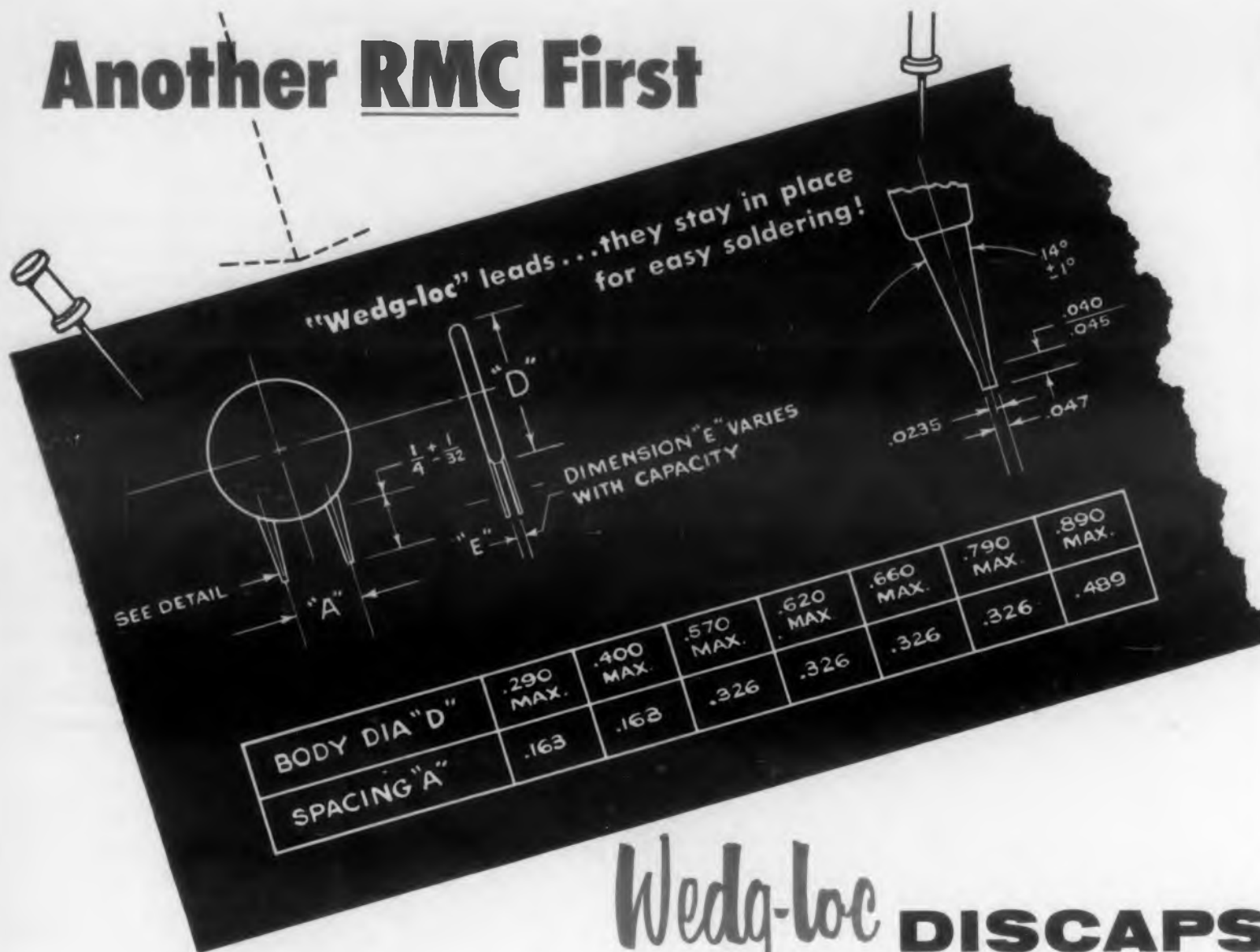


**AIRCRAFT-MARINE PRODUCTS, INC.**  
2100 PAXTON STREET, Harrisburg, Pennsylvania  
In Canada — AIRCRAFT-MARINE PRODUCTS, INC.  
1764 Avenue Road, Toronto 12, Ontario, Canada

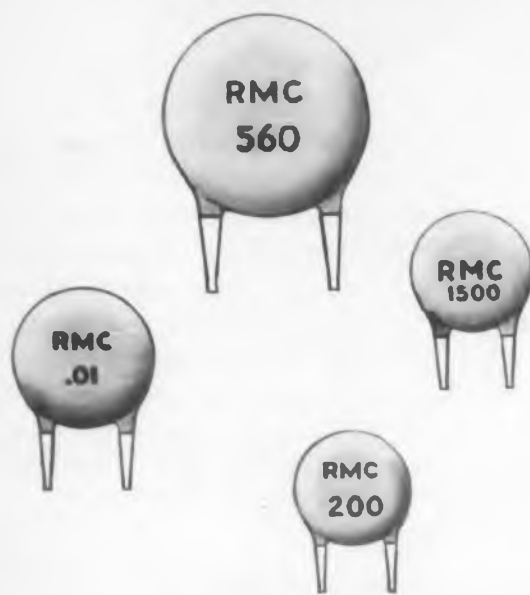
**AMP**

CIRCLE ED-6 ON READER-SERVICE CARD FOR MORE INFORMATION

# Another RMC First



## Wedg-loc DISCAPS for printed wire circuits



The exclusive wedge design of the leads on these new DISCAPS lock them securely in place on printed circuit assemblies prior to the soldering operation. The "Wedg-loc" leads eliminate the possibility of the capacitors becoming loose or falling out. Application of "Wedg-loc" lead DISCAPS to your printed circuits will cut production time, reduce costs, and insure the uniformity of your soldered connection.

"Wedg-loc" DISCAPS are available in capacities between 2 MMF and 10,000 MMF in temperature compensating, by-pass, and stable capacity types with lead spacing as shown above. Electrical specifications and tolerances are the same as standard wire lead DISCAPS. Your inquiry is invited.

**ANOTHER NEW DEVELOPMENT FROM THE  
RMC TECHNICAL CERAMIC LABORATORY**

DISCAP  
CERAMIC  
CAPACITORS

# RMC

**RADIO MATERIALS CORPORATION**  
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.  
Two RMC Plants Devoted Exclusively to Ceramic Capacitors

CIRCLE ED-8 ON READER-SERVICE CARD FOR MORE INFORMATION



The wearer would hear rather than see the time if this "electronic watch" was ever developed, manufactured, and marketed.

**Electronic Watches Proposed . . .** A proposed nationwide electronic timing system would employ a network of powerful f-m transmitters sending out time signals to be received by tiny receivers worn like wrist-watches. The time signals would be rebroadcast by the transmitters from a central source. A designer's conception of what one of the electronic watches would look like is shown above.

In order for the fixed-tuned receiver to be small enough to fit into a watch case, transistorized circuitry and subminiature batteries would be required. Engineers at Elgin National Watch Co., Elgin, Ill., who conceived the system, have already developed the battery. The necessary system of time-signal transmitters could only be constructed at great cost, and this is the major obstacle in the development of the system.

### Records Played "Straight"

Tracking distortion is eliminated by the "Trans Linear" tone arm, which moves the needle across the record along a radius instead of an arc. This is the same manner in which the cutting needle moves across the master record. The arm, furnished in 12" and 16" sizes, is made by Kral Products, 1704 Walnut St., Philadelphia, Pa.



ELECTRONIC DESIGN • December 1954

**Computer Installed at Purdue . . .** A high-speed electronic computing system has been installed at Purdue University, Lafayette, Ind. In addition to providing student engineers and scientists with experience in the operation and maintenance of computers, the computer will solve research and management problems for the various departments of the university and for midwestern industrial organizations. Graduate students specializing in computer technology will also be given the opportunity to participate in computer design and research studies. The computer is manufactured by ElectroData Corp., 717 N. Lake Ave., Pasadena 6, Calif.

**Rural Telephone Service Improvement . . .** The newly developed microwave relay equipment illustrated below will help to bring telephone service to many families in remote or rugged areas. Two TCR-12 "Telelink" units may be located as far as 50 miles apart.

Produced by Raytheon Manufacturing Co., Waltham, Mass., the units each handle up to 20 telephones on two channels. Unlike the usual party line, each telephone can be signaled separately. Two two-way conversations are carried at one time. The f-m transmitter operates in the 6000Mc band with a bandwidth of about 1Mc. It utilizes a type 5976 klystron and emits 100mw.

The antenna can be aimed directly at its mating antenna or the enclosure can be mounted horizontally on the ground with its antenna aimed at a reflecting antenna placed on some higher point. This latter "periscope" arrangement makes for easier and cheaper installation and servicing. Antenna bandwidth is about 5°.

The "Telelink" microwave telephone relay is mounted on some high point in a watertight container. The unit is 88" high and weighs 270 lb.



# NOW . . . FROM **Transitron**

## P-N-P JUNCTION TRANSISTORS WITH VACUUM HERMETIC SEALING

*designed for specific applications*

### COMPUTER TYPES

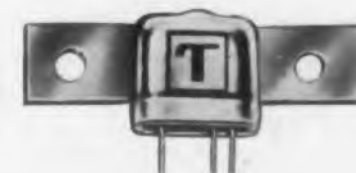
Less than 1 microsecond is required to switch 100 ma collector current with type 2N92. Smaller collector currents can be switched efficiently with type 2N91. Careful manufacturing and conservative ratings insure reliability in excess of vacuum tubes.



1½ x actual size

### MEDIUM POWER TYPES

For applications requiring up to 750 milliwatts dissipation and alpha cutoff up to 1 megacycle, the type 2N85 and 2N86 are ideal. They provide a linear transfer characteristic up to 20 ma collector current and can be operated at ambient temperatures up to 75°C.



1½ x actual size

### HIGH POWER TYPES

The 2N83 and 2N84 are intended for high-power applications and are conservatively rated at 10 watts dissipation. A Class B amplifier using these types would be capable of 5.0 watts output at 60°C. The 2N83 is comparable electrically to the 2N57.



¾ actual size

### SUBMINIATURE TYPES

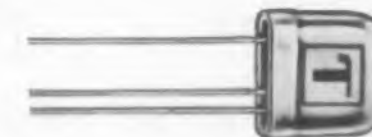
Types 2N88, 2N89, and 2N90 are especially useful where small size and excellent low level performance is desired.



actual size

### STANDARD TYPES

A wide variety of RETMA types including the 2N34, 2N43, and 2N65 are available for most general purpose applications.



1½ x actual size

*Transitron's special engineering group is available to help you with specific transistor applications. Inquiries concerning your particular design problems are invited.*

Send for  
Bulletin  
T 1320

**Transitron** electronic corporation • melrose 76, massachusetts



Glass Diodes



Quads



Silicon Diodes



Germanium Diodes



Transistors



Power Transistors

CIRCLE ED-9 ON READER-SERVICE CARD FOR MORE INFORMATION

announcing . . . a new source for

# Permalloy POWDER CORES

**MAGNETICS inc.**

*Performance-  
Guaranteed*

Here's something to ring bells about, for Magnetics, Inc., the nation's largest manufacturer of tape wound cores, is now licensed by the Western Electric Company to manufacture molybdenum permalloy Powder Cores.

So now Magnetics, Inc. brings to powder core users the same "Performance-Guarantee" which has already provided a major free bonus to users of our tape wound cores, bobbin cores, magnetic shields and magnetic laminations. This is a guarantee of performance to your specifications.

"Performance-Guarantee" is your assurance of savings in production and assembly. It costs you no more . . . our prices are standard in the industry . . . so make sure your next permalloy powder core order reads, "Magnetics, Inc. Performance-Guaranteed."

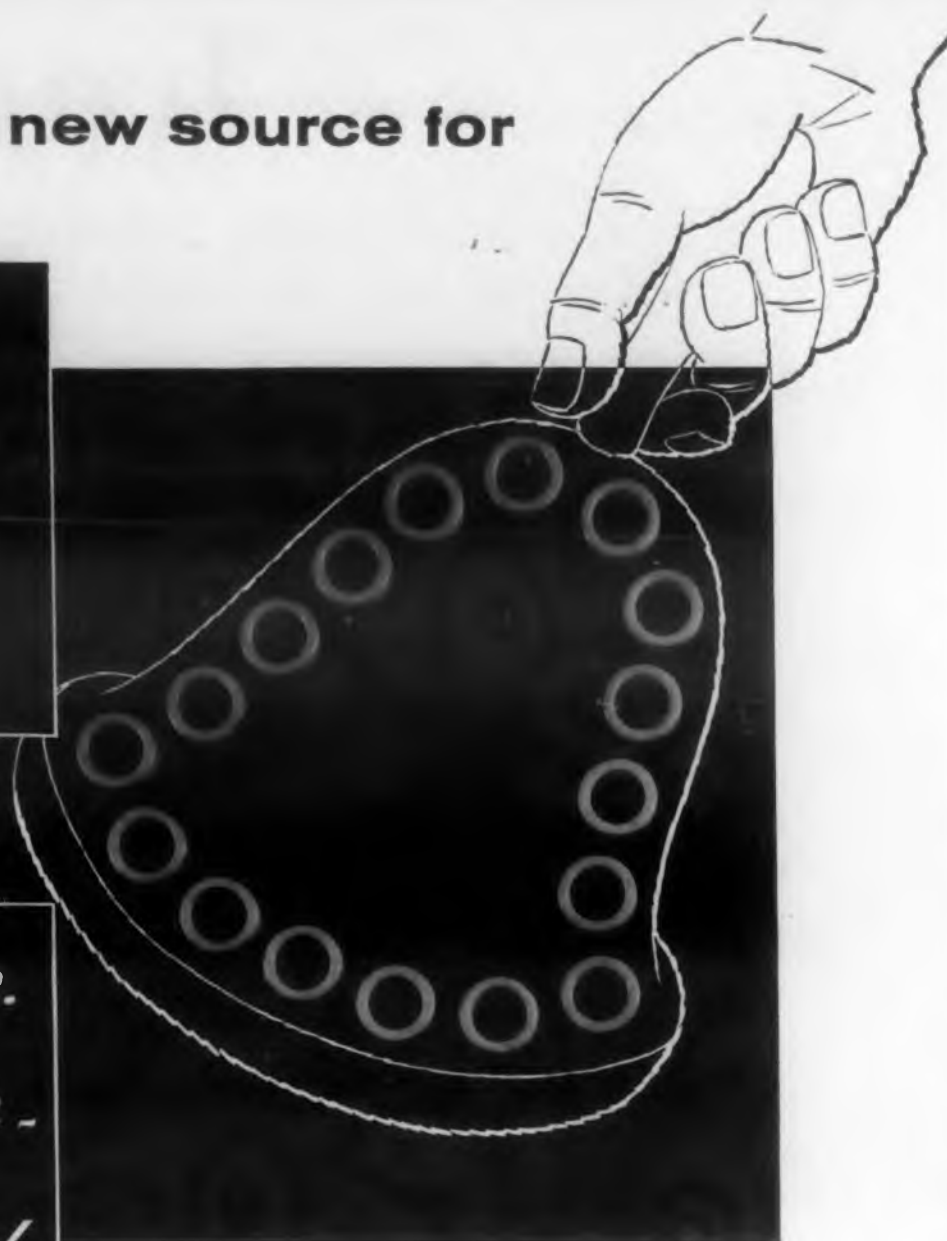
**READILY AVAILABLE** Why wait to have your Performance-Guaranteed Powder Core orders filled? Our expanded production facilities can have your order on its way almost as soon as it arrives. And send for our Bulletin PC-103 today so that you're ready to order Performance-Guaranteed Powder Cores as soon as you need them.

Write on company letterhead

**MAGNETICS inc.**

DEPARTMENT E-19, BUTLER, PENNSYLVANIA

CIRCLE ED-10 ON READER-SERVICE CARD FOR MORE INFORMATION



**Large-Screen Scopes for Computers . . .** Television picture tubes are employed in newly developed oscilloscopes for displaying visually various operations of large computers. Graphs, geometrical figures, engineering symbols, or words and numbers will appear on the scope to aid the operators of the computer and extend the ability of the computer to solve problems.

Known as the Type 740 Cathode Ray Tube Output Recorder, it is being produced by the International Business Machines Corp., 590 Madison Ave., New York 22, N. Y., for use with this firm's Types 701 and 704 Electronic Data Processing Machines, 18 of which are now in use. The recorder actually consists of two parts, a display unit and a recording unit. The display unit features a 21" cathode-ray tube which is used for immediate visual display of the data being computed. The recording unit contains a 7" tube. A 35mm pulse-operated camera may be used with this latter unit for photographing data. One of the 21" display units is shown below with a typical display.



The recorder could aid computers in such functions as designing equipment, enemy plane interception, and air traffic control. Displays on the smaller-tube in the recording unit last for only a few microseconds, so that it is able to record as many as 8000 displays a second.

**Transistorized Autopilot . . .** A transistorized automatic pilot has been developed and has already flown a plane successfully. The flight took place last May 18, but was not revealed for security reasons.

Developed by Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J., one model of the pilot is installed in the firm's B-25 and another in a Lockheed F94C is being ground-tested by the Air Force at Wright-Patterson Air Force Base.

**Uses for Rhenium . . .** Rhenium may soon be found in service as electrical contacts and electron tube materials, C. T. Sims, C. M. Craighead, and R. I. Jaffe of Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio, reported at a meeting of the

American Institute of Mining and Metallurgical Engineers. Other potential uses are seen in high-temperature thermocouples and high-wear-resistant parts such as instrument points.

Even though rhenium is expected to be relatively expensive, its superior properties are sufficient to make its use economically justifiable for highly specialized electrical and electronic applications. Among other properties, it has the second highest melting point of all metals (about 3180°C) and has very high elevated temperature strength. Though ductile at room temperatures, rhenium hardens, when worked, more than any other pure metal. Unlike tungsten, Mr. Sims pointed out, rhenium does not enter into the so-called "water-cycle." This phenomenon causes blackening of lamp bulbs with subsequent failure of filaments.

Studies at Battelle have also shown that rhenium, which possesses a conducting oxide, performs outstandingly in certain electrical contact applications. As a result of these findings, P. R. Mallory & Co., 3029 E. Washington St., Indianapolis 6, Ind., is conducting more detailed research on contacts and is expected to market rhenium-containing electrical contacts in the near future.

**High Servicing Income . . .** Sales of servicing of electronic equipment is expected to reach an annual total of \$2.7 billion by 1957, according to Charles M. Odorizzi, Executive Vice-President, Corporate Staff, Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y. The total was less than \$145 million in 1946, and \$1.4 billion in 1953. Since total industry sales was \$8.4 billion in 1953, sales of service therefore accounted for 16.4%.

**Thin Walled Coil Forms . . .** Coil forms with walls 0.02" thick are being machined from nylon rod in a new application for the plastic. Illustrated below, the coil forms are used to wind the inductances shown, which are part of frequency meters made by Lavoie Laboratories, Inc., Morganville, N. J. The nylon bobbins are light, smooth-surfaced, fungus-proof, and strong. They are machined on standard metal-working equipment from nylon stock supplied by Polymer Corp. of Pennsylvania, Reading, Pa.



ELECTRONIC DESIGN • December 1954

## WHEN YOU SPECIFY... TAPE WOUND CORES

SPECIFY

**MAGNETICS inc.**

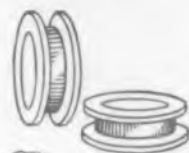
*Performance -  
Guaranteed*

### HERE'S WHY

Only Magnetism, Inc. "Performance-Guaranteed" Tape Wound cores are *guaranteed* to meet *your* performance specifications. These are truly the most economical tape wound cores offered to industry today, for their guaranteed performance effects major savings on your production line. *They are sold to you at no increase over standard core prices.*

When you specify "Performance-Guaranteed" Tape Wound Cores from Magnetism, Inc., you have your choice of the largest selection of standard tape wound cores offered by any manufacturer. In addition, the nationally renowned Magnetism Engineering and Development Department will design cores to meet your product needs as a completely free service.

Why not write us today, and put Guaranteed Performance to work for you?



### *Performance - Guaranteed* BOBBIN CORES, TOO

Tiny Bobbin Cores made with ultra-thin tape down to 0.000125" in thickness, and possessing very rectangular hysteresis loops under pulse conditions, are now available for the first time with the famous Performance-Guarantee. If temperature stability, low coercive value, high saturation density, and ability to switch from positive to negative saturation in a very few microseconds, are of value to you, it will pay you to investigate Magnetism, Inc. Bobbin Cores.

#### WANT THE COMPLETE STORY?

It's easy to get the detailed story . . . simply write on company letterhead. We'll send complete literature, containing specifications and design information.

CIRCLE ED-11 ON READER-SERVICE CARD FOR MORE INFORMATION

**MAGNETICS inc.**

DEPT. ED-13, BUTLER, PENNSYLVANIA

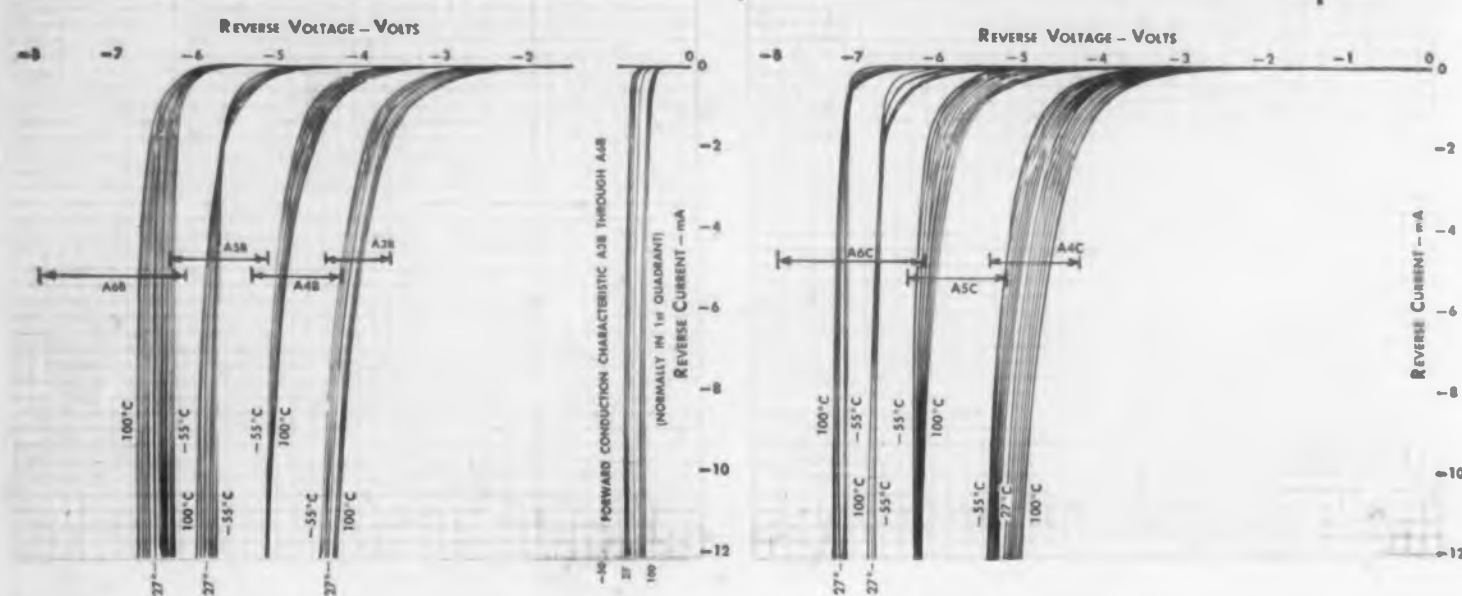
# SILICONDUCTORS\*

TRADE-MARK

## LOW VOLTAGE TYPES FOR USE AS VOLTAGE REFERENCE DEVICES

CONVENTIONAL SINGLE ANODE RECTIFIER TYPES

DOUBLE ANODE TYPES



To supply the growing demand for low zener voltage SILICONDUCTORS as voltage reference devices, four new Type numbers are now available in production quantities. The voltage-current-temperature characteristic curve of a typical SILICONDUCTOR of the new Types A3B, A4B, A5B, and A6B are shown above. All diodes of one Type do not have identical curves; these data only demonstrate the general trend from a negative temperature coefficient of zener voltage for the A3B to a positive coefficient for the A6B, with both negative and positive coefficients possible at different current levels among individual diodes of Types A4B and A5B. Note that in the region of intersection between positive and negative temperature coefficients it is possible to realize extremely low coefficients. The forward conduction characteristics shown are typical of all of the A3B to A6B types. If two diodes of these types are connected in parallel with polarities reversed, they will serve effectively as a limiter at a level

of approximately 0.7 volts. Two diodes in series with opposite polarities will clip or limit at a level corresponding to their Zener breakdown characteristics.

Our types A3C through A6C are effectively two diodes in series in the same size envelope used for normal diodes. Besides being useful as balanced limiters, they also are applicable as voltage reference units. Note that the voltage-current-temperature curves shown above for one of the A6C types shows a low temperature coefficient combined with low dynamic or ac impedance at a current level of only 3 mA.

Application engineers will find it possible to make many interesting series combinations of units having temperature coefficient of opposite sign so that they tend to cancel. NATIONAL SEMICONDUCTOR PRODUCTS expects to offer shortly one or two additional Types which will carry firm specification limits on dynamic impedance and temperature coefficient.

SILICONDUCTOR TYPE NO.		REVERSE VOLTAGE RANGE @ 5.0 mA OF BACK CURRENT
Single Anode	Double Anode	
A3B	A3C	3.7 to 4.5 Volts
A4B	A4C	4.3 to 5.4 Volts
A5B	A5C	5.2 to 6.4 Volts
A6B	A6C	6.2 to 8.0 Volts

Maximum dissipation 150 mW @ 25° C  
Derate 1mW per ° C. 150° C max. ambient

All of the above Types are available in production quantities, in addition to SILICONDUCTORS 1N200 to 1N222 inclusive with maximum reverse working voltage ratings to 470 volts.

### \*SINGLE CRYSTAL SILICON JUNCTION DIODES

LICENSED BY WESTERN ELECTRIC CO., INC.

## NATIONAL SEMICONDUCTOR PRODUCTS

DIVISION OF NATIONAL FABRICATED PRODUCTS, INC.

930 PITNER AVENUE

DAvis 8-0800

EVANSTON, ILLINOIS

CIRCLE ED-12 ON READER-SERVICE CARD FOR MORE INFORMATION

**Increase in Radio-TV Dealers . . .** The number of retail radio and TV dealers in the country increased by nearly 12,000 in less than two years, the Radio-Electronics-Television Manufacturers Association reported in its latest dealer census. RETMA, 777 14th St., Washington 5, D. C. announced that as of July 1, there were 107,100 firms engaged in the retail distribution of radio and/or TV receivers. This compares with 105,150 such dealers found to be in business a year earlier and 95,400 reported in a RETMA dealer census dated Sept. 1, 1952.

During the year ending June 30, 1954, it was found that the average retail dealer sold 60 TV receivers and 61 radios, excluding auto sets. This decrease from 69 TV receivers and 74 radios averaged the previous year followed the general decline in set sales for the periods covered.



### Klystron or Crankshaft?

This Type X566 modulating-anode klystron, made by Eitel-McCullough, Inc., 198 San Mateo Ave., San Bruno, Calif., is designed for distance measuring equipment, an important aid to air navigation. At 900-1400Mc, it delivers over 20kw of peak pulse power with only 100mw drive. This is a power gain of 53db for this experimental air-cooled tube.

**TV In a Furnace . . .** Closed-circuit TV was used to take visitors at the recent National Metals Exposition inside a 4' diam vacuum furnace and let them watch the actual melting and casting of high-purity metal. The camera, trained on the interior of the chamber through one of the 6" sight glasses, picked up details of the operation and transmitted them over a short length of coaxial cable to a monitor screen in the exhibition booth of the F. J. Stokes Co., 5500 Tabor Rd., Philadelphia 20, Pa. Radio Corp. of America industrial TV equipment was used.

**Government Spending for Research . . .** To help maintain American scientific and technological supremacy, the federal government in the current fiscal year will spend about \$1,700,000,000 on research related to national security, according to the November *Industrial Research Newsletter*, published by Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. This is 85% of all government spending for scientific research and development.

# DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company

DECEMBER 1954

## Insulator of KEL-F® Plastic Doubles as Vital Structural Part in Severe 250°F Water-Immersion Service

Perfect electrical insulation and maintenance of critical spacing of electrodes are provided by this spacer of KEL-F polymer plastic. Even under constant immersion in water at 250°F, insulation remains high, precision tolerances and dimensions of the spacer-insulator are maintained.

Excellent mechanical properties of this fluorocarbon plastic dielectric under extremes of temperature and stress permit the critical spacer to be used under heavy spring loading without deformation or failure. Accurately machined grooves in the plastic hold O rings to prevent liquid leakage.

McNab Incorporated, New York City, machines the spacers from rod extruded from unplasticized KEL-F polymer by the Resistoflex Corporation, Belleville, N. J. Spacers are used in special conductivity cell-valve units manufactured by the McNab company for use in marine and industrial installations producing potable water.

For further information ask for Application Report E-131



## Insulated Union of KEL-F® Plastic Carries 400 psi Gas Safely Through 10 Kv Potential in Atom Research

A hollow threaded stud of KEL-F plastic, one of the best "tough" dielectrics, maintains a gas-tight connection and effectively insulates the line in a high potential field. The plastic union is also required to hold a high vacuum when used in the nuclear research device.

Used to carry a gas with an extremely high diffusion rate, the fluoro-

carbon plastic's non-porosity effectively blocks leakage.

The novel coupling was devised by the Brookhaven National Laboratory, Upton, N. Y. and machined from rod extruded from KEL-F polymer Grade 300 by the Plax Corporation, Hartford, Connecticut.

For further information ask for Application Report E-132

(SEE REVERSE SIDE)

KEL-F

TRIFLUORO  
CHLORO  
ETHYLENE  
POLYMERS

KEL-F

MOLDING  
POWDERS

KEL-F

FLUORO  
CHLORO  
CARBON  
PLASTIC

KEL-F

DISPERSION  
COATINGS

KEL-F

TRIFLUORO  
CHLORO  
ETHYLENE  
POLYMERS

KEL-F

OILS  
WAXES  
GREASES



KEL-F

# Dome of KEL-F® Plastic Pressurizes Airborne Radar Antenna in Minus 85°F — Plus 160°F... Cuts Power Losses

A "test tube" and machined lock nut—both made from KEL-F polymer—help maintain this radar "horn" under 15 psi positive pressure and prevent power breakdown even at high altitudes. Tough, but resilient, they are undamaged by accidental blows, vibration or exposure.

The fluorocarbon plastic remains transparent to high frequency pulses indefinitely. Zero water absorbing and non-wetting, interference from high humidity or fungus is cut.

Rigid but not brittle, the plastic tube and lock nut are readily installed and removed for servicing without danger of breakage or chipping.

Fluro Plastics, Inc., custom molders of Philadelphia, Pa., compression-mold these new radar domes from unplasticized KEL-F polymer Grade 300. The molded tubes are ready for use without machining. The lock nut is machined from rod stock by the radar manufacturer.

For further information ask for Application Report E-133



## Recent Significant KEL-F Polymer Developments...

Lip seals for liquid oxygen and other liquefied gas equipment operating at low temperatures are molded now of KEL-F plastic. Resiliency at sub-zero temperatures, dimensional stability and chemical inertness overcome shortcomings of other gasket and sealing materials used.

Liquid level gauges now have their glasses protected by a thin sheet of KEL-F plastic. Remaining transparent indefinitely in spite of contact with highly corrosive chemicals such as HF, the plastic sheets act as their own gaskets.

Miniature coil forms are molded of KEL-F plastic for use in electronic devices operating at elevated temperatures. Types include special models with metal inserts.

Quality test for use by the manufacturer of trifluorochloroethylene polymer parts (the "Z.S.T." test) has been developed and field-tested by Kellogg. Test is simple, requires no special training. Equipment is automatic, eliminates the human error factor in test results.

OFF THE PRESS... Revised "BUYERS GUIDE" listing KEL-F polymer products, molders and fabricators.

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service  
**CHEMICAL  
 MANUFACTURING  
 DIVISION**  
 THE  
**M. W. KELLOGG  
 COMPANY**

P. O. Box 469, Jersey City 3, N. J.  
 or offices in Boston, Chicago, Dayton,  
 Los Angeles, and New York



## Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F"... each month this column will spotlight several of these companies with their principal services and products.

### Auburn Button Works, Inc.

Auburn, N. Y.  
 Injection molding

### Bacon Industries, Inc.

Watertown, Mass.  
 Compression & transfer molding  
 Gaskets & O rings

### Elco Corporation

Philadelphia, Pa.  
 Injection molding  
 Electronic tube sockets

### Electronic Mechanics Inc.

Clifton, N. J.  
 Extrusion, injection, compression & transfer molding  
 Forming  
 Rod, tube & sheet  
 Coil forms & tube sockets  
 Diaphragms & gaskets

### A. Gusmer, Inc.

Stalpic Division  
 Woodbridge, N. J.  
 Corrosion control  
 Dispersion application

TRIFLUORO  
CHLORO  
ETHYLENE  
POLYMERS

KEL-F

MOLDING  
POWDERS

KEL-F

FLURO  
CHLORO  
CARBON  
PLASTIC

KEL-F

DISPERSION  
COATINGS

KEL-F

TRIFLUORO  
CHLORO  
ETHYLENE  
POLYMERS

KEL-F

OILS  
WAXES  
GREASES

## Meetings

**December 27-29:** *The Society for Industrial and Applied Mathematics* will hold its first national meeting in conjunction with the annual meetings of American Mathematical Society, the Mathematical Association of America, and the Association for Symbolic Logic, Univ. of Pittsburgh. Write to H. W. Kuhn, Dalton Hall, Bryn Mawr College, Bryn Mawr, Pa.

**January 17-19:** *High Frequency Measurements Conference*, Hotel Statler, Washington, D. C. Sponsored by AIEE and IRE. One-hundred-word abstracts of papers to be submitted should be sent to the chairman of the appropriate session listed as follows: Frequency and Time Measurements, Dr. B. M. Oliver, Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.; Power and Attenuation Measurements, E. W. Houghton, Bell Telephone Laboratories, Murray Hill, N. J.; Impedance Measurements, Dr. D. D. King, Johns Hopkins Univ., Baltimore, Md.; and Measurements in Transmission and Reception, B. Parzen, Olympic Television and Radio Co., 34-01 38th Ave., Long Island City 1, N. Y. For information, write to AIEE, 33 West 39th St., New York 19, N. Y.

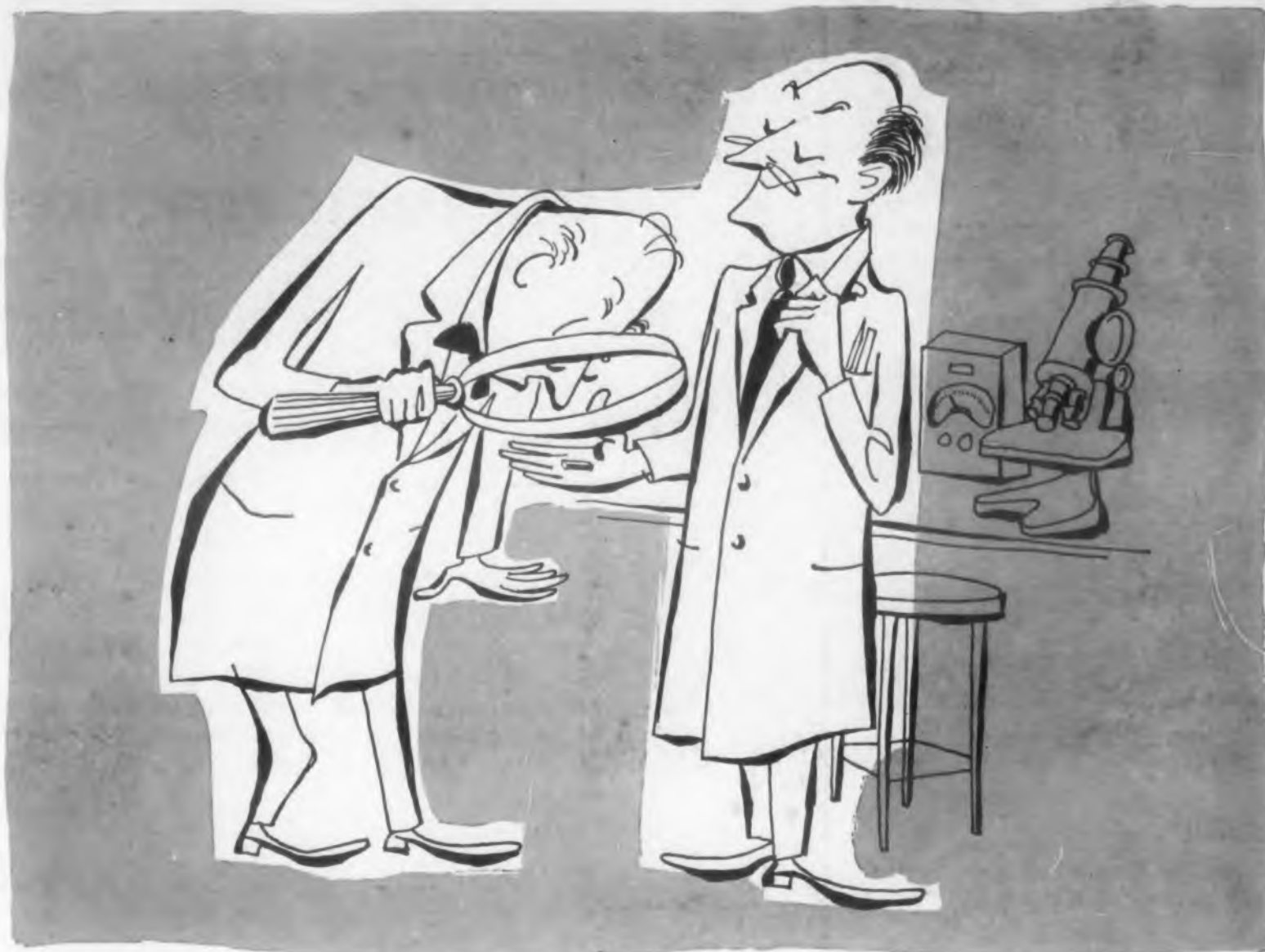
**January 20-21:** *Printed Circuit Symposium*, University of Pennsylvania, Philadelphia, Pa. Sponsored by the Engineering Dept., Radio-Electronics-Television Manufacturers Association. Tentative subjects of the six sessions are: "Product Design Applications"; "Reliability and Serviceability"; "Management Considerations"; "Techniques of Producing Printed Wiring Boards" (panel session); "Printed Components and Components For Use With Printed Wiring"; and "Production Techniques and Manufacturing Methods". Submit papers to and request information from Donald E. Cottle, General Electric Co., Electronics Park, Syracuse, N. Y.

**January 31-February 4:** *AIEE Winter General Meeting*, Hotel Statler, New York, N. Y. For information, write to AIEE, 33 W. 39 St., New York 19, N. Y.

**March 1-3:** *Western Computer Conference*, Hotel Statler, Los Angeles, Calif. Sponsored by IRE, AIEE, and Association for Computing Machinery. Will include exhibits by computer manufacturers. For information, write to William Gunning, International Telemetering Corp., 2000 Stoner Ave., Los Angeles 25, Calif.

**April 6-10:** *World Plastics Fair and Trade Exposition*, National Guard Armory, Los Angeles, Calif.

**May 2-5:** *Semiconductor Symposium*, Cincinnati, Ohio. For information, write to F. J. Biondi, Bell Telephone Laboratories, Murray Hill, N. J.



## How to make a Magnetic Core that's really small? Use PERMENDUR!



Write for  
your copy  
"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

ADDRESS DEPT. ED-60

When the conditions of service make it imperative for you to hold the size and weight of magnetic cores at an absolute minimum, that's the place to use Permendur. With it you can push the flux density up to 20 kilogausses, and practically eliminate weight as a consideration.

Along with its suitability for cores wherever the premium is laid on compactness, Permendur is just the thing for sonar magnetostriction applications, too. We maintain proper annealing facilities for this

alloy. Write for technical data on it, and let our engineers help you to cash in on its possibilities.

In addition to Permendur, we offer a range of high-permeability alloys, oriented silicon steels and other electrical alloys that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment.

Let us supply your requirements. Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.

STEELMAKERS to the Electrical Industry

# Allegheny Ludlum



W&D 5443

CIRCLE ED-13 ON READER-SERVICE CARD FOR MORE INFORMATION

# Temperature Compensating a Meter Rectifier

By Edward L. Pagano, Chief Development Engineer

Bradley Laboratories, Inc., New Haven, Conn.

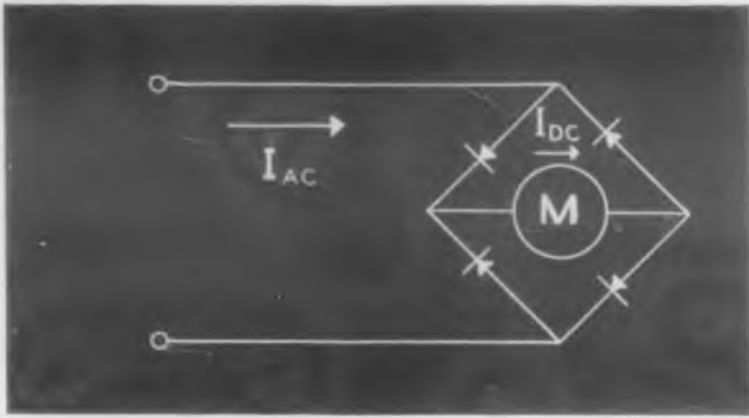


Fig. 1. Bridge rectifier and meter.

Fig. 3. Simplified equivalent circuit for constant current and frequency applied.  $R_r$  equals  $R_2/2$ ;  $R_f = 2R_1$ .

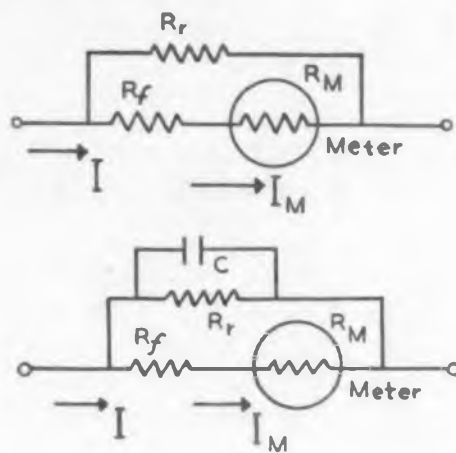


Fig. 4. Simplified equivalent circuit for constant temperature and current applied.  $C$  equals  $2C_2$ .

## Symbol Key

- $R_1$  = Rectifier forward resistance.
- $R_2$  = Rectifier reverse resistance.
- $C_1$  = Rectifier forward capacitance.
- $C_2$  = Rectifier reverse capacitance.
- $R_m$  = Meter resistance.
- $L_m$  = Meter inductance.
- $C_m$  = Meter capacitance.

THE VARIATION of rectifier characteristics due to large temperature changes often make it desirable to devise a method of temperature compensating meter rectifiers in order to maintain accuracy within specified limits. This article is confined to a discussion of methods of compensating a basic unit that

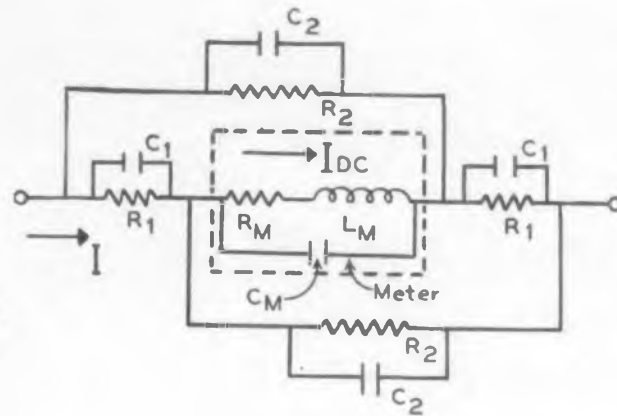


Fig. 2. Complete equivalent circuit for the rectifier and meter. ( $R_1$ ), ( $R_2$ ), ( $C_1$ ), and ( $C_2$ ) are non-linear and temperature sensitive compared to ( $R_m$ ), ( $L_m$ ), and ( $C_m$ ) (see Key below).

must function as a multi-range milliammeter and voltmeter over a temperature range of  $-55^\circ\text{C}$  to  $+85^\circ\text{C}$ .

The curves and specific values shown were obtained with a specific size, copper-oxide, full-wave bridge rectifier, used in conjunction with a 0-1ma, 100-ohm d-c meter. Although the results apply to this combination only, the basic concepts and methodology are valid for any combination of meter and rectifier.

## Voltage Correction

Temperature compensation can be achieved by using a large "swamping" resistor in series with a rectifier assembly. The hypothesis is that where the resistor is of a value much larger than the resistance of the rectifier and where this series swamping resistor is held constant as temperature varies, any change in the resistance of the rectifier, as compared to the unit's total resistance, will be so minute that it can be neglected. However, this line of reasoning is applicable only to voltmeters using large multi-

pliers, and is not valid for the present application.

By analyzing the equivalent circuit of Fig. 3, it becomes apparent that the voltage error with temperature change is due to the change of rectifier forward resistance. However, when a resistor is inserted in series with this circuit, the change of reverse resistance of the rectifier influences the response. As the temperature increases, the reverse resistance decreases to a point where the increase of reverse leakage current causes an appreciable drop across the series resistor, and as the value of this resistor increases, the voltage drop across it also increases, thereby limiting the usable size of series resistor that can be employed.

At low temperatures, the reverse resistance of the rectifier increases, thereby reducing the reverse leakage current to negligible values. But at these temperatures, the forward resistance of the rectifier increases appreciably, necessitating a large series resistor. As the size of this resistor increases, the increase of the forward resistance of the rectifier becomes more negligible because a relatively small portion of the total input voltage is attenuated across the rectifier.

In summary, at high temperatures a small series resistor is required due to the increase of reverse leakage current, but, at low temperatures a large series resistor is needed to offset the increase of forward resistance. A compromise is therefore necessary, and Fig. 9 illustrates the fact that an optimum value

1. Since a rectifier is a unilateral non-linear device, the term forward or reverse resistance is meaningless unless accompanied by either a definite value of current or voltage. For the purpose of this article, the term forward resistance shall be defined as the average resistance throughout the half cycle in which current flows internally within the rectifier from the negative electrode to the positive electrode at rated values of current for this application. Similarly, reverse resistance is the average resistance throughout the remaining half cycle in which current flows internally within the rectifier from the positive electrode to the negative electrode at rated values of voltage for this application.

of a fixed series resistor is required to produce a minimum overall error at the extreme temperature limits.

Another factor limiting the size of the series resistor is the maximum allowable resistance of the unit. As the resistance of the unit increases, the voltage required to produce full scale deflection also increases, thereby limiting the usefulness of the unit both as a current meter and as a voltmeter. The increased voltage drop may prevent its use as a current meter, and when used as a voltmeter the value of the lowest available range is increased.

A series resistor is needed to compensate for voltage changes as temperature varies. However, since a constant value of resistance over the temperature range would tend to increase the error, a temperature sensitive resistor is required. The nominal value of resistance necessary to produce minimum initial error can be selected from the intersection of the curves of Fig. 9, and the necessary deviation of resistance as temperature changes can be calculated from the full scale voltage and current response curves of Figs. 5 and 6. Referring to the temperature-compensated network of Fig. 7, where  $V_{Re}$  and  $I_{Re}$  are rectifier voltage and current, respectively.

$$V = I_{Re} \times R + V_{Re}$$

Since  $V_{Re}$  and  $I_{Re}$  can be selected from Figs. 5 and 6,  $V$  can be determined and will be constant over the temperature range. The value of  $R$ , the compensating resistance, at any temperature can then be calculated.

This resistance, as illustrated in Fig. 8, exhibits a characteristic curve with a positive temperature coefficient at low temperatures and a negative temperature coefficient at high temperatures. Theoretically this effect can be achieved with proper selection of a parallel network consisting of a negative temperature coefficient resistor ( $R_n$ ) and a positive temperature coefficient resistor ( $R_p$ ). In order to keep the physical size of the unit to a minimum,  $R_p$  must be constructed from wire possessing both a large temperature coefficient and a large specific resistance.

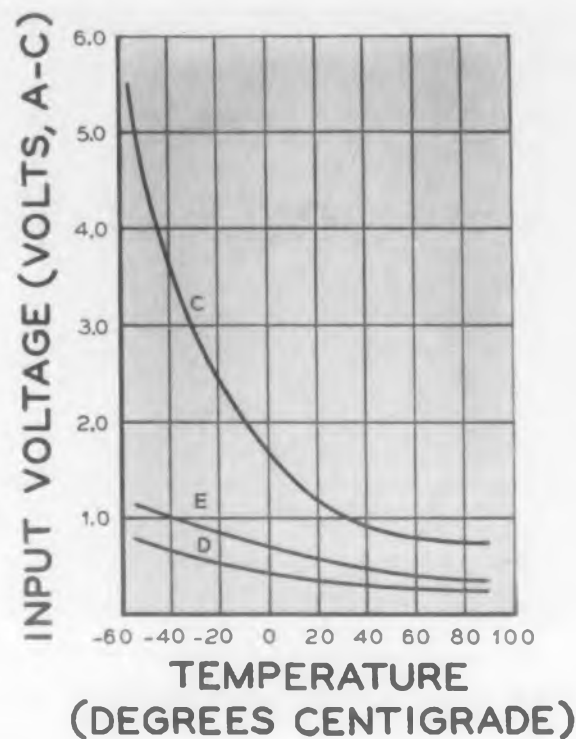


Fig. 5. Input voltage ( $V_{Re}$ ) required to produce full-scale deflection of the meter in the basic full-wave bridge circuit of Fig. 1 at various temperatures. The meter in this circuit is a 0-1 ma, 100-ohm d-c meter. Curves "C", "E", and "D" are for 0.080", 0.187", and 0.5" diam copper-oxide cells, respectively.

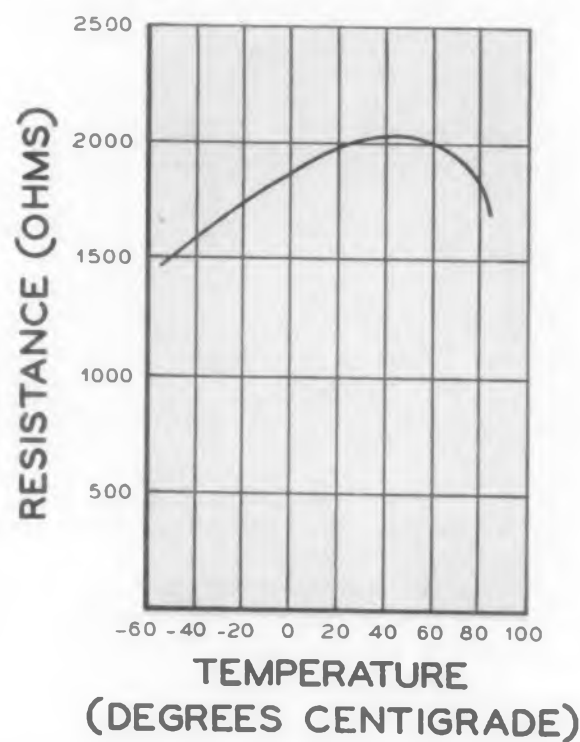


Fig. 8. The required variation in the series-compensating resistance,  $R$  above, for voltage correction.

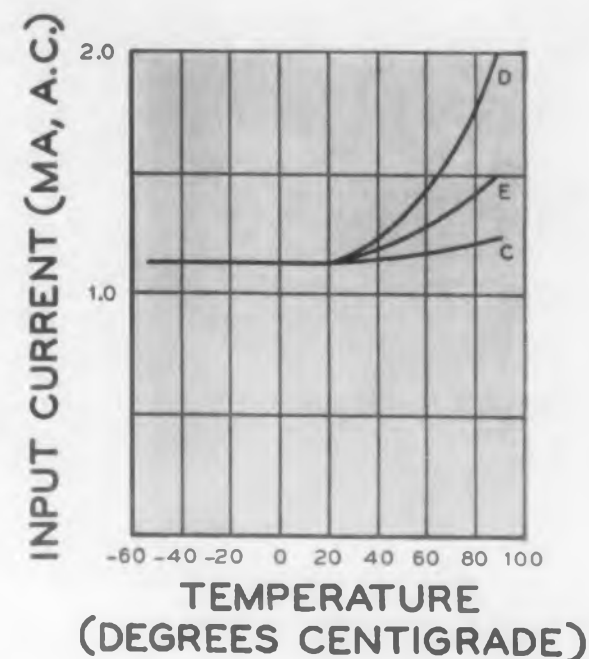


Fig. 6. Input current ( $I_{Re}$ ) required to produce full-scale deflection of the meter and rectifiers determining Fig. 5.

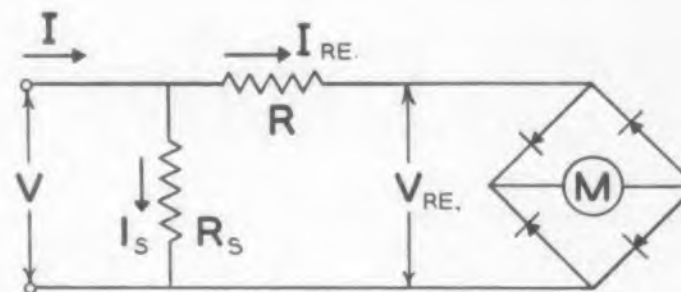


Fig. 7. A temperature-compensating network for meter and rectifier.

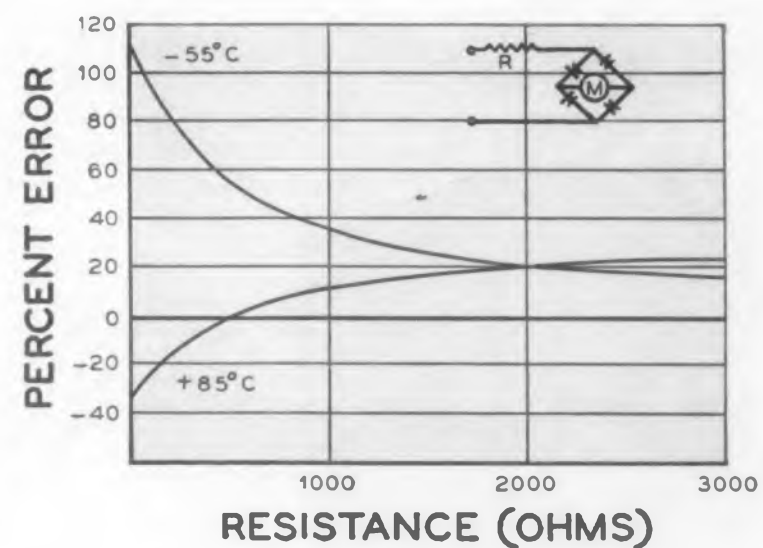
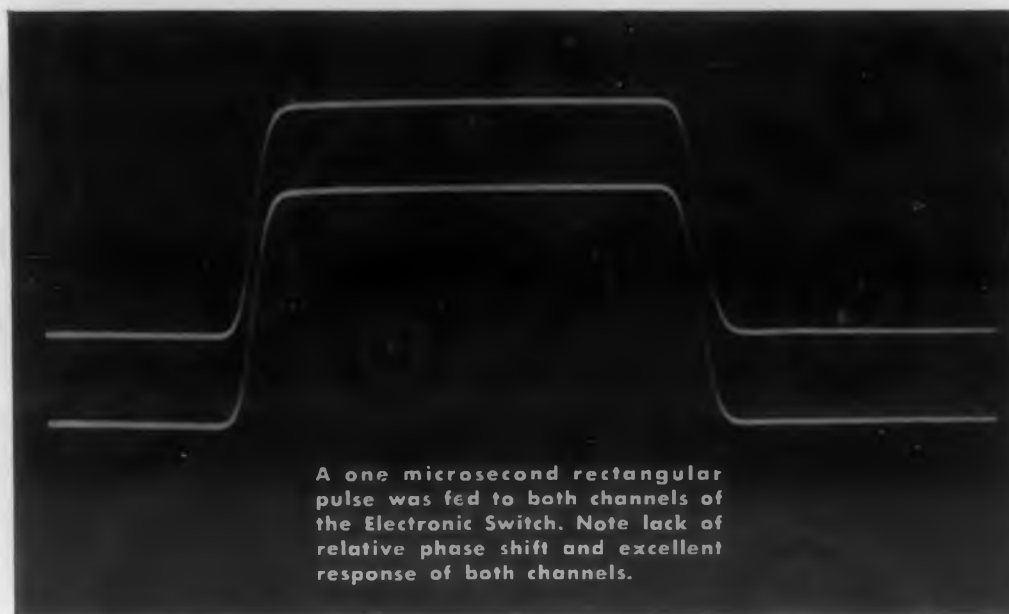


Fig. 9. Percentage error of the meter in the circuit with variation of the fixed series resistor at the two extremes of temperature considered in this article.

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20, 40, 100, 200, and 400; accuracy of attenuators  $\pm 2\%$ .

- IV. Output: Level is zero volts d.c. with no signal or positioning voltage; positioning controls provide  $\pm 1$  volt of d.c. positioning voltage.

#### SWITCHING

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Since  $R_n$ , which exhibits a logarithmic response, has little effect at low temperatures, the proper positive temperature coefficient resistor can practically duplicate the desired characteristic curve below  $+25^\circ\text{C}$ . However, as the temperature increases, it begins to affect the total effective resistance and produces the desired characteristic.

Since  $R_p$  has a much lower resistance than  $R_n$ , it primarily determines the slope of the characteristic curve. In addition, because this resistor is composed of a metal wire a high degree of accuracy and stability can be achieved, with small inaccuracies of  $R_n$  having little effect upon the overall response.

### Current Correction

The problem of current correction as temperature varies is similar to that of voltage correction. However, whereas voltage error is due to the increase of forward resistance as temperature decreases, current error is due to the decrease of reverse resistance as temperature increases. To correct for current error it is necessary to devise a method of either increasing the input current at low temperatures or decreasing it at elevated temperatures. Although definitely desirable, decreasing the current at elevated temperatures cannot be done without destroying voltage stability. A temperature sensitive resistor in series with the reverse resistance of the rectifier cell would be required, but since the reverse resistance is an inherent part of the rectifier cell and cannot physically be separated from the forward resistance, any resistor utilized would also be in series with the forward resistance thereby destroying the voltage stability.

The alternative is to increase the input current at low temperatures. Theoretically, this can be accomplished by shunting the unit with a temperature-sensitive resistor, and the proper value can be determined with the aid of the current response curves of Fig. 6 and the compensating network of Fig. 7. Since it is necessary to raise the level of the input current to the value drawn at  $+85^\circ\text{C}$ , the shunting current ( $I_s$ ) and the corresponding value of shunting resistance ( $R_s$ ) can be calculated for any temperature ( $t$ ) as follows:

$$I_s \text{ (at } t_1) = I_{Re} \text{ (at } t_1 + 85^\circ\text{C}) - I_{Re} \text{ (at } t_1)$$

$$R_s = V/I_s$$

Because the input voltage has been corrected over the temperature range and should be constant, the theoretical value of shunting resistance required follows the same general characteristic as the full-scale current response curve. It exhibits a constant value from the extreme cold limit to slightly above room temperature, at which point there is a very rapid increase to large values at extreme hot temperatures.

Theoretically, it is feasible to approach this curve by employing two series of resistors, one with a slight negative temperature coefficient and the other with a large positive temperature coefficient, but in practice it cannot be done within practical space limitations. A compromise is required to maintain a flat

current response over most of the temperature range. The usable temperature range can effectively be increased by shunting the unit with a resistor possessing a constant value over the temperature range. This shunting is possible because this resistor increases the input current, and, as the input current increases, the ratio of reverse leakage, due to temperature change, to the input current is reduced.

#### Corrected Network

By utilizing the methods described, a basic meter rectifier has been constructed with dimensions of  $5/8'' \times 5/8'' \times 1''$ . For this unit, the input voltage required to produce full scale deflection is  $2.85 \pm 3\% v_{rms}$ , over the temperature range of  $-45^\circ C$  to  $+55^\circ C$  and does not exceed 8% over the temperature range of  $-55^\circ C$  to  $+85^\circ C$ . The input current required to produce full scale deflection is  $1.62 ma \pm 3\%$  over the temperature range of  $-55^\circ C$  to  $+55^\circ C$  with a gradual increase from  $+55^\circ C$  to  $+85^\circ C$ .

The current and voltage responses, being inter-related, affect each other. At low temperatures the input voltage required to produce a definite meter deflection increases, and this voltage increase across the shunting resistor produces an increase of input current to maintain a definite meter indication.

At high temperatures, the input current required to produce a definite deflection increases. This increase produces a corresponding increase in voltage drop across the series resistor, thereby requiring an increase of input voltage to hold a constant meter indication.

Since this unit is to function as a multi-range voltmeter and milliammeter, the voltage response determines the limitations of the unit as a current indicating device and the current response determines its limitation as a voltmeter. In a conventional ammeter, the current range is increased by shunting a definite value of resistance across the input terminals and therefore, the current drawn by this resistor directly depends upon the voltage impressed across it.

Because the voltage response of the basic unit has only a slight variation over the temperature range, the current response will improve considerably as the range of the meter is extended. As it is extended, the current flowing through the meter becomes small compared to the current flowing through the shunting resistor, causing the current response to depend upon the voltage impressed across this resistor.

To increase the range of a voltmeter a specified resistance is inserted in series with the meter; thus, its response is directly related to the current flowing through this resistance. By modifying this conventional arrangement slightly, the percentage variation of input voltage required to maintain a constant deflection over the temperature range can be reduced as the range of the voltmeter is extended. By shunting the basic unit before inserting the series voltage-multiplying resistor, the current response becomes more constant over the temperature range and so the voltage response will also become more constant.

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# Miniature Transistor Radio



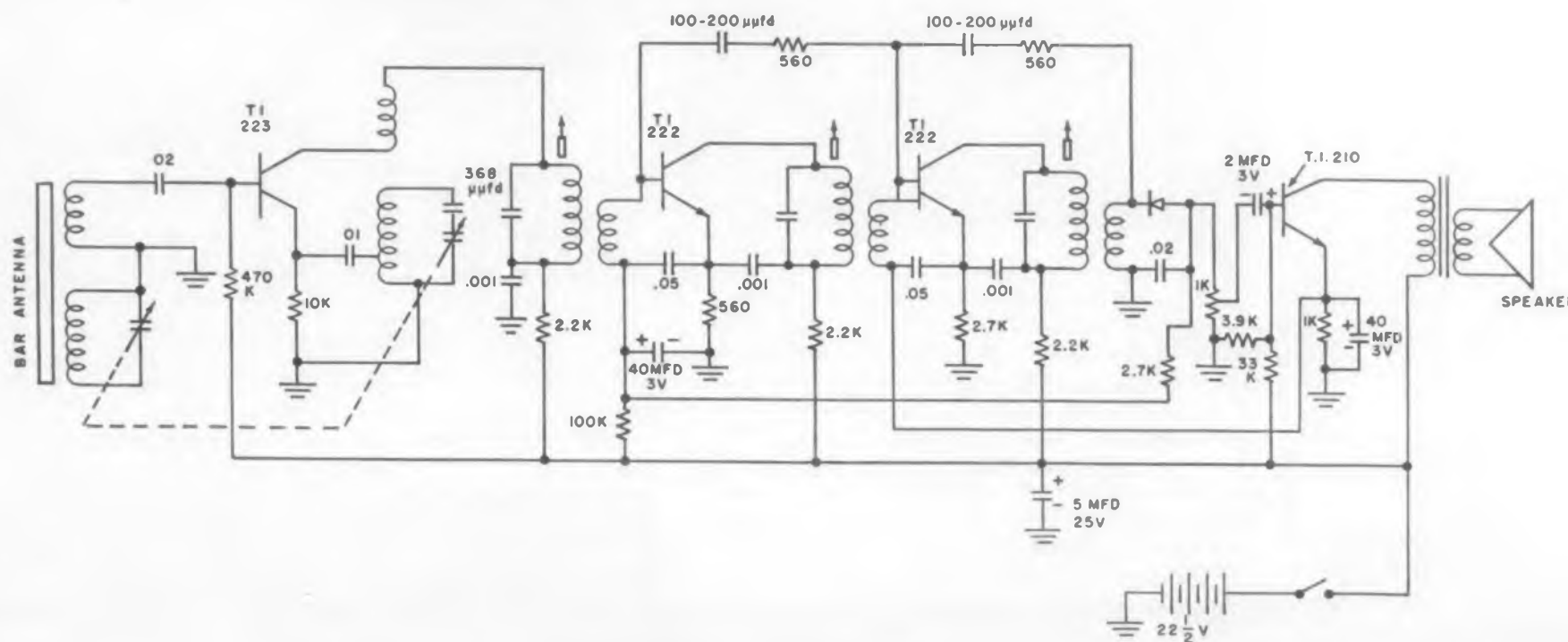
The "Conelrad" Civil Defense stations are marked in red on the dial of the TR-1 radio.



The chassis is a printed circuit board. The bar antenna is mounted at the top.

**B**Y TAKING advantage of new, low-cost transistors, the first transistorized radio for the consumer market has been developed for sale at a reasonable price. Incorporating only four transistors and one diode, the Model TR-1 radio illustrated on these pages utilizes miniature components especially designed for it by a number of electronic manufacturers. Printed circuit techniques are also employed for additional economies.

The set was developed by Regency Div., I.D.E.A., Inc., 7900 Pendelton Pike, Indianapolis 26, Ind. As shown by the circuit diagram, the radio is a five-stage, superheterodyne design. All four transistors are made by Texas Instruments, Inc., Dallas, Tex. The diode detector is a Raytheon CK706A or a Tungsol TS117.



The five-stage superheterodyne circuit of the TR-1.

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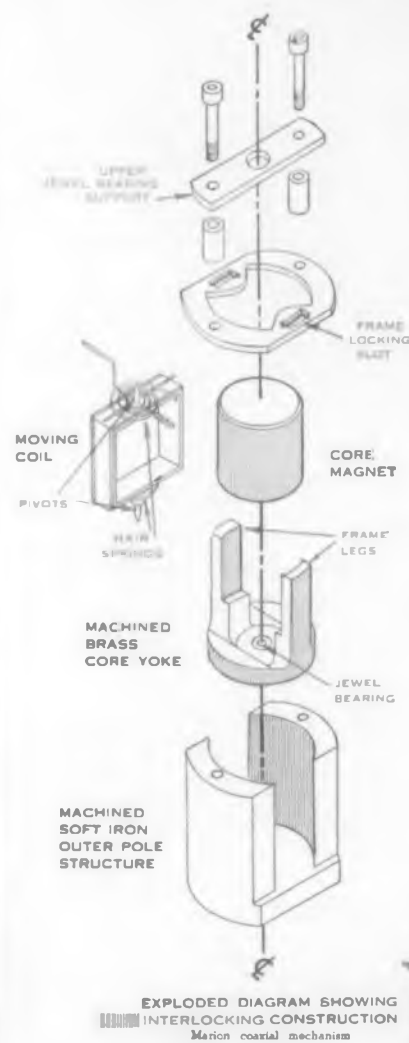
The Coaxial Mechanism making these improvements possible represents a new Marion concept in the mechanical design of moving coil mechanisms. The Coaxial assembly provides a self-shielded magnetic field of great strength, uniformity and stability. Ruggedness and stability are inherent in the basic simplicity of the design. Only two fasteners hold the rigid, interlocked assembly together. All critical dimensions are machined from a common center (the bearing axis), facilitating precise alignment of parts.

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# marion meters

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One of the n-p-n grown junction transistors, a Type TI223, has sufficient gain at high frequencies to function as a combined mixer-oscillator stage.

There are two i-f stages incorporating Type TI222 transistors. The intermediate frequency is 262kc. A Type TI210 transistor is employed in the audio stage. Power gains of 34db and 40db are achieved in the i-f and audio stages, respectively. Total gain of the radio is 110db.

The overall dimensions of the case are 5" x 3" x 1-1/4". The polystyrene case is supplied in four colors. The complete radio weighs about 12oz. Since heater power is not needed, only one 22-1/2v hearing-aid type battery is required. Current drain on the battery with no signal is about 4ma, which means that the battery should last from 20 to 30hr.

The antenna is a high-Q, ferrite-core loop. The speaker, specially made by Jensen Manufacturing Co., Chicago, Ill., is a 2-3/4" diam electrodynamic type. An earphone is also provided. The earphone jack automatically disconnects the speaker on insertion in its plug. The unit's output is flat within 3db from 200 to 7000cy. The output transformer, Type TI-210, is also supplied by Texas Instruments. The tuning capacitor, i-f transformer, volume control, and a miniature ceramic capacitor were supplied by Radio Condenser Co., Camden, N. J., Vokar Corp., Dexter, Mich., Chicago Telephone Supply Corp., Elkhart, Ind., and Centralab div., Globe Union, Inc., Milwaukee, Wis., respectively.

To date large-scale use of transistors has been limited to the hearing-aid market. The development of the Regency radio opens up a large new market for transistors, with important benefits for all present and future users of transistors. The designers and promoters of this product deserve the congratulations of the industry.



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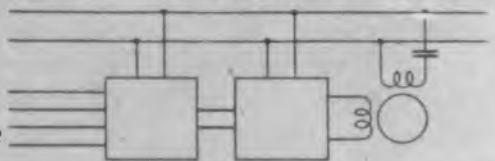
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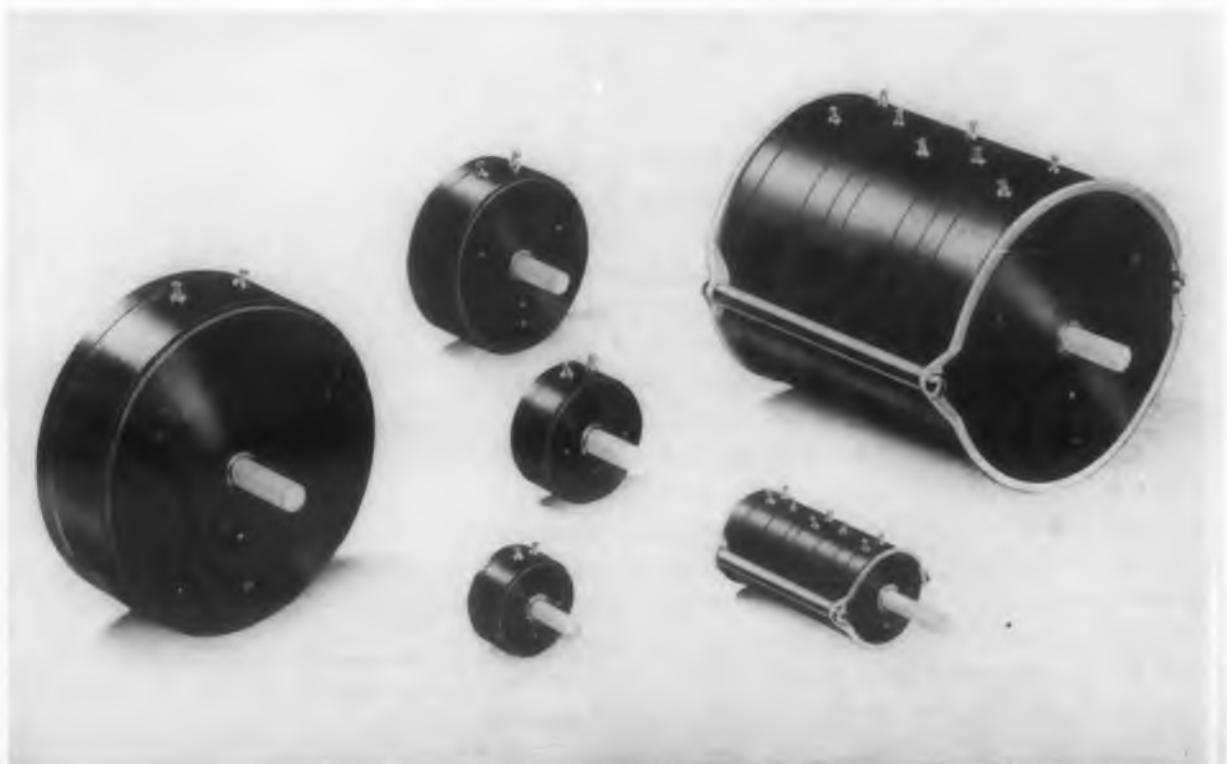
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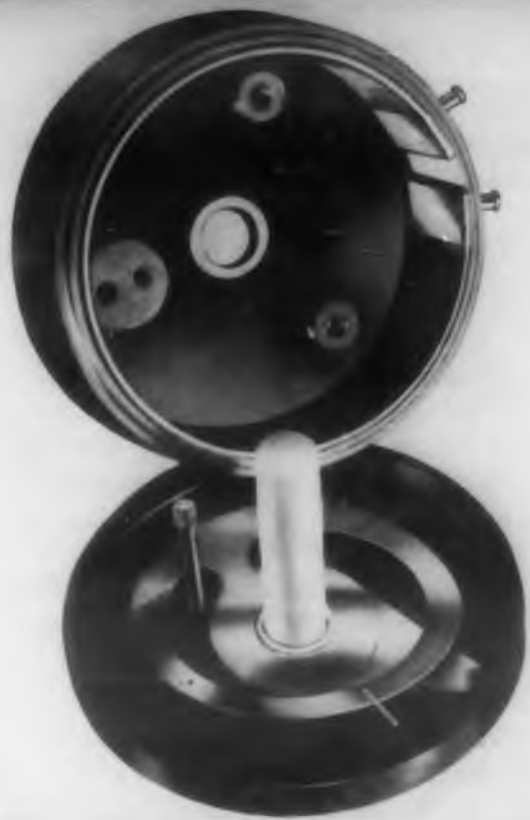
# Low-Cost Precision Potentiometers

The 970 Series potentiometers are available in various sizes and ganging arrangements.

**A**VAILABLE in eight different sizes, the 970 Series Precision Potentiometers offer high resolution, good linearity, and very little capacitance to ground at low prices. As shown in the photos, they can be used individually or ganged. Utilizing a new design, these potentiometers can be employed at audio frequencies or direct current. These potentiometers are also shown on the cover.

The small-diameter cylindrical brush contacts the edge of the card-wound resistance wire, resulting in low electrical noise. For high resolution, this





The bolt that holds the two halves of the potentiometer together also functions as the stop in this strikingly simple design.

precious-metal alloy brush touches only two turns at any time. A circular spring-metal member supports the brush. The portion of this circular member that catches the stop is 180° away from the brush, so that the brush is never distorted, bent, or damaged when the stop is reached. Total mechanical rotation is 330° ±5%. Effective electrical rotation is 320° ±5%. The body is made of phenolic. The shaft is glass-reinforced polyester, which aids in preventing coupling between ganged units.

These low-cost potentiometers are manufactured by General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. They are made in four OD's: 1-1/4", 1-3/4", 2-3/4", and 4-1/4", with two heights in each diameter. Stock resistance values range from 2 to 500,000 ohms, in various sizes. The potentiometers are rated from 2 to 20w at 40°C ambient, and from 3 to 25w at 20°C ambient. Resolution for the low-resistance units in the small model (Type 971) is ±1%. Linearity is ±2%. Resolution for the largest-diameter, high-resistance units (Type 978) is ±0.05%. Average torque for the largest units is 10 oz-in.

The following characteristics can be obtained on specification: taps as close as 1/4" apart along the entire winding; 360° mechanical rotation; special resistances; resistance tapers; resistance and linearity tolerance better than standard. For more data on these widely applicable units, turn to the Reader's Service Card and circle **ED-35**.

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CIRCLE ED-36 ON READER-SERVICE CARD FOR MORE INFORMATION

# Designing Transistor Audio Amplifiers

By R. F. Shea

Laboratories Dept., General Electric Co., Syracuse, N. Y.

*Editor's Note: This article is largely taken from the eighth and concluding chapter in Mr. Shea's new book "Transistor Audio Amplifiers". Priced at \$6.00, it will be published next month by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.*

**T**RANSISTORS have already pre-empted a considerable number of hearing aids and should in time be used in all these instruments. The truly tremendous saving in battery power made possible by the use of transistors here results in sufficient saving to the user over the comparable cost of the older types to pay for the instruments in a relatively few years.

Let us set up some typical requirements: Desired power output is 5mw. Overall transducer gain at least 75db, working from a microphone having an impedance of around 1000 ohms. Battery supply to be either one or two 1-1/2v cells. Overall frequency response to be comparable to commercial units.

The first circuit to be analyzed is shown in Fig. 1. In this circuit three grounded-emitter stages are utilized, with transistors of the 2N44 type. Comparatively little will be gained by the use of a better type in transformer-coupled stages. Transformers are utilized in order to obtain maximum gain and, at the same time, provide maximum bias stability. By using separate batteries for emitter and collector supply, and holding the d-c base resistance to minimum values, the variation of collector current with variation of  $I_{co}$  may be held to an acceptable minimum, thus avoiding any excessive temperature effects.

Let us now design this amplifier on a stage-by-stage

basis. With 3v available, the net voltage between base and collector can be about 2.2v. Let us assume 47% efficiency in the output stage, which operates class A. For 5-mw output this indicates a battery power for this stage of 10.6mw. If  $V_c = 2.2v$ , this will mean a collector current of 4.8ma. The approximate value of load resistance will then be  $2.2/4.8 \times 10^{-3} = 460$  ohms. Let us, therefore, use 500 ohms.

The grounded-base  $h$  parameters may be obtained for this stage by using the values given in the specification sheet and multiplying by factors to account for the change in operating point. Taking the  $h$  parameters for the 2N44 at  $I_e = 1ma$ ,  $V_c = 5v$ , and converting to the conditions of  $I_e = 5ma$ ,  $V_c = 2.2v$ , we obtain the following:

$$h_{11} = 40 \times 1/2.4 \times 1 = 16.7$$

$$h_{12} = 3 \times 10^{-4} \times 3 \times 1.5 = 13.5 \times 10^{-4}$$

$$-h_{21}/(1 + h_{21}) = 21.2 \times 0.82 = 17.4$$

$$\text{whence } h_{21} = -0.946$$

$$h_{22} = 1 \times 10^{-6} \times 4.4 \times 1.5 = 8.25 \times 10^{-6}$$

The grounded-emitter parameters can be calculated from these relationships as follows:

$$h'_{11} \cong (h_{11})/(1 + h_{21}) = 307$$

$$h'_{12} \cong \frac{h_{11}h_{22} - h_{12}h_{21} - h_{12}}{1 + h_{21}} = 1.2 \times 10^{-3}$$

$$h'_{21} \cong (-h_{21})/(1 + h_{21}) = 17.4$$

$$h'_{22} \cong (h_{22})/(1 + h_{21}) = 152 \times 10^{-6}$$

$$\Delta h' = 15.7 \times 10^{-3}$$

Using the above parameters and a load resistance of

500 ohms we can calculate the input resistance and current and voltage amplification and gain from the following equations:

$$z_i = (\Delta h' + h'_{22} y_i)/(h'_{22} + y_i) = r_i = 293$$

$$A_e = h'_{21} z_i/(h'_{11} + \Delta h' z_i) = 27.6 \text{ ohms}$$

$$A_v = h'_{21} y_i/(h'_{22} + y_i) = 16.2$$

$$G_i = 4(h'_{21})^2 y_i / [\Delta h' + h'_{11} y_i + z_o(h'_{22} + y_i)]^2 = 26.5 \text{ db}$$

For the driver stage let us assume a collector voltage of about 1-1.2 v. Assuming a loss in the coupling transformer of about 2db the output power of this stage is 5mw — 24.5db, or 17.7 $\mu$ w. From this it can be seen that the power level of this stage will have little effect on the choice of operating point, as a signal as small as this will not drive the stage to either extremity of its load line unless an impractically low value of collector current is used. The choice is therefore dictated by gain considerations.

For this type of transistor the gain peaks at an emitter current of 0.5 ma, with about 1/2db drop at 0.3ma. Let us therefore take as the operating point of this stage  $I_e = 0.3ma$ ,  $V_e = 1.1v$ . By the process followed above we can obtain the corresponding grounded-base parameters:

$$h_{11} = 40 \times 1/0.38 \times 1 = 105 \text{ ohms}$$

$$h_{12} = 3 \times 10^{-4} \times 0.75 \times 1.9 = 4.27 \times 10^{-4}$$

$$-h_{21}/(1 + h_{21}) = 21.2 \times 0.95 \times 0.77 = 15.5$$

$$\text{or } h_{21} = -0.940$$

$$h_{22} = 1 \times 10^{-6} \times 0.50 \times 2.00 = 1 \times 10^{-6}$$

$$\Delta h = 5.06 \times 10^{-3}$$

The corresponding grounded-emitter parameters are

$$h'_{11} = 1730 \quad h'_{12} = 13 \times 10^{-4}$$

$$h'_{21} = 15.5 \quad h'_{22} = 16.5 \times 10^{-6} \quad \Delta h' = 8.35 \times 10^{-3}$$

Assuming the same operating point for the first stage, we obtain the same values of matched resistances and gain. Resultant overall gain will therefore be:

$$35.4 + 35.4 + 26.5 = 97.3 \text{ db}$$

less the loss in the three transformers. Assuming about 2- to 3-db loss per transformer the net overall gain should be about 90db. The input resistance as

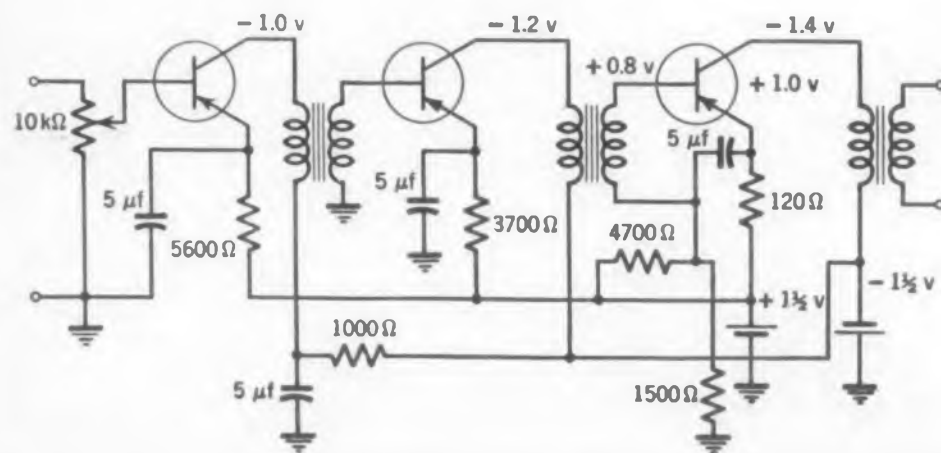


Fig. 1. A stable hearing-aid circuit utilizing two batteries. Gain is 90db.

Fig. 2. A simplified hearing-aid circuit with less stability but using only one 1-1/2v cell.

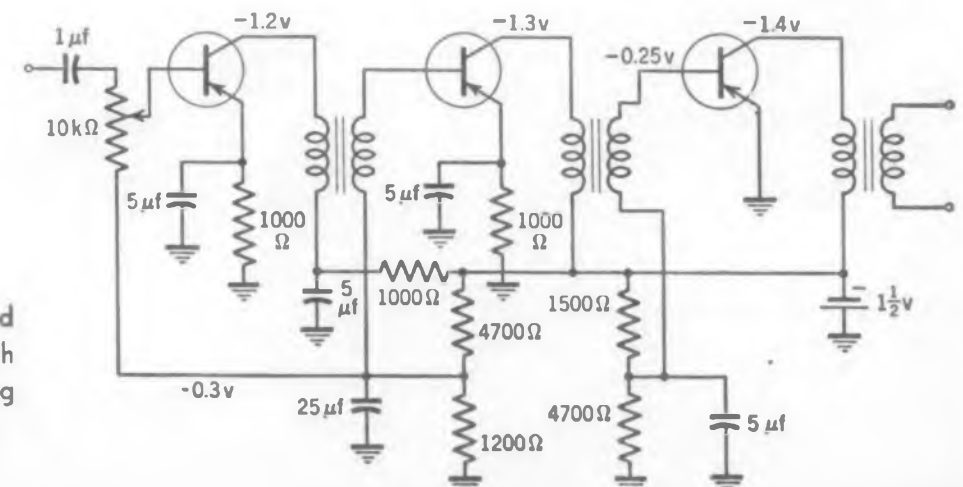
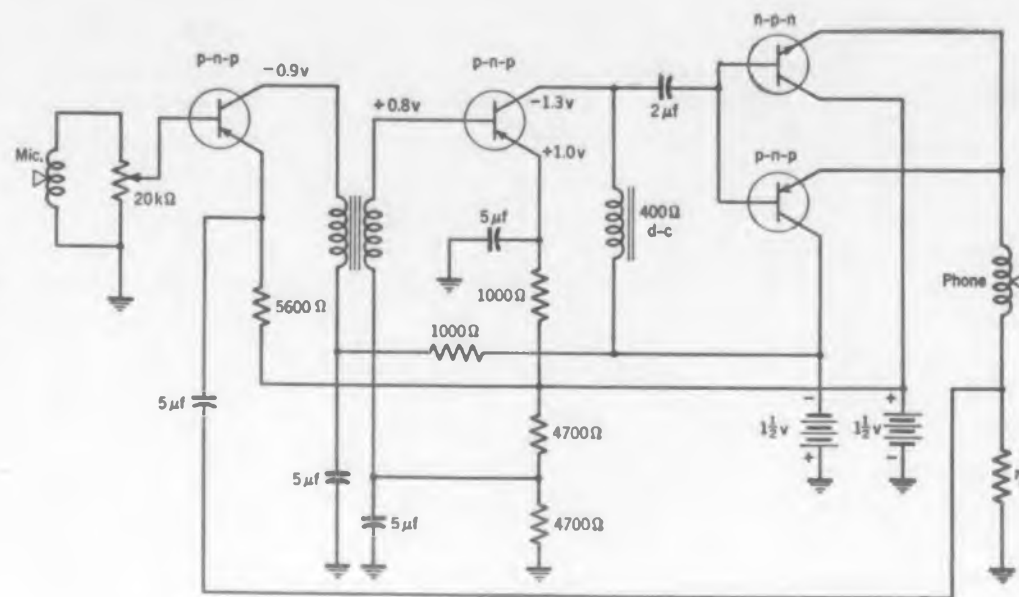


Fig. 3. A Class B hearing-aid circuit which has the advantage of greater battery life.



obtained above is very close to the desired value of 1000 ohms.

Such an amplifier was constructed, using the values shown on Fig. 1. The power output at the point where a sharp rise in distortion occurred was 4.8mw. The overall gain was 83db, using three type 2N44 transistors. The coupling transformers between stages were extremely small size, approximately 1/2" maximum dimension; however, the impedance ratio was 30,000-3000 ohms, rather than the 112,000-293 and 112,000-935 ohms indicated above for perfect match. For this reason a considerable increase in gain was obtained by using 2N43 transistors, which produced nearly matched conditions. Each of the 1-1/2v batteries delivered about 4.7ma, or a total power of 14.1mw, or an efficiency of 34%. Measured input resistance was 900 ohms. Optimum output load resistance was 500 ohms.

The hearing aid described above meets the initial requirements quite closely, but it requires two batteries and also employs quite a few components designed to insure maximum operational reliability, for example, the 1000-ohm resistor and 5-μf capacitor used to decouple the first stage and thus permit operation down to relatively low battery voltage without instability. Thus this circuit represents about the best that can be done in this type of application.

Fig. 2 illustrates a somewhat simpler circuit which uses only one battery and in which some of the stability features of the first circuit have been sacrificed in the interests of further economy.

### Class B Hearing-Aid

While the two circuits described above provide a great deal of performance at relatively little cost there are some additional advantages to be obtained from the use of class B amplifiers in hearing aids. The major advantage is the even greater battery saving made possible by this arrangement. In class B operation the quiescent power required is very low,

and so the average power may be much less than that required for class A amplifiers, where the same amount of power is being taken regardless of output power. In addition it is possible to get greater power output from class B operation where there is any limitation on supply power or transistor dissipation.

Fig. 3 shows the circuit of a three-stage amplifier with class B output, employing a complementary p-n-p n-p-n arrangement. The overall behavior of this amplifier is as follows: Output power 6mw. Power requirements at this output 10.5mw, efficiency 57%. Standby power is only 2.8mw. The input impedance of the amplifier at 1000cy varies from about 1200 ohms for  $r_f = 0$  to 7000 ohms for 0.5 ohm. Overall transducer gain working from a 1000-ohm source varies from 77db for  $r_f = 0$  to 62db for 0.5 ohm. The equivalent noise input power measures  $3 \times 10^{-14}$ w.

### Phonograph Preamplifier

Preamplifiers offer considerable opportunity for the utilization of transistors, particularly where the low power requirement is important, as in portable equipment. The operating levels are well suited to transistor operation, and much higher power efficiency is possible than with tubes.

In order to illustrate the application of transistors to preamplifiers the following specifications have been set up, corresponding approximately to those currently applicable to vacuum-tube preamplifiers.

Input signal	10mv,	Input impedance	60,000 ohms
Output	1v rms.	Noise	-50db at 50cy
Frequency response	-18db at 800cy, relative to 50cy, with about 3db additional drop-off at higher frequencies		

In addition it is desired that the above 1v output be approximately 1ma output, so that this amplifier can be used to feed into a nominal 600-ohm line by proper transformation, for utilization with commercial equipment.

The first step in the design of this amplifier is the determination of the requisite number of stages. The

specified input of 10mv into 60,000 ohms corresponds to an input power of  $1.67 \times 10^{-10}$ w. For 1mw output this requires an overall gain, therefore, of approximately 58db. This could be obtained readily from two grounded-emitter stages operating in normal manner for high gain; however, here we have several circumstances tending to reduce the gain obtainable. First, the requirement of an input resistance of 60,000 ohms will necessitate one of the various forms of modifications, such as degenerative grounded-emitter operation, with resultant loss of gain in the first stage. Secondly, the last stage must lose gain if it is to be operated as a power stage, with load resistance chosen for maximum power output rather than maximum power gain. The third consideration is the required frequency response. It is not quite possible to obtain the desired attenuation between 50cy and 800 with one compensating network, owing to the finite loading presented by the transistor input circuit. It therefore becomes necessary to have two such compensating networks. These factors indicate the need for three stages.

The next consideration is the matter of noise. For an input signal as above and a desired signal-to-noise ratio of 50db the equivalent input noise becomes  $1.7 \times 10^{-14}$ w. The usual frequency range for such an amplifier is 30-12,000cy or a ratio of 400. A noise figure of around 25db should be adequate. The frequency response of the amplifier will be of assistance in this respect, although less so than with tubes, on account of the inverse frequency characteristic of transistor noise. We thus see that the noise requirement should be met with specification transistors.

Because of the requirement for such devices to go to extremely low frequencies it becomes impractical to use coupling transformers for this application, as the size of suitable transformers would be prohibitive. Since resistance-capacitance coupling is therefore indicated, our next consideration is the determination of which transistor to use. Consider the 2N43 transistor. For the output stage a load of about 2000 ohms is indicated if we are to produce about 2v, 2mw output (this allows us a 2-1 safety factor above our specified output). The 2N43 in the grounded-emitter configuration will have an input resistance of about 1800 ohms, power gain of about 34db for this load. It can be shown that transducer gain of the first two stages is about 47db for a source of 60,000 ohms, load of 1800 ohms. The overall gain will therefore be 81db. Allowing about 2-3db loss in each coupling network will leave about 75db of overall gain, which should be more than enough. A similar analysis for the 2N44 gives about 65db, indicating the 2N44 is adequate.

Starting with the output stage we indicated that a load of 2000 ohms will give a 2-1 safety factor. This means a potential output of about 2mw at peak clipping. Assuming about 48% efficiency, class A operation, the collector dissipation for this stage is therefore 4.2mw. This may be obtained, for example, from 1v, 4.2ma, or 4.2v, 1ma. In the former case the drop in the 2000-ohm collector resistor is 8.2v; hence the

battery required is 9.2v. In the second case the drop is 2v, battery 6.2v. Obviously the latter operation is the better, and so we will operate the last stage from a 6v battery, with about 4v on the collector. The other stages can operate adequately at much lower voltage, but since we have this voltage available we may as well use the same battery for all collector supplies, also by this means increasing the collector supply resistors and thereby reducing the loading. For the emitter supplies previous discussion has indicated the considerable benefit to be obtained from the two-battery supply; hence we will use a 1-1/2v supply for all the emitters, with individual series resistors, adequately bypassed.

The performance of the last stage can now be calculated. The operating point is approximately 4v, 1ma, which is close enough to specification operation that we can use the specification values of  $h_{11} = 40$   $h_{12} = 3 \times 10^{-4}$   $h_{21} = -0.955$   $h_{22} = 1 \times 10^{-6}$ . The corresponding grounded-emitter values are

$$h'_{11} = 888 \quad h'_{12} = 5.88 \times 10^{-4} \quad h'_{21} = 21.2$$

$$h'_{22} = 22.2 \times 10^{-6} \quad \Delta h' = 7.26 \times 10^{-3}$$

For these parameters and a load of 2000 ohms the input resistance and amplification can readily be obtained, using equations given previously:

$$r_i = (\Delta h' + h'_{11}y_i / (h'_{22} + y_i)) = 863 \text{ ohms}$$

$$A_i = ((h'_{21}y_i) / (h'_{22} + y_i)) = 20.3$$

For an input resistance as above a resistor of 4700 ohms is about the minimum permissible without excessive loss. For such a resistor the next input resistance is therefore 730 ohms.

The next step is the design of the compensating network. We have specified that the total attenuation from 50cy to the upper frequency limit (say about 10,000cy) be 20db, or 10db per stage. This corresponds to a current attenuation of 3.2. To achieve this attenuation the above 730 ohms must be reduced

to an effective 230 ohms at the upper frequency limit, which means that it must be shunted by 340 ohms. This, then, is the value of the series resistor of the compensating network shunting the input of the last stage. For a turnover at 800cy the series capacitor must have this value of reactance at 800cy, which indicates a capacitance of about 0.6 $\mu$ f. A larger capacitor will move the cross-over to a lower frequency. Thus the compensating network will consist of a resistor of about 300-400 ohms in series with a 1/2- to 1- $\mu$ f capacitor.

The calculation for the second stage is similar to that made above for the last stage. It is complicated somewhat by the fact that the operating point will not correspond to the specification sheet, and so the proper parameters must be determined in the same manner as was done for the hearing-aid design. Then, to obtain the load admittance  $y_i$  it is necessary to obtain the complex resultant of the shunt combination of the input admittance of the last stage, the admittance of the compensating network and the conductances of the base resistor of the last stage, and collector supply resistor of the second stage. This admittance is inserted in the equations above, and the input impedance and current amplification of the second stage are thus obtained.

A similar operation is now performed to obtain the load admittance for the first stage. This first stage will utilize the degenerated grounded-emitter configuration to obtain the desired input resistance. The input resistance of this arrangement is approximately  $r_e' / (1 + h_{21})$ . For the 2N44 and a desired input resistance of 60,000 ohms the indicated value of  $r_e'$  is 2700 ohms. For a 2N43 this value would be lower, owing to the higher value of  $h_{21}$ . There is an error in this approximation when  $r_e'$  is larger than about 1000 ohms, and the current amplification is not quite the equal of the other two arrangements. From this standpoint it may be desirable to use the 2N43 here

and reduce the value of this resistor.

To obtain the overall gain we must now combine the current amplifications of the three stages with the attenuations in the compensating networks. The overall gain will be  $A_i^2 r_i / r_o$ .

Fig. 4 gives the complete schematic of a transistor preamplifier designed to the above specifications. The two compensating networks were set to produce the proper frequency response curve, and it will be noted that the values agree quite well with those indicated above. The network for the second stage has higher impedances than that for the last stage on account of the higher value of input impedance. Note also the values of coupling capacitors and bypass capacitors. These values are necessary to obtain the full gain of each stage at the low-frequency end.

This amplifier had about 64db overall gain at 50cy, with 50db signal-to-noise ratio. A volume control is inserted between the first and second stages to adjust the gain to accommodate different recordings.

### High-Power Transistor Amplifier

All the circuits described have comparatively standard, moderate-power units. In the following a high-power amplifier will be described to illustrate some of the ultimate potentialities of transistors. It must be emphasized, however, that these are experimental units, which may not be commercially available for some time. Nevertheless, all these results are technically feasible and, in fact, do not represent in any way an upper limit to high-power operation of transistors. The limit, if there is any, will be ultimately dictated by the permissible designs of the devices themselves.

The schematic of this amplifier is shown in Fig. 5. The basic details of the design will be given below, although the complete design will not be developed.

The output stage employs two high-power units in

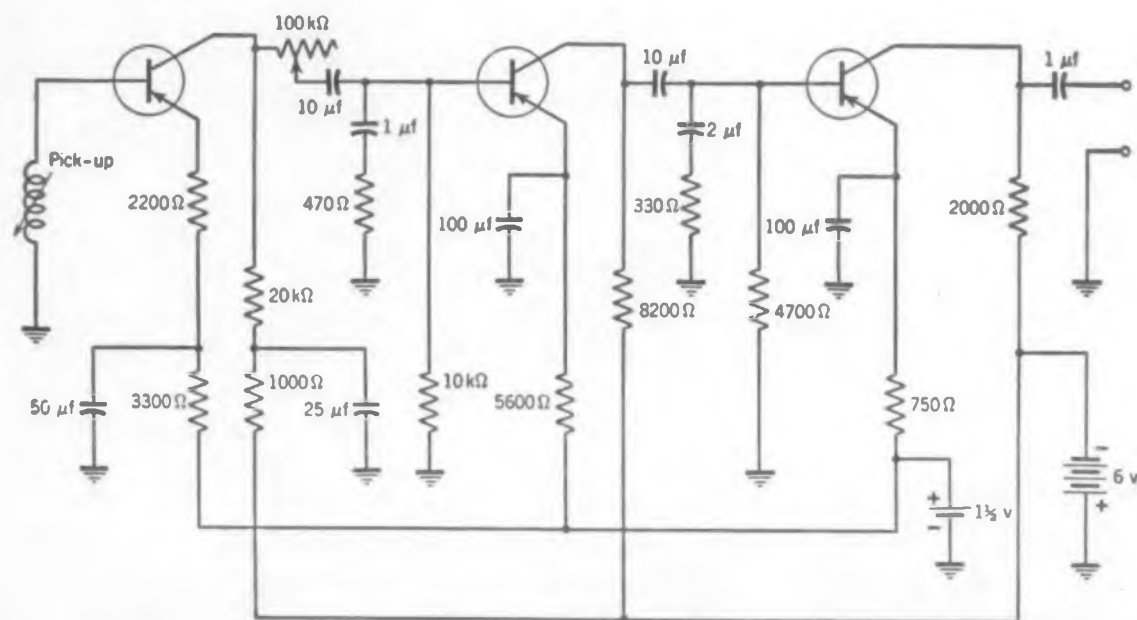


Fig. 4. Phonograph preamplifier circuit with a 50db signal-to-noise ratio.

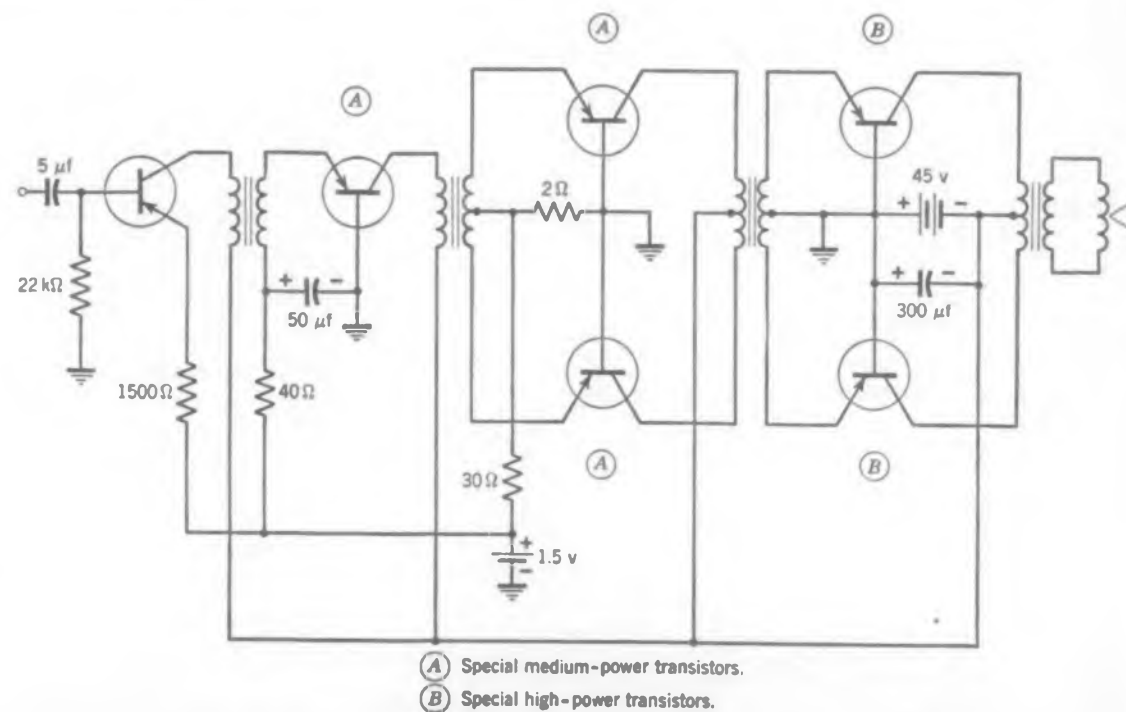


Fig. 5. This power amplifier can be driven by the preamplifier.

a class B grounded-base arrangement. The reason for this choice is twofold. In the first place this amplifier is intended for reproduction of music, and so the requirement for high quality rules out the grounded-emitter configuration. At the extremely high values of peak current encountered in this design the drop-off in "alpha" is quite extreme, so that the non-linearity in the grounded-base configuration is all that can be tolerated. The grounded-collector configuration is ruled out on the basis of low power gain, as it is expensive in terms of power to lose gain here.

All the stages operate from a common 45v source. The limit here is dictated by the maximum peak inverse voltage, which is generally of the order of 100v; hence the supply battery is restricted to half this value. The peak collector current is approximately 1 amp, even at this voltage, which illustrates the order of magnitudes of currents encountered in such transistor applications. The output transformer is therefore required to present an impedance of approximately 40 ohms per transistor, or 160 ohms from collector to collector. As the speaker impedance is 15 ohms, the output transformer is required to have an impedance ratio of 160-15 ohms and to handle 22w of power with about 1/2db loss.

The input impedance presented by these two special transistors is 2.5 ohms emitter-to-emitter. It should be emphasized that as low a value of this resistance as possible is necessary if the driving power is to be held to a reasonable level, and that it takes very careful design to achieve low values of this input resistance at peak currents in amperes!

The driver stage also employs class B grounded-base stages. These two transistors are also special, although related more closely to the low-power units than to the 20w output units. The requirement here is that the driver stage supply about 3.5w to the output stage. Optimum load resistance for this stage is about 900 ohms, collector-to-collector; hence the requirement for this audio transformer is 900-2.5 ohms, with about 1db permissible loss. It will be noted that a "step" removing bias was found necessary for this stage, consisting of a voltage divider and a 1-1/2v battery. The 2 ohms represents about the maximum permissible without loss of gain.

The input resistance of the driver stage is about 20 ohms emitter-to-emitter, and about 200mw is required. This requires a third transistor of the same type as used for the driver stage, now operated single-ended in class A. Output impedance for this stage is 1500 ohms.

Finally, the input transistor is a low-power unit, in a degenerated-emitter arrangement. This provides a fairly high impedance input, so that this amplifier may be operated from the preamplifier of Fig. 4.

The complete amplifier produces an output of 20w into a 15 ohms load, with standby power of about 2w. It can be operated from a single 45v B battery plus a small 1-1/2v dry cell, although, of course, the battery life would be quite short at such power levels.

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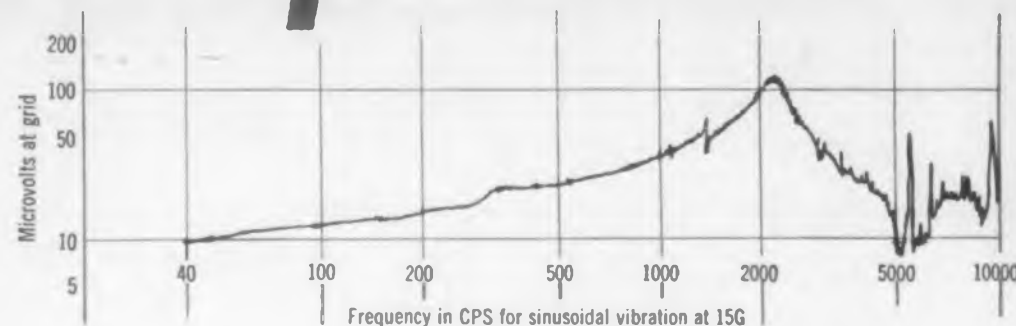
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# Printed Circuit Design

## IV—Base Materials for Printed Circuits

By George Maisch, Chief Electronic Engineer,  
Photocircuits Corp., Glen Cove, N. Y.

**S**HEETS of laminated plastic clad with metal foil on one or both sides are the foundation of all printed circuits. When a printed circuit pattern has been designed, the design engineer is faced with the sometimes difficult task of choosing the proper material to use in the manufacture of the circuit. This article covers the factors to be considered in choosing a laminate and presents technical data which should help the designer arrive at his decision.

No perfect insulating base for a printed circuit exists. The material used in a particular application rarely has everything the designing engineer would like it to have. As in most engineering problems all of the factors including cost are weighed and the best compromise is effected.

Laminated plastics are made in the following manner. Paper, cloth, or glass matte, usually about 40" wide in long rolls, is impregnated with a liquid varnish or resin by dip coating. After impregnation the material is passed through a drying tunnel or tower where the solvent in the varnish is driven off. The resin impregnated cloth or paper is then cut into sheets. Stacks of these sheets are sandwiched between thin, polished stainless steel plates. Groups of these sandwiches are then placed in heated, high pressure, multiple platen hydraulic presses. Under high pressure and temperature the sheets of laminated plastic are formed as the thermosetting resins melt, flow to a degree, and are cured.

Obviously, the types of plastic laminates are many since a wide variety of resins may be used with an equally wide variety of binders. Phenolics, melamine, epoxies, polyesters, silicones, and teflon are the usual resins or families of resins. Various grades of paper, ranging from kraft to the best alpha pulp; various grades of cloth woven with glass fiber, linen, cotton, nylon, dacron, orlon, asbestos; and glass fiber matte are the binders used. The laminated plastic manufacturers offer in the neighborhood of 25 to 40 grades of sheet stock. Each grade has specific properties which establish a market for it. However, the requirements of the average printed circuit narrow the

choice down to 10 grades on which pertinent technical data is presented in this article.

The requirements for the metal foil to be laminated to the plastic sheet are stringent. For convenient handling it must be available in rolls or sheets as wide as the laminating presses in use (36" or more). The thickness should be of the order of 0.001" to 0.004". It must be highly conductive, readily etched, easy to solder, and corrosion resistant. The only metal foil presently available in large quantities meeting all of these requirements is copper. Fortunately, prior to the growth of the etched circuit business, the American Brass Co., Waterbury, Conn., had developed a process and large capacity for manufacturing copper foil for the building trades. In this process, copper is electro-deposited on large lead-coated drums turning slowly in a copper solution. The copper foil is stripped off the drums, washed, dried, protected with a corrosion inhibitor and rolled up. Plastic laminators buy it in rolls up to 60" wide in standard thicknesses (0.00135", 0.0027", 0.00405"). One side of the copper is smooth; the other side has the matte finish characteristic of copper deposited rapidly from an acid bath. This is an advantage be-

cause the matte finish improves adhesion to the insulating laminate base.

Aluminum foil is available from Reynolds Metals Co., Louisville, Ky., in standard widths and thicknesses with a copper flash on one side to improve solderability, but it has not been widely used to date primarily because the etching reaction is rapid, exothermic, and difficult to control. Brass, phosphor-bronze, and silver foil are other metals that have been used for special applications, but they require special handling because rolling mills are not available to roll these foils much wider than about 12". The smooth surfaces of the rolled foils of these metals is also more difficult to bond. No facilities exist for the large-scale production of electrodeposited foils other than copper.

The type of bonding agents and the method of bonding the foil to the sheets are very important considerations. Several systems are used by the various laminators. Where close laminate thickness tolerances are not required (see Table I), the copper is laminated to the sheet as the sheet is made. If close thickness tolerances are required, the sheet is made without the copper foil and then sanded to the desired thickness. The copper is then applied in a second laminating operation. Precoating the copper with an adhesive<sup>1</sup>, using an adhesive film such as "Permacel" 1824<sup>2</sup>, or using an adhesive impregnated surface sheet in the lay up, are bonding systems now in use with the phenolic laminates. It is important that the adhesives used have good electrical properties, solvent resistance, and low moisture absorption or the properties of the base material will be greatly degraded.

With phenolic laminates the adhesive used is usually a phenolic resin modified with an elastomeric resin such as polyvinyl butyral to provide the necessary tack.

One big advantage of epoxy laminates is that epoxy resins are good adhesives in themselves. Copper can

Table I. Thickness tolerances for three types of plastics.

Thickness Tolerances—(plus or minus)				
Thickness	1/32	1/16	3/32	1/8
<u>Materials</u>				
Paper-base stock	0.0035	0.005	0.007	0.008
Fabric base stock	0.0065	0.0075	0.009	0.010
Special sanded stock (double pressed)	0.002	0.002	0.003	0.003

1: Available from Rubber and Asbestos Corp., Bloomfield, N. J., and the Permacel Tape Corp., New Brunswick, N. J.

2: Manufactured by Permacel Tape Corp.



Table 2. Properties of standard National Association of Electrical Manufacturers grades of laminates.

NEMA Grade	Resin & Binder	Flexural Strength (psi)	Bond Strength (lb/inch)		Max Continuous Duty Temp (in °F)	Approx Dielectric Constant at 10 <sup>4</sup> cy	Dissipation Factor at 10 <sup>4</sup> cy	% Moisture Absorption (24 hr)	Volume Resistivity (Megohms/cm)		Arc Resistance	Fabrication Characteristics		Relative Cost (XXXP=1)
			(0.00135" thick copper)	(0.0027" copper)					As Received	1000 hrs 160°F-95% R.H.		Punchability	Tool Wear	
P	Phenolic-paper	14000	4-1/2-8	6-12	250	8.0	0.08	2.0	Variable-poor	Variable-poor	Poor	Excellent	Excellent	0.7
XXP	Phenolic-paper	19000	4-1/2-8	6-12	250	4.6	0.037	1.0	5x10 <sup>2</sup>	5 x 10 <sup>1</sup>	Poor	Excellent	Excellent	0.9
XXXP	Phenolic-paper	25000	4-1/2-8	6-12	250	4.3	0.029	0.65	2.4x10 <sup>4</sup> to 1x10 <sup>4</sup>	1 x 10 <sup>3</sup>	Poor	Fair	Good	1.0
N-1	Phenolic-nylon	35000	3-5	4-7	165	3.3	0.030	0.4	2.0x10 <sup>4</sup> to 1x10 <sup>4</sup>	.....	Poor	Excellent	Excellent	3.0
G-5	Melamine-glass	55000	4-6	5-8	300	6.8	0.030	2.0	1 x 10 <sup>4</sup>	6 x 10 <sup>2</sup>	Good	Fair	Very Poor	3.0
G-7	Silicone-glass	40000	1-1/2-4	1-1/2-4	350	3.9	0.015	0.4	1 x 10 <sup>7</sup>	2 x 10 <sup>6</sup>	Good	Fair	Poor	5.0
Epoxy Glass	Epoxy-glass	68000	5-10	6-12	350	4.9	0.028	0.10	1 x 10 <sup>7</sup>	.....	Good	Fair	Poor	4.0
Teflon Glass	Teflon-glass	13000	3-9	4-9	400	2.6	0.001	0.02-0.3	1 x 10 <sup>7</sup>	1 x 10 <sup>5</sup>	Good	Good	Poor	13.0
GP-9100	Polyester-glass matte	23000	2-4	3-5	300	4.3	0.015	0.2	.....	.....	Good	Good	Poor	1.5
CE	Phenolic-cotton	17000	4-1/2-8	6-12	250	5.0	0.050	1.2	1 x 10 <sup>7</sup>	.....	Poor	Excellent	Excellent	1.7

Comments and Uses

P	(Phenolic-paper)	Inexpensive grade used where good electrical properties are not required.
XXP	(Phenolic-paper)	Better electrical properties with excellent punchability. Used where severe humidity not encountered.
XXXP	(Phenolic-paper)	Most widely used grade. Recommended for applications requiring high insulation resistance and low dielectric losses under severe humidity conditions.
N-1	(Phenolic-nylon)	Very high insulation resistance under humid conditions. Good impact strength and vibration resistance.
G-5	(Melamine-glass)	Good arc resistance, higher temperature resistance, but poor on moisture absorption test.

Comments and Uses

G-7	(Silicone-glass)	Good arc and high temperature resistance, low dielectric losses, but subject to bond strength problems.
Epoxy Glass	(Epoxy-glass)	Most widely used glass-base grade—good mechanical and electrical properties combined with low moisture absorption.
Teflon Glass	(Teflon-glass)	Excellent electrically, but very expensive and poor mechanically. Used primarily in low-loss microwave applications.
GP-9100	(Polyester-glass matte)	General purpose glass-matte laminate, having good electrical and mechanical properties—doubtful bond strength.
CE	(Phenolic-cotton)	Phenolic grade useful where greater impact resistance than paper-based grades is required.

be bonded as the laminate is made using the laminating resin as an adhesive. There is no danger therefore that the bonding adhesive will degrade the properties of the material.

Silicone and epoxy resins are notably poor as adhesives. Copper has been successfully bonded to silicone and polyester glass laminates only by using epoxy type resins with silicones and either phenolics or epoxies with the polyesters.

Table 2 lists the standard NEMA grades of laminates used in manufacturing etched circuits along

with a few special grades. Their various physical and electrical properties are summarized in the table. It is advisable to comment briefly on each of these properties to demonstrate why they are of importance to the designer.

1. *Flexural Strength*: Flexural strength is the indication of the material's resistance to bending, shock, and vibration. Consideration of the size of the board, method of support, and the weight of mounted components, in the light of the flexural strength of the material used and the stress conditions to be encoun-

tered, will determine how thick the board should be. For example, a 1/16" thick epoxy glass board may suffice where a 3/32" or 1/8" thick paper-base phenolic would be required. Generally, high-flexural-strength materials such as glass-cloth laminates stand shock and vibration much better than low-flexural-strength materials.

2. *Bond Strength*: Although there are several methods of determining the strength of the bond between the copper and the laminated plastic, the so-called "one-inch-wide peel test" is the most commonly used at

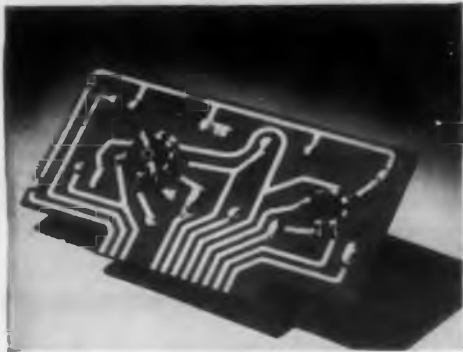
# Get better printed circuits . . . lower costs . . . fewer rejects

## with NEW C-D-F METAL CLADS

All manufacturers of metal clad stock for printed circuitry have made considerable progress in improving their product—a material with a metal foil surface bonded to a non-conducting base. How this has been done by one leading manufacturer, the Continental-Diamond Fibre Company, illustrates some of the problems involved in buying this type of material and in understanding its design potentials.

### C-D-F CONSOLIDATED GRADES

At first, small test lots of Dilecto laminated plastic with copper surfaces were made. Almost every core material was used. Finally the number of practical grades for printed circuit work narrowed down to these few grades which retained to a large degree the inherent electrical qualities of their base material and resin at high temperatures:



**COPPER CLAD  
GRADE XXXP-26**

A laminate with excellent electrical and mechanical properties. High moisture resistance and dimensional stability. Recommended for applications where

high heat and high insulation resistance plus low dielectric loss under high humidity is needed. Low cold flow characteristics. Can be hot punched to  $\frac{1}{8}$ ". Good flexural strength. Natural green color.

This is one of the improved C-D-F Dilecto laminates. Advances in resins and manufacturing techniques makes this grade almost homogeneous, with improved impregnation of the filler. Thorough impregnation eliminates entrapped moisture and air, giving greater moisture resistance and better dielectric properties.

Any metal clad is no better than its base and the care taken in laminating. With the cost of material high, compared to labor and inspection, the purchase of a uniform metal clad material, like this C-D-F grade, becomes vital.



**COPPER CLAD  
GRADE XXXP-24**

Similar to grade XXXP-26 in electrical and moisture resistance properties, but not quite as strong mechanically. Equal cold flow and punching characteristics. Natural brown.

### COPPER CLAD GRADES GB-112S AND GB-261S

These silicone grades use a glass fabric laminate with a copper foil surface on one or both sides. Recommended where high heat resistance and low dielectric loss properties are required. For certain tuners and inductances the

low dielectric loss factor of this grade makes its higher cost acceptable. A continuous filament (Grade GB-112S) is used for thicknesses  $\frac{1}{32}$  to  $\frac{1}{16}$ ". A staple filament (Grade GB-261S) is used for thicknesses over  $\frac{1}{16}$ ".

### COPPER CLAD GRADE GB-116T

A glass base laminate using duPont's tetrafluoroethylene resin, Teflon, for outstanding resistance to high heat with extremely low dielectric loss properties. A fine weave continuous filament glass fabric cloth is used for superior mechanical strength and good machining qualities. In spite of its high cost, this C-D-F grade has demonstrated that it can save money and do a job that no other single material can in microstrip high-voltage, high-frequency circuit elements. Remember, C-D-F is a major supplier of sheets, tapes, rods, tubes of Teflon, has valuable experience in its manufacture and fabrication. Write for samples.

### C-D-F INCREASED BOND STRENGTH

By developing a special thermo-setting adhesive particularly suited for metal clads, C-D-F was able to increase the bond strength of their laminates considerably above their original figures. Bond or peel strength, the amount of pull required to separate the foil from the core material, is one of the most important physical properties. Therefore, the purchaser should compare his source of supply with these C-D-F average test values:

BONDING STRENGTH—FOIL TO LAMINATE	
MATERIAL	Average or Typical Value Lbs. pull per 1" width of foil to separate
XXXP-24 or XXXP-26 plus 0.0014" copper	5 to 8
XXXP-24 or XXXP-26 plus 0.0028" copper	7 to 9
GB-116T plus 0.0014" copper	5 to 12
GB-112S plus 0.0014" copper	6 to 8
GB-261S plus 0.0014" copper	7 to 10

These values are based on tests at prevailing room temperature (20-30°C.)

### C-D-F INCREASED HEAT RESISTANCE

Special efforts by C-D-F technicians to increase the heat resistance of all C-D-F Metal Clads have resulted in certain special grade variations able to withstand higher soldering temperatures without damage. As production methods change, C-D-F offers materials to meet your requirements.

### NOW . . . HOW ABOUT YOUR STORY?

Notice how we have talked about C-D-F and what we have done to improve quality and uniformity of metal clad products. Much of this has been accomplished with the guidance and cooperation of leading users of printed circuit stock. No one company knows all the answers . . . but C-D-F, a big reliable source of supply, can help you get better printed circuits . . . lower costs . . . fewer rejects. Look up the address of your nearest C-D-F sales engineer in Sweets Design File, write us for samples you can test in the lab and on the production line, technical bulletins, help on your specific project. We want to work with you!



*Continental-Diamond Fibre*

CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK 107, DELAWARE

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this time. This test measures the force in pounds required to peel a 1" wide strip of copper away from the laminate at a 90° angle.

Bond strength is an indication of how well the printed circuit will stand abuse such as heat shock or mechanical shock and vibration without the circuit pattern lifting or pulling away. In general 4 to 5 lb minimum bond strength at room temperature is considered to be satisfactory and can be fairly easily attained by the laminate manufacturers.

3. *Temperature Resistance:* It is important to know the maximum temperature at which long term exposure will not degrade the mechanical or electrical properties of the material. The designer must consider the possibility of hot spots near tubes or high wattage resistors as well as the ambient temperature in choosing his material.

Bond strength for most adhesives will decrease with increase of temperature. At the maximum operating temperature of the material it may be as little as  $\frac{1}{3}$  to  $\frac{1}{2}$  of the bond strength at room temperature. For that reason, if there are any critical shock or vibration tests to be passed the tests should be run at the maximum operating temperature of the unit. In the case of laminates that have bonding adhesives different from the base material, the temperature resistance of the bond often is the limiting factor in setting a maximum operating temperature for the combination. For instance, although silicone glass laminates may stand 375°F continuously, the epoxy adhesives used to bond the copper foil to the laminate may only be good to 325°F.

4. *Dielectric Constant:* The dielectric constant of a material is important to the designer when the laminate also functions as the dielectric in a capacitor, i.e., when two plates are printed on opposite sides of the material to form a capacitor. The constant must be known in order to calculate the etched-foil area required to make up the plates.

5. *Dielectric Loss Factor:* This factor is a measure of the power that is lost in the dielectric when the base laminate is used as the dielectric in a capacitor or the support for a printed spiral coil. The dielectric loss is one of the factors that determines the efficiency of the capacitor or the Q of the coil. A spiral coil with 0.0015" line width and 0.0015" line spacing printed on  $\frac{1}{16}$ " thick XXXP will have a Q of approximately 40 to 60. The same coil printed on phenolic-impregnated glass-cloth, 0.006" thick, will have a Q of approximately 90 to 120.

6. *Moisture Absorption:* Moisture absorption is important because it is an indication of the probable change in electrical properties, such as surface and volume resistivity, with exposure to high humidity. It is also a measure of the tendency of the laminate to absorb chemicals during processing in the etching and plating solutions. The poorer grades of the paper-

base phenolics are close to rejection from this viewpoint. Other insulating materials, such as vulcanized fibre, Masonite, and the like, are not useable at all because of their high moisture absorption.

7. *Resistivity:* Leakage resistance between adjacent etched conductors and the volume resistivity of the printed circuit card are obviously important to the designer. Because resistance drops with increased temperature and humidity, it is necessary for the design engineer to have an approximate idea of these values under the worst humidity and temperature conditions to be encountered operationally by the unit. Materials, circuit impedance, and conductor line spacings must be considered and interrelated by the designer so that under the worst conditions leakage is not a problem.

The values given in Table 2 must be used with a high safety factor because of the variations in resins, binders, and processing techniques from batch to batch and sheet to sheet of the laminated plastic. It is difficult for manufacturers to hold resistivity values much closer than within a 10 to 1 range.

8. *Arc Resistance:* Arc resistance normally is not too important in printed circuit applications with the exception of printed circuit switches where a small arc is likely to be drawn at the make or break of the printed switch. Paper phenolics are generally very poor for switching applications and will be readily pitted, whereas epoxy or melamine laminates will stand up very well under these conditions.

9. *Fabrication Characteristics:* How well the laminated plastic handles under such machining operations as piercing, blanking, routing, milling, drilling, turning, etc., will often influence the designer in choosing a material. Extensive information on fabrication characteristics of the various laminate materials is available from the manufacturers. It should be studied carefully to determine its influence on such factors as hole spacing, thickness, hole size and spacing, tolerances, and cost.

In the experience of Photocircuits Corporation XXXP has by far been the most widely used base material. Its relatively low cost, good electrical properties, and easy fabrication characteristics account for its wide use in both government, commercial, and consumer equipment. Grades XXP and XP are next in use. Of the glass-base grades, epoxy glass is superior because of its low moisture absorption, good mechanical strength, and somewhat higher temperature resistance. It is used in government and commercial equipment. Its higher cost rules it out of the consumer radio and television market. Glass melamine is used very little because it is difficult to fabricate and has relatively high moisture absorption. Teflon glass, because of its high cost, is limited to microwave circuit elements where it is the only material with sufficiently low loss characteristics.

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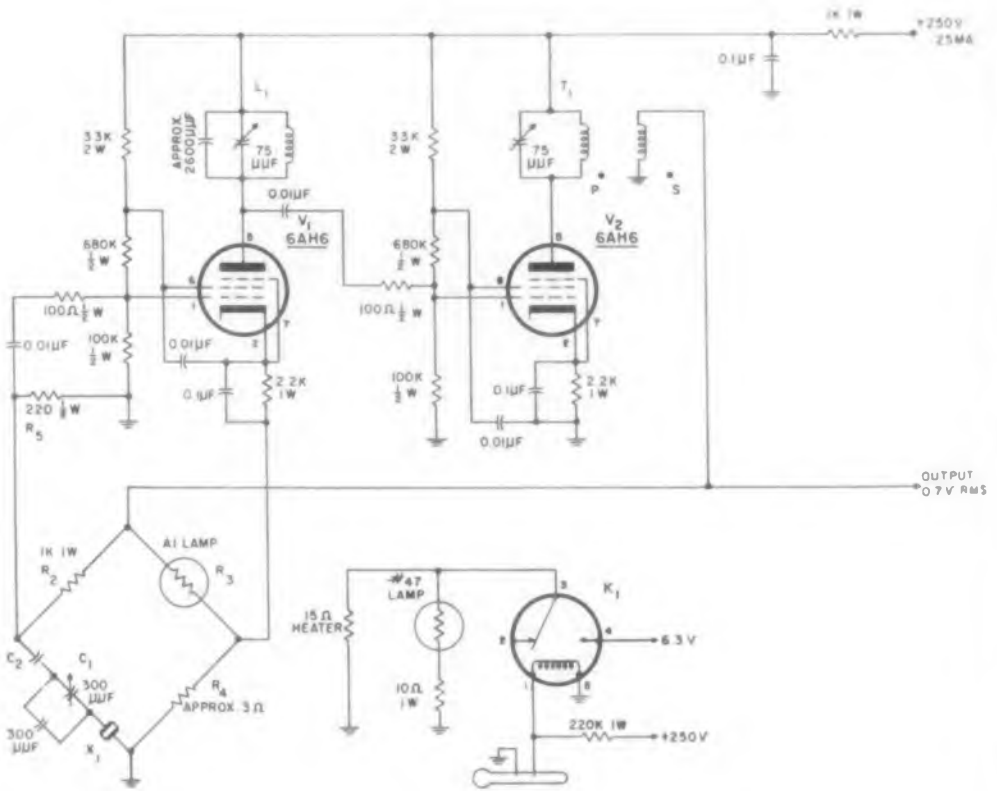
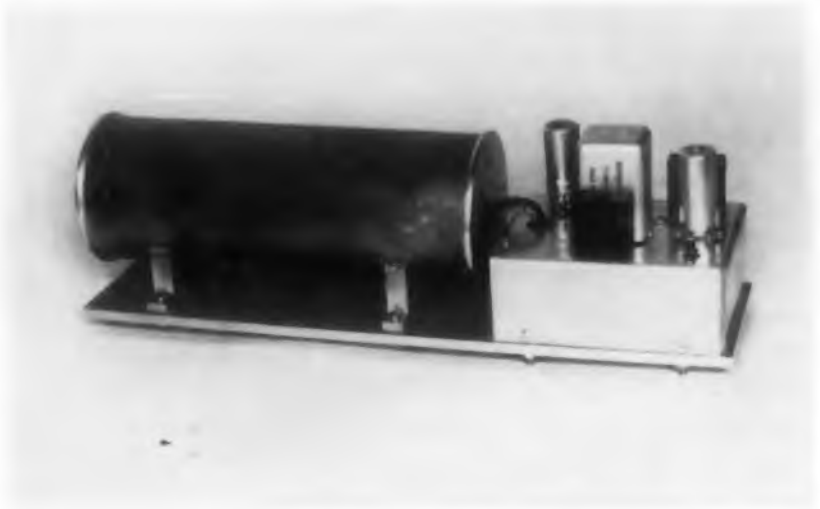
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# Frequency Standard

A 1Mc Frequency Standard constructed according to National Bureau of Standards specifications.



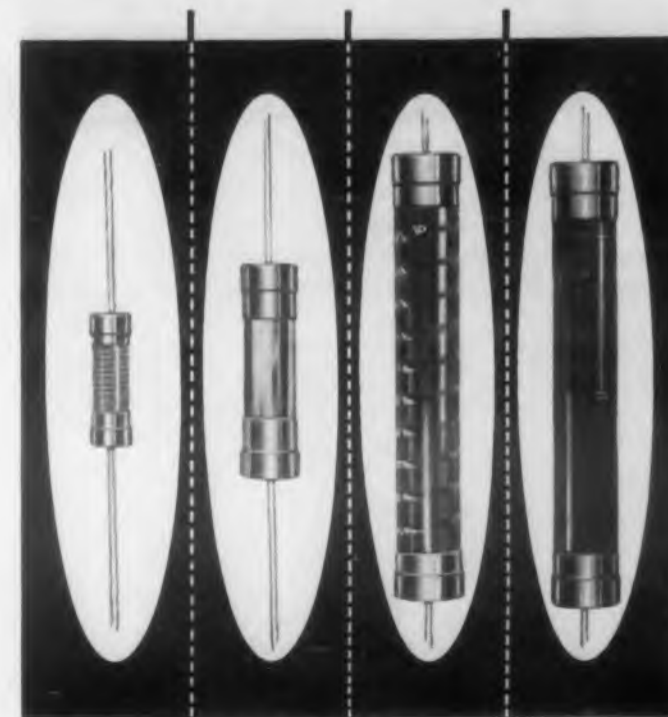
Circuit diagram of the frequency standard.

## THE HERMETICALLY SEALED DAVOHM SERIES 850 IS THE PERFECT COMPROMISE BETWEEN PRECISION WIRE WOUND AND COMPOSITION TYPE RESISTORS

Rugged simplicity keynotes the design of the new Davohm Series 850 resistor. Basically, it is a heat resistant glass tube, with the noble-metal resistive element deposited on the inside surface. Hermetically sealed, the resistive elements need no "protective" coatings, and are deposited with such extreme accuracy that even microscopic examination will show no flaws or raggedness which might otherwise result in noise, erratic readings, hot spots and opens. The temperature coefficient is always positive, always constant, and does not vary with resistance value. High frequency performance is excellent due to low reactive component of impedance.

The unique performance characteristics of the Davohm Series 850 compares with MIL-R-10509A as follows:

	MIL-R-10509A ALLOWABLE CHANGE	Series 850 TYPICAL CHANGE
Temperature Cycling	1.0%	0.02%
Low Temperature Exposure	3.0%	0.04%
Short Time Overload	0.5%	0.02%
Effect of Soldering	0.5%	0.02%
Moisture Resistance	5.0%	0.08%
Voltage Coefficient	0.002%	0.00%
Load-Life (per 1000 hours)	1.0%	0.20%
Temperature Coefficient (PPM/°C)	±500	+370 ±20



Available immediately in 1/2, 1 and 2 watt sizes and in ±1%, ±0.5%, and ±0.25% tolerances in any desired value.

Write for full technical data or see your local Daven Sales Representative.

**S**TABLE to a few parts in 100 million per day, this portable 1Mc frequency standard utilizes inexpensive, commercially available components. The equipment is sufficiently rugged for field use. Developed by P. G. Sulzer, National Bureau of Standards, Washington, D.C., it employs a crystal unit inside a constant-temperature oven to control an oscillator.

The NBS 1Mc standard, like similar crystal-controlled oscillators, consists of three elements: the crystal unit proper, an amplifier to supply the losses in the crystal unit and to deliver power to a load, and an amplitude control. This oscillator was especially designed to minimize frequency changes caused by tube or component instability.

The over-all stability of the unit is nearly that of the crystal itself. Any phase shift in the amplifier must be offset by a corresponding phase shift in the crystal unit. In this Meecham bridge oscillator, the effects of amplifier variations are decreased by the use of inverse feedback. The crystal is 20-ohm, glass-enclosed, contoured AT-cut type with a Q of  $5 \times 10^5$  and a maximum current limitation of 1ma. The A-1 switchboard lamp,  $R_3$ , used in the bridge requires at least 0.7v for proper operation.

To obtain the best frequency stability, the crystal is kept in an oven at a specified, constant temperature. The oven is of the single-stage type, with temperature control provided by a 50° mercury thermostat. A Dewar flask is used to isolate the controlled oven chamber from outside temperature changes. Consequently, the average power requirement is only 0.4w at a temperature difference of 25°C. Frequency changes in the crystal due to oven cycling are less than 10<sup>-6</sup>cy, and normal laboratory temperature changes are apparently not reflected in the temperature of the crystal.

## New and Revolutionary Davohm metal film Series 850 resistors ... outdates all previous film types in performance characteristics.

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FORM	GRADE DESCRIPTION	NEMA GRADE	MILITARY SPEC.	MILITARY SPEC. TYPE	NAVY 17-P-5 TYPE	JAN-P-79 TYPE LTS	FEDERAL SPEC. L-L-31	33P-46 (AER)BUR. AERO.	AAF SPEC. 12032	ASTM D-709 TYPE
TUBES (Rolled) Form Tr	Paper Filler—Hard Phenolic Resin	X	MIL-P-79	PBM	PBM	M-1	X	—	—	I
		XX	MIL-P-79	PBG	PBG	E-2	XX	—	—	I
		—	—	—	PBE	E-4	—	—	—	—
	Medium Weight Cotton Fabric Filler—Hard Phenolic Resin	C	MIL-P-79	FBM	FBM	M-4	C	—	—	II
		—	—	—	FBG	EM-1	—	—	—	—
	Fine Weave Cotton Fabric Filler—Hard Phenolic Resin	—	—	—	FBI	M-3	—	—	—	—
		LE	MIL-P-79	FBE	FBE	EM-2	LE	—	—	II
	Asbestos Paper Filler—Hard Phenolic Resin	A	MIL-P-8059(USAF)	A	—	—	—	—	—	—
	Asbestos Fabric Filler—Hard Phenolic Resin	AA	MIL-P-8059(USAF)	AA	—	—	—	—	—	—
	Continuous Filament Glass Fabric Filler—Phenolic Resin	G-3	—	—	—	—	G-3	—	—	IV
Continuous Filament Glass Fabric Filler—Melamine Resin	G-5	MIL-P-79	GMG	GMG	MG-1	G-5	—	—	IV	
TUBES (Molded) Form Tr	Paper Filler—Hard Phenolic Resin	—	—	—	PBM	M-1	—	—	—	—
		XX	MIL-P-79	PBG	PBG	E-2	XX	—	—	I
		XXX	MIL-P-79	PBE	PBE	E-4	XXX	—	—	I
	Medium Weight Cotton Fabric Filler—Hard Phenolic Resin	—	—	—	FBM	M-4	—	—	—	—
		CE	MIL-P-79	FBG	FBG	EM-1	CE	—	—	II
	Medium Weight Cotton Fabric Filler—Phenolic Resin Graphite Inclusion	—	—	—	—	—	—	CG	CG	—
	Fine Weave Cotton Fabric Filler—Hard Phenolic Resin	L	—	—	FBI	M-3	L	—	—	II
		LE	MIL-P-79	FBE	FBE	EM-2	LE	—	—	II
	Fine Weave Cotton Fabric Filler—Phenolic Resin Graphite Inclusion	—	—	—	—	—	—	LG	LG	—
	Asbestos Paper Filler—Hard Phenolic Resin	A	MIL-P-8059(USAF)	A	—	—	—	—	—	—
Asbestos Fabric Filler—Hard Phenolic Resin	AA	MIL-P-8059(USAF)	AA	—	—	—	—	—	—	
Continuous Filament Glass Fabric Filler—Phenolic Resin	—	—	—	—	—	—	—	—	—	
Continuous Filament Glass Fabric Filler—Melamine Resin	—	—	—	GMG	MG-1	—	—	—	—	
RODS (Molded) Form R	Paper Filler—Hard Phenolic Resin	—	—	—	PBM	M-1	—	—	—	—
		XX	MIL-P-79	PBG	PBG	E-2	XX	—	—	I
		XXX	MIL-P-79	PBE	PBE	E-4	XXX	—	—	I
	Medium Weight Cotton Fabric Filler—Hard Phenolic Resin	C	—	—	FBM	M-4	C	—	—	II
		CE	MIL-P-79	FBG	FBG	EM-1	CE	—	—	II
	Medium Weight Cotton Fabric Filler—Phenolic Resin Graphite Inclusion	—	—	—	—	—	—	CG	CG	—
	Fine Weave Cotton Fabric Filler—Hard Phenolic Resin	L	—	—	FBI	M-3	L	—	—	II
		LE	MIL-P-79	FBE	FBE	EM-2	LE	—	—	II
	Fine Weave Cotton Fabric Filler—Phenolic Resin Graphite Inclusion	—	—	—	—	—	—	LG	LG	—
	Asbestos Paper Filler—Hard Phenolic Resin	—	—	—	PBH	H-1	—	—	—	—
Asbestos Fabric Filler—Hard Phenolic Resin	—	—	—	FBH	MH-1	—	—	—	—	
Continuous Filament Glass Fabric Filler—Melamine Resin	G-5	MIL-P-79	GMG	GMG	MG-1	G-5	—	—	IV	

# Specifications for Laminated Plastics

By Dr. Norman A. Skow,  
Director of Research  
Synthane Corporation, Oaks, Pa.

## Key:

PBM	Paper base, best mechanical properties
PBE	Paper base, best electrical properties
PBE-P	Paper base, best electrical properties (for punching)
PBG	Paper base for general use
PBH	Paper base, best heat resistance
FB	Fabric base
G	Glass
A	Asbestos
FBI	Fabric base for intricate work requiring toughness
GMS	Glass melamine, general
GSG	Glass silicone, general
GMM	Glass melamine, mat

SHEET STOCK GRADE DESCRIPTION	NEMA GRADE	MILITARY SPEC.	MILITARY SPEC. TYPE	JAN-P-13 Type	NAVY 17-P-5 TYPE	ARMY 71-484 TYPE	ASTM (D-709) TYPE	33 P-46 (AER) BUR. AERO-NAUTICS	FEDERAL SPEC. L-L-31 (FORMERLY HHP-256) TYPE	AAF SPEC. 12032
Paper Filler—Hard Phenolic Resin	X	MIL-P-6885 (Formerly AN-P-68)	I (Cross Laminated) II (Parallel Laminated)	M-1	PBM	I	I	—	I	X
Paper Filler—Plasticized Phenolic Resin	P	—	—	E-1	PBP	—	I-1	—	I	P
Paper Filler—Hard Phenolic Resin	XX	MIL-P-3115	PBG	E-2	PBG	I	I	—	I	XX
Paper Filler—Plasticized Phenolic Resin—For Hot Punching	XXP	—	—	E-3	—	—	I-2	—	I	XXP
Paper Filler—Hard Phenolic Resin	XXX	MIL-P-3115	PBE	E-4	PBE	I	I-4	—	I	XXX
Paper Filler—Plasticized Phenolic Resin—For Hot Punching	XXXP	MIL-P-3115	PBE-P	E-5	PBE-P	—	I-3	—	I	XXXP
Medium Weight Cotton Fabric Filler—Hard Phenolic Resin	C	MIL-P-15035	FBM	M-4	FBM	II	II	—	II	C
	CE	MIL-P-15035	FBG	EM-1	FBG	II	II-5	—	II	CE
Medium Weight Cotton Fabric Filler—Hard Phenolic Resin With Graphite Inclusion	—	—	—	—	—	—	—	CG	—	CG
Fine Weave Cotton Fabric Filler—Hard Phenolic Resin	L	MIL-P-15035	FBI	M-3	FBI	II	II	—	II	L
Fine Weave Cotton Fabric Filler—Hard Phenolic Resin With Graphite inclusion	LE	MIL-P-15035	FBE	EM-2	FBE	II	II-5	—	II	LE
Asbestos Paper Filler—Hard Phenolic Resin	A	MIL-P-8059(USAF)	A	H-1	PBH	—	III	—	III	A
Asbestos Paper Filler—Melamine Resin	—	—	—	A-1	AMG	—	—	—	—	—
Asbestos Fabric Filler—Hard Phenolic Resin	AA	MIL-P-8059(USAF)	AA	MH-1	FBH	—	III	—	III	AA
Staple Fibre Glass Cloth Filler—Melamine Resin	—	—	—	M-5	GBM GBH	—	IV	—	IV	—
Continuous Filament Glass Cloth Filler—Melamine Resin	G-5	MIL-P-15037	GMG	MG-1	GMG	—	IV	—	IV	G-5
Continuous Filament Glass Cloth Filler—Silicone Resin	G-7	MIL-P-997	GSG	—	GSG	—	IV	—	IV	G-7
Glass Mat Filler—Melamine Resin	G-8	MIL-P-17721(SHIPS)	GMM	—	—	—	IV	—	—	—
Nylon Fabric Filler—Phenolic Resin	N-1	MIL-P-15047	NPG	—	—	—	V	—	V	N-1
Chopped Medium Weight Cotton Fabric—Hard Phenolic Resin	—	MIL-P-14	CFI-20	—	—	—	—	—	—	—

**T**HE ACCOMPANYING charts list all government and military specifications applicable to the purchase of thermosetting laminated plastic sheets, tubes and rods. The charts were compiled to provide the electronic designer with a cross-reference of each of the National Electrical Manufacturers Association standard grades indexed to the various specifications under which it falls.

Thermosetting laminated plastic sheet stock is produced by impregnating or coating a filler material (various grades of paper, cotton, glass, nylon or asbestos fabric) and consolidating a predetermined number of layers under heat and high pressure. During this process, a chemical reaction occurs that permanently changes the structure of the resin from a fusible and soluble state to a point where it becomes virtually infusible and insoluble. The fact that they cannot be resoftened again by additional applications of heat differentiates "thermosetting" materials from "thermoplastic". Standard sheet size is 36" x 36", with thicknesses ranging from .005" up to and including 8". When bonded with a thin sheet of copper or aluminum, paper-base sheet stock becomes the most widely used base in printed circuits.

Tubing is produced by winding layers of impregnated material around a heated mandrel. The size of the mandrel establishes the ID of the tube, while the number of wraps determine the thickness. Diameters range from 3/32" ID up to 26" OD. Wall thicknesses vary from .0075" to 2". Tubes may be round, square, rectangular, or oval, and are universally used as insulators.

Rods are produced in the same manner as tubes, except that the mandrel seldom exceeds 1/4" diam. After winding, the mandrel is pulled and the tube is pressed in a mold to close up the center hole. Rods are used as mounting posts, spacers, etc.

The combined properties and proven versatility of thermosetting laminated plastics offer the electronic designer a material that is light in weight (about 1/2 that of aluminum), with excellent electrical properties and high mechanical strength. Thermosetting laminated plastics resist moisture, aging, corrosion, heat, and temperature deterioration. In addition, they are dimensionally stable and easily machined.

Grade selection is very important and is largely dependent upon the type of critical factor encountered. In certain applications surface resistivity may be the most important requirement; power factor, "Q" factor, or low moisture absorption may be more important in others. To this end, the grade possessing the desired quality in the greatest degree is chosen.

**DOW CORNING  
CORPORATION**

# Silicone News

FOR DESIGN ENGINEERS

## Silicone-Based Paint Withstands Up To 1000 F On Oven Interiors

Especially adapted to preheating and stress relief of small parts, the new Grieve-Hendry cabinet drawer electric oven has a capacity of 850 F. It is so well designed that any one of the 24 drawers may be opened without lowering the temperature of the remaining drawers.

The service life of the oven is increased by finishing the interior of each drawer with a silicone-based aluminum paint formulated by Midland Industrial Finishes of Waukegan, Illinois. Grieve-Hendry has been applying this silicone finish to the interiors of all their oil, gas and electric ovens for over 3 years. Easily applied by spraying to form a smooth and uniform coating, the silicone paint protects the metal surfaces against corrosion at surface temperatures up to 1000 F. **No. 15**



**New Pressure Sensitive Adhesives** that stick to almost any material remain serviceable and can be applied at temperatures from -67 to 480 F. Uses include bonding silicone treated electrical insulating materials, sealing and wrapping tapes and assembly of small electronic parts prior to mechanical installation. **No. 18**

## Pressure Cooker Gaskets of Silastic Last Longer, Reduce Clean-up Time

The new pressure cooker made by the Hamilton Copper & Brass Works of Cincinnati, features a steam jacket that heats the entire inner bowl. Designed for internal kettle pressures up to 15 psi and steam pressures up to 90 psi, the cookers are sealed with a Silastic\* gasket fabricated by Garlock Packing Company.



## SILICONE INSULATED WOVEN HEATERS PROVIDE MORE EFFICIENT METHOD OF CONTACT HEATING

Woven contact heaters, once reserved exclusively for the military, are now being offered for a variety of industrial applications. One of these is a 5 gallon drum heater developed by the Pre-Fab Heater Company, Inc., of Guildford, Conn. Designed to melt drums of plastisol, this lightweight heater brings the contents of the drum to temperatures in the range of 110 to 500 F with maximum speed and uniformity. Safe and convenient, the heater snaps in place around the drum and plugs into any 115 volt outlet.

Contact heaters of this type were originally developed to keep high altitude aerial cameras and control mechanisms operable at sub-zero temperatures. Lighter, less bulky and more flexible than conventional heating pads, the heaters are custom woven to fit the part. Some of the dozens of configurations and patterns developed for military use are shown above. These heaters, operating in the far infra-red range at high efficiencies, carry current-densities

of 15 watts per square foot to 15 watts per square inch.

The wires in the heaters designed to meet military specifications, are served with glass yarn impregnated with Dow Corning silicone electrical insulating varnishes to assure long and reliable performance at temperatures in the range of 500 F. The silicone-glass combination eliminates electrical breakdowns caused by sudden and extreme changes in ambient temperatures. It withstands heavy thermal shock without loss of electrical properties.

Another feature of importance to designers is that only slight consideration must be given the heater when designing parts or products requiring this protection. The thin structures are easily tailored to meet specific needs. **No. 16**

### Design Edition 4

**DOW CORNING CORPORATION - Dept. DA-24**  
Midland, Michigan

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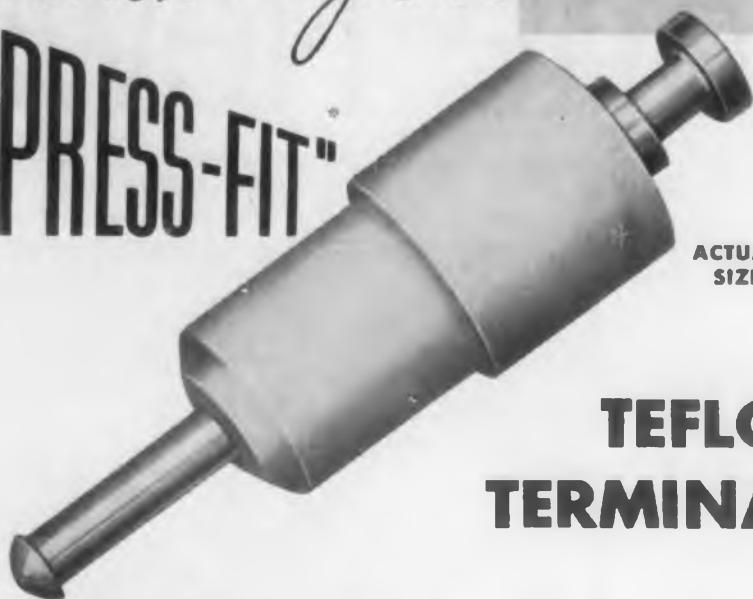
CIRCLE ED-37 ON READER-SERVICE CARD FOR MORE INFORMATION



there's only one

"PRESS-FIT"

ORIGINAL



ACTUAL  
SIZE



## TEFLON TERMINAL!

Sealectro has pioneered the use of Teflon\*\* in its "Press-Fit" stand-off and feed-thru terminals. And the "Press-Fit" technic of simplified mounting reflects years of specialized engineering in closest collaboration with designers and assemblers who want the very best. Such "know-how" is available to you, through Sealectro.

Here, briefly, is why Sealectro "Press-Fit" Teflon terminals are so popular in so many fine assemblies:



"Press-Fit" Teflon terminals press-fit into chassis holes by means of inexpensive insertion tool. Teflon seals terminal firmly and permanently in place.



Stand-offs, feed-thrus, connectors and other "Press-Fit" Teflon pieces available in wide variety of standard and special types. Also sub-miniature types used in most compact assemblies.

### INSULATION

Typical electrical characteristics: Dielectric Strength, 400 to 500 V/mil. Volume Resistivity, ohm-cm., less than  $10^{15}$ . Surface Resistivity, 100% R.H.,  $3.6 \times 10^4$ . Dielectric Constant, 60 cycles, greater than 0.0005;  $10^6$  cycles, greater than 0.0005. Excellent Temperature Stability of dielectric properties. Non-adhesive Surface. No Shelf Deterioration. Etc.

### IMMUNITY

Unaffected by widest range of climatic conditions. Immune to chemicals and salts. Unaffected by corrosive atmospheres or fungus. Zero water absorption. Will not melt, burn, char. No breakage or damage from vibration, mechanical shock, rough handling. No acute strain point as with fused glass and metal seals with different thermal expansion rates. Resists collection of dust and dirt to non-adhesive surface, prolonging use of maximum terminal ratings.

### MINIATURIZATION

Teflon's superior insulating properties enable quick and easy miniaturization. Minimum material for maximum insulation. Replaces glass and ceramics.

### ASSEMBLY

"Press-Fit" means pressing insulator into chassis hole, with inexpensive Sealectro insertion tool. No hardware needed such as nuts, washers, screw-threads, glands, gaskets. Precision-machined insulator press-fits into chassis hole for immediate yet permanent mounting. Withstands 10 lbs. pull test.

### — AND ECONOMICAL!

"Press-Fit" eliminates usual mounting hardware. Big saving in materials. Likewise in labor. Overall cost compares favorably with ordinary terminals.

*Write*

for sample and literature, on your company stationery. Let us collaborate on your insulated terminal requirements and problems.

\*Pat. Pending.

\*\*Reg. Trade-mark of E. I. Du Pont de Nemours & Co.



# Sealectro

CORPORATION

Manufacturers of "PRESS-FIT" TERMINALS

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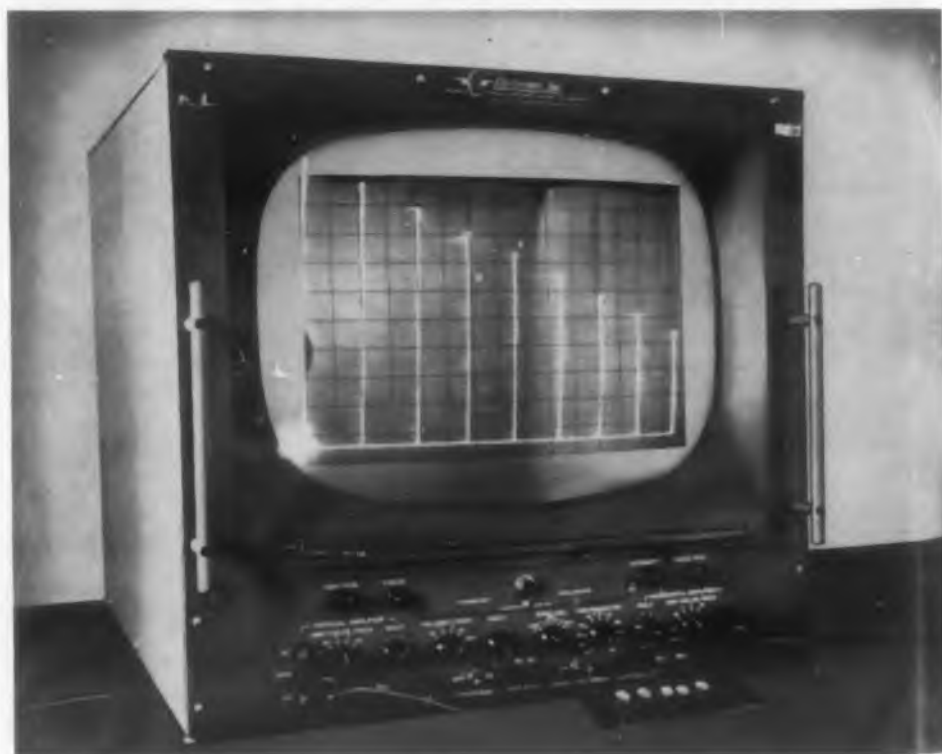
CIRCLE ED-23 ON READER-SERVICE CARD FOR MORE INFORMATION

# Large-Screen Oscilloscopes

**B**Y DISPLAYING various forms of data on the Large-Screen Oscilloscopes shown on these pages, greater accuracy in waveform analysis and other techniques useful in circuit design can be achieved. Available with a 21" rectangular cathode-ray tube in a cabinet or with a 17" tube for rack mounting, these instruments feature high resolution, an overall linearity of  $\pm 2\%$ , and 2:1 sweep magnification. In addition to their many uses in circuit design, these scopes could be incorporated in telemetering systems or computers for the display of data. Highly stable d-c amplifiers with feedback are incorporated in the design.

Manufactured by Electromec, Inc., 3200 N. San Fernando Blvd., Burbank, Calif., the oscilloscopes have a maximum trigger frequency of 250kc. The tubes are magnetically deflected and can be

This display of transistor characteristics is typical of the uses to which a Large-Screen Oscilloscope can be put. The transistor is a Hydro-Aire JP-1.

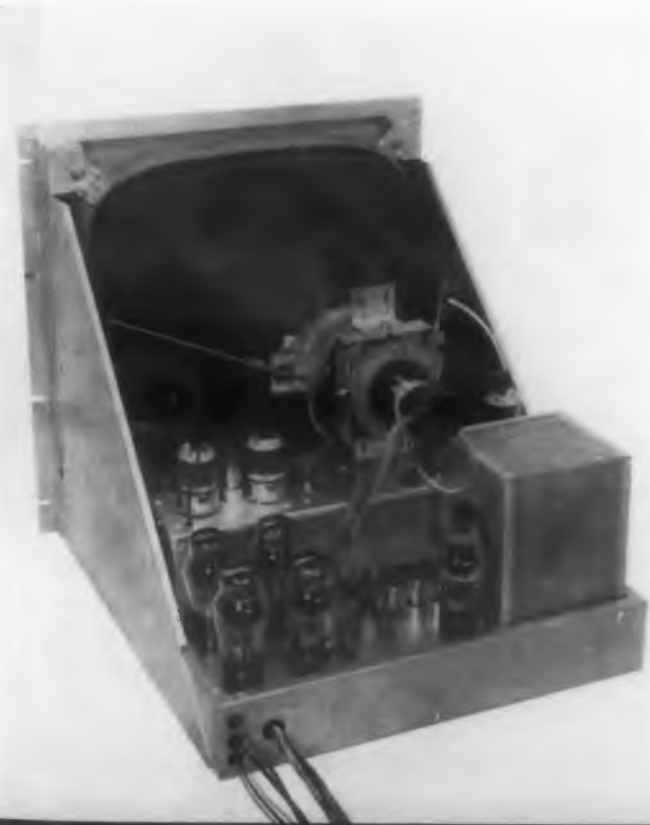


The construction of the 17" type oscilloscope is similar to that of TV receivers, but with greater shielding.

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furnished with a variety of phosphors. Input impedance is 2 megohms shunted with 200mmfd. Calibration accuracy is better than  $\pm 4\%$  from 10 to 100microsec/inch, and better than  $\pm 2\%$  100microsec/inch to 1sec/inch.

The 2100 Series 21" units are 24-1/2" wide x 22-1/2" high x 26-1/2" deep and weigh about 125lb. The 1700 Series 17" types are 19" wide x 19-1/4" high x 22" deep and weigh about 110lb. The standard graticule is 15" wide x 10" high and is ruled in 1/10" divisions. A camera mounting attachment is available for use with both types. Performance is unaffected by line voltage changes from 105 to 125v. Variations on the standard models are available on specification. For more data on these useful laboratory instruments, turn to the Reader's Service Card and circle **ED-24**.



type  
 of TV  
 lding.  
 1954



IN HOT DIMPLING  
 HIGH STRESS METALS

**WESTON**  
*Sensitrol* RELAYS  
 CONTROL CRITICAL TEMPERATURES  
 DIRECT FROM  
 THERMOCOUPLE OUTPUT!



**Ultra-Sensitive SENSITROL Relays . . .**

- Operate directly on values low as 1/2 micro-ampere or 1/4 millivolt.
- Handle substantial wattage at 110 volts on non-chattering magnetic contacts.
- Eliminate need for amplifiers and auxiliary power supplies.
- Available with single or double contacts, fixed or adjustable, manual or solenoid set.

Hot dimpling of high stress materials for flush riveting used in today's airframes requires unflinching control of sheet temperatures within very close limits. Over temperatures might cause annealing and loss of strength, and under temperatures, inter-granular disorder and cracking.

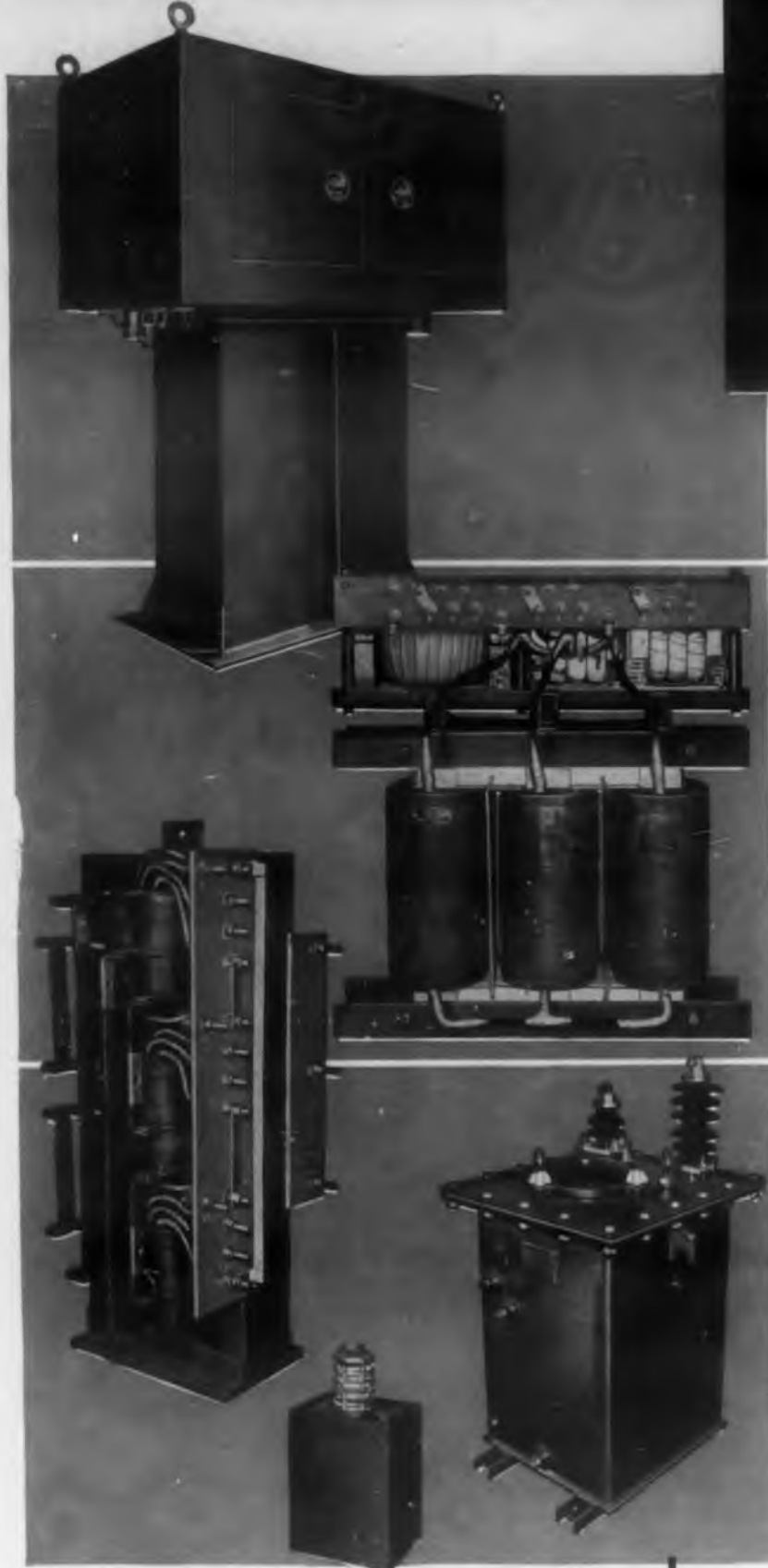
To assure this precise and dependable control, Aircraft Tools, Inc. employ Sensitrol Relays in the Hot Dimpling Press illustrated, as well as in their portable dimpling tools. Operating directly from thermocouple output, these relays render the equipment inoperative should temperatures drop below a specified limit during dimpling; and also are used in the thermocouple break-circuit to prevent heater burn-out in case of thermocouple failure.

This is another instance where Sensitrol Relays have been adopted because they provide a positive means of control direct from feeble input signals . . . without any amplification. Some of their outstanding features are listed at the left. The complete story, in bulletin form, is available on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey. 8098

**WESTON**  
*Instruments*

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**R**EADING to three places, the "Microdial" is a direct-reading, digital-indicating dial for manual or mechanically driven multi-turn devices. Designed for use with this firm's 10-turn potentiometers, the dial has no stops and indicates from 0 to 999 then returning to 0. The unit is furnished with or without a brake. The brake lever and control knob can be operated with one hand.

There are three molded Nylon indicating wheels in the dial. The "unit" wheel adds or subtracts one count for each complete revolution of the

The little knob on the edge of the "Microdial" applies the brake.



control knob and shaft. The second wheel adds or subtracts ten counts for each revolution, and the third wheel adds or subtracts ten counts for each tenth revolution. In standard models the "turns" and "tenths" wheels will have white numbers on a black background. The "hundredths" wheel black on white. This makes the dial readily applicable as a percentage marker, indicating increments of 0.1%. The "Microdial" is manufactured by Borg Equipment Div., George W. Borg Corp., 120 S. Main St., Janesville, Wis.

The recommended maximum speed of operation is 10,000 counts/min or 100rpm of the shaft. The dust-sealed dial has a 1-3/4" diam x 1-5/8" high. The letters, read through a glass window, are 3/16" high. The shaft is 1/4" diam. The three-point brake is applied with light pressure for holding settings. For more data on this easily read dial, turn to the Reader's Service Card and circle **ED-21**.

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This simple experimental computer shows how the dials are employed.

These improved Sylvania tubes are manufactured and quality controlled for highest dependability. Now for the first time they enable circuit engineers to meet precisely the ever-widening range of today's application requirements.

**5675** a low Mu tube for CW operation to 3000 cycles as an amplifier, oscillator, or frequency multiplier in either lumped, constant, or external cavity-type circuits. Delivers 300 mw average power at 1700 megacycles.

**5794** designed for continuous wave operation, this tube oscillates inside a cavity tuned to a fixed frequency of 1680 megacycles. This low Mu tube with its special heater at 5.2 volts is capable of delivering a power of 300 milliwatts.

**5876** is a high Mu triode designed for continuous wave operation up to 3000 megacycles in either lumped, constant, or external cavity-type circuits.

**5893** for pulse operation to 3400 megacycles. Will deliver .750 KW peak minimum at maximum frequency with .001 duty cycle.

**6263** a low Mu high power tube for application as an amplifier, oscillator to 1700 megacycles. Plate input power is 22 watts and plate dissipation is 13 watts.

**6264** a medium Mu frequency multiplier version of the 6263 with the same plate characteristics.

The attached coupon brings you full engineering data and characteristics of Sylvania's complete pencil tube line.

*"Another reason why it pays to specify Sylvania."*

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CIRCLE ED-22 ON READER-SERVICE CARD FOR MORE INFORMATION

# Index of 1954 Articles

## January

Empirical Techniques for Microwave Component Design, by S. Levine (p 12) *Practical approach to microwave component design using the empirical design of a broadband coaxial-to-waveguide transition or adaptor as an example.*

A New Beam Switching Tube (p 14) *This tube has a beam that can be switched in 10 discrete automatically locked positions consecutively or at random (Burroughs Electronic Instruments Div.).*

High Current D-C Supply Design, by F. A. MacPherson (p 16) *Design procedure for a single-phase full wave rectifier supply that has a high current output. Table of rectifier circuit constants is included.*

Miniature Electrostatic Generator (p 18) *Compact unit provides high voltage for radiation survey instruments. Rotor and stator elements are made by printed circuit techniques.*

Space Saving Panel Meters (p 20) *These tiny rectangular units require a panel space of only 1.687" x 0.531" and can be mounted side by side or back to back (International Instruments, Inc.).*

Coaxial Galvanometer Mechanism (p 22) *Small in size and weight, this D'Arsonval movement uses a coaxial construction to achieve ruggedness and high accuracy (Marion Electrical Instrument Co.).*

Portable Plastic Drawing Board (p 24) *This 9-3/4" x 12-1/4" board weighs 8 oz and fits into a briefcase. Comes with two 8" triangles (Graphostat Co.).*

New Permanent Magnet Alloy (p 25) *Known as "Alnico 5Cb" this alloy has an energy product of 5.70 x 10<sup>6</sup> Bd Hd (Thomas & Skinner Steel Products Co. Inc.).*

## February

Null Detection, by R. Rothschild (p 18) *The fundamental frequency and its harmonics of a complex wave as well as noise and pickup are shown to be basic factors that influence accurate detection of a null voltage. A null meter that overcomes these limitations is described.*

A Sensitive Nonmagnetic Relay (p 20) *This unit employs an electrostrictive capacitive element which requires 0.5 mw-sec of operating power at 150-v d-c to close the contacts and less than 0.1 mw to hold them closed (Mullenbach Electrical Mfg. Co.).*

Relay & Switch Contact Protector (p 22) *This arrangement of selenium rectifier cells prevents arcing at switch and relay contact points. It has negligible effect on circuit operation and can be used in a-c and d-c circuits (Federal Telephone & Radio Co.).*

Universal Measuring Test Set (p 24) *Four separate instruments in one case, this unit provides over 200 measuring ranges (Sensitive Research Instrument Corp.).*

Silicon Junction Diodes (p 26) *Definite Zener voltage values, operation at temperatures to +100°C, and good stability are features of these p-n silicon units (National Semiconductor Products Div.).*

A Precision A-C Volt-Ammeter (p 28) *This precision a-c multi-range instrument can measure voltages from 5v to 300v and currents from 0.1 amp to 5 amp with an accuracy of 0.05% over a frequency range of 20cy to 20 kc (Charles Engelhard Inc.).*

A Metal Film Potentiometer (p 30) *This unit, known as the "FilmPot" provides infinite resolution, high wattage dissipation, and can operate at ambients from -55° to 225°C (Fairchild Camera & Instrument Corp.).*

Transistorized Microphone Preamplifier (p 32) *An early commercial application of transistors. This unit is a rugged magnetic variable reluctance microphone combined with a high gain transistor preamplifier (Remler Company, Ltd.).*

## March

Cutting Costs of Chassis and Enclosures, by D. S. Karp (p 12) *Factors affecting the cost of producing sheet metal chassis & enclosures. Tables are included to guide designers in making chassis layouts.*

True G<sub>m</sub> Analyzer (p 14) *By means of a new circuit design in this instrument, transconductance can be measured independently of all other tube parameters (Weston Electrical Instrument Corp.).*

Compact Computer Design (p 16) *Outstanding design features of a desk top computer. (Reeves Instrument Corp.).*

Compact High Voltage Power Supply (p 18) *This circuit weighs 2 lb, measures 5-1/2" x 4" x 2-5/8", and has an output of 5000v d-c at 300µamp (Servo Corp. of America).*

Transparent Drawing Instrument (p 20) *This design drawing aid can be used as a triangle, T-square, straight edge, scale, and protractor (Smith Drake Corp.).*

Typical Application of TV Receiver Tubes, by H. J. Shulman (p 22) *A tabulation by function and popularity of the tubes used in 26 TV receivers (1954 models) of 22 manufacturers.*

Picture Tube For Color TV (p 24) *Description of the "Colortron", a 15" color TV picture tube (CBS-Hytron).*

Tandem Mounted Potentiometers (p 26) *Up to 18 of these precision potentiometers can be mounted on a single shaft to form a compact plug-in assembly (Clarostat Mfg. Co., Inc.).*

## April

Circuit Design with Controllable Inductors, by A. L. Kaufman (p 12) *Design considerations in applying the "Increductor" controllable inductor. Use of the "Q map", a special type of nomograph is explained.*

Low-Distortion Magnetic Modulator (p 14) *This unit converts low level d-c signals into proportional a-c signals and can operate as a biased or unbiased modulator (Lear, Inc.).*

Panel-Mounted VTVM (p 16) *A miniaturized vacuum tube voltmeter that occupies the same panel space as a 3-1/2" meter. (Trio Laboratories).*

Printed Circuit Connectors (p 18) *Rectangular miniature and subminiature connectors especially suited for printed circuits (Circon Component Co.).*

Color TV Receiver Tubes (p 20) *Five tubes specifically designed for color TV receivers (Radio Corp. of America).*

Ruggedized Contact Meter Relays (p 22) *Using a D'Arsonval meter movement, these units can be used for a wide variety of control functions (Assembly Products, Inc.).*

R vs T of Resistance Materials, by R. G. Lindstrom (p 24) *A chart which simplifies selection of resistance materials for applications operating over wide temperature ranges.*

Small Electric Brakes and Clutches (p 26) *With special controls, these compact, powerful units can be made to have a response time in the order of milliseconds (Warner Brake & Clutch Co.).*

High Capacity Ceramic Capacitors (p 28) *These units have a high capacity for a given size and they retain their properties to 1000Mc and above (Aerovox Corp.).*

Dynamically Compensated D-C Power Supply (p 29) *By means of a special load compensation control in these units the user can set the regulated supply voltage to increase or decrease slightly with load, or remain completely constant (Millivac Instrument Corp.).*

Thin Gage Metals in Electronics, by H. Schwartz (p 30) *Facts about thin gage metals which can guide electronic designers towards many cost-saving uses. Includes tables of properties, uses, and tolerances.*

Plug-In Diode Units (p 32) *Three sizes of plug-in units accommodate 8, 12 or 16 diodes for such applications as computers and mixers (Electronic Engineering Co. of California).*

High Drain Alkaline Batteries (p 34) *Underwater ordnance, guided missiles, portable gear, and aircraft electronic equipment are some applications that can use these batteries, available with up to 100 amp-hr capacities (Yardney Electric Corp.).*

Printed Circuit High Pass Filters (p 35) *Interference occurring at 54Mc is suppressed by this printed circuit filter which is intended for incorporation into TV receiver set designs (Photocircuits Corp.).*

## May

Circuit Breaker Considerations, by R. S. Kurtz (p 14)  *ratings, inrush characteristics, temperature and frequency considerations, and circuitry are covered in this review of circuit breaker application problems.*

A New Indicator Tube (p 16) *Any number from 0 to 9 can be made to appear on this tube which has a seated height of 2". (National Union Radio Corp.).*

Vertical Chassis TV Receiver (p 18) *By making the chassis vertical and mounting it on a plywood baseboard all the tubes and parts are made easily accessible for service.*

Miniature Sealed-Contact Relays (p 20) *Ingenious units in which the combination motor-contact element consists of two rods placed in the center of a coil. When the coil is engaged, the magnetic alloy rods are brought together to close the circuit (G. M. Giannini & Co. Inc.).*

Miniature Servo Amplifier (p 22) *Fluid filled and hermetically sealed, this plug-in circuit is designed for analog-computer servo loop applications (Servomechanisms, Inc.).*

Circuit Design with Controllable Inductors—II by A. L. Kaufman (p 24) *Nine different circuit applications for controllable inductors are presented and explained.*

3-D Printed Circuits (p 26) *Using one-inch-square panels known as "Reliaplates" carrying certain conventional or printed components a third dimension can be added to printed circuits to effect considerable space saving (Sanders Associates, Inc.).*

A Versatile Patchcord System (p 28) *Simplified design and operation, ease of installation, and the use of solderless "Taper Terminals" are features of this patchcord system which has a removable program board (Aircraft-Marine Products, Inc.).*

## June

Evaluating Tube-Clamping Shields, by L. Woods (p 14) *Factors in selecting tube shields, a new tube clamp, and a special method for determining tube envelope temperature are discussed.*

Traveling-Wave Tube Amplifier (p 16) *This unit provides broadband high-gain amplification between 2kMc and 4kMc (Huggins Laboratories, Inc.).*

Meter-Type Sensitive Relay (p 18) *This little relay operates directly from thermocouples or photocells and can take the place*

of a vacuum tube amplifier in a control circuit (Thomas A. Edison, Inc.).

Plug-In Shift Register (p 20) Only one shift pulse per bit of information stored is required by this unit, which can operate at frequencies from 0 to 100kc (Raytheon Mfg. Co.).

Decade Delay Line (p 22) These lines facilitate delay specification at the development stage of instrumentation systems, pulse forming networks, etc. (ESC Corp.).

Cartridge-Mounted Thermistor (p 24) The cartridge that holds this thermistor can be inserted into all types of crystal detectors and probes (Narda Corp.).

C vs T For Capacitors, by R. G. Lindstrom (p 26) A chart which shows percent change in capacity vs temperature change for common capacitor insulation materials.

Step-Function Potentiometer (p 28) The entire voltage output of this potentiometer is obtained over a shaft rotation of 3°, making it useful for analog to digital information conversion, torque amplification, and transducer applications (Computer Instrument Co.).

Modular Mounting Units (p 30) A glass bonded mica base plate with a molded-in tube socket, a similar top plate with a hole, and two steel spacers comprise this compact mounting unit. Resistors and capacitors are carried vertically between the plates (Myceler Corp.).

Airborne Computer Amplifier, by S. Frangoulis (p 32) The clever packaging of this amplifier resulted in a light weight, compact unit which is easily serviced and can withstand extremes of temperatures, altitude, vibration, and shock.

#### July

Choosing Wire Insulation for High Temperatures, by J. Holland (p 14) A designer's guide which includes a valuable comparison table of five high temperature materials.

Hermetically Sealed Thermostats (p 16) The enclosure of this thermostat is the thermally responsive element, making for a rugged, fast response unit (G-V Controls, Inc.).

Multi-Channel Amplifier Test System (p 18) A neatly designed system that affords great flexibility for the user, permitting remote operation (Heiland Research Corp.).

Transistor Data Chart (p 20) Complete tabulation of all commercially available transistors, their important characteristics, and sources. One hundred and thirty two types are covered.

Plug In Transistor Circuits (p 22) Mounted in a standard 9-pin base, these units include an audio amplifier, cathode follower, two pulse generators, and a sine wave oscillator (Lee Laboratories).

High-Output Crystal Photocell (p 24) This unit has a sensitivity of 100µamp at 100v and 2 foot candles. Four typical application circuits are included (Clairer Corp.).

Voltage Sensitive Capacitors (p 26) Up to 70% change in capacitance can be obtained by varying the voltage applied to these units. 3 application circuits included (Mucon Corp.).

Single-Gun Color TV Picture Tube (p 28) A rectangular color TV picture tube known as the "Chromatron" which uses only one gun instead of the usual three (Chromatic Television Laboratories, Inc.).

Laboratory Phase Comparator, by S. Feinstein (p 30) A simple, easily constructed test unit which affords rapid, accurate measurement of phase differences.

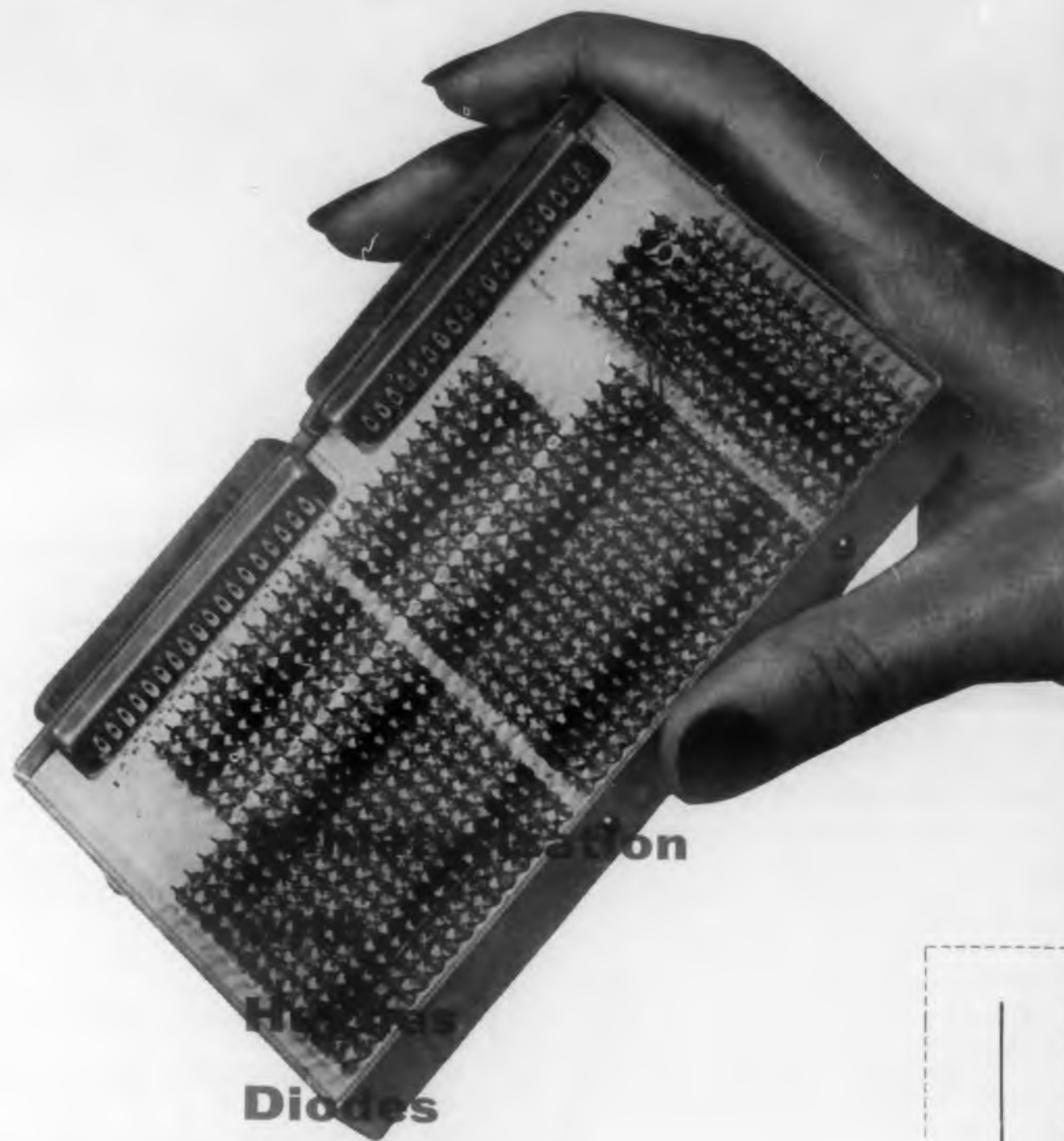
Accurate Voltmeter (p 32) This unit is a nulling voltmeter that can be used to measure extremely low d-c voltages with an accuracy of 0.01% (Computer Co. of America).

#### August

Three-Dimensional Displays on Cathode Ray Oscilloscopes, by S. Meyers, C. Laskin, D. Schachet (p 14) Four resolver synchros, a control box, and an oscilloscope are combined to provide a means of showing three parameters simultaneously on a C-R oscilloscope.

A New Power Supply Design, by C. H. Richards and W. A. Geohegan (p 16) A regulated, d-c supply that provides low voltage, high current output.

"Printed" Amplifier Subassembly (p 18) A compact 2-stage audio amplifier that can be incorporated into portable phonographs, intercom systems, etc., or it can be used by itself (Photocircuits Corp.).



## New computer matrix has high component density

This experimental reading gate matrix for airborne computers effectively utilizes the subminiature size of Hughes Point-Contact Germanium Diodes\*. Developed by the Miniaturization Group of Hughes Research and Development Laboratories, the unit measures 5¼ by 3⅞ by ½ inches (excluding plugs and frame). It contains 504 diodes, 209 resistors. Average component density: 94.5 per cubic inch!

Frequently, space requirements of conventional wiring techniques will not permit electronic equipment to be miniaturized to the same extent as the components. However, spot-welded connections can effectively reduce wiring space... and it is easy to spot-weld the dumet leads of Hughes diodes. There is no adverse effect on diode characteristics, even when the connections are welded close to the diode body. With Hughes

diodes, designers can take full advantage of advanced packaging and wiring techniques.

Hughes diodes are easy to mount in conventional assemblies or in subminiature equipment. In service, these diodes have earned a reputation for reliable performance and stability under severe operating conditions. Make your selection from the many standard and special types available — all listed and described in our new Bulletin, SP-2A.

\*Actual size, diode body: 0.265 by 0.130 inches, maximum.

Reprints of a paper describing the packaging techniques of the subminiature matrix are available, too. Your copy will be sent promptly on request.

# Hughes

SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif.



New York Chicago

CIRCLE ED-42 ON READER-SERVICE CARD FOR MORE INFORMATION



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Mission-Western Engineers offer an unusually wide range of basic miniature motor designs. We have available more than fifty basic types, including axial and centrifugal blower designs to cover the great variety of equipment adaptations. Our basic motor designs range from .001 to 2 H.P., from 50 to 1,000 cycles in frequency and in any voltage range required. Complete motor design service available. For further information or a copy of our motor catalog #254, write Mission-Western Engineers, Inc.,\* 132 West Colorado Street, Pasadena 1, California.

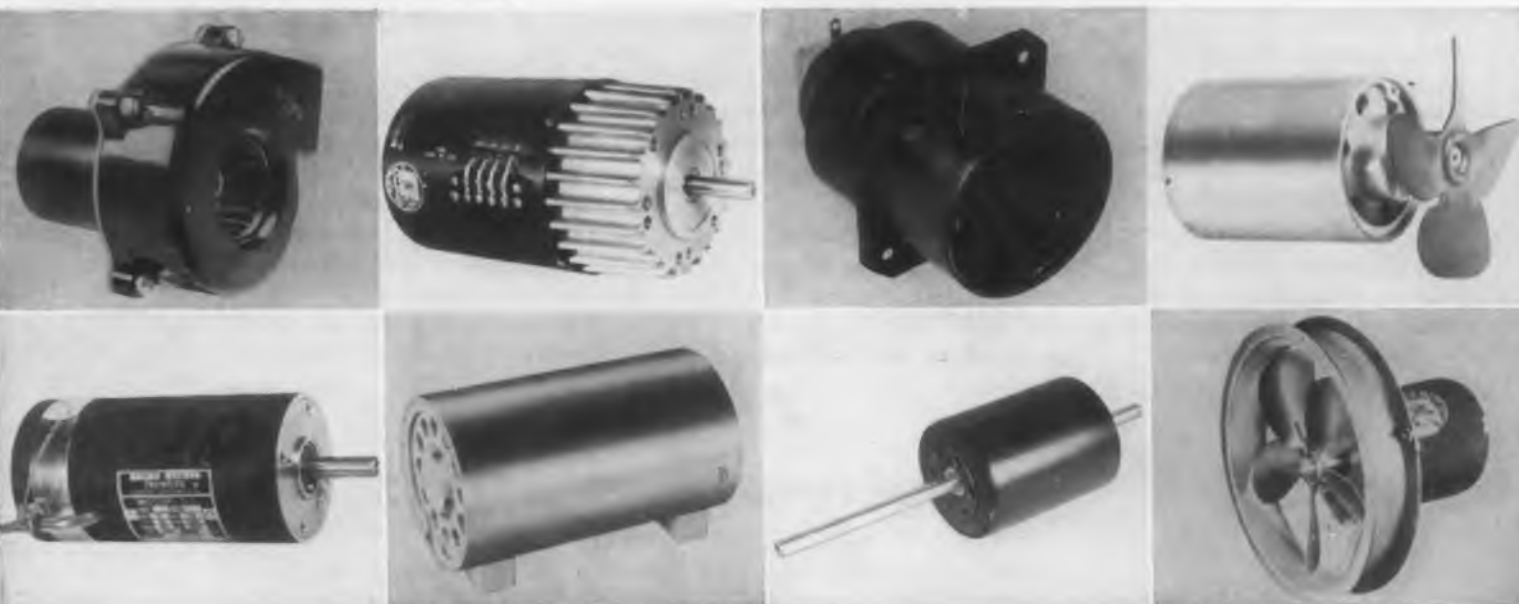
\*An affiliate of Western Gear Works, since 1888 a leader in the mechanical power transmission field.

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from 200 to 6 Diametral Pitch and dimensions from .125" to 10" diameter. Western Gear Works makes available complete engineering and manufacturing facilities for the application of high precision gearing and gear drives in electronics equipment. For assistance, without obligation, write Executive Offices, Western Gear Works, P.O. Box 182, Lynwood, Calif.

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CIRCLE ED-26 ON READER-SERVICE CARD FOR MORE INFORMATION

Network Design Board (p 20) A wide variety of RC circuits can be set up on this unit for rapid design evaluation (Instrument Research Co.).

Extended-Range Oscillator (p 22) The range from 0.9cy to 510kc is covered by this unit, which is especially useful in servo-mechanism and computer design (Waveforms, Inc.).

Transistor Curve Analyser (p 24) This unit can determine the equivalent circuit parameters of a transistor from characteristic curves, plate resistance of a triode at a chosen operating point, and forward and reverse resistances of semiconductor diodes (Electronic Engineering Co.).

"Bobbinless" Precision Resistors (p 26) These highly stable resistors are produced by a special winding technique that eliminates the usual bobbin (Monson Mfg. Corp.).

"Unitized" Audio Amplifiers (p 28) A new trend in audio design is noted wherein the preamplifier, tone controls, power amplifier, and power supply are combined into a single flat cabinet about 4" high.

Connector Cables for High Potentials (p 30) These integrally molded cables save space and eliminate the problems of strain relief, insulation pull back, and high voltage arc-over at wire holes (Alden Products Co.).

Standard Etched-Wiring Circuit Boards (p 32) These are prewired (etched copper conductors) boards which accommodate more than 72 common tube types as well as power supply filter circuits (Tri-Dex Electronics Co.).

**September**

Printed Circuit Design: 1—Basic Design Factors, by G. Maisch (p 16) The electronic designer can decide whether or not to use printed circuits in a particular application on the basis of these factors. Includes tables of foil current-carrying capacity.

Easily Installed Controls (p 20) These inexpensive controls are installed without tools (Centralab Div., Globe-Union, Inc.).

High-Output Subminiature Diodes (p 22) Five application circuits are included in this feature on goldbonded diodes (Transitron Electronic Corp.).

Measurement of Cable-to-Rigid Line VSWR, by A. B. Giordano (p 24) Two of the four methods of making this measurement are discussed. Examples are given.

Miniature Servomechanism Components (p 28) Accuracy is not sacrificed in the design of these 3/4" diam components (Kearfott Co.).

Universal Circuit Breadboard Chassis (p 30) Circuit design and prototype construction is simplified by use of these chassis (Allen B. Du Mont Laboratories, Inc.).

Relay Klystrons (p 34) A line of inexpensive klystrons for the 6 to 8kMc band (Varian Associates).

Precision Attenuator (p 36) This rugged attenuator is designed for the 25-35Mc range (Airborne Instruments Laboratory, Inc.).

Mechanized Production of Printed-Wire Subassemblies (p 32) The manufacture of these compact subassemblies is illustrated step-by-step. Standard components are utilized.

Mobile "Master" Computer (p 38) The possible ramifications of the National Bureau of Standards' DYSEAC computer are discussed in this "Design Forum" article.

**October**

Choosing Wire Sizes for High Temperatures, by J. Holland (p 18) Graphs for choosing wire size for wiring in both continuous and pulse service at high temperatures are given with actual examples that illustrate their use.

Miniature Time-Delay Relay (p 22) An inexpensive, miniature time-delay relay, which can be specified with delays from 2 to 120sec (Belltron Mfg. Co.).

Diode Amplifiers (p 24) The use of commercial diodes as amplifiers is explained in this article, which includes 7 circuits.

Servomechanism Prototype Components (p 26) Designing servo-mechanism systems is simplified by use of these components, which include a universal base plate (Link Aviation, Inc.).

CRO Dual-Trace Switch (p 28) A high switching rate is the outstanding characteristic of this dual trace switch (Teletronics Laboratory, Inc.).

Subjective Design, by J. W. Dunlap (p 30) A proposal that electronic equipment be designed to the consumer's subjective



standards rather than engineering standards is put forth in this "Ideas for Design" article.

Color TV Delay Assembly (p 32) *The TV receiver circuit utilizing this inexpensive, custom-made delay line assembly is included (General Electric Co.).*

Printed Circuit Design: II—From Circuit Diagram to Printed Wire Pattern, by G. Maisch (p 34) *All the steps in the translation of a circuit diagram into the "master drawing" are discussed and illustrated in this unique design article.*

Audio Power Pentodes (p 38) *Two pentodes for audio amplifiers afford a higher output than the tubes they are designed to replace (Ampere Electronic Corp.).*

#### November

Design of Optimum Horns for Rectangular Waveguide, by H. E. Schrank (p 18) *Since a true pyramidal horn cannot be directly mounted on rectangular waveguide, this article provides a means of designing an optimum horn with the proper rectangular proportions.*

Attenuation Constant Measurement with a Lossy Variable Short Circuit, by H. M. Altschuler (p 22) *Two methods of measuring this constant at microwave frequencies are described in this book abstract.*

Tube Socket Test Adapters (p 24) *Components can be temporarily inserted in a circuit without soldering by means of these three adapters (A. L. Products, Inc.).*

Technical Problems Affecting National Defense (p 26) *Needed components, electronic gear and instruments, materials, and methods are described in this list prepared by National Inventors Council.*

Precision Synchro Element (p 28) *A highly accurate resolver known as the "Inductosyne" with printed rotors and stators is described (Farrand Optical Co., Inc.).*

Metal-Film Precision Resistors (p 30) *These precision resistors have the resistive element deposited on the inside surface of a hermetically sealed glass tube (Daven Co.).*

Transistorized Testing Oscillator (p 32) *This portable audio oscillator for testing purposes uses a transistor circuit for long battery life (General Radio Co.).*

A Miniature Tape Recorder (p 34) *The design considerations in the development of a miniature tape recorder are discussed in this well-illustrated "Design Forum" article (Broadcast Equipment Specialties Co.).*

Printed Circuit Design: III—Choosing Components for Printed Circuits, by G. Maisch (p 36) *A list of components specifically designed for printed circuits and a nomograph for designing printed inductors are included in this article.*

Resistors for Printed Circuits (p 40) *Designed for automatic insertion in printed circuits, these precision wire-wound units have an indexing key on one side (Cinema Engineering Co.).*

#### December

Temperature Compensating a Meter Rectifier, by F. L. Pagano (p 16) *A method of compensating copper-oxide meter rectifiers with resistors of the proper temperature coefficients.*

Miniature Transistor Radio (p 20) *The four-transistor circuit of the first commercial transistor radio is included.*

Low Cost Precision Potentiometers (p 22) *Simplified design accounts for the low cost of these potentiometers, which are made in eight sizes and are gangable (General Radio Co.).*

Designing Transistor Audio Amplifiers, by R. F. Shea (p 24) *Five useful circuits are proposed and analysed.*

Printed Circuit Design: IV—Base Materials for Printed Circuits, by G. Maisch (p 28) *Selection factors and a comparative table of base materials are given.*

Frequency Standard (p 32) *Designed by the National Bureau of Standards, this 1Mc standard is highly stable.*

Specifications for Laminated Plastics, by Dr. N. A. Skow (p 34) *Lists file numbers of government specifications applying to NEMA grades of thermosetting laminate rods, tubes, and sheets plus a discussion of their manufacture.*

Large-Screen Oscilloscopes (p 36) *Data analysis is implemented by these 17" and 21" scopes (Electromec, Inc.).*

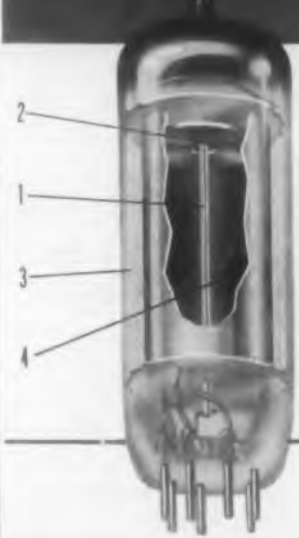
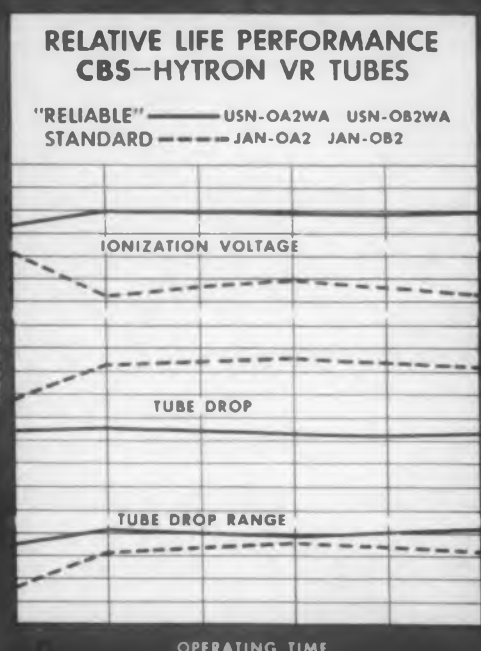
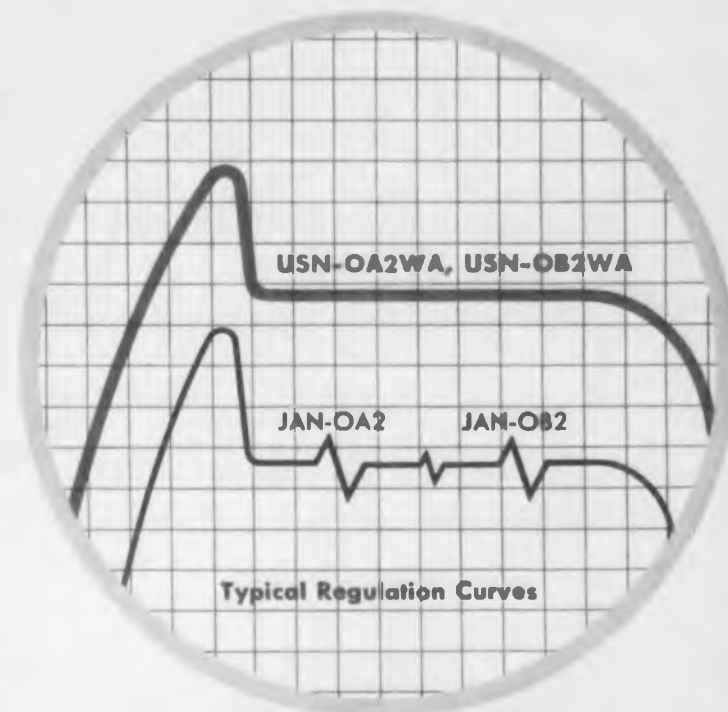
Digital-Indicating Dial (p 38) *The number of rotations of a multi-turn potentiometer is clearly indicated by this three-digit dial (Borg. Equip. Div., George W. Borg Corp.).*

## NOW...VR TUBES WITHOUT "PIPS"! ...for Stable Voltage Reference

### NEW "RELIABLE"...DUAL-PURPOSE CBS-HYTRON USN-OA2WA USN-OB2WA\*

CBS-Hytron, the leader in VR tubes, has solved the "unsolvable" VR-tube problem. Has taken those annoying "pips" (sudden discrete voltage shifts) out of two new CBS-Hytron VR developments: The dual-purpose USN-OA2WA and USN-OB2WA. Both are superior, "reliable" voltage regulators. Both also achieve stable voltage-reference performance.

These new tubes are directly interchangeable with the JAN-OA2 and JAN-OB2. But they are manufactured and tested to new, more rigid U. S. N. Bureau of Ships specifications. USN-OA2WA and USN-OB2WA are designed for dependability under severe environmental conditions... and for a wide range of applications. Improved construction and tight quality control offer many advantages. Check features, curves, and construction of these versatile tubes.



#### IMPROVED CONSTRUCTION USN-OB2WA

Note these improvements: 1. New, simplified aluminum-rod anode. 2. New disc-type starting electrode, to minimize gap-spacing variations and give more uniform starting voltage. (In USN-OA2WA, this electrode is located at bottom of mount assembly.) 3. New gas fill with neon body and low argon content. 4. New composite nickel-aluminum cathode work surface. Improvements 3 and 4 make possible operation at 150°C... and stable voltage-reference applications.



#### CHECK THESE FEATURES

1. Flat, smooth voltage-current characteristic.
2. Greatly improved voltage repeatability.
3. Stable electrical characteristics.
4. Tested under severe conditions of shock, vibration, temperature, and altitude.

FREE DATA for both USN-OA2WA and USN-OB2WA. Write for Bulletin E-235.

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CIRCLE ED-28 ON READER-SERVICE CARD FOR MORE INFORMATION

# New Products . . .

## Pulse Transformers For Printed Circuitry



The Type GEM series of miniature plug-in pulse transformers is available in the pulse width range of  $0.05\mu\text{sec}$  to  $2\mu\text{sec}$ , with two or three windings.

The transformers are epoxy resin impregnated and molded. Operating temperature range is from  $-70^\circ$  to  $+135^\circ\text{C}$ , and they surpass MIL-T-27, grade 1, class A test specifications.

Size is  $5/8''$  diam x  $9/16''$  high. Weight is approximately 5gr. Terminals are No. 22 AWG copper wire (maximum length  $7/16''$ ). Hi-pot test is 2000v. Gude-man Co. of California, Inc., Dept. ED, 9200 Exposition Blvd., Los Angeles 34, Calif.

CIRCLE ED-45 ON READER-SERVICE CARD FOR MORE INFORMATION

## Xenon Thyatron For High Altitudes



The 6478 Xenon Thyatron meets exacting electrical and mechanical requirements for reliable airborne operation at high altitudes. Its small size and flexible anode lead make the tube ideal for applications where space is limited.

The 6478 has a maximum operating voltage of 1500v a-c; continuous anode current is 1.5amp, and the continuously recurring peak anode current is 20amp. Filament current is 7amp at 2.5v. The tube features a maximum deionization

time of 80sec. Ambient temperature limits are  $-75^\circ$  to  $+85^\circ\text{C}$ . Maximum cathode warm-up time is 15sec.

Hard glass construction makes the tube applicable to high-shock installations. Its maximum physical dimensions are  $4-7/8''$  long x  $1-9/16''$  diam. The anode lead has a maximum length of  $4-1/2''$  with a closed No. 6 lug. Taylor Tubes, Inc. Dept. ED, 2312 Wabansia Ave., Chicago 47, Ill.

CIRCLE ED-46 ON READER-SERVICE CARD FOR MORE INFORMATION

## Miniature Clutch With 3-5millisec Response



The "Micro-Clutch" is a miniature clutch designed primarily to meet limited customer space requirements, particularly in computers, and in aircraft and guided missile instrumen-

tation work. It is available as a clutch and a clutch brake. The unit itself has a maximum diameter of  $63/64''$  and a overall length of  $2-1/8''$  including both shaft extensions. Despite its small size, it can transmit a torque of 8 oz-in with a control current of 65ma.

Weight is in the order of  $1-1/2\text{oz}$ . Response time is 3 to 5millisec. The unit will meet all military specifications, and will operate in ambient temperatures of  $-67^\circ$  to  $+70^\circ\text{C}$ . Magtrol Inc., Dept. ED, 533 S. Niagara St., Tonawanda, N. Y.

CIRCLE ED-47 ON READER-SERVICE CARD FOR MORE INFORMATION

## Capacitor

### Miniature Variable Dual Unit



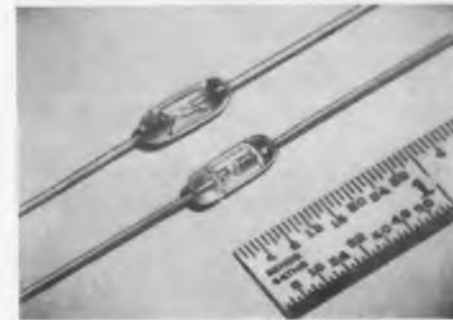
The "Mini-Dual" variable capacitor is designed for sub-miniature receivers and transmitters. Its dimensions, exclusive of shaft, are only  $13/16''$  x  $11/16''$  x  $1-1/6''$ . Capacitance range is up

to 385mmfd per section, with at least 10:1 ratio from maximum to minimum. Both "rotors" and both "stators" are isolated for flexibility of circuitry.

Other specifications include: shaft diameter,  $3/16''$  or  $1/4''$ ; standard shaft length  $3/8''$ ; weight is only  $1/2$  oz. McCoy Electronics Co., Dept. ED, Mt. Holly Springs, Pa.

CIRCLE ED-48 ON READER-SERVICE CARD FOR MORE INFORMATION

## Germanium Diodes With All-Glass Envelopes



Three "all-glass envelope" types of germanium diodes have been added to this firm's line. These types are designed to meet the needs of users who are interest-

ed primarily in reliability of performance and stability. They feature unusual resistance to humidity and other environmental conditions. The three diodes are known as types *IN87G*, *OA71*, and *OA73*.

The *IN87G* is a high-quality video detector, which offers high rectification efficiency coupled with low loading on resonant circuits. The *OA71* is a high back resistance type designed for computer and general purpose applications.

The *OA73* is also a video detector having advantages similar to the *IN87G*, and is intended for higher level i-f signals where the greater back resistance eliminates peak sync clipping. Its stability and high front-to-back ratio also make it applicable for computer applications such as transistor clamps. Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.

CIRCLE ED-49 ON READER-SERVICE CARD FOR MORE INFORMATION

## Locknut

### Free Spinning, Reusable Design



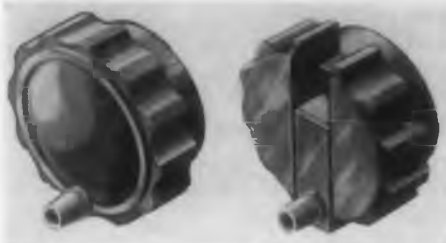
This locknut is an inexpensive one-piece, free spinning, reusable nut which locks itself when seated. The upper portion of the unit is slotted, and the bottom face is undercut, so that when the nut is tight-

ened, the threaded upper segments move inward, producing a vibration-proof lock on the threads of the screw. In addition, the all-metal construction makes the nut immune to the effects of both oil and water. These locknuts are made in all machine screw sizes, in steel, brass, or aluminum. Jacobson Nut Mfg. Corp., Dept. ED, Kenilworth, N. J.

CIRCLE ED-50 ON READER-SERVICE CARD FOR MORE INFORMATION

## Knobs

### With Built-In Clutches



"Controlled Torque" knobs are designed to safeguard delicate and costly instruments against careless or inadvertent cranking

beyond their normal stops. Designed for multi-turn devices, such as variable capacitors, inductors, potentiometers, etc., the knobs work on the principle of the slip clutch, automatically disengaging and slipping when a predetermined torque is exceeded. Fluted to aid in sensitive adjustment, they also have spinners for rapid setting.

The knobs measure 1-7/8" OD x 15/16" thick, for use with standard 1/4" shafting. Model K1375 has a non-retractable spinner. Model K1376 has the additional feature of a retractable spinner. The retractable feature is useful when equipment must fit into small storage space or where there is danger of accidental movement of protruding controls. It has a positive toggle action, being spring loaded open and closed. The knobs are also available without the slip clutch; Model K1385 has non-retractable spinner and Model K1386 has a retractable spinner. Jan Hardware Manufacturing Co., Inc., Dept. ED, 75 N. 11th St., Brooklyn 11, N. Y.

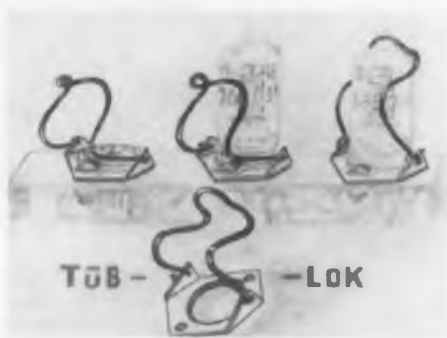
CIRCLE ED-51 ON READER-SERVICE CARD FOR MORE INFORMATION

## Tube Clamp

### Provides Simple, Safe Mounting

The "Tub-Lok" securely holds tubes in their sockets and minimizes the temperature rise that such components usually cause. It has been subjected to a Navy vibration test and approved.

The clamp provides economies, not only in low cost, but in ease of installation. The light aluminum base is riveted to the chassis with the same rivets that secure the tube socket. Socket and "Tub-Lok" base can be installed in one operation. The phosphor-bronze spring wire slips easily into the holes of the upturned ears of the base and is ready to be snapped into place on the tube. To remove the tube, a flick of the finger releases the spring and it hinges out of the way. G-D Manufacturing Co., Dept. ED, 767 Loma Verde, Palo Alto, Calif.



CIRCLE ED-52 ON READER-SERVICE CARD FOR MORE INFORMATION  
ELECTRONIC DESIGN • December 1954

# PERKIN

## New!! Compact!!

### 28 VOLTS @ 100 AMPERES ± 1/2% REGULATION

SPECIFICATIONS

DC OUTPUT: 24-32 Volts at 100 amperes

AC INPUT: 230 or 460V. ± 10%, 3 phase, 60 cycles

RIPPLE: 1% rms

VOLTAGE REGULATION: ± 1/2%: (a) from no load to full load; (b) from 24-32 Volts DC; (c) for 230 (or 460) Volts ± 10%

RESPONSE TIME: 0.2 seconds • WEIGHT: 250 lbs.

DIMENSION: 25" long x 15" deep x 15" high

Price: \$1,149.00, including meters & cabinets

### PROMPT DELIVERY



MODEL MR532-15

### 5 to 32 VOLTS @ 15 AMPS (CONT.) IMMEDIATE DELIVERY!!!

REGULATION: ± 1% (a) from 5-32 Volts D.C.; (b) from 1.5 to 15 amps.; (c) from 105-125 Volts A.C. (Single phase, 60 cps.)

RIPPLE: 1% rms @ 32 Volts and full load, increases to max. of 2% rms @ 5 Volts and full load.

RESPONSE: 0.2 seconds

METERS: 4 1/2" Rectangular AM and VM—2% Accuracy

DIMENSIONS: 22" x 17" x 14 1/2"

MOUNTING: Cabinet or 19" Rack Panel

FINISH: Baked Grey Wrinkle

WEIGHT: 150 lbs.

Price: \$524 w/o cabinet, \$549 w/cabinet

All prices F.O.B. El Segundo. Terms: 1%—10 days, net 30. Phone collect for quantity discounts.

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## TUBELESS!!! MAGNETIC AMPLIFIER REGULATED DC POWER SUPPLIES



Model MR2432-100X  
24 to 32 volts @ 100 amps



MODEL M60VMC

### 0 to 32 VOLTS @ 25 AMPS (CONT.) IMMEDIATE DELIVERY!!!

REGULATION: ± 1% \* (a) At 28 Volts D.C.—Increases to 2% max. over the range 24-32 V.; does not exceed 2 volts regulation over the range 4-24 volts D.C.; (b) from 1/10 Full Load to Full Load; (c) at a fixed A.C. Input of 115 volts.

RIPPLE: 1% rms @ 32V. and Full Load — 2% rms max. @ any voltage above 4 volts.

A.C. INPUT: 115 Volts, Single Phase, 60 cps

FINISH: Baked Grey Wrinkle

WEIGHT: 130 lbs.

DIMENSIONS: 22" x 15" x 14 1/2"

\*This unit is an economical solution to your power supply needs if stabilization for A.C. Voltage changes are not required. If this is required, write for spec. on Model MR1040-30.

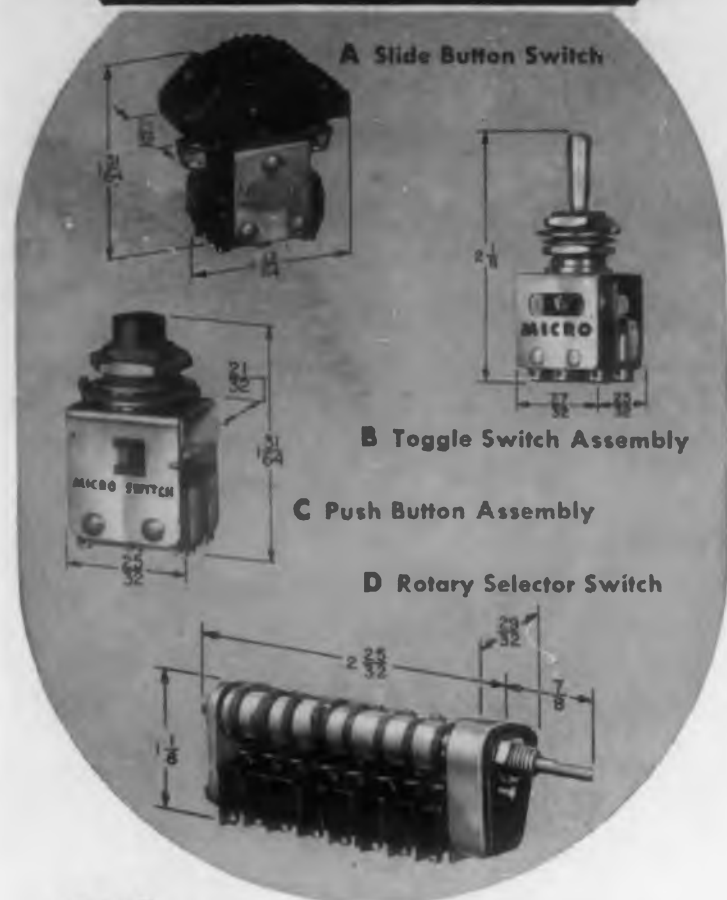
Price \$439 w/o cabinet, \$474 w/cabinet

# PERKIN ENGINEERING CORP.

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## MICRO SWITCH Precision Switches

A PRINCIPLE OF GOOD DESIGN



## Why Electronic designers turn to MICRO SWITCH

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- A Slide Button Switch.** Designed for two-circuit control. Two subminiature switches mounted in a three-position, maintained contact, slide-button assembly.
- B Toggle Switch Assembly.** For panel mounting and providing control of as many as 4 circuits. One of two single-pole, double-throw subminiature switches is actuated in each extreme toggle position.
- C Push Button Assembly.** Composed of two single-pole, double-throw subminiature switches. Switch provides an improved "feel" and simultaneous make and break of the two circuits.
- D Rotary Selector Switch.** Uses from 2 to 8 single-pole, double-throw subminiature switches to control multiple circuits. It permits 2 to 8 switching positions with spring or manual return to neutral position.

For complete information—call your nearest MICRO SWITCH branch office.

## MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY  
FREEMONT, ILLINOIS



CIRCLE ED-55 ON READER-SERVICE CARD FOR MORE INFORMATION

## Germanium Diodes Feature Gold Junctions



This line of sub-miniature germanium diodes, employing miniature gold junctions, features exceptionally stable mechanical and electrical characteristics. The high forward conductance of the diodes, with high back resistance properties, makes them particularly suitable for such applications as magnetic amplifier circuits, clamps, d-c restorers, and logical gates.

The diodes are manufactured with a fusion-sealed, one-piece glass body, impervious to external contaminating agents. Actual size of the diode body is 0.265" long x 0.130" diam, maximum. The "Dumet" leads are tinned and are easy to solder or spot-weld. Semiconductor Div., Hughes Aircraft Co., Dept. ED, Florence Ave. at Teale St., Culver City, Calif.

CIRCLE ED-56 ON READER-SERVICE CARD FOR MORE INFORMATION

## Time-Mark Generator Calibrates Oscilloscopes



The Type 181 is an accurate, inexpensive, portable time-mark generator designed primarily to calibrate oscilloscope time bases. The basic characteristics are: Markers—1, 10, 100, 1000 and 10,000  $\mu$ sec at rise times of 0.05, 0.15, 0.2, 0.4 and 0.4  $\mu$ sec; sine wave—10mc; output amplitude approximately 3.0v; output impedances approximately 100 ohms.

Marker and sine waves are available at a common output connector. The output is selected by a six-position switch; each marker is also available at separate binding posts. Markers can only be mixed at an approximate 10% mixing level for a count-down check.

All frequencies are controlled by a 1Mc crystal-stabilized oscillator accurate within 0.03%. Electronic voltage regulation is provided. Weight is 16-1/2lb. The unit requires 50-60cy, 110w. Dimensions are 8-1/4" x 5-1/2" x 15-1/2" deep.

Better stability (two parts per million over a 24-hour period) with a type H-17 crystal in a Type JKO-2 temperature-stabilized oven, directly interchangeable with the standard crystal, is available as extra. Tektronix, Inc., Dept. ED, P. O. Box 831, Portland 7, Ore.

CIRCLE ED-57 ON READER-SERVICE CARD FOR MORE INFORMATION

## Announcing A GREAT NEW DEVELOPMENT

### Self Tapping Set Screws

—in full range, including the smaller sizes  
Save taps, save time, save on production cost!  
2 Cutting Edges

Cutting thread extends only around top or slotted section; cuts on both sides of hole; chips are gathered in slot instead of accumulating below. Self-aligning, self-tapping, self-locking! "Pulls itself in." Can be supplied with any type set screw point. Sizes as small as #2 x 3/32.

Write for new illustrated, descriptive bulletin.

**Set Screw & Mfg. Co.**

265 Main St., Bartlett, Ill. (Chicago Suburb)

We Specialize in Solving Puzzling Set Screw Problems

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## Only Precision OFFERS YOU HIGHEST QUALITY, LOW COST PAPER TUBING



any shape  
every size  
any length  
plus  
any ID  
every OD  
any quantity

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Round, square, rectangular, triangular, any shape, any size—Precision Paper Tube Co. can provide all your paper tubing needs. Your specifications are met to the most exacting tolerances. Precision Paper Tubes are sturdy, crush resistant, have high tensile strength and excellent dimensional stability.

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Plant No. 2: 79 Chapel St., Hartford, Conn.  
Also Mfrs. of Precision Coil Bobbins

CIRCLE ED-59 ON READER-SERVICE CARD FOR MORE INFORMATION

### Glass Laminate High Impact Strength

Fiber-glass-polyester laminate in the price range of "NEMA XX" laminates is now available in Grade TS "Glastic". It offers 20% higher heat stability, 3 times better impact strength, 25 times better arc resistance, and 40% lower moisture absorption than XX laminates. These characteristics combine with punch-toughness, which permits punching holes close to the edge of narrow strips without preheating. Available from stock in thicknesses from 1/16" through 1/2" in sheets 24" x 36" and 36" x 72". Glastic Corp., Dept. ED, 1823 E. 40 St., Cleveland 3, Ohio.

CIRCLE ED-87 ON READER-SERVICE CARD

### Pulse-Power Sources Custom-Made

This firm custom manufactures microwave pulsed power sources with outputs as high as 1.5 megawatts. The units feature adjustable pulse widths from 0.1 to 5  $\mu$ sec, and provide for continuously variable repetition rates. Radio-frequency heads, consisting of magnetrons and pulse transformers, are interchangeable so that units may be used on more than one frequency. Adequate ventilation and safety features are provided. Chicago Electronics Laboratories, Dept. ED, 1214 W. Madison St., Chicago 7, Ill.

CIRCLE ED-88 ON READER-SERVICE CARD

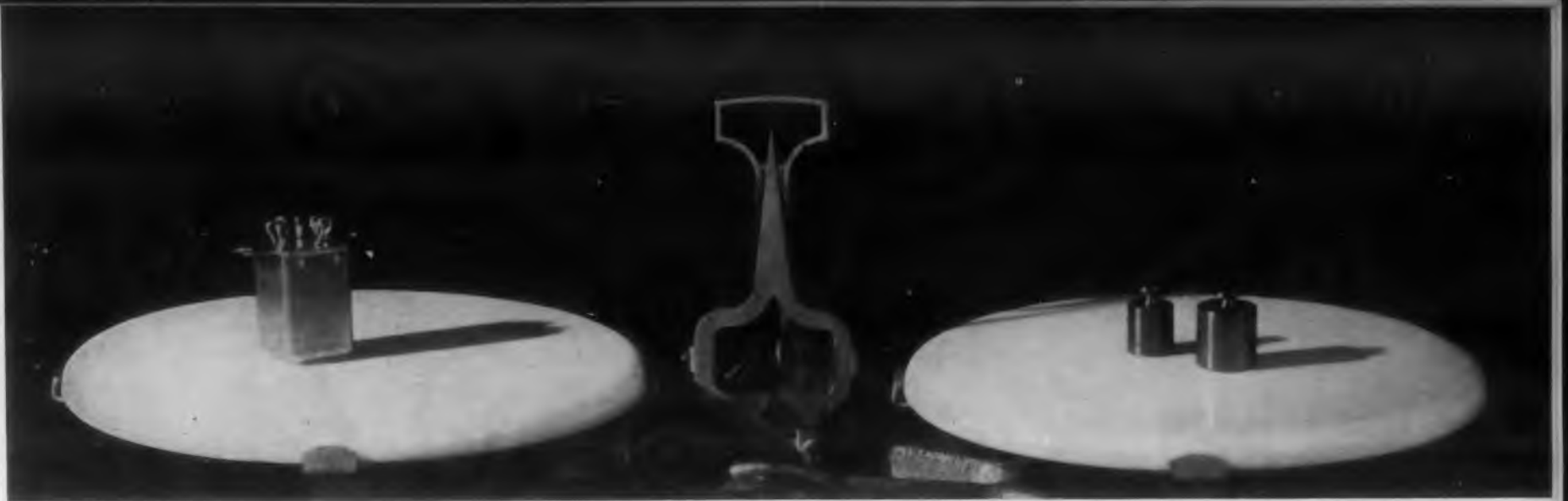
### Wire Markers

#### Withstand 300°F Temperatures

These self-adhering wire markers withstand continuous heat to 300°F, intermittent heat to 450°F, and continuous cold to -300°F. They are mounted on handy dispenser cards. They have a silicone-plastic over-coating to protect them from dirt, dust, grease, moisture, and abrasion. Available in two sizes: 1-1/2" long for wires over 1/4" OD, and 3/4" long for smaller wires. Furnished in 2000 different stock types, they conform to ASA Standard C6.1-1944. W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 12, Wisc.

CIRCLE ED-89 ON READER-SERVICE CARD

CIRCLE ED-90 ON READER-SERVICE CARD >



SMALLER AND LIGHTER: typical unit from new line of General Electric subminiature transformers weighs 30 grams, is 1 1/8 in. high.

GENERAL ELECTRIC ANNOUNCES . . .

## New line of subminiature transformers tailored to meet customer requirements

Wide range of ratings available in five matching case designs, 1-1/8" to 1-7/16" high

General Electric is now producing subminiature transformers to meet the wide variety of applications found in the electronic industry. As a result of our continuing program of research and development, G.E. has extended the new subminiature transformer sizes downward to serve the range of equipments utilizing printed circuits.

G-E engineers, with their extensive research and development facilities, have successfully designed units for guided missiles, servo-mechanisms, and computing systems, as well as printed circuits.

Metal-clad and hermetically sealed, the new subminiature transformers can be designed to withstand high potential test voltages of 1000 volts d-c. They are capable of operating in ambient temperatures of 125°C, and at altitudes up to 70,000 feet above sea level.

#### Other outstanding features:

**Rectangular cases** reduce cubic volume and weight to a minimum.

**Base dimensions** neatly fit chassis punched for standard tube sockets.

**Uniform case designs** enhance chassis appearance.

**Compression glass bushings** withstand severe thermal shock.

**Hook-type terminals** make installation easier.

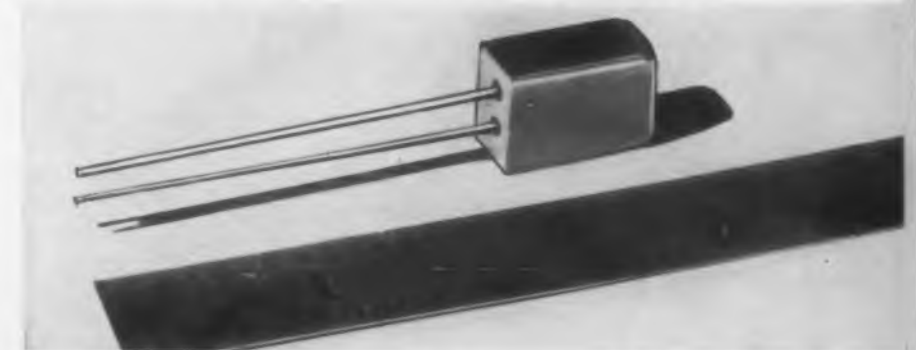
**Tin dip** provides better protection against corrosion.

Experienced G-E engineers are eager to accept the challenge to produce the subminiature transformer you specify. For additional information call upon your nearest G-E Apparatus Sales Office. General Electric Company, Schenectady 5, New York.

412-116

#### Approximate case dimensions in inches

Height	Width	Depth	Case Designation	Tube Socket Punch
1 1/8	1/8	3/8	BD	(For printed Circuit Applications)
3/8	1/8	1/8	BE	Miniature
1 1/8	3/4	3/4	AF	Noval
1 7/8	1 1/2	1 1/2	BG	Noval
1 3/8	1	1	AG	Octal



SMALLEST UNIT, designed for printed circuits, has solid wire conductors two inches long for easy, direct connection to the other components.

*Progress Is Our Most Important Product*

GENERAL  ELECTRIC

# IF YOU WORK WITH PULSES...



...read how Burroughs Pulse Units can save you weeks of engineering time

**This new, free brochure** shows by actual examples how you can assemble even complex pulse systems simply by connecting together matched Burroughs Pulse Units that perform basic functions.

You save weeks of breadboard engineering and can begin immediately on your primary engineering project. All your time can be spent designing commercial products—none lost designing test equipment. Because Burroughs Pulse Units are so easy to use, you can do many jobs you might otherwise never get time to do at all.

Prove to your management just how much engineering cost Burroughs Units can save for you. Without charge, we'll engineer a system to meet one of your current problems and let you compare the cost. Write for your free copy of the new brochure. Burroughs Corp., Electronic Instruments Div., Dept. 4M, 1209 Vine St., Phila. 7, Pa.

## EASY AS THIS TO ASSEMBLE A PULSE SYSTEM WITH BURROUGHS PULSE UNITS



1. Prepare a time chart of the desired pulse sequence.



2. Draw a block diagram and determine which units you need.



3. Connect the units together with standard coaxial cables.

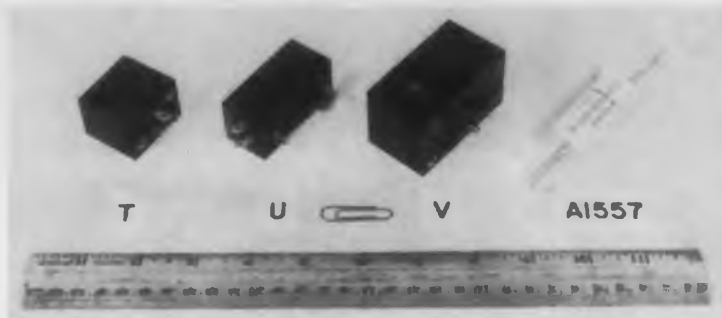
**ELECTRONIC INSTRUMENTS DIVISION**  
**Burroughs**

FIRST IN PULSE HANDLING EQUIPMENT

CIRCLE ED-93 ON READER-SERVICE CARD FOR MORE INFORMATION

## Delay Lines

### Military Types in Three Series



Three series of Military-type lines have been introduced by this firm. They are characterized by high precision and performance and the ability to withstand very difficult environmental conditions. They have excellent thermal coefficients of delay. In each of the three new series, a wide range of characteristic impedances and delay times is offered (delays range from  $0.1\mu\text{sec}$  to  $4.0\mu\text{sec}$ ).

The basic difference between the three series lies in their relative complexity of construction (i.e., number of sections). The V Series has the largest number of sections, and hence the largest ratio of delay time to rise time. The U Series has a somewhat simpler and more compact construction, and the T Series is the smallest and simplest.

In addition, the firm has greatly extended the range of delay times covered by its subminiature (A1557) Series of delay lines by the addition of new items in range from  $0.1\mu\text{sec}$  to  $2.5\mu\text{sec}$ ; also a  $3.0\mu\text{sec}$  line has been added. Jacobs Instrument Co., Dept. ED, Bethesda 14, Md.

CIRCLE ED-94 ON READER-SERVICE CARD FOR MORE INFORMATION

## Wire Caliper

### Provides Direct Readings



The "Wire-Mike" is a pocket-size stainless steel caliper for direct reading of electrical conductor sizes. It gives direct size readings of stranded commercial cable from No. 18 through 2000Mem; solid wire (AWG) from No. 20 through 4/0; ACSR from No. 5 through 336.5Mem; rigid conduit and copper pipe from  $1/4''$  through  $2-1/2''$ ; and thinwall conduit from  $3/8''$  through  $2''$ .

In addition, the unit is an inside and outside caliper, in divisions of  $1/32''$ , and a  $3-1/2''$  rule. Included is a handy conversion table of pipe sizes to inside dimensions. Constructed of heavy-gauge stainless steel, weighing 2 oz, with an overall length (closed) of  $4-1/2''$ , it comes in a leather slip case, Burndy Engineering Co., Inc., Dept. ED, Norwalk, Conn.

CIRCLE ED-95 ON READER-SERVICE CARD FOR MORE INFORMATION



precision resolvers  
SIZES 11, 15, 23



400~ servo motors  
SIZES 11, 15, 18



brushless induction  
potentiometers  
SIZE 15



Let us quote on your  
detailed requirements.

**American Electronic Mfg., Inc.**

9503 W. JEFFERSON BLVD., CULVER CITY, CALIF.  
TELEPHONE: TEXAS 8-5471



## Resinite VINYL TUBING

Resinite Vinyl Tubing not only meets, but consistently surpasses specifications for control of fungus and corrosion, flame resistance, dielectric strength and for performance at low and high temperatures. Extreme operating conditions prove the superiority of Resinite Specification Vinyl Tubing.

This superior quality of Resinite Tubing has been achieved through many years of specializing in vinyl tubing. It is maintained through constant research, accurate compounding, skillful workmanship, rigid quality control and thorough inspection. That's why more Resinite Specification Vinyl Tubing than any other is used by the aircraft and electronics industries.

Write today for samples  
and performance data.

# Resinite

RESIN INDUSTRIES, INC.

315 Olive St. • Box 1589 • Santa Barbara, Calif.

SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE  
AIRCRAFT ELECTRONICS AND PHARMACEUTICAL FIELDS

CIRCLE ED-98 ON READER-SERVICE CARD

## D-C Indicating Instruments

Meet ASA Specifications



This firm is now producing a series of electrical indicating instruments that conform to American Standards Association specifications and specification JAN-1-6. The series includes d-c microammeters, milliammeters, voltmeters, and ammeters in a variety of ranges, resistance values and sensitivities. They are available in 2-1/2" and 3-1/2" round or square cases, and 4" rectangular models. Modifications can be made to fit individual requirements. The instruments feature the external pivot D'Arsonval movement for maximum accuracy and pointer steadiness. DeJur-Amseco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N. Y.

CIRCLE ED-99 ON READER-SERVICE CARD FOR MORE INFORMATION

## Thermostat

Provides Rapid, Close Control



The "Stemeo Type A" is an extremely compact, quick make and break thermostat for close control of temperatures in electronic, appliance, and industrial apparatus applications. It uses a disk-type bimetal thermal element.

The rapid response and close control are due to two main design advantages. First, the brass housing in which the bimetal disk is carried is mounted against the controlled surface. This means that the bimetal is in extremely close proximity and is heated by both conduction and radiation from the controlled device. Second, since current is carried through a copper contact spring which is insulated from the thermal element, the bimetal is electrically independent. The latter advantage results in fewer contact operations, and elimination of false cycling and life-shortening "jitters". The thermostats are precalibrated at the factory.

Maximum operating temperature is 400°F; temperatures as low as -60°C do not impair normal operation. A wide variety of terminal arrangements is available. Stevens Manufacturing Co., Dept. ED, 69 S. Walnut St., Mansfield, Ohio.

CIRCLE ED-100 ON READER-SERVICE CARD FOR MORE INFORMATION

# We

are the originators of  
**Engineered Economy\*\***  
**Iron Cores**

\* **Radio Cores, Inc.**, created and originated ENGINEERED ECONOMY IRON CORES . . . which are available at money saving prices and from stock.

Now . . . we have added six new Engineered Economy Iron Cores to expand our line to fourteen, covering most insert and threaded applications.

As the originators and creators of Engineered Economy Cores . . . leaders in engineering, quality, delivery and supply of samples, we are pleased that our tremendous volume enables us to lead in lower prices, too.

This has been achieved through our efficient production and your acceptance of "EE" cores.

We maintain an inventory of "EE" cores to eliminate your inventory problems and save you down time. Make certain that your "EE" cores come from the originator . . . RADIO CORES, INC.

We welcome your inquiries on "Custom Engineered Cores."

Write for our new "EE" specification data booklet

\*\* TRADE MARK

# Radio Cores, Inc.

9540 Tulley Avenue • Oak Lawn, Illinois

CIRCLE ED-101 ON READER-SERVICE CARD FOR MORE INFORMATION



## Latching Relay

Operates Over  $15 \times 10^6$  Times



The Type G Electromechanical Latching Relay was designed to meet the punishing service requirements of an in-

ternationally known business machine manufacturer. Where other such relays measured life cycles in thousands, these relays are still operating satisfactorily at well over 15,000,000 operations.

The assembly shown consists of two Type GAC a-c relays with interlocking armatures. They are aligned one above the other on a common mounting bracket to save chassis space. The assembly may also consist of two Type G d-c relays, or one a-c and one d-c relay.

Typical circuit functions performed by this relay include: (1) hold contacts operated any length of time without consuming power, (2) operate contacts over one lead; release them over another, (3) act as overload relay—electrically reset from remote point when tripped, (4) act as interlocking relay pair on either a-c or d-c, or combination of both. C. P. Clare & Co., Dept. ED, 3101 W. Pratt Blvd., Chicago 45, Ill.

CIRCLE ED-75 ON READER'S SERVICE CARD FOR MORE DATA

## Transformers

Polyvinyl Insulated



Available in sizes 2va and larger, these transformers are designed and manufactured to industrial standards. They are especially

suitable for laboratory power control panels because of their compact size.

The coils are precision wound with a high dielectric insulation between winding layers. The 105°C polyvinyl insulated, color-coded leads are firmly taped to the coils. These flexible leads are extra-long for convenient wiring. A high-grade core steel minimizes electrical losses.

All sizes are available with either sturdy slotted mounting feet or encased in a channel type frame. The transformer is impregnated with a polymerizing type varnish which is resistant to moisture and acid. Hevi Duty Electric Co., Dept. ED, Milwaukee 1, Wis.

CIRCLE ED-76 ON READER'S SERVICE CARD FOR MORE DATA

**NOW, A REMARKABLE "READY-TO-SOLDER"**

# PHELPS DODGE

**MANY NEW APPLICATIONS POSSIBLE**



Universal wound TV choke coil



Magnet coil



AC-DC motor coil



Transformer coil



Solenoid coil



IF-RF coil

*First for Lasting Quality—from Mine to Market!*

CIRCLE ED-77 ON READER-SERVICE CARD FOR MORE INFORMATION

" **MAGNET WIRE.....**



# NEW SODEREZE!

- \* Instant Soldering Without Stripping
- \* Improved Moisture Resistance
- \* Good Electrical Properties
- \* Excellent Flexibility and Toughness

New Sodereze represents a spectacular advance in ready-to-solder magnet wire. It's a new and typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, save time, reduce overall costs and satisfy a variety of different operat-

ing conditions. The versatility and outstanding properties of New Sodereze not only permit its use wherever solderable wire has been *proved* practical and dependable but suggest its application in unlimited other electronic and electrical fields to replace conventional wires.

*Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer.*

\*SODEREZE is a Phelps Dodge Trademark.



**PHELPS DODGE COPPER PRODUCTS  
CORPORATION**

**INCA MANUFACTURING DIVISION  
FORT WAYNE, INDIANA**

CIRCLE ED-77 ON READER-SERVICE CARD FOR MORE INFORMATION

## Multi-Channel Switch For High Speed Sampling



The 4000 Series Multichannel "Roto-Speed" Sampling Switch is of special value for high speed multi-contact

sampling in missile and aircraft instrumentation. This unit features unique wiper design and select contact material. It is d-c motor driven at any standard voltage, has a compact planetary gear reduction unit, and provides sampling at rates up to about 100,000 contacts per minute.

The switch has sturdy soldering terminals and semi-molded contact pins to achieve high performance. It is small in size, and may be furnished with up to 90 shorting contacts. The unit shown has 60 contacts with alternate contacts brought to the terminals. The switch is available with sub-miniature connectors in place of terminals. A similar unit in the 6000 Series is available without motor drive. General Devices, Inc., Dept. ED, P. O. Box 253, Princeton, N. J.

CIRCLE ED-78 ON READER'S SERVICE CARD FOR MORE DATA

## Connectors Corner-Keyed Miniatures



These fittings, available in two types, occupy approximately 35% less area for rack, panel

or chassis mounting than this firm's standard DPD series. The shell of the Type DPA measures 2" x 1" x 23/32" overall; the DPX, 2-5/16" x 1-1/8" x 1-1/8". Straight and angle 90° junction shells with integral clamps are made for Type DPA.

A corner-keying design aids polarization. The elimination of conventional insert retaining screws allows maximum insert space utilization for contacts. Chamfered lead edges of the shell permit blind piloting compensation for a 1/16" misalignment of the male and female parts. The shell finish is cadmium plate with chromate conversion. Special finishes can be furnished.

Contact arrangements currently available include standard 5amp, 10amp, and coaxials (5amp) up to a total of 32 contacts, with two DPA and seven DPX layouts available. Insulation materials used are high dielectric strength plastics: melamine or "Diall 51-01". The shell is made of lightweight aluminum alloy. Cannon Electric Co., Dept. ED, 3209 Humboldt St., Los Angeles, 31, Calif.

CIRCLE ED-79 ON READER'S SERVICE CARD FOR MORE DATA



**NOW!**

## Leading Distributors Stock Them!

Now, for the first time, you can get these famous original equipment favorites in lots up to 1,000—fast and economically from local parts distributors. Previously sold to the world's leading manufacturers *only*, in huge production quantities, these Stackpole components are now available from selected distributors in the same quality that has made them favorites for over 25 years.

Every Stackpole component is produced under full quality control—from raw material to final test. Each is fully proved through years of field service in the most exacting applications—military, service replacement, and commercial.

Write for bulletin on any type and name of nearest distributor.

for  
**SERVICE**  
**EXPERIMENTAL**  
**INDUSTRIAL**  
and **MILITARY**  
Applications

# STACKPOLE

Variable Resistors



Low Cost Slide Switches



Iron Cores



Fixed Resistors

DISTRIBUTORS' DIVISION

**STACKPOLE CARBON COMPANY**

26 Rittenhouse Place, Ardmore, Pa.

(Plants in St. Marys and Kane, Pa.)

### Insulating Material

For Class B Use

"Bi-Glas", a new high-temperature electrical insulating material will withstand "hot spot" operating temperatures up to 150°C. The material is supplied in full-width form for use as layer insulation and phase insulation. Also available in easy-to-use tape form, it provides uniform, tight, and smooth lapping over irregular surfaces for a wide variety of uses.

Bi-Glas is made of a special bias-woven fibre-glas cloth treated with a high-temperature varnish. Its inorganic properties provide maximum protection against oils, acids, moisture, fungus, and ozone. Sun Chemical Corp., Dept. ED, Long Island City, N. Y.

CIRCLE ED-126 ON READER-SERVICE CARD

### Beryllium Alloy Wire

Resists Flexing Fatigue

"Silvercote" No. 10 Alloy, composed of 0.5% beryllium, 2.5% cobalt, and the balance of copper, has 65-70% of the conductivity of copper but will withstand higher temperatures than copper wire. It also resists fatigue from flexing and vibration. It is furnished with a light silverplating, which makes it easy to solder. Available in single or multiple strands. Little Falls Alloys, Dept. ED, 194 Caldwell Ave., Paterson, N. J.

CIRCLE ED-127 ON READER-SERVICE CARD

### Foam Vinyl

Used as Acoustical Insulation

Flexible foamed Vinyl and other foam products are available in varying cell size, resiliencies, and densities ranging from 5 to 25lb per cubic foot. "Crestfoam" foamed Vinyls are odorless and can be had in a full range of colors. Tactile and decorative properties and shapes can be varied to meet a variety of functional requirements. Applications include thermal and acoustical insulation, shock absorbing pads, and molded gasketing. Crest Chemical Industries, Dept. ED, 72 Delavan St., Brooklyn 31, N. Y.

CIRCLE ED-128 ON READER-SERVICE CARD

◀ CIRCLE ED-125 ON READER-SERVICE CARD

Precision  
AND  
Accuracy  
GIANNINI  
Potentiometers

SOME OUTSTANDING EXAMPLES:



**SPIRALPOT**  
Models 85175A  
85171A  
85172A  
85173A

Slide-wire, infinite resolution, low noise. Resistances 2 to 2500 ohms. Linearities  $\pm 0.1\%$  to  $\pm 0.025\%$ . 1 to 40 turns.



**MICROTORQUE**  
Model 85111

Extremely low torque (.003 oz. in.). Resolution to .06%, 1" dia. x 1.31"; shaft 0.031" dia. 1.63 watts (average). Resistance: 250 to 25,000 ohms; 12 wiring types. Linearity:  $\pm 0.5\%$  or  $\pm 0.25\%$ .



**MINIGANG**  
Model 85193

Rugged—small; resolution to .06%, 1.125" dia. up to six sections; 2 watts per section. Resistances: 130 to 70,000 ohms. Linearities:  $\pm 0.5\%$  or  $\pm 0.25\%$ .



**RECTIPOT**  
Model 8620

Linear motion, rigid metal case; 1" dia. one or two elements; strokes from 0.1" to 6.0". Resistances from 400 ohms/in. to 15,000 ohms/in.; taps available.



**UNIVERSAL GANGPOT**  
Model 85197

1 to 12 sections; 2" dia. Resistances 360 to 200,000 ohms per section. Linearities:  $\pm 0.3\%$  to  $\pm 0.15\%$ ; sleeve or ball bearings; sections phaseable 360°; solid shaft, anodized aluminum case.

**Giannini**

Products of Electromechanical Division  
EAST ORANGE, NEW JERSEY

for information write

**G. M. GIANNINI & CO., INC.**  
PASADENA 1, CALIFORNIA

CIRCLE ED-131 ON READER-SERVICE CARD

**Jack and Plug**  
For Miniature Equipment



This subminiature phone-type closed circuit jack and plug combination has numerous audio and electronic uses. Approximately one-third the size of previ-

ous models, the unit is recommended for use in computers, tape recorders, dictating machines and miniature radios.

The jack can be mounted in any panel up to 1/8" in thickness. Overall length of the plug is 3/4", with a diameter of 9/64". In the present model the plug is molded directly on the cord, but detachable cords are being developed for later availability. Telex, Inc., Dept. KP, 1633 Eustis Ave., St. Paul, Minn.

CIRCLE ED-132 ON READER-SERVICE CARD FOR MORE INFORMATION

**Oscilloscope Camera**  
Employs Fast-Print Principle



The "Recordscope 1185" is an oscilloscope camera of special configuration and based on an adaptation of the "Polaroid" fast-print principle.

The camera is simple to operate, using a standard "Polaroid" magazine and fast self-developing film. It delivers a finished black field print in 60sec or less. The fully automatic magazine-shifting mechanism records 3 to 16 traces per 3" x 4" print. Automatic cycling (exposure plus automatic movement to next trace position) can be accomplished in three ways: (1) manual shutter release, (2) cable release, (3) remote operating switch. The final print provides full size image on 3" scopes and half-size image on 5" scopes, with no reversal of image.

A specially designed camera-to-scope hood is of the swing-away type and insures sturdy camera mounting. One camera can service several 3" and 5" scopes of different makes, when provided with adapter plates and hoods. The unit has a coated oscillator f/2.3-67.5mm lens; "time" and "bulb" shutter having speeds from 1sec to 1/100sec; and fixed focus. The camera measures approximately 4-1/2" x 6-1/4" x 9-1/2". Aremac Associates, Dept. ED, 329 W. Washington St., Pasadena 3, Calif.

CIRCLE ED-133 ON READER-SERVICE CARD FOR MORE INFORMATION

Burton Browne Advertising

James is the complete source for all vibratory products!\*

THE ENGINEER'S STANDARD SINCE 1936

\*Send your engineering problems to us



Introducing the first instrument-type double-pole, double-throw chopper featuring complete coaxial isolation of all contacts, low residual noise, 60 c.p.s., and meeting military environmental specifications for temperature, humidity, shock and vibration. The JAMES engineering department will be happy to analyze the application of this device to your specialized electronic circuitry.

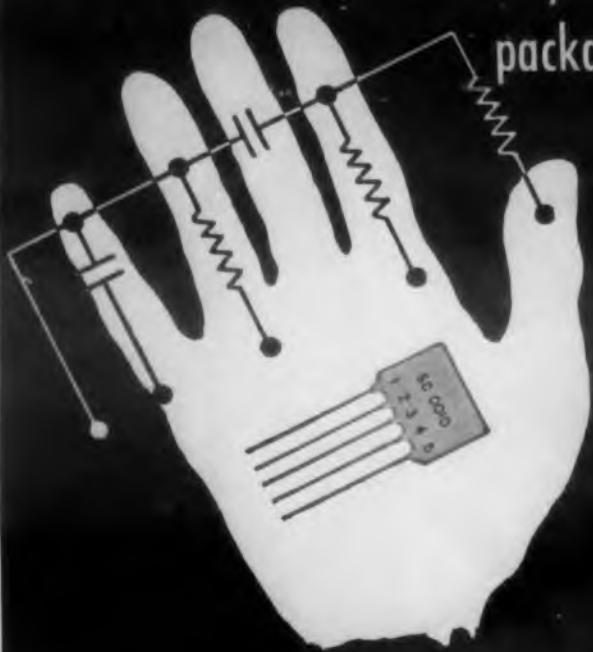
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CIRCLE ED-134 ON READER-SERVICE CARD FOR MORE INFORMATION

a handful of components

in one  
tiny  
package



**Stupakoff**  
Printed Circuits

Space is saved, assembly time reduced and errors eliminated when sturdy, compact Stupakoff Printed Circuits are used. In one tiny package—half the size of a book of matches—few or many accurately rated components—resistors and capacitors—are permanently assembled according to specifications. The only connections to be made are the external leads.

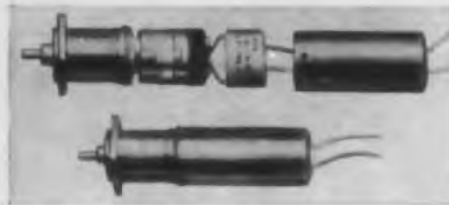
Stupakoff excels in the development and manufacture of Printed Circuits, and today is equipped with modern facilities for the mass-production of dependable units made to your specifications. Write for Bulletin 1151-A.

**STUPAKOFF CERAMIC & MFG. CO.**  
LATROBE, PENNSYLVANIA  
DIVISION OF THE CARBORUNDUM COMPANY

CIRCLE ED-184 ON READER-SERVICE CARD FOR MORE INFORMATION

## Radio Noise Filter

An Integral Part of Motors



This miniature molded radio noise filter is designed to fit a small motor and gear assembly. Measuring only 1-3/16" OD x 3/4"

long, it serves as an integral part of the motor instead of as an external accessory. Replacing a conventional assembly, it reduces overall filter length about 50%.

Along with its miniature size, this continuous-duty, dual-section filter features greater than 50db attenuation over the range of 150ke to 1000Mc. It operates satisfactorily in ambient temperatures as high as 125°C. It exceeds Air Force Specification MIL-I-6181-B as applied to small motors, and meets metallized paper size with paper and foil reliability. A molded metal insert is drilled and tapped to simplify mounting. The Potter Co., Dept. EDN, North Chicago, Ill.

CIRCLE ED-185 ON READER-SERVICE CARD FOR MORE INFORMATION

## Power Supply

For Klystron Tubes



The "Klystron Tube Power Supply" has interior accommodation for Types 2K39, 2K41, 2K42, 2K43, and 2K44 klystron tubes. It provides all four necessary voltages for klystron tube operation: reflection, beam, control electrode, and heater. The supply also provides for exterior connection for other types of Klystron tubes.

Performance specifications include: reflector voltage of 0.01%, from 10% to full load with line voltage variation of 20v; and beam and control electrode voltages with 0.05% regulation, from 10% load to full load with line voltage variation of 20v. Long time stability is 100 parts in a million, and ripple is less than 0.002rms.

The reflector voltage is 0 to -750v at 5ma max; the beam voltage is +500v to +1250v at 60ma max; the control electrode voltage is -150v to +50v at 25ma max; the heater voltage is 6.3v unregulated, at 6amp max. All voltages, except heater voltage, are indicated on front-panel meters.

The unit has a multi-turn dial for control of the five types of mounted internally tubes. For use with other klystron types, the supply has terminals on the front panel. Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena 8, Calif.

The unit has a multi-turn dial for control of the five types of mounted internally tubes. For use with other klystron types, the supply has terminals on the front panel. Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena 8, Calif.

CIRCLE ED-186 ON READER-SERVICE CARD FOR MORE INFORMATION



Miniature,

Hermetically Sealed, Aircraft Type Relays

Have a New, Wider Range of Performance Characteristics

If you need a small, light 4 PTD or DPDT relay to operate consistently under extremely critical or downright adverse conditions, chances are your requirements can be readily met by one of the multitude of variations possible with the basic "Diamond H" Series R relay. Originally designed to meet all requirements of USAF Spec. MIL-R-5757B, they far surpass many. For example: Various brackets of vibration resistance from 10 to 2,000 cps, plus temperature ranges from -55° to +200° C., coil resistances from 1 to 50,000 ohms, contact capacities from 350 V., D.C., 400 MA, to 10 A. at 30 V., D.C. (20 A. for reduced life). Also reliable in signal circuits. Operating time (24 V. models) 10 ms. or less; dropout less than 3 ms. Dielectric strength 450 to 1,250 V., RMS. Insulation resistance 1,000 megohms at room temperature (100 at 200° C.). Operational shock resistance 30, 40 or over 50 "G". Mechanical shock resistance to 1,000 "G". Single or two independent coils, either or both of which will operate unit. All standard mounting arrangements.

Call on "Diamond H" engineers to work with you in developing a variation to meet your specific needs.

**THE HART MANUFACTURING COMPANY**  
210 Bartholomew Ave., Hartford, Conn.

CIRCLE ED-187 ON READER-SERVICE CARD FOR MORE INFORMATION

## Metron BANTAM SPEED REDUCERS

- Complete!
- Compact!
- Adaptable!

The New Bantam combines power capacity and toughness with small size.



Write for Data Sheet 10 and 11 for details

**Metron INSTRUMENT COMPANY**  
450 Lincoln St. • Denver 3, Colorado

CIRCLE ED-188 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

## Grid-Dip Oscillator

Covers 430-940Mc Range



Designated the Model 59-UHF "Megacycle Meter," this instrument covers the 430-940Mc range. It incorporates an oscillator with a split-stator tuning condenser, ar-

anged so that a fixed coupling point is at the center of the oscillator inductance. Coupling sensitivity is excellent, and grid current variation is minimal over the entire band. The oscillator output is either cw or 120-cycle modulated. Linear calibration is provided with a calibration point every 10Mc (individually calibrated), and accuracy is better than 2%.

Some of the many uses of the instrument are: measuring the resonant frequencies of passive circuits such as cavities, tank circuits, and transmission lines; an auxiliary signal generator for alignment and tuning of u-h-f receivers and transmitters; as an oscillating or absorption marker for use with a sweep-frequency generator; and as a wavemeter or heterodyne frequency meter.

The instrument is encased in an octagonal metal box 2-1/2" deep and 4-5/8" wide. This case contains a standard camera socket for tripod mounting. Rated at 30w and operating from 117v 60cy, the unit employs a separate power supply and indicating unit. Measurements Corp., Dept. ED, Boonton, N. J.

CIRCLE ED-190 ON READER-SERVICE CARD FOR MORE INFORMATION

## Counter

Counts 2-3 Objects/sec



The Model F-1 is designed to count continually at a speed of 2 to 3 per second; during sudden bursts it will count up to 7 objects per second. However, it is advised that an average 2 to 3 object-per-second rate be maintained to preserve totalizer life. Any of this company's photoheads can be used, and line voltages from 100-120v operate the counter.

The counter can be located as far away as 100' from the photohead. The photohead can be used in highly confined areas, and the counter can be mounted in plain view somewhere on the production machine. The standard Model F-1 counter is provided with an 8' length of cord from counter to photohead. Longer cords can be specified. Electronic Products Div., Dept. ED, Post Machinery Co., Beverly, Mass.

CIRCLE ED-191 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

Keystone announces...

## a new tubeless MOTO MAG

Now, from the world's leading producer of magnetic amplifiers... a new tubeless two-stage magnetic amplifier of saturable transformer type



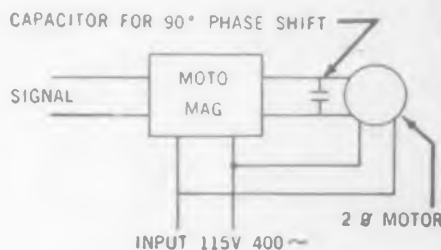
3 3/8" high x 2 1/4" deep x 2 3/8" wide • mounting dimensions 1 3/8" x 1 3/4" chassis cutout 1" diameter weight 1 3/4 lbs.

any  
2-phase  
motor

remote  
control  
devices

computers

positioning  
servos



power input 115 volts 400 cycles  
output 115 volts 5 watts  
AC phase reversible • output at zero signal 1.5 volts maximum  
signal for full output 800 microamps • control circuit resistance 2800 ohms • response 63% .06 seconds • phasing capacitor .4 microfarads  
temperature range -40°C. to +100°C. • AC control available on special order

Newest members of the famous MOTO MAG family, these improved models offer several unique advantages:

- In many applications they eliminate use of a pre-amplifier
- Smaller size — fit into more installations
- Operate on a smaller signal
- Self-contained phase detector
- Incorporate high-temperature germanium diodes for high operating temperatures

These hermetically sealed units provide precision variable phase power control with a minimum of size and weight. Six standard models available — each can be quickly and economically adapted to meet your individual specifications.

### PRICES:

1-24, \$58 ea.; 25-49, \$40 ea.; 50-99, \$35 ea.; 100-299, \$32 ea.; 300-499, \$30 ea.; 500-999, \$28 ea.; 1000-2500, \$27 ea.

Write today for complete specifications, performance data, and quotes to meet your specific application.

**keystone**  PRODUCTS COMPANY

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CIRCLE ED-192 ON READER-SERVICE CARD FOR MORE INFORMATION

# NEW WEATHER-LAB



## ... LOW COST Full-Range Temperature-Humidity Cabinet

Answers the need for a readily-available environmental test tool that meets JAN, MIL and all above-freezing gov't. specifications. Automatically controls or programs dry and wet bulb conditions for checking product performance under extreme tropical or desert conditions. Typical HUDSON BAY® stainless steel construction with many plus features.

WRITE FOR DESCRIPTIVE BULLETIN NO. 109-101

### HUDSON BAY DIVISION

REFRIGERATION SYSTEMS, INC.  
645 W. Washington Blvd., Div. ED, Chicago 6, Ill.  
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CIRCLE ED-81 ON READER-SERVICE CARD FOR MORE INFORMATION

# 1440 page MASTER for everything in Electronics

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CIRCLE ED-82 ON READER-SERVICE CARD FOR MORE INFORMATION

## Remote Positioning System Highly Accurate



Designers of remote control equipment for industrial or aircraft service will find the accurate, high-torque "Electrolink" remote positioning system of great value. Designed for operation on 400cy power, the all-electric system will shortly be available in a 60cy version that would not require a frequency converter for use in automatic industrial controls.

The three components of the system are an amplifier, a transmitter autosyn, and a magnetic-powder-clutch servo-drive with integral receiver autosyn. The contra-rotating clutches are the key to the system. The clutches isolate the inertia of the rotating servo components from the driven load during stops and starts. As a result, the torque-to-inertia ratio is unusually high, and the servo is able to exceed the accuracy and response speed capabilities of electric-motor drives. Grand Rapids Div., Lear, Inc., Dept. ED, 110 Ionia Ave., N. W., Grand Rapids, Mich.

CIRCLE ED-83 ON READER-SERVICE CARD FOR MORE INFORMATION

## Decade Box

Has 1,199,999 Resistance Steps



The "Dekabox" is an a-e decade resistance box providing more than a million 1 ohm resistance steps (from zero to 1,199,999 ohms). The assembly is mounted on a compact adjustable

mounting base and may be set to the most convenient angle for reading the six decade dials that display the value of resistance in a single horizontal line.

All resistors are precision wire-wound units adjusted to within  $\pm 0.05\%$  of their rated value, and they have special windings to minimize frequency error. The temperature coefficient of individual resistors is less than  $\pm 0.002\%$  per  $^{\circ}\text{C}$ . All switch contacts are solid silver for minimum contact resistance, and all switch plates are made of ceramic material specially treated for maximum insulation resistance. A circuit diagram and all resistance and rated current values appear on the front panel with the laboratory type binding posts. Electro-Measurements, Inc., Dept. ED, 4312 S. E. Stark St., Portland 15, Ore.

CIRCLE ED-84 ON READER-SERVICE CARD FOR MORE INFORMATION

new designs on the board?

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Gries' unique single cavity molding facilities are flexible—provide the practical answer to countless problems of product design and improvement. No matter how tiny, or how intricate, GRC molds nylon parts to meet your exact specifications, with precise tolerances and uniform quality. And, because GRC methods are completely automatic, costs are surprisingly low—GRC tiny nylon parts are produced, completely trimmed and ready for use, in one high-speed, money-saving operation!

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World's Foremost Producer of Small Die Castings

CIRCLE ED-85 ON READER-SERVICE CARD FOR MORE INFORMATION

# WIDE BAND POWER OSCILLATOR

200 to 2500 mc/sec.



A new instrument of unusual capabilities, the Maxson Model M1141 UHF Wideband Power Oscillator, provides exceptionally broad frequency coverage and substantial power output in a single source. A simple changeover of feedback assemblies provides overlapping coverage of the full range in two bands. For easier portability, the instrument is divided into two units. Provision is made for internal and external amplitude modulation and for CW operation. With its smooth tuning and precise resettability, the Model M1141 is an excellent general-purpose signal source.

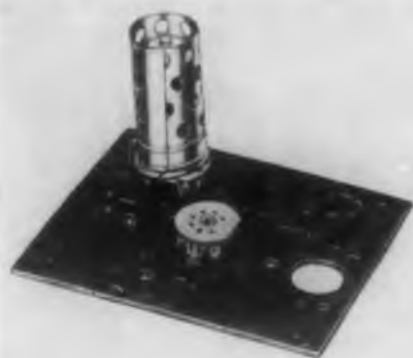
Specifications are: ranges—200 to 1050 and 1000 to 2500 mc; power—50 watts to 400 mc—25 watts to 1000 mc—10 watts to 2500 mc; calibration accuracy  $\pm 1\%$  or  $\pm 5$  mc, whichever is greater; resettability—better than 0.1%; modulation—internal square- and sine-wave at 400 and 1000 cps; output impedance—50 ohms (nominal); price, including both units—\$1990 net F.O.B. Long Island City, N. Y.

## THE W. L. MAXSON CORP.

460 WEST 34TH STREET, NEW YORK 1, N. Y.

CIRCLE ED-86 ON READER-SERVICE CARD FOR MORE INFORMATION

## Tube Socket For Printed Circuits



These laminated tube sockets feature twin wafers supporting contacts with vertical terminals that snap into individual holes in the circuit board. This feature permits the printing

of jumpers on the circuit laminate underneath the socket to connect different pin positions.

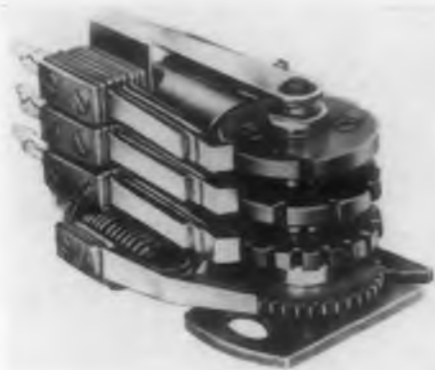
Static load tests indicate that this socket properly dip-soldered into a multiple-hole array in the etched-foil pattern will withstand a force 10 times normal tube withdrawal force, with the printed circuit base material fracturing before failure of connections.

These sockets are available in 7- and 9-pin types, and can be used either with or without tube shields, as illustrated. They can be furnished in most grades of sheet phenolic and polyester fiberglass insulating material. Methode Mfg. Co., Dept. ED, 2021 Churchill St., Chicago, Ill.

CIRCLE ED-60 ON READER-SERVICE CARD FOR MORE INFORMATION

## Rotary Relay

### Replaces a Group of Relays



Whole banks of relays or combinations of relays and stepping switches can be replaced by this single cam-type rotary relay, the "Series OCS". It has additional advantages of being small, light, and exceptionally

resistant to shock, vibration, and temperature changes. It measures 3-1/4" x 2-7/16" x 1-25/32", and weighs from 14 to 20oz, depending on design.

The unit has performance records in excess of 250,000,000 high-speed operations. It replaces delicate latch-in type relays for alternate on-off operations, providing dependable service under extremes of shock and temperature. For stepping operations, it is fast and accurate, and can be driven self-interruptedly to produce a time cycle, or for "homing". Automatic Electric Sales Corp., Dept. ED, 1033 W. Van Buren St., Chicago 7, Ill.

CIRCLE ED-61 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

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<b>ARKANSAS</b> Little Rock	Southern Radio Supply	<b>NEW JERSEY</b> Newark 4 Newark 5	Aaron Lippman & Company Parr Electric Company, Inc.
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## ELECTRONS, INCORPORATED

127 SUSSEX AVENUE

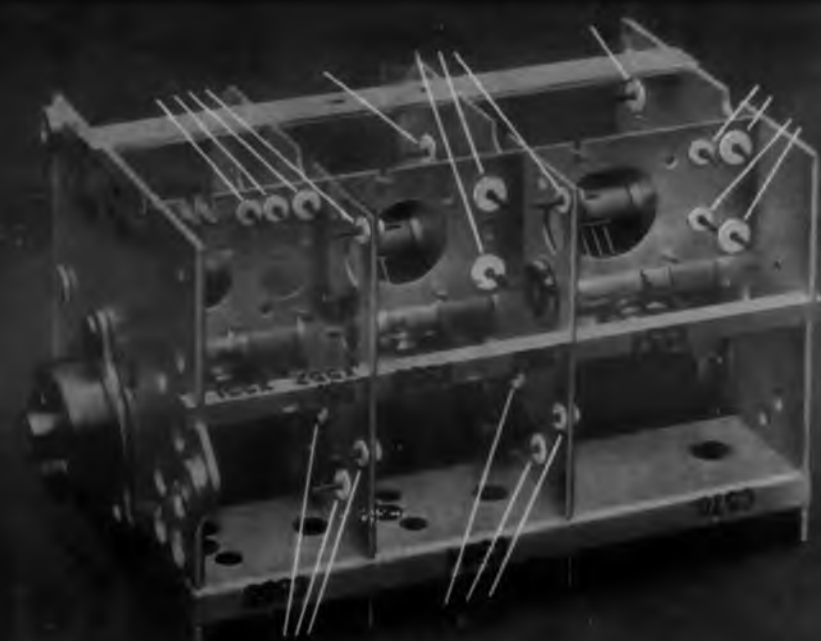
NEWARK 3, N. J.

*Our industrial electronic tubes are  
in stock near you.*

CIRCLE ED-62 ON READER-SERVICE CARD FOR MORE INFORMATION



# replacing GLASS with TEFLON



## Chemelec Stand-Off and Feed-Through Insulators

● Tough, resilient TEFLON made these miniatures possible—and **BETTER**—than glass-insulated components.

**COMPRESSION MOUNTING**, without breakage.

**WITHSTAND SHOCK** and vibration in service.

**NO ADDITIONAL HARDWARE NEEDED.**

**ASSEMBLY COSTS GREATLY REDUCED.**

**THE PLASTIC'S "MEMORY"** securely locks insulators permanently in place. Minimum pull test 10 lbs., insulator to deck, hardware to insulator.

**MINIATURIZATION** is easily accomplished.

**INVESTIGATE** Chemelec Stand-Off and Feed-Through Insulators for superior service and lower assembly costs.

**SEVEN STOCK SIZES**, including sub-miniatures. Other dimensions feasible.

**WRITE** for Chemelec Bulletin EC-1153.

● TEFLON's superior insulating characteristics made these miniatures possible—and **BETTER**—especially for high frequency, high voltage or current, high temperature service.

**HIGHER** surface and volume resistivity.

**LOWER** loss factor and dielectric constant.

**HIGHER** dielectric strength.

**WIDER** service temperature range ( $-110^{\circ}\text{F}$  to  $+500^{\circ}\text{F}$ ).

**ZERO** water absorption (A.S.T.M. Test).

**WON'T CARBONIZE** under arcing or DC-plate.

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**FLUOROCARBON  
PRODUCTS, INC., DIVISION  
CAMDEN 1 • NEW JERSEY**

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CIRCLE ED-137 ON READER-SERVICE CARD FOR MORE INFORMATION

## Gear Motor Miniature D-C Unit



The Model 1300-1 gear motor is a miniature permanent magnet d-c unit built for extremely long-life operation. It is 2.8" long x 1-1/8" OD. Weight is 4-1/2oz.

The gear motor is especially designed for timing equipment and other applications requiring constant speed under continuous use. It meets or exceeds all applicable requirements of Specification AN-M-40. It may be designed for any input voltage from 6v to 30v d-c, and has an output of 6w maximum for continuous duty or 12w maximum for intermittent duty. The output can be designed for any speed from 1/2-rpm to 9,000rpm depending on the gearing installed. The unit has an aluminum alloy case with plastic molded brush housing. The ball bearings are sealed and greased for the life of the motor.

At customer's option, the motor can be supplied with leads or feed-through terminals. It also can be supplied with a governor which increases length by 5/8". The governor provides a control range of  $\pm 1\%$  for a constant load over  $\pm 10\%$  voltage range. El Ray Motor Co., Dept. ED, North Hollywood, Calif.

CIRCLE ED-138 ON READER-SERVICE CARD FOR MORE INFORMATION

## Strobe Light

Flashes up to 6000rpm



This inexpensive, lightweight, strobe light emits a high intensity bluish-white light, capable of stopping motion in ordinary daylight or room illumination. With a weight of 1-1/2lb, the lamp is cable connected to the control box and can easily be set in many places. The control unit weighs only 8lb.

Flashing up to 6000rpm is initiated from either an external contactor or an audio oscillator. Simple intensity adjustment is provided in the control unit. Med-E-Cal Lab., Dept. ED, 65 Strathmore Rd., Brookline, Mass.

CIRCLE ED-139 ON READER-SERVICE CARD FOR MORE INFORMATION

# HAVING PRINTED CIRCUIT



## SOLDERING OR FLUX PROBLEMS?

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ELECTRONIC INDUSTRY

The facilities of a modern, well equipped metallurgical laboratory, competent research staff and trained field engineers are available to help you solve printed circuitry problems.

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CIRCLE ED-140 ON READER-SERVICE CARD

select your  
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devices  
from TI's wide  
range

Outstanding research-to-production teamwork makes Texas Instruments your best source of supply for reliable semiconductor devices. The new silicon transistor—produced first by TI in commercial quantities—is the most recent result of this teamwork. All TI semiconductor devices are glass-to-metal hermetically sealed and are tested over 20 times before shipment.

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Detailed information is  
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the complete TI line of  
semiconductor devices.

TEXAS INSTRUMENTS  
INCORPORATED  
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### Coil Forms For Flyback Transformers

These custom constructed high dielectric coil forms are designed for improved performance in flyback transformers. Fabricated from select materials, they are resin impregnated by a special process to provide exceptionally high insulation resistances.



The forms are notched to specification. They are available in any shape or size and can now be supplied in any quantity. Resinite Corp., Dept. EDN, 2035 W. Charleston St., Chicago 47, Ill.

CIRCLE ED-144 ON READER-SERVICE CARD FOR MORE INFORMATION

### Transmission Employs Magnetic Fluid Elements



The Model 795 unit serves as a transmission link between the prime mover and the load in a servo actuator or any device in which power, compactness, and precision control are prerequisites.

This unit, in effect, is a variable-torque, selective-rotation transmission employing a pair of magnetic fluid elements for control. The two clutch elements are located side-by-side and driven in opposite directions from the input shaft and back-to-back gearing. The direction and magnitude of the transmitted torque depends on which clutch is energized and the amount of d-c current.

All components are packaged within a housing assembly and operate in an oil bath for lubrication and cooling. Ball bearing and fluid seals give a high precision, smooth acting, compact device which measures 14" x 8-3/4" x 4-3/4" (including shafts).

The clutch element utilizes a grease-like lubricant in which fine magnetic particles are suspended. The application of a magnetic field from a coil, energized with d-c, will cause the heavy fluid to "solidify".

This unit employs stationary coils with no slip rings. 350 in-lbs are available on the output shaft. At the recommended maximum input speed of 650rpm, the clutch element will transmit 542w; thus a power gain of 31 is obtained. Raymond Engineering Laboratory, Inc., Dept. ED, Middletown, Conn.

CIRCLE ED-145 ON READER-SERVICE CARD FOR MORE INFORMATION

## LOWER YOUR SET COSTS

## WITH THIS LOWER-PRICED DEPENDABLE SPEAKER



A line of 4" and 5" speakers designed for peak performance. Break off or cast magnet may be used.

Low priced only because of unusually efficient manufacturing techniques.

Produced under rigid quality control. Metal stampings completely manufactured in our own Tool, Die and Punch Press Departments. Exceptionally thorough final inspection.

Plugs, transformers and/or brackets to your specifications.

Lower your set costs with this dependable speaker. Write for further information TODAY.

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Phone: 6-2161  
Specialists in Electro-Magnetic Devices

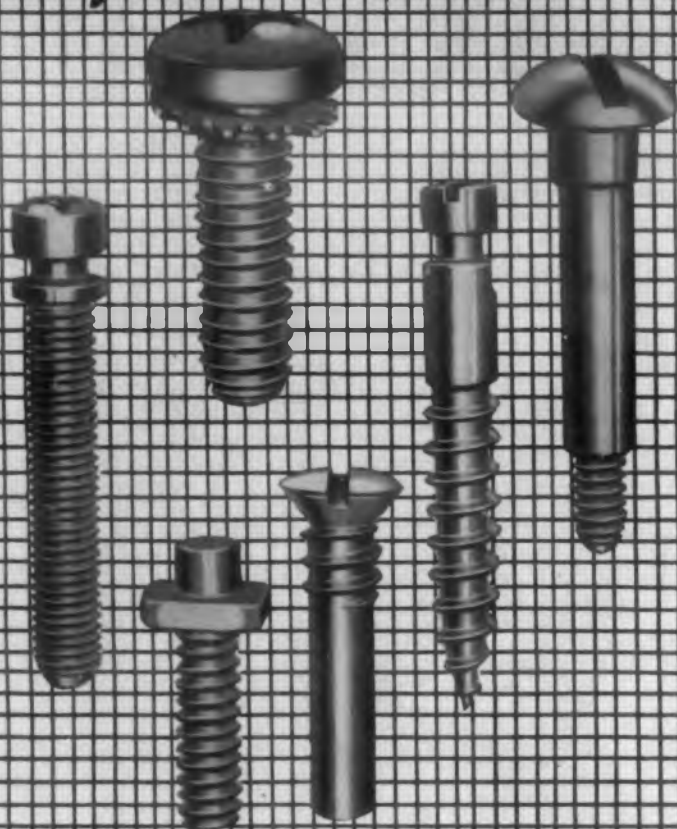
Representatives:

JAMES C. MUGGLEWORTH, 324 Haddon Avenue, Collingswood 7, New Jersey • RALPH HAFEEY, R.R. 1, U.S. 27, Coldwater Rd., Ft. Wayne 8, Indiana • IRV. M. COCHRANE CO., 408 So Alvarado St., Los Angeles, Calif. • JOHN J. KOPPLE, 60 E. 42nd St., New York 17, N. Y.

CIRCLE ED-146 ON READER-SERVICE CARD FOR MORE INFORMATION



*Specials*



#### FOR EXAMPLE

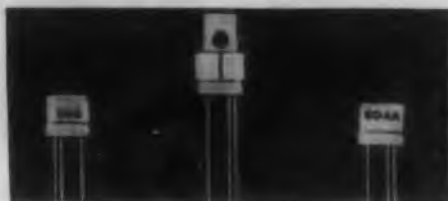
By changing to the Cold Heading method of manufacturing, this stainless steel part was made at a savings of \$6.45 per thousand. Over a period of one year the approximate savings in cost, in comparison to previous cost, was \$4,837.50.

OVER 30 YEARS EXPERIENCE MAKING SPECIALS AND STANDARDS

**ELCO TOOL AND SCREW CORPORATION**  
1948 BROADWAY • ROCKFORD, ILLINOIS

CIRCLE ED-54 ON READER-SERVICE CARD FOR MORE INFORMATION

### Silicon Transistors Offered in Five Types



High volume production of silicon transistors has made possible the addition of two more models (for

a total of five) to this firm's line, one with an alpha (current amplification factor) of 0.975 or better, and the other with an alpha cutoff frequency of 8Mc.

Grown junction silicon transistors operate with little change at 150°C compared to a considerably lower limit for germanium transistors. Average alpha cutoff frequency is 3Mc for three of the types, with alpha guaranteed to be from 0.90 to 0.95 for Type 903, 0.95 to 0.97 for Type 904, and 0.975 or better for Type 905. Type 904A has an alpha cutoff frequency of 8Mc or better and an alpha of 0.95 or better. The Type X-15 (the middle unit above) large signal unit gives a power gain of 14db with collector dissipation of 1w in Class B operation.

Field experience gained so far with silicon transistors indicates that they have great potential in many fields, including computer, aircraft, and guided missile application. Silicon transistors are also valuable because of such other vital characteristics as frequency, rise and decay times, and power output. Texas Instruments, Inc., Dept. ED, 6000 Lemmon Ave., Dallas 9, Tex.

CIRCLE ED-162 ON READER-SERVICE CARD FOR MORE INFORMATION

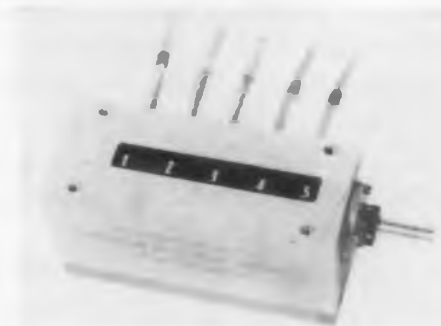
### Telemetering Counters For Indicating and Recording

Both of two new series of telemetering counters are small lightweight precision instruments that totalize and visually indicate shaft rotation in either direction in increments of 1/10 revolution.

The PC-500 Series potentiometer counters have an accurate electrical potentiometer on each counter wheel. The potentiometer resistance ratios are directly proportional to the visual indication. The CC-500 Series contacting counters have electrical contacts corresponding to each number on each wheel.

Both types are suited to many control and computing applications, as well as to remote indication and recording of data correlated photographically. Photocon Research Products, Dept. ED, 421 N. Foothill Blvd., Pasadena 8, Calif.

CIRCLE ED-163 ON READER-SERVICE CARD FOR MORE INFORMATION



### HIGH CURRENT REGULATED DC SUPPLY



Sorensen's new Model 600B meets the need for a laboratory power supply with current capacity up to one-half ampere, and embodies characteristics making it suitable for pulse work.

Outstanding features of the instrument are reduced ripple, superior internal impedance specifications, and incorporation of type 5651 tubes for increased long-term output voltage stability.

#### SPECIFICATIONS

Output voltage	0-600 VDC
Output current	0-500 ma
Regulation accuracy	±0.25% above 100 VDC ±0.5% below 100 VDC
Ripple (mV-RMS)	3 maximum
Bias supply	0-150 VDC at 0-5 ma
Maximum bias circuit impedance	50000 ohms
Internal impedance, max.	2.0 ohms
Input range	105-125 VAC, 1φ, 50-60 cycles
AC voltage unregulated	6.3 VAC, C.T., at 15 amperes

for  
further  
information  
write to

Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn.

## SORENSEN

CIRCLE ED-164 ON READER-SERVICE CARD FOR MORE INFORMATION

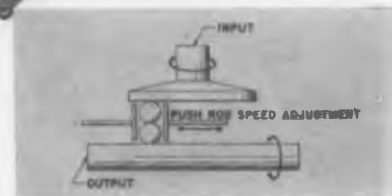
### NEW

## BALL & DISK SPEED CHANGER



High Precision  
Variable Speed  
Device

- Reversible
- Stepless
- Precise
- Compact



Moving parts are of hardened alloy steel. Light in weight, long life, great accuracy and reasonable cost. A comparatively low torque speed changer for generating reversible speeds in a smooth and stepless fashion from forward to zero to full reverse.

Size: Width 2-1/8" Length 2-3/4"  
Height 3-11/16" Weight 17 oz.  
\$90.00 F.O.B. Stamford.  
Quantity Discounts.

Used as INTEGRATORS for analog computers, servo mechanisms and similar devices requiring smooth and high precision speed control.

**TRC THE REFLECTONE CORPORATION**  
639 W. Main Street  
Stamford, Connecticut

CIRCLE ED-165 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

### "Series String" Tubes Have Equal Warm-Up Times

Designed for operation with their heaters in a "series string" circuit in TV receivers, these 27 vacuum tubes have equal warm-up times. They can operate directly across the power line without a heater transformer. Each heater requires 600ma. Some of the tubes, with the standard tube to which they correspond electrically given in parentheses, are as follows: 3BC5 (6BC5), a sharp-cutoff pentode; 3CB6 (6CB6), a sharp-cutoff pentode; 5AN8 (6AN8), a general purpose, medium- $\mu$  triode—sharp-cutoff pentode; 5AT8 (6AT8), a triode-pentode converter; 5J6 (6J6), a twin triode; 5U8 (6U8), a medium- $\mu$  triode—sharp-cutoff pentode; and the 12L6-GT (25L6-GT), a beam-power tube. Tube Div., Dept. ED, Radio Corporation of America, Harrison, N. J.

CIRCLE ED-166 ON READER-SERVICE CARD

### Nameplate Decals

#### Resist High Temperatures

Three new types of heat-resistant nameplate decals will resist any of an extensive list of commercial solvents. Because of their elasticity, they also resist abrasion. Types HR, SHR, and HHR resist temperatures up to 400°F, 600°F, and intermittent temperatures of 1000°F, respectively. Meyercord Co., Dept. ED, 5323 W. Lake St., Chicago 44, Ill.

CIRCLE ED-167 ON READER-SERVICE CARD

### Hook-Up Wire

#### With "Teflon" Insulation

Being coated with a smooth "Teflon" sheath, "Temprex" hook-up wire is impervious to all known commercial solvents. This insulation is unaffected by weathering, aging, fungus, or moisture. It meets the requirements of MIL Standard 104 and MIL-W-16878A for type E and EE gear. Resists temperatures from -90°C to 260°C. Made in Nos. 26 to 10 AWG in 14 standard colors. Hi-temp Wires, Inc., Dept. ED, 26 Windsor Ave., Mineola, L. I., N. Y.

CIRCLE ED-168 ON READER-SERVICE CARD

CIRCLE ED-169 ON READER-SERVICE CARD



J. L. ADRIAN, CHIEF PROPELLER DESIGN ENGINEER, PROPELLER DIVISION, CURTISS-WRIGHT CORPORATION, CALDWELL, N. J.

## G-E aircraft motors meet C-W's toughest specs

"When Curtiss-Wright was developing its now famous Electric Propeller," says J. L. Adrian, Chief Propeller Design Engineer of the company's Propeller Division, "it faced very strict design requirements. For instance, C-W needed a propeller pitch-changing motor that would function with precision under the rigors of combat military service—extremes of altitude, temperature, vibration, shock, and centrifugal force.

"Then G-E engineers were called in. They came through with a basic motor design that not only met Curtiss-Wright's toughest specifications but, with variations, has been used in 55 different Curtiss Propeller applications

since—on such planes as the B-50 Superfortresses, C-124 Globemasters, and DC-6, CV-240, and Constellation transports."

**IN SERVING YOU**, G-E engineers can draw on unmatched experience gained in solving this and many hundreds of other aircraft motor problems. In addition, they'll have at their disposal complete aircraft motor development and testing facilities.

To take full advantage of this service, contact your local G-E Apparatus Sales Office *early in your planning*. And, for more information, write today to Section 704-30, General Electric Co., Schenectady 5, N. Y.

*Progress Is Our Most Important Product*

GENERAL  ELECTRIC

New variety of  
**CLARE**  
**Type J Relay**  
provides a power relay  
as sensitive and  
accurate as tele-  
phone-type relay



1

Handles inrush current of 50 amperes for 50,000 operations—rating of 10 amperes, 27½ volts d-c.

2 Has exceeded 500,000 operations on motor load of 6 amperes—inrush current of 15 amperes—at 70,000 feet altitude.

The new CLARE Type J Relay has all the advantages of the small size, light weight and sturdy construction which makes the standard Type J Relay so popular with designers of electrical and electronic equipment.

Increased current carrying capacity is provided by the use of Code 18 (Silver) heavy duty contacts which are riveted to the springs. A combination of the standard Type J twin contacts and the new heavy duty contacts is also available.

Nominal rating of this new Type J Relay is: 10 amperes, 115 volts a-c (resistive); 10 amperes, 27½ volts d-c. The relay is 2¼" long, 1¼" wide and 1⅜" high with two Form C contacts.

Long life and increased adjustment stability is provided by a new hinge-type armature. The new heavy-duty yoke has a stainless steel pivot pin with a large bearing surface which turns in precisely reamed bearings of nonferrous material.

Write for CLARE Bulletin No. 119 for complete information. Send for Engineering Data Book for further information on other variations of the Type J Relay. Address: C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

**CLARE RELAYS**  
FIRST IN THE INDUSTRIAL FIELD

CIRCLE ED-112 ON READER-SERVICE CARD FOR MORE INFORMATION

62

**Miniature Capacitors**  
With "Teflon" Dielectric



Designed to be smaller in size than other capacitors available for the same purposes, the "Glassmike TSC" is available in a line of 29 units.

Compactness of the design is due to the use of "Teflon" as the dielectric. Smallest unit in the line is a 0.0004mfd capacitor with 6000v effective working voltage. It is rated at 2amp at 1Mc. It measures 19/32" diam x 1-1/4" long. Largest unit in the line is 0.001mfd with 24,000v effective working voltage. It is rated at 20amp at 1Mc.

The capacitors will operate up to 100°C and are designed to meet all electrical specifications of JAN-C-5, types E, F, and G. They have high Q. Condenser Products Co., Division of New Haven Clock and Watch Co., Dept. ED, 140 Hamilton St., New Haven, Conn.

CIRCLE ED-113 ON READER'S SERVICE CARD FOR MORE DATA

**Twin Triode**  
For "On-Off" Control



The 5965 is a medium-mu twin triode of the nine-pin miniature type, especially designed for frequency-divider circuits in electronic computers and other "on-off" control applications involving long periods of operation under cutoff conditions. In such service, it maintains its emission capabilities even after long periods of operation under cutoff conditions and, therefore, provides

good consistency of plate current during its "on" cycles. Balance of cutoff bias between the two units is closely controlled during manufacture.

The tube has separate terminals for each cathode to facilitate flexibility of circuit arrangement, and a mid-tapped heater to permit operation from either a 6.3v or 12.6v supply. Tube Division, Radio Corporation of America, Dept. ED, Harrison, N. J.

CIRCLE ED-114 ON READER'S SERVICE CARD FOR MORE DATA

**Tracing Cloth**  
Has Greater Transparency

This tracing cloth has greater transparency for improved prints and a finer surface for speedier drafting. Free samples are available to design departments, Arkwright Finishing Co., Dept. ED, Industrial Trust Bldg., Providence, R. I.

CIRCLE ED-115 ON READER'S SERVICE CARD FOR MORE DATA

For ANY speed...

use **Metron** MINIATURE VARIABLE SPEED DRIVES

Variable speed drives give you variable speeds from 1-5 increase through 1-1, to 5-1 decrease! Just move the lever to the desired speed ratio and the miniature variable instantly produces the speed you want!

- Speeds up to 10,000 Rev/minute or down to ¼ Rev/day
- Small — to fit into your product
- Permanently lubricated
- Your choice of 6 controls
- Output up to .025 HP

\*representative speeds only

for details write for Bulletin No. 99

**Metron** INSTRUMENT CO.  
450 Lincoln St., Denver 3, Colorado  
DISTRICT OFFICES • NEW YORK • CHICAGO • LOS ANGELES

CIRCLE ED-116 ON READER-SERVICE CARD FOR MORE INFORMATION

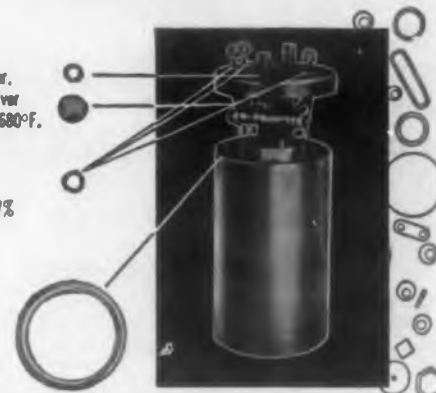
3 Soldering Operations in 1  
Easy as ABC

with **KESTER "SOLDERFORMS"**

A Solder screws and stud to can cover. "Solderform" Disc & Rings 5% Silver —95% Lead Alloy. Melting Point 680°F.

B Solder glass terminals to cover. "Solderform" Rings 63% Tin—37% Lead Alloy. Melting Point 361°F.

C Hermetically seal cover on can. "Solderform" Ring 20.5% Bismuth—29.5% Tin—43% Lead Alloy. Softening Point 250°F.



Here's a typical example of a tough resistance soldering job involving progressively lower melting temperatures. Kester "Solderforms" made sure this high precision oscillator coil came through every test successfully.

WRITE TODAY for free "Solderform" samples and literature.

**KESTER**  
SOLDER COMPANY  
4266 Wrightwood Avenue • Chicago 39, Illinois  
Newark 5, New Jersey • Brantford, Canada

CIRCLE ED-117 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

*Linde* synthetic sapphire  
... for excellent optical transmission  
**PLUS** physical strength and chemical inertness

Sapphire is hard, strong, chemically inert and transmits a high percentage of radiation in the important ultra-violet and infra-red regions. At 1750A forty per cent of the radiation is transmitted by a .059 inch section; at 5.7 microns forty per cent is transmitted by a .100 inch section. This unique combination of properties makes it ideal for optical systems that require resistance to abrasion and corrosion and high temperature strength as well as excellent optical transmission.

Now single-crystal sapphire windows are available in diameters up to 2 inches in several finishes. For further information, call or write your nearest LINDE office.

**LINDE AIR PRODUCTS COMPANY**

A DIVISION OF UNION CARBIDE AND CARBON CORPORATION  
30 East 42nd Street, New York 17, N. Y. **UCC** Offices in Other Principal Cities

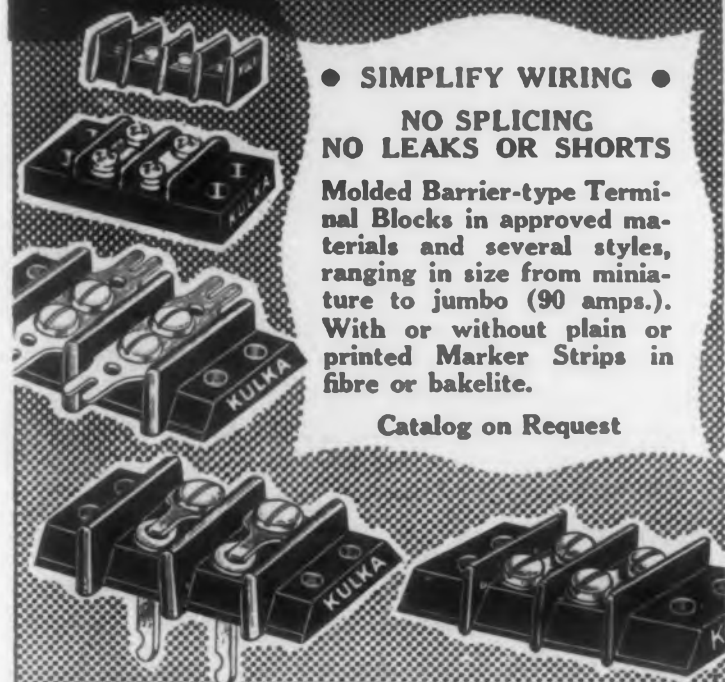
In Canada: DOMINION OXYGEN COMPANY  
Division of Union Carbide Canada Limited, Toronto

"Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

CIRCLE ED-118 ON READER-SERVICE CARD FOR MORE INFORMATION

**KULKA TERMINAL BLOCKS**

CUT COSTS... SPEED PRODUCTION



- SIMPLIFY WIRING ●
- NO SPLICING
- NO LEAKS OR SHORTS

Molded Barrier-type Terminal Blocks in approved materials and several styles, ranging in size from miniature to jumbo (90 amps). With or without plain or printed Marker Strips in fibre or bakelite.

Catalog on Request

**KULKA ELECTRIC MFG. CO., Inc.**

Manufacturers of Electrical Wiring Devices  
MOUNT VERNON, N. Y.

CIRCLE ED-119 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

**Hot-Wire Switch**  
Limits Current Flow



This normally closed hot-wire type of switch is designed to limit the current flow in a circuit to its nominal critical value. In a typical

application, it serves to protect the input coils and other components in radio receivers from over-currents induced by nearby transmitting equipment.

In operation, current through the actuating wire causes it to expand and separate the contacts. When the current level exceeds the critical point, the contacts make and break rapidly, causing the current flow through the switch to average out at the desired preset value.

The present model operates at 125ma with a tolerance of  $\pm 25.0$ ma. Other models may be developed to higher or lower operating values. This hermetically sealed switch is compensated for an ambient temperature range of 0 to  $+90^{\circ}\text{C}$  and has been subjected to 60g shock in all directions without damage or change in calibration. It has passed the vibration and shock requirements of BuShips Specification 40T-9. Size is 9/16" diam x 2-1/8" long. Instrument Div., Thomas A. Edison, Inc., Dept. ED, West Orange, N. J.

CIRCLE ED-120 ON READER-SERVICE CARD FOR MORE INFORMATION

**Microphone**

Has Wide Frequency Response



The Model 623 slim-type general-purpose dynamic microphone has many indoor and outdoor applications, including public address systems, paging, recording, and radio communications. A major feature is an "Acoustalloy" diaphragm, designed to assure smooth response, which is virtually indestructible.

The microphone can be used on a stand or in the hand. A firm, smooth swivel permits easy change from vertical to angle position for best pick-up. Frequency response is 60cy to 11,000cy. Output level is -55db. Polar pattern is omnidirectional.

The unit has a built-in cable connector, with 5/8" -27 thread stand coupler, a convenient on-off switch, and is supplied with an 18' cable. Choice of high or low impedance is available by changing one wire in the cable connector. Size is 1-5/16" x 7-1/2". Net weight is 15oz. Electro-Voice, Inc., Dept. ED, Buchanan, Mich.

CIRCLE ED-121 ON READER-SERVICE CARD FOR MORE INFORMATION

**DESIGNERS**

for  
layout  
and  
design of  
electronic and  
mechanical  
components  
of radar systems  
and computing  
equipment.

1  
THE  
COMPANY

Hughes Research and Development Laboratories form one of the nation's leading electronics organizations. The Laboratories are presently engaged in the development of advanced electronic systems and devices produced by the Hughes manufacturing divisions.

2  
AREAS  
OF WORK

The work calls for layout and production design of: 1. Reliable, maintainable electronic units. 2. Unique electromechanical devices. 3. Installation of electronic equipment for ground locations and in interceptor airframes.

Relocation of the applicant must not disrupt an urgent military project.

3  
THE  
FUTURE

Designers experienced in the field of electromechanical design for production, or those interested in entering this field, will find outlets for their abilities and imagination in these active areas. New electromechanical techniques are opening new applications of ground and airborne electronic equipment. Hughes designers will have the benefit of working experience in these fundamental developments.

**HUGHES**

RESEARCH AND DEVELOPMENT LABORATORIES

Scientific and Engineering Staff

Culver City,  
Los Angeles County, California



*Electro Bi-Glas* is the first and only Class B insulation that keeps its superior electrical properties after elongation. Stands high ambients and resists oils, acids, moisture and fungus. Available in convenient tape form for wrapping coils, spiral windings, cable splices and terminal connections. For data sheet and prices, write Dept. E7-1269.

A Division of  Chemical Corporation



**Electro-Technical Products**

Nutley 10, N. J.

CIRCLE ED-172 ON READER-SERVICE CARD FOR MORE INFORMATION

## NEW PECO A-C LINE VOLTAGE REGULATOR

**Gives Greater  
Efficiency In A  
Smaller Package**



Smaller in size . . . lighter in weight, the new compact Peco A-C Line Voltage Regulator establishes a new standard of efficiency in voltage regulating equipment. Convenient and

economical, this new regulator utilizes greater power efficiency. It is exceptionally small and light, yet its size does not limit its power capacity.

### Here's Why This New Regulator Can Simplify Your Control Problem . . .

- **GREATER FLEXIBILITY**—It corrects for fluctuations of the A-C input line voltage and can tolerate variations in the A-C frequency. Result: it can be used with portable and standby alternators as well as on utility lines.
- **LESS CUBIC SPACE**—Designed for 19 inch relay rack mounting, with minimum panel height per KVA.
- **LONGER LIFE**—Shut-downs are practically eliminated by the conservative design of all components and the inclusion of two voltage reference tubes—one used as an ever-ready alternate.
- **LESS MAINTENANCE**—After the initial installation, no daily or weekly operating adjustments are required.
- **MORE DEPENDABLE**—Provides a constant output voltage regardless of the fluctuations normally present in the input line.

Peco A-C line voltage regulators are offered as separate items in five of the most popular ratings. For complete specifications write for bulletin Peco 110.

**POWER EQUIPMENT COMPANY**

5740 Nevada, East

Detroit 34, Michigan



CIRCLE ED-173 ON READER-SERVICE CARD FOR MORE INFORMATION

64

## Sample Parts Kit

Contains Insulated Hardware and Sockets



Packed in a small cardboard box and easily portable, this parts kit contains more than 30 different "Mycalex" glass-bonded mica items, with duplicates or different sizes of each. One tray contains 46 miniature and subminiature "Type 410" tube sockets. The other tray contains terminal boards, rods, and strips fabricated of "Type 400" and an assortment of "Type 410" molded products, such as coil forms, stand-off terminals, connector sleeves, rotors and rings, motor slot wedges, and switch wafers.

The items were chosen with a view to what might prove handy in building prototype models. The kit is offered at a very low price to engineers to introduce them to this firm's products. Mycalex Corp. of America, Dept. ED, 125 Clifton Blvd., Clifton, N. J.

CIRCLE ED-174 ON READER-SERVICE CARD FOR MORE INFORMATION

## Gaskets

For Waveguide Applications



This series of rectangular O-ring gaskets and their associated pressurized contact flanges were designed to meet the demand for more compact r-f and pressure-tight waveguide connections without loss in electrical performance.

The gaskets have a circular cross-section which provides an airtight seal upon compression. To insure an adequate r-f seal, a silver plated copper strip is mounted on the inner periphery of the gasket. This arrangement allows for a continuous electrical contact along both flange surfaces without disrupting the air seal.

This low vswr flange connection will transmit up to the peak power rating of the rigid waveguide, while eliminating the need for bulky cover-choke flange connections. Airtron, Inc., Dept. B, 1105 W. Elizabeth Ave., Linden, N. J.

CIRCLE ED-175 ON READER-SERVICE CARD FOR MORE INFORMATION

## RHODIUM PLATING

### Improves Contact Performance

With These Unbeatable Qualities:

- hard, corrosion-resistant, electrical contact surface
- assures low and stable contact resistance
- allows higher pressures to be used in sliding contacts
- not affected by atmospheric changes
- oxide-free contacts eliminate partial rectification and unwanted signals
- provides low noise level for moving contacts
- extremely long-wearing

These exceptional properties of RHODIUM plate assure greater efficiency; as a result, it is widely adaptable for electrical and electronic applications. RHODIUM plated contact surfaces are resistant to surface corrosion under all atmospheric conditions, proving extremely efficient in the field of high and ultra-high frequency.

Write for Free, detailed booklet on RHODIUM PLATING.



113 ASTOR STREET, NEWARK 5, NEW JERSEY

NEW YORK • SAN FRANCISCO • CHICAGO • LOS ANGELES

CIRCLE ED-176 ON READER-SERVICE CARD FOR MORE INFORMATION

*Kanthal DR resistance wire  
SAVES YOU UP TO 50% because...*

. . . it is lighter in weight (more feet per pound), and the per pound price is low. Total savings approximately 50%.

. . . Kanthal DR improves the performance of resistors and precision equipment. Its electrical resistivity is high — 812 ohms per circular mil foot — its temperature coefficient is low ( $\pm 0.00002^\circ\text{C}$  between  $-50^\circ$  and  $+150^\circ\text{C}$ ), and it has a low thermal EMF to copper.

Available in fine gages and all types of insulation.

WRITE FOR FURTHER INFORMATION AND PRICES TODAY



CIRCLE ED-177 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

## Another **FLASH-O-LENS** at work ...checking pigment dispersion at **B. F. Goodrich**



The inspection tool that *lights and magnifies*—FLASH-O-LENS—is in daily use at The B. F. Goodrich Company in making laboratory checks on the dispersion of pigments in milled rubber stocks.

The built-in bulb of a FLASH-O-LENS brightly illuminates the inspection area—the accurately ground lenses give sharp, detailed enlargement. Result: quick, simple inspection!

Battery and plug-in models from \$10.95. Write for free literature on applications, types, prices.

**E. W. PIKE & COMPANY**  
492 NORTH AVENUE ELIZABETH 3, N. J.  
CIRCLE ED-178 ON READER-SERVICE CARD FOR MORE INFORMATION

## How to select G-E wires cables and cords

for fixtures  
appliances  
machine tools  
portable tools  
and electrical  
equipment



### FREE BOOKLET

puts complete data at your fingertips.  
Write Section W112-1220, Construction  
Materials Division, General Electric  
Company, Bridgeport 2, Connecticut.

*Progress Is Our Most Important Product*  
**GENERAL ELECTRIC**

CIRCLE ED-179 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

## Rotary Indicator A Hand-Reset Signalling Device



With a length of only 3" and a width of 3/4", this Rotary Indicator has built-in spdt contacts. It can be used as a low power drain annunciator; a sensitive latching relay with mechanical reset; an overload circuit breaker with electrical and mechanical signal features at tripping levels from 6 mils upward; and in similar applications.

Having high shock and vibration resistance, it may be used on airborne control panels. The indicating face of the rotary latch may be colored to specification. Luminescent pigments may also be used.

A sufficient signal into the coil terminals causes the release of the rotating latch protruding from the face of the unit. The latch rotates downward exposing a marked or colored face. The latch is reset by finger and will lock into the reset position only if the incoming signal has been removed. The latch controls the spdt contacts so that these are switched only as the latch moves.

The indicator is built into an anodized aluminum case. It is furnished for use with a wide range of d-c or a-c currents from 6 mils up and for frequencies up to 60cy. Weight is less than 3oz, and power drain, depending on application, can be as low as 0.03w. Allard Instrument Corp., Dept. ED, 30 Broad St., New York 4, N. Y.

CIRCLE ED-180 ON READER-SERVICE CARD FOR MORE INFORMATION

## Humidity Cabinets Provides 50-99% Humidity



This low cost cabinet provides controlled relative humidity at any point from 50% to 99%, and a dry bulb temperature range from ambient to +70°C. High humidity without condensation on test specimens is provided by a counterflow air baffle—cooling coil arrangement.

The design allows automatic operation at ambient, slightly below ambient, and up to 70°C, with fine control of humidity ( $\pm 2\%$  at any point). Dry bulb temperature is controlled to  $\pm 1^\circ\text{C}$ . The cabinet may be drained and used as a dry type incubator.

Cabinets are made in four standard sizes from 1.4 cu ft to 10.0 cu ft capacity. Standard operation is from 115v 60cy a-c. Blue M Electric Co., Dept. ED, 306-308 W. 69th St., Chicago 21, Ill.

CIRCLE ED-181 ON READER-SERVICE CARD FOR MORE INFORMATION

*Have you a similar fastening problem?*

File: Simmons LINK-LOCK



When the armed forces needed a positive, high-strength fastening device for instrument housings, transit cases, and storage boxes, Simmons developed LINK-LOCK. This brand-new device works with fingertip pressure, furnishes up to 450-lb. pull-down pressure. Open or closed, it always lies perfectly flat.

LINK-LOCK may be the answer to your fastening problem. If your design involves heavy fastening pressures, watertight sealing, high strength, resistance to impact, write for LINK-LOCK DATA SHEET.

SIMMONS FASTENER CORPORATION, 1763 No. Broadway, Albany 1, N. Y.

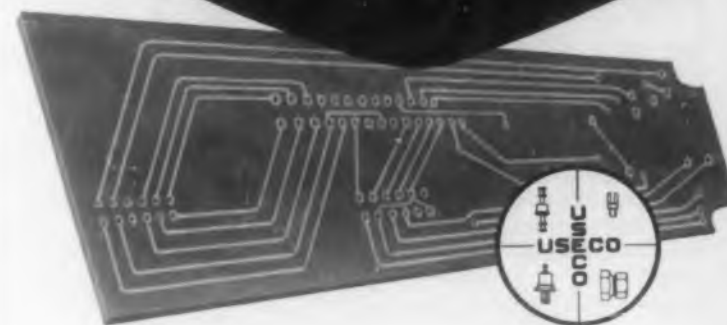
**Simmons**

LINK-LOCK  
QUICK-LOCK  
SPRING-LOCK  
ROTO-LOCK

FASTENERS WITH USES UNLIMITED

CIRCLE ED-182 ON READER-SERVICE CARD FOR MORE INFORMATION

ETCHED AND PRINTED  
**CIRCUITS**



Long a recognized leader in standardized electronic hardware and terminal board fabrication, U. S. Engineering Co. now offers expanded facilities for the mass production of *quality* etched circuits to your prints. Prototype inquiries as well as production runs are invited. Cost estimates and quotations are given immediate attention. Send for new illustrated 8-page Brochure.

**U.S. ENGINEERING CO.**  
521 COMMERCIAL ST., GLENDALE 3, CALIF

CIRCLE ED-183 ON READER-SERVICE CARD FOR MORE INFORMATION

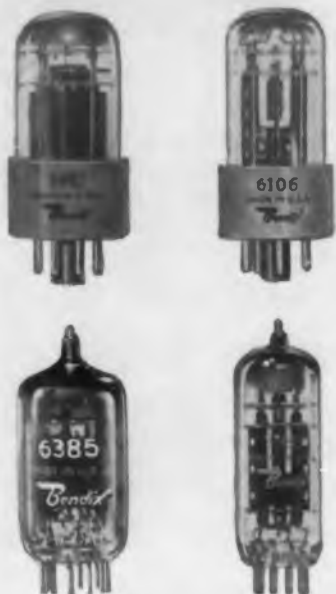


# DEPEND ON

# Bendix

Red Bank

## RELIABLE ELECTRON TUBES



With electronic controls taking over more and more operational functions in military and industrial applications, it is becoming increasingly important that the electron tubes used be dependable under extremely severe conditions. This applies particularly to installations in aircraft where tubes must operate reliably at high altitudes, while subjected to continuous vibration, varying voltages and frequent shock. Because of their advanced design and construction . . . born of never-ceasing research and special production skills . . . Bendix Red Bank Reliable Electron Tubes have the dependability necessary to meet these severe operating conditions. You can depend on our long, specialized experience to give you the right answer . . . for all types of regular as well as special-purpose tube applications. Tubes can be supplied to both commercial and military specifications. Call on us for full details.

Manufacturers of Special-Purpose Electron Tubes, Inverters, Dynamotors, Voltage Regulators and Fractional D. C. Motors

DESIGNATION AND TYPE					TYPICAL OPERATING CONDITIONS		
Type	Proto-type	Bendix No.	Description	Base And Bulb	Heater Voltage	Plate Voltage Per Plate	M.A. Load
5838	6X5	TE-3	Full Wave Rectifier	Octal T-9	12.6	350.	70.
5839	6X5	TE-2	Full Wave Rectifier	Octal T-9	26.5	350.	70.
5852	6X5	TE-5	Full Wave Rectifier	Octal T-9	6.3	350.	70.
5993	6X4	TE-10	Full Wave Rectifier	9-Pin Miniature	6.3	350.	70.
6106	5Y3	TE-22	Full Wave Rectifier	Octal T-9	5.0	350.	100.

Type	Proto-type	Bendix No.	Description	Base And Bulb	Heater Voltage	Plate Voltage	Screen Voltage	Grid Voltage	Gm	Plate Current	Power Output
5992	6V6	TE-8	Beam Power Amplifier	Octal T-9	6.3	250.	250.	12.5	4000	45. MA	3.5 W
*6094	6AQ5 6005	TE-18	Beam Power Amplifier	9-Pin Miniature	6.3	250.	250.	12.5	4500	45. MA	3.5 W
6385	2C51 5670	TE-21	Double Triode	9-Pin Miniature	6.3	150.	—	-2.0	5000	8. MA	—

\*Tube Manufactured with Hard (Nonex) Glass for High Temperature Operation (Max. Bulb Temp. 300°C.)

# Bendix

Red Bank

DIVISION OF



EATONTOWN, N. J.

West Coast Sales and Service: 117 E. Providencia Ave., Burbank, Calif. • Expert Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y. Canadian Distributor: Aviation Electric Ltd., P.O. Box 6102, Montreal, P. Q.

CIRCLE ED-149 ON READER-SERVICE CARD FOR MORE INFORMATION

## Dynamotor

Withstands 10,000g

This extremely rugged dynamotor, developed for the U.S. Army, is for use where space and weight are at a premium. It measures 3-5/8" long x 1-1/4" diam: about the size of a roll of quarters.

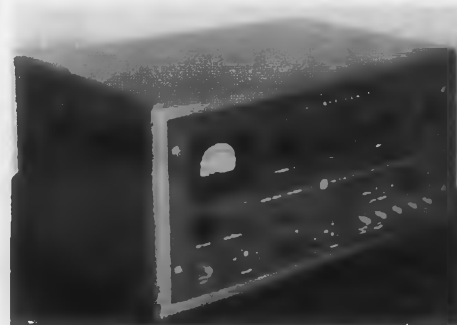


The miniature dynamotor's ruggedness was tested by firing it from a 57mm rifle. It withstood a force of 10,000g. It continues to operate during a 10,000rpm spin. The dynamotor has an input of 6v at 1.5amp, an output of 150v at 25ma, 42% efficiency, and weighs 1 lb. Electro Engineering Products, Dept. ED, 75 E. Wacker Dr., Chicago, Ill.

CIRCLE ED-150 ON READER-SERVICE CARD FOR MORE INFORMATION

## Pulse Delay Generator

With Internal or External Trigger



The "1000-A" is a precision variable-delay generator that provides a positive pulse, variable in delay from 1.0μsec to 999.9μsec. The accuracy of delay

is ±0.05μsec, and the jitter is less than 0.01μsec. Selection of delay is accomplished by gating a single pulse from an accurately generated pulse train.

The unit may be triggered externally or internally, with the PRF in pulses per second being indicated on a meter. The internal trigger generator provides pulses in two ranges (20-200pps and 200-2000 pps) and supplies a trigger pulse for an oscilloscope approximately 2μsec in advance of the reference pulse. The reference pulse is made available from a separate jack for use in triggering other equipment. This pulse may also be selected to appear with the delayed pulse to give a paired pulse output.

Calibration is readily accomplished by throwing a switch to "CAL" and adjusting the PRF meter for a dip. Other features include a delayed scope trigger which makes it possible to readily observe the delayed output pulse on a 10μsec sweep with less than 0.01μsec jitter. A built-in mixer circuit is also incorporated which mixes the selected delayed pulse with positive pulse video signals. The unit is designed to mount into a standard relay rack, the front panel being 8-3/4" x 19". Donald C. Harder Co., Dept. ED, 338 India St., San Diego 1, Calif.

CIRCLE ED-151 ON READER-SERVICE CARD FOR MORE INFORMATION

# COOL



## BIRTCHEK KOOL KLAMPS



KOOL KLAMPS are made of a specially developed, heat treatable alloy 99 1/2% pure silver. Under certain conditions, KOOL KLAMPS reduce subminiature tube temperatures as much as 40° C.

In addition, KOOL KLAMPS hold tubes firm and secure, regardless of how they are shaken or vibrated.

Where heat conditions are less critical, beryllium copper KOOL KLAMPS are available.

The BIRTCHEK CORPORATION

4371 Volley Blvd.  
Los Angeles 32, California

Dept. EL 12-54

Please send Bulletin which describes and illustrates Kool Klamps in detail.

Company .....  
Attention of .....  
City ..... State .....

CIRCLE ED-152 ON READER-SERVICE CARD



**ADVANCE** builds  
'em for heavy loads  
and long service!

Cramped quarters don't cramp the style of ADVANCE midgets and miniatures. You can use them on loads up to 5 amperes continuously... and at three times their rating intermittently—with complete safety. They'll resist shock and vibration... stand up under temperature extremes. You'll find them readily adaptable to any mounting need... any type of duty. Here are a few examples:

#### "TINY MITE"

##### MM & MP SERIES

This ultra-small d-c relay occupies less than 1/2 cu. in. mounting space! It's stable under vibration and shock... plated to prevent corrosion. Operate time is 5 milliseconds. Contact rating: .5 amp. or 1 amp.

##### MINIATURE TELEPHONE TYPE TQ SERIES

Only .94 cu. inches in size, yet this relay carries 5-amp. loads in any combination up to 4 PDT. Mechanically secured throughout, it's extremely efficient. No gassing or bubbling. Withstands 10G vibration. Temperature range: -55° to +125° C.

**Hermetic enclosures** on these types are impervious to varying climatic conditions... are sealed and carefully checked against leakage.

Write for literature on any of the above series, or the complete ADVANCE line.



### ADVANCE ELECTRIC AND RELAY CO.

2345-K NORTH NAOMI STREET  
BURBANK, CALIFORNIA

Sales Representatives in Principal Cities of  
U.S. and Canada

CIRCLE ED-155 ON READERS-SERVICE CARD

### Vacuum Tube Voltmeter For A-C and D-C Measurements

The "VM-82" a-c/d-c Vacuum Tube Voltmeter features wide range, excellent stability, and high sensitivity. The unit has a sloping front control panel mounted in a polished walnut cabinet. Output terminals, controls, and a 4-1/2" panel meter are mounted on the front, and a calibrating potentiometer is conveniently located at the rear of the unit.



For d-c measurements, the range is 50mv full-scale to 500v full-scale, with 11 range positions. Input resistance is 50 megohms on all ranges. Power input is 115v, 60cy a-c, approximately 25w. Accuracy is 3% of full scale on all range positions.

For a-c measurements, an r-f probe using a germanium diode in a half wave rectifier is provided. The probe is so designed as to keep a high input impedance at high frequencies. The range is from 75mv full-scale up to 20v rms full-scale, with eight range positions. Shunt capacitance is 1.5mmfd. The frequency response is from 10ke to 250Mc and is essentially flat from 11ke to 200Mc.

Curves are provided with the instrument calibrated in terms of the d-c scale for more accurate readings in the r-f ranges. Scientific Specialities Corp., Dept. ED, Snow & Union Sts., Boston 35, Mass.

CIRCLE ED-156 ON READER-SERVICE CARD FOR MORE INFORMATION

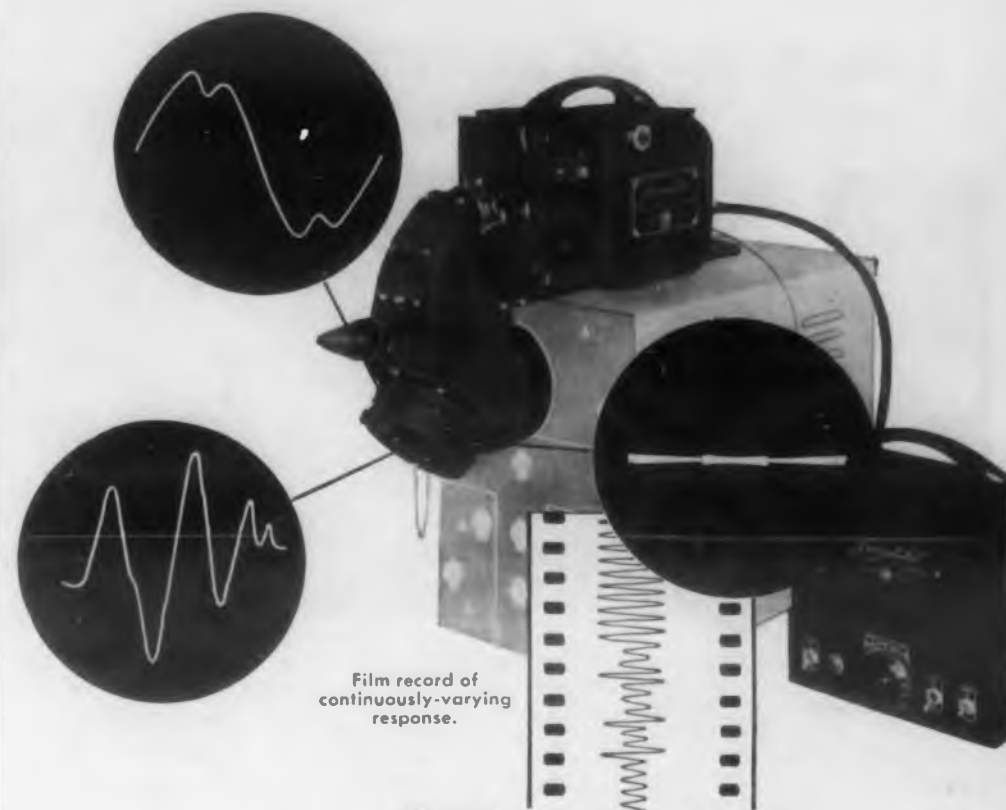
### Wattmeter Terminations Cover 100-26,500Mc Spectrum



This firm has extended its series of primary standard calorimetric wattmeter terminations to cover the spectrum from 100Mc to 26,500Mc. The MC-1B model, with associated adapters, covers the range from 2600Mc to 26,500Mc. The MCX-1A, a coaxial type, covers the range from 100Mc to 3000Mc. The MCL-1A L-band termination (illustrated) covers, with adapters, the range from 1120Mc to 2600Mc.

All models feature a very low residual vswr, primary standard accuracy, and direct-reading of average power up to 600w over a plurality of expanded scales. The wattmeter terminations are supplied with an associated liquid circulator which can be modified, on request, to permit metering of high average powers. Cubic Corporation, Dept. ED, San Diego, Calif.

CIRCLE ED-157 ON READER-SERVICE CARD FOR MORE INFORMATION



Film record of continuously-varying response.

## the FAIRCHILD Oscillo-Record Camera

# WILL CATCH ANY TYPE PATTERN

Any type of wave pattern—stationary, single-transient or continuously varying, can be photographed with the Fairchild Oscillo-Record Camera. Film speed is electronically controlled and continuously adjustable for all speeds from 1 to 3600 inches per minute (on special order, 2 to 7200 inches per minute). You can adjust to the correct speed for maximum clarity without wasting film. The sprocket film drive eliminates film slippage.

The Oscillo-Record will accommodate either 100-, 400- or 1000-foot lengths of 35 mm film. The entire length of film can be exposed at any speed. Fairchild's top-of-scope mounting permits easy adjustment of the oscilloscope controls and eliminates the use of a tripod.

#### Fairchild-Polaroid® Oscilloscope Camera

You can produce a print of any stationary or single-transient pattern in one minute with this Fairchild camera. The trace reads from left to right and is reduced to exactly one-half life size for easy measurement. Two images may be exposed on each 3 1/4 x 4 1/4 print.

For more information on Fairchild oscilloscope cameras and how they can assist you in engineering and research analysis, write Fairchild Camera and Instrument Corporation, Robbins Lane, Syosset, L. I., N. Y., Department 120-22G2.

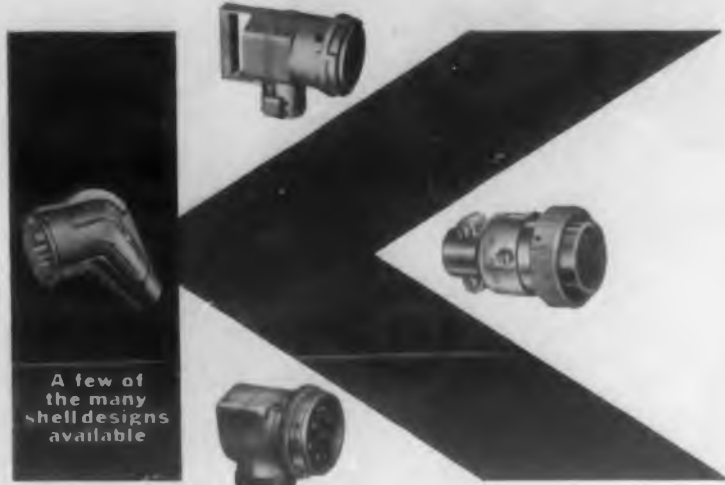
# FAIRCHILD

## OSCILLOSCOPE RECORDING CAMERAS

CIRCLE ED-158 ON READER-SERVICE CARD FOR MORE INFORMATION

## Specify Cannon K Connectors!

All-Purpose • Versatile • Stable Design



A few of the many shell designs available

- Special Acme thread for rapid disconnect
- Improved insulating materials
- 10 to 200 amp. contacts
- Thermocouple contacts
- Integral clamps
- Miniatures
- Hermetic sealed units
- High temperature types
- Widest variety of circuitry
- Complete line of fittings and accessories
- Shielded single and twin co-axial contacts

You'll find—

Popular groups of K units are available near you from many Cannon distributors

## CANNON PLUGS

Please refer to Dept. 143 in requesting K-5 Bulletin  
**CANNON ELECTRIC COMPANY** 3209 Humboldt St., Los Angeles 31, Calif.  
 Factories in Los Angeles; East Haven; Toronto, Canada; London, England  
 Representatives and distributors in all principal cities.

CIRCLE ED-196 ON READER-SERVICE CARD FOR MORE INFORMATION

## Power Tube For U-H-F Service



The 6524 is a sturdy, compact, twin-unit, beam-power tube for service in fixed or mobile communications equipment operating in the ultra-high-frequency range from 450Mc to 470Mc. The tube is engineered for use as a push-pull r-f power amplifier or as a frequency tripler. It has a maximum plate dissipation of 25w under ICAS conditions, and, in class C telegraphy and frequency-modulated service, is capable of approximately 20w of useful power output at 462Mc. This output can be delivered with a plate voltage of only 300v and a plate current of 150ma.

Designed to provide highly efficient push-pull service with conventional line-type circuits, the transmitting tube provides a single cathode for the two beam power units to make cathode inductance negligible; balanced unit arrangement to prevent input degeneration; and short, heavy internal leads and high-conductivity seals to minimize r-f losses. Maximum overall length is 3-9/16"; maximum diameter is 1-13/16". Weight is about 3oz. Tube Div., Radio Corporation of America, Dept. ED, Harrison, N. J.

CIRCLE ED-198 ON READER-SERVICE CARD FOR MORE INFORMATION

## for Rapid Testing and INSPECTING RESISTORS

1 Ohm to 1,111,111 Ohms

Large panel meter indicates deviation from -20% to +20% as rapidly as unknowns are plugged into terminals, in terms of built-in standard. Colored meter-scale segments clearly indicate 5% and 10% limits. Accuracy is within ±0.5%.

This limit bridge is ideally suited for use as a control unit in automatic sorting or inspecting. It is a precise Wheatstone Bridge for general resistance measurements by the null method for ±0.25 to ±0.4% accuracy.



Write for Complete Data

Type 1652-AM Resistance Limit Bridge (Cabinet Model): \$425.00  
 Type 1652-AR Resistance Limit Bridge (Relay Rack): 425.00

**GENERAL RADIO Company** 275 Massachusetts Ave., Cambridge 39, Mass.  
 90 West St. NEW YORK 6 • 1100 17th St., Silver Spring, Md. WASHINGTON, D.C.  
 920 South Michigan Ave. CHICAGO 5 • 1000 North Seward St. LOS ANGELES 38

CIRCLE ED-200 ON READER-SERVICE CARD FOR MORE INFORMATION



## CASTELL push button LOCKTITE lead holder has PERFECT BALANCE

Perfect balance makes Push Button CASTELL LOCKTITE Holder the king of its class.

Exclusive collet holds lead in **bull dog grip**, preventing slipping or turning.

No graphite dust stains your fingers—because with one-hand push-button action you extend and retract the lead. No need to touch graphite. Comfortable "wood-pencil" feel—not metallic.

Equipped with easily-replaced clutch, giving your LOCKTITE indefinite life.

Imported CASTELL 9030 Lead inserted in your LOCKTITE Holder gives you the combination for brilliant results on your drawing board. Ask your Dealer for both—LOCKTITE Holder and Imported CASTELL 9030 Lead in 19 degrees, 7B to 10H.

**AW. FABER-CASTELL**  
 PENCIL COMPANY, INC., NEWARK 3, N. J.

CIRCLE ED-197 ON READER-SERVICE CARD FOR MORE INFORMATION

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## ANOTHER NEW FAIRCHILD POTENTIOMETER



### TYPE 745 10-TURN HELICAL

Designed for use in high speed computers, guided missiles, etc., the Type 745 features high electrical accuracy (linearity ±0.025%) and a resistance range from 100 to 300,000 ohms. This 10-turn helical potentiometer weighs 7 ounces and meets rigid government requirements for resistance to humidity, salt spray, altitude, temperature, vibration, shock, sand and dust, and fungus. The Type 745 is 2" in diameter and 2-5/32" long from the front of the servo flange to the end of the case. Mechanical and electrical rotation is 3600° (+2°-0°) with a starting torque of 1 oz.-in.

### SAMPLES AVAILABLE ON ORDER

The Type 745 is another reason why Fairchild can help you solve all your precision potentiometer problems. For more information write Fairchild Camera & Instrument Corp., Potentiometer Division, 225 Park Avenue, Hicksville, L. I., N. Y., Department 140-49N1.

**FAIRCHILD**  
 PRECISION POTENTIOMETERS

CIRCLE ED-199 ON READER-SERVICE CARD FOR MORE INFORMATION

## MARKEM MACHINES

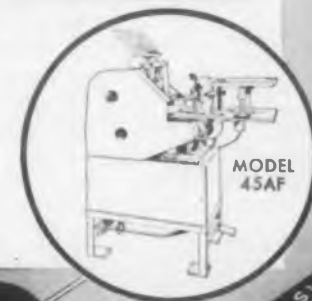
### Solve "IN-PLANT" PRINTING PROBLEMS

— FASTER — NEATER — AT LOWER COST

The Markem Model 45AF Machine prints trade name, trade mark, specifications, etc., on resistors, condensers, capacitors, diodes, triodes, transistors, etc., at production rates. Feeds, prints, and ejects automatically. Quickly insertable type provides easy change in data being printed.

Write for further information. Submit sample of item you wish to mark.

### WIRE LEAD COMPONENT PRINTING

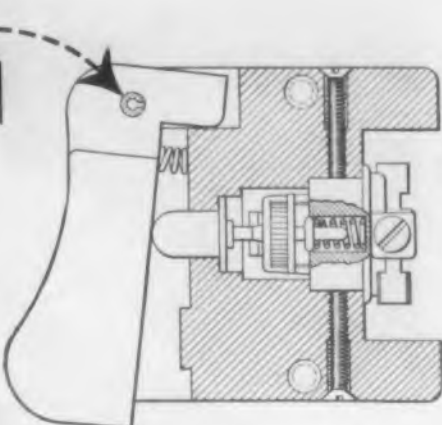


**MARKEM  
MACHINE CO.**  
 KEENE 19,  
 NEW HAMPSHIRE

CIRCLE ED-201 ON READER-SERVICE CARD FOR MORE INFORMATION

**ROLLPIN**  
TRADEMARK

**cuts rejects on this plastic assembly 25%**



If your assembly is made of plastics, check up on Rollpin. In applications like the phenolic trigger switch above, it cut production costs and actually reduced, from 25% to zero, rejections due to cracking of the plastic parts during seating of the pivot pin. Rollpin is a slotted, hollow steel spring pin with chamfered ends. Pressed into holes molded or drilled to normal production tolerances, it compresses as inserted. It makes a self-locking, vibration-proof fastener. It is light, easily removable, and reusable. Available in diameters .062, .078, .094, .125, .140, .156, .187, and up to .500 in a broad range of standard lengths.



For detailed information and help with electronic fastening problems, write Dept. R32-1257.

**ELASTIC STOP NUT CORPORATION OF AMERICA**

2330 Vauxhall Road, Union, N. J.

DESIGN HEADQUARTERS FOR SELF-LOCKING FASTENERS  
CIRCLE ED-202 ON READER-SERVICE CARD FOR MORE INFORMATION

**Microwave Testing Unit For X-Band Measurements**



This compact, easy-to-operate microwave testing instrument is designed to simplify laboratory and field testing of X-band Radar. It is entirely self-contained, except

for external connecting cables. Its functions include means to measure power, observe transmitter spectra distribution, measure frequency, and supply artificial signals. Bandwidth characteristics may also be analyzed, and there is a self-contained square wave generator useful for standing wave measurements.

Designed for easy operation by personnel with minimum training, the equipment features quick function selection and conveniently grouped controls. It has a modular construction, with each test section mounted on a separate plug-in sub-chassis. Special sections can be provided for unusual applications. It functions in the 8.5-10kMc range. Size is 17" wide x 10-1/2" high x 13" deep. Weight is 45lb. Kearfott Co., Inc., Western Manufacturing Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE ED-204 ON READER-SERVICE CARD FOR MORE INFORMATION

**Teflon\***

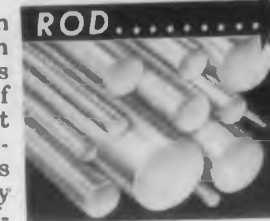
Your Best Source is



Thickness Inches	Nominal Size
1/16	12 x 12
3/16	18 x 18
1/4	24 x 24
5/16	36 x 36†
3/8	48 x 48†
1/2 & Up	

† Can be furnished in 1/2 sheets

**HERE'S WHY:** You can order in quantity, in a wide variety of sizes—and be certain of uniformity. Strict density control assures non-porous Teflon—free from any flaws that might affect end use or product. Dimensions are accurate—no rejects, waste of material, loss of time. You get product purity—Teflon at its best in every characteristic. Delivery is prompt—the quantity you want when you want it.



DIAMETER INCHES	
1/4	1
3/8	1 1/4
1/2	1 1/2
3/4	1 3/4
1	2
1 1/4	2 1/4
1 1/2	2 1/2
1 3/4	3

Other diameters on specification

TYPICAL SIZES INCHES	
O. D.	I. D.
3/8	1/4
1/2	3/8
3/4	1/2
1	3/4
1 1/2	1
2 1/2	1 1/2
3	1 3/4

Request full information, including informative bulletin, Crane Packing Co., 1841 Belle Plaine Ave., Chicago 13, Ill.  
In Canada: Crane Packing Co., Ltd., 617 Parkdale Avenue, N., Hamilton, Ont.  
\*DuPont Trademark

**JOHN CRANE CRANE PACKING COMPANY**

CIRCLE ED-206 ON READER-SERVICE CARD FOR MORE INFORMATION

the most widely used  
**Electronic Supply Guide**

free send for it

**ALLIED'S**  
COMPLETE 308-PAGE  
**1955 CATALOG**

**your guide to the world's largest stocks of ELECTRONIC SUPPLIES FOR INDUSTRY**

Simplify and speed all your purchasing of electronic supplies and equipment. Send your orders to us for fast shipment from the world's largest stocks of electron tubes (all types), test instruments, audio equipment, electronic parts (transformers, capacitors, controls, etc.). Our expert Industrial supply service saves you time, effort and money. Send today for your FREE 1955 ALLIED Catalog—the complete up-to-date guide to the world's largest stocks of quality Electronic supplies for Industrial use.

**ALLIED RADIO**

100 N. Western Ave., Dept. 69-M-4  
Chicago 80, Illinois

One complete dependable source for everything in electronics

CIRCLE ED-203 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

For Mark 7 and 8 Servo Motors—

**MAGNETIC SERVO AMPLIFIER**



Features of the PRD Type R40G10W1 Magnetic Amplifier:

The R40G10W1 can be supplied either as illustrated or with a built-in magnetic, transistor, or vacuum tube preamplifier. The moisture and fungus proofed rectifier is supplied for external mounting. This economical unit is ideal for integration with servo systems requiring Mark 7 and Mark 8 motors. Write for complete details or send your performance requirements for special magnetic amplifier applications.

- Response time of one cycle
- Temperature range -55°C to +85°C with normal servo duty cycles
- Hermetically sealed reactor unit only 2 1/2" high and 2 1/4" diam., weighs less than 12 oz.
- Power supply 115V ±10%, 400 cps ±10%, single phase
- Rugged design meets MIL-5272 Procedure I Vibration Spec.

**Polytechnic RESEARCH & DEVELOPMENT CO. Inc**  
202 TILLARY ST., BROOKLYN 1, NEW YORK  
Telephone: ULster 2-6800

CIRCLE FD-205 ON READER-SERVICE CARD FOR MORE INFORMATION



PANEL MOUNT

**MODEL "Y" ELECTRIC PRODUCTIMETER**

on the MACHINE or at CONTROL CENTER

The flexibility of the Model "Y" Electric Productimeter offers versatility of application to suit individual needs. Panel mounts grouped at control center give immediate production figures of many machines in different plant departments. Operates accurately over wide current fluctuations. Totally enclosed.



Hi-Speed, Compact, Accurate, Durable. Adaptable to panel or base mounting.

**DURANT MANUFACTURING CO.**

1993 N. Buffum St. Milwaukee 1, Wis.  
193 S. Water St. Providence 3, R. I.  
Representatives in Principal Cities

**PRODUCTIMETERS**  
Count Everything

CIRCLE ED-207 ON READER-SERVICE CARD FOR MORE INFORMATION

## Measure INDUCTANCE & CAPACITANCE ...just like ohms or volts!

**Inductance Ranges**  
0 to 3, 10, 30, 100, 300  $\mu$ h

**Capacitance Ranges**  
0 to 3, 10, 30, 100, 300  $\mu$ mf  
Accurate within 3%  
of Full Scale



The direct-reading Type 130 L,C Meter is as fast and as easy to use as an ohmmeter. With it you can accurately measure very small quantities of inductance and capacitance — full scale deflection equals 3 microhenries or 3 micromicrofarads on the lowest range. And it's easy to make capacitance measurements that used to be difficult... by application of the guard voltage to cancel strays and other undesirable effects. A real timesaver in circuit development... and a fast, accurate component tester.

**Tektronix Type 130 L,C Meter — \$195** f.o.b. Portland (Beaverton), Oregon

Call your Tektronix field engineer or representative for a demonstration — or write for descriptive folder.



**Tektronix, Inc.**

P. O. Box 831, Portland 7, Oregon  
CYpress 2-2611, Cable: TEKTRONIX

CIRCLE ED-208 ON READER-SERVICE CARD FOR MORE INFORMATION

## A-C INDUCTION TYPE New Series 15 and 18 SERVO MOTORS

Two new G-M Miniature Servo Motors are now available for use in electronic control circuits. The motors are standard frame sizes 15 and 18 which are 1.437" and 1.750" in diameter respectively, and are designed for use in a wide variety of equipment such as computers, gun sights, navigation equipment, guided missiles, radar and similar applications. These light weight, high torque, low inertia, two-phase induction motors are available in 2, 4 and 8-pole models for 400 or 60 cycle supply, and can be supplied to meet performance specifications for military servo motors, Mark 7 and Mark 8. The control phase can be wound for connection by the user for either series or parallel operation. The stators of the motors, as in all G-M Servo Motors, are embedded in an insulating compound of high dielectric strength and high temperature stability. This material has a low mechanical coefficient of expansion and great stability at high temperatures. High dielectric strength is maintained between windings and housing when at high altitudes. Write for information on G-M Size 15 and/or Size 18 Servo Motors to

**G-M LABORATORIES, INC.**  
4284 N. Knox Ave., Chicago 41, Ill.

CIRCLE ED-209 ON READER-SERVICE CARD FOR MORE INFORMATION



## Crossbar Switch

Handles High Frequencies



Developed originally as a color TV switcher, the "Type P" Crossbar Switch has features, such as ability to handle high frequencies, extremely low cross-

talk level, high speed, and compactness, making it useful in many multiple-switching applications.

The switch has two lines and 10 links with a maximum of six conductors per circuit; the upper two of the six conductors can be arranged to serve as holding circuits for the magnet coils. Each "crossover", of which there are 20, is controlled by an individual magnet coil. This switch, in effect, can perform the function of 20 six-pole relays bussed together, but without limitations in higher frequencies.

Each circuit behaves essentially as a transmission line of 110-ohm impedance up to a frequency of approximately 200Mc. The highest standing-wave ratio from d-c up to this frequency is 1.15 when the circuits are properly matched. The switch can be used with either unbalanced or balanced circuits. Bridging capacitance is of the order of 4mmfd for each link, and 15mmfd for line circuits. Maximum operating voltage is conservatively rated at 500v d-c.

Operate time is 6millisecc, and release time is 3.4-millisecc. Contacts are of the twin-palladium type, engaging with a minimum pressure of 35g. This relatively high pressure ensures freedom from microphonics and bounce. Actuating coils require approximately 2.5w d-c. Standard coils are manufactured for 12v, 24v, and 48v operation. James Cunningham, Son & Co., Inc., Dept. ED, Rochester 8, N. Y.

CIRCLE ED-210 ON READER-SERVICE CARD FOR MORE INFORMATION

## Capacitors

For High Temperature Uses

The Type XC line of tubular high temperature hermetically sealed miniature capacitors is designed for continuous operation from  $-65^{\circ}$  to  $+165^{\circ}$ C. The line has insulation resistance of 50,000 megohm per



mmfd minimum at  $+25^{\circ}$ C, 100 megohm per mmfd minimum at  $+125^{\circ}$ C, and 20 megohm per mmfd minimum at  $+165^{\circ}$ C. These new units are offered for any high temperature military or industrial application. Gudeman Co., Dept. ED, 340 W. Huron St., Chicago 10, Ill.

CIRCLE ED-211 ON READER-SERVICE CARD FOR MORE INFORMATION

## HIGH VOLTAGE PLATE TRANSFORMER



CLASS  
A, B,  
C, H



MOLDED MINIATURE  
BLOCKING OSCILLATOR TRANSFORMER

## TESTED PER MIL-T-27 IN OUR "IN-PLANT" FACILITIES

We are now producing government and commercial transformers in quantity. Our top flight engineering staff and complete electrical test facilities can help solve your toughest transformer problems.

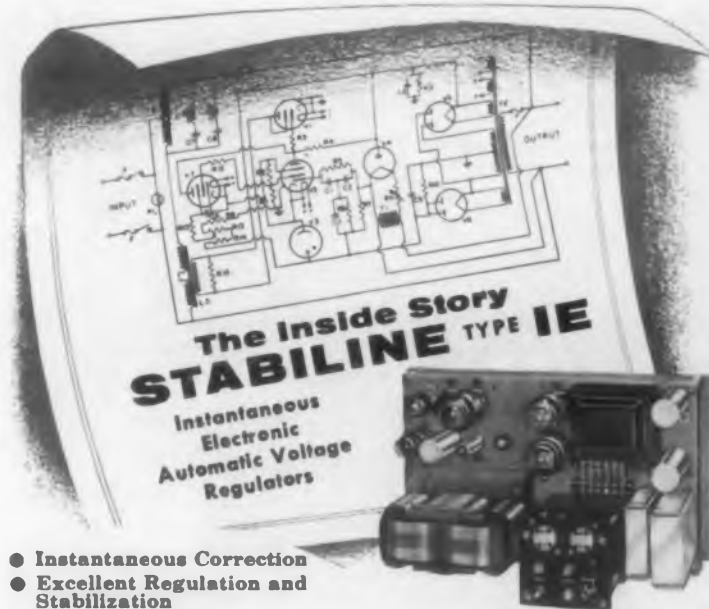
"In-plant" testing means a minimum of waiting before passing Government tests.

Write or phone for detailed information.

## ATLANTIC TRANSFORMER CORP.

30 Hynes Avenue, Groton, Connecticut • Hilltop 5-0353

CIRCLE ED-212 ON READER-SERVICE CARD FOR MORE INFORMATION



The Inside Story  
**STABILINE**  
TYPE IE

Instantaneous  
Electronic  
Automatic Voltage  
Regulators

- Instantaneous Correction
- Excellent Regulation and Stabilization
- Minimum Waveform Distortion
- Wide Input Range
- Adjustable Output Voltage
- Insensitivity to Frequency Changes

STABILINE Type IE5101R. Rated  
95-135 Volts, 60 cycles input,  
115 volts, 1.0 KVA output.

The circuit diagram shows how the error detector, the amplifier and power control circuit are combined in a STABILINE Type IE to deliver stabilized and regulated a-c voltage.

You will find a combination of circuit simplicity and mechanical ruggedness in STABILINE Automatic Voltage Regulators Type IE. Send us the details of your specific requirements or use the coupon below. Numerous models are offered in capacities from 0.25 to 5.0 KVA.

**The SUPERIOR ELECTRIC Company**

1712 Clarke Ave., Bristol, Conn.

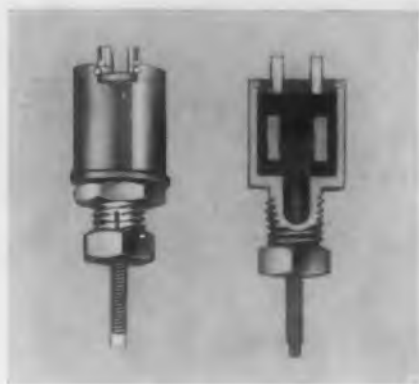
CIRCLE ED-213 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

Advertisement

## New Miniature LS-9 Coil Form

Unusually well shielded, rugged



Shown actual size

First of its kind! C.T.C.'s new LS-9 coil form assembly is particularly suited for applications that require miniature size, a rugged, shock-resistant construction and a mechanically enclosed, protected coil.

Electrically and mechanically shielded, the new assembly is excellent in I. F. strips and numerous receiver designs as they can be mounted adjacent to one another and can be used in circuits requiring coils shielded from outside radiation. Forms can be used as simple R. F. coils, tapped R. F. coils or R. F. transformers.

Each LS-9 assembly consists of a brass shell enclosing a powdered iron cup-core, tuning slug, phenolic coil form and silicone fibreglas terminal board. Three terminal boards are available with either a two, three or four terminal layout. Forms can be wound to customers' specifications. For complete information, write Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Mass.

CIRCLE ED-214 ON READER-SERVICE CARD FOR MORE INFORMATION

FREE

SAMPLES  
AND BOOKLET!

NEW SHAKEPROOF®

Plasti-Rings\*

CUT SHAFT  
RETAINING COSTS



\*Trade Mark

Slash costs of shaft retention and provide a more powerful, efficient retainer! Made of elastic vinyl that's oil, chemical and corrosion resistant, SHAKEPROOF Plasti-Rings roll into prepared groove on shaft . . . provide a shoulder that withstands up to 250 lbs. direct shear. 16 sizes: 1/8"–1" shaft size. Send for free Sample Kit and Booklet today!

SHAKEPROOF

"Fastening Headquarters"®



DIVISION OF ILLINOIS TOOL WORKS  
St. Charles Road, Elgin, Illinois • Offices in principal cities

CIRCLE ED-215 ON READER-SERVICE CARD FOR MORE INFORMATION

## Potentiometer

Dissipates 1w at 200°C



Designed for rugged, high-temperature use in computers, jet aircraft, and guided missiles, this compact "Hot-Pot" has a stainless steel case and shaft, precision toroidal winding on a ceramic form, and "Teflon"-insulated terminals.

Standard linearity is 0.5%; on special order, 0.25%. With standard single-hole panel mounting, depth behind panel 13/16".

Operating at 80°C, the dissipation is 5w. The toroidal winding allows winding angles up to 360° with extreme precision; standard is 354°. The unit is available in any resistance from 1000 ohms to 25,000 ohms. Waters Mfg., Inc., Dept. ED, 4 Gordon St., Waltham 54, Mass.

CIRCLE ED-216 ON READER-SERVICE CARD FOR MORE INFORMATION

## Calibration-Test Unit

Can Handle Four Instruments at Once



The "Model 500-A" is primarily for calibrating and testing all types of instruments using potentiometer type pick-offs. It is particularly applicable for calibration of free and erecting type gyroscopes, but modifications are easily made to adapt it to other types of instruments.

Simultaneous calibration of one, two, three, or four instruments is possible.

The set operates from 115v 60cy, and is built on a standard 19" relay rack. It incorporates a 28v power supply controlled by a magnetic amplifier, and has facilities for a 400cy 3-phase external source to operate the motors of the instrument being calibrated. This supply is rated at 2.5amp; regulation is 1%, and ripple voltage is 0.05v.

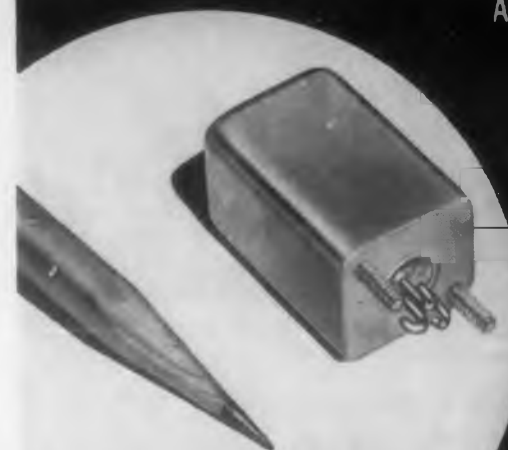
Four galvanometers on the panel front have associated bridge circuits for use in determining the following: potentiometer centering, drift, precession, spin axis, and many others. Potentiometer noise is quickly determined.

A major feature is an automatic timing device. The elapsed time meters are read in minutes and tenths of minutes, and an indicator lamp illuminates as a signal when timers have stopped. North American Electronic Research Corp., Dept. ED, 2301 S. Purdue Ave., West Los Angeles 64, Calif.

CIRCLE ED-217 ON READER-SERVICE CARD FOR MORE INFORMATION

# NEW SUBMINIATURE FILTERS

FOR TELEMETERING AND AIRBORNE EQUIPMENT



3 db AT 6% Band Width

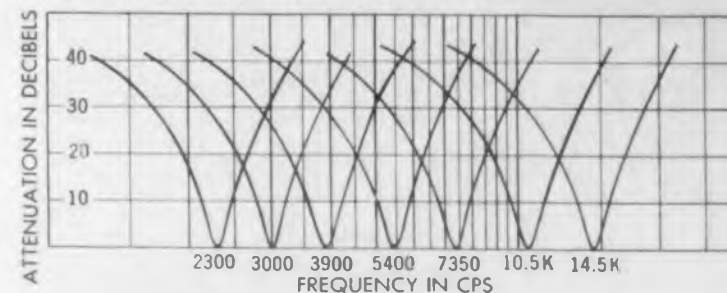
40 db/octave

FREQUENCY  
2.3–35Kc

IMPEDANCE IN  
600–10K  
OHMS

IMPEDANCE  
OUT—GRID

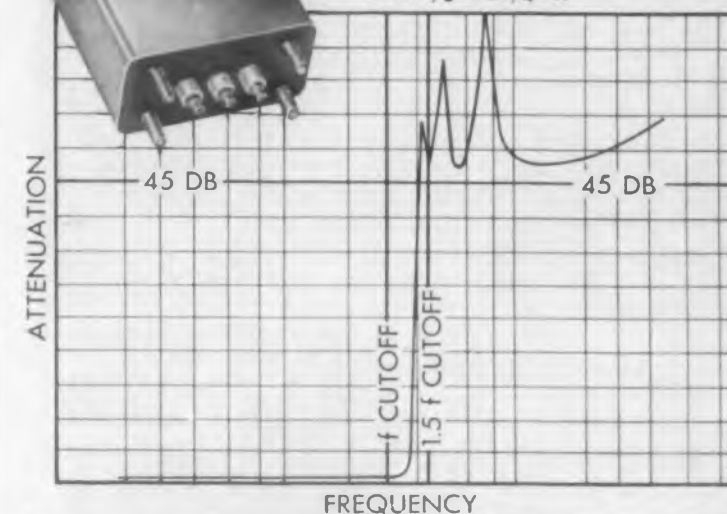
23/32" x 23/32" x 11/16" (Pictured Actual Size)



## STANDARD LOW PASS FILTER SERIES

OVER 45 DB ABOVE 1.5 f CUTOFF  
ALSO AVAILABLE IN SUBMINIATURE VERSION

1" x 17/8" x 23/4" H



### STANDARD FILTERS

PART NO.	IMPEDANCE	f-CUTOFF	PART NO.	IMPEDANCE	f-CUTOFF
90115	600	3000	90438	600	10000
90433	5000	3000	90439	5000	10000
90434	10000	3000	90440	10000	10000
90435	600	6000	90441	600	15000
90436	5000	6000	90442	5000	15000
90437	10000	6000	90443	10000	15000

FOR ADDITIONAL INFORMATION CONTACT

**COMMUNICATION ACCESSORIES COMPANY**  
HICKMAN MILLS, MISSOURI • PHONE KANSAS CITY, SOUTH 5528

CIRCLE ED-220 ON READER-SERVICE CARD FOR MORE INFORMATION

# MINIATURIZING YOUR EQUIPMENT?

Specify SIMPLEST, MOST COMPACT

## AMPERITE THERMOSTATIC DELAY RELAYS

MOST ECONOMICAL, HERMETICALLY SEALED



STANDARD



MINIATURE

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- Hermetically sealed. Not affected by altitude, moisture, or other climate changes.
- Circuits: SPST only — normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from  $-55^{\circ}$  to  $+70^{\circ}$ C. Heaters consume approximately 2 W. and may be operated continuously. The units are most compact, rugged, explosion-proof, long-lived, and — very inexpensive!

TYPES: Standard Radio Octal, and 9-Pin Miniature.

PROBLEM? Send for Bulletin No. TR-81

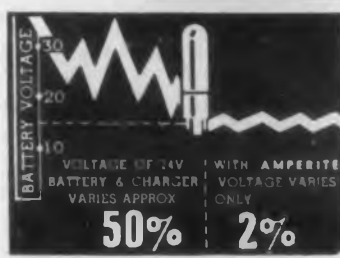
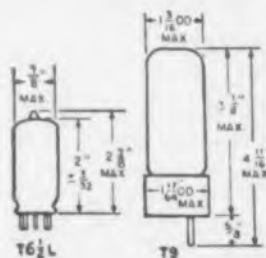
## BALLAST-REGULATORS

- Amperite Regulators are designed to keep the current in a circuit automatically regulated at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. Operates on A.C., D.C., or Pulsating Current.
- Hermetically sealed, light, compact, and most inexpensive.

Maximum Wattage Dissipation:  
T6½L—5W. T9—10W.



T9 BUBB



Amperite Regulators are the simplest, most effective method for obtaining automatic regulation of current or voltage. Hermetically sealed, they are not affected by changes in altitude, ambient temperature ( $-55^{\circ}$  to  $+90^{\circ}$ C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.  
In Canada: Atlas Radio Corp., Ltd., 560 King St. W., Toronto 2B

CIRCLE ED-221 ON READER-SERVICE CARD FOR MORE INFORMATION

## Electronic Counter

Will Count at 100,000cy Rate



Ruggedized for military field use, the Model 111 Electronic Counter will operate in ambient temperatures from  $-20^{\circ}$  to  $+150^{\circ}$ F. All components are military qual-

ity. Hermetically sealed transformers, glass-sealed high temperature ( $125^{\circ}$ C) capacitors, and computer-type tubes are employed.

Frequency division is all-digital, using 11 special plug-in decade sealers. No frequency adjustments are required, because the counting interval is generated by digital division from a crystal oscillator.

Internal self-checking is provided so that the unit will count its own standard crystal at either of two selected rates, 100,000cy or 1000cy. The checking signals are fed to the input to check all possible components such as preamplifiers and attenuators. The basic crystal signal of 100,000cy is brought to a front panel connector to allow checking against an external standard, or for use as a secondary standard.

An input level meter is located on the front panel to indicate the proper amplitude of the input signal. The counter will count up to 99,999. The counting interval is 1sec or 10sec with an adjustable display time. The counter measures 22" wide x 12-1/2" high x 17" deep, and weighs 120lb. Electronic Engineering Co. of California, Dept. ED, 180 S. Alvarado St., Los Angeles 57, Calif.

CIRCLE ED-222 ON READER-SERVICE CARD FOR MORE INFORMATION

## Pressure Pickups

In Ranges from 1—75,000psi



This complete line of capacitive-type "Dyna-Gage" pressure pickups has highly improved performance, including capability of operation at temperatures up to  $600^{\circ}$ F, in highly corrosive atmospheres and under high vibration.

Among the features of these units are: pressure ranges from 1psi to 75,000psi; outputs up to 15v with a 25,000 ohm load; frequency response from 0 to 10,000cy; flush diaphragm construction; high stability with water cooling; and shock resistance. Photocon Research Products, Dept. ED, 421 N. Foothill Blvd., Pasadena 8, Calif.

CIRCLE ED-223 ON READER-SERVICE CARD FOR MORE INFORMATION

on the design table  
...and in the  
production line

## ACE NYLON BALLS

KEEP THINGS MOVING SMOOTHLY IN  
HUNDREDS OF INDUSTRIAL APPLICATIONS!

MASS-PRODUCED OF DuPONT NYLON FM No. 10001  
TO CLOSE TOLERANCES OF  $\pm .001$ . Sizes 1/8" to 3/4"

Ace Nylon Balls have brought new design flexibility and production economy to many of America's largest manufacturers. Uniform, precision-fabricated, light-weight Ace Nylon Balls are tough at low temperatures, stable at high temperatures, and resistant to chemicals and abrasion. Ace Nylon Balls may add greater efficiency and economy to your products, too.

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OUR ENGINEERS  
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## ACE PLASTIC COMPANY

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1207

## A Precise, Wide-band, Continuously Variable Delay Line

BY NORMAN GAW, JR.  
AND DAVID SILVERMAN  
Helipot Corporation  
MELVIN B. KLINE  
Instrument Division  
Allen B. DuMont Laboratories, Inc.

Presented at THE 1954 WESCON

416

**Helipot** first in precision potentiometers  
Helipot Corporation / South Pasadena, California  
a division of BECKMAN INSTRUMENTS, INC.

CIRCLE ED-225 ON READER-SERVICE CARD FOR MORE INFORMATION

## There's always room for a Fenwal Miniature THERMOSWITCH® control



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Designed for:  
CRYSTAL OVENS  
GUIDED MISSILES  
WAVE GUIDES  
RADAR - COMPUTERS  
ANTENNAS

and many others where temperature control is vital and space is at a premium, the new Fenwal Miniature THERMOSWITCH units are real problem solvers.

Bringing you advantages never before found in so small a control, these rugged little devices are extremely sensitive to temperature variations and positive in action. Adjustable anywhere within the range of 0°F to 200°F, they maintain normal control characteristics under vibrations ranging up to 5 G's.

For details on how you can get maximum dependability of temperature control in minimum space, send for your copy of the Miniature THERMOSWITCH Control bulletin.

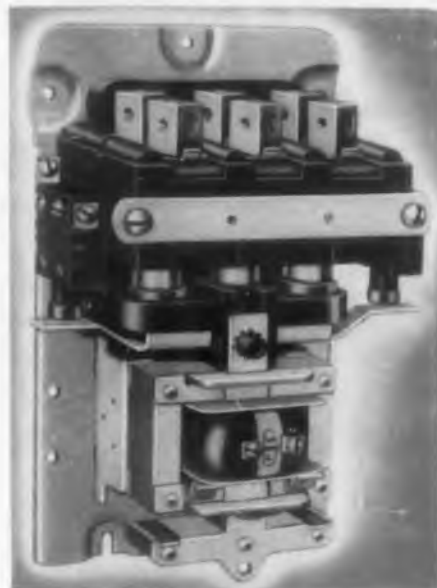
Write Fenwal Incorporated, 912 Pleasant St., Ashland, Mass.



**THERMOSWITCH®**

Electric Temperature Control and Detection Devices  
**SENSITIVE...but only to heat**

CIRCLE ED-226 ON READER-SERVICE CARD FOR MORE INFORMATION



**1000  
contactors  
in 1**

You're looking at the most versatile solenoid contactor ever developed for building electrical controls.

This Ward Leonard Size 2 contactor is available in three basic models, six major variations, one thousand combinations.

Your savings: reduced stock, minimum panel space, lower assembly costs, less layout and drafting time. Write for Bulletin 4450 to Ward Leonard Electric Co., 77 South St., Mount Vernon, N.Y.

4.15

**WARD LEONARD ELECTRIC CO.**

Result **E**ngineered Controls Since 1892

RESISTORS • RELAYS • MOTOR CONTROLS • CHROMASTER



CIRCLE ED-227 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

## Connectors Permit Side Mounting



The G-20 Series high potential miniaturized "Continental Connector" is designed for space-saving side mounting. It is available with two,

three, and four contacts. The precision machined sockets are of spring temper phosphor bronze, while pin contacts are of brass. Both are gold plated over silver for low contact resistance and easy assembly soldering.

Moldings are available in a choice of three different compounds: mineral filled melamine, plaskon reinforced (glass) alkyd type 440, and Orlon filled diallyl phthalate. DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N. Y.

CIRCLE ED-228 ON READER-SERVICE CARD FOR MORE INFORMATION

## Clutches and Brakes

With 6millisec Response Time



This line of magnetic clutching and braking devices is for application in computers and mechanisms that require a high order of clutching

and braking accuracy. The line includes a single clutch, a double clutch, and a clutch-brake.

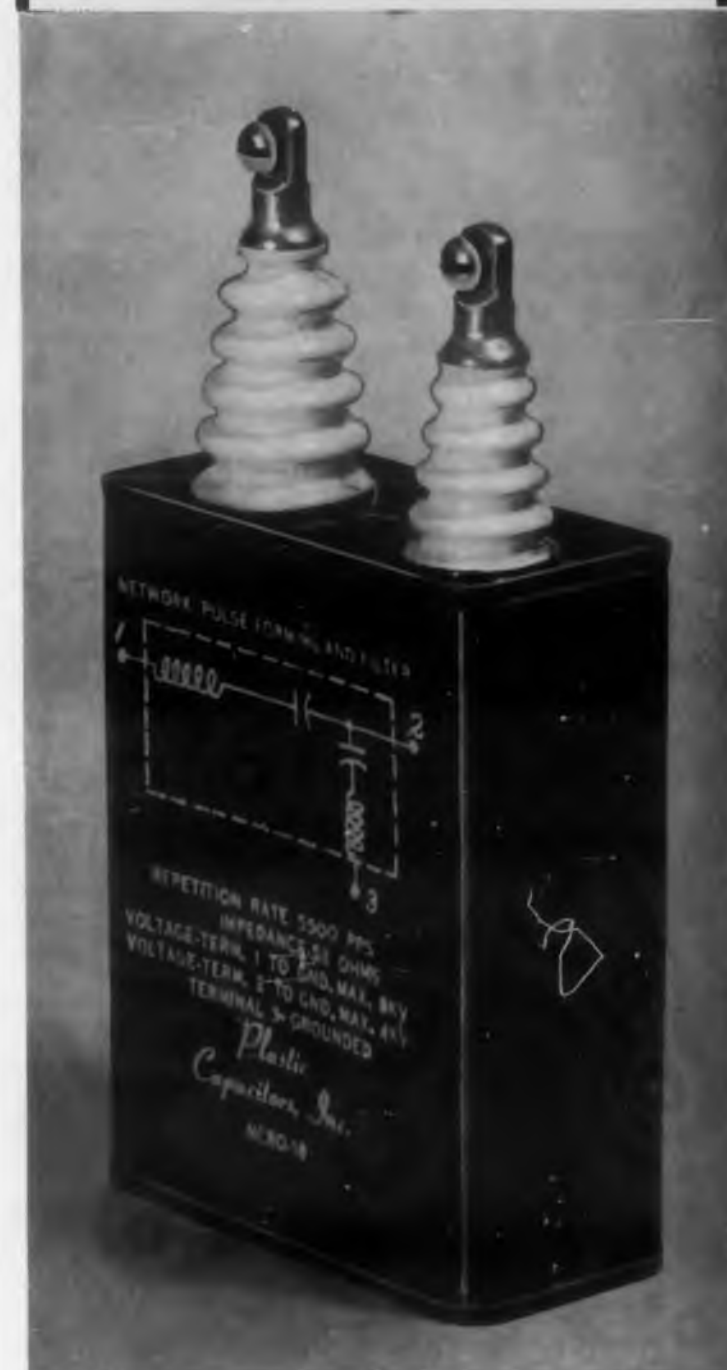
Designed to meet military specifications, the units provide the advantages of: continuous operation (can be energized for indefinite periods); immediate release upon de-energizing; extremely rapid "pull-in"; negligible steady state control current requirement; wide environmental range; miniature size, and light weight. They are designed with a definite neutral position for the friction disc, precluding dragging on the friction face regardless of mounting position. Operating temperature range is -65° to +165°F. Power requirement is 25v, d-c.

With the incorporation of a telephone-type relay, maximum response time of all three units is 6millisec or less; without a relay, response time is slightly higher. They are designed for a maximum torque of 16 oz-in, and for intermittent duty at speeds to 1000rpm.

Overall length (including shaft) of the largest unit—the double clutch—is only 4.50"; weight of this unit is 1.5 lb. Ford Instrument Company, Dept. ED, 31-10 Thomson Ave., Long Island City 1, N. Y.

CIRCLE ED-229 ON READER-SERVICE CARD FOR MORE INFORMATION

## Pulse Forming Networks



**We are specialists with many years of experience in engineering and producing PULSE FORMING NETWORKS**

*We invite your inquiries. Ask for our complete catalogue on your company letterhead*

- PLASTIC FILM CAPACITORS
- HIGH VOLTAGE POWER PACKS
- PULSE FORMING NETWORKS



*Plastic Capacitors, Inc.*

2511 W. MOFFAT STREET, CHICAGO 47, ILLINOIS

CIRCLE ED-230 ON READER-SERVICE CARD FOR MORE INFORMATION



## SHOCK ISOLATORS

*Effective in All Directions*



Combination shock and high-frequency-vibration isolators, cupmounts Type 1000-2000-3000-4000 series, will isolate short-duration shocks and vibrations above 45 cps. The isolators use rubber in compression to give smooth load-deflection curves and approximately equal stiffness in all directions. The design and assembly of the metal parts make the mounts self-captivating for maximum security. Four sizes of these cup-style isolators are available, ranging from Type 1000 (load range 7-50 pounds) to Type 3000 (load range 100-450 pounds). Vertical natural frequency at rated load is approximately 25 to 30 cps.

For additional information write to: The Barry Corp., 775 Pleasant St., Watertown 72, Mass.

CIRCLE ED-161 ON READER-SERVICE CARD FOR MORE INFORMATION

### LINEMASTER

## "LEKTRO-LOK"

### FOOT SWITCH

**SMALL...**

**SENSITIVE...**

**SAFE!**



**ONLY \$5.25**

Lektro-Lok is dependable because it's automatically safe — a mechanical interlock allows only one circuit to function at a time! Lektro-Lok operates on a teeter-totter principle with selective circuits — yet a single cord receptacle eliminates costly harness assemblies.

Lektro-Lok is lightweight — only 10 oz. — but built for stamina, with a rugged stamped metal case. You can depend on Lektro-Lok to give you years of trouble-free service — it's made by LINEMASTER, the leader!

Let us quote on your special problems.

Write today for catalog and price list

### LINEMASTER SWITCH CORP.

130 Putnam Road  
Woodstock, Conn.

## 5" Oscilloscope

Low Price, General Purpose Unit



Model ES-520, a 5" oscilloscope, is a low price instrument for basic oscillography. Specifications include: push-pull vertical and horizontal drive; 20-mv per inch vertical sensitivity; 50mv per inch horizontal sensitivity; three-step, frequency-compensated, vertical input attenuator; vertical frequency response 20cy to 500ke within 2db; excellent vertical square wave response from 20cy to 50ke; frequency response 20cy to 200ke within 3db (at full gain); 1v peak-to-peak, built-in vertical voltage calibrator.

Internal linear sweep is 10cy to 300ke. Negative and positive sweep synch selection is provided. The instrument has a filter-type, removable graph screen. It is furnished in a rugged, black-ripple-finished steel cabinet, 8-1/4" x 14-1/2" x 16-1/2". Normal operating power is 115v, 50-60cy. Precision Apparatus Co., Inc., Dept. ED, 92-27 Horace Harding Blvd., Elmhurst 6, L. I., N. Y.

CIRCLE ED-104 ON READER'S SERVICE CARD FOR MORE DATA

## NEY'S SMALL PARTS

### PLAY A BIG PART IN PRECISION INSTRUMENTS

The accurate transmission of electrical impulses through a movable contact is dependent solely upon the properties of that contact. Illustrated at the right is a Ketay Synchro, which is the heart of many precision indicating, communicating and control devices. Ketay is noted for Synchros and Resolvers capable of extreme accuracy. Therefore, Ney Precious Metal Contacts have been selected because of their practically ideal physical and electrical properties.

Ney Precious Metal Alloys have high resistance to tarnish, are unaffected by most industrial corrosive atmospheres, and are fabricated into slip rings, brushes, commutator segments, wipers, contacts and similar components for use in electrical instruments. Call the Ney Engineering Department for help in selecting the right Ney Precious Metal Alloy which will improve and prolong the life and accuracy of your instruments.

**THE J. M. NEY COMPANY • 373 ELM STREET, HARTFORD 1, CONN.**  
*Specialists in Precious Metal Metallurgy Since 1812*

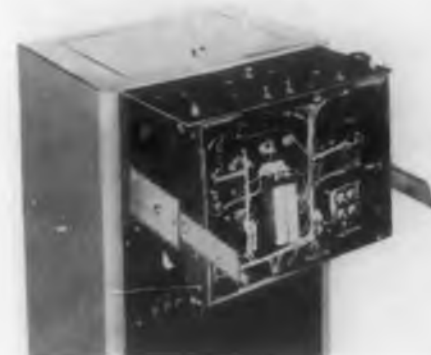
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CIRCLE ED-103 ON READER-SERVICE CARD FOR MORE INFORMATION



## Chassis Slides

Support 175 lb Extended



The "Chassis-Traks" series of ultra-thin (9/32"), heavy-duty chassis slides is available in four stock sizes to fit all standard electronic chassis, cabinets,

and racks. They feature automatic out-position locks with instant pushbutton return, or provide for chassis removal from cabinet for bench servicing or unit replacement.

The slides support 175lb in the fully extended position, and are permanently dry lubricated to insure trouble free operation. When the slides are fully extended, the chassis may be tilted back to service bottom components. The slides meet JAN slide specifications. Each pair of slides is furnished with all attaching hardware, mounting templates and instructions. Chassis-Trak Corp., Dept. ED, 6252 E. Iona Rd., Indianapolis 3, Ind.

CIRCLE ED-105 ON READER'S SERVICE CARD FOR MORE DATA

ELECTRONIC DESIGN • December 1954

## Viking miniature connectors

DESIGNED FOR  
LONG RELIABLE  
SERVICE LIFE



**VIKING circular types.**  
Positive polarization and shielding. Simple locking device mates units against vibration. One to four contacts on small units—5 to 9 on large units.



**VIKING printed circuit receptacle.** Increases your circuits—unit shown has 20 contacts, and is interchangeable with 18-contact types. Extremely strong contacts, pierced or unpierced.

**Hermetic sealing**  
is available on the circular and rectangular series. Write for literature on these or the complete line of VIKING connectors.

# VIKING

ELECTRIC

1061 INGRAHAM STREET  
LOS ANGELES 27, CALIF.

CIRCLE ED-107 ON READERS-SERVICE CARD

## Copper Louvers For Cooling



This line of midget copper louvers is adaptable for wood, metal, or other installations. All sizes are obtainable in weather and termite resistant design. Available in 1", 1-1/2", 2", 2-1/2", 3", 4" and 6" sizes, they are of value in electronic equipment, where they provide ventilation and moisture-vapor control for instrument and other type casings. When installed on radio transmission sets, they prevent picture interference on adjacent TV receivers. Midget Louver Co., Dept. ED, Norwalk, Conn.

CIRCLE ED-108 ON READER'S SERVICE CARD FOR MORE DATA

## Shaft Coupling Takes 30° Offset



Catalog No. AP15299, an insulated universal shaft coupling, can join two shafts offset from each other as much as  $\pm 30^\circ$  and separated by more than 3". It is designed for joining two 1/4" shafts, and has a zero backlash feature. It has many applications in electro-mechanical and electronic equipment.

The coupling is extremely durable, molded of nylon with nickel-plated brass inserts, and is supplied with set screws and coupling pins. It is finished in accord with military specifications. Typical applications are connection between the instrument panel of equipment and remote rotating components, and the zero backlash coupling of instrumentation components. Jan Hardware Manufacturing Co., Inc., Dept. ED, 75 N. 11th St., Brooklyn 11, N. Y.

CIRCLE ED-109 ON READER'S SERVICE CARD FOR MORE DATA

## Resin For Extruded Wire Insulation

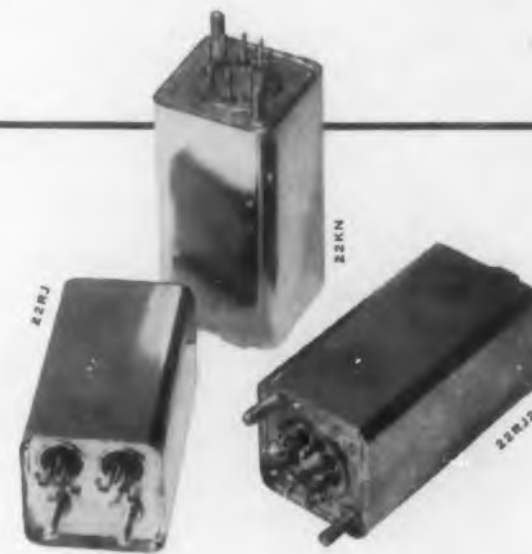
Designated as "Plivie EDB90", this product is a pure polyvinyl-chloride resin for use as an extruded wire insulation material. It is fully interchangeable with all other approved electrical grade vinyl resins where interchange of resins is permitted. Goodyear Tire & Rubber Co., Dept. ED, Akron 16, Ohio.

CIRCLE ED-110 ON READER'S SERVICE CARD FOR MORE DATA

The Sigma Type 22 miniature double-pole sensitive relay has now been made available with two new mounting styles, as illustrated. The plug-in model requires no external clamp. Brief specifications are given below.

### SPECIFICATIONS—TYPES 22KN, 22RJ and 22RJ2

		DPDT—SPST
Sensitivity . . . . .	20 and 40 mw DC	Contacts . . . . . 2 amp., 28 V DC/110 V AC Resistive Also reliable in low level audio circuits
Coils . . . . .	10-16,000 ohms	Life . . . . . millions of cycles
Temperature . . . . .	-65° C. to +125° C.	Hi-pot . . . . . 1000 V DC
Vibration . . . . .	10-55 cps, 20 g 10-2000 cps, 10 g (higher g's available at reduced sensitivity.)	Insulation resistance . . . . . 100 megohms
Shock . . . . .	100 g, non-operating	Weight . . . . . 3 1/2 ounces
Acceleration . . . . .	100 g, non-operating (50 g, operating)	Size . . . . . 1" x 1" x 1 3/4" (double header type) 1" x 1" x 2" (plug-in and round plan hook types)



More information is available on request. (Note: we suggest that those having immediate need of information write instead of using the "Reader Inquiry Service" supplied for convenience by this publication, as processing and forwarding of the cards often causes some unavoidable delay.)

# SIGMA

SIGMA INSTRUMENTS, INC.  
PEARL STREET, SO. BRAINTREE, BOSTON 85, MASS.

CIRCLE ED-111 ON READER-SERVICE CARD FOR MORE INFORMATION

Announcing the Honeywell H-2 . . .

## NEW, IMPROVED POWER TRANSISTOR!



"Growing" germanium in an induction furnace for use in the new Honeywell H-2 Power Transistor

The new Honeywell H-2 Transistor has remarkable power and gain characteristics. Operating from a standard 28-volt DC supply on a class B push-pull circuit, the H-2 will deliver 10 watts to a load with a gain of 30 db.

Having moved from the pilot line stage to production, the improved H-2 is available in quantities at the same low price as former models.

Like the Honeywell 2N57, the H-2 is ideal for driving servos and tripping relays—yet it requires less input.

It's available now as a solution to your weight, space, reliability and vibration problems.

Write for full information on your business letterhead to Honeywell, Transistor Division, Dept. ED-12-226, Minneapolis 8, Minn.

### REAL POWER AND GAIN — H-2 POWER TRANSISTOR

Collector current 800 ma max.

Collector voltage 60 volts max.

Collector dissipation—20 watts max. at 70° F. mounted on adequate heat sink.

Frequency range—Audio

Sinusoidal power outputs 5 watts max.

Push-pull output 10 watts (2 units) max.

DC switching 40 watts max.

Power gains for ordinary applications 20-30 db.

Maximum temperature—will operate at conservative output levels up to 165° F.

Vibrations resistance 30G up to 1000 cycles/sec.

Hermetically sealed.

MINNEAPOLIS  
**Honeywell**

Transistor Division

112 OFFICES ACROSS THE NATION



CIRCLE ED-233 ON READER-SERVICE CARD FOR MORE INFORMATION

### Variable Transformer For Low Wattage Applications



The "Adjust-A-Volt" 100BU Variable Transformer for 50-100-150w loads is designed for use as a variable a-c voltage component to replace rheostats in electric and electronic equipment.

It is easily installed in back-of-panel position. Small and compact, it takes little space, and ventilation is not a problem.

The unit, a toroidally-wound, hydrogen annealed auto-transformer, will smoothly and continuously deliver any output voltage from 0 to above line voltage. Voltage is adjusted with excellent regulation and no waveform distortion. Two exclusive design features are: 1) the extra long brush spring which allows free action and maintains constant brush pressure during entire brush life, and 2) a safety stop on the spring which prevents burnouts by making it impossible for the brush-holder to contact the winding when the brush has completely worn down. Special alloy brush track plating eliminates deterioration of the commutation surface and assures longer life. The transformer is rated 60cy, single phase, 120v input, 0-120v output, 1.25amp output, 150/165va. Standard Electrical Products Co., Dept. ED, 2240 E. Third St., Dayton, Ohio.

CIRCLE ED-234 ON READER-SERVICE CARD FOR MORE INFORMATION

### Frequency Standard Covers 10kc to 50Mc Range



The Model 701 Frequency Standard provides a source of highly stabilized frequencies covering the range from 10kc to 50-Mc at intervals of 10kc, 100kc, or 1Mc. Stability of one part in 10<sup>7</sup> per 24hr has been achieved by means of a unique method of temperature stabilization.

Frequency dividers and multivibration are used to develop the range of frequencies available. A warning light is provided to give an indication of temperature-stabilizing oven failure. There is also a fine frequency control for adjusting the standard oscillator output at 1Mc  $\pm$  10cy. New London Instrument Co., Dept. ED, P. O. Box 189, New London, Conn.

CIRCLE ED-235 ON READER-SERVICE CARD FOR MORE INFORMATION

# Aerohm

A Complete Line of  
Micro-miniature and  
Miniature Wire-wound

## Precision Potentiometers

### "LO-TORK" POT



Designed for minimum-torque use. Torque as low as 0.010 inch-ounce. Dissipates one watt at 80° C. Resistances — 100 to 100,000 ohms. Weight is only 1/2 ounce. Ganging to six decks, internal clamps hold 3/8 in. diameter.

These potentiometers have standard linearity of .5%, on special order .25%; precision toroidal winding allows winding angles up to 360°, standard is 354°

### "HOT- POT"



Designed for high-temperature use. At 200° C., dissipates one watt. Dissipates five watts at 80° C. Resistances — 1000 to 25,000 ohms. Stainless-steel case, one inch dia. by 1 1/8 inch depth behind panel. Teflon-insulated terminals.

### AP-1/2 RT/RTS-7/8 AP-1 1/8



- 3 micro- and miniature potentiometers
- Two, three, and four watts continuous at 80° C respectively.
  - 3 resistance ranges, 10 - 100,000 ohms.
  - Compact — 1/2, 7/8, and 1 1/8 in. dia.
  - Weights only 1/4, 1/2, and 3/4 ounce.

These potentiometers are precision machined, and have line-reamed bushings of phosphor bronze, centerless-ground stainless steel shafts, anodized aluminum bodies, and gold-plated fork-type terminals. All units are fully sealed, moisture-proofed and fungicide treated. On special order, potentiometers processed for operation up to 125° C.



Write today for detailed information and prices

WATERS MANUFACTURING, inc.

Waltham 34, Massachusetts

APPLICATION ENGINEERS' OFFICE IN PRINCIPAL CITIES

CIRCLE ED-236 ON READER-SERVICE CARD

# NOTHING



# ON THE SHELF!

We purposely keep our cupboard as bare as Mother Hubbard's. We have no stock items to sell—

Our business is designing, engineering and manufacturing of nothing but

*Special Purpose Devices* in the electrical, electro-mechanical and electronic fields.

When you need a component or device that isn't made or stocked—

## THINK of



Send your specifications or requirements to us for prompt quotations.

Ask for Brochure J54

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CIRCLE ED-239 ON READER-SERVICE CARD

## "Teflon" Products

Include Insulators and Sockets



These "Erie-Chemelec" "Teflon" products include stand-off and feed-thru insulators; miniature tube sockets, seven- and nine-pin, in "Teflon" and "Kelf"; crystal sockets; 15- and 18-pin connectors; and five sizes of spaghetti in three colors.

Erie Resistor Corp., Dept. ED, 644 W. 12 St., Erie, Pa.

CIRCLE ED-240 ON READER-SERVICE CARD FOR MORE INFORMATION

## Slip Ring Assemblies

For High Temperature Uses



Slip Ring Assemblies are made with a new plastic for high temperature applications. "ETC-7" withstands  $-60^{\circ}$  to  $+500^{\circ}\text{F}$  and has many other desirable properties, such as low water absorption, high surface resistivity, and excellent impact strength and dielectric properties.

Electro Tee Corp., Dept. ED, South Hackensack, N. J.

CIRCLE ED-241 ON READER-SERVICE CARD FOR MORE INFORMATION

## Line Voltage Regulator

For A-C Lines



Offered in five popular ratings, this regulator is exceptionally small in size and weight, due to the high efficiency of the power circuit. Its self-saturating circuit was designed

for a very low output impedance, which permits transient overloading without undue loss of regulation.

The control section is basically a magnetic amplifier with a cold cathode-type tube used as a voltage reference. In spite of this tube's dependability, the design also provides an alternate tube as a standby. Test switches permit routine checks of both tubes to make certain they are operable. Safety factors are designed into the iron core components of this design to insure trouble-free operation. Power Equipment Co., Dept. ED, 5740 Nevada East, Detroit, Mich.

CIRCLE ED-242 ON READER-SERVICE CARD FOR MORE INFORMATION

**Cartridges**

**Selenium Rectifiers**

**HIGH VOLTAGE TYPES**  
DC output voltage from 20 volts to 20,000 volts and up DC output current, half wave from .2 MA to 195 MA Cell diameter 1/16" to 1" Length from 1/2" to 12"  
Write for Bulletin H-2

**DC POWER TYPES**  
Ratings to 250 KW, 50 MA to 2,300 amperes and up 6 volts to 30,000 volts and up. Efficiency to 87% Power factor to 95% Ambient temperature range to 125°C with proper derating.  
Write for Bulletin C-349

**HERMETICALLY SEALED TYPES**  
Recommended for airborne equipment. Available in all types and sizes from .2 MA to 195 MA, DC current output, half wave.  
Write for Bulletin H-2

**TV & RADIO TYPES**  
Input ratings from 25 to 195 volts AC and up. DC output current from 10 to 1,000 MA. Available in half wave and voltage multiplier units. Bridge units available to 1200 MA.  
Write for Bulletin ER-178A

**Widest Range in the Industry**

# INTERNATIONAL RECTIFIER CORPORATION

EL SEGUNDO, CALIFORNIA • OREGON 8-6281

World's Largest Supplier of Quality Industrial Rectifiers

NEW YORK  
CHICAGO

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Remember...

# STANCOR

## REPLACEMENT TRANSFORMERS

are used for  
original  
equipment too!

Perhaps we shouldn't even mention it . . . but some people forget that a transformer had to be used in original equipment before it became a replacement unit. Many Stancor cataloged replacement transformers are being used in today's new equipment . . . because they represent the most efficient and economical original equipment design.

No matter what kind of equipment you are designing . . . for economical production of samples, pilot runs, etc. you are likely to find the transformers you need in the New 1954 Stancor Catalog.

Write now for your free copy, or get it from your authorized Stancor distributor. You'll find it a handy book to have around.



## CHICAGO STANDARD TRANSFORMER CORPORATION

3576 ELSTON AVENUE  
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CIRCLE ED-257 ON READER-SERVICE CARD FOR MORE INFORMATION

# New Literature . . .

## Transformers

258

A complete line of 32 subminiature transformers for transistorized and other equipment is covered in this 4-page bulletin (DL-C-424). Numerous graphs of performance characteristics, information on construction, basic specifications, mounting data, and other pertinent information are provided. Texas Instruments, Inc., Components Div., 6000 Lemmon Ave., Dallas 9, Texas.

## Automatic Positioners

259

A 16-page, 2-color bulletin describes this company's "Autotunes", which are automatic positioning units suitable for coupling to one or more shafts or devices. Many components requiring rotor or linear motion are suitable for "Autotune" control. The various components available for these systems are illustrated and described, along with specifications and dimensional drawings. Packaged units, multi-turn and single turn heads, and controlled units are covered. Collins Radio Co., 855 35th St., N.W., Cedar Rapids, Iowa.

## Magnetic Materials

260

Bulletin No. GC-106 describes in 8 pages, a variety of products and magnetic materials available from this firm. The products include such items as magnets; and cut, tape wound, and powder cores. The materials available include Alnico, Silectron, Mo-Permalloy, Vibralloy, Vicalloy, and a variety of others. Many tables and data on sizes and physical properties are provided. The Arnold Engineering Co., 350 Fifth Ave., New York, N. Y.

## Servo Design Kit

261

The "Servoboard" is a set of standard precision mechanical parts including gears, shafts, bearings, hangers, and mounting plates, which, when coupled to the necessary motors, tachometers, synchros, potentiometers, and amplifiers, permit rapidly building a flexible experimental mechanical assembly of a servo system, computer, or regulator. Described in a 4-page, 2-color bulletin, the "Servoboard" was developed as an aid to the design of servo mechanisms by providing means for quickly synthesizing the electro-mechanical parts of the control system. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.

## Potentiometer

262

The "Pot-100" film potentiometer is illustrated and described in a 4-page, 2-color brochure. The unit is an infinite resolution type with a standard linearity of 0.5% to 1.0%. Detailed characteristics, specifications, dimensions, and other data are provided. Servomechanisms, Inc., 316 Washington St., El Segundo, Calif.

## Glass Textiles

263

This 34-page highly illustrated brochure, "Glass Textiles for Industry", serves as an introduction to the use of glass fabrics in modern industry. The general nature of woven glass fabrics is described in a preliminary section. Two sections are devoted to broad glass fabrication and glass tapes: both include end-use charts and specification charts. Hess, Goldsmith & Co., Inc., 1400 Broadway, New York 18, N. Y.

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**Toroidal Coils 264**

This 24-page file of specification sheets covers a line of toroidal coils and filters as well as other filter types. Performance data, ranges, dimensional information, and many other pertinent data are provided. Communication Accessories Co., Hickmann Mills, Mo.

**Voltage Regulator 265**

"Type 1101 Recostat Generator Voltage Regulator" is the title of this 8-page brochure. It includes response-time and performance graphs, dimensional drawings, and size, and weight tables. Regulator Equipment Corp., 56 California Ave., Paterson, N. J.

**Interference Filters 266**

This 2-page "Guide to Specification of Interference Filters" (No. F-102) presents 27 electrical, environmental, and mechanical check points when designing, selecting, or specifying electronic noise filters. Reverse side of the bulletin has a decibel conversion chart. Tobe Deutschmann Corp., Norwood, Mass.

**Packaging 267**

The facilities of this firm for packaging to armed services specifications and other criteria are illustrated and described in detail in this 12-page, 2-color brochure. Numerous illustrations of equipment, typical products that have been packed, and conveyor facilities are shown. The firm also has a packaging consulting service available. Cargo Packers, Inc., 73 Rutledge St., Brooklyn, N. Y.

**Fasteners 268**

Easy-to-install and remove fasteners are described in this 4-page, 2-color catalog (No. 53). Originally developed for use in aircraft where extreme vibration is encountered, these fasteners have many applications in other equipment. They open and close in 1/4 turn. Two series are covered, with shear and tension strength of 300lb for one series and 1050lb for the other. Camloc Fastener Corp., 22 Spring Valley Rd., Paramus, N. J.

**Plastic Products 269**

This 12-page brochure covers a variety of compression and transfer molded products, including melamine jacks, phenolic pointer knobs, mineral-filled melamine terminals and numerous other electronic products made from a variety of plastic materials. Dimensional data, prices, and other pertinent information are included. Whitso, Inc., 9330 Byron St., Schiller Park, Ill.

**Indicators 270**

This firm's "Switchboard Indicator", which incorporates a frictionless galvanometer, is described in a 4-page, 2-color brochure. Detailed information on the advantages and features of the galvanometer are provided, as well as data on the standard scale ranges available with the indicator. A variety of pyrometric scales is offered. Charles Engelhard, Inc., 850 Passaic Ave., East Newark, N. J.

**Recording Oscillograph 271**

This 12-page, 2-color bulletin (CEC-1521A) describes a low-cost multi-channel dynamic recording oscillograph with a wide record speed range, a wide selection of galvanometers (0-3000cy), automatic numbering system, and remote control provisions. This unit is adaptable to a wide range of applications. Features, specifications, dimensions, available galvanometers, associated equipment, and other products of this firm are included. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

**Aircraft Instrumentation 272**

The facilities of this firm for service, development, and manufacturing in the field of aircraft instrumentation are illustrated and described in a 16-page, 2-color brochure. The manufactured products fall into two classifications: instrument test equipment, and custom-built instruments including altitude transducers, engine temperature indicators, and telemetering gyros. Test equipment includes gyro, rotor, synchro, and temperature testers. The firm is equipped to overhaul and certify a variety of gear. Aerosmith Instrument Co., 12909 S. Cerise Ave., Hawthorne, Calif.




# KEARFOTT ANNOUNCES a new product line from the West CUSTOM AND STANDARD MICROWAVE EQUIPMENT

**STANDARD** microwave equipment by Kearfott for laboratory or production includes attenuators, directional couplers, crystal-mixers, wavemeters and all universally-used microwave components. Units have been developed for the S, C, X<sub>u</sub>, X, and K<sub>u</sub> microwave bands. Components to applicable AN specifications are available in brass or aluminum—other materials to order.

**CUSTOM-DESIGNED** microwave equipment is a specialty of Kearfott. Manufacturing facilities, engineering-design personnel, a complete test laboratory and wide experience can be brought to bear on your problem. Kearfott can supply specialized components such as rotary joints, RF sources, matched assemblies and test equipment such as:

#### **X-BAND TEST SET MODEL W-109**



A four-in one instrument that saves time and money. Precision Wavemeter, Signal Generator, Spectrum Analyzer and Power Monitor in a single instrument for rapid field or assembly line testing. Designed by Kearfott engineers, utilizing Kearfott specialized microwave components.

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**NEW            IMPROVED**  
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**FOR**

- GREATER ACCURACY
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- BETTER LINEARITY
- ADJUSTABLE FREQUENCY RESPONSE
- HIGHER OUTPUT

***Bendix***  
***Pacific Division***  
*Bendix Aviation Corporation*  
NORTH HOLLYWOOD, CALIF.

CIRCLE ED-276 ON READER-SERVICE CARD FOR MORE INFORMATION

## Wafer Capacitors

277

This catalog and price list (series 935,000) gives complete descriptions of this company's line of "Capitron" wafer capacitors. Special design factors, voltages, dissipation factors, leakage resistance, temperature vs. voltage derating factor, and absorption and capacitance variation vs. frequency and temperature of the capacitors are pointed out. The capacitors range from 25 to 100,000mmfd with a tolerance of  $\pm 5\%$ . Aircraft-Marine Products, Inc., Chemical & Dielectric Div., 155 Park St., Elizabethtown, Pa.

## Insulated Terminals

278

This 12-page illustrated bulletin (No. YAE54) provides the latest information on this company's tin-plated copper, nylon-insulated, compression-installed terminals and links. It contains all straight and right-angle links and terminals for copper aircraft and flexible cable sizes No. 26 through 210. A 4-page section is devoted to manual and power-operated installation tools. Burndy Engineering Co., Inc., Norwalk, Conn.

## Pulse-Testing Systems

280

A simple guide to the assembly of a variety of pulse testing systems is provided in this 6-page brochure. Using block diagrams and pulse timing charts, the basic functions of individual units such as precision pulse generators, flip-flops, pulse generators, pulse delay lines, coincidence detectors, and counters are explained and the assembly of these units to form such basic test tools as square wave generators, pulse burst generators, pulse stretchers, pulse distributors, frequency dividers, pulse synchronizers, etc., is shown. Burroughs Corp., Electronic Instruments Division, 1209 Vine St., Philadelphia 7, Pa.

## Components

281

General Products Catalog No. 975 describes in 22 pages a variety of electronic products, including capacitors, inductors, sockets, insulators, plugs, jacks, knobs, dials, pilot lights, and transmitters, as well as numerous other items. Illustrations, prices, and other data necessary for correct selection are included. E. F. Johnson Company, Waseca, Minn.

PATENTED

Socket-Turrets for most tube types will carry a wide variety of circuit elements.

4-40U NUT

1

2

DECK TYPE

3

TEST ADAPTER

4

"C" PLUG-IN

5

TUBE BASE PLUGS

6

"B" PLUG-IN

# Vector

## SOCKET-TURRETS

### UNIQUE

Unitize those tricky circuits for quick change or repair, compactness, ease of wiring. New snap-on 4-40 U nuts for socket saddles enable easy mounting (1). New pre-punched, eye-letted strip construction provides many variations (2). New Socket Test Adapters for most tubes enable quick tests on tube side (3). New miniature tube base plugs (5). Write for new catalog.

REPRESENTATIVES

B. B. Taylor Company  
241 Sunrise Hwy., Rockville Centre, N.Y.  
R. J. Magnuson  
4258 W. Irving Park Rd., Chicago 41, Ill.  
David H. Ross Company  
534 El Camino Real, San Carlos, Calif.

**Vector Electronic Co.**  
3352 SAN FERNANDO RD., LOS ANGELES 65

CIRCLE ED-279 ON READER-SERVICE CARD FOR MORE INFORMATION

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## Calibration Standards 285

Several technical data sheets on this firm's line of calibration standards have been published. The models described include two a-c instrument calibration standards, a dual potentiometer calibration standard, and an a-c—d-c instrument calibration standard. A general and physical description of the units is provided as well as a chart of electrical specifications and information on accuracy, power supply, standard instrumentation, safety features, and applications. Radio Frequency Laboratories, Inc., Boonton 11, N. J.

## Hose and Duct Hardware 286

Useful accessories facilitating installation of hoses and ducts for industrial applications are described in this illustrated bulletin No. 41. The bulletin shows the use of screw couplings, soft-end cuffs, and flanges for assembling hose in long lengths, attaching it to pipe of varying sizes, connecting to outlets of different shapes, and applying to equipment. The available accessories include "Y's", transitions, reducers, and branches. Flexaust Co., 100 Park Ave., New York 17, N. Y.

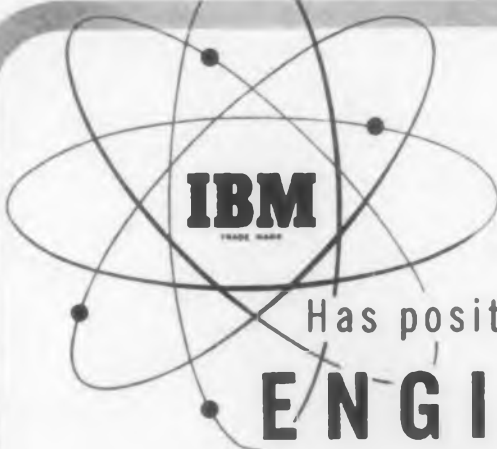
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## Sweeping-Image Recorder 287

Details of a new research camera system using synchronized-streak techniques to produce a writing speed of  $5.46\text{mm}/\mu\text{sec}$  and a sweep duration of  $44\mu\text{sec}$  are given in this 4-page booklet, Form 168-754. A number of typical illustrations of research pictures taken with the camera are included as well as a discussion of the kind of explosive, flash-tube, shock-wave, and spark-discharge phenomena suitable for study with the instrument. A data tabulation gives engineering details on the camera and the remote control unit. Beckman & Whitley, Inc., 1085 E. San Carlos Ave., San Carlos, Calif.

## Magnetic Tape Equipment 288

Bulletin No. 54-D describes this firm's magnetic tape equipment for data recording, reproduction, and analysis. Included is information on recording and playback heads, portable recorders, laboratory recording and reproducing equipment, tape transports, f-m discriminators, playback amplifiers, and speed control servos. Davies Laboratories, Inc., 4705 Queensbury Rd., Riverdale, Md.



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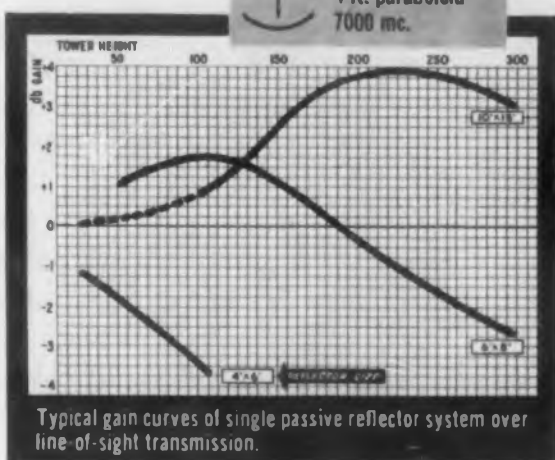
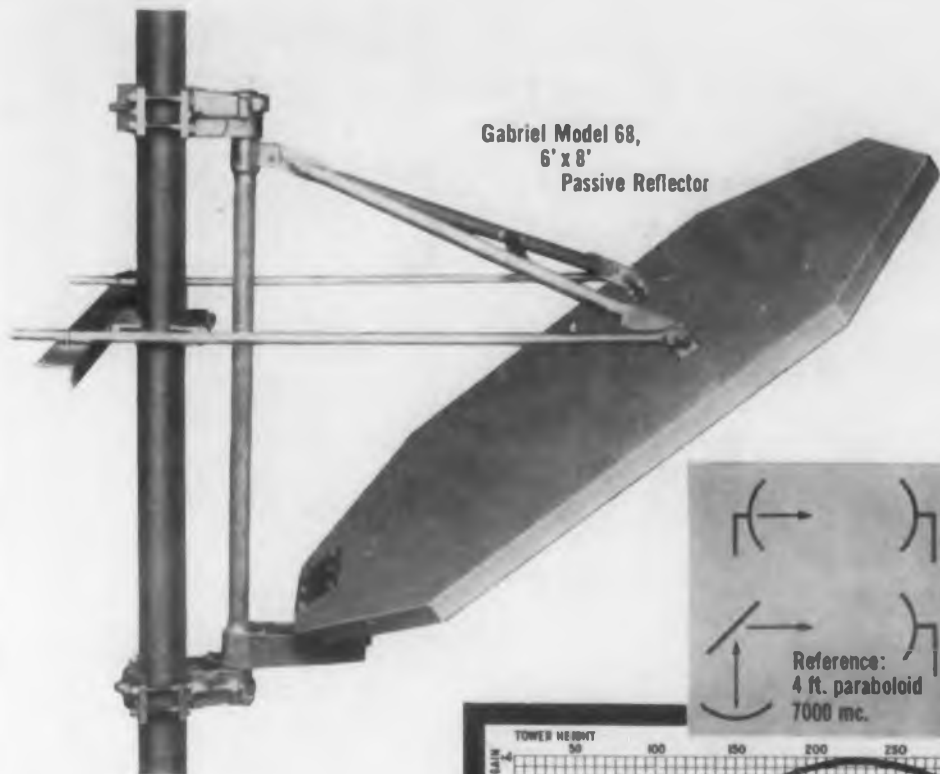
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Gabriel Model 68,  
6' x 8'  
Passive Reflector



Typical gain curves of single passive reflector system over line-of-sight transmission.

*gain*  
**“PEAK”**  
*performance at lower cost*  
*with*

**GABRIEL** passive reflectors

*Fast . . . accurate . . . easy* adjustment permits peaking Gabriel Passive Reflectors in microwave relay links to gain maximum point-to-point transmission at lower overall cost. Gabriel's new design offers increased system efficiency that can out-perform line-of-sight transmission.



Adjusting elevation done  
by one man on tower.

- Two lead-screw systems permit continuous, stepless adjustment in azimuth and elevation by one man on the tower with only a hand wrench.
  - Mounting on the tower can be done usually by a two-man crew, with total man-hours cut as much as 50%.
  - Increased gain over line-of-sight transmission is obtainable with optimum size reflector for various tower heights.
- Ask for Gabriel recommendations for your system.**

Write for Bulletin PR-11 for complete mechanical and electrical systems data.

**Gabriel Electronics Division**

THE GABRIEL COMPANY, Endicott Street, Norwood, Mass.



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# precision potentiometers by DeJUR

Simplify your design problems



SERIES C-200  
FULLY ENCLOSED  
HIGH PRECISION  
POTENTIOMETERS

OPEN VIEW SHOWING DRIVE END

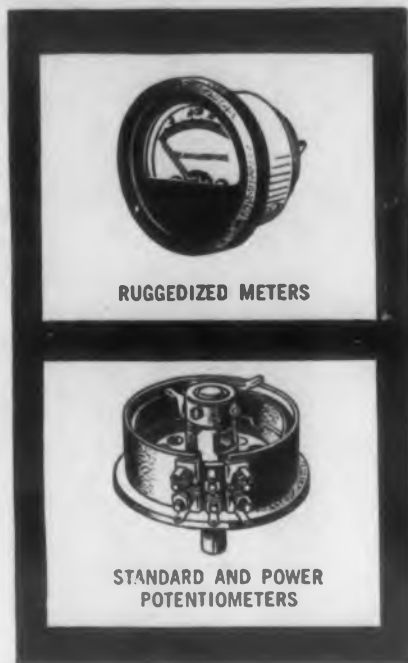
## non-linear function external phasing potentiometers

- Logarithmic, sine-cosine and other shape functions
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- Unitized design for universal coupling
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- Servo or single hole mounting

Our engineering department can supply linear as well as non-linear potentiometers on short notice for tests and approval. Write DeJUR-Amsco Corporation, Dept. ED, 45-01 Northern Blvd., Long Island City 1, N. Y.

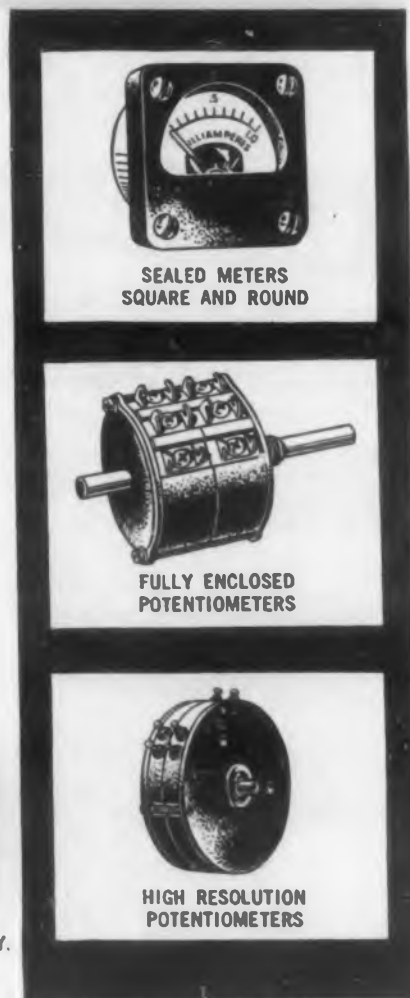
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RUGGEDIZED METERS

STANDARD AND POWER  
POTENTIOMETERS



SEALED METERS  
SQUARE AND ROUND

FULLY ENCLOSED  
POTENTIOMETERS

HIGH RESOLUTION  
POTENTIOMETERS

## Small Motors

299

This 26-page catalog (No. E1-3A) provides a quick, comprehensive reference to this company's complete line of induction and torque motors. In addition to listing physical characteristics, dimensional drawings, and performance curves for these motor types, the catalog also includes detailed electrical specifications in appropriate groupings for induction units ranging from 1/1000 to 1/6hp for single, 2-, and 3-phase operation, 15 to 400cy. Listings for torque motors cover an equally broad selection of types and sizes for operation under stall conditions and reverse rotation. Electric Indicator Co., Inc., Camp Ave., Springdale, Conn.

## Caps and Plugs

300

This illustrated file folder describes this company's complete line of threaded and non-threaded caps and plugs. Enclosed are complete price lists for over 100 stocked sizes of the five standardized designs used to protect tubing, fittings, valves, hydraulic components, and numerous machined parts. Protective Closures Co., Inc., 2207 Elmwood Ave., Buffalo 23, N. Y.

## Switches

301

This 12-page illustrated catalog of this firm's type P and JR rotary, multipole switches contains complete wiring diagrams and contact charts for voltmeter, ammeter, and voltmeter-ammeter switches. Detailed drawings of these snap-acting and detent-action switches are included, with handle and panel-mounting data, physical dimensions, special switch information, and electrical ratings. Electro Switch Corp., Weymouth 88, Mass.

## Packaged Control Systems

302

Solutions to control problems using packaged control systems are illustrated in these sheets. Problems of various types are presented with solutions. John C. Whiddett Co., 9 Union Ave., Bala-Cynwyd, Pa.

## Engraver

303

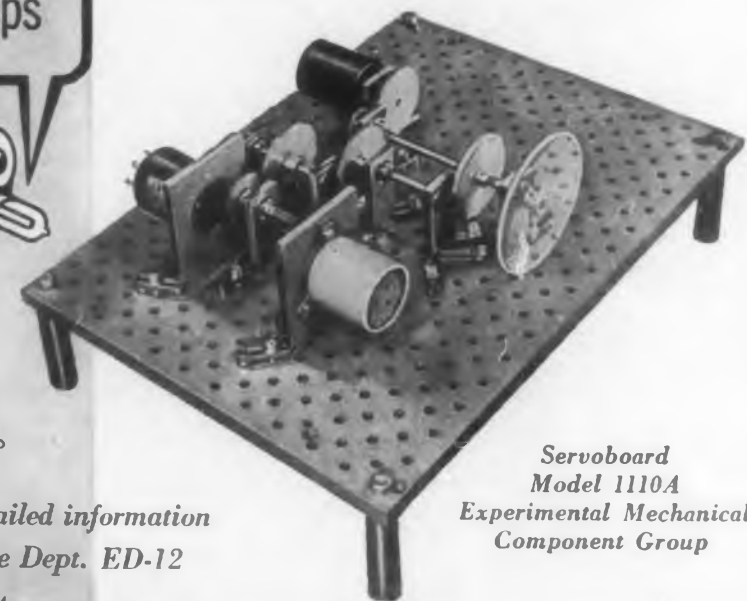
This 4-page illustrated brochure discusses this company's model D-2 heavy duty pantograph engraver. It contains a full description of the unit's construction and precision-machine tooling. Green Instrument Co., 385 Putnam Ave., Cambridge, Mass.

Hook Up  
With  
Servoboard  
and Speed Up  
Your Set-Ups



SERVOBIRD

Whatever you're assembling—servo system, computer or regulator—the Servoboard speeds up the job by providing means for quickly synthesizing the electro-mechanical parts of the control system. Complete set includes gears, shafts, bearings, hangers and mounting plates, all precision made for rapid coupling with necessary motors, tachometers, synchros, potentiometers and amplifiers.



Servoboard  
Model 1110A  
Experimental Mechanical  
Component Group

For detailed information  
Write Dept. ED-12



**SERVO**

**CORPORATION OF AMERICA**

New Hyde Park, New York

SC 121

CIRCLE ED-304 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE ED-298 ON READER-SERVICE CARD FOR MORE INFORMATION

## Mastic Boxes

A wide range of plastic boxes made from stock molds in many sizes and shapes is illustrated in this 16-page catalog. The boxes are ideal containers for electronic components, hardware, and other products. Plasti-Paks, 500 A St., Wilmington 99, Del.

## Cold Casting Compounds 306

Several trial formulations and properties of cold casting compounds based on liquid polymer LP-2 are described briefly in this 4-page bulletin. A table on three trial cold casting formulations includes working properties and physical and electrical properties. Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton 7, N. J.

## Chassis Fabricator 307

This 4-page 2-color illustrated brochure describes this company's facilities for precision fabricating and finishing of metal parts and equipment. Electronic chassis can be built to the specifications of the television and radio industry. Admiral Metal Products, Inc., 252-258 Astor St., Newark 4, N. J.

305

## Voltage Stabilizers

308

Voltage stabilizers, their performance characteristics and applications are discussed in this 16-page catalog (No. 4-260). Principles of operation, output characteristics, effect of frequency on output voltage, efficiency, and other characteristics are illustrated by charts and diagrams. Raytheon Mfg. Co., Waltham 54, Mass.

## Precision Instruments 309

This 20-page booklet contains photographs of machine tools, inspection gages, and environmental test chambers as well as illustrations with explanatory notes of some of the tools, fixtures, and complete instruments produced by this company. Daco Machine & Tool Co., 202 Tillary St., Brooklyn 1, N. Y.

## Fasteners 310

Complete information on this company's line of special rivets, nails, screws, and small parts manufactured by the cold heading process is provided in this 12-page catalog (No. 58). John Hassall, Inc., Westbury, L. I., N. Y.

# EXACTLY your type and size in Spiral Wound **PAPER TUBES**



### SQUARE, RECTANGULAR, ROUND

Standard-type PARAMOUNT paper tubes used for millions of coil forms and other applications. Hi-Dielectric. Hi-Strength. Kraft, Fish Paper, Red Rope, Acetate, or any combination wound on automatic machines. Any size from 1/2' to 30' long, from .450" to 25" I.P. Produced from wide range of stock arbors or specially engineered for you.

### NEW "PARAFORMED" TUBES SQUARE OR RECTANGULAR

Entirely new technique in tube making developed and perfected by PARAMOUNT. Perfectly flat side walls, sharp square inside corners, and very small radius on the four outside corners. Spiral wound, not die formed. No sharp outside edges to cut wire. No need for wedges to tighten winding on laminated core. Full rigidity and physical strength. Permits winding coils to closer tolerances. Allows faster automatic stacking of coils. Approved and used by leading manufacturers. *No extra cost!*



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OF OVER 2000 SIZES

## PARAMOUNT PAPER TUBE CORP.

608 LAFAYETTE ST., FORT WAYNE, IND.

*Standard of the Coil Winding Industry for Over 20 Years*

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Long aging on racks (background) followed by rigid operational testing assures full compliance with specifications, reliable service.

Model 705A. Note compact plug-in design, illuminated readout panel. Single and dual preset types for counting control applications available.



## The 100,000th DCU another BERKELEY First

BERKELEY's development of the first commercially produced decimal counting unit in 1946 provided the key to a whole new field of direct reading digital instrumentation. Out of this pioneering a family of BERKELEY "firsts" has emerged. To name a few: the first electronic Decade Counter; first direct-reading Time Interval Meter; first direct-reading Frequency Meter; first digital recording Printed Readout.

Production of the 100,000th DCU is more than other BERKELEY "first" — it is convincing proof of leadership and growth, and the superior quality and performance of the BERKELEY DCU.

### New Low Prices

Now, with the largest DCU volume in the industry, BERKELEY production savings make possible price reductions up to 50%, with continued use of highest quality components and workmanship. Here are typical new prices:

Model	Max. Counting Rate	New Price*
705A	100,000 cps	\$30.00
706A	350,000 cps	60.00
707A	1,000,000 cps	90.00

\* f.o.b. factory; liberal OEM and quantity discounts

The proved reliability, high quality and superior performance of BERKELEY decimal counting units costs you nothing extra — why accept less? Investigate now; write for complete technical data and application information. Please address Dept. D12.

M-44

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*division*

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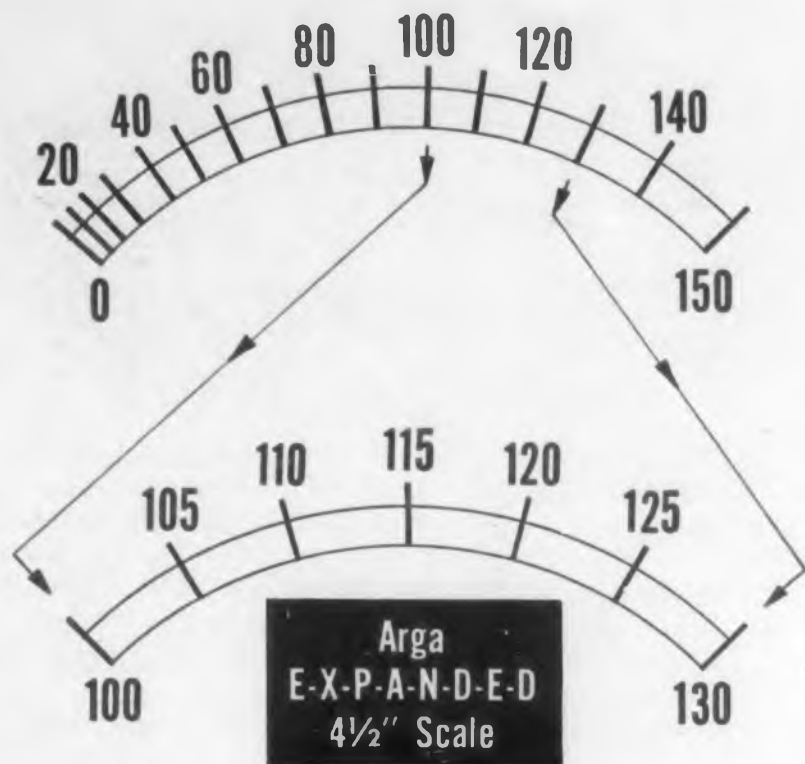
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# Arga

## E-X-P-A-N-D-E-D SCALE A. C. VOLTMETER



Conventional  
4½" Scale



### SPECIFICATIONS

ACCURACY — ½% input voltage  
 FREQUENCY RANGE — 50-2000 cps  
 BASE VOLTAGE — 115, 120, 208, 230 volts  
 SPAN — ±5, ±10, ±15 volts  
 SIZE — 3½" or 4½" — Panel Mounting  
 SHAPE — Round or Square

Write for Data File 12-116

# Arga division

BECKMAN INSTRUMENTS, INC.  
 SOUTH PASADENA 1, CALIFORNIA

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### Radioactive Cells 340

This 12-page catalog, entitled "Ohmart Cells in Industry", describes the use of cells that directly convert radioactive energy to electrical energy in industrial applications. It includes sections on specific gravity meters, level gages, and other equipment employing these cells. Also included are descriptions of amplifiers, cable connectors, and other associated instruments which are used in applications of this type of cell. Another section is on the principles of operation of the cell itself. Ohmart Corp., 2236 Bogen St., Cincinnati 14, Ohio.

### Laminated Plastics 341

Two paper-base phenolic laminate series are described in this 4-page color brochure. One is a hot-punching laminate for use in high quality electronic components requiring high insulation resistance; and the other is a cold-punching laminate with excellent electrical properties. Numerous illustrations are provided to show the nature of these products and their advantages. A detailed table of properties is also given. Taylor Fibre Co., Norristown, Pa.

### Systems Engineering 342

A 16-page color brochure describes this firm's System Division for systems engineering through instrumentation for dynamic and static testing, chemical analysis, and process monitoring and control. The division can assume full responsibility for engineering, building, installing, and servicing instrumentation or control systems custom-designed to meet customer requirements. Various types of instrumentation systems which the firm can provide are described, as are the top personnel and organizational make up. Systems Div., Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

### Platinum Clad Products 343

"Platinum Clad" sheet, tubing, wire, and other products are described in this 4-page, 2-color brochure. The products are prepared by welding together plates of platinum and base metal in a variety of thickness ratios. The advantages of this process for a variety of applications are delineated. Baker & Co., Inc., 113 Astor St., Newark 5, N. J.

## New FOR STILL FASTER COMPUTERS

G.E.'s high-perveance, high-capacity twin triode...

### GL-6463

- Per plate: 28 ma avg current, 4 w dissipation.
- On-off dependability assured by special cathode design.
- Life-tested under cutoff conditions.

HIGH CURRENT OUTPUT enables the GL-6463 to maintain voltage when tube plate resistance is lowered for extra-fast computer circuits now being developed. Ample plate dissipation assures long and dependable tube performance under high-output conditions.

Get ratings, performance curves, and prices on this newest G-E tube to be designed, built, and life-tested for computer service! *Tube Department, General Electric Company, Schenectady 5, N. Y.*

Three special twin triodes are the first types in General Electric's extensive program of computer-tube development. Step-up in capacity gives you a choice for different circuit needs.

GL-5844	GL-5965	GL-6463
.5 w dissip. per plate	2.2 w dissip. per plate	4 w dissip. per plate
1 w tube dissipation	4 w tube dissipation	7 w tube dissipation
.3 amp heater current	.45 amp heater current	.6 amp heater current



## GENERAL ELECTRIC

CIRCLE ED-344 ON READER-SERVICE CARD FOR MORE INFORMATION



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Astor

### Magnetic Tape

A discussion of the characteristics and applications for this company's No. 190 "Extra Play" magnetic tape is the subject of bulletin No. 30. The 3-page bulletin covers the physical and magnetic specifications of the new tape and is illustrated by two charts showing comparative frequency response curves and layer-to-layer signal transfer. Minnesota Mining & Manufacturing Co., 900 Fauquier St., St. Paul 6, Minn.

### Tapemaker

The "Tapemaker" is a machine for making pressure-sensitive tape while it is being used. The unit, which measures about 18" square x 5' high, can handle any standard tape operation, such as sealing, labeling, packing, binding, etc. It can handle many varieties of material, including cloth, paper impregnated stock, films, foil, celluloid and printed surfaces. A drum applies special adhesive to the tape as it is withdrawn from the machine. The unit handles tape from 1/4" to 3" wide. Williamson Adhesives, Inc., 8220 Kimball Ave., Skokie, Ill.

### Microwave Test Equipment 347

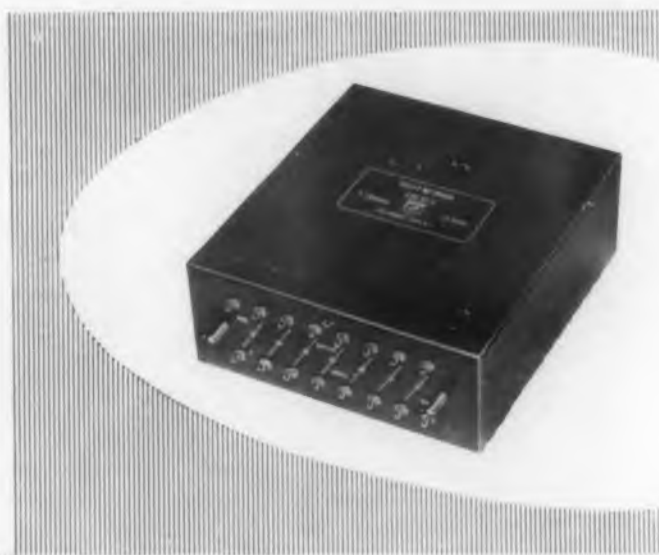
A variety of precision microwave test equipment is described in this loose-leaf catalog, which contains 24 bulletins. Each of the bulletins contains dimensional data, ranges and illustrations, and other specification data on the equipment described. Such items are covered as slotted sections, flap attenuators, broadband probes, detector mounts, double stub tuners, frequency meters, waveguide terminations, waveguide to coax adapters, series and shunt "T's", spectrum analyzers, klystron oscillator cavities, power supplies, and numerous other products. Electronics & X-Ray Div., F-R Machine Works, Inc., 26-12 Borough Pl., Woodside 77, N. Y.

### Wires and Cables

Numerous wire and cable types are illustrated and described in a 6-page catalog. All of them utilize "Plasticord" and "Plasticote" insulations. Some of the many types described are: appliance wire, hook-up wire, rotor cable, coaxial cable, h-f lead wire, antenna loop wire, flexible cords, and flame retardant high-voltage wire. Chester Cable Corp., Chester, N. Y.

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delay-line*

by **ESC**



\*Custom-made to precise specifications, this unit replaces 1,423 feet of 75 ohm cable for variable delay equalization between television cameras and central studio console.

Our facilities are organized for design, development and production of delay lines in any quantity including Lumped Constant and Distributed Parameter.

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CIRCLE ED-359 ON READER-SERVICE CARD FOR MORE INFORMATION

## Electronics Facilities

360

The facilities of this firm for research, development and production of a wide variety of equipment types are illustrated and described in this colorful 32-page brochure, "Electronics for Defense". The factory facilities, engineering equipment, and production facilities are highly illustrated in the first sections of the brochure. The remainder is devoted to typical products manufactured for government and industry, ranging from mobile transmitters and gunfire control systems, to life test racks for power tubes, and a navigational radar trainer. Otis Elevator Co., 35 Ryerson St., Brooklyn 5, N. Y.

## Measuring Equipment

361

An 8-page general catalog contains illustrations, application data specifications, and information on features of 18 different types of measuring and testing equipment. It covers such units as capacitors, inductance meters, distortion factor meter, electronic multimeter, a high power RC oscillator, and other precision equipments. Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J.

## Insulating Varnishes

362

Two 2-page brochures contain specifications, application information, and other data on two basic types of varnishes. One type is a clear impregnating varnish formulated from synthetic resins blended with modifying oils which produce high dielectric strength films. General applications include impregnation of small coil armatures, glass- or nylon-covered wire, and general motor usage. The other type is an air dry varnish formulated with phenolic resin and tung oil. It is a general fungus- and moisture-proof coating for electronic equipment and other assemblies to be subjected to tropical conditions. Insl-X Company, Inc. Ossining, N. Y.

## Ceramics

363

The electrical-mechanical properties of this firm's standard grades of electrical ceramics are provided in full in this 4-page 2-color technical data brochure. Fourteen standard materials are covered. Also included are recommended general applications for the materials. General Ceramics Corp., Keasbey, N. J.

## UHF BALUNS

COMPLETE COVERAGE  
FOR TV FREQUENCIES



### FEATURES:

- VSWR: Less than 1.2 over band
- Insertion Loss: Less than 0.2 DB
- Balance Efficiency: Better than 85%
- Size: 2" diameter x 2" long

<b>Model U-2A</b>	50 to 300 OHMS	PRICE <b>\$45</b>
<b>Model U-2</b>	75 to 300 OHMS	PRICE <b>\$35</b>

WRITE FOR COMPLETE CATALOG RU-1

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## VHF BALUNS

COMPLETE COVERAGE  
FOR TV FREQUENCIES



### FEATURES:

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- Insertion Loss: Less than 0.2 DB
- Balance Efficiency: Better than 85%
- Size: 2" diameter x 2 3/4" long

<b>Model V-6A</b>	50 to 300 OHMS	PRICE <b>\$45</b>
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ELECTRONIC DESIGN • December 1954

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## Solenoids

365

Two series of a-c solenoids are covered in this 8-page 2-color brochure. One provides a 1 lb to 4 lb push or pull with 7/8" plunger travel, and the other 4 lb to 20 lb with 1" plunger travel. They operate in the 24-440v 25-60cy range. Dimensions, performance curves, and specifications are provided. Facilities of the firm are also illustrated and described. Included is a price list for the solenoids. West Coast Electrical Mfg. Corp., 233 116th Pl., Los Angeles 61, Calif.

## Vibration Meter

366

The Type 1-110B vibration meter, described in a 4-page brochure, provides accurate direct indication of both amplitude and velocity of practically any type of oscillatory motion. Completely portable, it may be used wherever standard 115v 50/60/400cy power is available. Information on input and output equipment, specifications, accessories, and associated equipment and applications of this unit are covered. Also included is a price sheet. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

## Microwave Equipment

367

This 12-page 2-color brochure describes microwave communication equipment for a variety of applications. Equipment is available to provide communications circuits for telephone, teletype, telemetering, supervisory control and facsimile and video transmission. The radio frequency section of this equipment can be supplied for operation in the 5925-7500Mc range. Units described range from frequency amplifiers and terminal station units, to fuse panels, control units, alarm systems, and frequency generators. Collins Radio Co., Cedar Rapids, Iowa.

## Crossbar Switch

368

An HF crossbar switch with numerous applications ranging from telephony and inter-communication to computer systems, is illustrated and described in this 2-page bulletin. The unit switches up to 70Mc and features low crosstalk level, plug-in connections, and compact design. Data on applications, function, operation, and construction are provided, as well as detailed specifications. James Cunningham, Son & Co., Inc., Rochester 8, N. Y.

read  
correct  
air velocities  
instantly



Model H. 0-6000 fpm at 2% accuracy. Continuous calibration check. \$175.00

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One small probe for entire speed range . . . Small enough to allow direct, *correct* readings from motor vents, pipe interiors, hard to reach spots in electronic equipment. Short, direct-heated noble metal elements give instantaneous response, prevent damage due to vibration and shock.

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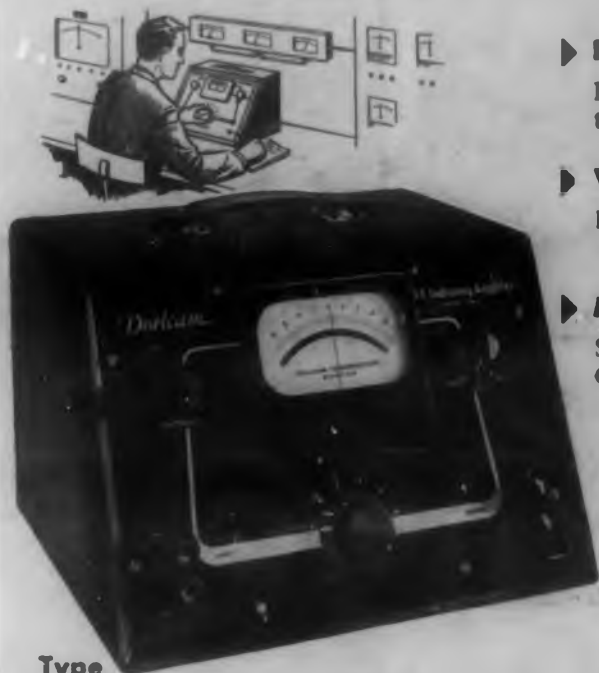
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ELECTRONIC DESIGN • December 1954

a **UNIQUE** application . . . of a **NEW** principle  
for a **BETTER** instrument

# Doelcam

## D-C Indicating Amplifier



- ▶ **High Stability**  
Less than 10 microvolts long term drift
  - ▶ **Wide Dynamic Response**  
Flat from 0 to greater than 20 cps
  - ▶ **Magnetic Input**  
Second-Harmonic Magnetic Converter for input stage
- Linearity within 1 %**
- High input impedance**
- Zero-center meter**
- Will drive recorders**

Type  
2HLA-3

Write for Bulletin 1A10

**T**HE DOELCAM D-C Indicating Amplifier is a completely self-contained instrument for the amplification and measurement of d-c voltages and currents of minute magnitude. A new design concept employing the remarkable sensitivity and inherent stability of the second harmonic magnetic converter is used in the input stage of the amplifier. This design feature, by eliminating all moving parts such

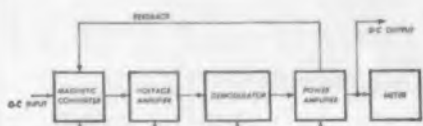
as mechanical choppers, makes this instrument ideally suited for applications where accuracy, reliability and insensitivity to changing ambient conditions are of prime importance.

### Doelcam CORPORATION

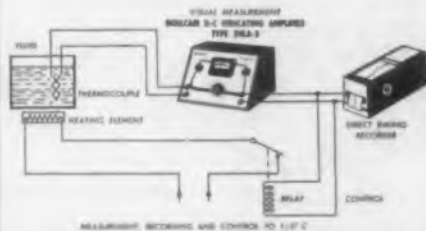
SOLDIERS FIELD ROAD, BOSTON 35, MASS.  
West Coast Office: 304 Tejon Pl., Palos Verdes, Calif.

*Instruments for Measurement and Control*

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**MAGNETIC INPUT . . .** Block Diagram showing DOELCAM Second Harmonic Magnetic Converter as input stage . . . a new design concept



**MEASUREMENT - RECORDING - CONTROL to 1/5° C.** A typical Process Control application showing high accuracy of DOELCAM Type 2HLA-3

CIRCLE ED-370 ON READER-SERVICE CARD FOR MORE INFORMATION

# KEARFOTT ADAC



ADAC shown in plastic case is normally hermetically sealed in metal cover.

servo

Analog

Digital

Analog

Converter

This servo driven Converter is designed to be read-out either "on the run" or "on demand". For read-out, the digital computer sends an interrogating pulse to all the drums (and their segments) in common. The pulse can only return to the computer via the brushes contacting the tracks. If a brush is on a conducting segment, the pulse returns to the computer; if the brush is on an insulated segment, the pulse is blocked. All 12 tracks are simultaneously read and the return pulses are thus coded to represent discrete steps of the transducer feeding ADAC.

By using precision servo components, the accuracy of ADAC has been reduced to

ADAC is a device for the precise electro-mechanical conversion of analog information to digital form. ADAC works from a synchro voltage input and produces a 12-binary-digit informational output.

one part in 4096 (.02%), or approximately 5 minutes of transmitter rotation. It weighs only 2½ pounds and measures three inches in diameter and four inches in length. The device is hermetically sealed and is highly shock resistant. The T3100 Servo Amplifier provides the necessary excitation for the servo elements of the Converter. A direct drive ADAC providing the segmented drums and necessary gear trains, and an inverse ADAC for digital-analog conversion is available.

Let us send you complete data sheets. Write today.

## KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

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West Coast Office: 253 N. Vinado Avenue, Pasadena, Calif.

CIRCLE ED-319 ON READER-SERVICE CARD FOR MORE INFORMATION

## Indicating Instruments 320

Catalog No. 28A is a 20-page publication describing a wide line of electrical indicating instruments for a variety of applications. Included are portable a-c and d-c milliammeters, ammeters, voltmeters, wattmeters; panel mounting instruments in a wide range of sizes; "ruggedized" meters; switchboard type meters; and accessories for mounting of instruments, such as shunts and multipliers. Many data are provided, including ranges, dimensions, and applications. The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

## Components Catalog 321

This 224-page price catalog illustrates and describes an extremely wide range of equipment in a wide variety of makes. Products range from acoustic linings, adapters, Allen wrenches, alligator clips, and antennas, through batteries, cable connectors, dials, magnetic recorders, pilot lights, and resistors to speakers, vacuum tubes, wires, and yokes. Radio Shack Corp., 167 Washington St., Boston 8, Mass.

## Ceramic Coatings 322

Ceramic coatings and porcelain enamels available from this firm are described in a 6-page, 3-color brochure. The coatings offer advantages such as corrosion resistance; ability to withstand abrasion, high temperatures, and other special conditions; and applicability to a wide range of products. Graphs and charts are provided to illustrate properties. Typical products are illustrated, and numerous other data are presented. General Ceramics Corp., Keasbey, N. J.

## Desk Assemblies 323

Bulletin C2 covers, in 8 pages, a variety of "utility desk assemblies". These units are standardized, adaptable to individual requirements, and designed to eliminate custom-built construction. The basic assemblies are illustrated and described, as are a variety of assembly components such as cabinets, table tops, sliding tops, pedestal units, pedestal doors, floor braces, shelves, mounting brackets, and other items. Par-Metal Products Corp., 32-62 49th St., Long Island City 3, N. Y.

for all applications  
requiring exceptionally  
high insulation  
resistance and unusual  
stability at high  
temperature



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## HOPKINS "HY-THERM"

New sub-miniature  
high temperature

## CAPACITOR

Hermetically sealed and metal encased, new HY-THERM capacitors have been designed to meet or exceed military requirements (Mil-C-25A). Example: At 125°C the minimum insulation resistance is 20 megohm-microfarads and maximum insulation resistance is 500 megohms. Available in all standard values and tolerances. Variety of mounting and circuit combinations. Special units designed to meet individual requirements.



Have a special problem? Write,  
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CIRCLE ED-324 ON READER-SERVICE CARD FOR MORE INFORMATION

## Environmental Test Gear 325

This 6-page catalog, No. 55, covers developments in and additions to this firm's line of environmental test equipment. In addition to regular equipment for testing under conditions of temperature, altitude, humidity, and sand and dust at various extremes in various combinations, the catalog includes a recently developed explosion chamber, rain and sunshine chambers, altitude and temperature equipment for occasional and visible testing, and a calibration test stand for sensitive calibration of temperature measurement and control devices. American Research Corp., 11 Brook St., Bristol, Conn.

## Wire Terminal Machine 326

The "Bandolug" is covered in detail in a 16-page, 2-color brochure. The unit is a single machine with a die that installs 11 different terminals without adjustment. It is valuable for automatic installation of insulated terminals on wire sizes from No. 22 through No. 14, and stud sizes from No. 4 through 5/16". Burndy Engineering Co., Inc., Norwalk, Conn.

## Electronic Components 327

Electronic components for industrial applications, high fidelity, radio, and television are listed in this 192-page illustrated catalog. In addition, meters, instruments, and test equipment of all manufacturers are included with prices. Newark Electric Co., 223 W. Madison St., Chicago 6, Ill.

## Reproduction Materials 328

The variety of materials and applications available to users of the diazotype reproduction process is described in this 36-page brochure. A table of diazotype manufacturers' comparative catalog numbers is included. Teenifax Corp., 195 Appleton St., Holyoke, Mass.

## Electronic Timer 329

The T-2 timer, described in this 4-page brochure, is designed for interval timing, timed delay, repeat cycling, programming, and pulsing. Six of the more common connection possibilities with the timer are illustrated. Ferrara Inc., 8106 W. Nine Mile Rd., Oak Park 37, Mich.

### WINCHESTER ELECTRONICS, INC.

## "PRINTED CIRCUIT" CONNECTORS

- 3 CONNECTOR STYLES
- 2 TO 37 CONTACTS
- 5 TERMINAL TYPES
- 2 CONTACT SPACINGS
  - 5-AMP OR 3-AMP CONTACTS



ACTUAL SIZE  
K15: 15 Contacts

- These precision "printed circuit" connector receptacles and many variants of them, or others to your specifications, are the accepted standard... for quality, compactness, ruggedness, light weight and dependability. For complete information on all connector designs and problems... write or telephone

<b>"K"</b> Type T rivets to circuit card.	<b>"K"</b> Type S with solder cup.	<b>"K"</b> Type W for wire wrap.
<b>"KK"</b> Type with slotted eyelet.	<b>"KKM"</b> Type for wire wrap.	<b>"KKM"</b> Type with eyelet.

(KKM is ideal for low-cost commercial application - mechanically interchangeable with comparable "K" type.)

"The undeniable, and unequalled, best."

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# Introducing— THE MYCALEX PARTS KIT

- \* For design projects
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To acquaint engineers with the superior qualities of Mycalex glass-bonded mica the world's most nearly perfect insulation a conveniently packaged kit containing more than 30 Mycalex products has been assembled

This assortment includes 46 miniature and sub-miniature tube sockets, terminal boards, rods and strips of fabricated Mycalex 400 and various Mycalex 410 injection-molded products such as connector sleeves, coil forms, stand off terminals, rotors and rings, motor slot wedges and switch wafers. A handy reference table compares the superior physical and electrical properties of Mycalex glass-bonded mica with those of other insulating materials.



## MYCALEX

- \* withstands extreme operating temperatures
- \* offers high arc resistances
- \* possesses low loss and power factors
- \* for permanent dimensional stability

The Introductory Mycalex Kit is being offered to qualified engineers and others who are interested

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Please send me the new Mycalex Parts Kit at the introductory price of \$10.00.

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# of the future



**6 P.D.T.**

**30 + G to 500 cps**

**15 + G to 2000 cps**

**100 + G Shock**

## **AVAILABLE TODAY!**

### **A Radically New Relay**

Here's a radically new relay specifically designed to meet high performance characteristics. With pure silver contacts for general purpose duty and specially compounded contacts for "dry circuit" or signal switching, it provides exceptional reliability over a wide range of applications, with low contact resistance and long life. Meets or exceeds specifications of MIL-R-5757B.

#### **FEATURES:**

6 P.D.T.  
Length (overall): 1.785"  
Diameter: 1.19"  
Weight: 4 oz.  
Mtg. Centers: 1.562"  
Life: 100,000 cycles (min.)  
Temperature: -65°C to +125°C  
Operate time: 8 ms.  
Drop-out time: 3 ms.  
Resistive load: 2 amps.  
Contact resistance: .03 ohm  
Insulation resistance:  
(min.) 1000 megohms  
Voltage insulation: 1000 V.R.M.S.

#### **DRY CIRCUIT APPLICATIONS:**

Micro Amp Switching  
New Compounded Alloy Contacts  
Extremely Low Contact Resistance

# **Deltronic** CORPORATION

DEPT. ED, 9010 BELLANCA AVENUE, LOS ANGELES 45, CALIFORNIA

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# Books

**Fabricated Materials and Parts . . .** By Theodore C. DuMond, 332 pages. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. \$6.50.

Written by the editor of *Materials & Methods*, this readable, working book was especially prepared for the engineer who must decide what manufacturing process is best or most economical for some small part to be produced. For the electronic designer, this decision may often affect design and the choice of materials.

A chapter is devoted to each of twenty different fabricating processes. Two plas-

tic forming methods are included. Sufficient information is given to help the reader to eliminate those processes that are not proper for the part in question and to concentrate on reasonable possibilities. The volume begins with three concise chapters entitled "The Problem of Selecting Methods for Small Parts", "Cost as a Factor in Selecting Fabricated Materials and Parts", and "Production Factors".

A number of photographs, charts, and tables are included. The electronic designer will find this book to be a valuable guide, especially in the design of microwave plumbing.

## A. R. C. CERAMIC INSULATED CONNECTORS



**Minimize Leakage, Save Space**

We developed this ceramic-insulated connector to obtain performance features we needed in our airborne communications and test equipment. Doubly silicone coated, it is virtually impervious to extremes of moisture, and mechanically stable under heat. Eight contact points per pin make for

low contact resistance. Being of small overall dimensions, these connectors are space savers. 2, 3, 4, 6, 8, 12 and 19 contact connectors each are available in three-key keyway combinations to prevent incorrect insertion. Design them into your equipment for extra dependability. Write for details.

Dependable Airborne Electronic Equipment Since 1928

**AIRCRAFT RADIO CORPORATION**  
BOONTON, NEW JERSEY



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ELECTRONIC DESIGN • December 1954

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**The Psychology of Invention in the Mathematical Field . . .** By Jacques Hadamard, 145 pages, paper-bound. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. \$1.25.

This slim reprint will be of great value to the electronic design engineer who is interested in developing his skills by an improvement in design thinking procedures rather than by simply gaining greater knowledge of electronics per se. Since electronic developers often use mathematics as a tool, and since electronics is often as abstract as mathematics, the lessons to be learned from the experiences of mathematical inventors applies very well to the electronic engineer.

Among the nine interesting chapters, are ones entitled: "The Preparation Stage: Logic and Chance"; "Discovery as a Synthesis"; and "The General Direction of Research". One of the three addendices is a letter by Albert Einstein analyzing his own thinking processes. An inexpensive, paper-bound edition of a work first published by the Princeton University Press in 1945, it is based on a series of lectures given by the author, the French mathe-

matician Hadamard, in New York in 1943.

This volume is also recommended to the supervisors of design departments who are searching for a different type of solution to some difficult design problem.

**Government Owned Inventions Available for License . . .** Paper cover, 168 pages. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. \$1.25.

Among the 3658 royalty-free, government-owned patents listed in this volume for licensing, are hundreds of interest to the electronic designer. Circuits to accomplish nearly all functions of electronic equipment and testing devices to measure many parameters are available.

Many inventions of possible consumer use are listed in Subgroup 3661, "Radios, radio and television equipment, radar and related detection apparatus, and phonographs." There are also 34 patents relating to storage and primary batteries. Most of the patents were invented by employees of the Army, Navy or Atomic Energy Commission. This catalog is recommended for all design department libraries.

## CHATHAM ELECTRONICS ULTRA-STABLE REGULATED POWER SUPPLIES

**.002% REGULATION FOR  
10% CHANGE IN LINE VOLTAGE**

For those laboratories requiring the utmost in stability and regulation from D.C. power supplies, Chatham Electronics offers a group of ultra-stable regulated power supplies. The use of a driftless regulating circuit and mercury cell batteries as a voltage reference provides the extreme stability attained. These units can be supplied to meet your power requirements. Some typical supplies are listed below:

D.C. VOLTAGE RANGE	CURRENT MILLIAMPERES	HUM MV	LINE REGULATION 110-120 VOLTS A.C.	LONG-TIME STABILITY*
400 to 1500	180	2	.002%	20
0 to 400	20	0.5	.005%	10
1500 to 3500	100	3	.005%	30
290 to 310	500	0.5	.002%	5
6.3 to 7.3	3 amps	10	.03%	1

\*Max. drift in millivolts over 10 min. period

### STANDARD REGULATED POWER SUPPLIES




These units are ruggedly built and designed to give long time, trouble free operation. Either positive or negative output may be grounded. All voltages and load currents are metered. Model E-50A (at left) also has a 6.3 volt 10 ampere output available. (Non-Regulated.)

MODEL	VOLTAGE RANGE	CURRENT MA	HUM	LINE VOLT. REG. 105-125 V.
EA-50A	0-500 Volts	0-300 MA	2 MV	1%
EA-48	160 to 1500 Volts	0-125 MA	Less than 20 MV	0.5%

**CHATHAM ELECTRONICS CORP.**  
Executive and General Offices: LIVINGSTON, NEW JERSEY  
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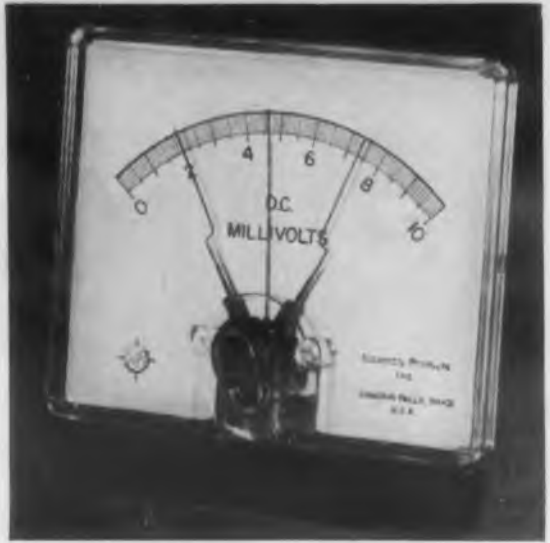
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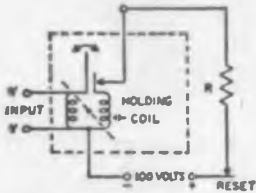


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# Patents . . . By John Montstream

**Variable Frequency Oscillator . . . Patent No. 2,673,932.** Wolcott M. Smith (Assigned to General Instrument Corporation, Elizabeth, N. J.)

An oscillator circuit that is simple and inexpensive to produce by employing only a single vacuum tube and inexpensive components has considerable merit. Such circuits should have stability and a high degree of sensitivity as well as an ability to change the frequency over a wide range and in a simple manner. The circuit shown

in Fig. 1 has many applications, but it has particular usefulness in frequency modulation transmitters.

The circuit uses a single vacuum tube, such as a 7A8, 6A8, and 7B8, having at least a control grid ( $G_1$ ), an oscillator anode ( $G_2$ ), and an oscillator control grid ( $G_4$ ) between the cathode (2) and the anode (4). It is also desirable that screen grids ( $G_3$  and  $G_5$ ) be provided as well as a suppressor grid ( $G_6$ ). The control is maintained at a voltage low enough so that neg-

ative  $G_2$  or the oscillator power upon shown repre  $Z_0$ , w ments having Impe and

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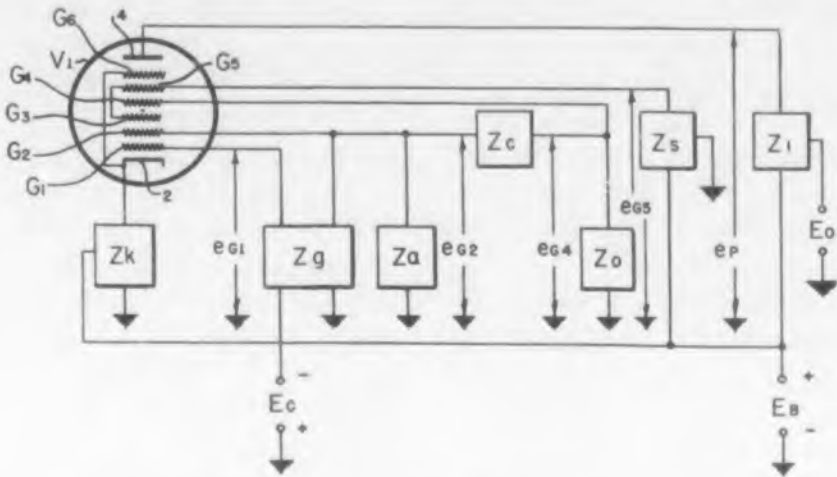


Fig. 1. Circuit for a variable frequency oscillator.

ative transconductance exists between grid  $G_2$  or the oscillator anode and grid  $G_4$ , or the oscillator control grid. The circuit components may take several forms depending upon the result desired; one example is shown in Fig. 1. The oscillatory circuit is represented by the impedances  $Z_a$ ,  $Z_c$ , and  $Z_o$ , which may be resistive-capacitive elements or may be composed of elements having a resonant frequency, as shown. Impedance  $Z_o$  is coupled between grid  $G_1$  and oscillatory anode  $G_2$  and to ground.

However, the coupling may be made with anode 4 or any of the other grids, except the suppressor grid, and different effects will be secured from each arrangement. By varying the amplitude of voltage  $E_c$  on the control grid, the output frequency at  $E_o$  will vary.

This circuit is versatile as to results, and has a high degree of sensitivity with high output stability. The output is rich in harmonics as well so that the circuit can be used for frequency multiplication.

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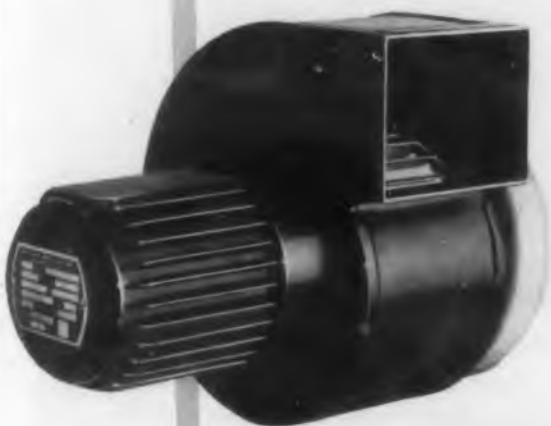
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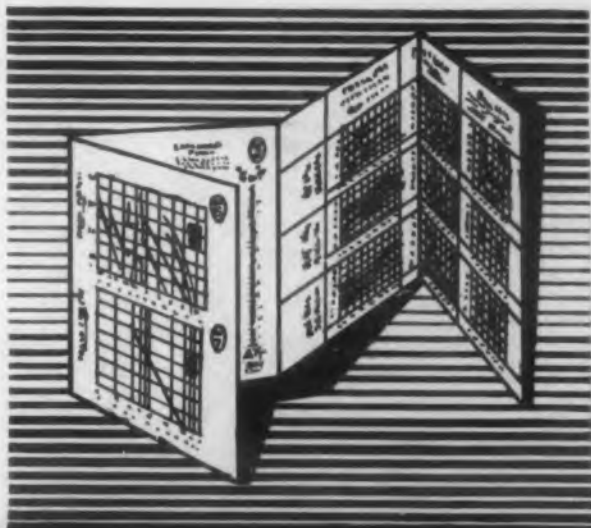
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**Pulse Clipping Circuit . . . Patent No. 2,676,250, Robert B. Tronsdale, (Assigned to Stromberg-Carlson Co.)**

A pulse clipping circuit is used to remove noise bursts, base-line hash and other undesired impulse disturbances from the input signal in electronic pulse transmission systems such as electronic telephone and television circuits. For accurate control or triggering of electrical circuits it is essential that noise and other disturbing impulses be removed from the control pulses or signal. In a television receiver, the clipping circuit may also be used to separate the synchronizing signal from the video signal and also to provide the clipped synchronizing pulses with a fixed amplitude irrespective of the widely varying amplitude of the received signal.

In order to improve the accuracy with which circuits are triggered from such control or synchronizing pulses, the clipping circuit shown in Fig. 2 was devised. The source of input signals (10) may be a TV or other control circuit. The signal wave train shown in Fig. 2 has a positive value so that current flow is through resistor 18, condenser 12, and rectifier 13 to ground.

If signal  $E_1$  is of sufficient duration, the input side of the condenser is charged to this potential, after which current stops.

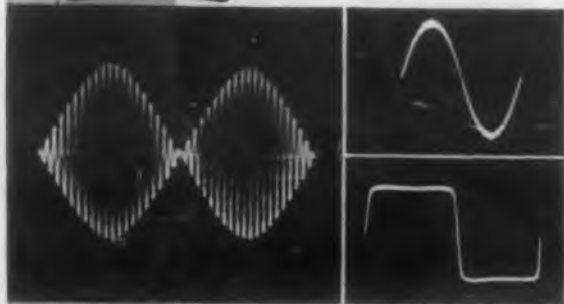
A negative going pulse in the input signal potential drops the potential to  $E_2$ , so that the cathode (17) of the rectifier (11) becomes negative with respect to its anode (14) and condenser 12 discharges through the tube to bring point B in the circuit to a potential corresponding to  $E_2$ . Rectifier 13 is normally conducting, since battery 23 applies a positive potential to its anode 15 through resistor 20; however, the potential drop across this rectifier is low and hence the potential across the output terminals (25 and 26) is low or substantially zero. The corresponding side of the condenser is therefore at this potential. When the negative going pulse of potential  $E_2$  discharges condenser 12 to this potential, the pulse signal passes through the condenser so that the potential of anode 15 of rectifier 13 is lowered below ground level and conduction through this rectifier ceases until the input potential returns to  $E_1$  after time interval  $t_1$ . Then the condenser is recharged to potential  $E_1$ . This restores the potential upon the anode of rectifier 13 and the tube again conducts.

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Output wave forms of Servoscope displayed against internal linear sweep generator, frequency 1/2 cps.

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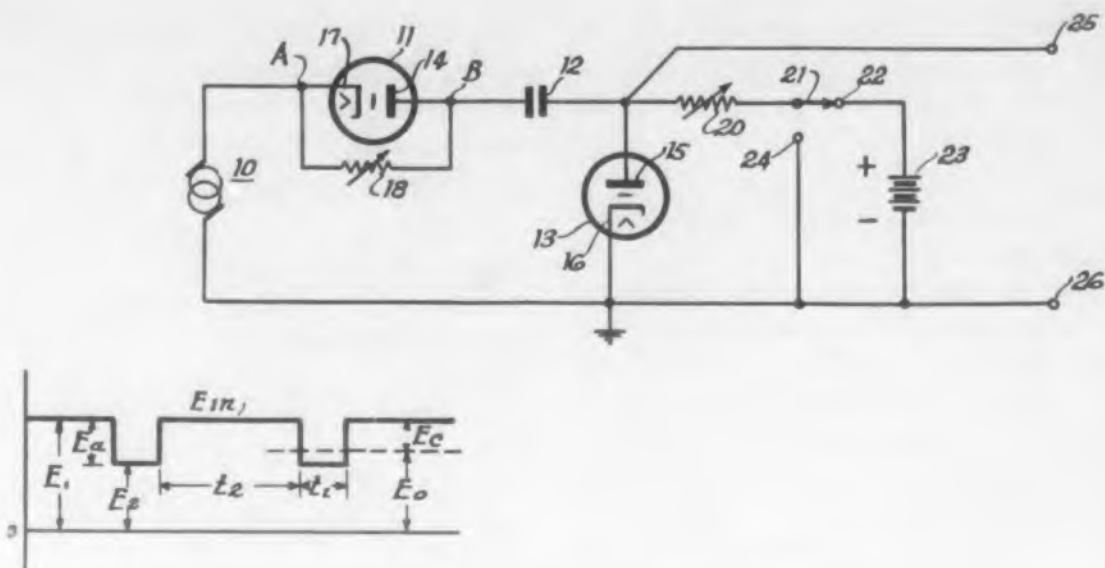


Fig. 2. A pulse clipping circuit and signal representation.

This operation results in a pulse across the output terminals.

By proper selection of the values of resistance of resistors 18 and 20 in relation to the time intervals  $t_1$  and  $t_2$ , the circuit operates to establish an equilibrium value of potential across the condenser between  $E_1$  and  $E_2$  or of a value equal to  $E_a - E_c$  that clips noise and other disturbances from the signal. If resistor 20 is connected to

ground through the switch (21), the circuit will operate to separate the synchronizing pulses from the video portion of a television signal. Also with proper circuit values chosen, the circuit transmits a predetermined percentage of the input signal, so that the signal appearing at the output terminals is a fixed proportion of the signal irrespective of wide variations in the amplitude of the input signal.

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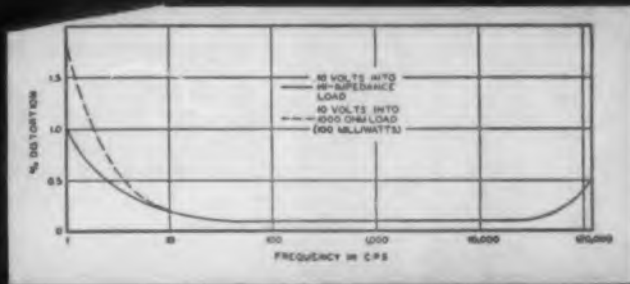
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Reel Size (dia. in inches)	10½	10½	8	10½	8
Reel Capacity (feet)	2,400	2,400	1,200	2,400	1,200
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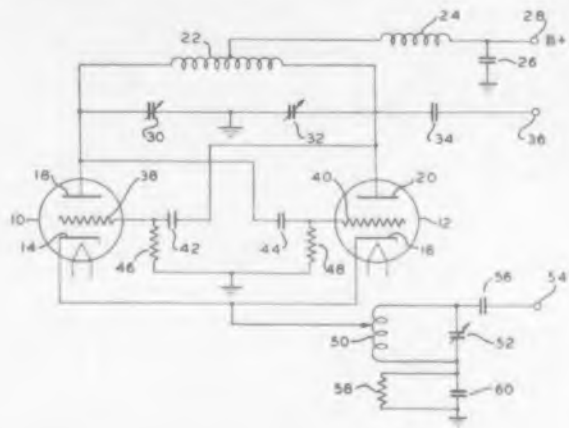
**Oscillator . . . Patent No. 2,675,476, R. A. Isberg, (Assigned to United States of America as represented by the Secretary of the Navy).**

The well-known push-pull oscillator has been improved upon in this patent by the addition of a second tank circuit consisting of coil 50 (Fig. 3), condenser 52, resistor 58, and by-pass condenser 60. This second tank circuit is connected in the common circuit for triode cathodes 14 and 16 and is tuned to practically any desired even harmonic of the fundamental frequency. The harmonic frequency appears at the output terminal (54) and, since the tank circuit is in the cathode circuit, the output is at a low d-c potential with respect to ground. It is pointed out, too, that the second tank circuit may be coupled into the common anode connection.

The circuit provides two frequencies from the push-pull oscillator. A circuit from which three frequencies are derived is also given. Briefly this circuit is similar to that of Fig. 3 except that a pair of tetrodes are used rather than triodes and a third tank circuit, similar to the tank circuit between

the anodes of the triodes of Fig. 3, is connected between the screen grids of the two tetrode tubes. This third or screen grid tank circuit is tuned to and provides the fundamental frequency. The anode tank

**Fig. 3. A second tank circuit has been added to this push-pull oscillator.**

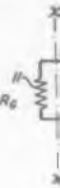


circuit is tuned to an odd harmonic of the fundamental frequency. The oscillator circuits that have been devised by the inventor and described in the patent materially increase the usefulness of this type of oscillator circuit.

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**Fig. 4  
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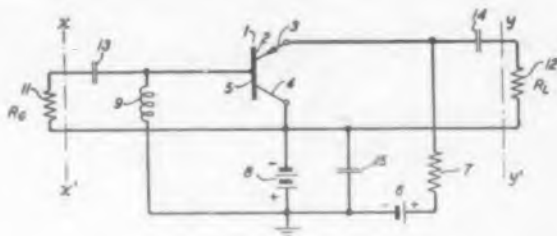
**Two-Way Transistor Electrical Transmission System . . . Patent No. 2,662,122.**  
*Robert M. Ryder. (Assigned to Bell Telephone Laboratories, New York, N. Y.).*

The circuit shown in Fig. 4 is a two-way transmission system in which amplification occurs in both directions and with equal power gain. The transistor is an n-p type, although a p-n type may be used with a reversal of the polarity of the biases on the emitter and collector electrodes. Two-way transmissions are secured by using a grounded collector connection. Connections, such as the resistor (11) between the base electrode (5) and ground, provide one input-output connection for the transistor. The resistor (12) between the emit-

ter (3) and ground provide the other output-input connection for the transistor. Positive emitter bias of 100v is provided by a potential source (6) which is connected with the emitter (3) through a resistor (7). Collector 4 is given its bias through connection with the negative terminal of a 40v potential source (8). The base electrode (5) is coupled to the positive side of the source (8) through a choke coil (9). Capacitor 15, connected across source 8, serves as signal by-pass. For operating power gains to be of the same magnitude in both directions, the current amplification factor, that is, the ratio of mutual resistance of the transistor to the collector resistance, must be two.

The circuits, which give gain in both directions of transmission, have regions of instability, conditional stability, and unconditional stability depending upon the value of the impedance  $R_L$ . If  $R_L$  is large enough, then the device is stable for any positive termination on the base side of the transistor. Operation in the conditionally stable region gives greater gain; however, the impedance must be more closely controlled in order to avoid oscillation.

Fig. 4. Circuit for two-way transistor transmission system.



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### WAVE COMPONENT MEASUREMENTS

**-hp- 300A Harmonic Wave Analyzer** incorporates a unique selective amplifier that isolates individual wave components quickly and easily. Instrument covers frequencies 30 cps to 16 kc, gives full scale readings with inputs of 0.001 to 500 volts. \$625.00.



### BROADCAST MEASUREMENTS

**-hp- 330C Distortion Analyzer**, for FM measurements, is identical with **-hp- 330B** except meter has VU ballistic characteristics meeting F.C.C. requirements. \$425.00.

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### HIGH QUALITY AUDIO TESTS

**-hp- 201B Audio Oscillator** covers all frequencies 20 cps to 20 kc, provides 3 watts or 42.5 volts output into 600 ohms. Stability better than  $\pm 2\%$  including warmup; frequency response  $\pm 1$  db full range. \$250.00.



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# Fast, convenient distortion measurements—20 cps to 20 kc



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phor dot screen gives largest pic-  
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pictures.

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electron gun having  
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Beam Triode  
(Shunt Voltage  
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**RCA-6CB5—**  
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*RCA pioneered and developed compatible color television*

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