Simplicity 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.
THE NEW MINIATURE

**Transco**

**R. F. CO-AXIAL SWITCH**

**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:** 30 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:** .830" 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.

Complete technical specifications available upon request.
ELECTRONIC DESIGN

Vol. 2
No. 12
December 1954

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Not Only a 
Time Delay Relay...

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:

- Tube heater voltage regulation
- Power supply overload protection
- Over- or under-voltage alarm or cut-off
- Low or high frequency cut-off

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

Greatly expanded production facilities assure prompt deliveries.

Write for bulletin and help with your particular problems.

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U.S. and Foreign Patents Pending

CIRCLE ED-2 ON READER-SERVICE CARD FOR MORE INFORMATION
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 = Forward Volts x Amperes  
Filament Volts, each tube: 20.

ML-5575/100 operating at peak rated current uses only 1/3 of anode dissipation rating.  
Competitive Rectifier operating at 65% of peak anode current uses entire anode dissipation rating.

ML-5575/100 operates at 100% of current rating with 300% safety factor for anode dissipation. For 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**

**Coolest 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.
- 150 PKV, 2.00 max anode amps; 1000 watts anode dissipation.
- 110 PKV, 10.00 max anode amps; 1500 watts anode dissipation.

*Thoriated Tungsten Filament.

For complete data write to:
MACHLETT LABORATORIES, INC.
Springdale, Connecticut

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 $1,000.

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.
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 attack 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.
The Senior Staff of The Ramo-Woolridge 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-Woolridge Corporation
8820 Bellanca Avenue, Los Angeles 45, California, Dept. ED-2

The Bellanca shown above, a twin-engine, low-wing monoplane, is being used for the Bellanca aircraft group, in cooperation with the United States Navy, to perform flight tests of the Bellanca guidance system. The system is being developed by the company for use in its single-engine Bellanca aircraft. The Bellanca guidance system is designed to provide a high degree of accuracy and reliability in the guidance of the aircraft, and to ensure safe and efficient operation in all weather conditions.

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 p-n-p 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 2200 kc. Its output is 50 to 100 microwatts 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 300 microwatts to the transmitter over an ambient temperature range of -60°C to 100°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 Ramo-Woolridge Corporation
8820 BELLANCA AVENUE, LOS ANGELES 45, CALIFORNIA, DEPT. ED-2

1. Dr. Burton F. Miller
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POSITIONS ARE AVAILABLE FOR SCIENTISTS AND ENGINEERS IN THESE FIELDS OF CURRENT ACTIVITY
Guided Missile Research and Development
Digital Computer Research and Development
Business Data Systems Development
Radar and Control Systems Development
Communication Systems Development

ELECTRONIC DESIGN • December 1954
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 the "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-television 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 Mackintosh-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.
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.
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 29\textquoteleft diam. folded-path delay lines with a delay of 3,333\textmu 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 ±0.0003\textquoteleft. 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.
Con
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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 wristwatches. 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.

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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.
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., Wal- tham, 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.
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 place 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 oscillographs 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, the 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 pulsed 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. Its high melting temperature is a factor in its use, since it is not affected by temperatures of up to 3000°F.
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.

HERE'S WHY

Only Magnetics, 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 Magnetics, Inc., you have your choice of the largest selection of standard tape wound cores offered by any manufacturer. In addition, the nationally renowned Magnetics 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 Magnetics, 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
**SILICON CONDUCTORS**

**TRACE MATERIAL

LOW VOLTAGE TYPES FOR USE AS VOLTAGE REFERENCE DEVICES**

**CONVENTIONAL SINGLE ANODE RECTIFIER TYPES**

![Graph 1: Reverse Voltage - Volts](image)

**DOUBLE ANODE TYPES**

![Graph 2: Reverse Voltage - Volts](image)

To supply the growing demand for low zener voltage SILICON CONDUCTORS as voltage reference devices, high new Type numbers are now available in production quantities. The voltage-current-temperature characteristic curve of a typical SILICON CONDUCTOR 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, within 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.

<table>
<thead>
<tr>
<th>SILICON CONDUCTOR TYPE NO.</th>
<th>REVERSE VOLTAGE RANGE @ 5.0 mA OF BACK CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Anode</td>
<td>Double Anode</td>
</tr>
<tr>
<td>A3B</td>
<td>A3C</td>
</tr>
<tr>
<td>A4B</td>
<td>A5C</td>
</tr>
<tr>
<td>A5B</td>
<td>A6C</td>
</tr>
<tr>
<td>Maximum dissipation 150 mW @ 25°C</td>
<td></td>
</tr>
<tr>
<td>Derate 1 mW per °C, 150°C max. ambient</td>
<td></td>
</tr>
</tbody>
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All of the above Types are available in production quantities, in addition to SILICON CONDUCTORS 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.

ELECTRONIC DESIGN - December 195-
**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 K-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 fluorocarbon 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 K-132 (SEE REVERSE SIDE)
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.

Fluoro 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 K-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.

© Registered trademark for The M. W. Kellogg Company's fluorocarbon Polymers.
Meetings

December 27-29: The Society for Industrial and Applied Mathematics will hold its first national meeting in conjunction with the annual meetings of the 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, M.; 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.


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

May 2-3: 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!

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.
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 must function as a multi-range milliammeter and voltmeter over a temperature range of -55°C to +85°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-e 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 multipliers, 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 of a series resistor can be determined by using the above method.

---

**Symbol Key**

- $R_1$: Rectifier forward resistance.
- $R_2$: Rectifier reverse resistance.
- $R_m$: Meter resistance.
- $C$: Meter capacitance.
- $L_m$: Meter inductance.
- $C_m$: Meter capacitance.

---

**Fig. 1. Bridge rectifier and meter.**

**Fig. 2. Complete equivalent circuit for the rectifier and meter.**

- $R_1$, $R_2$, $C_1$, $C_2$ are nonlinear and temperature sensitive compared to $R_m$, $L_m$, and $C_m$ (see Key below).

**Fig. 3. Simplified equivalent circuit for constant current and frequency applied.**

- $R_1$ equals $R_f/2$; $R_f = 2R_1$.

**Fig. 4. Simplified equivalent circuit for constant temperature and current applied.**

- $C = 2C_m$.
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.

$$V = I_{RE} X R + V_{RE}$$

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

**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.
The oscillograph limited 3.

New operation the DU

Convert to Dual Channel Operation in the Range of DC to 15 MC

...using any Single-Channel Oscillograph with the NEW DU MONT TYPE 330 ELECTRONIC SWITCH

The new Du Mont Type 330 Electronic Switch is a self-contained accessory for oscillography that permits...

1. Converting any single-beam oscillograph into a dual-channel instrument.
2. Adding a channel to any multi-channel instrument.
3. As a chopper, converting an a-c oscillograph for d-c measurement.

Within the range of DC to 15 MC, the Type 330 is limited only by the characteristics of the cathode-ray oscillograph being used.

This is the answer to those studies requiring comparison between two or more functions. Maximum time shift between the channels of the Type 330 is within one millisecond. Both channels may be adjusted for unity gain making it a simple matter to superimpose two phenomena for very precise time, phase or amplitude comparison.

Three free-running switching rates, 1KC, 10KC and 100KC, or triggered operation allow selection for best presentation on the cathode-ray oscillograph. The Type 330 can be connected into a test setup or disconnected as the need arises.

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°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°C, the shunting current ($I_t$) and the corresponding value of shunting resistance ($R_s$) can be calculated for any temperature ($T$) as follows:

\[ I_t (at T) = \frac{V}{R_s} - I_{pe} (at 85°C) \]

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 response.

MAJOR SPECIFICATIONS

<table>
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<tr>
<th>SIGNAL CHANNELS</th>
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<tr>
<td>I. Sinusoidal Frequency Response: with an output load of 60 uf, either channel, flat to d.c. and down not more than 3 db at 15 mc.</td>
</tr>
<tr>
<td>II. Amplifier Rise Time: with external load of 600 uf, no greater than 0.022 usec.</td>
</tr>
<tr>
<td>III. Variable Attenuator: Each channel has two series stepped attenuators with attenuation ratios of 1, 2, 4, 10, 20, 40, 100, 200, and 400; accuracy of attenuators ± 2%.</td>
</tr>
<tr>
<td>IV. Output: Level is zero volts d.c. with no signal or positioning voltage; positioning controls provide ±1 volt of d.c. positioning voltage.</td>
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SWITCHING

| I. Recurrent: Free-running, fixed frequencies of approximately 1 KC, 10 KC and 100 KC; Triggered, rate may be triggered at 0 to 100 KC rates. |

PRICE $295
WRITE FOR COMPLETE INFORMATION
current response over most of the temperature range. The usable temperature range can 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" x 5/8" x 1". For this unit, the input voltage required to produce full scale deflection is 2.85 ±3%v, rms, over the temperature range of -45°C to +55°C and does not exceed 8% over the temperature range of -55°C to +85°C. The input current required to produce a full scale deflection is 1.62mA ±3% over the temperature range of -55°C to +55°C with a gradual increase from ±55°C to ±85°C.

The current and voltage responses, being interrelated, affect each other. At low temperatures the input voltage required to produce a definite deflection decreases, 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 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-multi-lying resistor, the current response becomes more constant over the temperature range and so the voltage response will also become more constant.

---

**Electronic Design** • December 1954
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.

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

By 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 Pendleton 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 TS417.
One of the n-p-n grown junction transistors, a Type T1223, has sufficient gain at high frequencies to function as a combined mixer-oscillator stage.

There are two i-f stages incorporating Type T1222 transistors. The intermediate frequency is 262kc. A Type T1210 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.

A new AN type multi-element aircraft instrument, incorporating recently developed Marion Coaxial Mechanisms, has greater durability and performance stability than many existing instruments of much greater size and weight. Applications of the new instrument, available with two, three or four elements, include ammeters, voltmeters, temperature indicators and radio navigational instruments. They meet the requirements of Army-Navy Aeronautical Design Standard AND10401 for 2¾" dial instruments.

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.

MECHANISMS BY MARION
The Coaxial Mechanism typifies the way each Mechanism by Marion is designed to meet the particular requirements of a specific application — and to provide substantially improved performance, with large reductions in cube and weight. They are not adaptations or variations of standard, conventional mechanisms.

Marion Electrical Instrument Company
417 Canal Street, Manchester, New Hampshire

*Trade Mark Patents Pending

MANUFACTURERS OF RUGGEDIZED AND "REGULAR" METERS AND RELATED PRODUCTS

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Three New AC Servo Types Available...

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- MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS
  Supply: 115 volt 400 cps.
  Power output: 3.5, 6, 10, 18 watts
  Sensitivity: 1 volt AC
  Response Time: .03 sec.
  Lowest Cost — Smallest Size
  For further information request Form S493

- MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER
  Supply: 115 volt 400 cps.
  Power output: 5, 10, 15, 20 watts
  Sensitivity: .1 volt AC
  Response Time: .008 to .1 sec.
  Highest performance — All magnetic
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- TRANSI-MAG*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER
  Supply: 115 volt 400 or 60 cps.
  Power output: 2, 5, 10, 15, 20 watts
  Sensitivity: .08 volt AC into 10,000 ohms
  Response Time: .01 sec.
  Fast response at high gain
  For further information request Form S499 (400 cps.); Form S497 (60 cps.)

*MAGNETIC AMPLIFIERS • INC
Telephone: Cypress 2-6510
632 Tinton Ave., New York 55, N. Y.

CIRCLE ED-34 ON READER-SERVICE CARD FOR MORE INFORMATION
Low-Cost Precision Potentiometers

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

Available 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...
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**.

THE BOLT THAT HOLDS THE TWO HALVES OF THE POTENTIOMETER TOGETHER ALSO FUNCTIONS AS THE STOP IN THIS STRIKINGLY SIMPLE DESIGN.

When Consolidated Edison came to the Wire and Cable Department of General Electric for generator leads with greater capacity, a tough cable problem came along, too. Con Edison needed cable to carry increased loads without increase in size.

By taking advantage of the new SE-100 silicone rubber coating compound developed by the G-E Silicone Products Department, G-E wire engineers were able to build a cable that could carry nearly twice as much current as before with the same conductor cross section!

**NEARLY TWICE THE CURRENT WITH NO INCREASE IN SIZE**

**HOW CAN SE-100 BENEFIT YOU?**

General Electric's new SE-100 offers a combination of heat life, electrical properties, and abrasion resistance superior to any other silicone rubber coating material. SE-100 is ideal for coating glass or organic fabrics for service at high or low temperatures, or where resistance to weather, ozone, corona, or chemicals is required. Where can you use it to extend equipment life, minimize insulation failures or create new product designs? Ask your fabricator to tell you more about SE-100, or send the coupon today for complete information!

G-E silicones fit in your future

**GENERAL ELECTRIC**

CIRCLE ED-35 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". Prized at $6.00, it will be published next month by John Wiley & Sons, Inc., 410 Fourth Ave., New York 16, N. Y.

Transistors 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 Ieb 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 Vc = 2.2v, this will mean a collector current of 4.8ma. The approximate value of load resistance will then be 2.2/4.8 x 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 Ic=1ma, Vbe=5v, and converting to the conditions of Ic=5ma, Vbe=2.2v, we obtain the following:

h11 = 40 x 1/2.4 x 1 = 16.7
h12 = 3 x 10^4 x 3 x 1.5 = 13.5 x 10^4
–h21/(1 + h21) = 21.2 x 0.82 = 17.4
whence h21 = 0.946
h22 = 1 x 10^4 x 4.4 x 1.5 = 8.25 x 10^4

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

h'11 = (h11)/(1 + h21) = 307

h'12 = h12/h22 = 12.9 x 10^4

h'21 = (–h21)/(1 + h21) = 17.4

h'22 = h22/(1 + h21) = 152 x 10^4

Δ' = 15.7 x 10^4

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:

r1 = (Δ' + h'22 yl)/(h'22 + yl) = r1 = 293
A1 = h'22 yl/(h'22 + yl) = 27.6 ohms
A1 = h'22 yl/(h'22 + yl) = 16.2
G1 = 4(h'21)2yl/[Δ'+h'11 yl+(h'22+yl)]^2 = 26.5db

For the driver stage let us assume a collector voltage of about 1-1.2v. Assuming a loss in the coupling transformer of about 2db the output power of this stage is 5mw = 24.3db, or 17.7μw. 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 impracticably 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 Ic = 0.3ma, Vbe = 1.1v. By the process followed above we can obtain the corresponding grounded-base parameters:

h'11 = 40 x 1/0.38 x 1 = 105 ohms
h'12 = 3 x 10^4 x 0.75 x 1.9 = 4.27 x 10^4

–h21/(1 + h21) = 21.2 x 0.95 x 0.77 = 15.5
or h21 = -0.940
h22 = 1 x 10^4 x 0.50 x 2.00 = 1 x 10^4
Δ' = 5.06 x 10^4

The corresponding grounded-emitter parameters are

h'11 = 1730
h'12 = 13 x 10^4
h'21 = 15.5
h'22 = 16.5 x 10^4 Δ' = 8.35 x 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:

33.4 + 33.4 = 26.5 = 97.3db

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.
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 2N441 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 112,000-925 ohms indicated above for perfect match. For this reason a considerable increase in gain was obtained by using 2N13 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 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.

As shown in Fig. 1, the circuit is a simple half-wave rectifier followed by a conventional class A amplifier. The output power is about 5mw, which is adequate for the purpose.

**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 x 10^-10w. 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 power 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 gain. The third consideration is the required frequency response. It is not quite possible to obtain the desired attenuation between 50cy and 800cy 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 of 10mV and a desired signal-to-noise ratio of 50db the equivalent input noise becomes 1.7 x 10^-11w. The usual frequency range for such an amplifier is 30-12,000cy or a ratio of 400. A noise figure of around 5db should be adequate. The frequency response of the amplifier will be of assistance in this respect, although less 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 2N449 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 2N449 in the grounded-emitter configuration will have a maximum input 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 indicate 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 effort 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

$$h_{11} = 40 \ h_{12} = 3 \times 10^{-4} \ h_{21} = -0.955 \ h_{22} = 1 \times 10^{-4}$$

The corresponding grounded-emitter values are

$$h_{11}' = 888 \ h_{12}' = 5.88 \times 10^{-4} \ h_{21}' = 21.2 \ h_{22}' = 22.2 \times 10^{-4} \ \Delta' = 7.26 \times 10^{-3}$$

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

$$r_i = (\Delta' + h_{11}y_i)/(h_{12}' + y_i) = 863 \text{ ohms}$$
$$A_i = ((h_{12}' + y_i)/h_{22}') = 20.3$$

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 conductance 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 both stages 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

$$r_i'/(1 + h_{21}).$$

For the 2N44 and a desired input resistance of 60,000 ohms the indicated value of \(r_i'\) 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 \(r_i'\) 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 \(A_i r_i/r_e\).

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 first 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 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 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
combine the two transistors. The input impedance of these stages will be low, since the plate current in a class B grounded-base stage is quite high, so that the non-linearity of the grounded-base configuration will be tolerated. The grounded-collector configuration is ruled out on the basis of low power gain, because 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 voltage is restricted to half this value. The peak collector current is approximately 1amp, even at this voltage, which illustrates the order of magnitude 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.
Printed Circuit Design
IV—Base Materials for Printed Circuits

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

Sheets 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 mat, 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 platens 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, melamines, epoxies, polyesters, silcones, 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 mat 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 (0.0013", 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 because 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 electro-deposited 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 1), 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, using an adhesive film such as "Permacel" 1824, 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 1. Thickness tolerances
for three types of plastics.

<table>
<thead>
<tr>
<th>Thickness Tolerances—(plus or minus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
</tr>
<tr>
<td>Materials</td>
</tr>
<tr>
<td>Paper-base stock</td>
</tr>
<tr>
<td>Fabric base stock</td>
</tr>
<tr>
<td>Special sanded stock (double pressed)</td>
</tr>
</tbody>
</table>

2: Manufactured by Permael Tape Corp.
Table 2. Properties of standard National Association of Electrical Manufacturers grades of laminates.

<table>
<thead>
<tr>
<th>NEMA Grade</th>
<th>Resin &amp; Binder</th>
<th>Flexural Bond Strength (psi)</th>
<th>Max Continuous Duty Temp (°F)</th>
<th>Approx. Dielectric Constant @ 10^6 cy</th>
<th>Dissipation Factor @ 10^6 cy</th>
<th>% Moisture Absorption @ 1000 hrs</th>
<th>Volume Resistivity (Megaohms/cm)</th>
<th>Arc Resistance</th>
<th>Fabrication Characteristics</th>
<th>Relative Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Phenolic-paper</td>
<td>14000</td>
<td>250</td>
<td>8.0</td>
<td>0.08</td>
<td>2.0</td>
<td>Variable-poor</td>
<td>Poor</td>
<td>Excellent</td>
<td>0.7</td>
</tr>
<tr>
<td>XXP</td>
<td>Phenolic-paper</td>
<td>19000</td>
<td>250</td>
<td>4.6</td>
<td>0.037</td>
<td>1.0</td>
<td>5 x 10^5</td>
<td>Poor</td>
<td>Excellent</td>
<td>0.9</td>
</tr>
<tr>
<td>XXXP</td>
<td>Phenolic-paper</td>
<td>25000</td>
<td>250</td>
<td>4.5</td>
<td>0.029</td>
<td>0.65</td>
<td>1 x 10^5</td>
<td>Poor</td>
<td>Fair</td>
<td>1.0</td>
</tr>
<tr>
<td>N-1</td>
<td>Phenolic-nylon</td>
<td>35000</td>
<td>165</td>
<td>3.3</td>
<td>0.030</td>
<td>0.4</td>
<td>6 x 10^5</td>
<td>Good</td>
<td>Fair</td>
<td>3.0</td>
</tr>
<tr>
<td>G-5</td>
<td>Melamine-glass</td>
<td>55000</td>
<td>300</td>
<td>6.8</td>
<td>0.030</td>
<td>2.0</td>
<td>1 x 10^5</td>
<td>Good</td>
<td>Fair</td>
<td>5.0</td>
</tr>
<tr>
<td>G-7</td>
<td>Silicone-glass</td>
<td>40000</td>
<td>350</td>
<td>3.9</td>
<td>0.015</td>
<td>0.4</td>
<td>1 x 10^5</td>
<td>Good</td>
<td>Fair</td>
<td>4.0</td>
</tr>
<tr>
<td>Epoxy</td>
<td>Epoxy-glass</td>
<td>68000</td>
<td>350</td>
<td>4.9</td>
<td>0.028</td>
<td>1.0</td>
<td>1 x 10^5</td>
<td>Good</td>
<td>Fair</td>
<td>10.0</td>
</tr>
<tr>
<td>Teflon</td>
<td>Teflon-glass</td>
<td>13000</td>
<td>400</td>
<td>2.6</td>
<td>0.001</td>
<td>0.2</td>
<td>1 x 10^5</td>
<td>Good</td>
<td>Good</td>
<td>13.0</td>
</tr>
<tr>
<td>GP-9100</td>
<td>Polyester-glass matte</td>
<td>23000</td>
<td>300</td>
<td>4.3</td>
<td>0.015</td>
<td>0.2</td>
<td>1 x 10^5</td>
<td>Good</td>
<td>Poor</td>
<td>1.5</td>
</tr>
<tr>
<td>CE</td>
<td>Phenolic-cotton</td>
<td>17000</td>
<td>250</td>
<td>5.0</td>
<td>0.050</td>
<td>1.2</td>
<td>1 x 10^5</td>
<td>Poor</td>
<td>Excellent</td>
<td>1.7</td>
</tr>
</tbody>
</table>

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.

G-7 (Silicone-glass) - Good arc and high temperature resistance, low dielectric losses, but subject to bond strength problems.

Epoxy Glass - Most widely used glass-base grade—good mechanical and electrical properties combined with low moisture absorption.

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-base 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 notoriously 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 encountered, 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 1/16”. Good flexural strength. Natural green color.

This is one of the improved C-D-F Dilecto laminates. Advances in resins and manufacturing techniques make 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-2615
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 1/32 to 1/16”. A staple filament (Grade GB-2615) is used for thicknesses over 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**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>Average or Typical Value Lbs. pull per 1” width of foil to separate</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXP-24 or XXXP-26 plus 0.0014” copper</td>
<td>5 to 8</td>
</tr>
<tr>
<td>XXXP-24 or XXXP-26 plus 0.0028” copper</td>
<td>7 to 9</td>
</tr>
<tr>
<td>GB-116T plus 0.0014” copper</td>
<td>5 to 12</td>
</tr>
<tr>
<td>GB-112S plus 0.0014” copper</td>
<td>6 to 8</td>
</tr>
<tr>
<td>GB-261S plus 0.0014” copper</td>
<td>7 to 10</td>
</tr>
</tbody>
</table>

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, has helped 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***

NEWARK 107, DELAWARE

CIRCLE ED-29 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Design • December 1954
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 area 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.

Radio Receptor Co. conducts continuing laboratory research to maintain highest standards for existing types of selenium rectifiers, silicon and germanium diodes and transistors—and to develop new units, including those to meet special needs where necessary.

As rapidly as possible we publish bulletins on our products and they are always available upon request. Sometimes, though, we find the printing presses simply cannot keep up with our progress... So, for the best and most up-to-date facts about Radio Receptor semi-conductor products we suggest you submit your specifications. Our engineers will gladly make recommendations incorporating the very latest information at their command. Just address Section D-2.
Specify POTTER capacitors especially if:

1. your product reputation makes component quality the primary consideration.

2. you need flexible production facilities capable of producing small runs of capacitors, engineered to fit your specific needs, quickly and economically.

Send now for this Free Catalog of the complete Potter Line.

THE POTTER COMPANY
North Chicago, Illinois, U.S.A.
Dept. C
Frequency Standard

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

Circuit diagram of the frequency standard.
STABLE 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 x 10⁶ and a maximum current limitation of 1ma. The A-1 switchboard lamp, R₁, 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°C 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 23°C. Frequency changes in the crystal due to oven cycling are less than 10⁻⁶/sec., and normal laboratory temperature changes are apparently not reflected in the temperature of the crystal.

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:

<table>
<thead>
<tr>
<th></th>
<th>MIL-R-10509A ALLOWABLE CHANGE</th>
<th>Series 850 TYPICAL CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Cycling</td>
<td>1.0%</td>
<td>0.02%</td>
</tr>
<tr>
<td>Low Temperature Exposure</td>
<td>3.0%</td>
<td>0.04%</td>
</tr>
<tr>
<td>Short Time Overload</td>
<td>0.5%</td>
<td>0.02%</td>
</tr>
<tr>
<td>Effect of Soldering</td>
<td>0.5%</td>
<td>0.02%</td>
</tr>
<tr>
<td>Moisture Resistance</td>
<td>5.0%</td>
<td>0.08%</td>
</tr>
<tr>
<td>Voltage Coefficient</td>
<td>0.002%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Load-Life (per 1000 hours)</td>
<td>1.0%</td>
<td>0.20%</td>
</tr>
<tr>
<td>Temperature Coefficient (PPM/°C)</td>
<td>±3000</td>
<td>+370 ±20</td>
</tr>
</tbody>
</table>

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.

**New and Revolutionary Davohm**

**metal film**

resistors...

outdates all previous film types in performance characteristics.
## Specifications for Laminated Plastics

By Dr. Norman A. Skow, Director of Research

### Table of Grades

<table>
<thead>
<tr>
<th>Form</th>
<th>Grade Description</th>
<th>NEMA Grade</th>
<th>MILITARY SPEC</th>
<th>MILITARY TYPE</th>
<th>JAN-P-79 TYPE</th>
<th>FEDERAL SPEC 23-P-46</th>
<th>AAF-SPEC</th>
<th>ASTM D-709 TYPE</th>
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<tr>
<td>TUBES (Rounded)</td>
<td>Form Tr</td>
<td>Paper Filler—Hard Phenolic Resin</td>
<td>X</td>
<td>MIL-P-79</td>
<td>PBM</td>
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<td>X</td>
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<td>Medium Weight Cotton Fabric Filler—Hard Phenolic Resin</td>
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<td>MIL-P-79</td>
<td>PBG</td>
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<td>E-4</td>
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<td>EM-2</td>
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<td>MIL-P-79</td>
<td>GMM</td>
<td>GMM-1</td>
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<td>MIL-P-79</td>
<td>GMM</td>
<td>GMM-1</td>
<td>G-5</td>
<td></td>
</tr>
</tbody>
</table>

### Key:
- **PBM**: Paper base, best mechanical properties
- **PBE**: Paper base, best electrical properties
- **PB**: Paper base for general use
- **FB**: Fabric base, best heat resistance
- **G**: Glass
- **A**: Asbestos
- **S**: Fabric base for intricate work
- **GMS**: Glass melamine, general
- **GSG**: Glass silicate, general
- **GMA**: Glass melamine, mat

### Sheet Stock Grade Description

<table>
<thead>
<tr>
<th>NEMA Grade</th>
<th>MILITARY SPEC</th>
<th>MILITARY TYPE</th>
<th>JAN-P-13 Type</th>
<th>NAVY 71-P-7 Type</th>
<th>ARMY 1-P Type</th>
<th>ASTM (D-709)</th>
<th>FEDERAL SPEC</th>
<th>AAF SPEC</th>
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</tbody>
</table>

### Notes:
- The specifications provide information on the properties and performance characteristics of the various grades of material suitable for laminated plastics applications.
- The table includes grades for paper, cotton, fabric, glass, and asbestos-filled resins, among others.
- The grades vary in terms of mechanical and electrical properties, providing options for different applications.
- The table also includes specifications for the United States military and aerospace industries, indicating compliance with relevant standards.
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.

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.

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.

Tests indicate that the Silastic gaskets will have at least twice the service life of the organic rubber seals previously used. Furthermore, even foods as hard to clean off as tomato paste or candy do not stick to the gasket. Cleaning time is reduced and the carry-over taste associated with organic rubber gaskets eliminated.
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*. Surface Resistivity, 100% R.H., 3.6 X 10*. Dielectric Constant, 60 cycles, greater than 0.0005; 10* 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.


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

*Pat. Pending.
Large-Screen Oscilloscopes

By 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 ±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 250 kc. 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.
furnished with a variety of phosphors. Input impedance is 2 megohms shunted with 200mfd.
Calibration accuracy is better than ±4% from 10 to 100microsec/inch, and better than ±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.

Hot dimpling of high stress materials for flush riveting used in today's airframes requires unfailing 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.
Now Available

Complete Assemblies or Sub-Assemblies for your Power Supplies

- Unitized Rectifiers
- Plate-Filament-Reactor Assemblies
- Plate Transformers
- Filament Transformers
- Filter Reactors

Moloney now offers complete power supplies custom built to your needs. Complete power supplies or any sub-assembly can be had, manufactured to your most rigid specifications.

High Power or High Voltage offers no problem to Moloney, long experienced in the manufacture of quality transformers. Moloney, supplying transformers to the electrical industry for over 58 years, stands ready to apply this experience to the manufacture of your most exacting requirement for power supplies.

Reading 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 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.
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**
A high Mu triode designed for continuous wave operation up to 300 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."

This simple experimental computer shows how the dials are employed.
of a vacuum tube amplifier in a control circuit (Thomas A. Edison, Inc.).

Plugging in a Switch Register (p 20). Only one switch pulse per bit of information stored is required by this unit, which can operate at frequencies from 0 to 100 kc (Raytheon Mfg. Co.).

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

Cartridge-Mounted Thermistor (p 24). The cartridge, that holds a chip of crystal detector and probe (Yardia Corp.), can be inserted into all types of crystal detectors and probes.

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 360°, making it useful for analog-to-digital information conversion, torque amplification, and transistor applications (Computer Instrument Co.).

Modular Mounting Units (p 30). A glass bonded metal 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 (Midget Corp.).

Airborne Computer Amplifier, by S. Frangoulidis (p 32). The entire packaging of this unit is put into a light weight, compact case, 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 11). A designer's guide which includes a valuable comparison table of low temperature materials.

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

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

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

Plug-In Transistor Circuits (p 22). Mounted in a standard 5-pin base, these units include an audio amplifier, cathode follower, two pulse generators, and a sine wave oscillator (Lee Laboratories).

High Output Crystal Photodetector (p 24). This unit has a sensitivity of 100,000 at 10% and 2 foot candles. Four typic application circuits are included (Clarex Corp.).

Voltage Sensitive Capacitors (p 26). Up to 75% change in capacitance can be obtained by varying the voltage applied to these units. At this application circuit is included (Maurer 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).

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 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. Schaefer (p 34). 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.


"Printed" Amplifier Subassembly (p 18). A compact 2-stage audio amplifier that can be incorporated into portable phonographs, intercom systems, etc., or 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 3/4 by 3/4 by 3/4 inches (excluding plugs and frame). It contains 504 diodes, 200 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 this easy to spot-weld the diodes of Hughes diodes. There is no adverse effect on circuit 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.
MINIATURE MOTOR problems, 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 .005 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.

For the answers to your MINIATURE MOTOR problems, 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 .005 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.

HIGH PRECISION GEARS and precision fine pitch gearing
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.

PLANTS AT LYNNWOOD, PASADENA, BELMONT, SAN FRANCISCO, (CALIF), SEATTLE, HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

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

Network Design Board (p 20) A wide variety of R-C circuits can be set up on this unit for rapid design evaluation (Instrument Research Co.).
Extended Range Oscillator (p 22) The range from 0.3 to 510 kc is covered by this unit, which is especially useful in servomechanism 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 diode 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 are over at wire holes (Allen Products Co.).
Standard Etched-Wiring Circuit Boards (p 32) These are prewired (etched copper conductors) boards which accommodate more than 20 common tube types as well as power supply filter circuits (Tri-Dez Electronics Co.).

September
Printed Circuit Design: I—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 24) Five application circuits are included in this feature on goldbonded diodes (Transistor Electronic Corp.).
Measurement of Cable to Rigid Line VSWR, by A. H. 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" dual components (Kroff 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 SLMc band (Varian Associates).
Precision Attenuator (p 36) This rugged attenuator is designed for the 25 SLMc range (Airborne Instruments Laboratory, Inc.).
Mechanized Production of Etched-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' DYEAC computer are discussed in this "Design Forum" article.

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 120 sec (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 servomechanism 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
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 "pipe" (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.

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

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

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A member of the CBS family: CBS Radio • CBS Television • Columbia Records • CBS Laboratories • CBS-Columbia • CBS International • and CBS-Hytron

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

Pulse Transformers
For Printed Circuity
The Type GEM series of miniature plug-in pulse transformers is available in the pulse width range of 0.05 μsec to 2 μsec, with two or three windings. The transformers are epoxy resin impregnated and molded. Operating temperature range is from -70° to +135°C, and they surpass MIL-T-27, grade 1, class A test specifications.
Size is 5/8" diam x 9 1/2" high. Weight is approximately 5 gr. Terminals are No. 22 AWG copper wire (maximum length 7 1/2"). 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 Thyratron
For High Altitudes
The 647A Xenon Thyratron 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 647A has a maximum operating voltage of 1500v a-c; continuous anode current is 1.5amp, and the continuously occurring 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° to +85°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 1/16" 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 3-5millssec 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 instrumentation work. It is available as a clutch and a clutch brake. The unit itself has a maximum diameter of 65/64" and an 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 1/2-2oz. Response time is 3 to 5millssee. The unit will meet all military specifications, and will operate in ambient temperatures of -67° to +70°C. Magtral 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 subminiature receivers and transmitters. Its dimensions, exclusive of shaft, are only 13/16" x 11/16" x 1 1/6". Capacitance range is up to 350mmfd 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 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 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 tightened, 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

Electronics Design - December 1954
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 upright ears of the base and is ready to be snapped into place on the tube. To remove the tube, a flick of the spring 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

PERKIN
ENGINEERING CORP.

345 KANSAS ST. • EL SEGUNDO, CALIFORNIA

PHONE: ORegon 8-7215

CIRCLE ED-53 ON READER-SERVICE CARD FOR MORE INFORMATION
Germanium Diodes

Feature Gold Junctions

This line of subminiature 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. Semicon-ductor 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 µsec at rise times of 0.05, 0.15, 0.2, 0.4 and 0.4 µsec; sine wave—10 mV; output amplitude approximately 3.0 V; 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 1-Me crystal-stabilized oscillator accurate within 0.03%. Electronic voltage regulation is provided. Weight is 16-1/2 lb. The unit requires 50-60 c, 110 V. 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 time, save labor, 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.

CIRCLE ED-58 ON READER-SERVICE CARD FOR MORE INFORMATION

Round, square, rectangular, triangular, any shape, any size—Precision Paper Tube Co. can provide all your 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.

Send in your specifications for samples. Request Arbor List of over 2000 sizes.

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Cleveland, Ohio, Atlanta, 1-1060
Indiana, Southern Ohio:
Loganport, Indiana, Loganport 2555
Michigan, Southern Illinois, Iowa:
Sterling, Illinois, Loganport 2555
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Pasadena, California, Loganport 2318
Precise Electronic Diodes

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

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

Electric Design • December 1954
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 usec, 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

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 equipment 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.

Approximate case dimensions in inches

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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...

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.

IF YOU WORK WITH PULSES...
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{s} to 4.0\mu\text{s}).

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{s} to 2.5\mu\text{s}; also a 3.0\mu\text{s} 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 2000Mcm; solid wire (AWG) from No. 20 through 4/0; ACSR from No. 5 through 336.5Mcm; 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

American Electronic Mfg., Inc.
9563 W. JEFFERSON BLVD., CULVER CITY, CALIF.
TELEPHONE: Texas 8-3471

Let us quote on your detailed requirements.
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- Ameo 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 “Stemco 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°F 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
Latching Relay
Operates Over $15 \times 10^9$ Times

The Type G Electromechanical Latching Relay was designed to meet the punishing service requirements of an internationally 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 $2\frac{1}{2}$a 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 $105^\circ$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
ELECTRONIC DESIGN • December 1954
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 operating 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

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 subminiature 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 DPD, 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.

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-glass 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, resiliences, and densities ranging from 5 to 25 lb 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
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 previous 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 "Recordoscope 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 60 sec 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 contol oscillator f 2.3-67.5mm lens; "time" and "bulb" shutter having speeds from 1/sec to 1000/sec; and fixed focus. The camera measures approximately 4 1/2" x 6 1/4" x 9/16". Arenac Associates, Dept. ED, 329 W. Washington St., Pasadena 3, Calif.

CIRCLE ED-133 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 50th 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-T-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.

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 II 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 to 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.

- 130 oz./in. output torque
- Sealed oil bath lubrication
- Speeds up to 10,000 RPM input
- Coaxial shafts for in-line construction
- Available in 642 STANDARD ratios
- Quick delivery — 1 or 100 unit

Write for Data Sheet 10 and 11 for details

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

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

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

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

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:

Write today for complete specifications, performance data, and quotes to meet your specific application.
Remote Positioning System
Highly Accurate

Designers of remote control equipment for industrial or aircraft service will find the accuracy of 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.

Decade Box
Has 1,199,999 Resistance Steps

The “Dekabox” is an a-d 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 ±0.05% of their rated value, and they have special windings to minimize frequency error. The temperature coefficient of individual resistors is less than ±0.002% per °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.
Tube Socket
For Printed Circuits

These laminated tube sockets feature twin wafer supporting contacts with vertical terminals that snap into individual holes in the circuit board. This feature permits the printing of jumping 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 glass insulation material. Methode Mfg. Co., Dept. ED, 2921 Church St., Chicago, III.

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 200z, 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, III.

CIRCLE ED-61 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONS, INCORPORATED
127 SUSSEX AVENUE
NEWARK 3, N. J.

Our industrial electronic tubes are in stock near you.
replacing GLASS with TEFLO

Chemec Stand-Off and Feed-Through Insulators

- Tough, resilient TEFLO made these miniatures possible—and BETTER—than glass-insulated component.
- 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 Chemec Stand-Off and Feed-Through Insulators for superior service and lower assembly costs.
- SEVEN STOCK SIZES, including sub-miniatures. Other dimensions feasible.
- WRITE for Chemec Bulletin EC-1153.

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 1/2rpm 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 ±1% for a constant load over ±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 lamp emits a high intensity blueish-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
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, 2635 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.

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.
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 $8\text{me}$.

Grown junction silicon transistors operate with little change at $150^\circ\text{C}$ compared to a considerably lower limit for germanium transistors. Average alpha cutoff frequency is $3\text{me}$ 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 $8\text{me}$ or better and an alpha of 0.95 or better. The Type 915 (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.

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.

Elco Tool and Screw Corporation
1948 Broadway-Rockford, Illinois

CIRCLE ED-54 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

<table>
<thead>
<tr>
<th>Current</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 mA</td>
<td>0-600 VDC</td>
</tr>
<tr>
<td>300 mA</td>
<td>0-300 VDC</td>
</tr>
<tr>
<td>100 mA</td>
<td>0-100 VDC</td>
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<tr>
<td>50 mA</td>
<td>0-50 VDC</td>
</tr>
<tr>
<td>25 mA</td>
<td>0-25 VDC</td>
</tr>
<tr>
<td>12.5 mA</td>
<td>0-12.5 VDC</td>
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</tbody>
</table>

Ripple (mV-RMS): 100 VDC at 50-60 cycles
Maximum bias circuit impedance: 2.5 kohms
Internal impedance, max: 2.0 ohms
Input range: 0-150 VAC, 10-50-60 cycles

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 at a smooth and stepless fashion from forward to zero to full reverse.

Size: Width 2-1/8" Length 3-3/4" Height 3-11/16" Weight 17 oz.
$90.00 F.O.B. Stamford, Connecticut

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, 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, III.

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 wire. 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

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
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 2½" long, 1¾" wide and 1¾" 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.


CLARE RELAYS
FIRST IN THE INDUSTRIAL FIELD

CIRCLE ED-112 ON READER-SERVICE CARD FOR MORE INFORMATION

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 1Me. 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 1Me.

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...
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

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 ±25.0mA. 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°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 1-3/4" x 7-1/2". Weight is 15oz. Electro-Voice, Inc., Dept. ED, Buchanan, Mich.

CIRCLE ED-121 ON READER-SERVICE CARD FOR MORE INFORMATION
Electro Bi-Glas is the first and only Class B insulation that keeps its superior electrical properties after elongation. Stands high temperatures 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.

Electro-Techical 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, maintaining an output within ±5% of its rated voltage.
- LESS CUBIC SPACE—Designed for 19 inch relay rack mounting, with minimum panel height per kVA.
- LONGER LIFE—Short runs are practically eliminated by the conservative design of all components and the inclusion of two voltage reference units—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

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 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 washers.

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 air tight 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.

Baker & Company, Inc.
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 (+0.0002°C between —50° and +150°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

KANTHAL
THE KANTHAL CORPORATION
8 Amelia Place, Stamford, Conn.

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 $10.05. 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

put 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

Electronics 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 rest 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 90%, 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 (±2% at any point). Dry bulb temperature is controlled to ±1°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

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
### 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**

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### DESIGNATION AND TYPE

**TYPICAL OPERATING CONDITIONS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Designation</th>
<th>Bendix No.</th>
<th>Description</th>
<th>Base And Bulb</th>
<th>Heater Voltage</th>
<th>Plate Voltage</th>
<th>Plate Current</th>
<th>M.A. Load</th>
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<td>6X5</td>
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<td>70.</td>
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</tbody>
</table>

- Tube Manufactured with Hard (Nonox) Glass for High Temperature Operation (Max. Bulb Temp. 300°C.)

**CIRCLE ED-149 ON READER-SERVICE CARD FOR MORE INFORMATION**

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**KOOL KLAMPS**

KOOL KLAMPS are made of a specially developed, heat treatable alloy 99.9% 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 BIRTCHE Corporation

4371 Valley 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**
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 1.5mfd. The frequency response is from 10kc to 250Mc and is essentially flat from 11kc 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 Specialties Corp., Dept. ED, Snow & Union Sts., Boston, 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
Specify Cannon \( \mathbf{K} \) Connectors!
All-Purpose • Versatile • Stable Design

- 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

**CANNON PLUGS**

Please refer to Dec. 143 in requesting K-5 Bulletin

CANNON ELECTRIC COMPANY 3209 Humboldt St., Los Angeles 31, Calif.
Factories in Los Angeles, East Nanticoke, Pennsylvania, England
Representatives and distributors in all principal cities.

CIRCLE ED-196 ON READER-SERVICE CARD FOR MORE INFORMATION

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**ASTELL**

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 collet, 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.

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**PERFORMANCE THROUGH ASSOCIATION**

**CIRCLE ED-197 ON READER-SERVICE CARD FOR MORE INFORMATION**

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**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.

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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 2-3/32" 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 140-491.

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**CIRCLE ED-199 ON READER-SERVICE CARD FOR MORE INFORMATION**

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**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.

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**WIRE LEAD COMPONENT PRINTING**

**MARKEM MACHINE CO.**
KEENE 19, NEW HAMPSHIRE
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 8-10KMc range. Size is 17" wide x 10-1/2" high x 13" deep. Weight is 45 lb. Kearfott Co., Inc., Western Manufacturing Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE ED-204 ON READER-SERVICE CARD FOR MORE INFORMATION

For Mark 7 and 8 Servo Motors—
MAGNETIC SERVO AMPLIFIER

Features of the PRD Type R40G10W1 Magnetic Amplifier:

- Response time of one cycle
- Temperature range -55°C to +85°C with normal servo duty cycles
- Hermetically sealed reactor unit only 2½" high and 2½" diam., weighs less than 12 oz.
- Power supply 115V ±10%, 400 cps ±10%, single phase
- Rugged design meets MIL-5727 Procedure I Vibration Spec.

CIRCLE FD-205 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 crosstalk 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 4 mmfd for each link, and 15 mmfd for line circuits. Maximum operating voltage is conservatively rated at 500v d-c.

Operate time is 0.001 sec, and release time is 3.4 milliseconds. 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.

Capacitors
For High Temperature Uses

The Type XC line of tubular high temperature hermetically sealed miniature capacitors is designed for continuous operation from -65° to +165° C. The line has insulation resistance of 50,000 megohms per mmfd minimum at +25° C, 100 megohms per mmfd minimum at +125° C, and 20 megohms per mmfd minimum at +165° C. New units are offered for any high temperature military or industrial application. Gudecon Co., Dept. ED. 340 W. Huron St., Chicago 10, Ill.

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

The Inside Story
STABILINE TYPE IE

- Instantaneous Correction
- Excellent Regulation and Stabilization
- Minimum Waveform Distortion
- Wide Input Range
- Adjustable Output Voltage
- Insensitivity to Frequency Changes

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

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 motors are lightweight, high torque, low inertia, two-phase induction motors and are available in 2, 4 and 8-pole models for 400 or 60 cycle supply, and can be coupled to meet performance specifications for military servo motors, Mark 7 and Mark 8. The control 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 Series 15 and 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

CIRCLE ED-210 ON READER-SERVICE CARD FOR MORE INFORMATION

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 Naves Avenue, Groton, Connecticut  - Hilltop 5-0353

CIRCLE ED-212 ON READER-SERVICE CARD FOR MORE INFORMATION
New Miniature LS-9 Coil Form
Unusually well shielded, rugged

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.

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
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°C to +150°C. All components are military quality. Hermetically sealed transformers, glass-sealed high temperature (125°C) capacitors, and computer-type tubes are employed.

Frequency division is all-digital, using 11 special plug-in decade dividers. 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 100,000cy. 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 120lbs. Electronic Engineering Co. of California, Dept. ED, 180 S. Alvarado St., Los Angeles 57, Calif.

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°F, in highly corrosive atmospheres and under high vibration.

Among the features of these units are: pressure ranges from 1psi to 75,000psi; output up to 15v with a 25,000 ohm load; frequency response from 0 to 10,000cy; flash diaphragm construction; high stability with water cooling; and shock resistance. Photocom Research Products, Dept. ED, 421 N. Foothill Blvd., Pasadena 8, Calif.
There's always room for a Fenwal Miniature THERMOSWITCH® control

SEND FOR BULLETIN

Designed for:
- CRISTAL OVENS
- GUIDED MISSILES
- WAVE GUIDES
- RADAR • COMPUTORS
- ANTENNAS

and many others where temperature control is vital and space is 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.

WARD LEONARD ELECTRIC CO.

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°C to +165°C. Power requirement is 25W, d.c.

With the incorporation of a telephone-type relay, maximum response time of all three units is 6millisecond 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, Mass.
CIRCLE ED-161 ON READER-SERVICE CARD FOR MORE INFORMATION

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 sync 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, 50-60c/60c. Precision Apparatus Co., Inc., Dept. ED, 92-27 Florance Harding Blvd., Elmhurst 6, L. I., N. Y.
CIRCLE ED-104 ON READER’S SERVICE CARD FOR MORE DATA

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

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
CIRCLE ED-103 ON READER-SERVICE CARD FOR MORE INFORMATION
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 ±30° 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 accordance with military specifications. Typical applications are connection between the instrument panel of equipment and remote rotating components, and the zero backlash design 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 "Plovic 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
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.

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 600, single phase, 120v input, 0-120v output, 1.25amp output, 150/160va. 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 50Mce Range

The Model 701 Frequency Standard provides a source of highly stabilized frequencies covering the range from 10kc to 50Mce at intervals of 10kc, 100kc, or 1Mc. Stability of one part in 107 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 ± 10cy. New London Instrument Co., Dept. ED, P. O. Box 189, New London, Conn.

CIRCLE ED-235 ON READER-SERVICE CARD FOR MORE INFORMATION
“Teflon” Products
Include Insulators and Sockets

These “Erie-Chemelee” “Teflon” products include stand-off and feed-thru insulators; miniature tube sockets, seven- and nine-pin, in “Teflon” and “Kel-F”; 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° to +500°F and has many other desirable properties, such as low water absorption, high surface resistivity, and excellent impact strength and dielectric properties. Electro Tec 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

ENTRANCE TO NATIONAL ELECTRONIC SHOW
December 21-23, 1954
Hilton Hotel, New York City

INTERNATIONAL RECTIFIER CORPORATION
EL SEGUNDO, CALIFORNIA • OREGON 8-6281
World’s Largest Supplier of Quality Industrial Rectifiers
NEW YORK CHICAGO
CIRCLE ED-243 ON READER-SERVICE CARD FOR MORE INFORMATION
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.
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, Sillectron, Mo-Permalloy, Vivalloy, 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 servomechanisms 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.

ELECTRONIC DESIGN • December 1954

Toroidics

This 32-page pamphlet covers all aspects of toroidal coils as well as data, tables, and formulas. Many companies, including Collins Radio Co., N.W., Texas, are described.

Volta

"Type-306" and "Type-3001" Regulators are described in this 15-page bulletin. Data, tables, and specifications are provided. Equipment, Inc., 350 3rd Ave., New York, N. Y.

Intergraph

This bulletin, Intergraph No. 22, covers the 72-page Interisec schematic description of many magnetic products, such as Mo-Permalloy, Magnafer, or special magnetic materials. New version cover illustrated. Intergraph, Inc., Cedar St., Norwood, N. Y.

Packard

The "Packard Gears" to armor and to armor parts of other materials on a non-critical basis. The bulletin describes the various parts, their properties, and the various uses for which they are intended.

Faston

Each Faston is described and illustrated. Faston Corp., (No. 1) 318 33rd Street, Brooklyn 10, N. Y. The bulletin contains data, graphs, and specifications of the type of Faston offered, including Faston 30000 and 300000. Other Faston producers are Valley Products Co., and Miller Fastons, Inc.
Toraloid 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 Recosstat 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., Schlilfer 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 range 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 gyro. 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, X, and K- 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.

Write for brochures
☐ X Band Test Set.
☐ Microwave Components.

CIRCLE ED-273 ON READER-SERVICE CARD FOR MORE INFORMATION
NEW IMPROVED DISCRIMINATORS FOR

- GREATER ACCURACY
- INCREASED STABILITY
- BETTER LINEARITY
- ADJUSTABLE FREQUENCY RESPONSE
- HIGHER OUTPUT

CIRCLE ED-276 ON READER-SERVICE CARD FOR MORE INFORMATION
Wafer Capacitors

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 ±5%. Aircraft-Marine Products, Inc., Chemical & Dielectric Div., 155 Park St., Elizabethtown, Pa.

Insulated Terminals

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 No. 210. A 4-page section is devoted to manual and power-operated installation tools, Burndy Engineering Co., Inc., Norwalk, Conn.

Pulse-Testing Systems

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 gates, 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

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.

Vector Socket-Turrets

Patented. Socket-Turrets for most tube types will carry a wide variety of circuit elements.

U N I Q U E

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, eyeleted 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 261 Sunrise Hwy., Rockville Centre, N.Y.
R. J. Magnuson 4259 W. Irving Park Rd., Chicago 41, II.
David H. Ross Company 534 El Camino Real, San Carlos, Calif.*

Vector Electronic Co.
3332 San Fernando Rd., Los Angeles 65

CIRCLE ED-279 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

Calif.

Several of this firm’s products have been mentioned in previous issues. The products include, among others, the “Beta-Phase” variable escapement, “Beta-Tubes” self-contained clocks, and “Beta-Alarm” alarm systems. Information on these and other products is available from the firm’s offices.

Hosp.

Use of the new miniaturized type of rhodoid tube socket plug is illustrated on the cover of this year’s rhodoid catalog. The plug can be mounted on the side or end of the tube, or a bracket can be used to support it. Information on this and other applications is available from the firm’s sales and engineering offices.
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 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.

Sweeping-Image Recorder 287

Details of a new research camera system using synchronized-streak techniques to produce a writing speed of 5.46mm/μsec and a sweep duration of 44μsec 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.
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.

- 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.

CIRCLE ED-290 ON READER-SERVICE CARD FOR MORE INFORMATION
Small Motors

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 motors ranging from 1/4 hp to 6 hp for single-, 2-, and 3-phase operation, 15 to 400 hp. 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

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 Elwood Ave., Buffalo 23, N. Y.

Switches

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 voltметр-ammeter switches. Drawings of these snap-action and detent-snap 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

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

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

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.

For detailed information
Write Dept. ED-12

Servoboard
Model 1110A
Experimental Mechanical Component Group

SERVO
CORPORATION OF AMERICA

New Hyde Park, New York

CIRCLE ED-304 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954
Mastic Boxes 305

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.

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, ROWN

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 50" long, from .450" to 25" I.P. Produced from wide range of stock arbor 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 outer sides of 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!

PARAMOUNT PAPER TUBE CORP.
608 LAFAYETTE ST., FORT WAYNE, IND.
Standard of the Coil Winding Industry for Over 20 Years

CIRCLE ED-311 ON READER-SERVICE CARD FOR MORE INFORMATION
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:

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Counting Rate</th>
<th>New Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>705A</td>
<td>100,000 cps</td>
<td>$30.00</td>
</tr>
<tr>
<td>706A</td>
<td>350,000 cps</td>
<td>60.00</td>
</tr>
<tr>
<td>707A</td>
<td>1,000,000 cps</td>
<td>90.00</td>
</tr>
</tbody>
</table>

*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.

beCkenMAn iNuStrumEnts iNC.
2200 WRIGHT AVE., RICHMOND 4, CALIF.

CIRCLE ED-312 ON READER-SERVICE CARD FOR MORE INFORMATION
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 gauges, 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 3, N. J.

New FOR STILL FASTER COMPUTERS

G.E.'s high-perveance, high-capacity twin triode...

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-6844 GL-5965 GL-6463
5 w dissip. per plate 7.2 w dissip. per plate 5 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
Magnetic Tape 345

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 346

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 specific information 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 348

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.

This is a custom-made* 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.

Brochure Available Upon Request

ESC CORPORATION
534 Bergen Blvd., Palisades Park, New Jersey

Send Your Prints For Quotation.

KLEINER METAL SPECIALTIES INC.
P. O. BOX 185, DUNELLEN, NEW JERSEY

IN THESE DAYS OF MINIATURIZATION
SPECIFY SEAMLESS TUBING
CUT AND FORMED
WITH PRECISION FOR . . . .

★ BUSHINGS ★ COMPONENT PARTS
★ LEADS ★ FEED-THROUGHS
★ CONTACTS ★ EYELETS
★ CATHODES ★ TERMINALS
★ SPACERS ★ ANODES

CIRCLE ED-349 ON READER-SERVICE CARD FOR MORE INFORMATION
I.E.R.C. has the best answers to your equipment failures due to tube heat and vibration!

I.E.R.C.'s research, design, development and manufacturing facilities are saving time and money — speeding "top level" projects into production for many leading electronic equipment firms.

For these achievements, I.E.R.C. is recognized as the finest source for effectively solving electron tube heat and vibration problems — the major cause of short tube life and other heat-vibration affected failures in electronic and electro-mechanical equipment.

Prevent future failures TODAY by calling I.E.R.C. or a convenient I.E.R.C. engineering representative nearest you!
 enacted Facilities 360

The facilities of this firm for research, development and production of a wide variety of electronic types are illustrated 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 fungicidal 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.

Solvent-Resistant Varnishes

Two 2-page brochures in the "Paints" series provides 7½" x 11" operation data for three varnishes. Cost is $1 each and mailed to 200 business days.

Vihartron Transistors

The "Transistor" series describes the transistor type of oscillator. It measures 7½" x 11" and is priced at $1 each. Special ceramists are covered.

Linear Equipment Laboratories

LINEAR EQUIPMENT LABORATORIES INC.

CIRCLE ED-364 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN  •  December 1954
Solenoids

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

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 50/60 400+cy 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

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, tele-metering, supervisory control and facsimile and video transmission. The radio frequency section of this equipment can be supplied for operation in the 5925-7500Me 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

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 70Me 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.

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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. Calibration accuracy is constant, regardless of lead lengths or temperature changes. Lower range indications expanded for increased accuracy in reading important low velocities. Meters are rugged, simple to operate, compact. Available in several models, from small hand-sized meter to extremely accurate laboratory models. Adapted for master station indication and strip chart recording.

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ELECTRONIC DESIGN • December 1954
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.

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West Coast Office: 304 Tajum Pt., Palos Verdes, Calif.
Instruments for Measurement and Control
Synchros • Gyros • Servos • Microsyns • Servo Motors
Indicating Instruments

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

This 324-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

Ceramic coatings and porcelain enameled 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

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.

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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.

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. Tecnifax Corp., 195 Appleton St., Holyoke, Mass.

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 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.
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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.

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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:
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- Length (overall): 1.785"
- Diameter: 1.19"
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- Mtg. Centers: 1.562"
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- 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
Books


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 plastic 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.

AIRCRAFT RADIO CORPORATION
BOONTON, NEW JERSEY

CIRCLE ED-377 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • December 1954

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.


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.
Raydist, designed and built by the Hastings Instrument Company, Inc., of Hampton, Virginia, is a remarkably precise and sensitive electronic radio location system. Raydist systems are used for air and marine navigation tracking, marine geophysical surveying, chartmaking, meteorological studies and a host of applications requiring infinitely accurate tracking and plotting.

Because Raydist precision performance is dependent upon the quality of the components used, Hastings specifies and uses CHICAGO MIL-T-27 hermetically sealed transformers.

Wherever absolute reliability and optimum precision are essential, you'll find CHICAGO, truly the world's toughest transformers.
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Jeweled Moving Coil Armature

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**SENSITIVE**

0.2 Microamperes
(0/20 scale range)

0.05 Millivolts
(0/5 scale range)

A.C. D.C.
(voltage - current)

Thermocouples
(R.F. or temperature)

Adjustable
(90° scale arc)

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The contact meter-relay as made by Assembly Products is an indicating meter with built-in micro-contacts which can be set to operate at any point of indication on the scale.

Made like a conventional panel meter, it can be substituted for an existing meter in most circuits and will add relay action for over or under limit or automatic control.

A locking coil gives high contact pressure. Spring action in the contacts gives forceful separation. Contacts are released by breaking the circuit to the locking coil, either manually or by an automatic interrupter switch.

---

Model 261-C. (2½ inch), single contact, high limit, 0/200 DC Microamperes as used in Consolidated Engineering Corp., Pasadena, California Model 21-220 Mass Spectrometer.

Model 263-C. (⅝ inch), double contact, (non-indicating) hermetically sealed, with shock mounted movement. Suited to marine or aircraft or other mobile installations.

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Contact Meter-Relay

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CIRCLE ED-382 ON READER-SERVICE CARD FOR MORE INFORMATION

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 7R8, having at least a control grid (G1), an oscillator anode (G2), and an oscillator control grid (G4) between the cathode (2) and the anode (4). It is also desirable that screen grids (G3 and G5) be provided as well as a suppressor grid (G6). The control is maintained at a voltage low enough so that neg-
Fig. 1. Circuit for a variable frequency oscillator.

ative transconductance exists between grid $G_2$ or the oscillator anode and grid $G_i$ 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 $Z_g$ is coupled between grid $G_i$ and oscillator anode $G_o$ 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 $E_o$ 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.
Constant cooling efficiency at high altitudes can now be realized with brushless induction motors of the ALTIVAR type, pioneered by ROTRON. Blowers and fans thus fitted will move 2 to 10 times more volume of cooling air at altitudes than at sea level.

Select ROTRON cooling components from our 160 page engineering catalog and know what you are buying. Specify ROTRON and eliminate hidden costs.

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New Shallcross Castohm power resistors surpass all previous standards for high wattage fixed power resistors. Thoroughly tested and designed to MIL-R-10566 specifications, Castohms offer unique opportunities for saving space and weight while improving the reliability and efficiency of modern industrial and military equipment. Specifications on all types from 8 to 225 watts are yours for the asking.

SHALLCROSS MANUFACTURING COMPANY,
526 Pusey Ave., Collingdale, Pa.
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 15 is lowered below ground level and conduction through this rectifier ceases until the input potential returns to $E_1$ after time interval $t$. 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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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 \( E_1 - E_2 \) 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.
SIE MODEL M-2
Low Distortion
R-C OSCILLATOR

Unexcelled for:
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★ Galvanometer manufacture
★ Vibration Analysis
★ Variable frequency standard
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Guaranteed SPECIFICATIONS:

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1 to 120,000 cycles per second

Accurate dial calibration
within 1.5% ± 1 cps

Fully regulated power supply
ripple less than .01% of output

Low frequency drift
less than .1% over long term

Excellent amplitude stability
within .5 db. throughout range

High output
20 volts into 1000 ohms or more
12 volts into 600 ohms
1 volt at 300 ohms constant impedance

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High-speed magnetic tape recorders with low start-stop times bring a new dimension to data handling by absorbing and dispensing digital information when and where it's needed! Any phenomenon can be recorded as it occurs, continuously or intermittently, fast or slow. It can later be fed into computers, punch cards, printers, etc.

Speeds of 60 inches per second with 5-millisecond start-stop times permit digital techniques with jobs previously requiring more expensive, less reliable methods. Typical applications include business problems, high-speed industrial control processes, missile study, and telemetering.

In addition, Potter Magnetic Tape Handlers offer wider tape widths for more channels with lower tape tension controlled by photoelectric servos. Yet, the price is a fraction of much less versatile recorders. Other data handling components and complete systems are available for special problems.

DETAILED SPECIFICATIONS

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<th>Model</th>
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<th>902BJ</th>
<th>9020K</th>
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For complete information, write to Department 10-F.

POTTER INSTRUMENT CO., INC.
115 Cutter Mill Road, Great Neck, N. Y.

CIRCLE ED-394 ON READER-SERVICE CARD FOR MORE INFORMATION

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 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.

---

Fig. 3. A second tank circuit has been added to this push-pull oscillator.

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 emitter (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.

---


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---

Fig. 4. Circuit for two-way transistor transmission system.
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**BROADCAST MEASUREMENTS**

- **hp-33C Distortion Analyzer**, for FM measurements, is identical with **hp-330B except meter has VU ballistic characteristics meeting FCC requirements. $425.00.**
- **hp-330D Distortion Analyzer**, for AM and FM, includes detector to rectify AM carrier, plus VU meter described above. $440.00.

**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 ± 2% including warmup; frequency response ± 1 db full range. $250.00.

**HIGH QUALITY VOLTAGE SOURCE**

- **hp-206A Audio Signal Generator** covers frequencies 20 cps to 20 kc; is highly accurate, highly stable. Provides continuously variable signal with less than 0.1% distortion. Includes VTVM, 111 db attenuator adjustable in 0.1 db steps, and transformer for matching to 50, 150, and 600 ohm loads. Maximum output level ± 15 dbm. $550.00.

Want to measure total distortion quickly and accurately? Study individual wave components simply and directly? Determine transient and frequency response? Make AM or FM broadcast measurements for FCC reports?

Whatever your requirement—**hp**—has proper instrumentation; the broad **hp**-line provides complete coverage for all distortion measurements 20 cps to 20 kc. Typical of quality-built **hp** distortion measuring equipment is **hp-330B Distortion Analyzer**. This instrument provides fast, accurate measurement of values as low as 0.1%, 20 cps to 20 kc, and also measures voltage level, power output, amplifier gain, response, audio noise and hum (direct readings) unknown audio frequencies; and serves as a high gain, wide band stabilized amplifier. **hp-330B**, $395.00.

**GET COMPLETE INFORMATION TODAY**

HEWLETT-PACKARD COMPANY
Dept. K, 3035 Page Mill Road, Palo Alto, California
Please send me complete data on:

- **330B**
- **330C/D**
- **300A**
- **201B**
- **206A**

Name ____________

Company ____________

Street ____________

City ____________ Zone ____________ State ____________

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

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