WENTY-FIVE new type subminiature high-output diodes can be mounted on a 1/4 sq in plate. Upper curves compare two conventional with two new diodes as to null voltage outputs in a balanced bridge rectifier circuit. Flatness of the red curve indicates extreme uniformity of the new units. Lower curves compare forward drop with a 100ma, one microsecond pulse applied.
FREED MAGNETIC AMPLIFIERS

Series MAFS
Designed for high-performance control systems

TWO CYCLE RESPONSE TIME—DRIFT-FREE

The Freed MAFS series of Magnetic Amplifiers is characterized by:

- FAST RESPONSE — 2 cycles of power frequency delay for 100% response to step input signal.
- PHASE REVERSIBLE A.C. OUTPUT WITH ZERO DRIFT OF NULL POINT

The MAFS series includes the units described below. Engineering and development facilities are available for the design and development of Magnetic Amplifiers having special performance characteristics.

<table>
<thead>
<tr>
<th>Fast-Response Magentic Amplifiers — Drift-Free</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply Voltage and Frequency</strong></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>115V, 60</td>
</tr>
<tr>
<td>115V, 400</td>
</tr>
<tr>
<td>115V, 400</td>
</tr>
<tr>
<td>115V, 400</td>
</tr>
</tbody>
</table>

SEND FOR LATEST DETAILED BULLETINS AND CATALOGS

FREED RESEARCH, Engineering and Production Facilities Combine to Produce Transformers and Instruments of Top Performance.

FREED MAGNETIC AMPLIFIERS, Saturable Transformers and Reactors are designed for efficient operation and long life. They can be used wherever reliable, rugged and maintenance free systems are required.

The types of amplifiers listed are designed to control AC servomotors.

Development facilities are available for the design of magnetic amplifiers to meet specific requirements.

All standard units are hermetically sealed and meet MIL-T-27 Specifications.

SATURABLE TRANSFORMERS — Controlled with dual triode plate supply can be either DC or AC; no rectifiers; AC or DC control signals.

PUSH-PULL MAGNETIC AMPLIFIERS — AC or DC control signals; high gain may be used with magnetic or vacuum tube preamplifiers if needed.

FAST-RESPONSE MAGNETIC AMPLIFIERS — High gain; half-cycle per stage response time; AC or DC control signals; RC feedback networks for control system stabilization can be used directly; preamplifier not needed.

HIGH TEMPERATURE MAGNETIC AMPLIFIERS — Designed to operate in ambient temperatures as high as 200°C. AC or DC control signals.

DRIFT-FREE MAGNETIC AMPLIFIERS — For rigid drift-free requirements of control systems; designed to meet specific requirements.

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- High Fidelity Amplifiers
- High Level Power Amplifiers
- High Q Transformers
- Power Amplifiers
- Sing-Toned Amplifiers
- Harmonic Amplifiers
- Sealed Amplifiers
- Step-down Amplifiers
- Precision Amplifiers

INSTRUMENTS
- Comparison and Limiting Bridges
- Low frequency "U" indicators
- Incremental Inductance Bridges
- Universal Bridges
- Mill Detectors and D.T. Voltmeters
- Power Supplies
- A.C. Bridges and Accessories
- Differential Voltmeters
- Harmonic Distortion Meters
- Wide Band Amplifiers
- Decade Counters
- Decade Capacitors
- Filters
- Magnetic Voltage Regulators

FREED TRANSFORMER CO., INC.
1718-36 WEIRFIELD ST., BROOKLYN (RIDgewood) 27, N.Y.
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Here's a low-cost solution to your high-precision timing problems

The New Potter Model 432 Interval Timer is a general-purpose instrument for timing relays, camera shutters, high-speed machine operations, and for calibrating electrical and mechanical timing devices. It is simple to operate—even an unskilled operator can make interval measurements to within 0.00001 second.

Versatile Input Circuits permit measurement of time between any combination of voltage changes, contact opening, or contact closure, thus accommodating a wide variety of timing problems.

Timing Is Achieved by Electronically Counting the number of pulses produced by a high-frequency crystal-controlled time-base oscillator during the unknown interval. Three time-base frequencies (1, 10, and 100 kc) are provided for making measurements in increments of 0.01, 0.1, and 1 millisecond. Results are displayed directly in milliseconds with an illuminated decimal point—misinterpretation of readings is virtually impossible.

Maximum Timing Range of the 432 is 1 second; this can be extended to 1,000,000 seconds by addition of a mechanical register (available as an optional feature). The 432 also serves as a totalizing counter (can be used to count relay contact bounces) and as a secondary frequency standard with outputs of 100 kc, 10 kc, 1 kc, 100 cps, 10 cps, and 1 cps for general laboratory use.

Descriptive Literature Is Yours for the asking. Write today and see how this compact, low-cost instrument can solve your timing problems with greater accuracy and convenience.
Machlett Hydrogen Thyratrons

ML-5949/1907 • ML-5948/1754

Typical Operation

<table>
<thead>
<tr>
<th></th>
<th>ML-5949 1907</th>
<th>ML-5948 1754</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate voltage, forward, epy</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Plate voltage, inverse</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Peak current, ib</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>Pulse repetition rate, prr</td>
<td>450</td>
<td>360</td>
</tr>
<tr>
<td>Pulse duration (nominal)</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>epv × prr × ib*</td>
<td>6.25 × 10⁶</td>
<td>9.0 × 10⁶</td>
</tr>
</tbody>
</table>

* epy × prr × ib is the product of maximum forward plate voltage by pulse repetition rate by maximum pulse current. The maximum limit is determined to hold average tube dissipation to a reasonable maximum value.

Protective Circuits Described

Hydrogen thyratrons as high speed shunting switches are described in Cathode Press, Vol. 11, No. 1, 1954. Write for a copy.

Editorial...

The Quiet Revolution

For some time now, a slow steady change has been taking place in electronic devices as a result of two relatively recent developments in the field. One of these is a component and the other a production technique. Both are so basic that their adoption is causing a "quiet revolution" in the electronic industries. We are, of course, referring to the transistor and the use of printed circuit techniques.

Of these two developments, the transistor has produced the lesser impact as far as commercial applications are concerned. Cost, availability, limited frequency range, and lack of standardization are some of the reasons why many designers have been reluctant to use transistors. Through intensive research and development programs on the part of transistor manufacturers, all of these deterring factors are rapidly being corrected. Before too long we should see many new commercial applications of transistors on the market.

Printed circuit techniques, on the other hand, have gained a fair amount of acceptance among designers. Test instruments, small phonograph amplifiers, larger audio amplifiers, a-m/f-m receivers, computers, and TV receivers are some of the places where printed circuit techniques are being employed. One TV set manufacturer has designed his set using section- alized printed circuits throughout, and a French TV receiver has been publicized that has the entire chassis printed on a single sheet of laminate material. All kinds of interesting schemes are being tried. The next several issues of Electronic Design will cover some of these design ideas in detail.

This revolution, though quiet in the sense that not much publicity has been given the commercial applications of these developments, is none the less real. It is up to the designer to make his company aware of this trend and to lead management out of its interior by thoroughly investigating the possibilities of these developments for his particular product line.

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

Over 55 years of electron tube experience!
Engineering Review...

TV of the Future... The television receiver of 1964 is envisioned as having a picture screen so thin that the complete unit could be hung on the living room wall like a painting. The circuitry would be built into the picture frame and would use printed wiring and miniaturized components. Controls would be located in a small box beside the viewer's chair.

For those who prefer a table model, the thin picture screen would be mounted, like a vanity mirror, attached to slender arms extending upright from a small cabinet that would house the circuitry.

As explained by Dr. Lloyd T. DeVore, manager of the General Electric Company's Electronics Laboratory, the "picture on the wall" concept stems from a complex project to speed the plotting of aircraft in military filter centers. At present, this aircraft plotting is done manually. Plotting would be automatic with a thin-type screen. Development of speedier switching techniques and new fast-reacting phosphors are needed before the thin-type screen can be applied to TV sets.

Scientist Honored... For his invention of the zirconium concentrated-arc lamp, Mr. William D. Buckingham of the Western Union Telegraph Company has been awarded a John Price Wetherill Medal by the Franklin Institute, Philadelphia, Pa. The device produces a high-intensity, sharply defined, extremely small beam of light with modulation characteristics unobtainable at the time of its invention.

Compact Airborne Radar... A new airborne radar that can spot storms up to 150 miles ahead is being installed on Pan American-Grace Airways’ new fleet of Douglas DC-7’s. Designated the Type RDR-1, the equipment operates in the X-band (3.2 cm).

Manufactured by Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md., the design of the radar is based on this firm’s military weather radar. The five-unit system weighs 136-1/2 lb. Power output for a pulse width of 2 μsec is 40 kw peak. The repetition rate is 400pps. Beamwidth is 3.8°.

Sweep ranges available on the point position indicator are 0-20, 0-50, and 0-150 miles, with range marks at 5, 10, and 25 miles. The nose-mounted 22” diam antenna is gyro-stabilized. While designed primarily for weather purposes and as a storm-warning device, the radar has provisions for ground beacon navigation and terrain radar mapping.

Tri-Element Atomic Battery... By adding a third element to an atomic battery, the Ohmrat Corporation has produced a cell in which a varying signal applied to this control element results in a variation in current output of the cell. Acting very much like the grid of a vacuum tube, the added element converts the battery into a self-powered amplifier with wide application possibilities. A photograph of the unit and cross-section are shown below.

The radioactive source is strontium-90, a long-life isotope. Although it is a waste product of atomic reactors, this atom source is very expensive at present. It is also employed in this firm's two-element atomic battery. The efficiency of utilization of the isotope is not very high and should be increased with further development.

In the first version of the tri-element type, the control element is in the form of a metallic ring and the enclosure is filled with argon gas as a separating medium. With a load resistor of 10¹⁰ ohms, the amplification factor is 0.075 within the range of control element potential of -12 to zero volts and 0.28 when the potential is +2 to +10v. Argon is a more suitable separating medium than air, which has also been tested.

The amplification factor can be increased by making the control element in the form of a grid instead of a ring and by increasing the density of the separating medium. A semi-conductor could serve as the required separating medium.

The Ohmrat Corporation, located at 2236 Bogen St., Cincinnati 14, Ohio, has developed some applications for the device. One, in which the cell serves as a transducer to match a low impedance to a high impedance, is in a small, all-electronic integrating device. The firm's two-element battery, which has an adjustable output, has already been widely applied in industry to furnish constant currents for reference purposes. One application is in a density gage for pipe lines to determine what fluid is flowing in the line. This gage is manufactured by Ohmrat. The battery can also be used as a standard cell.

Radio Research Laboratory... A new multimillion dollar radio research laboratory is being established at Boulder, Colo., by the National Bureau of Standards, Washington 25, D. C. The NBS already maintains a number of transmitting antennas for research purposes in the same area.

The laboratory will continue efforts for more effective utilization of the available spectrum and compile information about the characteristics of radio energy under diverse conditions.
Millionth Transistor... Raytheon Manufacturing Company has produced its one-millionth transistor. The great majority of the firm's output has gone into hearing aids, where field failures are running at the low rate of less than 2% per year. This compares with a failure rate of about 2% for subminiature tubes in the same service. The transistors were produced at Raytheon's Receiving Tube Div., 55 Chapel St., Newton 38, Mass.

Electronic Air Traffic Control... The latest development in air-ground communications receives messages on flight plans and the weather, answers them within minutes where necessary, and stores the information for future use—all without human intervention. Known as the "Message Storage and Processing System", it was recently installed at the Civil Aeronautics Authority Technical Development and Evaluation Center at Indianapolis, Indiana.

Developed by the Engineering Research Associates Div., Remington-Rand, Inc., 315 Fourth Ave., New York 10, N.Y., it is estimated that 12 to 15 such installations can service all the major aircraft traffic centers in the nation. The system automatically receives coded messages from several remote points by teletypewriters, examines these messages and performs clerical operations on them, files up to 2000 such messages on a magnetic drum reference, locates any desired message and causes it to be typed out at one or more remote points, and discards any message when notified that it is not needed.

Using a magnetic memory drum, information on departure times, fuel loads, destinations, routes, pay-loads, and other data is compared with other flight plans already recorded on the drum. Existing plans are then revised, cancelled, or brought up to date, according to the circumstances. The system will warn automatically of possible emergency situations when a position report has not been received within a specified time interval after a flight has been estimated over a fix.

Electronic Farming... In order to harvest crops at the optimum time, two-way radios are being employed by a large food processor to direct harvesting equipment. The system is applied to the harvesting of such delicate crops as beans and peas, which reach and remain at peak quality for only a few hours.

Gibbs Foods of Quarryville, Pa., has four vehicles equipped with communication gear supplied by Radio Division, Bendix Aviation Corp., Baltimore, Md.
General Electric leads the industry again! Announcement of this revolutionary G-E Stacked Germanium Rectifier opens up new avenues of power progress that were heretofore thought impossible to travel. Now, the amazing total of 143 power combinations has been provided with this one product! Your specifications requiring series or parallel stacks in single or polyphase circuits are custom-completed at G-E's factory.

This unit is smaller, weighs less, is more reliable, lasts longer, has better power ratings than any other dry rectifier made any place by any other company. AND, G.E. offers you immediate delivery.

Designed and built to deliver new power performance, the G-E Stacked Rectifier is 75% less by volume and weight than any other comparable dry type rectifier. And, rectifier losses are reduced to one-third or less of those encountered with any other type of rectifier. You can count on extreme reliability...tested for compliance to 10,000-hour standards. Note also that there are no forming or aging effects.

WRITE US TODAY! GET ALL THE FACTS ON THIS IMPORTANT NEW PRODUCT!
General Electric Company, Section X4894, Electronics Park, Syracuse, New York

Instruments for Rent . . . Small electronic manufacturers can now utilize expensive electronic instruments for laboratory or production use by renting them. Polarad Electronic Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y., will rent valuable instruments at a monthly rental that is only a small fraction of their price.

The plan is particularly useful when some instrument is only required for a short time. A purchase option is available with the rental plan. Under the separate option contract, most of the rental charge may be applied towards eventual purchase.

Computer Clinic . . . An Electronic Computer Clinic will be held in conjunction with the First International Automation Exposition at the 244th Regiment Armory, 14th St., New York City, from November 30 to December 2, 1954. The clinic is a lecture and demonstration course on both digital and analog computers.

The course is planned for personnel who contemplate using computers in the laboratory or plant. Advance registration is required. Attendance at the sessions will be restricted in size. Sessions will be repeated up to a maximum of nine times to accommodate registrants. The registration fee is $5.00, payable in advance. Registration forms may be obtained from Richard Rimbach, Electronic Computer Clinic, 845 Ridge Ave., Pittsburgh 12, Pa.

Eight-Hour Magnetic Tapes . . . Magnetic recording tapes that run continuously for eight hours are now being offered to provide music in stores, factories, etc. The tapes are manufactured by Magne-Tronics, Inc., 122 E. 42nd St., New York 17, N. Y.

Antenna Rating System . . . A new antenna rating system known as the “Signal-to-Noise Figure of Merit Rating” has been proposed by Douglas Carpenter, Chief Antenna Engineer, JFD Manufacturing Company.

Five basic antenna functions, (1) horizontal polar pattern, (2) front-to-back ratio, (3) terminating impedance, (4) gain, and (5) vertical polar pattern, were selected to be considered in composite form to create the specific value designated “Signal-to-Noise Figure of Merit Rating”. For each characteristic, an optimum level was established. A theoretically perfect antenna would be rated 100%, made up of a maximum of 20% for each of the factors.

A six-page brochure entitled “Signal-to-Noise Figure of Merit”, is available from JFD Manufacturing Co., Form No. 287, 6101-16th Ave., Brooklyn 4, N. Y. It is complete with diagrams, charts, and an actual example of how this system can be applied.
Engineering Review . . .

Transatlantic Data Processing . . . Statistical information has been transferred from one punched card to another across the Atlantic Ocean in a recent demonstration. The data was transmitted at the rate of 1000 characters a minute by radio.

The two-way experimental transmission was undertaken by the U. S. Air Force. It linked Port Lyman, Morocco, and Washington, D. C. The punched cards were fed into a "data transceiver", a new machine developed by International Business Machines Corp., 390 Madison Ave., New York 22, N. Y., which converted the data into electrical signals.

If adopted, the system would eliminate steps in accounting procedures dealing with the deployment of military forces and the distribution of replacement equipment now maintained at Air Force bases. It would materially contribute to the speeding of procedures necessary to move replacement parts to overseas bases.

High-Fidelity Sales Premium . . . High fidelity components installed as original equipment in a home like a refrigerator are being used as a sales stimulant by a Dayton, Ohio contractor now developing a suburban residential area. In the model home, the sound equipment is installed in two mahogany panels that flank the fireplace. Behind one panel is the dual coaxial speaker and its enclosure. The amplifier, preamplifier, and record changer are located behind the opposite panel. Both panels are set flush in the wall at waist level. The record changer is mounted on a pull-out drawer.

The living room wall in which the equipment is installed divides the garage from the house. Easy accessibility for servicing is provided by removing the backs of the panels on the garage side. The contractor, G. W. Leckrone & Sons, Inc., plans to equip each home in the development with the "Custom Music Ensemble" manufactured by General Electric Co., Syracuse, N. Y.

F-M Military Radio . . . Frequency-modulation radio equipment newly developed for the U. S. Army Signal Corps provides sending and receiving facilities in the frequency range of 100 to 400 Mc for relaying a broadband signal of 250 to 68,000 Mc over a line-of-sight path. One link would require only one set at each end, but where multi-link coverage is desired, one set would be used at each end of the system and two sets would be used at each relay point connected "back to back".

Designated AN/TRC-24, the gear has a 45-ft antenna divided into nine easily assembled sections. The antenna consists of two half-wave dipoles, which may be polarized horizontally or vertically. Developed by the Bell Telephone Laboratories, the AN/TRC-24 is manufactured by Western Electric Co., Inc., 195 Broadway, New York 7, N. Y.

Tiny TV Station . . . Transmitting over a maximum of only three miles, a tiny 8-watt TV transmitter at the U. S. Air Force Base, Limestone, Me., provides 10 hours of major network programs daily for the base's 15,000 personnel.

Designed as a morale aid, the station broadcasts in an area not covered by commercial stations. A grant of $34,000 from the Strategic Air Command's welfare fund paid for the installation, which was designed, built and erected at cost by the Radio Corporation of America. The equipment and studio are housed in a 10' x 13' shack atop the 4-story base hospital.

Taping "Gun"

Electrical harness wrapping is greatly accelerated by using this new "taping gun" to dispense plastic tape. Weighting less than 20 oz with a 36-yard roll of 3/8" tape in the circular magazine, the gun enables an operator to bundle the wires and cut the tape in about one second. Once the tape is threaded around the bundle by the curved tip, it is cut by pressing a thumb button. This tool is marketed by Minnesota Mining and Manufacturing Co., St. Paul, Minn.
Movie on Stamping... A thorough tour of a modern metal stamping plant is shown in "Stamping For Electronics", a 20-minute 16mm color movie available for free showings to technical societies, industrial management, and other interested groups.

The design and construction of accurate progressive dies for subminiature and other sizes of stampings for electronic components is a feature of this filming of the John Volkert Metal Stampings, Inc., plant at 222-34 96th Ave., Queens Village 29, N. Y.

Tiny Speaker... No larger than a candy bar, the newly developed "Kilosphere" loudspeaker accurately reproduces frequencies in the treble range. The unit is a perforated metal oblong with about 1000 tiny rectangular apertures, encaised in a metallized-plastic foil. One of the speakers is shown in the photograph below. It is 5" long by 2" wide by 3/8" thick.

Each of the 1/8" x 25/1000" apertures acts as a speaker when the covering foil is set into vibration by the output from the audio amplifier. Since electrostatic force is applied over the entire speaker instead of a single point, as in conventional cone speakers, the aperture speakers all operate in phase. Distortion due to variations in phase is thus eliminated, and excellent reproduction in the treble range is made possible.

The Kilosphere produces an unusually smooth sound pressure curve in the range from 3000 to 20,000cy. In operation, it is driven from a band-pass filter that eliminates the lower frequencies, which are reproduced by a conventional "base" speaker. Developed by Columbia Records, Inc., 799 Seventh Ave., New York 19, N. Y., the new-type speaker is being incorporated in this firm's Type 360 phonograph and in a table-model tape recorder. Two of the Kilospheres and a pair of 6" speakers are mounted in the phonograph. These speakers will eventually be offered to other manufacturers.

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

Collins Mechanical Filter for MAXIMUM SELECTIVITY

Today's expanded air-ground radio communications have greatly increased the problem of adjacent channel interference. It has become increasingly difficult to control sideband radiation and maintain good channel selectivity.

Collins has solved these problems by incorporating the Mechanical Filter in the Collins 18S-4A HF Transmitter/Receiver. The Mechanical Filter, recently developed by Collins, produces a better signal-to-noise ratio — greatly increases channel selectivity — practically eliminates adjacent channel interference. The effect of the Mechanical Filter on the 18S-4A's selectivity is clearly shown on the accompanying graph.

Collins 18S-4A provides both receiving and transmitting facilities — up to twenty crystal controlled frequencies assigned anywhere in the range of 2.0 to 18.5 mc. Transmitter output, nominally rated at 100 watts cw or voice, is sufficient to assure communication over very long distances. Full remote control is provided over a positive 26-wire system. The proven performance of the Collins 18S Transceivers coupled with the increased selectivity afforded by the Mechanical Filter in the 18S-4A offers aviation the most advanced transmitting-receiving equipment available today.

For additional information on the Collins 18S-3 or 18S-4 or the Collins Mechanical Filter line, now available to industry, contact your nearest Collins office. Technical brochures will be forwarded on request.
Daven turns to air to keep the molding material absolutely separated from the resistance wire in its new line of Super Davohm Encapsulated Seald-Ohm Resistors. The wire is maintained in a slot filled with dry air . . . no external pressures are applied to it. These air pockets, between the wire and the plastic coating, guarantee absolute stability . . . eliminate shorted turns.

Only DAVEN matches the temperature coefficient of expansion of the molding compound with the ceramic bobbin, the resistance wire and the metal terminals. This removes the possibility of cracks or strains on the wire during cycling.

Because of the special construction used, Daven can furnish Encapsulated Wire Wound Resistors with temperature coefficients below ±20 P.P.M./°C. when required, and with accuracies to ±0.05%.

These exclusive Daven precision wire wound resistors are completely hermetically sealed . . . yet are no larger than standard lug-type resistors.

In addition, these units are made in accordance with MIL-R-93A specifications, and are substantially more rugged than conventional resistors. They will withstand the JAN-R-93, characteristic A, salt-water immersion test, and, in addition, temperature cycling from -65°C to +125°C. The strong molding material will resist pressures equivalent to 75,000 ft. altitude, and will not cold flow at temperatures up to 150°C.

Write for latest Resistor Brochure

THE DAVEN CO. 169 Central Ave. Newark 4, N. J.
Rubber Dies for Tin... The cost of tin-base die casting has been materially reduced with the development of rubber dies, which are used in conjunction with a simple centrifugal casting process, according to the August, 1954, issue of Tin News, published by the Malayan Tin Bureau, 128 Connecticut Ave., Washington, D.C.

Transistorized Engine Room... A robot bearing temperature monitoring system that employs transistors has been developed for use in the engine rooms of U.S. Naval vessels. When one of the bearings reaches its critical temperature, an alarm sounds and a signal light glows to indicate the troubled area. By turning a switch, a miniaturized electronic indicator then gives the duty engineman a precise temperature reading. Capable of steadily monitoring some 40 locations, usually in the turbine area, the system was developed by the Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Winding Aves., Philadelphia 44, Pa. A prototype system utilizes three transistors in each of 40 amplifiers. Thermistors imbedded in the bearings act as the sensing elements. Printed circuit techniques were employed in the amplifiers. The complete transistorized systems draws less than 30w input power.

Superior Performance makes Philco Transistors the recognized standard.

With Philco Alloy Junction Transistors you gain the advantages of small size, low power consumption and simplified circuitry to improve your product.

Reliability... six years of Philco research and development in semi-conductors have established the quality, uniformity and production standards (from basic materials to tested transistors) required for large scale production.

Availability... recognizing the potential transistor requirements of the electronic industry, Philco planning has resulted in production facilities which assure an unfailing supply of high quality transistors—now!

Phone, write or wire Dept. ED today for descriptive literature and specifications on Philco transistors.

Philco Transistors Feature...
- Maximum reliability
- Hermetically-sealed resistance-welded case... leads fused in glass
- Uniform characteristics
- Minimum size
- Ruggedized construction

Philco Corporation
Government & Industrial Division - Philadelphia 44, Pa.
Engineering Review...

Automatic Production of Printed Circuits...
Machinery that automatically inserts certain components into printed-wire boards has been developed.

The experimental system is planned as the nucleus of a completely automatic method of producing printed-wire circuits using conventional components. One of the machines in the system is shown below.

Developed by the Research Div., United Shoe Machinery Corp., 140 Federal St., Boston, Mass., the equipment processes 5" x 8" boards at the rate of 9600 per 8-hr day. The experimental machine will only insert resistors, tubular and disc capacitors, jumper wires, and eyelets in pre-punched holes in the board. Additional inserting heads for tube sockets, coils, and other components have not as yet been developed.

An important part of the system is the "belting" of pigtail components in order to secure the best feeding conditions. After their leads are automatically straightened, the components are secured by their leads to two parallel-running strips of tape like the ties on railroad track. The belted components are wrapped on spools. One machine has already been built for "belting" resistors.

The spools feed the resistors into the inserting heads, and the tape runs under them. At the end of each line, the belting or component shears are triggered.

To make sure there are no mistakes, the machine has been equipped with "booster" heads which check each component before the entire board is ready.

TV "Belted" resistors are running out of the spool at the top and being inserted into 5" x 8" printed-wired circuit boards by this United Shoe Machinery Corporation experimental machine.
Important news!

EPON® resin 828 with new Curing Agent CL gives

- better Heat resistance
- better Chemical resistance
- better Electrical properties

If you are among the many users of Epon resin 828 for casting, laminating or other structural applications—you will welcome this new development of Shell Chemical's continuing research program.

Curing Agent CL produces Epon resin polymers with improved mechanical and electrical properties at temperatures as high as 300° F. After three hours' immersion in boiling water or acetone, glass cloth laminates of Epon resin 828 and Curing Agent CL retained more than 95% of their initial dry flexural strength. And with Curing Agent CL you can use the "B-stage," or pre-curing, permitting dry layups and specialized casting techniques.

Your request will bring you a sample of Epon resin 828 and Curing Agent CL for evaluation, as well as a copy of Technical Bulletin SC. Write for them—today.

Curing Agent CL is Shell Chemical Corporation's name for metathenylene diamine. We do not manufacture Curing Agent CL. It is available in commercial quantities from E. I. du Pont de Nemours & Company and National Aniline Division, Allied Chemical & Dye Corp.

* A development of Shell Chemical laboratories. Patent applied for.

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CHEMICAL PARTNER OF INDUSTRY AND AGRICULTURE
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In CANADA: Chemical Division, Shell Oil Company of Canada, Limited — Montreal — Toronto — Vancouver

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Engineered and Built to Meet the Most Rigid Military and Civilian Requirements

Kenyon's engineering staff and production department have had more than fifteen years' experience in designing and building units which exactly meet the most rigid and unusual specifications. Your inquiries are invited.

Miniature—Molded—Cased—Hermetically Sealed Oil-Filled—A-Line—T-Line—Toroids—The Kenyon Twins, M-Line to meet all Mil-T-27 Requirements; C-Line for all commercial requirements.

KENYON TRANSFORMER CO., INC.
840 Barry Street, New York 59

Meetings


September 15-17: Symposium on Information Theory, Massachusetts Institute of Technology, Cambridge 39, Mass. Sponsored by the Professional Group on Information Theory, IRE, and others. For information, write to Dr. R. M. Fano, Research Laboratory of Electronics, M.I.T.

September 16-18: Joint Electron Tube Engineering Council, General Conference, Chalfont-Haddon Hall, Atlantic City, N. J.


October 4-6: Tenth Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. For information, write to R. E. Honacek, Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.

October 4-13: International Telecommunication Union, Geneva, Switzerland. For information, write to Secretariat, ITU, Palais Wilson, Geneva.

October 11-15: AIEE Fall General Meeting, Morrison Hotel, Chicago, Ill. Special emphasis will be on electrical aspects of air transportation, with eight sessions planned on this subject. For information, write to AIEE, 33 W. 39th St., New York 18, N. Y.

October 12: Ferromagnetism Conference: Naval Ordnance Laboratory, Silver Springs, Md. For information, write to L. R. Maxwell, U.S.N. Ordnance Laboratory, Silver Spring, Md.

October 13-17: 1954 Annual Convention, Audio Engineering Society, Hotel New Yorker, New York N. Y. For information, write to C. J. LeBel, P. O. Box 12, New York 11, N. Y.

October 18-20: Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y. For information, write to Radio-Electronics-Television Manufacturers Association, 777 14th St., Washington 5, D. C.

October 18-20: Conference on Electrical Insulation, Pocono Manor Inn, Pocono Manor, Pa. For information, write to D. A. McLean, National Academy of Science, 2101 Constitution Ave., Washington 25, D. C.


CIRCLE ED-12 ON READER-SERVICE CARD FOR MORE INFORMATION
Casting Molds of KEL-F Polymer Replace Plated Metal Molds . . . Cut Costs, Finishing and Rejects!

Complex electrical terminal boards, made of an especially abrasive epoxy compound, are now cast in molds of KEL-F polymer, replacing former metal molds. Advantages include lower original mold costs, lower maintenance costs, fewer rejects and higher product precision without extensive machining.

Excellent wear characteristics of the new molds result in longer mold life despite high silica content of the casting resin. The non-hesive properties of KEL-F polymer prevent pitting by the resin, result in damage-free release of the product without special coatings. Penn-Plastics Manufacturing Company, Glenside, Pa., produce these intricate new molds by transfer methods. Molded of KEL-F polymer Grade 300, they are designed to hold 40 terminal pins and to impress forty 1/16” numerals in both faces of the finished part. Terminal boards are manufactured by Penn-Plastics in conjunction with Woodmont Products, Inc., electronic parts manufacturers of Huntingdon Valley, Pa.

Wafer-thin Insulator Mount of KEL-F Polymer Increases Life of Miniature Switch to 5-Million Cycles!

A wafer of KEL-F polymer provides a tough, insulated mount for a contact bar, guards the performance of this sealed precision switch under severe thermal cycling. Currents up to 10 amps are handled for a life of from 1 to 5 million cycles.

This fluorocarbon plastic is molded directly to the beryllium-copper switch blade. It insulates the switch blade against arc-heat damage and its dimensional stability guarantees positive contact position for service between minus 90°F and plus 200°F . . . without shorting. Haydon Switch, Inc., Waterbury, Conn., utilizes insulation molded of KEL-F polymer Grade 300 in single- and two-circuit snap switches for automatic equipment used in aircraft, marine and industrial applications.

For further information ask for Application Report E-123

(SEE REVERSE SIDE)
Only One RF Signal Probe, Insulated with KEL-F Plastic, Now Needed for Entire 500 to 5,000 Mc Range

Specification of KEL-F polymer plastic as the insulation for this wavemeter probe resulted not only in a widened instrument range and accuracy, but increased efficiency and life as well.

This readily-molded fluorocarbon plastic permits complete, “tight” insulation of the vital filaments in a single operation. Excellent electrical properties of KEL-F polymer under high humidity and thermal cycling eliminate leakage and shorts. High strength and dimensional stability prevent insulation failure from cracking or shrinkage in service.

Thompson Products, Inc., Cleveland, Ohio, insulates the probe by injection molding, using KEL-F polymer Grade 300. It is used in the company’s Model WINGA Wavemeter.

Recent Significant KEL-F Polymer Developments...

- Pyrex-to-steel seal is effected in a new centrifugal pump with a resilient O ring of KEL-F plastic. Damage to the glass observation plate, leaks at high pressures have been eliminated.

- Electronic tubes used at high altitudes are now hermetically sealed in new sockets made of fluorocarbon plastic. Consistent hermetic seal over a wide temperature range, low “are-over” and shock damage are major features.

- Conductivity cell-valve units for testing potable water use KEL-F polymer as a structural and electrical insulating member. Immersed continuously in water at temperatures up to 330°F, machined insulator maintains critical electrode gap.

- Pump vanes of molded glass-filled polymer have been found to have the necessary strength as well as complete chemical inertness to stand up under hot, extremely corrosive chemicals in a new transfer pump.

For further information use for Application Report S-526.
Hughes Fusion-Sealed Germanium Diodes

Hughes Point-Contact Germanium Diodes are fusion-sealed in a one-piece, gas-tight glass envelope...impervious to moisture, fumes or other external contaminating agents. The flexible dunet leads are especially suitable for spot-soldering; or they can be iron or tip-soldered as close as 1/4 inch to the diode body—with special precautions.

The germanium crystal is permanently bonded to one lead, the cat whisker is welded to the other, and the point of the cat whisker is welded to the crystal. Hughes diodes are highly resistant to shock and vibration. Positive mechanical stability is achieved without risking contamination from fluxes, waxes or impregnants. And—each diode is thoroughly tested to ensure the stability of its electrical and physical characteristics. All this means: sturdy, highly reliable diodes.

Types—The Hughes line of diodes comprises standard RETMA, JAN, and many special types. Special types are produced according to customer specifications and are tested at high or low temperatures...for specific recovery time...for matching in pairs or quads.

**ELECTRICAL SPECIFICATIONS AT 25°C unless otherwise indicated**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>RETMA Type</th>
<th>Clip-in Type</th>
<th>Peak Forward Voltage (volts)</th>
<th>Absolute Maximum Inverse Voltage (volts)</th>
<th>Minimum Forward Current @ 10V (mA)</th>
<th>Maximum Inverse Current @ 10V (mA)</th>
<th>Other Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH PEAK</strong></td>
<td>IN59B</td>
<td>HD008</td>
<td>2.0</td>
<td>200</td>
<td>5.0</td>
<td>0.500</td>
<td><strong>100 V</strong></td>
</tr>
<tr>
<td><strong>1 MEG TYPES</strong></td>
<td>IN69A</td>
<td>HD008</td>
<td>2.0</td>
<td>150</td>
<td>5.0</td>
<td>0.250</td>
<td><strong>75 V</strong></td>
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<tr>
<td><strong>500K TYPES</strong></td>
<td>IN90</td>
<td>HD006</td>
<td>2.0</td>
<td>100</td>
<td>5.0</td>
<td>0.125</td>
<td><strong>48 V</strong></td>
</tr>
<tr>
<td><strong>GENERAL PURPOSE</strong></td>
<td>IN185</td>
<td>HD008</td>
<td>2.0</td>
<td>75</td>
<td>5.0</td>
<td>0.100</td>
<td><strong>30 V</strong></td>
</tr>
<tr>
<td><strong>JAN TYPES</strong></td>
<td>IN187**</td>
<td>HD008</td>
<td>2.0</td>
<td>75</td>
<td>5.0</td>
<td>0.050</td>
<td><strong>15 V</strong></td>
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<tr>
<td><strong>COMPUTER TYPES</strong></td>
<td>IN191</td>
<td>HD007</td>
<td>2.0</td>
<td>5.0</td>
<td>5.0</td>
<td>0.025</td>
<td><strong>10 V</strong></td>
</tr>
<tr>
<td><strong>UHF TYPES</strong></td>
<td>HD9013</td>
<td></td>
<td>2.0</td>
<td>1.0</td>
<td>5.0</td>
<td>0.010</td>
<td><strong>5 V</strong></td>
</tr>
<tr>
<td><strong>UHF MISCELLANEOUS</strong></td>
<td>HD9016</td>
<td></td>
<td>2.0</td>
<td>1.0</td>
<td>5.0</td>
<td>0.005</td>
<td><strong>2.5 V</strong></td>
</tr>
</tbody>
</table>

*These values tested 100% at 75°C.

Hughes SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif. New York Chicago

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

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Printed circuit techniques are becoming more and more popular in electronic designs, aware of the many attractive inherent in these techniques, are easy and logical. Printed circuits in their electronic form have been widely used for a long time. As much has been written on the fabrication techniques of printed circuit information, however, has appeared a printed circuit.

It is the purpose of this series to give such basic information. We will begin with one of the more important basic design techniques in printed circuits. A designer can use for deciding whether or not to use printed techniques in a given piece of equipment. It is decided to use printed circuits, then it is decided to use the same designer so that he will avoid mistakes at the very outset.

Succeeding articles will cover this subject in greater detail. In this way it is hoped that the confusion and mistaken notions about printed circuits may be dispelled, and that the practicing engineers will be encouraged to take up this relatively new technique, which holds promise for the future of the electronic industry.

**Advantages of Printed Circuits**

Why should a designer consider the use of printed circuits? Over the past three or four years, the number of answers to that question have evolved. In recent years, all the solder joints in an electronic circuit may be made at one time by direct transfer of circuit card with its associated components and wiring. Where hand soldering is expedient, it may be that printed circuits offer considerable savings.

---

**Table 1. Currents sufficient to conduct**

<table>
<thead>
<tr>
<th>Burnout Current (mA)</th>
<th>Copper foil thickness (mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/64</td>
<td>.0014** thick</td>
</tr>
<tr>
<td>1/32</td>
<td>3</td>
</tr>
<tr>
<td>1/16</td>
<td>5</td>
</tr>
<tr>
<td>1/8</td>
<td>10</td>
</tr>
<tr>
<td>1/4</td>
<td>15</td>
</tr>
<tr>
<td>1/2</td>
<td>23</td>
</tr>
</tbody>
</table>
Printed Circuit Design

I—Basic Design Factors

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

Printed circuit techniques are becoming more and more popular in electronic applications. Designers, aware of the many attractive possibilities inherent in these techniques, are eager to incorporate printed circuits in their electronic devices. Although much has been written on the fabrication and production techniques of printed circuits, little or no information, however, has appeared on how to design a printed circuit.

It is the purpose of this series of articles to present such information. We will begin with a survey of some of the more important basic design factors involved in printed circuits. A designer can use these as a basis for deciding whether or not to use printed circuit techniques in a given piece of equipment. Having decided to use printed circuits, these factors can guide the designer so that he will avoid some basic design errors at the very outset.

Succeeding articles will cover these design factors in greater detail. In this way it is hoped that some of the confusion and mistaken notions surrounding printed circuits may be dispelled, and that electronic design engineers will be encouraged to take advantage of this relatively new technique, which holds so much promise for the future of the electronic industries.

Advantages of Printed Circuitry

Why should a designer consider the use of printed circuits? Over the past three or four years, a number of answers to that question have evolved. With printed circuits, all the solder joints in an electronic assembly may be made at one time by dipping the printed-circuit card with its associated components in a solder bath. Where hand soldering is expensive, printed circuits affect considerable savings.

Table 1. Currents sufficient to cause foil burnout.

<table>
<thead>
<tr>
<th>Foil width (Inches)</th>
<th>Burnout current (amperes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Copper foil .0014&quot; thick</td>
</tr>
<tr>
<td>1/64</td>
<td>3</td>
</tr>
<tr>
<td>1/32</td>
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<tr>
<td>1/8</td>
<td>15</td>
</tr>
<tr>
<td>1/4</td>
<td>23</td>
</tr>
</tbody>
</table>

Automatic manufacturing methods are readily applied to printed circuits production. Most or all of the components can be machine inserted in a printed circuit card (see pages 12, 32 and 33 of this issue). This eliminates hand wiring errors as well as a large part of assembly labor costs.

Prototype designs can be adhered to the production line. In the production of conventional electronic equipment, production engineers must often alter the prototype by changing component positions, lead dress, etc. Assemblers further affect these factors, leading to variations from the prototype as well as changes between production models. Unwanted effects such as instability of feedback loops, stray capacitances and inductances, etc., are easily introduced by these deviations from the prototype model. With printed circuits, the design engineer can freeze these variables and keep them under control. Performance characteristics that are determined by conductor width and pattern layout, change very little from one assembly to another.

Another advantage of printed circuits is that this technique permits making many devices that are almost impossible to produce in any other way. Complex switches and code wheels are typical examples.

Design Considerations

In order to realize these and other advantages of printed circuits, a number of very important factors must be kept in mind by the designer. Failure to do so will increase the cost of the assembly and create production problems that can easily nullify all of the advantages previously mentioned.

Process Limitations—As seen in Fig. 2, conductor patterns are produced by various methods. The steps...
in the making of plated-through holes are also illustrated. (This series will consider printed circuits produced by only one method—etched metal foil adhering to plastic sheets. However, portions may apply to other systems where techniques are similar.) There are inherent limitations in the process that limit a designer's freedom of effort in creating a pattern. The most important of these limitations involves considerations of line width, line spacing, and “undercut.”

**Line Width**—Since no printing process is perfect, lines that are too narrow result in a high production reject rate because of nicks, pinholes, or other imperfections. Although etched patterns with line widths as narrow as 0.003” can be made, a practical minimum width for economical production is 0.020”.

**Line Spacing**—Similarly, the use of narrow spaces between lines results in unetched copper or short circuits. Patterns have been produced with spacings as narrow as 0.003”, but for economical production, a minimum spacing of 0.020” is recommended.

**Undercut**—For each unit of depth of metal removed by etching an approximately similar unit in width under the protective resist is also removed. Due to the small dimensions involved, this is generally ignored, but it must be said that the effect is to make thin lines thinner, narrow spaces wider, and small holes larger. The term used to describe this condition is “undercut.” The designer can compensate for this condition by making lines wider on his master drawing. For example, in etching through copper 0.0027” thick, 0.002” to 0.003” will be lost from the edge of the line. If a line is to be 0.030” wide, the designer should make the line on the master drawing wide enough so that the printed resist line comes out 0.036” wide.

**Electrical Considerations**—Most of the electrical considerations relating to printed circuit design revolve about the fact that the conductor pattern is bonded to some kind of dielectric material. The surface and volume resistivity of this material, as well as its dielectric constant and dielectric loss factor, place significant limitations on designs. Environmental conditions such as temperature and humidity also must be considered. The designer has to select his dielectric material with all these factors in mind. The physical layout of the circuit pattern will be influenced by the electrical properties of this material.

**Mechanical Considerations**—The insulating material also influences the mechanical considerations in printed circuit design. Resistance to shock and vibration, deformations due to temperature, abrasion resistance, and similar mechanical characteristics are governed by the choice of materials for the conductor pattern and the insulating support.

**Current-carrying Capacity**—The designer of a printed circuit must know something of the ability of an etched foil circuit to carry an electric current. It will generally be found that patterns of very narrow lines will conduct ample current for a typical electronic circuit.

The major considerations remain those previously described under etching limitations as well as maintaining a line commensurate with the design under development. The table and curves shown on these pages present some basic data on the current-carrying characteristics of copper-foil patterns. They can be used as a guide in setting up the original design. Note that for most electronic circuits, with the possible exception of heater circuits, the line dimensions may be quite narrow.

Conductors that may be required to carry current several times normal because of some abnormal condition must be made wider. Low impedance circuits, such as the filament leads in a vacuum tube circuit, are typical examples. Plate circuits, although likely to develop short circuits, are usually protected by a series resistor or other means to prevent currents sufficient to burn out part of the foil conductor. Before laying out a printed wire pattern, the designer must determine approximately how wide each copper foil should be.

**Circuit Markings**—A desirable feature, which may be included at no extra cost other than the time required in the initial drawing, is copper-foil markings on the base to identify nearby components, to indicate correct voltage readings at certain points, and to give...
any other information that will aid in the identification or service of an assembly. Again the same caution used in determining line width and other problems in etching must be observed. If small markings are used, small isolated areas in letters and numerals should be filled in to appear as a solid area. This will help hold the letter intact. Numerals and letters should be not less than 3/32" high.

Mounting Considerations—It is not good design practice to mount speakers, transformers, big capacitors, and similar parts on a printed circuit card. They are usually better mounted on an associated rigid metal chassis.

A means of mounting a printed assembly must be included in the layout of the pattern. This may be nothing more than provision for holes with adequate clearance for screw heads and other hardware.

Printed wiring ordinarily involves exposed wiring with the danger of electric shock. Suitable provisions must be made to avoid this possibility. For example, the printed circuit may be coated with an insulating plastic or it can be placed in a protecting container.

Subassembly Techniques—Ordinarily most radio and TV circuit assemblies are too large to be made as a single assembly even in hand-wired units. The subassembly system of design is necessary with printed wiring since assemblies should be made small enough for convenient dip soldering, fabrication, and handling in automatic equipment. This is very useful in servicing equipment. A small section of a circuit can be quickly replaced to effect a repair if it is a subassembly. Thus, a necessity becomes an advantage.

Warpage—It is difficult to obtain perfect flatness in printed circuit boards. Any design should be so arranged that a small amount of warpage will not result in an awkward assembly procedure or shorts to adjacent components or chassis. Standards deemed acceptable by plastic manufacturers allow for large deviations from flatness and apply to large sheets. Table 2 gives information on warpage allowed on the laminate. Warpage is reduced when the material is cut to circuit-board size, but is still apparent and should be considered. This difficulty arises most often when using laminated plastics with copper on one side only.

Therefore, if a problem of insufficient clearance between copper strips is desirable...

Space Considerations—Considerations in subminiaturization and component arrangements should not be an excuse for a circuit that requires it.

It has been found to be human nature that unless something is made small, it is not accepted and standard. Such a small size contributes not only to the cost of the parts, but the correct components are usually close coupled; the printed circuit may be overcrowded and inefficient. The size of the printed circuit board may prohibit any applications. Some examples are: panels or cards is not always the answer. One example could be...
Marion's approach to Instrument Mechanism Design...

In any aircraft instrument system, reliable performance depends on an indicating mechanism which presents the information accurately, rapidly, simply and intelligently to the pilot. To Marion, who makes both moving coil mechanisms and components of indicating systems and complete integrated systems, this means specifically designing mechanisms to accomplish system objectives in an environment of vibration, rapid attitude changes and other influences, with full realization of the human elements involved.

This approach is represented by Marion's MEF-1 and Coaxial Mechanisms, which were designed to meet specific performance requirements in an indicating assembly for radio navigational use. The MEF-1 exhibits exceptional, gyro-like stability even under the influence of severe vibration and rapid attitude changes. The Marion Coaxial Mechanism is an extremely small, lightweight and rugged movement; its performance and durability exceed that of much larger and heavier moving coil mechanisms.

These are typical Mechanisms by Marion — examples of advancement in instrument design to better meet the critical needs of specific applications. Marion invites your inquiry concerning the application of Marion Mechanisms to your problems.

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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

Greatly expanded production facilities assure prompt deliveries.

Write for bulletin and help with your particular problems.

G-V CONTROLS INC. 18 Hollywood Plaza
East Orange, New Jersey

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

U. S. and Foreign Patents Pending

CIRCLE ED-16 ON READER-SERVICE CARD FOR MORE INFORMATION
Easily-Installed Controls

SIGNIFICANT production-cost savings in the mounting of controls can be gained by use of the "Snap-Tite" control shown in the drawing. No tools, hardware, or twisting of tabs are required to mount them. As shown in the photograph, an operator can push two of these controls into place at one time.

Six spring clips on the control fit into the standard tab and bushing holes in chassis. No panel retooling or production line rearrangements are required to accommodate them. The controls are primarily designed for fine-adjustment applications in TV and electronic equipment. The units have a short knurled and slotted shaft for fingertip or screwdriver adjustment. The shaft is molded of high-impact, blue-colored, polystyrene plastic for best electrical insulation and mechanical strength. It extends 1/2" from the face of the mounting panel. The length of the 1/4" diam shaft is 31/64". The unit is less than 1" broad.

"Snap-Tite" Controls are quickly installed two at a time without tools. Clips hold them in place.
G.E. designs 400-cycle alternator to meet demanding guided-missile requirements

Another example of G-E motors for aircraft

NEWLY DEVELOPED to withstand the tremendous range of shock, temperature and atmospheric conditions encountered in guided-missile applications, this explosion-resistant 400-cycle alternator meets rigid environmental and military specifications (MIL-E-5272, procedure 1). Rated up to 1500 volt-amperes, 12,000 rpm, for output of 115 volts, this unit is designed to be driven by a wide variety of d-c, a-c, turbine, and jet-air drives.

RIGID TESTING assures that this alternator—and all G.E aircraft and armament motors—meet specifications regarding altitude, shock, temperature, vibration, humidity, sand and dust, and centrifugal force.

YOUR SPECIFICATIONS are all that G-E motor engineers need to begin applying their years of experience to your aircraft and armament problems. Contact your G-E Apparatus Sales Office today. Or write: General Electric Co., Section 704-29, Schenectady 5, New York.
FORWARD current ratings in the order of hundreds of milliampere are characteristic of a new line of subminiature gold-bonded germanium diodes, one of which is shown in Fig. 1. Only 1/4" long x 0.1" diam, a number of the hermetically sealed units can be mounted in a small area (see cover). Produced with very uniform characteristics, the gold-bonded diodes are rugged, stable, and can operate to 90°C.

Divided into five classifications, the many types can be utilized in a variety of diode circuits, a few examples of which are given in Figs. 5 to 8.

Two outstanding characteristics of the diodes are demonstrated in the cathode-ray oscilloscope photos shown in Figs. 3 and 4 and on the cover. The lead wires are made of “Dumet”, a composite metal with a temperature coefficient of expansion that matches that of glass. Manufactured by Transitron Electronic Corp., 403 Main St., Melrose 76, Mass., they are also furnished in matched pairs and quads mounted on octal or 7-pin subminiature bases as shown in Fig. 2.

Each of the circuits illustrated utilizes the outstanding characteristics of the particular type or types of gold-bonded diodes employed. In the core-switching circuit shown in Fig. 6, the high pulse-current capacity of Types T25G and T6G is important. The core is alternately magnetized in opposite polarity by the input and clock pulses. When the clock pulse is applied, there will be an output pulse only if the core had previously been magnetized in the opposite polarity to that of the clock pulse.

The diodes are used to prevent the backward flow of pulses into the input circuits, to provide unidirectional clock pulses from a push-pull clock source, and to avoid loading of the inputs by the other windings. The resistors isolate the cores from the diodes. It is desirable to use high pulse currents in this application, for the rise time, driving requirements, and physical size are simplified if fewer turns may be used on a winding. Pulse currents commonly used are from 50 to 200ma. Operation of gold-bonded diodes in this application is practical up to 20Mc.

In the diode-capacitor memory matrix shown in Fig. 7, the input diodes are used to charge up the capacitor if a signal pulse is applied to any one of them. The output diode is normally biased in the reverse direction and does not interfere with this action. When it is desired to read out the presence or lack of stored voltage, the output diode is returned to zero bias, providing an output pulse if the capacitor has previously received a signal. This also serves to discharge the capacitor and erase any previous signals in the memory.

The capacitor charge will slowly leak off because of the inverse currents, I<sub>s</sub>, of the diodes. The holding time will depend on this parameter and the size of the capacitor. The time required to charge the capacitor also depends on its size and the short circuit current, I<sub>c</sub>, available from the signal source.

If the circuit is arranged so that the input pulse will charge the capacitor for one time constant, and holding time is defined as that time required for the capacitor voltage to drop to half or less of its initial storage voltage, it can be shown that:

Holding Time/Charging Time = 0.31 I<sub>c</sub>/I<sub>s</sub>

The diodes’ forward drop during the charging cycle is important under these conditions, and should be small compared to the source voltage to prevent a loss of stored voltage. In addition, the diodes should be uniform in inverse current to prevent the output diode from charging up the capacitor. The saturated or constant current nature of the gold-bonded diodes discussed here is helpful, for it prevents the capacitor from charging up to much more than about 1/2v.

When high-speed operation is desired, the inverse and forward pulse recovery characteristics may be important. Experiments with these units indicate that they are satisfactory in the range of 0.5µsec input pulses or larger.

The diodes can be furnished with a high degree of balance at high power levels. This feature is important for the following types of equipment: balanced modulators; phase, frequency, and amplitude discriminators; magnetic and differential amplifiers; suppressed carrier modulators and demodulators; d-c to a-c converters; and harmonic generators. For more information on these gold-bonded, subminiature diodes, turn to the Reader-Service Card and circle ED-20.

Fig. 7. The diodes are available in matched quads or pairs mounted in either octal bases (top) or 7-pin miniature bases (bottom).

Fig. 3. An oscilloscope comparison of null voltage output between conventional point-contact diodes (top) and Type T18G Diodes in a balanced bridge circuit. The new diodes are more easily matched over the entire forward current range.
Fig. 5. A bridge rectifier circuit capable of delivering 7.3W at 140mA and 52V. Utilizing Type T5G Diodes, the component values are as follows: R = 350 ohms, L = 0.25h, and C = 10μF. The input voltage, Ei, is 57V at 400Hz.

Fig. 6. This core-switching circuit can be used in shift registers, storage elements, delay lines, and as a pulse-shaper or gain stage.

Fig. 7. A memory-matrix circuit.

Fig. 8. A balanced rectifier circuit.

Fig. 4. The vertical scale is 8v/inch in this oscilloscope comparison of forward drop with a 100mA, μsec pulse applied to a conventional point-contact diode (top) and a Type T25G Diode.
Measurement of Cable-to-Rigid Line VSWR

By A. B. Giordano, Professor of Electrical Engineering
Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Editor's Note: This article is an excerpt from the "Handbook of Microwave Measurements", edited by Moe Wind, Research Assistant Professor, and Harold Rapaport, Research Associate, Polytechnic Institute of Brooklyn. It is taken from the section on the measurement of standing wave ratio written by Dr. Giordano. The Handbook, recently published by the Institute, is available from the Microwave Research Institute, 55 Johnson St., Brooklyn 1, N. Y. It is printed in two volumes and is priced at $12.00.

Two of the four methods of measuring one of the electrical characteristics of rigid-line cable connectors, the cable-to-rigid line VSWR, are described in this article. The rigid-line connector connects cables to rigid lines, as distinct from cable connectors, which join cables to cables.

The cable-to-rigid line VSWR includes the effects of the electrical reflections arising from the cable-clamping device in the connector, and from the difference in characteristic impedance between the cable and the cable connector. The cable-to-rigid line VSWR is defined, as shown in Fig. 1, as the VSWR seen looking into the rigid coaxial line with the cable terminated in a matched load. It is assumed that the characteristic impedance of the cable connector and the rigid coaxial line are equal.

Four methods of measurement are possible for measuring cable-to-rigid line VSWR. These are:

2. Two-slotted-section method with one slotted section built around the cable.
3. Frequency variation method.

The single-slotted-section method assumes that the cable-to-rigid line VSWR can be measured if the connector is terminated by a cable of sufficient length and attenuation such that the characteristic impedance is observed at the input. This method is not reliable, however, because of the so-called "periodicity effect" which may give rise to sudden changes in the input impedance of the cable, thus terminating the connector in a mismatched load. The two-slotted-section method can be used to measure the cable-to-rigid line VSWR provided one of the slotted sections is built having the cable as a core, hence a different slotted section is required for each different cable size. Cable slotted sections are ordinarily not available commercially and the accuracy and consistency of the results obtained with those that have been built are doubtful.

Frequency Variation Method

Direct cable-to-rigid line VSWR measurements can be made without the use of special cable slotted sections and lengths of periodicity-free cable by using the frequency-variation-of-VSWR measurement technique. This method uses the same equipment as the two-slotted-section method with an added length of cable (long in terms of wavelength) as part of the sample. The procedure consists of measuring the VSWR in the input slotted section as a function of a small variation in frequency and determining the cable-to-rigid line VSWR from a graphical analysis of this information.

The arrangement of equipment for this method is shown in Fig. 2 and except for the adapters, is the conventional type used for making VSWR measurements described in the Handbook. Adapters for some cable connectors and coaxial line sizes are reported in the literature; these must be reflection-free and specifically designed for the particular cable and cable connector under test.

Measurement Procedure

1. Arrange equipment as shown in Fig. 2 and follow the general tuning and warm-up procedures indicated in Section 2.02, Handbook.
2. Adjust the signal source frequency to a value on one side of the nominal frequency of measurement. (See Section 1, Handbook, for detailed procedures on the measurement of frequency and wavelength.)
3. Measure the standing wave pattern of the termination in slotted section No. 2. If the load termination is not matched (VSWR < 1.02) use a tuner to match the load. (See Appendix D, "Impedance Matching Techniques", Handbook, for detailed descriptions of tuning devices and matching procedures.)
4. Measure the input VSWR of the test sample (cable and connectors) in slotted section No. 1.
5. Vary the frequency of the signal source by a small amount and repeat steps 3 and 4. (The frequency increment is dependent upon the nominal frequency of measurement and the length of the cable between the two test connectors. For a sample length of cable 50 wavelengths long, a total frequency excursion of from 2 to 3% yields sufficient information for graphical analysis. Hence, if the nominal frequency of measurement is 3000Mc, then about ten points spaced 15Mc apart defining at least one maximum and one minimum are enough.)
6. Repeat step 5 for approximately 10 different frequencies about the nominal frequency (or a sufficient number of closely spaced points) so that the curve of input VSWR as a function of frequency can be plotted, as shown in Fig. 3.
7. From the plot of input VSWR versus frequency, determine $p_{max}$, the maximum VSWR and $p_{min}$, and the minimum VSWR, as shown in Fig. 3.
8. Calculate $p_f$ and $p'_f$ from equations (1) and (2)

\[ p_f = \sqrt{p_{max} p_{min}} \]
\[ p'_f = \sqrt{p_{max}/p_{min}} \]

where

$p_f =$ the cable-to-rigid line VSWR associated with the input or front end connector under test.

Illustration

Show how to calculate VSWR for the two-sloated section method.

Fig. 2. Arrangement of equipment for the two-sloated section method.
\( p'_b = \text{the attenuated cable-to-rigid line VSWR associated with the output or back end connector under test, seen at the input.} \)

If the attenuation of the cable is known, the cable-to-rigid line VSWR of the back end juncture can also be found by computing the back end reflection coefficient \( K_B \) from equation (3)

\[
K_B = K'_B \frac{1}{1 + p'_b} = \frac{1}{1 + p'_b} \frac{1}{1 + p'_B}
\]

where

\[
K_B = \frac{1}{1 + p'_B}
\]

and then the back end cable-to-rigid line VSWR, \( p_B \), is found from equation (4)

\[
p_B = \frac{1 + K_B}{1 - K_B}
\]

Illustrative Example:

Shown in Fig. 3 are sample measurement data taken at a nominal frequency of 3000 Mc.

From the plotted data,

\[
p_{\text{max}} = 1.15 \quad \text{and} \quad p_{\text{min}} = 1.02
\]

From equations (1) and (2)

\[
p_F = \sqrt{p_{\text{max}} \cdot p_{\text{min}}} = 1.08 = \text{cable-to-rigid line VSWR of the input connector.}
\]

\[
p'_F = \sqrt{p_{\text{max}} \cdot p_{\text{min}}} = 1.065 = \text{cable-to-rigid line VSWR of the output connector seen at the input.}
\]

Since the attenuation of the cable is known \((\gamma = 0.18\text{db/ft.}), p_B \), the cable-to-rigid line VSWR of the back end, can be calculated.

\[
K_B = \frac{1 - p'_B}{1 + p'_B} = \frac{0.065}{2.065} = 0.0314
\]

\[
\gamma = \frac{0.0314 \times 0.18 \times 10}{8.69} = 0.0386
\]

\[
p_B = \frac{1 + K_B}{1 - K_B} = \frac{1.065}{0.9686} = 1.08
\]

Variable-Short-Circuit Method

An alternate method of measuring the cable-to-rigid line VSWR is called the variable-short-circuit method and is based on the conformal transformation of a variable reactance (such as a shorting plunger) on the end of a cable into a circle on the Smith Chart representing the input impedance. It has the advantage that less time is required in making the measurement, since the oscillator frequency does not have to be varied as in the frequency variation method (with corresponding adjustments of the load termination tuners). Furthermore, it does not require the assumption that the VSWR of the connector under test varies slowly with frequency.

The arrangement of equipment for the variable short circuit of cable-to-rigid line VSWR measurement is shown in Fig. 4. Except for the variable short circuit, the equipment is the conventional type used for making VSWR measurements described in Section 2.02, Handbook. Although the variable short circuit may be either coaxial or waveguide, for simplicity of illustration, the conventional waveguide non-contacting shorting plunger is indicated in Fig. 4. Details of non-contacting shorting plunger designs are presented in many places.

Follow this measurement procedure:

1. Arrange equipment as shown in Fig. 4 and follow the general warm-up and tuning procedures as indicated (Section 2.02, Handbook). Measure
NEW AMP PATENTED "F" CRIMP TAPER PINS FOR WIRING AN TYPE CONNECTORS

IMPROVE RELIABILITY SAVE TIME REDUCE COST

Now AN type connectors can be wired 5 to 10 times faster with even superior performance reliability. There are no cold solder joints, burned insulation, embrittled wire and breakage at solder cups or short circuits due to loose strands and excess solder.

For many years the Aircraft, Electronics and Communication industries have awaited this new and simpler method, since the soldering of wires to conventional AN connector contacts is a slow and painstaking process involving much skill and repeated inspection checks.

With AMP's new Taper Technique, a special AMP Patented "F" Crimp Taper Pin is attached to the wires by high speed automatic machines. This pin is then installed in the connector with one easy and positive stroke of AMP's new "measured energy" CERTI-LOK insertion tool. The result is uniformly better connections, produced in much less time with tremendous cost savings.

Tests prove that AMP Taper Pins provide a greater degree of uniformity than soldered connections. Reliability is actually increased because the possibility of human error in assembly has been greatly reduced.

Leading Connector manufacturers are now supplying AN and other types of multiple contact connectors for use with AMP Taper Pins. Write today for further information.

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Leading Connector manufacturers are now supplying AN and other types of multiple contact connectors for use with AMP Taper Pins. Write today for further information.

the frequency of the signal source. (See Section II, Handbook, for detailed procedures for the measurement of frequency and wavelength.)

2. Adjust the position of the variable shorting plunger until a maximum VSWR is measured in the slotted section. Record this value of VSWR, $P_{\text{max}}$, and the position of the minimum.

3. Adjust the variable short position until a mini-

Fig. 5. A portion of a Smith chart showing a sample plot for determining $P_{\text{max}} (p_m)$ and $P_{\text{min}} (p_m)$.

In this case, the position that measured the slotted section.

In a similar manner for step 1, we would multiply the value of the center of the slotted section.

In this case, the position that measured

Shown is the VSWR of the circuit at the actual measured VSWR. The chart is plotted here to indicate the position of the coefficient. The high VSWR was directly read from the test by inspection of the chart.

From $P_{\text{max}} = 2.45,$

therefore $P_{\text{min}} = 1.30.$

From $P_{\text{max}} = 1.54,$

therefore $P_{\text{min}} = 1.08.$

Fig. 6. A variation in the variable short circuit method produces this plot on an expanded portion of the center of the Smith chart.

mum VSWR is measured in the slotted section. Record this value of VSWR, $P_{\text{min}}$, and the position of the minimum.

In one case, if the position of the minimum for step (2) and step (3) are identical or separated by a multiple of one-half wavelength, the VSWR of the connector, $P_{\text{co}}$, located between the cable and slotted section is given by:

$$P_{\text{co}} = \sqrt{P_{\text{max}} P_{\text{min}}}$$


ELECTRONIC DESIGN • September 1954
In this case, the VSWR of the connector is greater than that measured at the input end of the cable. The VSWR value, \( P_{\text{max}} \), corresponds to that measured in the slotted section with a match in the cable.

In a second case, if the position of the minimum for step (2) and step (3) above are separated by an odd multiple of one-quarter wavelength, the VSWR of the connector located between the cable and the slotted section is given by:

\[
P_{\text{co}} = \sqrt{P_{\text{max}}/P_{\text{min}}} \quad (6)
\]

In this case, the VSWR of the connector is less than that measured at the input end of the cable.

**Illustrative Example**

Shown in Figs. 5 and 6 are the results of plotting the VSWR and position of minimum as the short circuit at the output end of a cable is displaced. (The actual measurement procedure does not require the plotting of the data on a Smith Chart. It is included here to illustrate the circular locus of the reflection coefficient for the two cases discussed.) To obtain the high VSWR readings illustrated in Fig. 5, a mismatch was deliberately introduced in the connector under test by increasing the diameter of the inner conductor.

From the plot in Fig. 5

\[
P_{\text{max}} = 2.45 \quad \text{and} \quad P_{\text{min}} = 1.50
\]

therefore, from equation (5)

\[
P_{\text{co}} = \sqrt{2.45 \times 1.50} = 1.92
\]

From the plot in Fig. 6

\[
P_{\text{max}} = 1.4 \quad \text{and} \quad P_{\text{min}} = 1.08
\]

therefore, from equation (6)

\[
P_{\text{co}} = \sqrt{1.4/1.08} = 1.14
\]

**References**


---

The assurance that copper is in abundant supply and can be used without restrictions is the "go ahead" for industry. You can now rate performance over availability when choosing materials. By using copper and its alloys, brass and bronze, your product is easier to fabricate, better and more durable.

We can get more copper than we now have. Although industry and government have been consuming more copper than in any previous peacetime period, production has kept pace with this increased demand. And producers are not working at full capacity!

More copper keeps on coming. Eleven major new projects in the U.S. will start producing in the next 3 years. These mines will add 250,000 tons to our annual production—more than 1/4 of all the domestic copper mined during 1953. In addition, recent improvements in mining techniques now make it possible to obtain copper from ores considered commercially unworkable in the past.

**Copper is virtually indestructible.** At least 3 out of every 4 pounds of copper used in today's products, when scrapped, can be re-used in the future. Every day we are adding to our "copper capital". The more copper we use ... the more we have!
VICTOREEN SHOULD BE YOUR FIRST CHOICE FOR RESISTORS

The new Victoreen developed carbon film resistors, encapsulated in inert, gas-filled, glass tubes provide high watt dissipation or high voltage capacity with unusually high stability and long life. The high performance standards of these new resistors make them especially desirable in avionic, sonic, radar, computer and television circuits.

Whenever a circuit indicates a resistor for extraordinary high performance standards, specify Victoreen as your first choice for stability and long-life. From engineering, thru all manufacturing processes these resistors are made to the highest possible quality. To many manufacturers, the use of Victoreen resistors has meant the elimination of costly field failures.

VICTOREEN HI-MEG RESISTORS
Resistor elements are vacuum sealed in glass tubes, which have been processed to maintain stability under high humidity conditions and artificially aged to maintain their characteristics. Such processing assures the accuracy needed in circuit applications of very high impedance levels.
Fig. 1. By using "Penny Size" components, the servomechanism system at the right was redesigned into the system on the left, which is only one-half as high.

Miniature Servomechanism Components

Only 3/4" in diameter, "Penny Size" servo motors and their components, two of which are shown in Fig. 2, feature increased accuracy over this firm's larger servomechanism components. Units available in this size for use in control systems include servo motors, synchro transmitters, control transformers, differentials, and resolvers.

Fig. 2. Featuring high accuracy, these miniature components have the same diameter as a penny.
An example of weight-saving and size-reduction resulting from use of these components is shown in Fig. 1.

A subminiature servo amplifier, Type T3100, designed for use with these synchros is also shown in Fig. 2, left. Only the tubes in this amplifier are not hermetically sealed in a potting compound. The amplifier and the other components are all made by Kearfott Company, Inc., 1378 Main Ave., Binghamton, N. Y.

"Penny Size" components are constructed with an integral stator-housing assembly and a straight-through bore. The servo motor shown in Fig. 1 has a maximum no-load speed of 6500rpm, a stall torque of 0.1 in-oz, and a weight of 1.2 oz. The input-phase power and voltage are 1.5w and 18v, respectively. Another motor in this same size and with the same characteristics except for high inherent damping and a maximum no-load speed of 4000rpm is designed for simple instrument servos.

The synchro transmitters, control transformers, and differentials have maximum error limits of 10 minutes from electrical zero. For use in conjunction with the motors, they provide the sensors and error detectors of the servo loop. These units measure 3/4" diam x 1.658" long and weigh 1.75 oz.

An integral servo motor-damping generator in the 3/4" diameter size will be available soon. For more information on these components, turn to the Reader-Service Card and circle ED-25.

SYLVANIA LIGHTING * RADIO * ELECTRONICS * TELEVISION

CIRCLE ED-26 ON READER-SERVICE CARD FOR MORE INFORMATION
LOW CURRENT, HIGH INVERSE VOLTAGE OPERATION

Eimac's complete line of eight high vacuum rectifiers cover a wide range of average current, 15ma to 750ma and peak inverse voltages from 25,000v to 75,000v. In power supply units, voltage multipliers, pulse service or special applications at high frequencies, extreme ambient temperatures and high inverse voltages, Eimac high vacuum rectifiers are ideal. They give reliable performance at high frequencies and high voltages without generating radio frequency transients and have no lower limit to ambient operating temperature. Ruggedly constructed, Eimac high vacuum rectifiers contain many of the famous Eimac transmitting tube features such as an instant heating thoriated tungsten filament, that allows application of filament, plate voltages simultaneously; an exclusive radiation cooled pyrovac® plate; and elimination of internal insulators.

For additional information about Eimac high quality, high vacuum rectifiers, contact our Technical Services department.

* An Eimac trade name.
Universal Circuit Breadboard Chassis

Prototype construction as well as printed wiring layouts are implemented by use of the Universal Circuit Breadboard Chassis shown in Fig. 3. A complete variety of components can be placed on the chassis without using a single power tool.

The units can be used individually, mounted side-by-side, or stacked, as shown in Fig. 4, enabling the designer to utilize them in the construction of large equipment prototypes of "modular" design. The chassis can also be mounted end-to-end. They are held together by 6-32 self-tapping screws.

Because the sub-chassis are made of phenolic, prototype printed-wired circuits can be drawn on their surfaces for experimentation. The basic design of sockets is provided. The chassis can also be modified to accommodate printed wiring layouts to suit the designer's requirements.

Fig. 1. Details of a prototype circuit constructed on the breadboard with various types of subchassis.

Fig. 2. A partially completed prototype.
The sub-chassis come in four basic designs to accommodate various sizes of sockets. A terminal strip is also provided. The sub-chassis are also available with matching metal ground plane overlays to simulate metal chassis surfaces. One example of a sub-chassis with metal overlay for grounding is shown in Fig. 3. The cadmium-plated chassis frame is 4" wide x 12" long x 3" high. The end brackets of the frame have a series of 1/2" holes to accommodate regular and miniature potentiometers, fuses and switches as shown in Figs. 2 and 4. The chassis are manufactured by Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J. For more information, turn to the Reader-Service Card and circle ED-28.
a new achievement in fast-print oscilloscope recording...

Single to Operate. Uses standard Polaroid® magazine and fast self-developing film. Delivers finished black field print in 60 seconds. Automatically Records 3 to 16 traces per minute. Provides full size image on 3" scope, half-size image on 5" scope. No reversal of image.

The Arema Automatic

RECORDOSCOPE 1185

...a fully automatic oscilloscope camera that reduces engineering time and costs...

Steady Camera Mount with swing-away feature. Camera easily swung aside when not in use. Provides accurate data card exposure. Portable... The camera can service several oscilloscopes at once, and can be modified with adapter numbers and more. Can be interchangeably operated as a manual or automatic instrument. It is factory modified for automatic operation.

Manual

RECORDOSCOPE

The manually operated version of the RECORDOSCOPE 1185 offers many of the precision engineered advantages found in the companion automatic model. Though basically designed for manual release and advance of film, this camera can be factory modified for automatic operation.

The Arema

RECORDOSCOPE 1073

a Hi-HM Synchronous Camera for Continuous Motion in Single Frame Oscilloscope Recording

The Arema 1073 Recordscope is a compact self-contained unit mounting an f/2 six-element 50 mm lens and special fast Arema powered magazine. Shutter interlock system prevents film motion when shutter is closed. Synchronous film speeds range from 256'/sec. to 1/87' sec. in 12 steps of 2:1 ratio. The camera can be stopped and restarted with practically instantaneous speed synchronization. Periscope mounts camera vertically. Provision for automatically illuminated data cards and strobe contacts.

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CIRCLE ED-29 ON READER-SERVICE CARD FOR MORE INFORMATION
LOW-COST, rugged, compact electronic subassemblies utilizing printed wiring and standard components can be readily manufactured by the flexible, mechanized process described and illustrated on these pages. This production method was developed by James E. Huggins, Jr., Ordnance Corps, Frankford Arsenal, Philadelphia, Pa.

The completed “sandwich” assemblies, one of which is shown in Fig. 3, can incorporate much more complex circuitry than the familiar “two-dimensional” printed-wiring board because two printed-wiring plates are used, one at the bottom and one at the top. Design changes are readily accomplished and do not call for any modification of the basic assembly equipment shown in Fig. 2. Service problems are reduced to disposing of the entire unit because of its low cost. In addition, the assembly has all the familiar advantages of printed wiring.

The components and hardware used in this process are shown in Fig. 1. The through wires that are used to interconnect the two printed-wiring plates have a sleeved portion that prevents the wire from slipping through the plate hole after assembly. The component leads do not have to be unduly straight and are clipped short at only one end. The assembly procedures are illustrated in Figs. 4 to 9.

After dip-soldering, the leads are clipped flush against the plate, as shown in Fig. 3. The three miniature tubes are manually inserted in the remaining plate and the same dip-soldering procedures followed to complete the unit.

This design and assembly method will lend itself quite simply and economically to fully automatic production. Hopper feeding of components from bulk will prove easy, since the component leads are left straight rather than being preformed. An individual hopper or vibratory elevator feeder will be used for each component. The feeder will place the component in a simple inspection device which will carry “intolerance” components to a stack awaiting assembly. A relatively simple device will be used to ship each component from each stack simultaneously. Each component will be tripped into a tube which will convey it to gravity to a central master catacomb. This master catacomb will be located above the automatic assembling mechanism. All feeding of components will be accomplished by gravity. Components will be dropped from the master catacomb and assembled into the final unit, as previously described. After being assembled, the unit will be conveyed through fluxing and dip-soldering operations, after which the excess leads will be cut.

The “sandwich” type design has several additional welcome advantages. Components are rigidly mounted between the two plates and the unit is quite rugged when completed, even without a catacomb. Component leads require no sleeving. The design and method of assembly are flexible in that no machinery changes are required for changing lengths of the length.

Component changes are accomplished by a relatively simple device, a master catacomb and conveyor. Components are fed into this catacomb, and a simple device will place them in a stack awaiting assembly. Each stack will contain the components for a complete unit, and this method is the key to a simple design for automatic production.

Components are fed into the master catacomb in this manner. Each catacomb is quite flexible. Components are fed into the master catacomb, and the assembly is completed by a simple device which will place the components in a stack awaiting assembly. Each stack will contain the components for a complete unit, and this method is the key to a simple design for automatic production.

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are required to change from one size of component body to another. Components of widely varying lengths and diameters may be handled with equal ease because catacombs can be made any size, and at relatively low cost once the die is made. For that matter, catacombs are not required: a removable-type catacomb can be designed and used if one desires to build units without a catacomb. Furthermore, there is the natural advantage of the ease of circuitry change simply by changing the master circuit print. One of the main advantages of this method of assembly is that close tolerances are not required.

Complex electronic equipment can be subdivided into small units which can be designed and assembled in this manner. These units would be disposable when found to be faulty in the field and would help decrease costly trouble shooting. Repair of the unit after failure from use is rather difficult and, as such, uneconomical. Repair during manufacture would be unnecessary with adequate inspection of components and controlled manufacturing processes, as a result of the virtual elimination of human error.

The method described herein will result in large savings because of the decreased manual labor required. Further advantages lie in the fact that automatic machinery for this method will be relatively inexpensive and flexible. Less indirect labor is required because component leads are not formed, sleeving is not required, and component inspection can be readily accomplished.

Demands for cost and size reductions are forcing the design engineer to consider the final physical form in the earliest stages of the development of a new product, perhaps even before the circuit is conceived. Exciting new production techniques rather than advances in circuitry may lead to the solution of many of these problems. The electronic design engineer must now include a knowledge of production systems like printed-wired "sandwich" construction in the tools of his trade.

Fig. 4. The first stage in the assembly procedure after pin No. 1, a plate, and the catacomb have been positioned on the shafts with the proper holes in line.

Fig. 5. Hand loading of components begins after the pilot catacomb has been placed over the catacomb.

Fig. 6. The components have been vibrated into position and the pilot catacomb has been removed.
Fig. 7. The top printed-wire plate has been added and pin No. 2 has been threaded into pin No. 1.

Fig. 8. The catacomb is moved flush against the top plate prior to inverting the assembly.

Fig. 9. The assembly has been inverted and replaced on the shafts. Some of the component leads have already slipped through their holes in the plate. Vibrations will now shake the other leads into place.
Absolute reliability!

There, in two words, is the net result of all the engineering which TUNG-SOL has put into the 5881. This completely new tube is designed to operate in circuits for which the 6L6 is specified and is completely interchangeable wherever the 6L6 is now in use. Full utilization of the design and production techniques which have proved themselves over the past 15 years, has created this exceptionally reliable tube.

The 5881 is manufactured under laboratory conditions accompanied by the most severe tests. It is rugged both mechanically and electrically, with tremendous overload capacity. The 5881 maintains high efficiency throughout its life and provides low cost operation through reduced maintenance.

Where reliable service is essential in audio circuits, the TUNG-SOL 5881 is a "must." Order it from your regular TUNG-SOL supplier.

The TUNG-SOL engineering which has produced the 5881 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Information about this and other types are available on request to TUNG-SOL Commercial Engineering Department.

Tung-Sol Electric Inc., Newark 4, N. J.

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TUNG-SOL makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.
Fig. 1. One of the VA-220 Series Relay Klystrons, which are available in five frequency ranges.

Relay Klystron

FEATUREING negligible frequency drift, easier tuning and ample power to override noise, the long-life VA-220 Series Relay Klystrons offer significant advantages for all relay applications in the 6000-8000Mc band. Inherent noise and f-m distortion is 60db below a 1Mc deviation. In addition, the tubes, one of which is shown in Fig. 1, are offered at half the cost of this firm's earlier klystrons of comparable performance.

Fig. 2. A klystron in a modern relay system.
Various characteristics of these klystrons are given in the accompanying curves. Typical operation of one of the units calls for a resonator voltage of 750V for a power output of 1.2w, a bandwidth of 35Me, and a modulation sensitivity of $375 \text{ke}/v$. Reflector capacity is 6mmf maximum. Frequency ranges for the various models in the VA-220 Series are: Type F, 3925-6225Me; Type E, 6225-8750Me; Type D, 6575-8750Me; Type C, 8750-7125Me; and Type B, 7125-7425Me.

Life expectancy of the tubes is 10,000 hr, and they are guaranteed for 2000 hr of operation. Focused air cooling of 90cfm is required for the units, which are manufactured by Varian Associates, 611 Hansen Way, Palo Alto, Calif. Dimensions of the tubes are $2.375'' \times 3.75'' \times 3.19''$. The output connection mates with a UG-343/U choke. The tubes do not have any modulation anomalies.

The units may be operated in any position. The base is the small wafer octal type, and they have a signal-screw tuner. For more data on these tubes, turn to the Reader-Service Card and circle ED-31.

Fig. 3. Two characteristics of the Type D tube.

Modified Silicone Finish Used On Vehicle Heaters For Its Superior Heat And Salt Spray Resistance

Heaters manufactured for use in Ordnance vehicles by the Southwind Division of Stewart-Warner Corporation must withstand temperatures far higher than those involved in civilian applications. In the process of selecting the best finish for these units, the relative heat and corrosion resistance of organic and modified silicone paints were severely tested. The photograph shows the results.

The heater shell at left was sprayed with a modified silicone paint which is formulated by Midland Industrial Finishes, and baked for 30 minutes at 400 F. A similar unit, at right, was sprayed with conventional olive drab (TT-E-485b), and baked for 45 minutes at 250 F. Panels in the foreground illustrate the appearance of both finishes before testing.

Both shells were held at 500 F for 4 hours. The conventional finish was then exposed to salt spray for 100 hours. The modified silicone finish was similarly exposed to a salt spray for 300 hours or three times as long. The organic finish was stained, faded, and badly disintegrated, while the silicone coating remained virtually unchanged. As a result, Stewart-Warner specified the modified silicone finish for all such heaters. No. 1

“Silastic?” diaphragm has enabled Hayden Switch, Inc., of Waterbury, Connecticut, to produce a hermetically sealed snap-action switch that weighs only about half an ounce and operates with less than half the effort required by standard “aircraft quality” switches.

“The Tall Tales and Fabulous Facts” a 24-page booklet in which a parallel is drawn between the tall tales our ancestors told about legendary characters and some equally fabulous facts about Dow Corning silicones.

No. 3

Silicone News
FOR DESIGN ENGINEERS

Miniature Snap-Switch Sealed with Silastic Has Longer Life and Greater Reliability

The Silastic diaphragm remains so flexible that the operating force on the actuator need not exceed 32 ounces even at —90 F. Fatigue problems and subsequent unreliability associated with metal diaphragms are eliminated. Operational life in the range of a million cycles is far in excess of the best metal diaphragm or bellows.

Accelerated permeability tests indicate that the Silastic diaphragm maintains an effective hermetic seal for more than 10 years. Internal pressures up to 100 psi have failed to produce leakage or rupture, and no change in the diaphragms has been observed even after 72 hours’ immersion in salt, fresh or soda water, or in automotive or AN-0-64 aircraft oil.

Originally designed for aircraft, fire control and guided missile service, the new miniature switch is being applied to domestic and commercial washing machines, machine tools and other equipment exposed to liquids or moisture.

That’s the kind of performance that has established Silastic as an ideal diaphragm material where pressures must be maintained despite temperatures from —100 to 500 F, weathering and oxidation, or in contact with a variety of oils and chemicals. Silastic is also unique among resilient dielectric materials because it combines high thermal conductivity with excellent resistance to moisture, corona and to fatigue.

Westinghouse is Always Sure With Silicone Lubricants

For the past six years Westinghouse Electric Corporation has employed Dow Corning silicone fluids and greases to assure lifetime lubrication for their automatic toasters. Besides being used on the latch lever pivot, Dow Corning 41 Grease is also brushed on the guide bars and latch bar, as shown in photograph. A Dow Corning fluid lubricant, 710R, is applied to the pivots and bearings of the toaster timer.

No. 4

“Silastic?” is the title of a 32-page booklet which answers that often asked question. Indexed and illustrated, this booklet is an interesting and informative description of silicones.

No. 2

Despite operating temperatures ranging up to 400 F, these silicone lubricants stay in place without oxidizing or hardening. Six years of trouble-free service have convinced

Westinghouse that they are ideal lubricants for the job.

No. 5

Design Edition 1

DOW CORNING CORPORATION – Dept. DA-21
Midland, Michigan

Please send me more data on numbers:

NAME
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TITLE
CITY_ZONE_STATE

ATLANTA • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D.C. (Silver Spring, Md.)

Canada: Dow Corning Silicones Ltd., Toronto; England: Midland Silicones Ltd., London; France: St. Gobain, Paris

CIRCLE ED-33 ON READER-SERVICE CARD FOR MORE INFORMATION
How new Edison Relay with polarized operation helps simplify design problems

Current flow deflects the rotor of Edison's Sensitive Magnetic Relay in a direction determined by current polarity. Changing the operating current gradually causes the moving contact to follow the rate of change until it touches one of the stationary contacts. This basic operation adapts the Edison Relay for use as a null detector in a bridge circuit — and as a sensing element in a contactor servo circuit.

For designers of electronic equipment, Edison's Sensitive Magnetic Relay — a product of the world-famous Edison Laboratory — offers other outstanding features:

► Low power operation — Standard types close on input currents as low as 30 microamperes — available in special circumstances for even lower current.

► Versatility — Interchangeable coils can be supplied with resistances from 0.5 to 23,000 ohms. Normal closing power may be increased 10,000 times without adverse effects.

► Contacts — Platinum-iridium wire, either SPST or SPDT, with capacity of ½ ampere at 28 volts D.C. non-inductive.

► Stability — Test relays have exceeded 8,000,000 cycles without calibration change.

► Shock and vibration resistant — Relay will withstand shock of 50 g's in all planes without damage.

Write us for complete data on this new Edison development.
DESIGNATED the Type 30 Precision Attenuator, a continuously variable attenuator of the piston type featuring high accuracy, rugged construction and a direct-reading counter-type attenuation indicator is shown in Fig. 1. Attenuation is set to the desired value by the knob and is read from the indicator in tenths of a decibel without the necessity for interpolation.

The standard model has input and output coils tuned to a center frequency of 30Mc, and is intended for use over the range from 25 to 35Mc. Damping resistors in the standard model provide input and output impedances of 50 ohms. The unit has an attenuation range of 80db above a minimum insertion loss of 25db (at 30Mc). Actual attenuation above minimum insertion loss is within ±0.2db of the value indicated by the counter at any frequency from 25 to 35Mc. Input and output connections of 1/5 ohm impedance are provided by panel-mounted BNC connectors.

Fig. 2 is a view of the attenuator proper without the case. The body of the attenuator consists of a casting that houses the fixed input coils and provides a piston type rugged construction. The case is removed from the unit.

The standard model is provided as a counter-type attenuation indicator.

The counter-type attenuation indicator provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a direct-reading indication of attenuation. The indicator is designed for use in a balanced circuit and provides a
Precision Attenuator

A cylindrical attenuation chamber in which a piston carries the movable output coil. The rugged construction of the attenuator assures maximum long-term calibration accuracy and freedom from adverse effects of shock and vibration.

The fluted control knob drives the attenuator piston through a pair of stainless-steel bevel gears. The drive gear is internally threaded, thus acting as a driving nut for the internally threaded piston. This bevel gear is of the split, spring-loaded type to prevent play between the gear and the piston while still allowing the unit to operate smoothly and easily.

The shaft of the counter indicator is driven by a pinion from a second set of teeth on the split bevel gear, so that the counter gives a true indication of piston position without the effects of play or backlash. A set of piston rings prevents signal leakage past the end of the piston. Accuracy is maintained over the full attenuation range.

The Type 30 Attenuator is manufactured by Airborne Instruments Laboratory, Inc., 160 Old Country Rd., Mineola, N. Y. Housed in a walnut case for laboratory use, it is also available without case or panel for use as a component of more complex test equipment. In the case the attenuator measures 11” long x 4” wide x 3-3/4” high and weighs 3-1/4 lb. On special order, the attenuator can be supplied with input and output impedances other than 50 ohms and for use in other than the standard frequency range. For more information on this useful laboratory instrument, turn to the Reader-Service Card and circle ED-34.
DYSEAC, the mobile digital computer illustrated on these pages, can function as a computer by itself or serve as the “master computer” in a complex data-processing network in which it controls other digital computers or is controlled in turn by them. The instrument has extreme versatility of control and great latitude for expansion. While serving as a valuable scientific aid, it can also be the proving ground for evaluating certain novel control features and component packaging techniques. It was developed by the Electronic Computers Laboratory of the National Bureau of Standards, Washington 25, D. C.

At first glance the most striking feature of the instrument is its mobility. It is mounted in two standard 40-foot trailers. The control console, magnetic-wire input-output gear, computer, memory, and a 12-ton capacity air conditioner are in one trailer. The second van houses regulated d-c power supplies, some of the special instruments that may be connected to the computer, and provides a work area as well as storage space. Where standard 3-phase, 208v power is not available, a third vehicle will carry two 50kva alternators to power the computer. Since DYSEAC requires a minimum of 55kva, enough power is available from the mobile power plant to operate associated devices, thus making up a completely self-contained computer center.

When serving as the nucleus of a data-processing system, DYSEAC can solve problems fed directly to it, while simultaneously aiding remote external devices on other problems and sharing its memory with them. It can regulate the speed of its own computations to match those of “annexed” external computers, or interrupt its own computations entirely and devote itself to the external situation or new special problems. Among the devices that can be attached to the computer are those that store, tabulate, file, convert, display and sense information. Communication between DYSEAC and the external instruments can take place at any time, on a completely unscheduled basis, and in both directions at once.

As a consequence, supervisory control over the common problem may initially be loosely distributed throughout the system, and then temporarily concentrated in one computer, or even passed rapidly from one machine to another as the need arises. The special joint-control properties of DYSEAC could not be secured satisfactorily by the use of programming

In order to expand the capacity of the words, a delay is introduced. This expansion is organized so that...

The computer network...
Only two types of etched-circuit plug-in packages are required as basic building blocks in DYSEAC. These modular units are assembled in groups of 80 on three racks, one of which is shown in Fig. 2. One modular unit, consisting of an amplifier tube, a pulse transformer, and a number of diodes, is adaptable with minor changes to the majority of circuit needs. This unit serves as a low-impedance pulse driver, a flip-flop, and for a number of gating functions. A second type of package houses delay lines used for interconnection between the stages. The 524 tube packages and 251 delay-line packages, containing 21,000 diodes and 3800 1/4\(\mu\)sec delay-line segments constitute about 90% of the total circuit requirements of the computer exclusive of the acoustic memory and the input-output equipment. The racks, as well as the memory cabinet, are shock-mounted for protection while moving.

In designing DYSEAC, provision was made for expanding the high-speed storage from an initial capacity of 512 words up to a total capacity of 4096 words. The memory consists of 64 mercury acoustic delay line packages, one of which is shown in Fig. 4. This expansion is most significant, since the computer is organized around the memory unit. The memory has a normal 1Mc internal repetition rate.

The unusual control features of DYSEAC combined with its mobility represent an ingenious solution to the problem of setting up a data-processing network. At the same time, this computer is testing new construction methods. If DYSEAC is successful in demonstrating the feasibility of harnessing together a number of data-processing devices, including computers, it can help in the establishment of a standard method of feeding data to computers. Such a standard method, like the binary code employed in DYSEAC, combined with the joint control features, would multiply the total computation capacity of the nation's computers. The design of DYSEAC has implemented the concept of the "master computer" a stimulating idea for all designers of computers.
Fig. 3. The printed-wired circuit packages are quickly removed from the racks for servicing.
New Products...

**Miniature Resistor**
Surpasses MIL-R-10683A

The Type HFR 1/4w high-frequency miniature resistor is constructed of special solid ceramic rods to which a thin resistive film is permanently bonded. Featuring axial leads, it surpasses specification MIL-R-10683A.

The entire body assembly, including lead caps, is coated with a moisture-resistant protective coating especially designed for high frequency application. The unit is recommended for use in circuits requiring excellent frequency response over a wide band of frequencies and where low shunt capacity is desirable. Standard tolerance is ±20%, with ±10% and ±5% available. Body length is 9/16"; body diameter (over caps) 3/32", lead length 1-1/2", and lead diameter 0.025". International Resistance Co., Dept. ED, 401 North Broad St., Philadelphia 8, Pa.

**Time Delay Relay**
Plug-In Type

The type F "Silico-Netic" plug-in Time Delay Relay operates on the hydraulic-magnetic silicone operating principle. These compact, lightweight units are hermetically sealed against dust and moisture with an inert-gas fill optionally available.

The relay is provided with standard time delays from 1/4 to 120 sec.

These relays are furnished with either octal-pin or solder-lug terminals for operation on 24v to 220v, a-c, or 12v to 125v, d-c. Contact capacity is 3amp at 120v, a-c, or lamp at 50v, d-c, with spot through dpdt switching actions available. Heinemann Electric Co., Dept. ED, 449 Plum St., Trenton 2, N.J.

**Telephone Relays**
With up to 12 Contact Springs

The Series 5M relay incorporates all of the features of this firm's Series M relay, plus the additional features of: up to 12 contact springs (forms A to C); hermetically sealed construction; 7, 9 and 14 pin "plug-in" header; nitrogen filling; and ability to withstand 75g shock test. It is intended for use in all equipment where adverse climatic or environmental conditions exist.

The relay measures 2-11/16" x 1-5/8" x 1-13/32" overall. The hermetic sealing simplifies maintenance and renders the relay tamper-proof. The dry nitrogen gas produces high sparking potential or arc suppression. Hundreds of coil and contact combinations are available, and numerous additional features are available for special applications. Kurman Electric Co., Dept. ED, 35-18 37th Street, Long Island City 1, N.Y.

**Servo Motor**
Precision Miniature Design

The Model 1050 servo control motor, was specifically designed to operate this firm's "Microquats", but can be used in many other servo applications where a precision, high-quality motor is desired. A compact unit, it has three threaded holes in the housing for mounting the motor on a panel. Approximate dimensions are 1-1/2" diam x 1-1/2" long, with a 1/2" shaft extension.

Minimum locked rotor torque is 0.82 oz-in in either direction when operated at 115v. Other characteristics are: induction type, 2-phase, 115v, 400cy, 5500rpm no-load speed. Borg Equipment Division, The George W. Borg Corporation, Dept. ED, Janesville, Wis.
Precision Potentiometers

Standard 3-Turn Design

The "Series 930 Micropots" are standard 3-turn precision potentiometers designed to provide great flexibility of application. Either or both mechanical stops may be used as phasing points due to the adjustability of the contact drive assembly. This feature also provides greater accuracy in the four basic types of linearity without modification of the potentiometer.

Low starting and running torques make it possible to use these 3-turn units in lieu of single-turn pots and thereby gain greater accuracy and resolution. They are available in standard models from one to five-gang. Each model is produced with single-ended or double-ended shaft and with servo or bushing mount at either or both ends.

Additional advantages include extra-long life due to automatic compensation contact wear and the scanning action of the bar contact; no backlash between mechanical rotation and electrical rotation; finer resolution due to a longer Kohlrausch winding; welded terminal leads; and a plastic housing that embeds resistance element, lead wires, and terminals into a rigid, well-insulated assembly. Borg Equipment Division, The George W. Borg Corp., Dept. ED, Janesville, Wis.

CIRCLE ED-43 ON READER-SERVICE CARD FOR MORE INFORMATION

Flashlight Battery

Features No Corrosive Leakage

The danger of damaging expensive laboratory equipment due to the leakage of corrosive matter from their worn-out batteries can be avoided by using the "Eveready" D99 flashlight battery. In this battery the carbon electrode is on the outside, and the zinc electrode is on the inside.

The insert carbon wall keeps the battery sealed even when the zinc is consumed and the battery is exhausted. This leakproof battery will not swell. The construction also provides efficient consumption of the zinc, and, therefore, means a longer life. National Carbon Co., Dept. ED, 30 East 42nd St., New York 17, N. Y.

CIRCLE ED-44 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Blueprint Pencil
Eight Colors Available

A new blueprint pencil specifically designed for checking and marking on all blue or white prints and coarse tooth papers is resistant to oil, dirt, and grime and also unaffected by sunlight or moisture. The lead does not reflect light and results in opaque markings that give excellent reproductions without ghosts.

The specially formulated lead gives brilliant, insoluble, contrasting color markings. The pencil can be sharpened to a fine point and will not powder or smudge. They are marketed in an 8-color pack including a special obliteration blue pencil for eliminating white marks on blueprints. Colors are green, yellow, red, vermillion, light blue, dark blue, white, and black. A sample pencil is available on request. American Lead Pencil Co., Dept. ED, Hoboken, N. J.

CIRCLE ED-47 ON READER-SERVICE CARD

Lubricating Coatings
Applied by Dispensers

Two new “dag” dispersions can be used to coat all types of surfaces with dry lubricating coatings having epoxy resin bases. Typical uses for these products include dry lubricating films for high-temperature screw threads, precision gears, bearings, shafts, etc.

Dispersion No. 213, containing colloidal graphite, can be sprayed full-strength. Dispersion No. 223 contains colloidal molybdenum disulphide. Films properly formed with these dispersions show excellent adhesion and wear resistance. They are unaffected by oils and solvents, and can be used wherever temperatures do not go above 500°F.

In certain applications where electrical conductivity along with good heat stability is desired, Dispersion No. 213 also provides these properties. Acheson Colloids Co., Dept. ED, Port Huron, Mich.

CIRCLE ED-48 ON READER-SERVICE CARD

CIRCLE ED-49 ON READER-SERVICE CARD

MOST RELIABLE TUBES YOU CAN INSTALL!

5-Star Tubes

SPECIALY DESIGNED!

Superior dependability of G-E 5-Star Tubes is designed in, with many special features contributing to performance.

NOT selected tubes, but tubes engineered at the drawing-board level for greater reliability! General Electric 5-Star Tubes are special in every aspect of their design.

Resistance to shocks and vibration is superior to standard tubes because of double mica spacers, sturdy tube cages, double-staked getters, and other built-in strength and safety features.

Fewer “shorts”, more uniform electrical characteristics—these result from heavier, better-insulated heater wire; from steps taken to prevent inter-element leakage; from still other 5-Star design improvements that pay off in stable performance.

Millions of General Electric 5-Star Tubes—now giving far more reliable service for a longer period of time—prove that increased receiving-tube dependability starts at the design stage!
**SPECIALLY MANUFACTURED!**

Utmost care in manufacture follows. G-E 5-Star Tubes are built to only one standard of quality...the highest!

Increased reliability brought about by special tube design, is further accentuated by pre-assembly inspection of individual parts, painstaking manufacture, and thorough testing.

5-Star Tubes are built in separate G-E factory areas, by selected operators whose output features quality, not quantity. Advanced optical equipment is used to magnify parts and to check measurements. Many such inspections involve every 5-Star Tube.

The industry's strictest quality-control standards are observed. Final tube tests are comprehensive and exacting. All G-E 5-Star Tubes receive a final 46-hour "burn-in" before shipment.

Design, manufacture, testing—all focussed on dependability—join to make G-E 5-Star Tubes the best and most reliable you can install! *Tube Dept., General Electric Company, Schenectady 5, N. Y.*

**ATTENTION: EQUIPMENT DESIGNERS!**

33 G-E 5-Star Tubes—19 miniatures, 1 glass octal-base, 2 metal, 11 subminiatures—give you a wide choice, enabling you to put high reliability in virtually every socket. Ask for new Bulletin ETD-548C, with full tube listing and application data!

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**Audio Cables**

Polyethylene Insulated

A new, complete line of cables for audio, intercommunication, microphone, TV camera and other audio applications are made with polyethylene insulation. This insulation features low loss, long life, good flexibility, and high dielectric strength. Non-marring "Chrome Vinyl" jackets, durability, minimum maintenance, and ease of stripping are outstanding qualities of the new cabling.

The thermoplastic materials used are moisture-resistant, abrasion-resistant, and impervious to oil, grease, and most chemical fumes. Conductors are color coded for circuit identification. All leads are timed to simplify soldering operations. Components Div., Dept. ED, Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J.

**CIRCLE ED-50 ON READER-SERVICE CARD**

**"O" Rings**

Made to 0.020" ID

Available in sizes as small as 0.010" cross-section and 0.020" ID, subminiature "O" rings and other rubber parts are used in cables, micro switches and other electronic applications. They are made by an injection molding process, Minnesota Rubber and Gasket Co., Dept. ED, 3630 Wooddale Ave., Minneapolis 16, Minn.

**CIRCLE ED-51 ON READER-SERVICE CARD**

**Laminates**

Flame-Resistant

A new series of flame-resistant and flame-retardant laminates, impact phenolics, and fibrous materials can be blanked and punched as easily as standard grades of the same products. The flame-resistant ingredients of the laminates are a component part of the materials and not just a surface treatment. The entire series falls into Class A insulating materials. Rogers Corp., Dept. ED, Rogers, Conn.

**CIRCLE ED-52 ON READER-SERVICE CARD**

**Progress Is Our Most Important Product**

**GENERAL ELECTRIC**
New Products . . .

Pulse Generator
For Both Delay and Gate Uses

Utilizing block- unitized construction, the Model 2315A pulse generator consists of three semi-independent units and a power supply, providing either a variable-delayed, variable-width pulse, or two variable-width pulses with no delay, or two variably delayed blocking oscillator pulses whose delays may be paralleled or cascaded from the sync pulse.

An internal oscillator source generates positive and negative variable amplitude sync pulses from 10ny to 100ke, direct reading in four decade related ranges, along with a sync pulse delayed 2usec with respect to the initial sync pulses. External triggering and single shot operation are also provided.

Delays are direct reading and variable from zero (with respect to the delayed sync pulses) to 10,000usec in five decade related ranges. Jitter is 0.02%, and the units are calibrated to an accuracy of 0.5% of full scale. Blocking oscillator delayed outputs of both polarities and of variable amplitude are available.

Gate pulse rise and fall times are 2usec, and widths are direct reading and variable from 2usec to 10,000usec in the same ranges and with the same accuracy as the time delays. Positive and negative pulses are simultaneously available and are variable in amplitude to at least 50v across an internal 3000-ohms. Electro-Pulse, Inc., Dept. ED, 11811 Major St., Culver City, Calif.

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

Crystal
Shock-Proof Unit

This 1Me crystal unit in an HC-6 holder assures high stability in the low-frequency range. It utilizes a new nylon nest, permitting it to go down to 500ke. The crystal is firmly secured against shock without any hampering of its oscillating quality. It is built to meet all the requirements of the following MIL types: CR 18, 19, 27, 28, 35, 36, and 48/u. Reeves-Hoffman Corp., Dept. ED, Cherry & North Sts., Carlisle, Pa.

CIRCLE ED-56 ON READER-SERVICE CARD FOR MORE INFORMATION
Selenium Rectifiers
For Load Currents Under 50ma

For electronic equipment requiring a load current of 50mA or less, the "CR" series of miniature rectifiers consists of a number of selenium cells encapsulated within a cylindrical aluminum housing. Size ranges from the smallest type (CR08), 0.375" diam x 0.625" long, to the largest (CR58), 0.750" diam x 0.625" long.

The rectifiers are rated for maximum rms input voltage of 130v and 160v for operation into a capacitive load, and have a-d output current from 10mA to 50mA. For example, Type CR28 of this series is rated for a maximum of 130v input and will deliver approximately 170v d-c at 20mA with a capacitive filter. International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

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

Encapsulated Precision Wire Wound Resistors Defy Shock, Vibration and Extreme Changes

Completely sealed in epoxy resin and wound on ceramic bobbins, RPC has engineered Type L Resistors that are protected against extreme humidity, temperature and altitude conditions, mechanical damage, while maintaining dimensional stability.

Type L Resistors, in many tests, have withstood 30 humidity cycles of MIL-R-93A moisture resistance tests without deterioration. They fully meet the requirements of U.S. Govt. Specifications MIL-R-93A. Not affected by extremes in humidity, altitudes, and corrosive influences; protected against outside elements.

RPC can supply Type L on short notice with lug type terminals or wire leads; in a complete line of standard, midget and sub-miniature sizes. Wide range of performance! Write for catalog or additional details.

Sales representatives in all principal cities of the U.S.
Miniaturization Engineers

Significant advancements in the fields of guided missiles, airborne electronic systems and commercial electronic computers are requiring further applications of miniaturization techniques in the Hughes Advanced Electronics Laboratory. Positions are open for engineers qualified in this work.

THE COMPANY

Hughes Research and Development Laboratories, located in Southern California, form one of the nation's leading electronics organizations. The personnel are presently engaged in the development and production of advanced electronic systems and devices.

AREAS OF WORK

Techniques involved are those dealing with printed and etched circuits, encapsulation, plastics, metallurgy, dip-soldering, spot-welding, electrochemistry and materials. Development activities are concerned with plug-in units, auto-assembly techniques, potted units, new wiring methods, electromechanical devices, hardware and production techniques. These techniques are used to achieve compactness, reliability, ease of manufacture, serviceability and interchangeability.

THE FUTURE

Engineers who enjoy a variety of developmental problems find outlets for their abilities and imaginations in these activity areas. New semiconductor components are opening new avenues of miniaturization and are certain to have widespread application commercially in the next few years. Hughes engineers will have full benefit of working experience in this fundamental development.

Write today, giving details of qualifications and experience. Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

How to apply

Scientific and Engineering Staff

Hughes Research and Development Laboratories

Calver City, Los Angeles County, California

46
New Products . . .

Capacitors
Use “Mylar” Insulation

An economical process for constructing plastic film capacitors makes it possible to offer these units with close tolerances on a standard production basis. Designated Type MH, they are high quality, hermetically sealed tubular capacitors are available in any value from 0.01µfd to 1µfd with tolerances of 5%, 2%, and 1%.

The capacitors utilize moisture-proof “Mylar” polyester film, providing high insulation resistance combined with very low dielectric absorption and extremely low power factor. They are hermetically sealed in metal tubular cases with glass-to-metal seal terminals at each end, in standard miniature case sizes. Non-inductive extended foil type construction with leads soldered directly to the foil insures minimum contact resistance.

Capacitors are offered in voltage ratings of 200v, 400v, and 600v d-c and are production tested to withstand a d-c voltage of 250% of rated voltage at 25°C, between terminals and between terminals and case. Absolutely no de-rating is necessary between −20° and +125°C. Change in capacitance is less than 5% between −30° and +90°C. Electronic Fabricators, Inc., Dept. A, 682 Broadway, New York 12, N. Y.

CIRCLE ED-65 ON READER-SERVICE CARD FOR MORE INFORMATION

Connector

Automatic-Locking Subminiature Type

The Type “C” Subminiature Connector has all the features of the “Interlock” line: automatic locking, quick disconnect action, vibration-proof lock, and low contact resistance. Slightly over 1/2” long, it is especially suited for printed circuit use.

The connector is shown applied to a rotary switch plate circuit, illustrating how the wired plugs enter through set-in eyelets and lock automatically. Harvey Hubbell, Inc., Interlock Dept. (ED), Bridgeport, Conn.

CIRCLE ED-66 ON READER-SERVICE CARD FOR MORE INFORMATION
The leading quartz crystal developments of the past 25 years have been produced by Standard Piezo!

For an exact match of exacting specifications, it pays to choose frequency control crystals from the world's largest, most complete line... fully tested and proved in the world's most critical services.

NEW 20-PAGE CRYSTAL CATALOG SENT ON REQUEST

STANDARD PIEZO COMPANY Carlisle, Pa.

THE LEADING QUARTZ CRYSTAL DEVELOPMENTS OF THE PAST 25 YEARS HAVE BEEN PRODUCED BY STANDARD PIEZO!

Thyratron Tube Has Sharp Cut-Off

The 5684/C3J/A is an improved version of the C3J/A Xenon Thyatron. It features grids constructed with the "Gold Flow" process, assuring sharp cut-off characteristics throughout tube life. Other features include an arc-resistant, high-emission cathode, nickel-brazed anode assembly, automatic getters, and metalized graphite anode. It is applicable to high-shock installations.

Average anode current is 3amp, and average arc drop is 8v. Ambient temperature limits are -55° to +85°C. Warm-up time is 50sec. The tube also features a substantial overload capacity and a low deionization time of less than 500μsec.

Life expectancy is over 2000 hours when operated within ratings. Size is 6 1/4" long x 1 9/16" diam. Taylor Tubes, Inc., Dept. ED, 2312 W. Wabansia Ave., Chicago 47, III.

CIRCLE ED-69 ON READER-SERVICE CARD FOR MORE INFORMATION

Screen-Room Filters

Current Capacity to 100amp

Based on extensive experience with screen-room requirements, six standardized models of filter units are now available in single, double, and triple-line types. All models have attenuation equal to or exceeding that of the screen room itself. Units are housed in sturdy steel casings with 1-1/4" diam countersunk mounting holes to permit flush mounting on the screen-room wall.

Removable covers at the ends facilitate wiring. Case sizes range from 2 3/8" x 2 3/8" x 10", for a 30amp, single-line model, up to 4 3/8" x 4 3/8" x 22" for a 100amp, single-line filter. Voltage ratings range from 250 to 500v at line frequencies from 50 to 1000cy. Attenuation characteristics range from 100db or more from 5 to 1000Mc. Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE ED-70 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE ED-68 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 1954
WIDE-RANGE FREQUENCY METER 85-1000 MEGACYCLES

TS-175A/U
Government Approved
Calibration Accuracy: .005%
Stability: .0025%
Resettability: .0025%

A VERSATILE PRECISION MEASURING INSTRUMENT
Recommended Applications:
- Precise Measurements of Frequencies
- Production Testing
- Alignment of Transmitters and Receivers
- Laboratory Testing
- Portable Field Testing
- A Secondary Frequency Standard
- Signal Generator Calibration
- U.H.F. and V.H.F. Television Alignment

Calibration: Each instrument is individually calibrated, without interpolation, at 50 Kilocycle intervals throughout its range.
Frequency Range: The unit covers the calibrated range of 85 to 1000 megacycles. The fundamental of the precision variable frequency oscillator is 85 to 200 megacycles.
Sensitivity: The Frequency meter can detect a radio frequency signal of 20 microvolts with an audio power output up to 50 milliwatts depending on the frequency.
Internal Modulation: When desired, amplitude modulation of 1000 cycles in frequency can be employed. The modulation percentage is approximately 30%.
Radio Frequency Output: The output voltage from a 50 ohm source, varies from 300 to 100,000 microvolts, within the range of 85 to 1000 megacycles.
Secondary Frequency Standard: A 5000 Kc. oscillator incorporating a CR-18/U crystal can be used as a secondary frequency standard with harmonics of 5 megacycles up to 200 megacycles.

Territories for representation available.
We offer a complete automatic recalibration service on all frequency meters.

ELECTRONICS, Incorporated
238 William Street, New York, N. Y. * Cortlandt 7-5160
Executive Offices: 400 Duffy Ave., Hicksville, Long Island

CIRCLE ED-71 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Vacuum Tube Electrometer
Has High Input Impedance

The Model 210 is a line-operated d-c vacuum tube voltmeter with an extremely high input impedance. Basic specifications include an input greater than $10^{11}$ ohms, grid current below $10^{-13}$ amp, and drift within 10mv per hr. Five voltage ranges are provided: zero to 0.8v, 2v, 8v, 20v, and 80v, respectively, in either polarity.

The electrometer has output terminals for driving balanced or unbalanced recorders and recorder amplifiers, oscillographs, and galvanometers. The output amplifier drives the Esterline-Angus 0.1 milliamper recorder directly, or delivers 10v out on each range for full-scale input. Frequency response of the output amplifier is 0-5000cy, making the Model 210 useful as a d-c preamplifier wherever an ultra-high input impedance is needed.

The unit can be used not only as a d-c voltmeter, but as an extremely sensitive micromicroammeter, megohmmeter, and kilovoltmeter. Maximum full-scale sensitivities are $8 \times 10^{-14}$ amp, $3 \times 10^{-14}$ ohms, and 20,000v. Typical applications include potential measurements of charged capacitors, vacuum tube electrodes, and piezo-electric units. Keithley Instruments, Dept. ED, 3868 Carnegie Ave., Cleveland 15, Ohio.

CIRCLE ED-73 ON READER-SERVICE CARD

Waveguide Switch
Compact Unit

This waveguide switch, Model ASWI-X01, makes available to the microwave field a compact unit, 3/4" x 1-1/2" guide size. It includes such features as: vswr 1.05 to 1 maximum; crosstalk, 50db minimum; actuator, 110v 60cy; actuation time, 0.5sec maximum; vswr during switching, 1.2 to 1; power handling ability, approximately 0.35 megawatts cw. Thompson Products, Inc., Dept. ED, 2196 Clarkwood Road, Cleveland 3, Ohio.

CIRCLE ED-74 ON READER-SERVICE CARD

...that's why IBM uses Sangamo

The amazingly complex IBM "702" electronic calculator is hailed as the fastest and most flexible commercial data processing system ever devised. The central Arithmetical and Logical Unit performs calculations and makes decisions at a rate of more than 10,000,000 operations in an hour. Data and instructions for processing are stored in an electrostatic memory bank of cathode ray storage tubes. Output can be in the form of punch cards at the rate of 100 per minute.

A machine like this needs components that assure maximum performance to meet its exacting demands. That's why several different types of Sangamo Capacitors are used in the 702.

If you need capacitors for demanding electronic applications, Sangamo engineers can help you. You can choose from a complete line of paper, mica, electrolytic and button type capacitors for every industrial, electronic, and radio application.

SANGAMO ELECTRIC COMPANY
MARION, ILLINOIS
CIRCLE ED-75 ON READER-SERVICE CARD FOR MORE INFORMATION
Power Triode
Rugged Tube for D-C Supplies

Tube Type 6337 features high plate dissipation and high perveance, plate current held within ±10%, and absence of plate current drift. Compact in design, this tube is capable of withstanding 500g shock. A hard glass envelope and a button stem that strengthens the mount, provide high immunity to extreme shock and vibration. Wide interlead spacing practically eliminates electrolysis.

Characteristics include: plate supply, 225v; bias resistor, 100 ohms; amp factor, 2.7; plate resistance, 60 ohms; plate dissipation, 80w; transconductance, 45,000\mu\text{mhos}; plate current, 450ma; heater power, 6.3v, 7.25amp, a-c or d-c.

Chatham Electronics Corp., Dept. ED, 630 Mt. Pleasant Ave., Livingston, N. J.

CIRCLE ED-76 ON READER-SERVICE CARD

Power Supply
With 0.001% Regulation

The Model UHR-220 power supply features ultra-high regulation over its entire operating range under all conditions. It provides 0-200ma at 0-500v, with 0.001% regulation and ripple less than 100\mu v. The d-c impedance is less than 0.01 ohms and the a-c impedance is less than 0.1 ohms in series with 0.1\mu\text{h} (4" of wire). Transient response is 0.001milliseec.

Output voltage is kept extremely stable even at low voltages by the use of drift cancelling differential amplifiers with regulated heaters, a new high stability reference tube, and low-temperature-coefficient wire-wound resistors. Full current can be drawn at any line voltage from 105v to 125v with a substantial safety factor. There is an additional negative supply of 0-5ma at 0-150v with less than 2mv of ripple. Center-tapped 12.6v a-c at 4amp is also supplied.

The two front panel meters are ruggedized and hermetically sealed with ranges of 0-50v and 0-500v and 0-200ma. Dimensions are 7" x 10" x 13" deep. Krohn-Hite Instrument Co., Dept. ED, 580 Mass. Ave., Cambridge 39, Mass.

CIRCLE ED-77 ON READER-SERVICE CARD
Because of the rapidly increasing use of transistors, this firm has developed closely regulated d-c tube-type power supplies for powering transistors. Models embody two basic types. Model T-100-B is a meter-equipped regulated dual-voltage power supply with two duplicate outputs. Each of these outputs has three ranges: positive or negative 0-1v, 0.10v, 0.100v; adjustment of the three ranges is made by decade switches and potentiometers. Maximum d-c current output is 100ma.

A similar unit, the Model T-100-D, has no meters. It provides the same output ranges as the Model T-100-B, but adjustment is by direct-reading decade switches in steps of 0.1v, with 0.1% accuracy.

Regulation of both units is 0.05% from no-load to full load. D-c internal impedance is 0.6 ohms, 0.1 ohm at 120cy, 0.4 ohm at 50kc. Input regulation is 0.1% change per ±10% variation in line voltage. Ripple is 1mv, maximum.

Size of the transistor power supplies is 5-1/4" x 19"; shipping weight is 40 lb. Units are for rack panel mounting and include dust cover and removable end plates. Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena 8, Calif.

**Shunt Wound Motor**

Rated 0.02hp at 12,000rpm

This shunt wound d-c motor, designed for military use, operates on 28v. It is rated 0.02hp at 12,000rpm and is furnished complete with noise filter and high altitude brushes. The motor employs precision ball bearings and stainless steel shafts for extra-heavy duty. Parts are finished in accordance with rigid military specifications. Electro Engineering Products Co., Dept. ED, 609 W. Lake Street, Chicago, Ill.
A NEW CHAMPION
SUBMINIATURE
VOLTAGE REFERENCE TUBE
RAYTHEON CK5783WA

LOOK AT ALL TEN of these important performance features of the Raytheon CK5783WA Subminiature Voltage Reference Tube.

1. Tightened Voltage Drop Range: 83-89 volts.
2. Low dark starting voltage — only 15 volts maximum — no higher than for light starting.
3. Wider Ambient Temperature Range: -55°C to 150°C.
4. Lower Temperature Coefficient only -5 mV/°C maximum, from 25°C to 75°C.
5. Reduced voltage jump*. Maximum value: 5 mV.
6. Reduced drift** (1 hour). Typical value: 20 mV change.
7. Improved repeatability**. Typical value: 20 mV change.
8. Improved stability over 500-hour period (150°C ambient). Typically less than one volt change.
9. Improved stability over 5000-hour period (30°C ambient). Typically less than one volt change.
10. Ability to meet every requirement for military reliable tubes, including shock and vibration.

Notes: *Voltage jump — Maximum sudden jump in operating voltage when operating current is varied slowly over specified range.
**Drift — Maximum operating voltage change during the period of operation.
***Repeatability — Maximum shift in operating voltage between successive firings of the tube.

RAYTHEON VOLTAGE REGULATOR AND REFERENCE TUBES give you this complete range to choose from — each and every one a great performer

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NOTE: Type OB2WA now available to MIL specifications.

*Voltage Reference Tube

RAYTHEON MANUFACTURING COMPANY

CIRCLE ED-96 ON READER-SERVICE CARD FOR MORE INFORMATION

Mentioned in the text: A shock-absorbing rubber case which protects the instrument against normal shock, it is available in six standard ranges, starting at 400°F. It is 3-7/8" x 1-1/2" x 1-3/4" in size and has a 2.4" direct-reading indicator scale. Cybertronic Corp. of America, Dept. ED, Industrial Center, Third and Mortan Avenues, Chester, Pa.

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

Pocket Pyrometer
Handy Laboratory Device

The "Cybertronic" Pocket Pyrometer (Model 240-T) offers quick, accurate measurement of surface and subsurface temperatures through the use of interchangeable thermocouples. Housed in a shock-absorbing rubber case which protects the instrument against normal shock, it is available in six standard ranges, starting at 400°F. It is 3-7/8" x 1-1/2" x 1-3/4" in size and has a 2.4" direct-reading indicator scale. Cybertronic Corp. of America, Dept. ED, Industrial Center, Third and Mortan Avenues, Chester, Pa.

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

A-C Test Set
For 60cy Measurements

The Universal "60" Alternating Current Test Set is a compact, rugged, and accurate set of instruments, designed to be used together and capable of giving the complete picture of 60cy voltages, currents, power, and power factor.

There are four separate instruments: two 18-range ammeters, providing from 5w full scale to 2000w full scale, which can be used down to power factors of 10%; an ammeter with seven current ranges from 10mA full scale to 10amps full scale; and a voltmeter with four ranges from 30v full scale to 300v full scale. Sensitive Research Instrument Company, Dept. ED, 9-11 Elm Ave., Mount Vernon, N. Y.

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

Servo Transmission
Has Two Magnetic Clutches

This differential transmission for servo systems contains two magnetic clutches and a suitable gear train which affords starting, stopping, and reversing of any load within the rating of the unit. This is accomplished on any desired duty cycle with continuous input-shaft rotation.

The transmission is available in any desired fractional horsepower rating and gear ratio. Electrical input by means of plug or barrier terminal strip is provided, B & W Electronic Research Laboratories, Dept. ED, 5629 Goodwin Ave., Dallas 6, Texas.

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

ELECTRONIC DESIGN • September 1954
MODEL R-1

VOLTMETER

Designed and Engineered for Design Engineers

FEATURING:
- DC Volts & Millivolts
  Accurate to 1/3% of full scale
- AC Volts & Millivolts
  Accurate to 3% of full scale
- Balanced D-C Amplifier
  Flat ±1/2 db to 100 KC
- Ohmmeter
  with Expanded Scales
- Regulated Power Supply
  unaffected by line transients
- Illuminated Weston Meter
  accurate to 1% of full scale

...and the SIE Distended DC Scales, the most useful feature ever incorporated in a vacuum-tube voltmeter, enabling changes as small as one part in 10,000 to be read accurately.

The new rack-mounted version of the R-1 includes all of these features in a unit specially designed for this application.

SPECIFICATIONS:

AC & DC Volts Ranges: 1 mv. to 1000 v., full scale
Ohmmeter Ranges: zero ohms to 500 megohms
Maximum Gain, D-C Amplifier: 200
Drift (after warm up): less than 3 mv./hr.
Tube complement: 13
Weight: 34 lbs.

Price, f.o.b. Houston: $620.00
rack mounted: $700.00

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
P. O. Box 13058
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Houston, Texas

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REPRESENTATIVES THROUGHOUT THE WORLD.

CIRCLE ED-B8 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Special Amplifier
Generates Arbitrary Functions

The Type 6-1A Arbitrary Function Generator is a special form of amplifier whose output signal can be related to input by any predetermined, arbitrary function of the form \( y = f(x) \). Originally designed as a high-precision analog computer component, it is also well suited for handling non-linearities such as those encountered in missile telemetering and recording systems. Signal from zero frequency to several kilocycles can be handled.

Desired functions of the form \( y = f(x) \) are plotted, and reproduced on standard lantern-slide templates. The slide is inserted in the instrument between its cathode ray tube and photoelectric tube follower, which is arranged to follow the slide’s \( y = f(x) \) outline. The voltage required to position the cathode-ray tube beam in the \( y \) direction is amplified and used as the output signal. Instantaneous output signal is thus related to the instantaneous input signal in the same manner as \( y \) values on the template relate to \( x \) values.

The instrument has sufficient gain to permit operation with input signals as low as 0.1v for full scale. Output can provide up to \( \pm 100v \) or \( \pm 0.015amp \) full scale. The instrument operates from 117v, 50-60cy, and may be rack mounted or used on a table top.

Wm. Miller Instruments, Inc., Dept. ED, 325 N. Halstead, Pasadena, Calif.

CIRCLE ED-89 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Motors
Can Operate at 160°C

These servo motors include BuOrd Mark VII and Mark VIII types, as well as 15 other variations. They are available with a wide choice of plain or pinion shafts.

High torque to inertia ratio units, they can operate in the region of 160°C. They meet all military humidity, salt spray, and fungus test requirements. American Electronic Mfg. Co., Inc., Dept. ED, 9503 W. Jefferson Blvd., Culver City, Calif.

CIRCLE ED-90 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature AN Connector Assembly consists of

HBB 3358 Pressurized Receptacle
HBB 3359 Waterproof Plug Assembly
HBB 3310 Tubing Clamp

—for limited space requirements

This compact connector assembly (approx. 2¼-in. long x 1¼-in. dia.) is a forerunner of miniature AN Components design to be pioneered by HBB design and engineering departments.

Components include 38 contact receptacle and plug—two 35 Amp. (No. 12 wire) and thirty-six 5 Amp. (No. 18 wire) contact. Shell adapter and clamp of gray anodized aluminum.

Features the new HBB 3300 Series flexible plastic tubing clamp instead of standard AN cable clamp.

Write for complete data.

CIRCLE ED-91 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 1954
Insulation
For High Voltages

"Panelyte" Grade 471 melamine canvas is intended for use in TV high-voltage insulation requirements. It features flame retardancy, which makes it valuable for such applications as terminal boards, filament holders, high-voltage shields, and gate-back transformers. It has superior water absorption, arc resistance and dielectric strength properties. Panelyte Division, Dept. ED, St. Regis Paper Co., 230 Park Ave., New York 17, N.Y.

Circle ED-84 on Reader-Service Card

Picture Tubes
Two Aluminized Types

Two monochrome-TV picture tubes, models 17QP1 and 27SP1, are 17" and 27" types, respectively. Both feature all-glass construction, rectangular, aluminized screens, gray-filter spherical faces, single-field ion traps, and external conductive coatings.

The 17" type is magnetically focused and deflected with a deflection angle of 70°. It has a screen area of 14 3/16". Its over-all length is 19 2/16". The 27" type is electrostatically focused and magnetically deflected with a deflection angle of 90°. Over-all length is only 23 1/16". Total picture area is about 425 sq in.

Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York 19, N.Y.

Circle ED-85 on Reader-Service Card

Coil Forms
Made to Specification

This firm supplies coil forms in any shape, size, length, ID, or OD within critical tolerances. Sizes from a fraction of an inch to 9" ID can be furnished without extra tooling charges. The forms can be wound from a wide range of dielectical materials such as kraft, fish paper, acetate or combinations. Phenol impregnation is also available. Precision Paper Tube Co., Dept. EDN, 2035 W. Charleston St., Chicago, Ill.

Circle ED-86 on Reader-Service Card

Circle ED-87 on Reader-Service Card

Capacity: Whether you require a few hundred or several million parts, the right size and type of equipment is available. Ample kilns available plus many special kilns, including controlled atmosphere kilns, provide firing capacity at optimum temperature.

Low Cost: The right equipment for every job means that your work is produced at the most favorable cost.

Variety of Materials: In AISImag you have the widest choice of materials so that you can most readily match the material to your requirements. Latest property chart sent on request.

Versatility: Here is your key to the widest range of applications and equipment for AISImag parts; plus most reasonable requirements.

Engineering Assistance: If you will send details of your requirements, our engineers will submit suggestions on material and design to assist you in finding the most efficient and economical solution to your requirement.

53rd Year of Ceramic Leadership
AMERICAN LAVA CORPORATION
CHATTANOOGA 5, TENNESSEE

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PITTSBURGH: 911 Plaza Bldg., Atlantic 1-2075
CHICAGO audio transformers feature the famous "sealed-in-steel" construction. They have seamless drawn steel or cast cases for greater strength, moisture resistance and maximum shielding. These units are truly the world's toughest transformers.

These rugged transformers are designed to provide minimum leakage and hum pick-up, along with optimum coupling. Harmonic and intermodulation distortion are extremely low over the specified frequency ranges.

Most CHICAGO audio transformers are available in a choice of mounting styles, including hermetically sealed cases. You're almost sure to find the unit you require in the CHICAGO line of stock transformers.

FREE
Chicago Catalog CT-554
listing complete electrical and physical specifications on over 500 CHICAGO transformers. Available from your CHICAGO distributor or from Chicago Standard Transformer Corporation.
New Products...

Position Servo Actuator
Features High Torque, Fast Response

A torque-to-inertia ratio of 200,000 rad/sec² coupled with an acceleration constant of 10 millisecond are outstanding features of the Model 205 servo-actuator. It is offered in two basic versions: one for piloted, the other for pilotless aircraft. Each contains a drive motor, radio noise suppression network, low inertia precision gear train, and a follow-up potentiometer. In addition, the piloted model contains an overload and disconnect clutch, and the pilotless model an overload clutch. These elements are housed in a sealed, waterproof case 5-3/4" x 3-3/4" that weighs only 4-3/4 lb for the former and 4-1/2 lb for the latter. The output capstan of the unit is free to rotate 360°.

For a fixed supply voltage, output speed of the actuator is inversely proportional to applied load; for a constant load, speed of the actuator is proportional to the applied voltage. Control relays dynamically brake the motor when the control signal is removed. This quality allows the servo to maintain torque loads with only intermittent input power.

Maximum continuous torque at 28v is 200 in-lb. Additional torque outputs are available to customer requirements. Equivalent motor stall torque at 28v is 1290 in-lb. Operating voltage range is 5-35v. Operating current is 0.4amp at no load plus 0.1amp per in-lb of loads. Summers Gyroscope Co., Dept. ED, 2328 Broadway, Santa Monica, Calif.

CIRCLE ED-98 ON READER-SERVICE CARD FOR MORE INFORMATION

Phenolic Molding Material
Mica Filled

Resinox 3001, a mica-filled phenolic molding material, features improved moldability and mechanical strength. A thermosetting compound, it can be molded under the same conditions as other mica-filled phenolics.

The material is recommended for use in radio tube sockets, radio tube bases, electrical connectors, terminal strips, and miscellaneous electrical components where good electrical and mechanical strength are required. Monsanto Chemical Co., Dept. ED, Springfield, Mass.

CIRCLE ED-99 ON READER-SERVICE CARD FOR MORE INFORMATION
**400cy Transformers**

*Withstand High Temperatures*

These stock 400cy power and filament transformers and filter reactors are designed to meet MIL-T-27, Class B specifications for high-temperature operation. They are housed in seamless drawn steel, hermetically sealed cases with stud type terminals. Available in a full line, these units have ratings that were chosen after discussion with organizations engaged in the development of standards for aircraft, guided missiles, and related equipment.

All transformer primaries are rated 105/115/125v, 380-1,000cy. A wide variety of secondary voltages are available in the transformers. Chicago Standard Transformer Corp., Dept. ED, 3501 Addison St., Chicago 18, Ill.

**CIRCLE ED-110 ON READER-SERVICE CARD FOR MORE INFORMATION**

**Conductive-Coatings Kit**

*Makes 12 Coatings*

Design and development engineers concerned with or contemplating use of conductive coatings for printed circuits and other applications will be aided by this Basic Laboratory Kit, Type 831. The kit contains six electrically conductive silver coatings, six resistance coatings, six accessory chemicals, manuals, and technical data. Quantities of each material range from one ounce to one pint. Micro-Circuits Co., Dept. ED, New Buffalo, Mich.

**CIRCLE ED-111 ON READER-SERVICE CARD FOR MORE INFORMATION**

**Shields**

*Protect and Ventilate Tubes*

"Ventilator" shields are designed to improve tube performance by dissipating heat. Their design makes for low cost of manufacture.

Easily handled, the shields are compression fitted to ground terminals on laminated or printed wiring sockets. They are available in lengths of 1-11/16" or 2-1/6", with one standard diameter which fits either seven- or nine-pin tubes. They can be furnished with tin or black oxide finish. Methode Manufacturing Corp., Dept. ED, 2021 Churchill St., Chicago 47, Ill.

**CIRCLE ED-112 ON READER-SERVICE CARD FOR MORE INFORMATION**
complete testing with one convenient unit...

Kearfott
MICROWAVE TESTING EQUIPMENT

Combined in this equipment are means to measure power...observe transmitter spectra distribution...measure frequency and supply artificial signals. You can analyze bandwidth characteristics. A self-contained square wave generator aids in making standing wave measurements. One portable unit does all—on the bench or in the field—efficiently and at much lower first cost than with separate instruments.

Quick function selection—merely flick the front panel switch to the function desired. Controls are grouped for easy operation by personnel with minimum training. After initial warm-up, any function is immediately available for use.

Unitized construction—each test section is mounted on a separate plug-in sub-chassis. For unusual applications, special units can be provided which are interchangeable with standard sections. Service and maintenance is simple and quick.

FEATURES:

- **SIGNAL GENERATOR:** CW, Square Wave, FM or pulse mod. RF, 8.5 to 10 KMC.
- **POWER MONITOR:** Measures average power of signals from 8.5 to 10 KMC, Accuracy ±2 db of full range.
- **WAVEMETER:** Reaction cavity wavemeter, 8.5 to 10 KMC, accurate to 0.03% at standard temperature and humidity.
- **SPECTRUM ANALYZER:** 8.5 to 10 KMC displayed on 3" CRT, 10 bandwidth of 15 kc for optimum pulse rendition.

SIZE: 18" x 11½" x 14"
WEIGHT: 45 lbs.

Write for complete description and specifications.

Kearfott COMPANY, INC. • VAN NUYS, CALIF.

A GENERAL PRECISION EQUIPMENT CORP. SUBSIDIARY
CIRCLE ED-113 ON READER-SERVICE CARD FOR MORE INFORMATION
Bomac combines 4 COMPONENTS into 1

A complete Duplexer NOW in One Compact Unit

For the first time, Bomac offers to the electronic industry a complete duplexer as a single component... the BL-509.

Combining (1) a Bomac TR tube having (2) integral shutters, with (3,4) two hybrid junctions, the BL-509 eliminates the necessity of specifying these components separately. Light weight and compact, it also assures superior electrical performance and mechanical strength.

This duplexer may be fabricated to customer's configurations.

### RATINGS

| Shutter Holding Current | 0.060 amp |
| Shutter Operating Current | 0.280 amp |
| Shutter Operating Voltage | 28 V. |
| Ignitor Current | 100-200 μAdc |
| Ignitor Interaction, 100 μAdc (max.) | 0.1 db |
| Voltage Drop, 100 μAdc | 200-375 Vdc |

### CHARACTERISTICS

| Duplexer Loss (max.) | 1.2 db |
| Arc Loss (max., at 4 KW) | 0.6 db |
| Spike Leakage (at 40 KW) | 0.1 μA |
| Flat Leakage (at 40 KW) | 20 MW |
| Bandwidth | 8490-9578 MHz |
| Center Frequency | 9000 MHz |
| Recovery Time (at 200 KW) | 7 μsec. |
| Shutter Attenuation (min.) | 40 db |
| Isolation | 20 db min. at center, 15 db min. at ends |

### New Products...

#### Nameplates
Non-Tarnishing

Made of 0.003" or 0.005" thick anodized aluminum, "Thinplate" nameplates will not tarnish or oxidize and are highly resistant to abrasion, humidity, and salt spray. They are backed by a pressure-sensitive adhesive that passes all military tests.

Available in anodized colors, these nameplates can be cut to any size or shape, and can be serial numbered in any typewriter. Park Nameplate Co., Dept. ED, 61-07 Thirty-Second Ave., Woodside 77, N. Y.

CIRCLE ED-106 ON READER-SERVICE CARD

#### Metal Bellows
Have Small Diameters

Hydraulically formed, seamless metal bellows of 1/4" and 5/16" diameters are available with a wide range of characteristics. These sizes serve as components of switches designed for aircraft.

The bellows are made of brass, phosphor bronze, beryllium copper, and monel. Typical examples are 1/4" diameter, two-ply, phosphor bronze bellows, and a 1/4" beryllium copper bellows that will withstand maximum external pressure of 2300 psi. Bridgeport Thermostat Div., Robertshaw Fulton Controls Co., Dept. ED, Bridgeport 1, Conn.

CIRCLE ED-107 ON READER-SERVICE CARD

#### Protective Coating
Applied by Spray

Effective protection against short circuits, corrosion and corona loss is provided by coatings sprayed on by "Sprayon" Plastic Sealer. The coating is high in dielectric strength and dries quickly to a non-tarnishing flexible finish. It also acts as waterproof parts. The coating is applied by a handy 12-oz aerosol can with a non-clogging nozzle that requires only finger-tip pressure to operate. Champion Bronze Powder & Paint Co., Inc., Dept. ED, 2101 N. Elston Ave., Chicago 14, Ill.

CIRCLE ED-108 ON READER-SERVICE CARD

We invite your inquiries regarding

- ENGINEERING
- DEVELOPMENT
- PRODUCTION

Bomac Laboratories, Inc.
Beverly, Massachusetts

GAS SWITCHING TUBES · DIODES · HYDROGEN THYRATRONS · DUPLEXERS · MAGNETRONS
MODULATORS · CAVITIES

Write on your company letterhead
Waveguide Quick Disconnect
No Tools Required

The Waveguide Quick Disconnect provides a reliable method of rapidly making and breaking waveguide connections. No tools of any kind are required. Connections are made by simply inserting the flange and hand tightening the outer ring. Proper alignment is automatic.

In addition to its uses as a piece of laboratory equipment, the disconnect is well suited for incorporation in microwave test sets as a front or rear panel fixture. It is available in sizes to fit the standard chokes and flanges of Types RG-51/U, RG-52/U, and RG-91/U waveguides. Aircraft Armaments, Inc., Dept. ED, P.O. Box 1777, Baltimore 3, Md.
CIRCLE ED-122 ON READER-SERVICE CARD FOR MORE INFORMATION

Time Delay Network
Continuously Variable

Type 303 continuously variable time delay passive network is very suitable for use as a time delay matching device in television systems, variable time delay for pulses, or precision measurement of small time intervals. Both the bandwidth and the transient response are excellent.

The rise time is less than 7% of the time delay at any point, and the amount of overshoot is less than 2%. Resolution time is less than 5 x 10⁻¹⁴ sec, passing signals of any waveform. There is no time jitter.

This instrument consists of an input amplifier, an output amplifier, and a continuously variable delay line of which the time delay may be adjusted continuously by the front panel dial. Ten different types of continuously variable delay lines are available, with the shortest one being 0 to 0.05 μsec and the longest being 0 to 0.8 μsec.

The input impedance is 1 megohm shunted with 200 mfd. The output impedance is 1 megohm shunted with 15 mfd. Both the input and the output impedance can be made lower by shunting the terminals with proper resistors. Both amplifier stages have 15 MΩ bandwidth and 10 v peak-to-peak maximum signal level. Accuracy can be maintained within ±1% after calibration. Advance Electronics Co., Inc., Dept. ED, 451 Highland Ave., Passaic, N. J.
CIRCLE ED-309 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products

Oscilloscope
Precision Low Cost Unit

By combining engineering advances with large scale production, this firm is able to offer the same precision features in the Model 600 as in oscilloscopes selling up to twice its price. Some of the features of the new design are: a 5UP1-5" scope tube for sharp focusing and good intensity; a retrace blanking amplifier that eliminates confusion and gives clear, sharp pictures; a two-step compensated attenuator input; and a two-stage push-pull vertical amplifier with sensitivity 0.02v per inch.

Synchronization is also available on either positive or negative phase of input voltage through the vertical amplifier or from an external source. Electronic Measurements Corp., Dept. ED, 280 Lafayette St., New York, N. Y.

Compressor Amplifier
Provides Constant Output

The Type 501-A Compressor Amplifier is ideal for stabilizing varying signals to eliminate the necessity of adjusting levels when measurement or observation of signals are to be made with oscilloscopes, bridges, phase comparators, or wave analyzers. The instrument accepts input signals of variable amplitude between 1.25 and 50v and delivers an output signal of the same waveform but held at a substantially constant amplitude of 0.25v (+4db) by a servo-controlled distortionless variable attenuator.

Compression ratio is 40 to 1 (32db) from 5000 to 1M, slightly less below 5000. Frequency range for complex signals at any compression condition is 50cy to 50ke, within ±3%. Input impedance is 10 meg-ohms shunted with less than 10mild, and output impedance is less than 100 ohms for frequencies above 500cy. Technology Instrument Corp., Dept. ED, Aeton, Mass.
Slug Capacitors
Designed for Color TV Needs

Developed primarily for the critical requirements of color TV, these "Cartwheel" slug ceramic capacitors are available in ratings up to 30kv and are capable of operating under extreme humidity and at elevated temperatures. They are encased in casting compound as distinguished from the usual thermosetting molded plastic.

The sealing technique results in much higher Corona-starting voltages, greatly increased dielectric strength, excellent arc-resistance properties, and an insulation resistance greater than 50,000 megohms. They have a power factor of 1.5% maximum at 1000cy and a long service life.

Cartwheels are available in a choice of sizes, voltages, and capacitance as well as several terminal styles. Hi-Q Division, Dept. ED, Aerovox Corporation, Olean, N. Y.

CIRCLE ED-102 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Resistor
Shaft Adjustable at Both Ends

Designated Type LR6, a low-cost, tab-mounting variable resistor features a Bakelite shaft that is adjustable at both ends. The units are designed for use as

var-of-chassis and concealed front panel controls in TV receivers, as pre-set gain controls in multiple input pre-amplifiers, and in other circuits requiring only occasional adjustment. The insulated shaft feature is particularly desirable where the chassis or mounting plate is operated above ground.

The slotted hexagonal shaft extending forwards and backwards is adjustable by hand, 7/32 hex nut driver, or screwdriver. The rear portion of the Bakelite shaft is round with a screwdriver slot and projects slightly beyond the cover of the control. The units are available with shaft lengths of 3/16", 1/2", 5/8", 3/4" and 1" in all resistance values, tapers and other specifications according to RETMA Standards. Electronic Components Div., Dept. ED, Stackpole Carbon Co., St. Marys, Pa.

CIRCLE ED-103 ON READER-SERVICE CARD FOR MORE INFORMATION

MAKE YOUR QUALITY SOURCE FOR
Carry Through
Printed Circuits

SWITCHES - COMMUTATORS
ASSEMBLIES - COMPONENTS

"CARRY-THROUGH" For maximum economy and quality. No need for Space Consuming Large Holes for Through Continuity. Top and bottom soldering with selective dip-soldering of the bottom side only is an advantage, as shown.

Insulated Circuits
INCORPORATED
115 ROOSEVELT AVENUE, BELLEVILLE, N. J.

CIRCLE ED-104 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • September 1954
New Products...

Peak Reading Voltmeter
Measures up to 100kV

The High Voltage Vacuum Tube Voltmeter is a peak reading device designed to measure audio, supersonic, and r-f voltages that exceed the voltage range of most oscilloscopes or vacuum tube voltmeters. Utilizing two vacuum capacitor voltage dividers, it has five voltage ranges, including a 50kv range for single-ended use and a 100kv range for double-ended use.

Frequently response is flat from 50cy up to 20Me (or up to 50Me if derated to half voltage). Loading capacity is less than 4mfd, making the unit extremely useful in measuring and viewing high voltage pulses. It has a time delay of 0.16sec.

Transient viewing is facilitated by the oscilloscope connection provided for each divider with a division ratio of 300:1 and a resonant point of 220Me. Oscilloscope calibration is simplified by a provision for easy switching from the scope to the meter. Jennings Radio Manufacturing Corp., Dept. ED, P. O. Box 1278, 970 McLaughlin Ave., San Jose 8, Calif.

CIRCLE ED-127 ON READER-SERVICE CARD FOR MORE INFORMATION

Trimmer Potentiometers
Have Infinite Resolution

Featuring infinite resolution, the Type RFT "Metalfilm" miniature trimmer potentiometers are made in a wide range of total resistance values. They embody a deposited metal resistance element that is tough and smooth and has excellent characteristics of noise and wear.

The sliding contact rides upon the adjusting screw and contacts all of the available resistance variation with approximately 25 turns of this screw. A 90° turn of the drive screw results in an approximate voltage change of 1% of the applied voltage. Voltage settings can be maintained with great precision. With a mounting surface about 3/8" square, these potentiometers can be stacked so that seven units occupy a square inch of panel space. Technology Instrument Corp., Dept. ED, Acton, Mass.

CIRCLE ED-128 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW SMALLER DISC CATHODES
BASIC FOR COLOR TV TUBES

To fill a need for tri-gun color TV picture tubes with more slender necks, Superior Tube Company has developed new, "miniature" disc cathodes.

With length reduced by .092" and diameter of ceramic by .125", they require only half (in some cases) the heater power of cathodes used in monochromatic tubes. Yet they actually give equal or better emission. The regular Superior Tube advantages—wide choice of materials, close control of "E" dimension—are also offered on these new smaller disc cathodes.

For technical information on fine small tubing for electronic applications, write for Data Memos 5 and 19, Superior Tube Company, Electronics Division, 2030 Germantown Ave., Norristown, Pa.

SUPERIOR TUBE
THE BIG NAME IN SMALL TUBING
All analyses .010" to 1/4" O.D.
Certain analyses in light walls up to 2 1/4" O.D.
Combining the best features of metal clips with the advantages of nylon, Burndy molded nylon cable hangers weigh 70% less than metal cable clips of comparable size, yet have sustained loads of more than 500 lbs., in the larger sizes. Extremely flexible, these nylon cable hangers are preformed, for ease of installation, requiring no shaping or forming on the job and retaining their shape permanently. Resistant to sustained temperatures from −60°F to 250°F, these cable hangers are unaffected by oils, gasoline, alcohol, or hydraulic fluid. An insulator itself, this type of cable hanger cannot cause grounds or short circuits and is free from hysteresis losses. Smooth, rounded-edge, non-abrasive surfaces facilitate installation and prevent injury to insulation.

For information on Burndy nylon cable hangers, write Department ED, BURNDY, Norwalk, Conn.

CIRCLE ED-131 ON READER-SERVICE CARD FOR MORE INFORMATION

DC-AC CHOPPERS
For 60 Cycle Use

Built to rigid commercial specifications.
Twenty-two types, both single and double pole.
Write for Catalog 370.

Linear Accelerometers
Withstand Wide Temperature Range

This series of linear accelerometers in ranges from ±0.5g to ±15g is designed to satisfy the need for acceleration transducers that perform reliably under variable temperature conditions, such as are encountered in flight operations. Operation through the ambient temperature range of −65° to ±120° is afforded by means of an electrical heater jacket with a peak power input of approximately 20w to 30w.

Illustrated is the Model A17 accelerometer, which is offered in ranges from ±1g to ±15g. The transducing element is the Statham unbounded resistance strain gage. Statham Laboratories, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

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

D-C Power Supply
Precision Laboratory Unit

This “super-precision” d-e power supply is designed for laboratory applications requiring very closely-regulated power. Designated the Model D3-300-E Multiple Power Supply, it is actually four power supplies in one.

One supply output is rated from 0 to 300v d-e, at 300ma. Regulation from no-load to full load is 0.003v load variation (0.001%). Ripple is 0.01milliv. A second output is identical, except for a current of 150ma.

Another rating of the supply provides continuously variable voltage from 0 to −150v, negative in respect to Output No. 2, with maximum current of 5ma regulated to line voltage but delivered through a 25,000 ohm, 10-turn “helipot”. A fourth output provides continuously adjustable, unregulated filament voltage, 0 to 10v a-e at 10 amps maximum. Dressen,Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena 8, Calif.

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

NEW ALL-METL VIBRATION ISOLATORS
Operate at Extreme Temperatures

New, miniature, ALL-METL BARRY MOUNTS — Series M24 — have been added to the Barry line. The stainless-steel spring and wiremesh construction of this tiny, new mount enable it to provide excellent isolation at extreme high or low temperatures. The M24 series meets all pertinent requirements of MIL specifications, as also do the larger M44 and M64 ALL-METL BARRY MOUNTS.

The weights and load ranges of ALL-METL BARRY MOUNTS are:
- miniature Series M24 — 1/2 oz., 9 load ratings covering range of 0.1 to 3 lbs.; JAN-size 1, Series M44 — 1/2 oz., 6 load ratings covering range of 1/2 to 10 lbs.; JAN-size 2, Series M64 — 4 1/4 oz., 8 load ratings covering range of 2 to 40 lbs. Write for Product Bulletins 542(M24), 534(M44), or 536(M64).

Special and standard mounting bases using any of these three ALL-METL BARRY MOUNTS can be furnished; detailed recommendations on request.

BARRY CORP., 775 Pleasant St., Watertown 72, Mass.

CIRCLE ED-135 ON READER-SERVICE CARD FOR MORE INFORMATION

SAVE
with MILWAUKEE ECONOMY RESISTORS

These “super-precision” d-e power supply is designed for laboratory applications requiring very closely-regulated power. Designated the Model D3-300-E Multiple Power Supply, it is actually four power supplies in one.

One supply output is rated from 0 to 300v d-e, at 300ma. Regulation from no-load to full load is 0.003v load variation (0.001%). Ripple is 0.01milliv. A second output is identical, except for a current of 150ma.

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

CIRCLE ED-136 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Magnetic Fluid Clutch
High Torque, Smooth Action Device

The 731B Magnetic Fluid Clutch is for use as a clutch element in reversing or speed changing transmissions, as a precision take-up device, and for many other applications. It utilizes a grease-like lubricant in which extremely fine magnetic particles are suspended. The application of a-c to the coil may be made from the plate of conventional vacuum tubes or suitable rectifiers. This causes the fluid to "stiffen" in proportion to the current. The fluid thereby acts as a clutch "lining", and the varied current produces torque much like the varied clutch pressure of a conventional clutch.

The clutch allows for 40w of heat dissipation and develops up to 50 in-lb of torque. At the maximum recommended speed of 800rpm, it can transmit up to 475w (2/3hp). The standard coil resistance is 1700 ohms, and a coil current of 75ma gives full torque, thus delivering a power gain of 50 at 800rpm.

Ball bearings and fluid seals result in a high precision device with high torque, smooth action. Weight is only 3-1/2 lbs. Size is 3-1/4" diam x 3-49/64" overall length. Raymond Engineering Laboratory, Inc., Dept. ED, Middletown, Conn.

Boro-Carbon Resistors
Meet Specification MIL-R-10509A

Known as the "Borohm" series, a line of 1/2, 1, and 2w boro-carbon resistors exceed all requirements of MIL - R - 10509A. Characteristic “R” as proved by temperature cycling, moisture resistance, and load life tests. The units have a tough epoxy resin coating that withstands rough handling.

Three styles are available. Type BC20 is rated 1/2w, Type BC25 is rated 1w, and Type BC30 is rated 2w. Standard resistance tolerances are 1, 2 and 5% with stability averaging 0.2% after 1000hr load life tests. Shallercross Manufacturing Co., Dept. ED, Collingdale, Pa.
Vacuum Tube Voltmeter
Has Wide Frequency Range

The Model 400D high accuracy vacuum tube voltmeter covers all frequencies from 10ey to 4 Mc. It measures voltages from 0.1 mv to 300, and is accurate to within 2% up to 1 megohm. Input impedance is 10 megohms so circuits under test are not loaded. The instrument has an additional circuit providing approximately 56 db of feedback in mid-range for high stability and freedom from calibration changes caused by external conditions.

Ranges are selected on a front panel switch that changes sensitivity in accurate 10 db steps. This switch plus calibration of the 4” meter directly in decibels means direct readings are available without calculation or conversion between -72 dbm and +32 dbm. Readings are always in the upper part of the scale where maximum accuracy is obtained.

In addition to measuring gain, response and output level, the voltmeter measures hum and noise directly, determines power circuit and broadcast high frequency voltages, serves as an audio level meter and high gain broad band amplifier, detects nulls, monitors waveforms, and measures coil “Q”, capacity, and resonance. Hewlett-Packard Co., Dept. P, 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE ED-145 ON READER-SERVICE CARD FOR MORE INFORMATION

New RF Choke Kit
Contains 14 pie-wound chokes

Chokes are on LPB-3 forms, which have axial leads and are only 1/8” in diameter by 1/2” long. Windings are 3/8” wide, varying up to 1/2” approximately in diameter. All units varnish-impregnated for moisture and fungus-proofing. Inductances are RMA preferred values from 6.8 microhenries to 1.0 millihenry, with color-coding enabling easy recognition of values.

Modern packaging adds to the advantages of the kit for laboratory or experimental use. Supported in a foam plastic block, the chokes are protected from damage in transit and can easily be removed and reinserted. Block fits on any flat surface. Chart on inside cover of kit gives necessary electrical data, plus C.T.C. part numbers for ordering separately or in bulk. Kit price is $4.25 F.O.B., Cambridge, net 30. Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Mass.

CIRCLE ED-150 ON READER-SERVICE CARD FOR MORE INFORMATION

Sampling Switch
Only 2” diam x 1” long

Contact plates molded with high quality mica-filled resin are employed in this high-speed precision switch. The design shown measures only 2” diam x 1” long. It is made in the same way as larger and subminiature commutators of standard form used for telemetering, thermocouple correction of multiple amplifiers, and for other uses.

Switches are available with any of a large variety of contact materials selected according to the application, and with a variety of features, such as number of contacts, number of poles, and sampling rates. They can be supplied with single or double-ended shaft, or integrally mounted with driving motor.

General Devices, Inc., Dept. ED, P.O. Box 253, Princeton, N.J.

CIRCLE ED-146 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Single-Sideband Filter

Utilizes Toroid Coil

The Type S-15000, a low-cost, single-sideband filter, utilizes a toroid coil instead of costly crystal filters. It is similar to this firm’s SSB filters and is designed to be a mass-produced SSB filter for incorporation into new designs by set manufacturers.

The filter features compact size and ease of installation. Fixed tuned and hermetically sealed, it requires no adjustment, is rugged and trouble-free. It may be installed in any existing amateur receiver now in use. It makes possible long-range reception with reduced interference and distortion not only of SSB signals, but of all a-m transmission. It utilizes 50ke as a 2nd i-f, and provides a narrow-band, sharp cut-off response which insures maximum intelligibility and maximum signal intensity. Burnell & Company, Dept. A, 45 Warburton Ave., Yonkers, N.Y.

CIRCLE ED-151 ON READER-SERVICE CARD FOR MORE INFORMATION

ANOTHER NEW FAIRCHILD POTentiometer

TYPE 751

7/8” LINEAR

The small size – 1/4” diameter, 0.693” length (from front of servo flange to rear of case) – and the 13-gram weight, make the Type 751 the perfect transducer for guided missile systems. Internal clamp rings permit ganging without increasing over-all diameter – length is increased only 1/16” for each added cup. Standard linearity is ±0.5%, in a resistance range of 400 to 20,000 ohms, with a maximum resolution of 0.071%. Terminals are gold-plated for reduced contact resistance and easier soldering.

SAMPLES AVAILABLE ON ORDER

The Type 751 is another important reason why Fairchild can help you solve all your precision potentiometer problems. For more information write Fairchild Camera & Instrument Corporation, Potentiometer Division, 225 Park Avenue, Hicksville, L.I., N.Y., Dept. 140-52.

CIRCLE ED-154 ON READER-SERVICE CARD FOR MORE INFORMATION
Perfect balance makes Push Button CASTELL LOCKTITE Holder the king of its class.

Exclusive collet holds lead in bull dog grip, preventing slipping or turning.

No graphite dust stains your fingers—because with one-hand push-button action you extend and retract the lead. No need to touch graphite. Comfortable "wood-pencil" feel—not metallic.

Equipped with easily-replaced clutch, giving your LOCKTITE indefinite life.

Imported CASTELL 9030 Lead inserted in your LOCKTITE Holder gives you the combination for brilliant results on your drawing board. Ask your Dealer for both—LOCKTITE Holder and Imported CASTELL 9030 Lead in 19 degrees, 7B to 10H.

CIRCLE ED-155 ON READER-SERVICE CARD FOR MORE INFORMATION

**Now Constant Stability of Tolerances at 1,500,000 Cycles!**

**BASIC SWITCH**

Gives You More Than Just Long Life!

- Maintains accurate repeatability and positive snap-action...even at 1,500,000 cycles and over!
- Durable, compact plastic case permits greater flexibility of application. Available in a wide selection of models, including "reset". Rated at 10 amps 125/250 v. AC, 50 v. DC inductive.

WRITE FOR DETAILS IN DATA SHEET 575-9

CIRCLE ED-156 ON READER-SERVICE CARD FOR MORE INFORMATION

**Reference Gyro**

**Reaches Control Speed in 10sec**

The Model 221 airborne reference gyro accelerates to operational control speeds in only 10sec. It is designed to withstand extreme acceleration and shock up to 60g. It will successfully operate, without excessive drift, during vibration up to and including 10g at 1500cy.

The unit is a two-degree-of-freedom gyro that measures displacement about two axes by means of a pickoff placed on each gimbal axis. Use of an electrically operated caging device permits the caging cycle to be completed in 4sec for normal displaced positions. With the gimbal displaced 180°, maximum caging time is 20sec. The gyro can be completely uncaged in less than 0.1sec.

The unit is offered with either a 28v d-c, a 115v d-c, 400cy single phase, or a 115v d-c, 400cy three-phase power supply. Pickoffs are supplied as either potentiometer type or a special "pancake" type precision synchro. Maximum drift will not exceed 0.1° per minute in either a-c or d-c units. The unit with a-c pickoff is contained in 3-1/2" diam x 5-1/8" long case. Length with d-c pickoff is 5". Weight is 4-3/4 lb. Summers Gyroscope Company, Dept. ED, 2328 Broadway, Santa Monica, Calif.

CIRCLE ED-157 ON READER-SERVICE CARD FOR MORE INFORMATION

**Square Wave Generator**

**For Testing Wide Band Amplifiers**

A new generator, Model 183, provides square waves suitable for testing the transient and frequency response of wide band amplifiers, and accurately measures their amplitude. The frequency range is from 10cps to 1ME, continuously variable over decade steps.

This unit has a low impedance output which provides 10v, peak-to-peak. At high impedance, 100v, peak-to-peak, is available. A 60db step attenuator and a 20db continuous attenuator (which do not affect wave shape) provide means of using the generator as a voltage calibrator. New London Instrument Co., Dept. ED, P. O. Box 189, New London, Conn.

CIRCLE ED-158 ON READER-SERVICE CARD FOR MORE INFORMATION

**low-priced, HIGH QUALITY Vacuum-Tube Voltmeter**

- A-C OPERATED
- 0.1 v to 150 v, a-c, in 5 ranges to 100 Mc
- Completely-Shielded Probe
- Large and Easily Read Meter
- Accuracy of 3% Full Scale on All Ranges
- Minimum Meter Variations with Line-Voltage Changes

**Type 1803-A Vacuum-Tube Voltmeter**

$155

CIRCLE ED-159 ON READER-SERVICE CARD FOR MORE INFORMATION

**THINKING OF EXPANDING YOUR PLANT? MAKE CONTACT WITH THE DAYTONA BEACH FLORIDA AREA!**

Here are a few of the outstanding advantages this area offers:

- Abundant labor supply
- Proximity to domestic and international markets
- Fast dependable transportation
- Moderate year-round climate
- Ample power and water
- Choice industrial sites
- Buildings available through community Industrial corporation

Write for free 42 page industrial brochure

INDUSTRIAL DEPARTMENT
Room 2, Chamber of Commerce
Daytona Beach, Fla.

CIRCLE ED-160 ON READER-SERVICE CARD FOR MORE INFORMATION
trifles make PERFECTION ... but PERFECTION is no trifle

3½ oz of perfection ... is VITAL to 61 TONS of MAGNIFICENT PERFORMANCE

When the mighty giants of the air lift their massive wings to fly, a thousand and more "tremendous trifles" instantly go to work in harmonious union to give life and power. It is the perfection of these "trifles" that makes possible the magnificent performance of today's luxurious aircraft.

The EL MENC0 Capacitor — CM-15 — is one of these "tremendous trifles" that plays such a vital part in the efficient operation of aircraft communication.

EL MENC0 IS THE ONE OUT OF MANY CHOSEN FIRST

Whether you use our high capacity CM-42 (10-25,000 mfd) or our moderate capacity CM-15 (3-525 mfd) you have guaranteed assurance of job-tested, job-rated capacitors — tremendous trifles of perfection so vital to the magnificent performance of YOUR product.

ELECTRO MOTIVE is now supplying special silvered mica films for the electronic and communication industries — just send us your specifications.

MAGNIFICENT ELECTRICAL of a reed able better Frahm 500 ... is number

50 provides Molded relay than it will capacities. none

ing CM-15/16 = .133 x .313 x .813"

CM-42

Made to Meet All MIL-C-5 Requirements. Largest Molded
Mica Capacitors of Wire Terminal Type. 13/16" x .133 x .813"

CIRCLE ED-163 ON READER-SERVICE CARD FOR MORE INFORMATION

Here is a pair of "Problem-Solvers" For Designers of Electrical Control Systems

FRAHM REED RELAYS 

FRAHM OSCILLATORS

Frahm Resonant Reed Relay is an electro mechanical device which responds to an alternating signal having frequency and amplitude values that lie within specified bands. A number of control signals over a single circuit is possible with all types of communication circuits, including radio. A signal is transmitted either on a wire line, or as a modulated carrier to some remote location where it operates a reed relay to indicate the control function at that point. Since each reed relay will respond only to a narrow band of frequencies, it is possible to operate a number of relays simultaneously by making use of an equal number of source generators arranged so that none of the operating frequency bands overlap. In a range of 200 to 500 cycles it is possible to operate up to 16 channels with no interference.

Frahm Oscillator controls are miniature tuning forks for use in electronic oscillators to provide stable output frequencies. Their use gives sine wave signals with output better than 1 volt can be obtained. They are available for any frequency in the range of 50 to 1000 cps with accuracies better than 0.2%. A series of standard units is available to match the standard Frahm Reed Relays.

New Products...

Transformers

Miniature Plug-In Designs

These audio transformers are built into a molded octal base 1-15/32" high x 1-1/32" diam. To assure maximum leakage resistance, they are embedded in a high melting point resin. They have the same nominal ratings as this firm's previously cataloged items. On special order, they are available with buss-type leads to enable use in printed circuits; the lead size varies from #22 for the "Miniature" size transformer, to #26 for the "Veri-Miniature" type.

Units of this type are being used in guided missile and encapsulated construction, as well as for radio paging and hearing aid applications. Microtran Co., Dept. ED, 84-11 Rockaway Beach Blvd., Rockaway Beach 93, N. Y.

CIRCLE ED-165 ON READER-SERVICE CARD FOR MORE INFORMATION

Delay Line

Provides 0-1.2 μsec Delay

The Model V-104 Delay Line provides a variable delay of from 0-1.2 μsec. The delay is obtained with a lumped-constant circuit consisting of 60 coil and capacitor sections. The delay of each section is 0.02 μsec. A 60-contact rotary switch is used to tap the delay line at the desired delay. Since the switch is of the shorting type, an incremental delay of 0.01 μsec is obtained with the switch in the shorted position, thus providing 120 steps.

Overall accuracy is ±5%. The rise time varies with delay from less than 0.02 μsec to approximately 0.04 μsec. Nominal impedance is 2700 ohms.

The unit is useful as a laboratory instrument for all types of pulse work, including computers, radar, television, etc., and can be used accurately to provide and measure phase shifts. It may be connected in series with other units of the same impedance manufactured by this company. Other models, both fixed and variable delay types, are available. Control Electronics Co., Inc., Dept. ED, 1925 New York Ave., Huntington Station, N. Y.

CIRCLE ED-166 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN  September 1954
The new "Radalyzer" gain measuring set has a 30Me i-f for low low-level microwave measurements. It has the following features: gain-loss measuring range is 0 to more than 60db vswr; 0 to more than 60db insertion loss or gain; receiver frequency of 30Me; and operating (signal) frequency range from 10Me to 10Me (furnished by external equipment under test).

Input rating is 50mv maximum at 30Me into a 50 ohm line. Attenuators are 0-101 db (steps—1, 2, 3, 5, 10, 20, 20, 20). The unit has a 0-100 db precision 10-turn potentiometer, calibrated. Regulated voltages are furnished for two external klystrons by the power supply. Pre-amp gain is linear over input level changes of more than 60db. Kay Electric Company, Dept. ED, 14 Maple Ave., Pine Brook, N. J.

CIRCLE ED-170 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Voltmeter
For 5-150kc Carrier Measurements

A compact precision-built voltmeter, the Model 104 is designed for measurements on communication systems. It covers a frequency range from 5kc to 150kc and has a frequency calibration accuracy of + 1kc. The signal measurement range is 

-0.42 to +0.42 dbm at 600 ohms impedance, and signal measuring accuracy is +0.5 db over the range -70 +42 dbm.

Input impedance is 10,000 ohms in the pass band, and is appreciably higher in the rejection band. The instrument has unusually high selectivity; response is down 3db at 300cy of resonance, 45db at 1,500cy of resonance. It reads direct in dbm, and is designed for operation into an unbalanced 600 ohm line. It may be converted quickly to balanced operation for 155 ohm or 600 ohm balanced line measurements with the Model 155 Line-Bridging Transformer. This transformer may be readily plugged into the input terminals on the front panel. Sierra Electronic Corporation, Dept. P, 1050 Brittan Ave., San Carlos 2, Calif.

Power Supply
Provides Constant Current or Voltage

The "Spineo Duostat" provides facilities for both constant - current and constant-voltage operation. Energized from a standard 115v 50/60cy power outlet, it can provide currents from 5ma to 50ma, automatically regulated to ±2% at voltages from 100v to 500v. In its constant voltage mode of operation, it is self-regulated to ±1% from 160v to 500v, over a load current range of 0 to 50ma.

Output is relatively unaffected by line voltage changes between 105v and 150v. Housed in a portable metal cabinet measuring 9-1/2" x 10-1/" x 9-1-2", it has a top-mounted carrying handle and weighs 11.1 lbs. Specialized Instruments Corp., Dept. ED, 532 O'Neill Ave., Belmont, Calif.

Electrical Noise in Wire-Wound Potentiometers

BY IRVING J. HOGAN
Research and Development Division
Helipot Corporation

Presented at the 1952 WEST COAST I.R.E. CONVENTION

397

CIRCLE ED-173 ON READER-SERVICE CARD FOR MORE INFORMATION

3 Soldering Operations in 1 Easy as ABC with KESTER "SOLDERFORMS"

A Solder screws and nut to the cover, "Solderform" Box & Rings 5% Silver 65 Lead Alloys, Melting Point 60°F.

B Solder glass terminals to cover, "Solderform" Rings 65% Tin 35% Lead Alloys, Melting Point 30°F.

C Hermetically sealed cover on one, "Solderform" Ring 95% Tin 5% Lead, Melting Point 350°F.

Here's a typical example of a tough resistance soldering job involving progressively lower melting temperatures. Kester "Solderforms" made sure this high precision oscillator coil came through every test successfully.

WRITE TODAY for free "Solderform" samples and literature.

KESTER SOLID COMPANY
4266 Weighwood Avenue • Chicago 29, Illinois
Newark, New Jersey • Brampton, Canada

CIRCLE ED-174 ON READER-SERVICE CARD FOR MORE INFORMATION

here's what DIE CAST CAST ZINC ALLOY THREADED FASTENINGS mean to you...

in terms of a better product, in terms of a more economical product!

Every Quality Feature is an Economy Feature!
- The plain bright finish does not require further surface finishing for most applications
- Closer tolerances • Cleaner threads
- Greater dependability, durability • Die-cast uniformity
- LOWER PRICED!
- NON-FERROUS • RUST-PROOF
- CORROSION-RESISTANT

Quick deliveries from stock • Specialized to order

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CIRCLE ED-178 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • September 1954
Plastic Panels

For Edge Lighting Uses

These edge-lighted plastic panels are for a wide variety of electronic equipment-mounting applications. They are highly durable due to a special molded laminate process, and are practically impervious to scratches and nicks which might cause light leakages. The panels are accurately sized, and the molded edges are an integral part of the front and back. The recessed engraved lettering is easy to clean.

Suggested uses for the rugged panels are in aircraft, mobile police transceivers, radio, television, and other broadcasting equipment.

The panels meet requirements of MIL-P-7788, including the tests for temperature change, humidity, moisture, salt spray, vibration and shattering, parallel, gloss, contrast, and altitude. The firm also produces a complete line of lighted or plain dials and knobs, which are equal in durability to the panels. Knobs and dials are made to match the panels, if desired. Kerroco Products, Dept. ED, Box 414, Hastings, Nebraska.
accurately positions heavy duty equipment by means of minute electrical signals

This Electro-Hydraulic Servo System is ideally suited for industrial controls to maintain flows, ratios, levels, pressures, speeds and for machine tool positioning. It is a 5½" cube self-contained unit and weighs but 12 pounds.

The Kearfott Electro Jet utilized the Askania jet pipe principle, characterized by high frequency response, rugged construction and highly accurate shaft positioning. Rated output is 200 inch pounds torque through ±60 degrees. Maximum torque rating is 333 inch pounds. Frequency response is flat (within 3 db) up to 25 cycles. Resolution of the output piston positions is one part in 500 or better.

Write today for full information about the Kearfott Electro Jet. It may help in the solution of your control problem.

KEARFOTT COMPONENTS INCLUDE:

Send for Bulletin giving data of components of interest to you.

CIRCLE ED-185 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Printed-Wiring Boards
With Pre-Punched Holes

To avoid the need for special tooling for punching the necessary holes in a printed-wiring board, designers can utilize pre-punched standard boards known as "Quad-Kards". Furnished in standard 2" square segments with or without conductors printed to specification, Quad-Kards have standard hole punchings for tube sockets, transformers, and capacitors, plus a grid pattern of 0.050" diam holes on 1/4" centers for conductors.

These boards may be abutted, angled, or stacked during incorporation into finished assemblies. Methode Manufacturing Corp., Dept. ED, 2021 W. Churchill St., Chicago 47, Ill.

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

Meter Mechanism
With Gyro-Like Stability

The mechanical design of this meter mechanism provides performance stability typical of that of a gyro. It is especially applicable in aircraft instruments and similar applications where the effects of vibration and rapid attitude changes must be considered.

Designed to develop maximum torque for a given volume of magnetic material, the mechanism employs an end-pivoted coil assembly with a one-piece bearing shaft and precise mechanical assembly that operates in a self-shielded magnet structure. This construction produces approximately 6000 gauss in a single air gap. Operation of the moving coil, of long turning radius, in a magnetic field of such strength, achieves gains in torque and eddy current damping.

Performance characteristics of the new mechanism also suggest application as the sensitive element in control devices where it is required to initiate a control function. Marion Electrical Instrument Co., Dept. ED, 400 Canal St., Manchester, N. H.

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

POPULAR DIALS AND KNOBS

For years, NATIONAL dials and knobs have been the popular choice of amateurs, experimenters, and commercial users. NATIONAL dials feature smooth, velvet action, easily-read scales and quality construction. Many dials, like the Ni-ACN dial shown, can be specially calibrated or supplied with blank scales for commercial applications.

NATIONAL knobs—distinguished by their clean, functional, chrome and plastic styling and sturdy construction—are the most popular of their type ever produced. All fit 1/4" shafts. For commercial applications, they can be supplied in special colors and with special calibrations.

Write for new NATIONAL catalog of dials and knobs to Dept. ED-954

CIRCLE ED-188 ON READER-SERVICE CARD
TV-Receiver Tubes
For "Series-String" Circuits

Twenty-six vacuum tube types designed for "series-string" operation in TV receivers feature a common heater current of 600ma at a variety of heater voltages ranging from 2.35v to 25v. The tubes, with their prototype with the same electrical characteristics given in parentheses, are as follows: 2AF4 (6AF4), 3AL5 (6AL5), 3AU6 (6AU6), 3BC5 (6BC5), 3BE6 (6BE6), 3CB6 (6CB6), 4BQA7 (6BQA7), 4BZ7 (6BZ7), 5AN8 (6AN8), 5AS8 (6AS8), 5T8 (6T8), 5U8 (6U8), 6AU7 (12AU7), 6AX7 (12AX7), 6BA1 (6BA1), 6B4 (6B4), 6BQ6GT (6BQ6GT), 12BH7A (12BH7), 12L6GT (25L6GT), 12BY7A (12BY7), 12W6GT (6W6GT), 19AU4 (6AU4GT) and 25CD6GA (25CD6G). Tung-Sol Electric, Inc., Dept. ED, Newark 4, N. J.

CIRCLE ED-189 ON READER-SERVICE CARD

Name Plate
Flexible Yet Tough

Designed for use as a name plate, a laminated plastic called "Gravoflex" is flexible yet scratch-proof, weather-proof, and stain-proof. It can be bent by hand to any shape. Being a sandwich material, it is easily engraved with any pantograph machine. Lettering cut through the top layer will stand out permanently on a contrasting background.

The material can also be stamped or embossed. It can be cut with an ordinary scissor, paper cutter, or metal shears. Edges will not chip, and they do not require bevelling. It can be nailed without pre-drilling, and can also be stitched or stapled. Gravoflex is available in sheets, strips, or cut name plates in various thicknesses. The colors are black surface with white core, or white surface with a red core. Hermes Plastics, Inc., Dept. ED, 13-19 University Pl., New York 3, N. Y.

CIRCLE ED-190 ON READER-SERVICE CARD

CIRCLE ED-191 ON READER-SERVICE CARD

PATENT PENDING
ALL RIGHTS RESERVED

AVAILABLE IN A WIDE RANGE OF STANDARD TYPES TO ECONOMICALLY MEET SPECIAL REQUIREMENTS!

Economical E-I standardized hermetically-sealed terminals and miniature closures are available to meet almost any electronic application. Samples and recommendations on your particular needs will be supplied promptly on receipt of your data. Call or write for complete E-I catalogs, today!
hermetically-sealed terminations and miniature closures

- **MULTIPLEX HEADERS**—Stain-free, cushioned glass construction. Silicone treated for maximum dielectric strength and tin dipped for easy soldering.

- **SEALED TERMINALS**—These E-I terminals offer high thermal shock resistance and feature cushioned glass construction. Available in many economical-preferred types and special designs.

- **OCTAL HEADERS**—Both plug-in and multiple types feature a new principle of hermetic sealing. Solid metal blanks afford maximum rigidity and mechanical strength.

- **E-I END SEALS**—Completely strain-free. Provide a permanent hermetic seal. For condensers, resistors and other tubular-type components. Available in many standard types.

- **COMPRESSION TYPE HEADERS**—Super rugged, practically indestructible and absolutely rigid. Exclusive E-I process affords increased resistance to shock and vibration.

- **LUG-TYPE, LEAD-THRU INSULATORS**—Compression sealed, super rugged. For applications requiring voltage ratings from 2000 to 4000 (rms.)—transformers, "bath-tub" condensers, etc.

- **MINIATURE CLOSURES**—For transistors and other components requiring hermetic sealing. Square, rectangular and round cases. Supplied in E-I standard types or custom designs to specifications.

- **COLOR-CODED TERMINALS**—Featuring glass inserts with permanent coloring in the glass. All types offered in standard, easily-identified RMA color codes.

**ELECTRICAL INDUSTRIES**
44 SUMMER AVENUE, NEWARK 4, NEW JERSEY
DIVISION OF AMPEREX ELECTRONIC CORP.
New Products...

Piezoelectric Ceramic
Formed Into Any Shape

Designated “Ceramelex”, this polycrystalline barium titanate ceramic performs in much the same manner as the natural piezoelectric crystals. It can be formed and polarized in any shape.

Polarized discs of this material have a very high coupling coefficient and are low-impedance devices because of their high dielectric constant. A “Ceramelex” Kit is available to design engineers. It contains 17 discs and cylinders of various sizes, with and without metal contacts, a research paper on the properties of the ceramic, and application notes.

Erie Resistor Corp., Dept. ED, Erie, Pa.
CIRCLE ED-193 ON READER-SERVICE CARD

Insulating Compound
Protects Tool Handles

Featuring a dielectric strength per coating of 1200 to 1500v, “E-33”, a dipping compound, is easily applied to tool handles. Available in either red or black, the compound can be used in the laboratory to coat electrical tools such as screwdrivers and pliers. The compound is chemically inert and is not affected by oils, greases, or ordinary acids or alkalies.

Insl-X Sales Co., Dept. ED, 26 Rittenhouse Sq., Ardmore, Pa.
CIRCLE ED-194 ON READER-SERVICE CARD

Random Noise Generators
Noise Output is 15.8db

Additions to this firm’s line of “Microwave Mega-Node” random noise generators employ new gas tubes. These tubes have approximately zero temperature coefficient and are independent of operating temperatures. Units with frequency ranges from 1200Mc to 26,500Mc are available. Accuracy is ±0.25db. Noise output is 15.8db.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pin Brook, N. J.
CIRCLE ED-195 ON READER-SERVICE CARD
CIRCLE ED-196 ON READER-SERVICE CARD

OTHER G-E CAPACITOR FIRSTS
★Thin kraft-paper dielectric
★Pyranol* liquid impregnant
★Drawn-oval capacitors with double-rolled seams
★Silicone bushings with stud-welded construction
★Permafil solid impregnant

General Electric announces another
NEW DRAWN-RECTANGULAR CAPACITORS

* Solderless, double-rolled cover seam
* Seamless case with standard dimensions

To answer the needs of the electronics industry, General Electric's capacitor engineers have developed a fixed paper-dielectric capacitor in a seamless, solderless case with standard dimensions. Because these new capacitors are the same sizes and have the same mounting dimensions as fabricated units, they can be applied to existing electronic equipment without changing component layouts.

**Drawn construction** offers the user important advantages. The seamless case is virtually leakproof. There is no dependence on solder for mechanical strength and effective sealing. The double-rolled seam between case and cover further assures a true hermetic seal.

**G-E Drawn-rectangular capacitors** can be supplied with suitable bushings for a wide range of voltage ratings or special applications. The new units comply with or exceed MIL specifications.

**Proof of the dependability** of the rugged construction of these new drawn-rectangular capacitors can be found in another General Electric pioneered development, the drawn-oval capacitor, of which there are more than 55 million being used in electrical and electronic equipment today.

For further information contact your nearest G-E Apparatus Sales Office.


* Reg. trademark of General Electric Co.

**Progress Is Our Most Important Product**

GENERAL ELECTRIC

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**Computing Service**

**Formulates and Solves Problems**

A group of highly trained mathematicians offers a service featuring the mathematical formulation and complete solution of a problem from given physical data. Charts and monographs of a high degree of complexity for the solution of electronic design problems can be prepared. Problems can be submitted for an estimate. Mathematical Computing Service, Dept. ED, 105 Court St., Brooklyn 2, N. Y.

CIRCLE ED-197 ON READER-SERVICE CARD

**Power Transistor**

**Collector Dissipates 500mw**

The Type HD-197 p-n-p germanium junction transistor is capable of 500mw collector dissipation without the use of a heat sink. Suitable for switching circuits, class B circuits, and servomechanisms, the unit has a base-to-collector current gain of 10.

Power gain, measured in a grounded-emitter circuit with an input impedance of 100 ohms and a load impedance of 5000 ohms, is 30db. Cutoff frequency is 150kc. Maximum operating temperature is 55°C. CBS-IVtron, Div., Columbia Broadcasting System, Dept. ED, Danvers, Mass.

CIRCLE ED-198 ON READER-SERVICE CARD

**Cement**

**Has High Strength**

Applied with moderate heat and little or no pressure, "Tygowieid", an organic cement, makes metal-to-glass, metal-to-porcelain, and metal-to-metal bonds that surpass high peel and shear tests. The bonds have been subjected to tensile strength tests where over 4000 lb/sq-in has been applied to standard lap shear specimens.

The following materials can be successfully bonded to themselves or to each other: aluminum, cast iron, copper, magnesium, sintered metals, ceramics, fiberglass, thermosetting plastics, wood, and nylon. It is furnished in rod, paste, or powder form with special colors and filleting characteristics available. U. S. Stoneware Co., Dept. ED, Akron 9, Ohio.

CIRCLE ED-199 ON READER-SERVICE CARD

< CIRCLE ED-196 ON READER-SERVICE CARD
PIONEER
IN WESTERN ELECTRONICS

IF IT'S AN ELECTRONIC PROBLEM — SIMPLE OR COMPLEX — IF IT CALLS FOR RESEARCH, DEVELOPMENT OR PRODUCTION —

CALL

HOFFMAN *

THE INTEGRATED ELECTRONICS OPERATION

Yes, Hoffman has established itself as a leader in the rapidly growing electronic industry in the West by doing progressively complex jobs — on schedule — to specifications — and to cost estimates.

Hoffman Laboratories, Inc., is engaged in projects covering every phase of electronics — radar, sonar, guided missile controls, countermeasures, fire-control apparatus, noise reduction, communications, navigation equipment, computers. Its long list of contributions to the electronics industries and to our national security is dramatic evidence that now, as in the past decade, Hoffman Laboratories gets things done.

Hoffman has the facilities to design, develop, test and produce this equipment — with the added advantage of being located in the heart of the airframe and missile industries. Its close liaison with the research centers, air-frame plants, military installations and test sites in this area means that Hoffman gets things done — on the spot where they’re most needed.

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electronics leader in the heart of
The Air-Frame Industry Electronics Research Guided Missile Development Military Test Sites

Challenging opportunities for outstanding electronic and mechanical engineers. Write Director of Engineering.

*Call Hoffman at Richmond 7-9661 in Los Angeles

New Products...

Rubber Coating
Vulcanizes Without Heat

Applied like paint by brush, spray, or dipping, "Rub-R-ize" is a liquid natural rubber that vulcanizes at normal temperatures into a flexible protective coating resistant to both heat and cold. It has the same insulation qualities as natural rubber.

The coating can be used to impregnate printed-circuit boards, insulate high-voltage cables, chassis, and antennas, protect components against humidity, and be used on phonograph turntables instead of flock. In the laboratory it can be used to repair frayed line cords, insulate tool handles, insulate the edges of work benches against grounding, and to coat leads instead of spaghetti. It can also be used as a sound absorbant material in bass reflex cabinets. Rubber Magic, Inc., Dept. ED, 4312 Third Ave., Brooklyn 32, N. Y.

CIRCLE ED-201 ON READER-SERVICE CARD

Photosensitive Metal Sheets
For Nameplates and Dial Faces

Photosensitive, anodized-aluminum sheets known as "Metalphoto" are designed for photographic reproduction by standard darkroom methods. The sheets can be used for nameplates, dial faces, wiring diagrams, instructions, instrument and sliderule scales, and other products where resistance to abrasion is vital.

Photographs and drawings are processed from ordinary photographic negatives. The image or written matter is sealed behind the hard, anodized layer. This layer protects the dimensionally stable image from abrasion, temperatures up to 1000°F, as well as acids, salts, and organic solvents.

The sheets, which measure 0.020" in thickness, are furnished in 4" x 5", 8" x 10", and 10" x 12" sizes. The sheets may be colored with the proper dyes. Metalphoto Corp., 2903 East 79th St., Cleveland 3, Ohio.

CIRCLE ED-202 ON READER-SERVICE CARD

< CIRCLE ED-200 ON READER-SERVICE CARD
D-C Solenoids
Miniature Types

Type 20288 and 20287 solenoids are designed for applications requiring d-c solenoids considerably smaller than standard types. The former has a coil enclosed in a steel cylinder and the latter an open coil. They may be used for the operation of keyboards, light springs, control board signal flags, etc.

They measure 3/4" diam x about 1-1/2" length. Either may be wound for a wide range of d-c voltages. Their weights are 0.122 and 0.141 lb., respectively. The nylon bobbin is used as a bearing surface, thus providing self-lubrication as well as excellent insulation. Armatures are of high-grade soft iron.

An example of pull characteristics is the 24v, 13amp type which is operated on intermittent duty, 5sec max on at 20°C ambient to pull 25 oz. for a 3/4" stroke. Cannon Electric Co., Dept. ED, 418 West Ave. 33, Los Angeles 31, Calif.

CIRCLE ED-205 ON READER-SERVICE CARD FOR MORE INFORMATION

Tracing Carbon Paper
For Reproducing Drawings

Greater line opacity for engineering drawings, necessary for Bruning, Ozalid and similar process reproduction, is gained by use of this single-use tracing carbon paper. Yellow on one side and black on the other, it also produces a duplicate copy in black. Columbia Ribbon & Carbon Manufacturing Co., Dept. ED, Glen Cove, N. Y.

CIRCLE ED-206 ON READER-SERVICE CARD FOR MORE INFORMATION

Marker Generator
For All U-H-F TV Channels

The "Ultra-Marker" is an u-h-f marker generator with crystal controlled narrow-pip-type markers at picture and sound carrier frequencies of all u-h-f channels. By switching means, crystal controlled narrow-pip-type markers are provided on every fourth u-h-f channel starting with Channel 15.

Maximum frequency error is 200ke, and mean percentage of error is 0.03% (percentage of error at center of band is 0.007%). Picture and sound carrier spacing is 4.5Mc ±0.01%. Input requirement is 10mv across 70 ohms from any sweeping oscillator covering the frequency range. Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N. J.

CIRCLE ED-207 ON READER-SERVICE CARD FOR MORE INFORMATION
FAST... economical assembly of motors, gear trains, electro-mechanical computing and transmission devices with mechanical development apparatus

Servomechanisms, Inc., versatile Mechanical Development Apparatus is intended for numerous applications in the research, instrumentation, and servocontrol fields. Typical applications of these precision built components include analog computers, signal generators, process programmers... Assembly is made with standard tools... each component is designed for repeated use.

A typical development assembly including servo motors and synchros.

Write for Descriptive literature MDA-200

Components Division, 625 Main Street, Westbury, N.Y.
West Coast Division, 316 Washington Street, El Segundo, California

CIRCLE ED-209 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products...

Heavy Duty Relay
Meets MIL-R-57578 Spec.

Designed to meet industrial requirements and comply with Specification MIL-R-5757B, the type RP 2pdt relay features a novel contact construction of high current carrying capacity. This construction and its linkage with the actuating mechanism make possible elimination of the usual flexible leads to the movable contacts.

The magnetic circuit is thoroughly laminated to reduce eddy current losses. The magnet winding is imbedded in a moisture-proof compound giving excellent resistance to ground. The electromagnet can be modified to operate the relay for up to 250v a-c or d-c interrupting a resistive load of 25amp 30v d-c or 110v a-c. At rated load the minimum life expectancy is 1,000,000 operations. The relay is available open or hermetically sealed. The Five Star Co., Inc., Dept. ED, West Main St., Plantsville, Conn.

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

Printed Card Receptacles
Permit Easy Removal and Change

These printed card receptacles feature ease of removability and changeability by means of tongue pinching on contact. They have multi-wire connections to terminals and afford dependable performance on repeated insertions over a range of card thickness from 0.061" to 0.071".

The contact or polarizing insert snaps into firm position on insertion into the molded body and is easily removed or its position changed by simply pinching the tongue and pushing out. Performance is assured by the high channel strength design of the contacts.

The insulating body is available in mineral-filled melamine, Alkyd 440 A, or Diallyl Phthalate. Contacts are spring phosphor bronze or beryllium copper, silver plated with gold flash. U.S. Components, Inc., Dept. ED, 454-462 East 74th St., New York 55, N.Y.

CIRCLE ED-211 ON READER-SERVICE CARD FOR MORE INFORMATION

TOROIDs... a Toroid Topic... SEE C-C-C MAN

UNCASED, Cased or Molded Plastic

Stocked for RUSH DELIVERY

Since CAC introduced the first miniaturized line of toroids in 1948, it has maintained a policy of prompt service and high quality. Standard types of cased, unced and molded plastic toroids are maintained for immediate delivery. By special order, any conceivable arrangement of closely coupled windings and multiplicity of taps may be supplied.

If toroids are a problem...

SEE YOUR CAC MAN

NEW YORK—Harold Gray Assoc.—La. 4-4258 260 Fifth Ave., New York, N.Y.
Baltimore—Charles R. Hile—Boulevard 1207 1717 Almondo St., Baltimore 29, Md.
CHICAGO—Gassner & Clark Co.—Rogers Park 4-6121 540 West Diversey Ave., Chicago, Ill.
KANSAS CITY—W. W. McGraw Co.—Delmar 2424 3117 Broadwater Plaza, Kansas City, Mo.
LOS ANGELES—Samuel G. Jewett—State 9-1214 455 South Broadway, Los Angeles 13, Cali.
HAMBURG—Cooper-Morgan, Inc.—Emerson 3405 900 Fifth Ave., New York 18, N.Y.
SYRACUSE—Naylor Electric Co.—2-3904 State Tower Bldg., Room 317, Syracuse 2, N.Y.
MERIDEN—Henry Levin Assoc.—7-6555 Hovington Co.—Bx. 196, Meriden, Conn.
NEEDHAM—Henry Levin Assoc.—34346 (Roch. V. Curran) 62 Curve St., Needham, Mass.
Cleveland—Emme Kohler Assoc.—Olympic 1-1242 810 World Trade Center, Cleveland 15, Ohio

COMMUNICATION ACCESSORIES CO. ickham Mills, Missouri

CIRCLE ED-212 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 1954
Power Supply
Provides 0.01% Regulation

The Model 712B Power Supply is designed for heavy-duty laboratory or production work and is useful in powering temporary electronic circuitry, oscillators, small transmitters, complex experiments, and many types of klystrons. It provides 0.01% regulation for all conditions of load variation and power supply variation. In addition, it has extremely low internal impedance of 0.1 ohm in series with 25mA, a transient response of less than 1 millisecond, and a hum voltage of less than 300mv.

The unit has four output options including 0 to 500v, 200mA regulated supply; a fixed — 300v regulated supply which may be in series with the 500v supply providing a 50mA, 500v to 800v variable supply for klystron tube operation; a 6.3v, 10amp a-c unregulated supply; and a continuously variable regulated bias voltage from 0 to 150v. There is less than 50mv change in the regulated supplies from no load to full load and for ±10% line variation. Other features include separate voltage and current meters and generous overload protection. Hewlett-Packard Co., Dept. P-ED, 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE ED-214 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply
For Use in Modular Systems

The Model 2 Modular Power Supply is especially designed for use with this firm’s Modular System of electronic units. It provides power to operate three or more modular units, depending on those used. It aids in the quick assembly of special function devices and in the design and construction of electronic equipment. Modular units are mechanically locked together, interconnected by special patchcords, and the electronic function desired from each unit is selected by a multi-position switch.

The new power unit is only 15” long x 4-3/4” wide x 7-1/2” high, with a weight of 11 lb. It has an output of 80mA, ±300 v d-c; 15ma, ±150v d-c; and 8amp, 6.3v a-c. It is connected to units by standard Modular power plugs. Audio Products Corp., Dept. ED, 2265 Westwood Blvd., Los Angeles 64, Calif.

CIRCLE ED-215 ON READER SERVICE CARD FOR MORE INFORMATION
Announcing...

STANDARD PIEZO

CdS Crystal Photocells
(Cadmium Sulfide Types)

FOR IMPORTANT COST SAVINGS ON PHOTOELECTRIC ASSEMBLIES!

- NO AMPLIFICATION REQUIRED in 4 out of 5 applications. Cell activates inexpensive sensitive relay directly.
- FAST RESPONSE TIME — 5 milliseconds. Better than most fast relays.
- SENSITIVITY per unit area comparable with conventional photo-multipliers.
- LINEAR RESPONSE ... TINY 2MM2 SENSITIVE ELEMENT means greater accuracy for delicate measuring devices.
- SMALLER IN SIZE ... FAR LOWER IN COST.

STANDARD PIEZO COMPANY, Carlisle, Pa.

From counters, headlamp dimmers, burglar alarms, process control and inspection devices to sensitive photoelectric measuring devices, these new Standard Piezo CdS Crystal Photocells pave the way to drastic cost and size reductions—even to the point of making photoelectric automation feasible for many home and industrial uses where equipment costs have been prohibitive in the past.

Using a special cadmium sulfide sensitive element, these tiny photocells deliver from 1 to 2 milliamperes when illuminated with 50 to 100 foot-candles and with a bias of approximately 100 volts. Inexpensive sensitive relays and the smallest batteries or power supplies can readily be used.

Standard Piezo CdS Crystal Photocells are supplied in two hermetically-sealed glass types and one subminiature type measuring only 1/8" in diameter by 1/4" long including built-in lens. Still smaller styles with identical characteristics can be made to order.

STANDARD PIEZO
Leaders in modern crystal development ... for over 25 years.

CIRCLE ED-216 ON READER-SERVICE CARD FOR MORE INFORMATION
NOW! For knots that tie easier, faster, tighter—and DO NOT SLIP!

FUNGUS-PROOF NYLON

Lacing Cords and Flat Braided Tapes

- Revolutionary synthetic resin coating prevents knots from slipping. Lacing actually tightens itself after knot is made.
- Greater strength means minimum breakage—minimum rejects.
- Special coating retains desirable malleability of wax and yet has a melting point of over 190°F. Non-toxic to humans.
- Complies with ALL requirements of Gov. Spec Jan-T-713 and Jan-T-152. Also available with wax finish.

FREE SAMPLES!
Foreign Agent: Turner, Halsey Co., Inc., 40 Worth St., N.Y.C.

ADC's new line of sub-miniature transformers and chokes

Hermetically sealed • Only 1/8" x 1/8" x 1/8" • Weight: approximately 1.8 oz. • Furnished with steel or mu-metal cases • Available in production quantities • Power level for voice range—without unbalanced DC, up to 3-5 watts, or for single tube output, up to 1 watt.

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For complete information, write to:

ADC AUDIO DEVELOPMENT COMPANY

2833 13th Avenue South
Minneapolis, Minnesota

CIRCLE ED-232 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

Relay
For Crowded Chassis

This sensitive relay is designed primarily for use in electronic chassis which have sufficient height but little adjacent space. The unit provides a hermetically sealed dpdt combination, and has a capacity up to 3amp inductive load. It is equipped with a standard octal socket. Wattage consumption is 0.1w and less, depending on the contact arrangement, or less than 1ma, depending on the voltage used. Coil resistances can be furnished up to 30,000 ohms. D-e relays have a drop-out approximately 80% of the pick-up. Hedlin Tele-Technical Corp., Dept. ED, 640 W. Mt. Pleasant Ave., Livingston, N. J.

CIRCLE ED-234 ON READER-SERVICE CARD

Varistor Unit
Eliminates Thermostat Arcing

Arcing, the main cause of contact failure in mercury-in-glass thermostats, can be eliminated by the use of the "Stat-Varistor". Normally, arcing occurs when the thermostat circuit opens. At this moment the magnetic energy stored in the relay changes quickly to surging electrical energy that unloads through the unit.

All of this firm's thermostats can now be provided complete with the "Stat-Varistor". In addition, the device is available as a separate unit for use on existing installations or as a component for other new relays. Precision Thermometer & Instrument Co., Dept. ED, 1434 Brandywine St., Philadelphia 30, Pa.

CIRCLE ED-235 ON READER-SERVICE CARD

Subminiature Toroids
Packaged for MIL-T-27

These subminiature toroids are available in three lines. They are designed for use in the 1ke to 1Me range, with Q's of 100-200, at a tolerance ±1%, with high stability over the temperature range of -55° to +85°C, and inductances from 4µh to 1h.

The QL050 Series are wax impregnated with flexible high temperature leads. Size: 5/8" OD x 1/8" ID x 9/32" high.

MP050 Series are molded plastic units with axial wire leads suitable for point-topoint wiring, or terminal board mounting.

The HS050 Series are hermetically sealed metal cans with wire leads. They can be wired in subminiature sockets or soldered to printed circuit boards. They will withstand tests of MIL-2-27, Class A, Grade 1. Case dimensions: 5/16" x 11/16" x 49/64" high.

Communication Accessories Co., Dept. ED, Hickman Mills, Mo.

CIRCLE ED-236 ON READER-SERVICE CARD

Thermal Time Delay Relay
In Variety of Ratings

"Snapper" thermal relays feature "snap action" of contacts in an inert gas-filled atmosphere. Units are spdt and are available in 7 or 9-pin miniature or octal metal envelopes.

Designed for ambient temperature operation ranges of -60° to +80°C, the relays operate on 6.3v, 26.5v, 115v, a-c or d-c, or as required. Time delay is from 2sec and up. The units withstand vibration of 30g at frequencies of 5 to 55cy. Elly Electronics Corp., Dept. ED, P.O. Box No. 395, Fairlawn, N. J.

CIRCLE ED-237 ON READER-SERVICE CARD
Hermetically Sealed Coils
From Stock or Custom-made

This series of hermetically sealed coils for electronic applications is offered in a wide range of electrical and mechanical characteristics. Features include: hermetic sealing to provide absolute protection against the effects of moisture; true glass-to-metal sealing technique; an insulated metal case; and specifications exceeding the most rigid requirements.

One typical unit has an inductance of 20 mh, current rating of 120 ma, and dimensions of 0.735" diam x 1-1/16" long. Another coil has an inductance of 4.7 mh, current rating of 600 ma, and dimensions of 0.450" diam x 1-1/16" long. In addition to a standard line, hermetically-sealed coils can be produced in types and sizes to customer specifications. Fugle-Miller Laboratories, Dept. ED, 398 Main St., Metuchen, N. J.

CIRCLE ED-238 ON READER-SERVICE CARD

Resistors
High Reliability Sub-miniatures

Subminiature Type J Precision Wire-Wound Resistors, designed for top reliability and performance in spite of small dimensions, employ an improved method of terminating the winding to the wire leads.

Type JA is 1/4" diam x 1/4" long. Maximum resistance is 125,000 ohms. Military power rating is 0.1w. Type JG is 1/4" diam x 3/8" long. Maximum resistance is 250,000 ohms. Power rating is 0.15w. Tolerance of 1% is standard, with 0.05% also available.

The resistors have a mounting hole for a No. 2 machine screw. Leads are of heavily tinned copper wire. All resistors are furnished with low temperature coefficient alloys unless otherwise specified. Special wire and impregnation is available for increased power rating. Resistance Products Co., Dept. ED, 714 Race St., Harrisburg, Pa.

CIRCLE ED-240 ON READER-SERVICE CARD

Variable Time Delay
Used at Audio Frequencies

The "Echo-Vox" is designed to provide a wide and continuously variable time delay at audio frequencies. One application is for the proper phasing of speakers in large areas where objectionable echoes exist.

Specifications are: frequency response, 40cy to 12,000cy; flutter, less than 0.3%; harmonic distortion, 2% maximum; inter-modulation distortion, 5% maximum; input impedance, 600 ohms; output impedance, choice of 600 ohms, 8 ohms, and 3.4 ohms; output power, 25w max., for speaker drive.

Single echo time delay is continuously variable from 100-500 milliseconds. There is an adjustable feedback for multiple reverberation. Power input is 115v 60cy, 160w. Dimensions of the carrying case are 9-1/4" x 15" x 20". Weight is 54lbs. Kay Electric Co., Dept. ED, Pine Brook, N. J.

CIRCLE ED-241 ON READER-SERVICE CARD

Toroid Coils
Provide Adjustable Inductance

Adjustable toroid coils which provide a simple method for varying inductance are announced by the company. Coils are factory adjusted to within ±5% of nominal inductance values and are economically priced due to the elimination of critical adjustment and impregnation.

Especially useful in resonant L-C circuits, these units are available with maximum Q factors from 120 to 200. Sizes range from 1" OD x 3/8" to 2-1/4" OD x 1". Hyecor Sales Co. of Calif., Dept. ED, 11423 Vanowen St., North Hollywood, Calif.

CIRCLE ED-242 ON READER-SERVICE CARD
Only the manufacturer of genuine Bead Chain offers you a new, more versatile belt drive that will accurately time and control the movement of all types of devices. Among such applications are radio and television tuners, recorders, air conditioners and timing devices. Costly gearing mechanisms can be eliminated and efficiently replaced by the specially designed sprockets that accurately fit the individual beads without slippage and backlash. Friction is at a minimum and tensile strength of the Bead Chain belt (from 15 to 200 lbs.) is very high in proportion to size and weight.

Write to us today for detailed information about sprockets and Bead Chain belts. It can save you a lot of time and money later.

THE BEAD CHAIN MANUFACTURING CO.
92 Mountain Grove St., Bridgeport, Conn.

Please send me information about Bead Chain sprocket drives.

NAME_________________________
TITLE_________________________
ADDRESS______________________

CIRCLE ED-243 ON READER-SERVICE CARD FOR MORE INFORMATION
New Products...

D-C Power Supplies
Magnetic Amplifier Controlled

These magnetic-amplifier-controlled d-c power supplies contain neither moving parts nor tubes, and require no warm-up time. They are constructed to withstand rough operating conditions and their life is rated in terms of years of maintenance-free operation. They have been successfully used in various applications, such as servomechanisms, bias supplies, reference supplies, filament power supplies, battery chargers, computer power supplies, and heavy-duty regulated sources of d-c power.

Typical specifications include: voltage regulation, ±1% from no-load to full load for ±10% change in line voltage; response time, 0.2sec or less; ripple voltage, 1% rms of nominal d-c output voltage; controls, one variable potentiometer for d-c output voltage range adjustment; line voltage, 115v, single-phase, 208/230/440v, three phase; d-c output voltage range, 28.5v nominal, 22-30v d-c; d-c output currents available, 5, 10, 50, 100, 200, 500amps. Mag-Electric Products, Inc., Dept. ED. 12822 Yukon Ave., Hawthorne, Calif.

CIRCLE ED-219 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Relays
Miniature D-C Units

Series 4B Power Relays are miniature d-c power contactors with high current contacts. They are small in size (1-23/32" length) and light in weight (3 oz. approx.), with the added feature of having the capacity to handle large currents through the contacts.

The relay's large coil capacity permits high-contact pressure and large contact gap with minimum power consumption in the coil. Operating voltage is up to 200v d-c. Maximum coil resistance is 16,000 ohms. The relays are available single or double wound.

The contact assembly is rated 20amps, 125v, continuous; 60amps, 280v inrush. Standard contacts are 1/4" silver contacts. Other contacts are available for special applications. The design is double make only. Phillips Control Corp., Dept. ED, 84 W. Jefferson St., Joliet, Ill.

CIRCLE ED-220 ON READER-SERVICE CARD FOR MORE INFORMATION

We invite your inquiry.

Cook Electric Company
Established 1897
2700 Southport, Chicago 14, Illinois

Diaphlex—Aircraft Components and Accessories
Wires—Wire Communication, Protection & Distribution Apparatus
Magnelastics—Expansion Joints
Heavy Industry Equipment, and Airframe Structures
Cook Research Laboratories—400 Monticello Avenue, Skokie, Illinois
Inland Testing Laboratories—1507 Shoreway Parkway, Chicago 14, Illinois
Electronic Systems Division—2333 N. Ashland Avenue, Chicago 14, Illinois
Subsidiary: Canadian Diaphlex Limited—Aircraft Components and Accessories, Toronto, Ontario, Canada
Plymouth Division—415 Belmont Avenue, Chicago 18, Illinois

CIRCLE ED-221 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Amplifier

The magnetic amplifier is a device which amplifies electrical energy, using magnetic fields. It is used in many electronic systems, such as control and regulation circuits.

Important Note

An important note regarding the use of magnetic amplifiers in electronic systems is that they require careful design and implementation to ensure safety and reliability. It is recommended to consult with experienced engineers to ensure proper application.

Metals

The use of metals in electronic systems is crucial, as they provide a conductive path for electrical currents. They also play a role in thermal management and structural integrity. It is important to select the right type of metal based on the application requirements.
New Literature . . .

Microwave Test Equipment 223

This firm's first catalog covers its full line of precision microwave test equipment, which includes all the required units and components for operation in the microwave region. The company also has a custom engineered and built line of antenna pattern analyzers, high power pulse modulators, and waveguide components for test and production applications. The catalog is well illustrated and firmly bound in multi-ring leatherette binders. Electronics and X-Ray Div., F-R Machine Works, Inc., 44-14 Astoria Blvd., Long Island City 3, N. Y.

Improved Tube 224

An 8-page booklet (No. ETD-881) describes the new GL-2C39-BB metal and ceramic “Lighthouse” tube, an improved version of a similar metal and glass tube. The new high-mu triode is designed for use in v-h-f—u-h-f circuits as a grounded-grid class C power amplifier, oscillator, or frequency-multiplier, at frequencies up to 2500 Mc. Technical data and typical operating conditions are included. General Electric Tube Dept., Schenectady 5, N. Y.

Metal Stampings 225

“Trims, Panels and Escutcheons” is the title of a 4-page booklet that illustrates the use of decorated metal stampings as functional component parts. It shows many examples of modern planning that reduce original tool costs by using stock dies in numerous cases. Samples shown cover a wide range of end product uses which vary from locomotives to table model radios. Piece size variation is from less than 1 sq” to a stove panel 37” x 8” wide. American Name Plate & Mfg. Co., 4254 West Arlington St., Chicago 24, Ill.

Transformer Laminations 226

Two new catalog pages on 1-3/4” E and I transformer laminations are now available from this company. Complete technical data is listed including dimensional drawings, stacking factor, specifications, weight and count. Type T-175 RH features the new RETMA corner mounting holes and Type T-175 H has standard mounting holes. Temple Manufacturing Co., Bryn Mawr at Damen, Chicago 26, Ill.

Training Method 227

An improved plan for training and testing proficiency of personnel to service electronic equipment is described in a 46-page illustrated folder. The method is covered in detail, and might be valuable for training assistants for electronic designers. Van Valkenburgh, Nooger & Neville, Inc., 15 Maiden Lane, New York 7, N. Y.

Indicating Instruments 228

A 48-page catalog covers various indicating instruments, laboratory portables, and panel meters of finer accuracy. It provides illustrations and specifications of the more popular sizes of round, square, flush, semi-flush, switchboard, horizontal, edge-wise, and fan type meters, as well as 250° arc-sealed and ruggedized types presently available. Hickok Electrical Instrument Co., 10515 Dupont Ave., Cleveland 8, Ohio.

Casting Resins 229

Potting and casting resins for high and low temperature applications are covered in this 16-page booklet. It presents technical data on a number of "Airtex" resins which are of the epoxy type. Aries Laboratories, Inc., 270 Park Ave., New York 17, N. Y.
for all applications requiring exceptionally high insulation resistance and unusual stability at high temperature

HOPKINS
"HY-THERM"
New sub-miniature high temperature CAPACITOR

Hermetically sealed and metal encased, new HY-THERM capacitors have been designed to meet or exceed military requirements (MIL-C-25A). Example: At 125°C the minimum insulation resistance is 20 megohm-microfarads and maximum insulation resistance is 500 megohms. Available in all standard values and tolerances. Variety of mounting and circuit combinations. Special units designed to meet individual requirements.

HOPKINS Engineering Co.

Have a special problem? Write, wire or phone for details, TODAY! Catalog available.

2082 Lincoln Ave., Altadena, Calif. Stycamore 8-1185
Offices in WASHINGTON, D. C. and DETROIT

LIBRASCOPE

Librascope read-record heads are designed for recording and reading on magnetic drums or other magnetic storage systems and consist of a center-tapped coil wound on a toroidal core and molded into a temperature-stable epoxy resin package ¾" long. Optimum read-back signal at high frequencies is made possible by sintered ferrite core, a winding with low distributed capacity and with back gap eliminated. Positioning dowel hole permits precise mounting. All heads subjected to 1200 volt RMS high potential test. Write for catalog.

SPECIFICATIONS:
- Crosstalk limited to minus 60 Db for adjacent heads. Resonant frequency above 500 KC.
- Track width: .090 in.
- Gap width: .0015 in.

CIRCLE ED-230 ON READER-SERVICE CARD FOR MORE INFORMATION
Requiring a panel area just ¾" wide by ¾" high (the longest models extend only 1-11/64" behind panel), these miniatures provide the ideal solution to compact design problems. Rugged, Johnson Miniature Air Variables will stand up under the most rigorous conditions, delivering peak performance throughout the VHF ranges. Soldered plate construction, oversize bearings, and heavily anchored stator supports provide extreme rigidity—torque is steady; rotor stays "put" where set. Bridge type stator terminal provides extremely low inductance path to BOTH stator supports. Silver plated rotor contacts for low noise level at high frequencies—all other metal parts nickel plated. DC-200 treated steatite end frames maintain high insulation resistance.
New Literature...

Component Catalog 247

A very wide variety of products for the electronics industry is listed in this 30-page catalog (No. C-1154). Foundation chassis, chassis parts, plugs, tools, sockets, switches, tube shields, coils, terminals, hardware, and hundreds of other components are illustrated and described. In-suline Corporation of America, 36-02 35th Ave., Long Island City 1, N. Y.

Time-Delay Relays 248

This bulletin (No. TD400) discusses the Series 6400, 11400, and 23300 miniature, hermetically sealed time delay relays. Delay settings from 2 sec to 3 hr for either a-c or d-c units are available. The relays are furnished in one-, two-, or three-switch units. Mounting is by flange or stud. A. W. Haydon Co., 230 N. Elm St., Waterbury, Conn.

Instrument Generator 249

A permanent magnet, continuous duty generator recommended as a precision voltage source is described in this leaflet, Form GPM-44A. The brochure illustrates the unit, provides dimensioned outlines, and tabulates physical and electrical characteristics. Operating parameters of phase voltage vs load-per-phase are presented graphically for operating speeds of 1200, 2100, and 4500 rpm, giving frequencies of 20, 35, and 75cy. It weighs 9 oz. Dalmotor Co., 1326 Clay Street, Santa Clara, Calif.

Pressure Transducers 250

Bulletin No. PT-1 (12 pages) describes instruments for the measurement of gage differential, and absolute pressures. The transducers are based on the principle of the firm's unbonded strain gage which translates pressure into an exact electrical analog output by means of a complete balanced bridge of strain-sensitive resistance wire. The bulletin includes drawings, specifications, and selection tables for eight designs for pressure measurements from 0-0.05 to 0-10,000psi. Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.

Clutches 251

Catalog No. B-54 depicts a line of miniature, one-way-roller clutches that permit drive in one direction with free-wheeling action in the opposite direction. Design and installation data and dimensions are given for roller assemblies as well as complete clutches. Typical applications for one-, two-, and three-clutch assemblies, with photographs and drawings, are included. Miniclutch Co., 379 Morse St., Hamden, Conn.

R-F Filters 252

A complete line of r-f filters, low-pass, high-pass, band-pass, band-rejection, and complementary, is described in this 4-page, bound bulletin. Actual photographs of typical response curves illustrate what can be done in extremely compact units to give maximum attenuation over the desired stop band with minimum insertion loss and VSWR over the pass band. Balco Research Laboratories, 49-53 Edison Pl., Newark 2, N. J.

Vibration Isolation 253

How to stop vibration and shock, reduce noise, and cut down on the wear and tear of industrial machinery is the subject of this booklet, designated No. 850. It describes a new concept of vibration and shock control based on the employment of resilient primary load-carrying cushions of knitted metal wire. Examples of typical industrial mounts and mounting systems are illustrated and engineering data given. Applications range from delicate precision equipment to massive machinery. Robinson Aviation, Inc., Teterboro, N. J.

Hand Tachometers 254

This manufacturer's Bulletin No. 103 describes a series of three new-in-one-hand tachometers which dependably measure the speeds of rotating parts and moving surfaces. Incorporating three separate ranges in one instrument, only one range appears at a time, thereby minimizing reading errors. Ranges are selected by flipping a switch, and there is no fear of damage due to over-speeding or selection of the wrong range. Metron Instrument Co., 432 Lincoln Street, Denver 3, Colo.
Plastic 255

A reinforced alkyd plastic known as "Plaskon" is described in this bulletin with all its advantages for the electronics industry listed. It is reinforced with glass fibers. Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N.Y.

Test Chamber 256

A temperature test chamber with a range from -65°F to +350°F is described in this 4-page bulletin. The test chamber is 7" x 15" x 7-1/2" deep. Statham Development Corp., 12411 West Olympic Blvd., Los Angeles 64, Calif.

Metal Processor 257

A description of the services of a processor of common, precious, and little-used metals and alloys into wire, ribbon, and foil is given in this 4-page bulletin. Such metals as indium, tellurium, palladium, etc. are extruded into wires used extensively as precision resistance elements. Baker & Co., Inc., 113 Astor St., Newark 5, N.J.

Environmental Testing 258

Tests for vibration, shock, acceleration, high and low temperature shock, humidity, high altitude and explosion, salt spray, sand and dust are covered in this 4-page illustrated folder. Some of the environmental equipment used in making the tests is also illustrated and described, the more common types of equipment being listed for quick reference. A brief review of other fields of testing specialized in this organization is also included. New York Testing Laboratories, Inc., 47 West St., New York 6, N.Y.

D-C Indicating Amplifier 259

A new design approach, the highly stable performance, and the unique principle of operation of this firm's Type 2HLA-3 D-C Indicating Amplifier are described in this engineering bulletin. It should be of particular interest to engineers in fields of automation, process control, and instrumentation. The bulletin (No. 1A) also includes a photographic illustration, detailed description, typical applications, and a discussion of the principle of operation. Doeleman Corp., 1400 Soldiers Field Road, Boston 35, Mass.

Co-axial Components 260

Various type connectors, adapters and waveguides for co-axial applications are described and illustrated in this 16-page catalog. An index by military types is also included. Electro Precision Products, Inc., 139-30 34th Road, Flushing, N.Y.

Galvanizing 261

A method of galvanizing ferrous metals by brushing or spraying a fluid known as "Galvicon" on the surface at room temperatures is described in a 10-page booklet. It leaves a coating of 96 parts, by weight, of zinc. The coating dries in 48 hr. Galvicon Corp., 40 W. 29th St., New York 1, N.Y.

Germanium Diodes 262

A complete crystal diode replacement chart is included in this 4-page bulletin (No. GD-1A), which lists ratings and specifications on this firm's line of germanium diodes. Included are the "Red Dot" line of diodes for 100°C applications. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Vibration Isolation 306

"Shock and Vibration Control Notes" is the title of this company's new technical house organ, the first of its kind devoted exclusively to shock, vibration, and noise isolation. Published quarterly, it is intended to provide a medium for the collection and propagation of ideas and information in the shock and vibration isolation fields. It will contain material dealing with specific technical problems and reports based on continuous research in these fields, as well as articles based on problems sent in by engineers, the solutions of which would be of interest to industry. The Barry Corp., 718 Pleasant St., Water- town 72, Mass.

Flexible Ducting 307

A 4-page illustrated brochure describes "Flexflyte", one of this company's new forms of flexible ducting. It covers the various types of Flexflyte, its method of manufacture, standard coatings and diameters available, and method of installation. Complete engineering and data sheets are provided with the booklet. Flexible Tubing Corp., Guilford, Conn.
NEVER COME HOME TO DARKNESS

We can't resist the opportunity to plug one of our old stand-bys (perhaps too long forgotten), and at the same time give a boost to a product of our affiliate, The Fisher-Pierce Co.

Fisher-Pierce, now well-established and in its eighth year in the photoelectric street lighting control business, recently decided they should have a consumer product as well. The result was just what you might expect: an inexpensive ($15.95 retail) little light control for home use.

F-P calls it the NITELIGHTER,* since it turns on a light at dark, when daylight ceases to energize its phototube. Its special plug goes in the AC wall outlet and takes the plug from your favorite lamp. For you who don't like to come home to darkness, want to make burglars think you're home when you're not, or have some other use for a daylight-sensitive light switch — the NITELIGHTER could be the answer. (In case you don't really need a NITELIGHTER, they're fun to just fool around with.)

The "old stand-by" is one of our Series 41 relays, originally designed as a "streamlined" version of our "4", for people who didn't need all the fancy features of the "4" and who were spending their own money. This particular 41 does very well in its intended applications, however, and switches up to 300 watt lamp loads on 0.15 watt coil signals in the NITELIGHTER. Relay mechanical life equals at least twice the lifespan of a NITELIGHTER owner. The 41 should be considered when high sensitivity, high speed, 5 ampere contact ratings and nominal cost are what you need.

*CIRCLE ED-308 ON READER-SERVICE CARD FOR MORE INFORMATION
SPECIAL OPPORTUNITIES FOR ELECTRONIC ENGINEERS

Convair in beautiful, sunny San Diego invites you to join an "engineers" engineering department. Interesting, challenging, essential long-range projects in missiles, engineering research and electronics development. Positions open in these specialized fields:

- Microwave Antennae
- Microwave Components
- Electronic Packaging
- Mathematical Physics
- Electronic Components
- Electronic Systems
- Applied Mathematics
- Transmitters & Receivers

- Dynamics Testing
- Telemetering
- Servomechanisms
- Electron Tubes
- Radome Design
- Digital Computers
- Test Equipment
- Miniature Circuits

Generous travel allowances to those accepted. For free brochure, write Mr. H. T. Brooks, Engineering Dept. E-9

CONVAIR
IN BEAUTIFUL SAN DIEGO
Division of General Dynamics
3302 PACIFIC HIWAY
SAN DIEGO 12, CALIFORNIA

CIRCLE ED-263 ON READER-SERVICE CARD FOR MORE INFORMATION
New Literature...

Wire Thread Inserts 264

Designers concerned with fastening and mounting and other users of wire thread inserts will be interested in this new 4-page bulletin (No. 708). By presenting all basic information on the manufacturer's wire thread inserts and tools in condensed form, it saves time in designing, specifying, and ordering inserts. Illustrations and tables present data and installation instructions on inserts and tools for National Course and Fine, Unified Course and Fine, Spark Plug, and Pipe Thread Series. Heli-Coil Corp., Danbury, Conn.

Catalog Index 265

Bulletin 100-C lists all current literature available from this company. Numbers and titles of all catalogs, bulletins, specification sheets, and instrumentation data sheets are included. Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa.

Actuator Motor 266

A series-wound 25w miniature motor designed for use as a driving element in low or high-speed linear or rotary-actuator applications is described in a new leaflet, Form SR-43. One of a series, the leaflet provides all primary data required for the design engineer. The motor is illustrated, detailed in dimensioned outline drawings, and described in a listing of electrical and physical characteristics. Performance data, given in graphic form, covers rpm, efficiency, output watts, and input amperes over the torque output range to 4.25 oz. Dalmotor Co., 1326 Clay St., Santa Clara, Calif.

Air Data Computer 273

An 8-page technical brochure gives information on the company's Master Air Data Computer which provides a single coordinated source of information and eliminates much duplication. Schematic diagrams show how the plug-in type computer permits calculation of complex functions with a minimum of equipment. Servomechanisms, Inc., Post and Stewart Aves., Westbury, L. I., N. Y.
Inductor Curves 269

A set of characteristic curves for the firm’s “Vari-L,” electrically variable inductors has been made available in the form of a series of data sheets. The units are high frequency saturable core reactors designed to control the resonant frequency of a tuned circuit as a function of a d-c or a-e current. The curves show the control characteristics of a number of typical units. Vari-L Company, Inc., P. O. Box 1433, Stamford, Conn.

Hardware 270

A folder gives a quick view in illustrations and text of all the products the company makes for the electronics industry. Included are socket head cap screws and shoulder screws, socket set screws, button head and flat head socket screws and dowel pins, “Flexloc” self-locking nuts, “Hallo well” steel collars, and “Sel-lok” spring pins. The folder, entitled “One Source of Supply For Your Fastener Requirements”, lists the sizes of all the products, their materials, and the plating they are available in. Standard Pressed Steel Co., Jenkintown, Pa.

Sintered Metals 271

This bulletin (No. 1) provides an introduction to the art of powder metallurgy. It describes the general types of metal powder offered by the company, and stresses the large number of grades required for different applications. Also included in the pamphlet are referencees to some of the other major uses for metal powders such as the fabrication of special electronic and magnetic parts. Among the metals available in powdered form are steel, nickel, manganese and silicon. Plastic Metals Division, National Radiator Co., Johnstown, Pa.

TV Tube Types 272

A 12-page booklet (No. ETR-886) lists recommended receiving and cathode ray tube types for AM, FM, and TV receivers. These are compiled in tabular form to cover essentially every requirement of the radio and television manufacturer. Included are characteristics reference charts on the tube types listed, and interpretation of technical data. General Electric Tube Dept., Schenectady 5, N. Y.

CompAir Corporation 273

This bulletin (No. 131) is intended for use in selecting the right unit for the job. Air compressors are available in both portable and cabinet type units. A list of industrial applications is included, along with tables covering the capacity, pressure and suction characteristics of the various types of units. CompAir Corporation, 1322 Mt. Vernon Avenue, St. Louis 5, Mo.

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The Fairchild Oscillo-Record camera will accurately record continuously varying phenomena as well as single transients and stationary patterns. Continuously variable electronic control of the film speed from 1 to 3600 inches per minute allows you to select the optimum speed for the greatest clarity and detail, without film waste. The entire length of the 35 mm. film (100, 400 or 1,000 feet) can be run off continuously at any speed. The film is sprocket-driven so there is no slippage at any speed.

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For more information, write Fairchild Camera and Instrument Corporation, Robbins Lane, Syosset, L. I., N. Y., Department 120-21G1.

The transistor circuit shown in Fig. 1 is a regenerative pulse amplifier that is useful in high-speed switching systems common in computers. In these systems low-level pulse signals are amplified and reshaped. Basically, the circuit is a flip-flop circuit having low and high current states. The input signal triggers the circuit from the low current state to the high current state. Either a p-type or an n-type transistor may be used with reversal of the battery and rectifier polarities. The circuit given calls for an n-type unit.

The circuit parameters are chosen so that the circuit operates in that region of transistor characteristic curve, as shown in Fig. 1, where the curve of emitter voltage versus current reaches a peak at or about zero emitter current and then the curve slopes off to a valley after which the curve again slopes upwardly. The potentials of battery 18, 12v, and battery 20, 1v, are also selected so that the respective load lines of resistor 19 and crystal diode 21 intersect at a point slightly displaced from but adjacent to the peak in the emitter characteristic curve. Battery 20 also serves to return the emitter to a small negative voltage. The junction of crystal diode 23 and coupling condenser 22 is maintained negative by battery 24, which delivers 8v. Crystal diode 23 serves to isolate

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ELECTRONIC DESIGN • September 1954
Fig. 1. A flip-flop transistor circuit that functions as a pulse amplifier and an explanatory characteristic curve.

The flip-flop circuit for the transistor from the preceding circuit.

Resistor 19, 24,000 ohms, and resistor 25, 3900 ohms, are selected so that when no emitter current flows the transistor rests at a voltage just below the peak of the characteristic curve or below the bias on diode 21. An input pulse raises the voltage above the peak point and diodes 21 and 23 are cut off. Positive emitter current then flows, which causes the emitter voltage to fall to the valley point of the characteristic curve and snap out to a high current point on the upward slope of the characteristic curve, where it remains indefinitely. The transistor circuit may be restored to its initial condition by applying a reset pulse to the base (14) of the transistor. By using timed reset pulses or signals, the very rigid synchronism required in computer circuits is secured in a simple manner and the duration of the pulse is controlled by the timing signal independently of the input signal.
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For complete illustrated engineering literature, and assistance on special or unusual connector problems, write Dept. EDHV9, DeJur Amseco Corporation, 45-01 Northern Blvd., Long Island City 1, New York.

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Patents...

Antenna ... Patent No. 2,671,855, Lester C. Van Atta, Winchester, Mass. (Assigned to the United States.)

In microwave antenna systems for the radiation or reception of short waves of the order of centimeters in length, it has been known that there is a reflection of energy from the reflector back into the feed or transmission line. By using matching transformers, this reflection of energy back into the feed line has been kept at a level where it is not troublesome for the frequency at which the system is designed to operate. If, however, there should be a slight change of operating frequency such as may well occur by a change in the transmitter tube, the present methods of keeping to a minimum the energy reflected back into the line do not function as well as desired because the components used as well as the antenna itself are frequency sensitive or lack broadband characteristics.

The antenna system illustrated in Fig. 2 has broadband characteristics gained by

Fig. 2. Microwave antenna system.

placing one or more matching or compensating reflectors (24, 25, and 26) of small size on the axis of the reflector 20° and between the antenna 21° and the reflector. Its location should be approximately one eighth of a wave length in front of the reflector, although in order to reduce the incidence of side lobes and a loss of antenna gain the compensating reflector may be located an even number of half waves from the position illustrated.

In a location farther removed from the reflector the matching reflector may be smaller. The compensating reflector has a size which has the effect of compensating or canceling out the energy reflected back

---

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For those laboratories requiring the utmost in stability and regulation from D.C. power supplies, Chatham Electronics offers a group of ultra-stable regulated power supplies. The use of a driftless regulating circuit and mercury cell batteries as a voltage reference provides the extreme stability attained. These units can be supplied to meet your power requirements. Some typical supplies are listed below:

<table>
<thead>
<tr>
<th>D.C. VOLTAGE RANGE</th>
<th>CURRENT MILLIAMPERES</th>
<th>HUM MV</th>
<th>LINE REGULATION 110-120 VOLTS A.C.</th>
<th>LONG-TIME STABILITY.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 to 1500</td>
<td>180</td>
<td>2</td>
<td>.002%</td>
<td>20</td>
</tr>
<tr>
<td>0 to 400</td>
<td>20</td>
<td>0.5</td>
<td>.005%</td>
<td>10</td>
</tr>
<tr>
<td>1500 to 3500</td>
<td>100</td>
<td>3</td>
<td>.005%</td>
<td>30</td>
</tr>
<tr>
<td>290 to 310</td>
<td>500</td>
<td>0.5</td>
<td>.002%</td>
<td>5</td>
</tr>
<tr>
<td>6.3 to 7.3</td>
<td>3 amps</td>
<td>10</td>
<td>.03%</td>
<td>1</td>
</tr>
</tbody>
</table>

*Max. drift in millivolts over 10 min. period.

STANDARD REGULATED POWER SUPPLIES

These units are ruggedly built and designed to give long time, trouble free operation. Either positive or negative output may be grounded. All voltages and load currents are metered. Model E-50A (at left) also has a 6.3 volt 10 ampere output available. (Non-Regulated.)

<table>
<thead>
<tr>
<th>MODEL</th>
<th>VOLTAGE RANGE</th>
<th>CURRENT MA</th>
<th>HUM LINE VOLT. REG. 105-125 V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA-50A</td>
<td>0-500 Volts</td>
<td>0-300 MA</td>
<td>2 MV 1%</td>
</tr>
<tr>
<td>EA-48</td>
<td>160 to 1500 Volts</td>
<td>0-125 MA</td>
<td>Less than 20 MV 0.5%</td>
</tr>
</tbody>
</table>

CHATHAM ELECTRONICS CORP.,
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Plants and Laboratories: NEWARK and LIVINGSTON, NEW JERSEY

CIRCLE ED-280 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • September 1954
into the feed line from the reflector 20, but should be small enough not to interfere with the directive function of the system. The optimum location and size of the matching reflector may be determined by test. The compensating reflector may have practically any desired shape. With more than one matching reflector, more effective broadband characteristics will be secured.

**Semiconductor Translating Device . . .**
*Patent No. 2,672,523. William Shockley. (Assigned to Bell Telephone Laboratories.)*

A transistor of the kind in which the body is of one type and a zone thereof is of the other type experiences a direct current bias of substantial proportions during operation between the P and N portions of the device at the collector. A P-type region may be made in an N-type body in various ways such as by nuclear bombardment of the surface. A transition region (24, Fig. 3) between the two type regions intersects the surface, and because of the potential difference between collector 12 and the body (10), there is a strong field present and leakage currents do occur. These cause noise in the output circuit.

A reduction in the field may be achieved by tapering the P-type zone near its margin. Other ways of tapering the zone are described in addition to the method illustrated. The leakage current can be further reduced by supplying an auxiliary electrode (21) surrounding collector 14 in the vicinity of the intersection. A condenser (22) between this electrode and the base (13) assures that it is at alternating current ground potential. A potential source (23) may bias the auxiliary electrode at a potential intermediate between that of the collector and base.
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NORWALK, CONNECTICUT

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Three of the world's largest producers of electronic equipment have recently made CUBIC Calorimetric Wattimeters standard test equipment in their laboratories and plants. For very good reason. No other instrument designed for power measurement gives you direct power readings...with such precision, and yet so simple in its application.

The model shown is the MC-1B for power measurement from 2600 to 26,500 MC. Also available are the models MCX-1A (coaxial type) for power measurement from 100 to 3000 MC, and MCL-1A (L-Band waveguide type) for power measurement from 1120 to 2600 MC.

Whether checking field equipment, developing or making acceptance tests on new equipment or magnetrons in the lab, or in production, one of CUBIC's Calorimetric Wattmeters will be an invaluable addition to your test equipment. Standard laboratories calibrate secondary power devices, especially bridge type bolometer instruments. Exact calibration is provided month to month.

Write for more information, and ask for our catalog of other test equipment and waveguide components. Or if you have a problem in development or engineering, CUBIC offers the services of its engineering staff and facilities in its solution.
Coated Method
starts

circuit, is metallic

Rochester, Mass.

Of primary importance in printed circuitry, a process for securing an adhering metallic coating upon an insulating plate is set forth in the patent. The process starts with a paper material that has a
metallic film evaporated on one surface. A metallic coating is then plated on the film, and the sheet is thoroughly cleaned. The unplated side of the paper sheet is then impregnated with a thermostetting resin that is only partially cured. A thermostetting base sheet is then applied under pressure to the partially cured impregnated surface, and the latter is then fully cured. With this method, a strong bond is secured between the metallic conductive coating and the insulating material (Fig. 4).

![Fig. 4. Cross-section of the printed-circuit laminate.](image)

**AEC Patents For Industry**

Additional patents owned by the Atomic Energy Commission have been made available for licensing. Licenses will be granted to applicants on a non-exclusive, royalty-free basis. Applicants should apply to the

Chief, Patent Branch, Office of the General Counsel, U.S. Atomic Energy Commission, Washington 25, D. C., identifying the subject matter by patent number and title. Of the 25 patents released, the following ones are particularly interesting to electronic design and development engineers.

Coincidence Circuit (Patent No. 2,657,759); R. Madey, inventor. The patent relates to an improved fast coincidence circuit which is highly
Linear Cathode (Patent No. 2,677,778); W. E. Baker and D. A. Vance, inventors. The patent pertains to an improved dispenser type thermionic cathode which is rugged, efficient, simple and easily disassembled.

Mechanical Register (Patent No. 2,678,773); W. E. Ellett, Jr., inventor. The patent pertains to a counting device having a magnetic rotor disposed between the poles of one magnet in cooperating relation with another magnet and indicating means for determining the angular disposition of the rotor. The low friction and low-inertia mechanism overcomes many of the disadvantages of existing mechanical registers.

Protective Circuit (Patent No. 2,680,212); P. E. Frazier, inventor. The patent relates to a protective circuit adapted for cooperation with a parallel-connected igniter for recording various types of operating faults and for de-energizing the tubes upon the occurrence of operating faults of predetermined seriousness.

Electronic Controlled Pumping System (Patent No. 2,682,964); D. S. Scherer, inventor. The patent describes an electronically controlled gas-pumping system of the tooper type. Electronic means are provided for alternately evacuating and applying pressure to the fluid pumping apparatus.

Variable Voltage Wave Form Generator (Patent No. 2,683,807); G. D. Paxson, inventor. The patent relates to an electronic circuit for generating a voltage waveform having a plurality of variable voltage points which may be varied independently without disturbing the value of the voltage at other points of adjustment of the waveform.

Ion Beam Measuring Device (Patent No. 2,684,814); E. L. Mather, inventor. The patent covers an ion beam energy measuring device and particularly to determining the angle of emission of secondary radiation generated by the bombarding beam. The angle of emission of the secondary radiation generated is a function of the energy of the bombarding beam, which may be determined thereby.

Shock or Vibration Isolating Means (Patent No. 2,684,855); E. K. Arnold, D. W. Leviano, and G. L. Cooper. The patent relates generally to means for isolating objects from shocks or vibration. The apparatus comprises a combination of steel springs and variable rate silicone springs in parallel to achieve isolation and protection at extreme high and low temperatures and regardless of the positioning or attitude of the moving system.

Resonant Type Shake Table (Patent No. 2,686,427); D. M. Ellert and W. E. Baker inventors. The patent covers an adjustable-frequency shake table capable of large excursions with small input energies. The table is caused to move to vibrate, by an electromagnetic motor, the energization of which is adjustable in frequency.
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Tiny-Mite Engineering Data Sheets are available on request to Wheeler — producers of fine gauge magnet wire, specialized coils, and transformers. Your own special needs can almost certainly be met by standard units in this new series, or by possible modifications. We will welcome your inquiry.

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Books...


Written for the engineer and not the artist or industrial designer, this book is based on the assumption that anyone has the ability to recognize good form. This assumption is followed to two conclusions: good appearance means good sales, and engineers can be trained to design products with pleasing appearances. Not simply a how-to-do-it handbook, the volume considers how a designer functions and what design is as a concept.

Beginning logically with the total form, which the writer holds is closely related to function, the work progresses to important details such as meters, handles, knobs, and finishes. The author makes the worthwhile point that a knob should indicate by its shape how it is manipulated. In other words, an on-off switch should not have a round knob, which indicates continuous rotation. The proper lettering for meter faces is also discussed.

The final chapter, entitled "Presentation", tells how to present a sketch in the manner most likely to enhance it and thereby gain approval from management. There are three appendices. The first is a bibliography with one-paragraph abstracts for each work listed. The second discusses perspective, and the third recommends various water-color washes to be used on sketches submitted for approval. Each chapter is well illustrated with drawings, and a group of photographs of outstanding technical designs is bound in the book.

Electronic design laboratories requiring the services of a digital computer will find this publication of great value. It is the result of the latest world-wide O.N.R. survey of digital computers in operation. The first such survey was undertaken in 1947. Ninety-eight different types of computers in the United States and 11 foreign countries are listed on separate pages with all pertinent data such as their capacity, speed, and availability. An alphabetical index of the computers by name and a listing of the computers and their builders by the state or nation they are located in are also given.


Based on the author's experience in teaching at the Massachusetts Institute of Technology and designed as a textbook, this well-illustrated volume should serve as a valuable introduction to or reference on acoustics for many electronic designers. Beginning with a discussion of the terminology in the field, the author devotes many pages to the wave equation, considers all types of sound producing and receiving equipment, and ends with a chapter on hearing, speech intelligibility, and psychoacoustic criteria.

The last chapter is of value to engineers seeking to determine the minimum frequency band or maximum noise level permissible to still convey speech or intelligibility. There is also a chapter on acoustic measurements. This work should help to secure the position of acoustics as a precise science.

Television Factbook . . . 400 pages, paper cover. Television Digest, Wyatt Building, Washington 5, D. C. $4.00.

Designers of equipment for the television industry will find the Television Factbook, of which this is the 19th semi-annual edition, of interest. All the TV stations in the United States and 110 stations in 32 foreign countries are listed together with many other industry statistics. The text of the FCC color standards is given.
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3. Hermetic's quality production techniques are field-performance-proved leak-proof. Mass spectrometers and similar inspection devices are employed. Extra quality finishing operations at Hermetic include hot tin dipping for ease-of-solderability.

Hermetic headers are equally applicable for other miniaturized electronics "packaging": rectifiers, relays, printed circuit assemblies, etc. Ask for our catalog.

Packaging

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September 1954

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![Graph showing temperature rise vs. load for IRC's PW-4, PW-7, and PW-10 resistors.](image-url)

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