VITREOUS ENAMEL IS FINE

But for Power Resistors you need IRC Resisteg Coating

Consider the curing temperatures required for wire wound power resistor coatings and you'll readily see the advantages of IRC's exclusive RESISTEG Coating.

The low curing temperature of RESISTEG Coating is 205°F.—about the boiling point of water in many areas. Vitreous enamel must be cured at 1200°F., or higher!

IRC's low-temperature curing doesn't change the position of the wire, and winding turns do not shift together. No wire stretching, with its "work-hardening" aftereffect, is needed to prevent wire shifts. RESULT: IRC Power Resistors have no "hot spots" from arcing-over. They offer greater stability, longer life and need no derating...even at high values.

Write for catalog of over 50 IRC Power Resistors including MIL types

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VIA AIR MAIL

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Optimum performance
in virtually all tape handling applications

The advanced design of the completely transistorized Potter Model 906 Tape Handler provides improved performance in virtually any tape handling application. Replaceable Capstan Panel permits use as Perforated Tape Reader with a remarkable new brake capable of stopping on the stop character at speeds up to 1000 characters per second. Using a small vacuum loop buffer, Model 906 features:

- Complete front accessibility—single panel construction
- Pinch rollers capable of 100 million start-stop operations
- In-line threading, end of tape sensing and tape break protection
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- As many as 4 speeds forward and reverse
- Capable of continuous cycling at any frequency from 0 to 200 cps without flutter
- Rewind or search at 400 ips
- 3 millisecond starts
- 1.5 millisecond stops
- Tape widths to 1-1/4"
- Up to 47 channels
- All functions remotely controllable
- The 906 may be supplied with a transistorized Record-Playback Amplifier featuring a separate module for each channel. Electronic switching from record to playback function is available as an optional feature.

Other Potter products include Transistorized Frequency Time Counters, Magnetic Tape Handlers, Perforated Tape Readers, High Speed Printers, Record-Playback Amplifiers and Record-Playback Heads.

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- For TV video and portable radio applications;
- Low capacity video detection; efficiency controlled at 50 Mc

Germanium VIDEO DETECTOR Diodes

Silicon DIFFUSED JUNCTION GLASS RECTIFIERS

<table>
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<tr>
<th>TYPE</th>
<th>Peak Operating Voltage -50°C to +75°C</th>
<th>Ave. Rectified Current</th>
<th>Reverse Current (Max.) in µA at Specified Voltage</th>
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<tbody>
<tr>
<td>1N558</td>
<td>150 5</td>
<td>500 at -150</td>
<td>10 at -10</td>
</tr>
<tr>
<td>1N66A</td>
<td>60 5</td>
<td>50 at -10</td>
<td>25 at -10</td>
</tr>
<tr>
<td>1N557</td>
<td>80 4</td>
<td>50 at -50</td>
<td>75 at -10</td>
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<tr>
<td>1N67B</td>
<td>100 3</td>
<td>625 at -100</td>
<td>100 at -100</td>
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<td>1N96</td>
<td>60 10</td>
<td>800 at -50</td>
<td>100 at -50</td>
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<td>1N126</td>
<td>60 5</td>
<td>50 at -10</td>
<td>100 at -10</td>
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<td>1N127</td>
<td>100 3</td>
<td>25 at -10</td>
<td>250 at -40</td>
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Silicon DIFFUSED JUNCTION RECTIFIERS

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<th>TYPE</th>
<th>Peak Operating Voltage -65°C to +15°C</th>
<th>Ave. Rectified Current</th>
<th>Reverse Current (Max.) at Specified PIV, 150°C</th>
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<tr>
<td>1N536</td>
<td>50 750 250</td>
<td>0.40</td>
<td>3.0 at 25°C</td>
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<tr>
<td>1N537</td>
<td>100 750 250</td>
<td>0.40</td>
<td>3.0 at 25°C</td>
</tr>
<tr>
<td>1N538</td>
<td>200 750 250</td>
<td>0.30</td>
<td>3.0 at 25°C</td>
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<tr>
<td>1N539</td>
<td>300 750 250</td>
<td>0.30</td>
<td>3.0 at 25°C</td>
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<td>1N540</td>
<td>400 750 250</td>
<td>0.30</td>
<td>3.0 at 25°C</td>
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<td>1N1095</td>
<td>500 750 250</td>
<td>0.35</td>
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<td>1N547</td>
<td>600 750 250</td>
<td>0.35</td>
<td>3.0 at 25°C</td>
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<tr>
<th>TYPE</th>
<th>Peak Operating Voltage -65°C to +15°C</th>
<th>Ave. Rectified Current</th>
<th>Reverse Current (Max.) at Specified PIV, 25°C</th>
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<td>95 3.0</td>
<td>1.0 at 25°C</td>
<td>10</td>
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<tr>
<td>1N254</td>
<td>190 3.0</td>
<td>1.5 at 25°C</td>
<td>10</td>
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<tr>
<td>1N255</td>
<td>380 3.0</td>
<td>1.5 at 25°C</td>
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<tr>
<td>1N256</td>
<td>570 0.95</td>
<td>0.2 at 25°C</td>
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<tr>
<td>CK846</td>
<td>100 3.5</td>
<td>1.0 at 25°C</td>
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<td>CK847</td>
<td>200 3.5</td>
<td>1.0 at 25°C</td>
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<td>CK848</td>
<td>300 3.5</td>
<td>1.0 at 25°C</td>
<td>2</td>
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<tr>
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<td>1.0 at 25°C</td>
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<tr>
<td>CK851</td>
<td>600 3.5</td>
<td>1.0 at 25°C</td>
<td>2</td>
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</tbody>
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Ratings at 25°C unless otherwise indicated. All illustrations actual size.
Manned Space Laboratory Within Three Years

WITHIN THREE YEARS a recoverable manned spaced laboratory may be hurtled into orbit by Northrup Aircraft, Hawthorne, Calif.

Company officials asserted that they have "developed basic design criteria for a perfectly feasible manned space laboratory." The space laboratory will be a bullet-shaped capsule, approximately 7 ft in diam and 10 ft long. The space traveler inside it would be strapped in a near-reclining position in order to withstand acceleration forces. Contemporary rocket engines would boost the space laboratory into orbit.

Once in orbit, it would be turned by attitude control jets so that its blunt end faced forward. This would provide a high drag to slow the capsule as it hurtled back into the earth's atmosphere.

During re-entry the vehicle would slow from 25,000 fps to 1000 fps by the time it descended to 60,000 ft altitude.

Between 20,000 and 30,000 ft, altitude parachutes would open to ease the capsule to the ground.

Many of space laboratory's preliminary design problems are being solved by COM-PADAC, an extensive computer and data handling facility. Installation includes IMB 704 which handles 4000 multiplications, or 40,000 additions per second.
Reverse thrust rocket would be fired at a point 180 deg from the desired landing point when manned space laboratory is to be returned to earth. Velocity would be reduced so that the capsule would go into an elliptical orbit whose perigee would be the earth's surface. Capsule would reenter atmosphere at an angle of two deg from local horizontal.

Luxuriating space traveler in one ton vehicle will play host to a multitude of instrumentation. In the nose of the capsule is the reverse thrust rocket. Below it are parachutes for the final stage descent. During launching pointed end of capsule would be forward to reduce drag. Man is supported in a nearly prone position during launch and recovery so that he may withstand the effects of acceleration and deceleration. Proposed navigation system for laboratory is a star tracking system similar to the one developed for the Snark missile.
Continuous Process For Etching Copper

Downtime of equipment such as that used in the manufacture of printed circuits will be eliminated by a new process for continuously regenerating copper etching solutions. Developed by Dr. Paul D. Curn and Dr. Louis H. Sharpe of Bell Telephone Labs., New York, N.Y., the process will also do away with the dangers inherent in changing the corrosive spent etchants and make it possible to salvage the etched copper.

Etching solutions used in the new process are composed of cupric chloride in the presence of excess chloride ions. They can be regenerated electrolytically while etching operations continue, either on a self-regulating basis, or on a time cycle. Hydrochloric acid, sodium chloride, and ammonium chloride have all been investigated as sources of the excess chloride ions.

Highway Control System Demonstrated

Demonstration facilities of the "electronic highway of tomorrow" are now in operation at RCA, Princeton, N.J.

Cars entering the trial grounds pass over electronic loops buried in the entrance road. Transistorized detector units connected to the loops count each of the passing cars, measure the speed of each, and flash a warning sign at the roadside saying "Slower, Please," to every driver exceeding the posted speed limit. The new equipment is a transistorized variation of the comprehensive electronic vehicle control system developed earlier by RCA and demonstrated last year at Lincoln, Nebraska, in cooperation with the Nebraska Department of Roads. Detector loops in the roadway consist of rectangles of wire 6 x 20 ft in outline.
Publication Date Set
For Printed Circuit Manual

Tentative publication date of the newly compiled circuit industry manual How to Design and Specify Printed Circuits, has been set for July according to W. J. McGanley, President of the Industry of Printed Circuitry, 27 E. Monroe, Chicago 3, Ill.

This manual, representing the combined experience of manufacturers who are members of the IPC, will include information on: engineering steps for utilizing printed circuits; mechanical considerations; characteristics of printed circuit switch plates; selection of materials; characteristics of copper-faced laminates; dimensional considerations; finishes; multiple soldering techniques; and a special section on standard tolerances. The booklet will sell for $5.00.

The Institute is currently making plans for a special technical session for members to be held in November, 1958, in Chicago.

Coiling World's Largest Inductance

This huge inductance coil, shown during assembly, supplies energy to an electric-arc tunnel for testing missiles. Coil is wound with thirty-six 850 mcw cables in parallel. It measures 119 in. in diam. Energy is stored in the coil when its field is built up by a d-c source; the chamber circuit is closed at this time. Contacts in series with the coil are then opened. An arc is produced in the chamber by the instantaneous collapse of the strong magnetic field in the coil. This heats the air in the arc chamber to 40,000 deg F and raises the pressure to 30,000 psi. The plastic seal vaporizes, releasing a blast of hot gas which rushes through the test section and into the vacuum chamber at a speed of 32,400 mph. It was designed and built at Westinghouse Electric Corp., Transformer Div., Sharon, Pa.

PROBLEM: How to Capture Elusive Transients

Attempting to analyze elusive non-recurring transients has sent the best of engineers “to the showers.” Conventional practices for monitoring or examining spurious signals or noise factors do not permit accurate investigations. The result is a wasteful expense of your time, your nerves, and your company’s money.

SOLUTION: The Hughes MEMO-SCOPE® oscilloscope freezes wave forms until intentionally erased. Selected transient information may be triggered externally or internally and retained for viewing. Successive wave forms may be written above, below or directly upon the original information.

HUGHES MEMO-SCOPE OSCILLOSCOPE
Sweep Speed for Storage: 10 microseconds to 10 seconds per division (0.33*).
Frequency Response: DC to 250 KC down 3 db.
Sensitivity: 10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.
Applications: Trouble shooting data reduction equipment... switch and relay contact study... ballistics and explosives research... ultrasoic flaw detection... physical testing - shock - stress - strain.

A Hughes representative will gladly demonstrate the Memo-SCOPE® in your company. Address requests to:
HUGHES PRODUCTS MEMO-SCOPE Oscilloscope
International Airport Station, Los Angeles 45, California

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HUGHES PRODUCTS
SERVICE

MICROWAVE ELECTRONIC INSTRUMENTS

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Field service is readily available when you need it — at no charge! Experienced maintenance engineers will make minor repairs at your plant, if necessary. Complete factory overhaul will be made in case of major repairs. This equipment service policy, at no charge, assures you of years of continuous use of Polarad equipment. This new service policy is in addition to the liberal Polarad parts warranty.

2 TECHNICAL ASSISTANCE:
The Polarad sales representative in your area is ready to render valuable technical assistance both at the time you purchase your Polarad Microwave instrument as well as throughout its long service life.

3 TRAINING:
Free training at our plant in the proper use, repair and maintenance of Polarad microwave instruments is available at all times.

Be sure you get Polarad's life-long service whenever you invest in complex microwave equipment.

*The equipment shown above:
1. Polarad Model R Extended Range Microwave Receiver
2. Model TSA Direct Reading Spectrum Analyzer
3. Model B Code Modulated Multiple Pulse Microwave Signal Generator
4. Model MSG-34 Ultra Broadband Microwave Signal Generator
5. Model ESG Microwave Sweep Generator

POLARAD ELECTRONICS CORPORATION
43-20 34th Street, Long Island City 1, N.Y. • EExeter 2-4500

ENGINEERING REVIEW

Wind Tunnel Adopts Digitizing System

A force and moment digitizing system has been selected for wind tunnel model studies at the Southern California Cooperative Wind Tunnel, Pasadena, Calif. It employs nine Vibrotron digital transducers and matched amplifiers to sense and signal hydraulic pressure variations from emery load sensing capsules directly attached to the test platform. Drag, lift and crosswind forces and pitch, yaw and roll moments are computed by the data digitizing equipment which consists of digital gating and counting circuits and relay control circuitry. A system signal commutator sequentially samples the transducer signals controlling the operation of the digitizing system to perform digitizing, totalizing and subtraction of forces and moments.

Each of the transducers basically consists of a fine hair-sized wire stretched between an anchor point and a metal diaphragm. In operation, the wire is set into vibration in a permanent magnetic field by an alternating current along the wire; wire length and tension determine the vibrating frequency.

During tunnel tests, the model is exposed to precisely controlled wind forces that subject the stand-mounted hydraulic emery capsules to variations in internal pressures, changing diaphragm displacement within each connected transducer. Subsequent wire tension change decreases or increases transducer vibrating frequency; output frequencies from the companion amplifier change accordingly, delivering a direct-signal output signal readable as a numerical indication.

Repeatability and resolution of the system from applied pressure to digital output is equal to or greater than plus or minus 0.05 per cent of full scale, based upon repetitive calibrations.
Now, just one step! Analac lets you solder without pre-stripping!

Analac's Analac* magnet wire saves time and money on the production line. This film-insulated, solderable magnet wire can be used just as you use Formvar or Plain Enamel—with this plus advantage... it is solderable without pre-stripping the insulation.

Analac cuts down labor-time where many solderable connections are to be made. It's ideal, too, where removal of the insulation is a hazard to the wire. Soldering Analac by dipping, iron or gun produces a perfect joint.

It performs well in high-speed winding! Analac has the excellent abrasion-resistance and other mechanical advantages of the enamel wire you're now using.

Distinctive red color simplifies identification... is highly visible, helping operators turn out higher quality work.

Analac, 105°C (AIEE Class A) wire, is available in sizes from 15 Awg to 46 Awg.

The Man from Anaconda will be glad to give you more information. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N.Y.

SEE THE MAN FROM ANACONDA®
FOR READY-TO SOLDER ANALAC MAGNET WIRE

For details on how you can save with Analac, and for engineering data—please turn the page!
IMPORTANT FACTS FOR YOUR WORK... about Analac 105°C (AIEE Class A) Magnet Wire

SOLDERABILITY. Anaconda’s Analac can be used to overcome high cost of insulation stripping by adapting your present system to automatic soldering techniques. Your Anaconda sales representative can arrange for cooperation from Anaconda’s Research Laboratories to help you take full advantage of Analac’s cost-saving possibilities.

Analac is versatile; lends itself to gang soldering, to iron, gun and dip soldering. Anaconda’s Analac Booklet contains full information on soldering methods, fluxes, temperature control. Use the coupon below for your copy.

WINDABILITY. Analac is abrasion-resistant... has excellent lubricity and surface characteristics which make it readily adaptable to automatic high-speed winding operations. Can be used on your present equipment—no retooling is necessary to adapt solderable Analac.

COMPATIBILITY. Analac is compatible with most insulation varnishes presently being used.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Analac has excellent mechanical properties. The film possesses superior abrasion-resistance and flexibility under a number of varied conditions—such as heat, cold and moisture. The wire shows no cracks when elongated rapidly to the breaking point. It will also withstand 3 times diameter wrap after 20 percent elongation.

MOISTURE-RESISTANCE

Analac’s moisture-resistance is excellent, particularly in size range 25 and heavier. It offers moisture-resistance superior to most other film-type insulations.

ELECTRICAL PROPERTIES

<table>
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<th>Dielectric strength</th>
<th>NEMA twist test, room conditions.</th>
<th>NEMA twist test, dry.</th>
<th>NEMA twist test after 6 hours exposure at 100°F and 100% relative humidity, layer test—double layer wind on 1-inch diameter mandrel, apply voltage between layers.</th>
<th>Number of Tests Averaged</th>
<th>Volts per Mil at Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>145</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>2840</td>
</tr>
</tbody>
</table>

Analac has superior dielectric strength both in a dry condition and after exposure to high humidity. Meets NEMA twist test requirements. Analac has unusually low dielectric losses at high frequencies, which are only slightly affected by high humidity. Thus Analac is particularly suited for electronic uses.

Chemical Properties

Analac has good resistance to the action of solvents, water, and dilute acids and bases. Analac will withstand 24 hours’ immersion at room temperature in most varnish solvents including naphtha, toluol, xylol, and ethyl alcohol. Shows excellent resistance to 5% sulfuric acid and 5% potassium hydroxide.

Thermal Properties

Analac is offered as 105°C (AIEE Class A) magnet wire, although its thermal stability shows it is capable of performance at much higher temperatures. Analac’s thermoplastic flow cut-through data, obtained on basis of MIL-W-583A methods, has been above 200°C.

New Analac Booklet—yours for the asking! Latest information...full technical data. Mail coupon for your copy.

ANAConDA WIRE & CABLE COMPANY
25 BROADWAY, NEW YORK 4, NEW YORK

Please send copy of your Analac Magnet Wire Booklet. I am interested in heavy or intermediate size (15 Awg to 30 Awg); fine sizes (31 Awg or finer)...
under stable environmental conditions. Digital outputs are stored in six relay bank registers for compatible use with summary punch and lamp bank display. The facility is operated by California Institute of Technology for 5 aircraft companies: Convair, Douglas, Lockheed, McDonnell, and North America.

New Satellite Transmitter Doubles Present Efficiency

The development of a new transmitter will enable U.S. satellites to telemeter data 1-1/2 to four times as long as is presently possible.

The transmitter is a 500 milliwatt version of the Naval Research Laboratory's 100 mw satellite transmitter. Months of extensive development and testing will be required before it can be programmed into an actual satellite. The crystal controlled transmitter employs three transistors capable of operating as oscillators or amplifiers at 108 mc. The transmitter weighs less than 3 oz, and occupies less than 6 cu in. For a power output of 500 mw, it uses one-half to one-fourth the battery power needed by any other transmitter now known. The transmitter can be operated on solar batteries, with one-half to one-fourth of the rocket surface heretofore required for sun exposure, according to engineers at Dukane Corp., St. Charles, Ill., who designed the device.

The output stage of a conventional tube-type transmitter doing the same job would need 4620 mw to produce 500 mw output. By contrast, the output stage of the new transmitter needs 930 mw power to produce the same output. The corresponding efficiencies are 11 per cent and 54 per cent, respectively. The circuit operates on a single 20 to 24 v battery.
ENGINEERING REVIEW

Improve Midwest Telegraph Facilities

Telegraph facilities for the midwest area were greatly increased with the addition of a 557 mile microwave radio beam system that was placed in operation between Pittsburgh, Cincinnati, and Chicago. 1600 telegrams can be transmitted simultaneously at the rate of more than 100,000 words a min over the Western Union system. The beam system is virtually immune to interruption from storms and electrical interference. Failure of local commercial power along the route will not halt operation. Propane gas-driven, automatically-controlled, emergency power generators will instantly continue the electrical power at all stations without the loss of a single telegraph pulse. Passive reflectors on the 290 ft masts deflect the arriving beam to the ground stations. There the received signals are amplified in power and flashed back to another reflector on the mast which projects the beam to the next mast 20 to 37 miles away.

Utility Poles Can Be Dangerous

Fine utility poles treated with creosote can be potentially dangerous, engineers were warned. At the Middle Eastern District Meeting of the A.I.E.E., J. H. Winters, Jr. and H. E. Zienengfuss of the Baltimore Gas & Electric Co., said that a number of tests indicated that electric equipment mounted on such poles “is not sufficiently insulated from ground to be safe. Linemen who consider such equipment to be isolated are under the wrong impression and perhaps lulled into a false sense of security.” Investigation showed that the resistance to ground of pole mounted metal structures varies with the age of the pole and the depth of penetration of the mounting bolts or lags and is generally low enough to

< CIRCLE 8 ON READER-SERVICE CARD
His tact against secondary structure resulting in either a fall or possible heart fibrillation. Ungrounded metallic pole mounted equipment, such as transformers, should be regarded as partially grounded or energized, they stated.

Scientific Russian To Be Taught in Summer

Carnegie Institute of Technology will offer a summer course in Scientific Russian in answer to increasing needs of graduate students and research workers. The 18-unit course, equivalent to a full year of work, will meet two hours daily from June 16 to August 9. Carnegie president John C. Warner, stated that only a small fraction of the leading Russian technical periodicals are translated into English, and that those which do appear are generally four to eighteen months later than their originals. College libraries could afford many more journals if researchers read Russian, he added, because translations are as much as ten times more expensive. The course places stress on a quick acquisition of reading knowledge in technical literature, with writing instruction deferred to advanced courses.

Brave New World? Step in Right Direction

Reproduction engineers are now rapidly spreading themselves throughout industry. Technical function of the new professional group lies in the field of processes for making multiple or single copies of any two-dimensional material used in business.

Reproduction engineering has already blossomed to an annual volume estimated at three billion dollars.

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This experience has met the challenge. Our precision quality and service in the infant Printed Circuitry industry has brought us acceptance of our circuits exceeding many of our older products. Our new Printed Circuit Division geared for volume production will share a major portion of our new facilities now under construction. Your acceptance of our products has made this expansion inevitable. We would like to help you improve your product now. Write for literature.

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ENGINEERING REVIEW

Pressure Regulator For Missile Equipment

Self-destruction of electronic guidance equipment on guided missiles is being prevented by a specially developed air pressure regulator. The regulator maintains approximate sea level pressure in an electronics compartment. Without this environmental control the equipment would be subjected to destructive electrical arcing at the low pressures of high altitude. Essentially, the unit developed by The Garrett Corporation's AirResearch Mfg. Div., Los Angeles, Calif., is an outflow valve operated by a spring and bellows arrangement. The interior of the bellows is evacuated to approximately 0 pressure. As the unit is carried to higher altitudes, faster flow of gas from the compartment to the atmosphere results in lower compartment pressure on the bellows. This allows the bellows to expand with the assistance of the spring.

The resulting action positions the valve to lessen the opening that permits flow to the atmosphere. In this manner, the gaseous environment of the chamber is kept in circulation at a constant pressure.

Magnetic Thrust Engine For Space Flight Described

Thrust to maneuver the first manned satellite in outer space may be accomplished by using a magnetic field to accelerate and expel a neutral plasma of fully ionized gas. According to Dr. Richard M. Patrick of Avco Mfg. Corp., Everett, Mass., the magnetic thrust engine would be used to alter the altitude of its orbit while circling the earth or speed it on trips to the moon or other planets. A number of different propulsion systems which have been suggested for travel outside the earth's atmosphere were mentioned including: the chemical rocket; the ion rocket;
“sails” which reflect solar radiation to produce thrust, and propellants accelerated by heat energy from a separate source (such as a nuclear reactor) and expanded to the outside of the vehicle in a nozzle.

The magnetic propulsion system eliminates the process of separating ions which is an integral part of the ion rocket system.

Transistor Amplifier Distortion Solved

Estimates of power output and per cent distortion for single-ended class A, transistor power amplifier may be made by a new method described at the Great Lakes District Meeting of the AIEE.

J. D. Horgan of Marquette University, Milwaukee, Wisc., said the method is based on piece-wise-linear approximations of the transistor's external characteristics. Construction of the usual load line on the output characteristics is required. Two points from the dynamic input characteristics are transferred to the load line and reference is then made to a universally applicable curve.

The problem of estimating distortion, Mr. Horgan pointed out, has usually been solved by approximating the transfer characteristic with a quadratic curve and selecting parameters in the equation to fit the characteristic at the operating point.

“Such approximations,” he said, “do not match the transfer characteristics well for large input signals, are restrictive in that distortion due to frequency components above the second harmonic is neglected, and are cumbersome to handle.”

The new method is generally accurate enough for engineering purposes, according to Mr. Horgan.

“The errors introduced by the method,” he said, “are...small and not as significant as the discrepancies which exist between the external characteristics of a particular transistor and the manufacturer's typical characteristics with which the circuit designer works.”

PHILCO. CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA
ENGINEERING REVIEW

Digital Computer Multiplication

An improved multiplication method developed at the National Bureau of Standards can achieve a three-fold increase in present operation speeds. The technique can be generally applied and does not require any particular kind of digital computing components or circuitry.

The most common method of multiplying with binary digital computers is the repeated addition of the multiplicand. A one-position shift accompanies each addition, and a running sum of the partial products is maintained in an accumulator. In this process, the accumulator is cleared initially. During the first addition cycle, if the least significant digit of the multiplier is a 1 the multiplicand is added to the contents of the accumulator. If it is a 0, nothing is added. In either case, the contents of the accumulator and of the multiplier register are shifted one position to the right. Similarly, during the second addition cycle, the next most significant digit of the multiplier determines whether the multiplicand is or is not added to the contents of the multiplier. Again, in either case, the contents of the accumulator and of the multiplier register are shifted one position to the right. After each multiplier digit in turn has controlled the addition of the multiplicand to the contents of the accumulator (with the one-position shift for each cycle) the multiplication operation is complete and the final product is available in the accumulator.

The Bureau's system omits some of these steps when a sequence of several consecutive 1's or 0's appears in the multiplier. Whenever any multiplier digit is a 0 and nothing is to be added to the partial-product sum, that addition cycle could be omitted entirely, and only a shift need be performed. A sequence of 0's would allow omitting as many addition cycles as there are 0's. Similarly, if a sequence of 1's occurs in the multiplier, cycles corresponding to these 1's may also be omitted in much the same way, if subtraction of the multiplicand from the partial-product sum is provided for.

Consider a string of \( n \) consecutive 1's in the multiplier. The numerical value of just this string of binary 1's is equivalent to \( 2^n - 2^0 \). Therefore, in computing the partial products corresponding to this string of \( n \) 1's, one subtraction of the multiplicand for the right-hand 1 and one addition of the multiplicand for the 0 to the left of the string of 1's are sufficient.

A fundamental requirement of the multiplication process is that the contents of the accumulator (and of the multiplier register) be shifted one position to the right for each digit of the multiplier, regardless of whether or not any of the cycles are omitted. Therefore, in order that
the multiplication time be shortened to the fullest extent by omitting cycles of the operation, some arrangement must be made for accomplishing multiple-position shifts as rapidly as possible. Ideally, the shifts that correspond to cycles to be omitted should be combined with the shift that accompanies the last cycle actually performed. Thus, for example, if three cycles are to be omitted, one shift of four digit positions should be executed instead of four shifts of one position each.

Some measure of the effectiveness of this shortcut multiplication technique can be determined on the basis of a purely random sequence of multiplier digits. In this case, it turns out that the number of cycles for \( n = 3 \) is about 40 per cent of the number of digits. In practice, multiplier digits are often not random, nor even apparently so, but experience indicates that departures from randomness usually favor sequences of similar digits. Thus, the average number of cycles required for multiplications will generally be less than the theoretical number for random sequences. If a curve were plotted for the average number of cycles required for multiplier sequences usually occurring in practice—a mixture of random digits and strings of similar digits—this curve would lie between the curve for purely random sequences and the curve for the best sequences.

Now in full-scale production is Sperry’s new SRU-95 reflex oscillator klystron developed especially for use as a signal source in radar test equipment.

The SRU-95 covers the frequency range from 12.4 to 15.5 kmc with two reflector-voltage modes, one with broad bandwidth and the other with high power. It delivers a minimum r-f power output of 20 mw into a load with a VSWR of less than 1.1. Small but rugged, the SRU-95 has superior mode characteristics for automatic frequency control operation.

Important features include waveguide output, integral cavity and tuner, single-screw tuning covering full frequency range in only 9 turns.

Other applications for the SRU-95 are local oscillator in microwave receivers and spectrum analyzers, low-power transmitting tube, and bench oscillator. Write or phone for data sheet on the Sperry SRU-95.
**The Arnoux Model TDS30-1 Decommuation System**

The Arnoux Model TDS30-1 Decommuation System is completely self-contained within three chassis assemblies consisting of: Gating Unit (TOP), Pulse Selector (MIDDLE) and Regulated Power Supply (BOTTOM). The unit handles 28 channels of information and occupies only 19½ inches of panel height in a standard relay rack. Overall depth behind panel is 13 inches.

**WASHINGTON REPORT**

Herbert H. Rosen

**Ad Hoc Group on Electronic Parts Set Up by DOD**

Assistant Secretaries of Defense for Supply and Logistics and for Research and Engineering have agreed to sponsor jointly an *ad hoc* group on electronic parts. Jim Bridges' Office of Electronics will administer a program aimed at setting up procedures and specifications for parts reliability. The group will review management, prepare parts and tubes specifications, and coordinate procedures and practices. The QPL and Qualifications Testing Procedures are also to be reviewed with an eye toward propriety of qualifications, adequacy of tests, and elimination of duplication.

Reliability Assurance Test Procedures are to be developed to verify compliance with the designated reliability level. A program is to be developed for obtaining technical characteristics and test data for parts. The group will, in addition, investigate the need for a document which will provide design guides rather than rigid specifications.

**Navy, Air Force To Spend Four Billion in Electronics**

Recent hearings before a House Appropriations Subcommittee have disclosed Navy and the Air Force hope to spend nearly four billion for electronics. Almost 10 per cent of the Navy's $1.1 billion budget request and $3 billion of the Air Force's $19 billion will be used to buy electronic equipment and services.

More specifically, the Navy plans for electronic spending breakdowns in this manner: $300 million in varied land, sea, and air electronics; $500 million in aircraft; $80 million in missile activity; $30 million in antisubmarine warfare; $20 million for R & D.

As for the Air Force: Missile support—ground electronics, $878 million; general support and ECM equipment, $747 million; command control and warning equipment, $810 million; R & D, $120 million; and O & M, modifications, air defense, ECM, installations, meteorology, $328 million.

In terms of equipment, the Navy will sink its money into missiles and submarines, the
Pacific Missile Testing Center, Sonobuoys, detection and ground approach radar, ASW, modernization of communications equipment, modernization of navigation aids; data processing systems; and R&D ranging from development of communications networks to high temperature components.

A hefty chunk of Air Force money is earmarked for the operational support of SAGE ($430 million), White Alice, DEWline, and Pinetree Line. The Ballistics Missile Early Warning System will receive an additional $86 million. New Air Defense electronics will be researched with about $28 million. The same amount of money will be turned over to the Army Ballistic Missile Agency for more work on the Jupiter missile.

DEWline, which is now getting eastern and western extensions, is to have new radars and associated communications equipment valued at $44 million. Other radar improvements costing $15 million, and high-power communications, data link, and identification equipment (at $34 million) together are sought to strengthen the early warning system.

Reorganization Effects

While most of the headlines underscore Defense Secretary McElroy's battle over a single chief, single service, there appears to be complete unanimity on setting up a Director of Defense Research and Engineering.

His Director will be the principal advisor on scientific and technical matters. He will supervise all R&E activities, including those of ARPA and the Office of the Director of Guided Missiles. He will also direct R&E activities that require centralized management.

Besides these broad duties, the Director of R&E will:

- plan research and development meeting military objectives;
- eliminate unnecessary duplication;
- release promising programs for development or production;
- analyze technical programs for integration of R&D to meet the needs of each operational command.

This job is going to require a great amount of advice from staffs of experts and consultants.

A growing fear among Pentagon officials is that well-known scientists and engineers from the universities will be drawn into these jobs. While they are by and large outstanding in their fields, there is doubt concerning their management capabilities. And this, in the final analysis, is the major responsibility of anyone who works for the upper echelons of the Department of Defense, and an area in which there have been noticeable deficiencies.
MEETINGS

July 24-25: 5th Annual Symposium on Computers and Data Processing
Albany Hotel, Denver, Colo. Sponsored by the Denver Research Institute Electronics Div., University of Denver. Symposium will consist of technical papers on basic problems in the field of data processing, particularly in the areas of formalized analysis techniques, logical design techniques, automatic programming, systems organization, digital communications, and components and devices. Queries concerning the symposium may be addressed to C. A. Hedberg, Head, Electronics Div., Denver Research Institute, University of Denver, Denver 10, Colo.

Aug. 6-8: Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers
Hotel Statler, Los Angeles, Calif. Sponsored by AIEE. The four technical sessions will include: technological and theoretical aspects of nonlinear magnetics and magnetic amplifiers; computer applications; special purpose devices and applications; and "new frontiers" in the field. Exhibits will be displayed by 40 manufacturers selected for their contributions to the industry. For more information about the conference, write AIEE, 33 West 39th St., New York 18, N.Y.

Aug. 13-15: 7th Annual Conference on Industrial Applications of X-Ray Analysis
Albany Hotel, Denver, Colo. Sponsored by University of Denver, Denver Research Institute, Metallurgy Div. For additional information write William M. Mueller, Metallurgy Div., Denver Research Institute, University of Denver, Denver 10, Colo.

Aug. 13-15: Conference on Electronic Standards and Measurements
NBS Boulder Labs., Boulder Colo. Sponsored by the Professional Group on Instrumentation of IEEE, Electronics and High-Frequency Instruments Committee of AIEE, and the Radio Standards Lab. of the National Bureau of Standards. Six technical sessions will cover the following subjects: The Relationship of Standards to Physical Constants; Frequency and Time Interval Standards; Direct-Current and Low-Frequency Standards; Radio-Frequency Standards (Measurement of voltage, current, power, impedance, attenuation, phase shift, field strength); Microwave Standards (Measurement of power, impedance, attenuation, noise), and The Organization and Operation of Standards Laboratories. Write

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Aug. 19-22: Western Electronic Show and Convention
Los Angeles, Calif. Details will be announced later. For more information write Western Electronic Show and Convention, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Sept. 12-14: 7th Annual High Fidelity Show
Palmer House, Chicago, Ill. Write to International Sight and Sound Exposition, Inc., One N. La Salle St., Chicago 2, Ill., for further details.


Sept. 22-24: National Symposium on Telemetering
Americana Hotel, Miami Beach, Fla. Sponsored by PGTRC of IRE. Ken West, 1345 Indian River Dr., Eau Gallie, Fla., has additional information about the symposium.

Sept. 24-25: 7th Annual Symposium on Industrial Electronics

Paper Deadlines
June 25: Deadline for papers to be presented at the 1958 National Simulation Conference. The conference, sponsored by the IRE, is planned for October 23-25 in Dallas, Tex. One hundred words abstracts and 500 word summaries of technical papers in the general field of simulation should be transmitted in duplicate to D. J. Simmons, Rt. 8, Box 447, Ft. Worth, Tex.

Aug. 1: Deadline for papers for the 7th Annual Meeting of the Standards Engineers Society. Papers preferably should be related to the theme of the meeting, Standardization; A Must for the Space Age. This meeting will be held on
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**MEETINGS**


**Courses—Seminars**

July 7-11: Institute in Technical and Industrial Communications. Colorado State University, Ft. Collins, Colo. Further details may be obtained by writing Herman M. Weisman, Associate Professor, Department of English and Modern Languages, Colorado State University, Ft. Collins, Colo.

July 8-12 and July 14-18: Two Special Summer Programs on Strain Gage Techniques. Massachusetts Institute of Technology, Cambridge 39 Mass. Additional information may be obtained from Dr. William M. Murray, Professor of Mechanical Engineering, M.I.T.


Aug. 11-22: 3rd Annual Statistical Methods in Industry Course. University of California, Los Angeles, Calif. Sponsored by the UCLA College of Engineering, University Extension, and the American Society for Quality Control. In addition to the above course, there will be a 3-week course in Industrial Reliability, Aug. 4-22. Address requests for information on the courses to Edward P. Coleman, Professor, College of Engineering, University of California, Los Angeles 24, Calif.
Printed-Wiring Comes of Age

Printed-wiring is an excellent concept promising many advantages. But like many other promising developments, its reputation suffered a setback when some manufacturers tried to cut production costs at the expense of quality. Others, through ignorance, didn't realize that certain production shortcuts degraded quality and cut reliability.

Now the emphasis is again on reliability. Much effort has gone into improving laminate quality and bond strength, standardizing dimensional tolerances, and most important, improving soldered connections. Better production processes and better care and handling of printed-wiring boards have been found necessary to effect these improvements.

But these changes didn't happen overnight. An education in good processing and handling techniques has been somewhat forced upon printed-wiring makers and users. They found that printed-wiring boards used in consumer products' applications wouldn't stand up in military applications. Even in some consumer products, printed-wiring was very unsatisfactory. So as users insisted on better quality, fabricators evolved standards to guarantee fulfillment of these quality requirements. Naturally, improved quality means more reliability.

The cost of printed-wiring is high. When reliability is a must, cost is secondary. Of course, the cost of the most expensive board is low compared to the cost of a reject that is completely assembled with fifty or more mounted parts. Nevertheless, designers must be cost-conscious. Part of the cost is both engineers' and draftsmen's time in laying out a circuit for printed wiring. Time saving short cuts should be explored.

One area still to be exploited is the education of designers in new uses of printed-wiring. Engineers should freely exchange printed-wiring information at technical meetings and through technical publications. It now becomes imperative to promote printed-wiring applications to enable the industry to profit by all its advantages.
The requirements of the military and industry are reflected in Daystrom Pacific's two standard lines of potentiometers. The series 300 subminiature, precision, space-wound standard potentiometer line is designed to meet the severe vibration, shock, high temperature and environmental requirements of aircraft and missile applications.

The series 400 miniature, precision potentiometer line was developed for industry as a complete low-cost line of high performance potentiometers.

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Printed Circuit Standardization

S. Kramer, L. Krauss, and J. Monturo
Arma Division,
American Bosch Arma Corp.,
Garden City, N.Y.

To insure reliability and uniformity of product at the lowest possible cost, Arma established a project to set up design procurement and processing standards for printed wiring. Their efforts have resulted in highly reliable designs for the military.

DESIGN standards must be based on commercially available production processes in lieu of specialized techniques. With this thought in mind, printed circuit design standards and related specifications established were based on Arma's requirements and the vendor's ability to consistently produce a high quality product at minimum cost. It was necessary that the design standards be sufficiently flexible for applications including missile guidance, naval navigation, and naval and airborne fire control systems.

Basic printed circuit design standards used at Arma (Table 1) were established as a result of past design experiences, laboratory evaluations, and other accumulated data.

Nominal conductor width preferred for all designs is 1/16 in. unless space and weight are a criteria. The allowable minimum is 3/64 in. providing the temperature rise due to current is acceptable. The established width was based primarily on: fabricators tolerances; pin holes in the copper foil; bond strength and current carrying capacity.

A fabricator's tolerances could reduce a given 0.032 in. conductor width, thus affecting reliability.

For example:

0.004 in. tolerance when 4 times artwork is reduced,
0.005 in. tolerance from screening process, 0.010 in. undercutter from etching, 0.019 in. total tolerance,
0.032 in. desired conductor width, 0.013 in. possible conductor after fabrication

When functional designs require conductors greater than 1/4 in. wide, for shielding or ground

| Table 1. Basic design standards using epoxy glass laminate, both sides plated with 2 oz copper; plated-through holes, gold-plated conductors. |
|---------------------------------|---------|---------|
| Nominal Width-in.                | 1/16    | 3/64    |
| Conductor Spacing-in.            | 1/16    | 3/64    |
| Pad Diameter-in.                 | 1/8     | 0.100   |
| Hole Diameter-in.                | 0.063   | 0.007   |
|                                 | 0.038   | 0.007   |

| Table 2. Minimum Spacing of Adjacent conductors |
|---------------------------------|--------|---------|
| Potential Difference, peak volts| Minimum Spacing-in. |
| 0 to 300                        | 3/64   |
| 301 to 500                      | 1/8    |
| Greater than 500                 | 0.0003-in. per volt |

Fig. 1. Poor bond strength and interlaminar blistering (upper samples). In the foreground is an example of excessive warp and twist.
planes, cross-hatching is required to eliminate blistering and other thermal effects from dip soldering.

Nominal conductor spacing is 1/16 in. Where space is at a premium a minimum of 3/64 in. spacing is permitted. Conductor spacing is dependent upon voltage differences. Table 2 is the guide used at Arma.

Other conductor spacing considerations: (a) 1/32 in. between conductors and edges of board or holes in the board; (b) 0.100 in. between conductors and metal hardware and/or metal type components.

Intersections of conductors, and conductors and pads are filleted. Smooth curves are employed to change conductor directions. Fillets and curves reduce the incidence of failures which occur at conductor intersections due to screening techniques.

Mounting components directly on or across conductors is undesirable. This type of mounting permits entrapment of flux and other contaminants. In addition, some component markings, such as tolerance bands on carbon composition resistors, are relatively conductive. When components must be placed on or across conductor lines, adequate protection should be taken. Coating the contact area with an insulating varnish prior to component assembly is one solution.

Minimum pad diameters are 0.062 in. larger than their respective hole diameters in order to provide sufficient annular foil area around the hole for soldering and strength. A pad diameter of 0.100 in. is used for 0.035 in. holes and 0.125 in. pad diameters for 0.063 in. holes.

Pads are required on both sides of the board when plated-through holes are used. This is necessary to prevent etch attack on the hole walls and provide maximum solder joint strength.

Arma uses plated-through holes rather than eyelets. Their decision is based on the requirements for mass soldering, reliable solder joints, and space considerations. Mechanical rigidity required is achieved by the capillary action of the solder during dip soldering.

Plated-through holes by themselves are not relied upon to provide electrical continuity from one side of the board to the other. When it is necessary to transfer circuitry through the board via a hole that does not contain a component lead wire, a separate piece of bus wire is secured into the hole. Diameters of plated-through holes are specified as “after plating.” In order to consistently obtain adequately plated-through holes and solder joints, the hole size must be compatible with the board thickness. Table 3 shows the hole diameter as a function of the board thickness and wire size.

Pigtail type components are mounted flush with the printed circuit board. To hold the com-

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Table 3. Hole Diameter vs Board Thickness

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Up to 0.022 diam</td>
<td>0.038 to 0.007</td>
<td>1/32</td>
</tr>
<tr>
<td>0.023 to 0.045 diam</td>
<td>0.063 to 0.007</td>
<td>1/16</td>
</tr>
<tr>
<td>over 0.045 diam</td>
<td>Wire size plus 0.015</td>
<td>Equal to hole diameter</td>
</tr>
</tbody>
</table>

Table 4. Bend Radii vs Lead Diameters

<table>
<thead>
<tr>
<th>Lead Diameter-in.</th>
<th>Lead Wire Bend Radius-in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 0.028</td>
<td>0.032 min.</td>
</tr>
<tr>
<td>0.029 to 0.045</td>
<td>0.062 min.</td>
</tr>
<tr>
<td>0.046 &amp; larger</td>
<td>twice lead wire diam min.</td>
</tr>
</tbody>
</table>

Table 5. Standard Mounting Centers For Fixed Composition Resistors

<table>
<thead>
<tr>
<th>MIL-R-11 Style</th>
<th>Center to Center Hole Distance-in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC09</td>
<td>0.700</td>
</tr>
<tr>
<td>RC20</td>
<td>0.700</td>
</tr>
<tr>
<td>RC32</td>
<td>1.100</td>
</tr>
<tr>
<td>RC42</td>
<td>1.100</td>
</tr>
</tbody>
</table>

Components securely in place prior to, and during dip-soldering, the lead wires are clinched on the solder side of the board. Components are mounted so that replacement may be easily accomplished without the use of special tools. The use of multiple-contact, flush-mounted components is avoided. When such a component must be used, the printed conductors to and from the component should be on the dip solder side of the board to insure maximum reliability.

All component leads should be straight, a minimum of 3/32 in. from the point of egress from the component body to the point of bend. Bend radii for various lead diameters are shown in Table 4.

Components fabricated with welded leads, such as tantalic capacitors, require that the leads be straight 5/32 in. minimum beyond the welds to prevent bending stress on the welded joint. Components leads are machine formed to provide lead support during the bending operation thereby minimizing seal failures.

Component leads are mounted to 0.100 in. grid intersections. Standardized component mounting centers assure uniform design, optimum packaging, lower tooling costs, and greater reliability. A typical example of this is shown in Table 5 for fixed composition resistors.

After basic design standards have been fixed and found acceptable, it is necessary to specify and control the material and processing parameters to assure a highly reliable end product. The basic mechanical and electrical properties required, such as flexural strength, warp, volume resistivity, surface resistivity, etc., are dictated by the design objectives. During the design stages these criteria dictate a choice of one of the basic laminate stocks, phenolic, epoxy, melamine, and filler (glass cloth, glass mat paper).

In seeking an answer to “What type of base material, and whose, will consistently meet the performance requirements desired?” we use:

- past experience and or test data obtained from a related design application;
- military and or commercial specifications;
- data available from laminators or fabricators;
- test data obtained from laboratory investigations of sample quantities.

These yield only typical properties and indicate solely the type of material to be used. Unfortunately available procurement specifications are inadequate because:

- Acceptance criteria are usually of a compromise nature. They reflect minimal properties for components.
the various types of materials. Superior materials in each of the grades are not readily detectable under a minimum requirement specification.

- Quality levels are inadequate for high reliability application. Basically the three elements of quality control that are lacking include: (1) repetitive control tests to insure consistency of product; (2) adequate sampling plans; (3) coordinated effort. Quality levels cannot be successfully maintained without coordinated control at all echelons of fabrication and manufacture.

- Test procedures are inadequate or inappropriate. For example, it is not unusual for published data to state that a particular material will withstand a hot solder bath of 500°F for 30 seconds. Based on this characteristic, dip soldering should be no problem as far as the material is concerned. In dip soldering, parameters are substantially lower. But, a check into the test procedure used for determining this published data will usually reveal that the test is conducted on small squares with the copper clad on one or both sides. The sole criteria of acceptance is usually no blistering of the foil. Most printed circuit boards are substantially larger, contain a circuit pattern, and, therefore, introduce other problems not readily detected by the hot solder test.

Major problem areas which require close surveillance and are important factors in the overall cost and reliability of printed circuits are:

- Bond Strength. Can be reduced after subjection to the hot solder test. More realistic data is obtained by testing etched conductor lines 1/16 in. or 1/8 in. wide.

- Blistering. Internal blistering is caused by the rapid expansion of volatile matter as a result of dip soldering. It is wise to test material for this defect after humidity conditioning.

- Plating. If plated through holes are used, inadequate plating thickness in the holes will not permit solder flow and adequate etching with the inserted lead on the component side of the board. Two other important problems with respect to plated through holes are: (1) insufficient etch resist will permit etching solution to attack the copper plating in the hole; and (2) plating thickness must be sufficient to allow for component replacement. Insufficient plating will not endure at least four rework cycles.

Type of circuitry, design, and environmental conditions dictate the required electrical parameters. Since the major use of printed circuits at Airm is in low impedance and low power devices, any electrical problems are minimized. In this case, electrical characteristics are used to define the product. Obviously when printed capacitors, inductors, transmission lines, or microwave antennas are employed, careful consideration must be given to any variation in dielectric constant, dissipation, and conductor spacings.
Making Printed-Wiring Reliable

Laurence D. Shergalis
Associate Editor
ELECTRONIC DESIGN

Printed wiring has many advantages. It saves valuable space in electronic assemblies and permits use of automatic production techniques. But these advantages can be lost through poor reliability. With increased emphasis on reliable performance, designers of equipment using printed-wiring are concerned with avoiding faults in printed-wiring boards. In this special issue, we are presenting the latest industry practices in achieving reliable printed-wiring. And, because military equipment demands the utmost in reliable performance, our articles stress these more rigid requirements.

The initial survey for this report on printed-wiring disclosed that nearly all major fabricators and users have their own standards. But many issues still remain unsettled. For example, opinion on the merits of eyelets as opposed to plated-through holes leans heavily toward eyelets. However, recent new advances in plating tend to make plated-through holes look more attractive to many manufacturers. Biggest complaint is in the care and handling of boards during and after manufacture. Because of its importance, the subject rates special attention in this report. Our survey indicated that manufacturers have acquired considerable background in the areas of processing, coatings and soldering. Techniques seem to be pretty well established. Now the emphasis will be on refinements to improve reliability.

For a free reprint, 8-1/2 x 11", of this staff report and the articles authored by engineers of Arma Div. and Formica Corp., circle 27 on Reader-Service card.
Is this the First?

Printed-wiring makers still debate the date printed-wiring first came into being and was patented. Many ideas similar to present-day printed-wiring are disclosed by early U. S. patents, many dating back into the later 19th Century.

But this British patent unearthed by a leading U. S. manufacturer during a patent search in England recently, may be the first. It specifically spells out the printing and electroplating process. Invented by a Frenchman named Cesar Parolini, the method consists "of an ebonite plate for radio outfits, having an electrolytically deposited system of connections." Application date is April 24, 1926 and the patent was granted April 28, 1927. British patent number is 269,729.
Accent on reliability

Over 8,000,000 printed circuits produced to a high standard of excellence since 1951... in step with every advancing military and civilian requirement... all attest to the confidence expressed in ELECTRALAB.

Reliability of our missiles... Titan, Nike and others... our jets... B-58, B-52, F-102... depends on quality components - such as printed circuits produced by ELECTRALAB.

Computers, data processing, radar, communications and other vital equipment... all find that plus factor inherent in the high quality of ELECTRALAB printed circuits.

Write for complete information.
1 Standards — The starting point for reliable printed-wiring

Reliability depends to a great extent upon adherence to standards. And standards reflect good design criteria to enable engineers to fully exploit the advantages of printed-wiring.

Designers have started to be more standards conscious. Establishing the 0.1 in. grid pattern was a step in standardization for automatic production. Recently, the Institute of Printed Circuit manufacturers devised a set of preliminary suggested standard tolerances. Much of this is based upon standard tolerances used by Photo-circuits Corp. the past few years. IPC expects to publish a working set by midsummer.

Other manufacturers and the military have also established various standards. These include standards tolerances in hole dimensions, registration, conductor size and spacing laminate thickness, plating thickness, and board size. Cleveland Metal Specialties for example, have published their own booklet entitled "Military Standards for Printed Circuits."

The Military, however, have established no dimensional tolerances. Most of their publications are good design guides including standard test procedures. Manufacturers are not differentiating between military and commercial standards. Standards are being based on price levels, and the Military may specify any standard they wish.

Several military standard specifications are applicable and are available to industry. Most noteworthy are:

- XAR-153, Printed Circuit Boards. This specification has been approved by the Bureau of Aeronautics, Dept. of the Navy and is available from the Commanding Officer, U. S. Naval Avionics Facility, Attention D/910, Indianapolis 18, Ind.
- MIL-STD-275 (Ships), Printed Wiring for Electronics Equipment. This standard has been approved by Bureau of Ships, Dept. of the Navy, available from Chief of Bureau of Ships, Dept. of the Navy, Washington 25, D.C.
- MIL-STD-429. Printed Circuit Terms and Definitions, (Standardization Division, Office of the Assistant Secretary of Defense, Supply and Logistics, Washington 25, D. C.) This standard, approved by Dept. of Defense, is mandatory for use by the Army, Navy, and Air Force. Available

Table 1. Underwriters' standards for conductors spacing based on the formula for breakdown of twice plus 1000 v.

<table>
<thead>
<tr>
<th>Spacing-in.</th>
<th>DC Working Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/32</td>
<td>500</td>
</tr>
<tr>
<td>1/8</td>
<td>750</td>
</tr>
<tr>
<td>3/16</td>
<td>1000</td>
</tr>
<tr>
<td>1/4</td>
<td>1500</td>
</tr>
<tr>
<td>3/8</td>
<td>2000</td>
</tr>
<tr>
<td>1/2</td>
<td>3000</td>
</tr>
</tbody>
</table>

Fig. 1. Maximum allowable temperature rise vs line width.

Fig. 2. Resistance of printed-wiring conductors.
Printed-wiring users—Arma, Consolidated Electrodynamics, Hughes, Motorola, Sperry are a few—have set up strict standards to insure reliability of the printed-wiring boards they buy. Many of these users require fabricators to submit samples made to special test patterns. From these pieces, purchasers make continuing quality checks on the materials they receive. Most make periodic quality checks according to a rigid schedule. These are some of the more important requirements for which users' standards have been written:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Solderability</th>
<th>High Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole Spacing</td>
<td>Soldering Rework</td>
<td>Endurance</td>
</tr>
<tr>
<td>Conductors</td>
<td>Endurance</td>
<td>Thermal Cycling</td>
</tr>
<tr>
<td>Plated Holes</td>
<td>Compatibility with</td>
<td>Low Temperature</td>
</tr>
<tr>
<td>Eyeleted Holes</td>
<td>Ultrasonic Cleaning</td>
<td>Endurance</td>
</tr>
<tr>
<td>Finish</td>
<td>Compatibility with Coating</td>
<td>Humidity Endurance</td>
</tr>
<tr>
<td>Marking</td>
<td>Electrical Performance</td>
<td>Vibration</td>
</tr>
<tr>
<td>Workmanship</td>
<td>Bond Strength</td>
<td>Resolderability</td>
</tr>
</tbody>
</table>

IPC standard tolerances are similar.

Generally, very close tolerances can be held if price is no object. But the proper approach should be, “How wide a tolerance can we hold without interfering with the proper functioning of the board?” For example, Arthur Ansley Mfg. Co is willing to hold overall board dimension tolerances to ±0.005 in. if the customer is willing to pay. Pattern to edge tolerance can be held to ±0.005 in.; registration, front to back ±0.005 in.; line width and spacing within ±0.003. All for a premium price.

Most manufacturers agree that line width tolerances are not to include nicks, pinholes, or scratches as long as the line width is not reduced more than one-third. Military specifications generally state that nicks and pinholes in conductors be invisible to the unaided eye.

Conductor width, conductor spacing, and clearance between component leads and holes are also covered by standards. A copper thickness of 0.0028 in. or 2 oz per square ft is most commonly used. Plating of a coating on the copper pattern is possible to protect the circuit from corrosion, wear, and to improve solderability. A common tolerance is plus 100 per cent, minus nothing.

Manufacturers like to maintain conductor width at 1/16 in. Photocircuits Corp. recommends a minimum of 0.031 in. for reliability. Greater widths are recommended where possible for ease in dip soldering and bonding. A conductor 1/16 in. wide and 0.0027 in. thick has a maximum current carrying capacity of about 15 amp. Parameters affected by conductor width are shown in Fig. 1 and 2.

(Continued on page 31)
### Table 2: Typical Standard Tolerances For Printed Wiring Boards

<table>
<thead>
<tr>
<th>Relative Cost Key</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall dimension</td>
<td>±0.15&quot;</td>
<td>±0.05&quot;</td>
<td>±0.10&quot;</td>
<td>±0.03&quot;</td>
<td>±0.03&quot;</td>
<td>±0.03&quot;</td>
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<td>±0.03&quot;</td>
<td>±0.03&quot;</td>
<td>±0.03&quot;</td>
</tr>
<tr>
<td>Ref. hole to edge</td>
<td>±0.010&quot;</td>
<td>±0.005&quot;</td>
<td>±0.015&quot;</td>
<td>±0.010&quot;</td>
<td>±0.015&quot;</td>
<td>±0.010&quot;</td>
<td>±0.005&quot;</td>
<td>±0.005&quot;</td>
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<td>±0.005&quot;</td>
<td>±0.005&quot;</td>
<td>±0.005&quot;</td>
</tr>
<tr>
<td>Pattern to edge</td>
<td>±0.015&quot;</td>
<td>±0.010&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
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<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
</tr>
<tr>
<td>Ref. hole to hole</td>
<td>See Note #1</td>
<td>±0.005&quot;</td>
<td>±0.005&quot;</td>
<td>±0.10&quot;</td>
<td>±0.010&quot;</td>
<td>±0.015&quot;</td>
<td>±0.05&quot;</td>
<td>±0.015&quot;</td>
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<td>±0.05&quot;</td>
<td>±0.015&quot;</td>
</tr>
<tr>
<td>Pattern to edge</td>
<td>See Note #1</td>
<td>±0.015&quot;</td>
<td>±0.010&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
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<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
</tr>
<tr>
<td>Pattern to pattern, either side</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.010&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
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<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
</tr>
<tr>
<td>Pattern to pattern, one side</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.010&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
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<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
</tr>
<tr>
<td>Pattern to pattern, two sides</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.010&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
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<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
<td>±0.015&quot;</td>
</tr>
</tbody>
</table>

**NOTE #1**—Holes requiring relative positioning tolerances closer than ±0.010" should be dimensioned as a cluster.

**NOTE #2**—Pattern to pattern tolerance is the accumulation of variances in the master drawing, and in printing and material stability. This tolerance is ±0.005" plus .001" for each five inches based on a final size master drawing error of not greater than .003". Additional variation must be added to the tolerances when master drawing accuracy does not meet this requirement.

---

**RELATIVE COST KEY:**

1. Low cost operation
2. Moderate cost operation
3. Premium cost operation

---

**SECTION W-W**

Pattern one side

**SECTION X-X**

Pattern two sides

**SECTION Y-Y**

Pattern two sides

---

**NOTE**—Where no tolerance dimension is indicated, such operation is not normally performed.

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**Electrical Design & Manufacturing**

June 1958

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At high volumes, copper roll costs less than copper strip, and in larger volume, less than preformed copper conductors. Unfinished copper strip is available at 0.025" per foot. For more information, please contact your local distributor.

When designing printed wiring boards, it is important to consider the width and thickness of the copper trace. The copper thickness and trace width will affect the power distribution and signal integrity of the circuit.

The thickness of the copper trace is typically specified in mils, with 1 mil equal to 0.001". For example, a 10-mil trace would be 0.010" thick. The thickness of the copper trace will affect the electrical characteristics of the trace, such as its impedance and the amount of signal attenuation.

Additionally, the width of the copper trace will affect its ability to carry current. A wider trace has a higher current capacity than a narrower trace. However, wider traces also require more area on the printed wiring board, which can affect the overall size and layout of the board.
At least 1/32 in., and preferably 1/16 in. of copper around each hole is preferred. Of course, less than this is possible in subminiature equipment. Arma requires that pad diameter be 0.060 greater than hole diameter.

Underwriters' Laboratories figures (Table 1) are a good guide to conductor spacing. About 250 v dc per 1/32 in. separation is considered safe. But designers are cautioned to design for peak voltages. Protective coatings may enable a decrease in conductor spacing.

Warp is defined as the deviation from the plane surface measured across the length or width of the board. It is expressed as a percentage of the length or width. Twist is defined as the deviation from the plane surface measured from one corner of the board to the opposite corner, and is expressed as a percentage of the diagonal dimension.

Tolerances for warp vary, depending on whether circuitry is on one or both sides. If the board is printed on both sides, a tolerance of 0.005 in. per lineal inch is recommended; with the pattern on one side, warp tolerance depends upon stock thickness. For example, for 1/8-in. stock thickness, tolerance is 0.012 in. per lineal inch. Methode Mfg. Co. specifies a general 0.015 in. per lineal inch tolerance.

Scratches, gouges, or pits in the laminate shall not exceed 0.005 in. in depth nor 0.010 sq. in. of area.

Almost every manufacturer has adopted the 0.1 in. grid pattern to facilitate automatic operation. General Electric's Light Military Electronic

### UNPLATED HOLES—Diameter Tolerances

<table>
<thead>
<tr>
<th>Drilled</th>
<th>Reamed</th>
<th>Counterebored or Re-cut (dias. from 5/16&quot; to 4&quot;&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAPER</td>
<td>GLASS</td>
<td>BASE</td>
</tr>
<tr>
<td>±002&quot;</td>
<td>±001&quot;</td>
<td>±005&quot;</td>
</tr>
</tbody>
</table>

Add ±001" to above for thicknesses of 3/32" through 1/5" routed slots and notches up to 2" milled or broached slots and notches up to 2" ±005"

*Punched Slots and Notches... use tolerances as above considering both length and width as hole diameters.

### PLATED HOLES—Diameter Tolerances

ADD the following tolerances to tolerances shown in (H) on drilled or punched holes:

<table>
<thead>
<tr>
<th>Drilled, paper base</th>
<th>Reamed, paper base</th>
<th>Counterebored or Re-cut (dias. from 5/16&quot; to 4&quot;&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±004&quot;</td>
<td>±005&quot;</td>
<td>±005&quot;</td>
</tr>
</tbody>
</table>

Minimum Line Width and/or Spacing... 0.031 for Reliability

NOTE—Line width tolerances do not include nicks, pin holes and scratches. Such imperfections are considered acceptable, provided the line is not reduced more than 33%. It is suggested that line width and spacing be specified as minimums provided the design is based on the tolerances given.

### STOCK THICKNESS (per NEMA Specifications)

**WARP**

The following values can be used as a guide in determining anticipated warpage of copper-clad boards.

<table>
<thead>
<tr>
<th>Pattern on ONE side:</th>
<th>Pattern on TWO sides:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16&quot; stock thickness</td>
<td>0.025&quot; per inch of length</td>
</tr>
<tr>
<td>3/32&quot; stock thickness</td>
<td>0.020&quot; per inch of length</td>
</tr>
<tr>
<td>1/8&quot; stock thickness</td>
<td>0.015&quot; per inch of length</td>
</tr>
<tr>
<td>1/4&quot; stock thickness</td>
<td>0.005&quot; per inch of length</td>
</tr>
</tbody>
</table>

### UNIMAX type USM integral-actuator switch benefits:

- **Saves space** in ganging, no build-up of thickness tolerance: stacking 4 per inch 8 in 2 inches, 12 in three inches, etc.
- **Quickly installed** in miniaturized apparatus or hard-to-get-at places: no auxiliary actuator mechanism to adjust or assemble.
- **High repeatability**, long switch life.
- **Vibration resistant**—integral actuator has no extra parts to shake out of adjustment.
- **Lighter actuating force possible** than with auxiliary mechanisms.
- **Leaf and leaf-roller actuator lengths** furnished to your requirements.

**UNIMAX SWITCH**

Division The W. L. Iverson Corporation
IVES ROAD, WALLINGFORD, CONNECTICUT

CIRCLE 24 ON READER-SERVICE CARD
2 Board Design Techniques—
Factors to consider for reliable operation

STARTING with his conventional wiring diagram, the printed-wiring designer must lay out his electrical circuit. His problem is to get the simplest layout with the most direct connections possible.

One Side vs Two Sides
In laying out the printed-wiring board, the designer is faced with the decision of whether to use a single-sided or double-sided board.

Two-sided printed-wiring takes on two forms. The circuitry on the two sides of the board may be different (the usual case), or, in instances where ultimate reliability is needed, the circuitry on one side of the board may be duplicated on the opposite side with through-the-board connections at numerous points.

Two-sided circuitry has an advantage over single-sided circuitry in size and weight reduction. This is of prime importance in miniaturized equipment and in airborne applications. Two-sided circuitry also tends to reduce the tendency of board warpage during fabrication. This is particularly true where the circuitry is the same, or nearly the same, on both sides. From the standpoint of warpage effects, therefore, two-sided circuitry tends to be a factor in improved reliability. Current-carrying capacity is increased by running two conductors in parallel.

In other respects, however, two-sided circuitry adds complexity which can be a source of unreliability. For this reason many users favor single-sided wiring, even though it usually means the use of hand-inserted jumper wires and increases warpage difficulties, particularly on large boards. Generally, one-sided boards are more economical and inherently more reliable.

The Signal Corps, in their design guide, SCL-6225, requires that printed-wiring on one side of the board only shall be used to the maximum extent possible. This to facilitate automatic assembly, they say. It also minimizes the need for interface connections, hand soldering, and reduces registration problems.
Some board materials must be supplied with copper on both sides to prevent excessive warpage (Choosing Board Materials, page 36. Of course, space factors, in missiles for example, may demand use of double metal boards.

How Large a Board?

Board size must be determined. For optimum ease of handling in production, and to facilitate mounting problems, many manufacturers limit the board size to 6 x 12 in. General Electric's Light Military Electronic Division limits board size to 12 x 12 in. A 6 x 6 in. card has been suggested as maximum.

In one application, Komak Inc. has fabricated boards as large as 34 x 9 x 1/16 in. Used in an electronic organ application, the boards are made of copper-clad Formica XXXP. The military, however, has placed no restrictions on printed-wiring board size.

For modular design, the Signal Corps requires the basic unit of length to be 0.025 in. This basic modular unit is to apply to all three axes of Cartesian coordinates. In equipment to be built on automatic machines, certain dimensions should be in multiples of this basic modular unit. These dimensions include: over-all board dimensions; spacing of part leads; location of holes; and test point locations.

The 0.1-in. grid pattern should be used wherever possible. For subminiature applications, a 0.05-in. grid may be used. With particularly stringent subminiature requirements, a 0.025 in. grid may also be used. Overall width and length of the board should coincide with the lines of the 0.1-in. grid pattern.

Component Mounting

Components should be oriented in both the horizontal and vertical planes. Most crossovers can be eliminated in this manner. But where crossovers are necessary to achieve a certain component layout, wires may be used. Treat the wire as a component.

Leg spacings should be to the 0.1-in. grid pattern. General Electric's Light Military Electronics Division specifies an additional 0.2-in. over the body length of axial-lead components.

Signal Corps requirements dictate that lead spacings coincide with a multiple of the 0.025-in. modular unit. Leads of axial-lead parts should remain straight for at least 0.015-in. from the end of the part.

Components should be mounted separately. Where components tie into a common lead, or are interconnected, separate mounting holes should be used. If a faulty component must be replaced, it isn't necessary to unsolder others.

Components have been developed to fit dip solder techniques. For tubes, socket terminals

---

400mA 600v silicon rectifiers in a subminiature package!

One of 35 PSI rectifiers representing the broadest range of miniature and subminiature silicon rectifiers in the industry.

Progress in silicon rectifier manufacture in the past six months has significantly outmoded recent design concepts. Notable advances have been made in miniaturization ... improved types have been introduced ... the relationship between power, size and price has been drastically changed.

PACIFIC SEMICONDUCTORS, INC. has added numerous types ranging from 50v to 600v . . . 200 to 500mA. PSI is now delivering the highest voltage, highest current silicon rectifiers ever offered in a subminiature package.

If your problem involves further miniaturization, it will pay you to look at the new PSI line of silicon rectifiers. Compare these husky subminiatures with the bulkier types you have been specifying. It's quite possible you'll find substantial performance, size and cost advantages.

Production quantity delivery is being made on all PSI rectifier types. Detailed specifications available on request.

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PSI also offers a broad line of Silicon and Germanium Diodes, Very High Voltage Silicon Cartridge Rectifiers, Varicaps (voltage-variable capacitors) and Diode Test Equipment.

CIRCLE 25 ON READER-SERVICE CARD
PRINTED-WIRING RELIABILITY

snap into holes in the base. There seems to be a need for a plug-in type i-f transformer which could be inserted into a standard tube socket. Superior reliability and ease of servicing are two advantages of this arrangement.

Several manufacturers have introduced, or are developing potentiometers and variable capacitors to meet printed-wiring requirements. Electrolytic capacitors can be simply inserted into standard spacing and dip soldering. The newer plug-in types improve reliability and reduce line repairs resulting from the broad tolerances on standard cases.

AMP Inc. has devised a component tip to speed assembly operations. Special tips are automatically placed on component leads which in turn are placed into holes in the board. This method insures better reliability and may eliminate the need for eyelets and plated-through holes.

Connectors

Connectors designed as receptacles for printed-wiring boards are commercially available with up to 44 contacts. These connectors enable the design of plug-in printed-wiring packages. Continental Connector Corp. has set up its own standards for printed-wiring circuit connectors. Their specifications cover mechanical, electrical, and environmental tests. Board thickness, contact size, and material are also included.

Unsatisfactory experience from the standpoint of reliability has often occurred from poor contact between printed-wiring board terminal fingers and connectors. Experience shows that high reliability can be achieved when the terminal fingers and connector inserts are plated with a noble metal such as gold, silver, or rhodium. More reliable connections are possible when rhodium is used because of its wearing properties. The Light Military Department of General Electric Co. recommends at least a 50 per cent overlap of contact area (board to socket). Tolerances should be so specified.

Chamfering of the edge of the printed-wiring board at the terminal fingers or plating around the edge of the board has been used to avoid the possibility of the terminal fingers lifting from the board upon insertion in the connectors. Recent improvements in adhesives, which hold the copper to the laminate, have just about eliminated this difficulty.

Eyelets vs Plated-Through

Biggest battle raging among printed-wiring makers is that of eyelets versus plated-through holes. Results of ELECTRONIC DESIGN's questionnaire show opinion favoring use of eyelets, but plated-through holes are gaining in favor.

![Fig. 4. Photomicrograph of a cross-section of a good quality plated-through hole.](Photocircuits Corp.)

Military specifications have specified eyelets in every case. But the new Signal Corps design guide, SCL-6225, section 3.4.4 states, "The use of mechanical eyelets or standoff terminals for electrical connections shall be avoided wherever possible because of difficulties in assuring reliable performance. Where frequent replacement of a particular electronic part is anticipated, suitable mechanical eyelets or plated-through holes may be used to assist in preventing delamination of the printed conductor. Mechanical eyelets for such purposes shall be of light-gage metal and shall be mechanically secured to the printed-wiring board. Their flanges shall be flared out from the printed-wiring so as to ensure the formation of an adequate solder fillet under the flange. Use of eyelets (either mechanical of plated-through types) may make replacement of the part difficult or impossible unless the part leads can be separately and individually removed from the printed-wiring board."

Section 3.4.5 of the Signal Corps publication states, "Plated-through holes shall not be used by themselves to effect interface connections. A

![Fig. 5. Cross-section showing poor eyeleted connection after temperature cycling.](Photocircuits Corp.)

Here are some suggested design techniques to improve reliability:

- Use single-sided printed-wiring boards instead of double sided.
- Use etched rather than plated boards.
- Use smallest possible "card" (6-in. square or less).
- Keep card as nearly same length on all sides as possible. (Square rather than rectangular).
- Use 0.1-in. grid layout as standard.
- Use "free-flowing" lines, rounded corners.
- Make conductors as short as possible.
- Avoid placing high impedance or rf circuits on printed-wiring board.
- Keep dc leads near edges.
- Avoid placing components across conductors.
- Clean component leads of wax, etc. before assembly on printed-wiring board.
- Specify tolerance for design-center conditions.
- Stick to proven design standards and tolerances.
- Keep both electrical and mechanical characteristics in mind.
- Watch out for "hot-spots" on printed-wiring board. Use heat sinks and heat shutters as required.
- Avoid eyelets altogether if equipment is subjected to vibration or shock.
- Boards 1/16 to 3/32-in. thick shall be supported at intervals of not more than 4-in. Boards thicker than 3/32-in. shall be supported at intervals of not more than 5-in.
- Holes for component leads should be spaced at least 1-1/2 times the thickness of stock apart and from outside edges and cutouts.
- Smallest hole no smaller than 2/3 stock thickness.
- Any conductor lines running near the edge should be spaced 1/16-in. from the edge of the final board or should be laid out so that the shearing or blanking edge will trim through the copper.
- The minimum spacing between conductor lines, copper pads or islands be no closer together than 0.032 in.
- That at least 0.030 in. of copper be around all holes that ultimately get soldered. (Signal Corps says 0.060 in.).
- Make conductor at least 0.040 in. wide. (Signal Corps says 0.060 in.).
- The width of any line be no smaller than 0.015 in.
- Large expanses of copper should be avoided as this tends to create a blistering condition during soldering. Any large expansion of copper should be checkered or cross-hatched to reduce possibility of blistering.
- Plate or etch the same information on both sides of the board for minimum warpage and maximum reliability.
properly formed lead shall be employed...."

Previously, plated-through holes were considered unsatisfactory because of failure of the plating inside the hole. As the board is dipped in hot solder, gases released by the laminate blow a hole through the plating where it is especially thin. As a result, solder was not drawn into the hole, thus effecting a poor solder joint.

Eyelets, on the other hand, have proven unreliable because of the difference in expansion and elasticity of the eyelet and the plastic laminate. The plastic base material, the eyelet, and the solder which bands the eyelet to the conductor pattern all have different coefficients of expansion and moduli of elasticity. After several temperature cycles during which the plastic expansion under heat exceeds that of the metal, the metal assumes a permanent set and breaks its contact with the solder on the surface of the board. In a plated-hole, the interlocked bond of the plating comes and goes with temperature changes. Tests show that failures have not occurred after seventy cycles of the same conditions under which eyelets began to fail after five cycles. Additional statistics will be presented in **Electronic Design**, when available.

Chief concern with plated-holes has been replacement of components without loosening the adhesion of the conductor pad around the hole during removal of one lead and resoldering the next. Those using plated-through holes extensively found that by educating service personnel to keep the iron up on the lead and away from the pads, components can be replaced three to six times. (Resoldering twenty times has been reported.)

**Funnel Type Best**

One solution to the eyelet problem was to switch to the funnel-type eyelets. Construction of these permits the base material to expand without undue pressure. Circron Component Corp. has developed a line of funnel flange eyelets. No under-head flux inclusions are possible because of the open character of the eyelet.

Several new developments in plated-through hole technique promise its growing use—possibly to replace eyelets entirely. Both Printed Electronics Corp. (Narcus process) and Precision Circuits Inc. have developed new techniques for securing better plated-through holes. Photocircuit Corp. has announced their "Tuf-Plate" process, which guarantees a wall thickness of at least 0.0015 in. Its current carrying capacity is equivalent to a 2 oz copper conductor of width equivalent to the hole diameter. It is said to be implosion proof and will stand up under thermal shock of repeated solderings.

Plated-through holes, then, with proper processing technique, will provide real reliability. The real test will be time.
3 Choosing Board Materials—Using the right laminate aids reliability

WITH a large number of laminates now available, the design engineer is faced with the difficult task of choosing the right material. Laminated thermostetting plastics including paper base phenolics, glass base epoxy, melamine, silicone, and teflon are available. NEMA lists over two dozen standard grades.

Copper, or other metal foils are bonded to one or both sides. Aluminum, copper-clad aluminum, silver, and brass are used. Aluminum is not widely used in high-quality printed-wiring boards because its uniformity is not as good as copper. It needs special surface preparation.

Phenolic laminates with a paper base are most commonly used. Type XXXP is one of the most popular. Other popular paper-base phenolics include XX, XXP, XXX, and XXXP-IR. These grades should be punched hot. P-25 is a cold-punch paper-base laminate similar to XXXP.

National Vulcanized Fibre Co. just announced a new phenolic grade XXXP-467-1. It is a paper-base material that combines the electrical characteristics of XXXP stock with flame resistant qualities. It also has very high insulation resistance and low moisture absorption. XXXP-467-1 is recommended for critical electrical applications where fire danger must be considered. Such applications include color TV sets because of the high voltage used, computers and telephone equipment because of the concern about loss of fire of expensive pieces of equipment, and other similar applications. XXXP-467-1 is a hot punching grade and cannot be punched cold.

Another fairly new National grade is G-11-861-1, a heat resistant epoxy glass laminate. It will retain 70 to 80 per cent of its original flexural strength when tested at 150 C after one hour conditioning at that temperature. (Conventional epoxy laminates of the G-10 type retain only 5 to 10 per cent when tested at 130 C).

Applications include military electronic circuits in rockets, missiles, and computers. It is, however, a premium price grade and does not supersede National's G-10 grade where heat resistance is not a problem.
**Printed-Wiring Laminate Materials**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Grade</th>
<th>NEMA Grade</th>
<th>MIL Spec No.</th>
<th>Spec. No.</th>
<th>Material</th>
<th>Resin</th>
<th>Base</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Mica Corp., Culver City, Calif. (Mica ply)</td>
<td>EG-758</td>
<td>G-10</td>
<td>GEE 18177</td>
<td>Epoxy</td>
<td>Glass</td>
<td>Plain weave, low warp or twist</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EG-751</td>
<td>G-10</td>
<td>GEE 18177</td>
<td>Epoxy</td>
<td>Glass</td>
<td>Satin weave, high strength</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>EG-752</td>
<td>G-10</td>
<td>GEE 18177</td>
<td>Epoxy</td>
<td>Glass</td>
<td>Fine weave, very thin laminates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Miss Insulator, Div. of Minnesota Mining &amp; Mfg. Co., Schenectady 1, N.Y. (Lamiclad)</td>
<td>6008</td>
<td>XXXP</td>
<td>PBE-P 31158</td>
<td>Melamine</td>
<td>Paper</td>
<td>High arc resistance, heat and flame resistant</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6038</td>
<td>G-5</td>
<td>GMG 150378</td>
<td>Phenolic</td>
<td>Paper</td>
<td>Very high heat distortion properties, self-extinguishing, low water absorption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. National Vulcanized Fibre Co., Wilmington, Delaware</td>
<td>6096</td>
<td>G-10</td>
<td>GEE 18177</td>
<td>Epoxy</td>
<td>Glass</td>
<td>Cold punching, excellent electrical properties, low moisture absorption</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XN-152-1</td>
<td>P</td>
<td>Phenolic Paper</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>Low cost, low resin content, hot punching</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>P-214-B-1</td>
<td>XXP</td>
<td>Phenolic Paper</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>Good electrical properties, cold punching</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>XXP-209-G-1</td>
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<td>Phenolic Paper</td>
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<td>Phenolic Paper</td>
<td>Warm punching grade</td>
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<td>XXP-229-1</td>
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<td>Phenolic Paper</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>High insulation resistance, hot punching</td>
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<td></td>
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<td>XXP-429-1</td>
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<td>Cold punching grade</td>
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<td>XXP-467-1</td>
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<td>Phenolic Paper</td>
<td>Heat resistant Epoxy Glass Grade</td>
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<td>100A</td>
<td>G-10</td>
<td>GEE 18177</td>
<td>Epoxy</td>
<td>Glass</td>
<td>As grade 100 but with greater bond strength</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>101</td>
<td></td>
<td>Epoxy Glass</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>For use with flush circuits</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td>Epoxy Glass</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>High res, special weave glass fabric</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>125</td>
<td></td>
<td>Epoxy Glass</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>Special weave</td>
<td></td>
<td></td>
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<td></td>
<td>130</td>
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<td>Epoxy Glass</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>As grade 100 but with greater bond strength</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>135</td>
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<td>Epoxy Glass</td>
<td>Paper</td>
<td>Phenolic Paper</td>
<td>As grade 100 but with greater bond strength</td>
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<tr>
<td></td>
<td>210</td>
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<td>Epoxy Glass</td>
<td>Paper</td>
<td>Phenolic Paper</td>
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<td>220</td>
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<td>Paper</td>
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<td>As grade 100 but with greater bond strength</td>
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<td></td>
<td>925</td>
<td>XXXP</td>
<td>PBE-P 3115</td>
<td>Phenolic</td>
<td>Paper</td>
<td>Glass cloth base</td>
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<tr>
<td>11. Panalyst Division, St. Regis Paper Co., Trenton, N.J.</td>
<td>1003</td>
<td>G-10</td>
<td>GEE 18177</td>
<td>Epoxy</td>
<td>Glass</td>
<td>Glass cloth base</td>
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<td>1603</td>
<td>G-10</td>
<td>GEE 18177</td>
<td>Epoxy</td>
<td>Glass</td>
<td>Glass cloth base</td>
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<td>1633</td>
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<td>Glass</td>
<td>Glass cloth base</td>
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<td></td>
<td>1403</td>
<td>G-5</td>
<td>GMG 150378</td>
<td>Melamine</td>
<td>Paper</td>
<td>Glass cloth base</td>
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<tr>
<td></td>
<td>1803</td>
<td></td>
<td>Teflon</td>
<td>Sheet base</td>
<td>Paper</td>
<td>Glass cloth base</td>
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<td></td>
<td>1813</td>
<td></td>
<td>Teflon</td>
<td>Tape Base</td>
<td>Paper</td>
<td>Glass cloth base</td>
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<td></td>
<td>7763</td>
<td>XXXP-HIR</td>
<td>PBE-P 31158</td>
<td>Phenolic</td>
<td>Paper</td>
<td>Hot punching</td>
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<tr>
<td></td>
<td>8103</td>
<td>XXXP-HIR</td>
<td>PBE-P 31158</td>
<td>Phenolic</td>
<td>Paper</td>
<td>Cold punching, high insulation resistance</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>8053</td>
<td>XXXP-HIR</td>
<td>PBE-P 31158</td>
<td>Phenolic</td>
<td>Paper</td>
<td>Hot punching, high insulation resistance</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>7743</td>
<td>XXP</td>
<td>PBE-P 31158</td>
<td>Phenolic</td>
<td>Paper</td>
<td>Hot punching</td>
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<td></td>
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<tr>
<td></td>
<td>8203</td>
<td>XXP</td>
<td>PBE-P 31158</td>
<td>Phenolic</td>
<td>Paper</td>
<td>Hot punching</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


2. 28EFR—Exhibits essentially the same excellent mechanical and electrical characteristics as Di-Clad 28E and good flame and heat resistance.

3. Di-Clad 28ECR—Exhibits essentially the same excellent mechanical and electrical characteristics as Di-Clad 28E, and employs a special copper foil to laminate bond resistant to hot cyanide solutions commonly used for etching the printed circuits on printed boards with precious metals such as gold and rhodium. Meets NEMA G-10 properties.

4. 16ECR—Exhibits essentially the same mechanical and electrical characteristics as Di-Clad 16E and employs the same copper cyanide resistant bond as Di-Clad 28ECR. Meets NEMA G-10 properties.

5. Teflon is a DuPont trademark for their polytetrafluoroethylene resin.
### Printed-Wiring Laminate Materials (cont.)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Grade</th>
<th>NEMA Grade</th>
<th>MIL Spec.</th>
<th>Spec. No.</th>
<th>Material</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Rex Corp., West Acton, Mass.</td>
<td>2200</td>
<td></td>
<td></td>
<td>1422</td>
<td>Glass</td>
<td>Cold punching, excellent UHF properties no cold flow</td>
</tr>
<tr>
<td>14. Rogers Corp., Rogers, Conn.</td>
<td>RM-2035IR</td>
<td>XXXP</td>
<td>PBE-P</td>
<td>3115B</td>
<td>Phenolic Paper</td>
<td>High insulation resistance</td>
</tr>
<tr>
<td>15. Spaulding Fibre Co., Tonawanda, N.Y., (Spauldite)</td>
<td>XXXP-690</td>
<td>XXXP</td>
<td>PBE-P</td>
<td>3115B</td>
<td>Phenolic Paper</td>
<td>Hot punching, high insulation resistance</td>
</tr>
</tbody>
</table>

**Notes:**
- Resolite 1422 cross-linked copolymer.
- All grades are in moldable form, especially suitable for molded mechanical methods of producing printed wiring. All grades are cold punching and exceptional high strength properties.
Where low dimensional changes are required along with high mechanical strength, low water absorption, and fungus resistance, epoxy laminates can be specified. Base material is a continuous filament glass cloth. Two of the most commonly used grades are G-10 and G-11. Both are continuous filament woven glass fabric grades noted especially for their electrical characteristics. G-10 retains 25 per cent of its flexural strength at 300 F; G-11 retains 50 per cent of its flexural strength at this same temperature.

Where high resistance to abrasion is desired, melamine laminates are preferred. Silicone laminates provide good resistance to heat with extreme flexibility. Teflon, because of its excellent high-frequency loss factor, is being used in microwave applications. Its cost rules it out except for the most critical applications.

Generally, paper-base phenolics offer considerable cost savings over glass fabric dielectrics. They also permit sharper definition of conductors. Also, the lower electrical grades of phenolics are less expensive than higher-rated materials.

Bond strength of copper to phenolics is better than some of the fabric and glass mat materials. However, the fabric and glass-base materials have better electrical characteristics.

Most copper-clad laminate makers use electrolytic copper foil. Further, it is specified by NEMA standards.

Synthane Corp. has developed a new adhesive with electrical properties equal to the base laminate. Minnesota Mining & Manufacturing Co. recently announced their formula XPA-220249, a liquid thermo setting type adhesive for bonding copper foil under heat and pressure. It withstands the visual 450 F solder bath for 10 sec and was found to have peel back strength of about 10 to 15 piw.
# 4 Proper Care and Handling—

An often neglected aspect of reliability in printed-wiring

To insure reliability of printed-wiring, proper handling is necessary from preparation of the board laminate until assembly of the device has been completed. Manufacturers of laminates constantly check each step in the production process. This insures the fabricator of a good quality uniform product.

Quality checking and inspection procedures at Synthane Corp. are an example of what a manufacturer and fabricator of industrial thermosetting laminated plastics does to insure reliability.

Synthane takes these steps:

- Incoming raw materials are checked, including rolls of fabric base materials.
- Electrolytic copper is spot-checked. But Synthane relies on its vendors to check first. They pay about four times the normal price of copper for this service. Copper is checked 100 per cent for lead inclusions.
- Resins are tested. Vendors reports are checked against lots received.
- Constant checks are made of impregnating materials used in the coating machine.
- As sheets are laid up for the presses, both the laminate and copper is given a quick visual inspection.
- Press pressure is maintained at 1767 psi at 335°F. Material goes through a 2-hour cycle; cold to cold. It cools under pressure.
- Finished copper-clad sheets, are trimmed, then thickness is checked on four corners. Sometimes customers require checking at 12 points on the sheet. Greatest variation is found on the edges.
- Samples are cut for lab tests. Tests are performed to check bond strength, blistering, insulation resistance. Usually the customers own test pattern is put on the sample.
- Remainder of the sheet is polished and given a final visual inspection. If the customer requests a protective coating is applied.
Because its 145 to 1 delay-to-rise-time ratio was considered impossible

THIS IS THE DELAY LINE THAT COULDN'T BE MADE

...BUT ESC MADE IT!

Compare the new ESC Delay Line Model 51-43 with these competitive units:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>TOTAL DELAY</th>
<th>RISE TIME</th>
<th>VOLUME INCHES</th>
<th>Zo OHMS</th>
<th>MAX. NO. PULSES</th>
<th>PULSES PER CU. IN.</th>
<th>TOTAL INSERTION LOSS IN SHEET</th>
<th>INSERTION LOSS PER PULSE</th>
<th>MERIT FACTOR</th>
<th>MIN. PULSE LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial Air Core Delay Line</strong></td>
<td>4.6 µs</td>
<td>0.1 µs</td>
<td>92.7</td>
<td>430</td>
<td>23</td>
<td>.248</td>
<td>7 db</td>
<td>.304 db</td>
<td>0.816</td>
<td>2 µs</td>
</tr>
<tr>
<td><strong>Commercial Ferrite Core Delay Line</strong></td>
<td>12 µs</td>
<td>0.26 µs</td>
<td>41.2</td>
<td>500</td>
<td>23.1</td>
<td>.56</td>
<td>2 db</td>
<td>.0866 db</td>
<td>6.45</td>
<td>52 µs</td>
</tr>
<tr>
<td><strong>Commercial Ferrite Core Delay Line</strong></td>
<td>200 µs</td>
<td>4.4 µs</td>
<td>74.4</td>
<td>500</td>
<td>22.8</td>
<td>.906</td>
<td>2 db</td>
<td>.0876 db</td>
<td>3.5</td>
<td>8.8 µs</td>
</tr>
<tr>
<td><strong>Commercial 1350 Ohm Distributed Line</strong></td>
<td>12 µs</td>
<td>0.44 µs</td>
<td>77.7</td>
<td>1350</td>
<td>13.6</td>
<td>.175</td>
<td>12.4 db</td>
<td>.911 db</td>
<td>0.192</td>
<td>28 µs</td>
</tr>
<tr>
<td><strong>RG 65 U</strong></td>
<td>8 µs</td>
<td>0.31 µs</td>
<td>820</td>
<td>950</td>
<td>12.9</td>
<td>.0157</td>
<td>11.5 db</td>
<td>.892 db</td>
<td>0.0176</td>
<td>62 µs</td>
</tr>
</tbody>
</table>

** Commercial Delay Line Model 51-43 | 20.3 µs | .14 µs | 115 | 470 | 72 | .025 | 2 db | .0278 db | 22.5 | .28 µs |

* Merit Factor = Pulses In. x Insertion loss per pulse


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ELECTRONIC DESIGN • June 11, 1958
pumice cleaner and a scrub brush before applying the acid resist.

After etching, the acid coating must be completely removed. Alcohol, acetone or various commercial cleaners may be used. Most makers blame 90 per cent of the printed-wiring problems on poor cleaning.

According to C. W. McClelland of Varian Associates, two types of contamination trouble printed-wiring—process and accidental. Production process contamination results from the etching bath and solder fluxes. Accidental contamination is a result of finger-prints and dust.

Using a ferric chloride etching process, iron and copper salts remain on the board. McClelland points out that recent research at Stanford indicates that hydrochloric acid and pluronic L62 are very effective. Other wash solutions are being tested. Ultrasonic cleaning is also satisfactory.

Printed-wiring boards should be stored in sealed plastic bags for storage. One military specification requires that, after cleaning, the board be placed in a polyethylene bag and heat sealed. Natural rubber or materials high in sulphur should not be in contact with the bag. Once the board is removed from its sealed container, it should go into production immediately.

Printed-wiring not sealed in plastic or other suitable air tight packaging should be treated as a board that has been in storage. To properly prepare a board that has been handled or stored in open air, the areas that are to be soldered should be burnished. A suitable material for burnishing is a "typewriter" eraser of the pencil type. In extreme cases 4.0 steel wool can be used. Be sure that steel "whiskers" are not entrapped or snagged under eyelets, fastenings, or pads.

Preproduction Washing

Cleveland Metal Specialties Co., in their excellent booklet, "Military Standards for Printed-Circuits" recommends preproduction washing of the printed-wiring boards in all cases where low leakage resistance and long term reliability are to be maintained. The following formula is suggested:

8 oz Ammonia
8 oz Murphy's Oil Soap
1 oz Swift & Co. No. 900 Solar Detergent
1 gallon Water
Heat water 140 F to 160 F, dissolve soap (stir slowly for minimum suds). Add ammonia; add Solar Detergent.

Use stock solution at above temperatures in cleaning printed-wiring. One gallon will treat approximately 15 sq ft of two sided printed-wiring material.

Allow circuits being washed to stand in heated solution for at least 20 sec. Using a stiff bristle brush, scrub both sides of the printed-wiring, rinse in filtered tap water, and force dry by air blast from filtered air supply.

During rinsing and drying, the board should be handled by the edges. They may be dried in lint free blotters. It is important that, during and after the production cycle, the board is to be handled by the edges.

Most resin fluxes are activated to some degree, therefore residue should be removed from the finished board when the assembly is complete. A suitable liquid flux is generally desirable in working printed-wiring boards. Where liquid flux cannot be used, use resin flux cored solders.

Upon completion of a printed-wiring assembly, flux and other residues should be removed immediately. Where possible, the entire assembly should be placed in a shallow pan of suitable flux remover such as toluol, or liquid trichloroethylene and allowed to soak. About 20 to 30 sec should be sufficient to soften and loosen the residues. The assembly can be brushed with a bristle brush to loosen residues, then redipped in flux remover. Remove the assembly and while dripping wet, use filtered compressed air blast to blow the assembly dry. Inadequate cleaning can be seen by inspecting assembly for streaks.

Suitable protective coatings such as varnishes and sprays, are available for covering the ex-
posed conductor areas to prevent leakage, and to render the areas humidity proof.

Types of Coatings

A wide variety of moisture, fungus proofing, insulating and fire resistant coatings are available. Epoxy coatings can be obtained in air-drying or bake-drying types. Phenolic or melamine coatings can also be applied. Nearly any method of application is possible—spray, roll coating or screen printing.

Method Manufacturing Corp. suggests these finishes:
- Protective lacquers, wax, thermoplastic or varnish compounds to prevent oxidation. Water-dip lacquer is the most commonly used protective finish.
- Flux Coats with or without activating agents. Slow drying characteristics defeat its purpose somewhat, however. This coating is mainly a soldering aid.
- Solder resist masks, keep solder off portions of the circuitry not to be soldered.
- Electrosolder plating aids soldering, often requires extra manufacturing costs.
- Silver Flash is useful where excellent appearance at low cost is desirable.
- Electrosilver plate used for switching and applications where good conductivity is important.
- Nickel rhodium for long-life switch uses.
- Gold for extra critical for high conductivity and resistance to oxidation is important.

Cadmium plate, nickel and silver-rhodium are also used for special applications.

All etched circuits should have a protective coating. Although no one coating fulfills all applications, one closest to meeting the necessary requirement should be chosen.
5 Factors in Soldering —

Good soldering practice insures reliable connections

DIP soldering presents the designer with the greatest opportunities for cost savings along with the greatest source for trouble. The method can be performed easily by relatively unskilled persons—providing proper preparations are made.

First, the base laminate must be able to withstand at least 450 F solder temperature. A suitable solder pot must be capable of holding enough solder at 475 F to handle the largest assembly. Solder is usually 60 per cent tin, 40 per cent lead, although some manufacturers use a 63-37 ratio. It must be carefully maintained at that ratio during production.

The circuit must be properly prepared to accept solder. Photocircuits Corp. makes a special protective film that can be applied to keep the pattern clean. The film decomposes at temperatures well below soldering temperature.

Other alternatives could be one of the many coatings discussed in the “Care and Handling” section. Unprotected boards must be carefully cleaned before soldering.

Choosing the flux is very important. Flux must be noncorrosive and yet extremely active in removing oxides and contaminates. A good flux can dissolve oxides at temperatures lower than the melting point of solder, is non-toxic, produces no offensive fumes, and will leave no corrosive residue.

Pure resin and resin-alcohol fluxes are most common. Resin flux is probably the safest. Organic-base fluxes possess greater fluxing powers than resin fluxes, but are also slightly more corrosive. All of the residue must be decomposed to noncorrosive residues.

Some fluxes have acid chloride base salts. They are extremely corrosive and should never be used for electronic assemblies.

Flux is applied to the work by floating the assembly in a container of flux. After draining, the piece is put in the solder pot. Circuit boards should enter the solder bath at an angle of about 3 to 5 degrees to allow the flux vapors to escape. The assembly should not be moved while in the solder.

About 8 to 10 seconds is the minimum dip time. Vibrating the board removes excess solder, then the board should stand for several seconds to allow the solder to solidify. Excess flux can be washed away with liquid trichloroethylene or ethyl alcohol.

The finished dip-soldered board should have a smooth bright appearance. The solder should not have the frosty appearance of cold-solder joints.

Insufficient time in the solder pot or too low temperature cause blobs or accumulations of excess solder. If the solder doesn’t take, insufficient flux or excessive dirt are usually the cause.

Often dried flux should not be removed from the assembly. Activated fluxes used in some commercial operations have very good insulation resistance in this dry state. Cleaning the flux off may be harmful unless it is thoroughly done. Any flux becomes active in solution.

Vapor degreasers are very good flux removers. But care must be taken not to remove component markings.

Many forms of dip soldering are practiced. Single dip soldering is most common. A double-dip method uses two solder pots. The second dip has a thin layer of high-temperature wax floating on top. This method permits reflow of solder that may have bridged across the printed pattern, and covers the circuit with a moisture and fungus-proof coating.

Masking keeps solder coatings off areas where it is not desired, such as component mountings. Marking tape or solder resistant varnish coatings are used.

Jig soldering is a fusion process which heats the elements to be joined and controls flow of solder to appropriate portions of the circuit. Because of considerable expense involved, the method is used only where production volume warrants.

Wave soldering, or contoured soldering is a
recent development. Instead of dipping the board into the solder pot, the level of the solder is raised to the board by pumping it up into a "sweat". Several advantages are apparent, such as a improved angle of insertion and withdrawal, better control of time and less heat applied to other parts of the board.

Method Manufacturing Corp. lists these important soldering considerations:
- Solder Composition—the eutectic solder alloy has the feature of going from solid to liquid or vice versa without a mushy stage and very quickly. To maintain the 63-37 alloy ratio, it may be necessary to add pure tin. Insufficient tin is indicated by a crystalline appearance of solder areas. The pot should be stirred before use to maintain balance between the tin and lead since the latter tends to go to the bottom during cooling. Impurities are added to the bath by the solvent action of the hot metal on components, fixtures, skimmers, etc., and periodic dumping is indicated.
- Temperature Uniformity—The solder reservoir should be large enough to maintain temperature at the desired level on a constant basis.
- Gas Entrapment—Fumes from flux if trapped between the panel and solder may impede wetting and a dip angle that allows trapped vapors to escape is suggested.
- Pads—Design of pattern may affect percentage of opens. Holes tangent with the edge of pads have been found on a statistical basis to tend more to opens than those centered. Ideally, each hole is a sort of focal point for its surrounding pad or portion of pad.
- Component leads—Metals and platings of components have contributed to many dip solder headaches. Cadmium, satisfactorily used for hand soldering electronic terminations, deteriorates too rapidly for use at dip solder temperatures. Zinc and aluminum go into solution easily and impede soldering. Resin or wax may mask solder from leads, or in liquid state form bubbles to prevent wetting action. Component leads should be carefully checked for solderability after aging.

**Fig. 2.** Dip soldering machine showing how board is loaded in spring loaded fingers. Dipping is controlled automatically; solder bath is covered except during dipping cycle.

**Fig. 3.** Wrong way (left) to design wiring terminations and how these faults may be overcome (right).

**Fig. 4.** Wave or fountain method of dip soldering concentrates heat on solder points.
Other Forms—

variations of well-known techniques

designed for

printed-wiring reliability

PLATING is the second most popular method of fabricating printed-wiring. Etching is first. In plating, a thin conducting film, usually silver, is applied to the laminate. Then, a reverse pattern is printed on the film with plating-resist ink. Electroplating follows, then an etching process to remove the ink and remaining silver.

One advantage of the plated method is its lower cost. Also, holes may be plated-through at the same time. Both sides of the base may be done at the same time.

Many other methods are less commonly used. They include embossed wiring, sprayed metal, "buried" wiring, and molded wiring. Most of these methods are expensive, but offer advantages like better insulating characteristics.

Flush Wiring

Flush wiring is commonly used for switch and commutator applications. Glass Products Co. provides an "inlaid" type. They make their boards by first plating a 0.0001-in. metal foil on a polished base. Then, a photo sensitive epoxy resin is coated upon the foil, an image is photographed and the resin remains in the non-image area.

After curing the resin, the exposed foil areas or image areas are then electroplated with any metal or combination of metals desired. The plate is now laminated onto any thermoset or thermoplastic resin desired (Fig. 1).

For thermoplastic material, polystyrene is commonly used. For thermoset applications, a special high insulation resistance XXXP bakelite phenolic can be used. After lamination the supporting surface is separated from the foil and the 0.0001-in. foil is etched in a material that does not affect either the electroplated metals which form the circuit or the plastic base.

Imbedded Wiring

Another important process has been devised and patented by John Beck of St. Paul, Minn. With the Beck process, the wiring may be completely imbedded (Fig. 1) in the laminate or flush with the surface. It uses much heavier copper conductor (5, 6, or 7 oz instead of 2 oz) and uses solid copper rivets (Fig. 2) to connect both sides of the board instead of eyelets or plated through holes. All this results in relatively heavy conductors and more reliable connections.

With the Beck method, circuitry may be fabricated by etching, forming, metallic spray, or electroplating. Etching is by far the most common. But even in etching, the Beck process differs from others. Here is how Beck's "controlled selective etching" works. It can start with 0.0081-in. (6 oz) copper, stop off the terminal areas, and etch the remaining metal part way. The exact circuit pattern is next stopped off and the remaining metal etched the rest of the way. The
result is a two-level circuit with the conductors themselves only 0.0052 in. (equivalent to 4 oz) and the terminals at their original thickness.

An overlay, using the same material as the base, is then applied overall and cured to the base. Following this, the new surface is sanded down to the surfaces of the terminal pads allowing them to be exposed, but flush with the surface of the base material.

The circuit is now completely embedded except for the terminal pads. During final assembly of these boards, it is customary that these terminal pads be coated completely with solder.

Problem of eyelets vs. plated-through holes is minimized in Beck’s circuit. A solid copper rivet, the same cross-section area as the metal conductor, is inserted in a predrilled hole. The rivet is then expanded by pressure so that it tends to fill out every irregularity of the hole. It bonds itself to the metallic conductor. The fact that the “Beck Process” uses heavy conductors makes this bond an extremely good one.

Multiple-level circuitry may be made by Beck’s process by building up two or more levels of laminated imbedded circuitry. The normal imbedded circuit may be produced and second level metallic conductor may form a heat sink. This heat sink could be brought to the surface at any place in the circuitry to dissipate heat from a particular location, or from the whole board in general.

**Painted and Indexed Wiring**

Another departure from standard techniques is Samuel Wein’s “Copperoid” process. It is a chemical process for deposition of copper on glass, ceramics, plastics or rubber. No special equipment is needed other than trays or tanks.

Copperoid compound is a water-soluble compound and is applied at slightly elevated temperatures. Its present applications include depositing a copper film on ceramic wafers and for connections between printed-wiring boards.

J. Frank Motson Co. are producers of wiring printed on varied shapes. Circuitry can be printed on tubes, cones, and curved base material. Motson uses special silver inks which vary in printed thickness from 0.0002 to 0.0018 in. Teflon epoxies, melamines, phenolics, and the like are used as base materials. Applications include rotors, commutators, and wave guides.

**Flexible Wiring**

Flexible printed-wiring offers many advantages, especially for wiring harnesses. Sanders Assoc., Inc., has introduced a new material called “Flexprint.” It consists of etched patterns of electro-deposited or rolled copper foil bonded between thin sheets of insulating plastics. It is available in single or multilayers.

Some of the insulating plastics include vinyls, polyesters, silicone, Kel-F, and Teflon. Its flexibility allows for irregular shapes and contours. For example, bending radius for 0.005 in. plastic is 1/16 in.

Applications include use with moving devices such as computer search carriages or reciprocating machine heads to reduce cable loading.

**Ceramic Boards**

Fotoceram, a process developed by Corning Glass Works, converts a special photo-sensitive glass into a ceramic printed-wiring base. Holes in the glass are etched in with hydrofluoric acid.

Then firing converts the glass into a ceramic. As a ceramic, the material will not warp or sag and does not absorb water.

After processing, copper is electroplated onto the base and through the holes. A resist is used to protect the insulating areas. Holes cannot be easily added after the material is processed.

Flexural strength is 25,000 psi, but the ceramic is brittle. Thus, added precautions must be observed in mounting. But the biggest advantage is in its resolderability. Removing and resoldering of a component up to 50 times has been accomplished with no sign of damage.

Fotoceram is competitive in price with high-quality epoxy base laminates. The material is intended mainly for use in missiles and radar equipment, where high reliability is necessary.

**Molded Circuits**

Printed-wiring boards may also be molded. Channels for the conductors can be molded on one or both sides. Circuitry is electro-deposited about 0.015 in. below the surface of the board. Conductors are thus protected against damage. Any material that can be transferred molded may be used. Resin used by Die Form Circuits Inc., developers of this process, is electrical grade phenol resin. Bakelite Co. supplies the resin.

A standard transfer molding press is used for molding the panels. All holes for feed-through wiring are molded in. Thus, the use of punch presses are not required. Holes have an “hourglass” cross section which assures uniform copper plating inside the hole.

Panel thickness has been standardized at 0.093 in. With conductors depressed about 0.015 in., base thickness between sides is 1/16 in. Maximum panel size so far is about 10 x 6-1/2 in.

Cost is expected to be considerably less than etched boards. Production of molded boards is inherently less complicated than processing of etched boards.

Rogers Corp. has developed a variation of Die Form’s molded circuits. Rogers uses a laminate as its base material instead of resin.

Printed-wiring is die blanked and molded into a laminated board of any NEMA grade. Standard stamping and compression molding machines can be used.

Copper scrap from the blanking process can be reused. Circuitry can be either raised or depressed. Rogers has developed their own laminate which meets NEMA XXXP specifications, but has better dielectric characteristics.

Although the Rogers method involves die blanking, other forms of fabrication may be used. Copper may be deposited on the board by electroplating or etching. But where high currents must be carried, die-blanked conductors can be made heavy enough to carry 70 amp.
Effects of Processing and Environment

On Printed-Wiring Laminates

Nearly all printed circuit boards are made from high-pressure laminates that use a paper-phenolic laminate or glass fabric-epoxy laminate. This article describes the process and environmental effects on the important electrical and physical properties of these two types of laminate.

Important laminate properties that concern printed circuit boards fall into three categories:
• Electrically, there is insulation resistance, surface resistivity, dielectric strength, dielectric constant, and arc resistance.
• Physically, there is flexural strength, impact strength, cold flow, and machinability.
• Chemically, there is the resistance of the laminate to the various processing solutions used in the manufacture of printed circuits.

The chart (Tab. 1) indicates “as received” values of various properties of paper-phenolic and glass fabric-epoxy laminates.

Of course, where high physical properties, such as flexural and impact strength are important, glass-base material is superior to a paper-base laminate. Better dimensional stability is also a characteristic of a glass base laminate as compared to paper. However, a paper-phenolic laminate having good electrical characteristics does satisfy a majority of printed circuit applications.

Effects of Environment

Before examining process effects on laminates, it would be in order to point out what happens to various properties as a function of temperature and humidity. These characteristics as well as “as received” properties will influence the choice of laminate for the particular printed circuit application.

Effect of temperature on power factor, dielectric constant, and dissipation factor is shown in Fig. 1.

Insulation resistance (Fig. 2) varies with temperature for a hot strength epoxy-glass laminate and a paper-phenolic XXXP grade.

Tab. 2 shows insulation resistance after exposure to high humidity for different types of

(Continued on page 50)
Table 1. Typical values of physical and electrical properties of paper-phenolic (XXXP) and glass-epoxy G-10 laminates:

<table>
<thead>
<tr>
<th>Properties</th>
<th>XXXP</th>
<th>G-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength, Flatwise, PSI</td>
<td>15,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Lead Impact, Edgewise, ft. lbs/in notch</td>
<td>.40</td>
<td>10.0</td>
</tr>
<tr>
<td>Water Absorption, % (1 x 3 -24 hr, immersion) 1/16”</td>
<td>.60</td>
<td>.25</td>
</tr>
<tr>
<td>Dissipation Factor (Powder Factor)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As Received</td>
<td>.032</td>
<td>.020</td>
</tr>
<tr>
<td>D 48/50</td>
<td>.041</td>
<td>.038</td>
</tr>
<tr>
<td>Dielectric Constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As Received</td>
<td>4.3</td>
<td>4.8</td>
</tr>
<tr>
<td>D 48/50</td>
<td>4.9</td>
<td>5.2</td>
</tr>
<tr>
<td>Dielectric Strength, Perpendicular to Lam.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/16” VPM</td>
<td>650</td>
<td>800</td>
</tr>
<tr>
<td>Short time</td>
<td>450</td>
<td>575</td>
</tr>
<tr>
<td>Step by step</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation Resistance, Megohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C 96/35/90</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Arc Resistance (ASTM D-495) Seconds</td>
<td></td>
<td>130</td>
</tr>
<tr>
<td>Coefficient of Thermal Expansion (in. per in. per degree C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lengthwise</td>
<td>1.7 x 10⁻⁵</td>
<td>1.1 x 10⁻⁵</td>
</tr>
<tr>
<td>Crosswise</td>
<td>3.3 x 10⁻⁵</td>
<td>1.1 x 10⁻⁵</td>
</tr>
</tbody>
</table>

Fig. 4. Shrinkage characteristics of NEMA grades XXXP and G-11.

STOPPED making our own etchant
STARTED using HUNT S.C.E.

“We used to make our own etchant for solder plated circuit boards until we heard of HUNT S.C.E. Solution.

“To mix our own etchant we used to stock large quantities of chronic and sulphuric acid. It took time to make up the solutions which filled the air with noxious fumes and was always dangerous to handle. Besides the time it took to make up the solutions we ended up with variations from batch to batch. And in order to get the solution working right, we had to heat it up to 140° F and over.

“So we did the wise thing...stopped making our own and started to use HUNT S.C.E. which works at room temperature. Now we have no more chemical dangers. We are really saving money — etching time is standardized and we maintain a uniform production rate around the clock.”

HUNT S.C.E. (Solder Circuit Etch) is superior to plant mixed etchants because it:
1. Etches rapidly at room temperature.
2. Is a ready, prepared product designed specifically for this one purpose.
3. Has a high capacity for copper.
4. Never attacks the solder plated circuit.
5. Has guaranteed uniformity and is the highest quality because of rigid laboratory control.
7. Produces boards that pass all corrosion and stability tests.

For detailed information about HUNT S.C.E. and valuable production handling information, write for Technical Bulletin No. 3 — "The Etching of Solder Plated Circuit Boards by Hunt S.C.E. Solution." HUNT S.C.E. Solution is available in 125 pound (12 gallon) carboys and 500 pound (55 gallon) drums.

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paper-phenolic laminates. An important fact is that it isn't the amount of resin in the paper that affects the insulation resistance under high humidity conditions, but rather the manner in which the paper fibers have been saturated. A sizing treatment is definitely necessary in addition to the proper application of the electrical grade phenolic resin.

Flexural strength of two types of epoxy-glass fabric laminates and a phenolic laminate as a function of temperature is plotted in Fig. 3.

Of course, “as received” values of a glass-base laminate are much higher than a paper-base laminate. It is interesting to note the difference between two types of epoxy resin on the same glass fabric. The hot strength epoxy resin laminates retain 60 per cent of its “as received”

Table 2. Insulation resistance for various grades of paper-phenolic laminates.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Insulation Resistance After C 96/35/90</th>
<th>Water Absorption 1/16” Thick</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXP</td>
<td>1,000,000 Meg.</td>
<td>.35%</td>
</tr>
<tr>
<td>(Ave. Resin Content 60%) (Proper Sizing Treatment)</td>
<td>1,000,000 Meg.</td>
<td>.45%</td>
</tr>
<tr>
<td>XXP</td>
<td>600 Meg.</td>
<td>1.65%</td>
</tr>
<tr>
<td>(Ave. Resin Content 52%) (No Sizing Treatment)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Effect of ferric chloride on insulation resistance (surface resistivity) of XXXP with various rinsing cycles.

<table>
<thead>
<tr>
<th>Rinsing Procedure on Sample Test Pattern</th>
<th>Insulation Resistance After C 96/35/90</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rinsed 30 seconds immediately after etching.</td>
<td>200,000</td>
</tr>
<tr>
<td>2. Rinsed 1 minute immediately after etching.</td>
<td>500,000</td>
</tr>
<tr>
<td>3. Rinsed 10 minutes immediately after etching.</td>
<td>over 1,000,000</td>
</tr>
<tr>
<td>4. Air dried, no rinse.</td>
<td>3</td>
</tr>
<tr>
<td>5. Air dried for 1 hour followed by 10 minute rinse.</td>
<td>55</td>
</tr>
</tbody>
</table>

Fig. 5. Dimensional change of NEMA grades XXXP and G-11 due to heat exposure.

Fig. 6. Shrinkage characteristics of NEMA grades XXXP and G-11.
shown in Fig. 5. Certain solder mask coating requires up to 2 hrs at 150 C to set up properly, so his chart indicates the degree of dimensional change that can be expected.

Shrinkage, (Fig. 6) once again on XXXP laminates, occurs as a result of etching, degreasing, and dip soldering. Basic points that should be taken into consideration when designing tolerances on dimensions and registration of printed circuits are:

- Dimensional changes as a result of processing are considerably greater with a phenolic-paper laminate than an epoxy-glass laminate.
- Dimensional changes as a result of processing a phenolic-paper laminate are considerably greater in the crosswise direction of the material than the lengthwise direction.
- Dimensional changes occur on a phenolic-paper laminate as a result of removing copper during the etching operation. This change occurs even though a room temperature etching solution may be used.

From these three points, it is apparent that, for the ultimate in tolerances on dimensions and registration, an epoxy-glass laminate should be used. In many cases, however, when highest physical properties are not necessary, economy dictates the use of a phenolic-paper, XXXP type, material. In order to obtain best results with a XXXP material, as far as accuracy of registration is concerned, it is suggested that all machining be performed prior to etching. If tolerances on machined or punched dimensions are paramount, then hole fabrication should be performed at room temperature as a final process operation, and critical dimensions should be located in the lengthwise direction of the material.

Processing operations affect the electrical properties, particularly insulation resistance of a laminate. Insulation resistance is materially deteriorated (Tab. 3) by improper rinsing after etching. The important point to stress is that any residual etching solution must be thoroughly rinsed off immediately after removal from the etching tank.

Investigation of the effect of dip soldering on the properties of phenolic-paper and epoxy-glass laminates show that there is no appreciable effect on the physical and electrical properties of the laminate.

Any new printed circuit material should be evaluated from both a processing and environmental standpoint. Consideration must be given to not only what happens to a material under various temperature and humidity conditions, but also what happens under various process operations to which the material is subjected.

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Are you responsible for any of the equipment involved in scenes of this kind? Any of the instrumentation or telemetering devices?

If so, you well know how little can be left to chance when a $100,000-plus pre-dawn “shot” is scheduled.

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   c. Complete facilities for producing custom-built or specification cable?
2. Are his cable conductors full-size, uniformly annealed and precisely stranded?
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Using Transistors In Demodulator Circuits

Part 2

Albert N. DeSautels
Minneapolis-Honeywell Regulator Co.
Minneapolis, Minn.

Part 1 of this two-part series discussed half-wave and full-wave phase discriminators using transistors.

This article analyzes operating characteristics, power considerations and limitations.

Transistors, when used as phase discriminators, display some of the characteristics of both switching and Class B operation. As a discriminator, the npn transistor conducts when both the base and the collector are positive. This condition occurs during one half-cycle. During the negative half-cycle, the transistor is cut off. Fig. 1 shows part of a phase-discriminating circuit.

The reference voltage, which provides the collector voltage, varies sinusoidally and is equal to $V_{R_{max}} \sin \theta$. For a given load, the load line superimposed on the transistor common emitter collector characteristics (Fig. 2) will be a series of lines with constant slope; however, perpendicular distance to the origin will be related to the

Fig. 1. Basic phase-discriminator circuit used to determine operating characteristics.
The load line will be a series of instantaneous load lines.

For example, taking \( V_R \text{max} = 41.5 \) v and \( R_L = 1 \) kilohm (neglecting, for convenience, the diode drop); 30 deg after start of the cycle, \( V_R = 20.7 \) v and the load line intersects the \( x \) and \( y \) axes at 30.7 ma and 20.7 v respectively; 60 deg after start of the cycle, \( V_R = 35.9 \) v and the load line intersects the \( x \) and \( y \) axes at 35.9 ma and 35.9 v.

The input current \( I_b \) is sinusoidal and equals \( I_{max} \cdot \sin \omega t \). This indicates that at the start of the transistor's conducting half-cycle, \( V_R = I_b = I_e = V_e = 0 \).

Referring again to Fig. 2, \( I_b = V_e = I_e = 0 \) at the start of the cycle, therefore, the start of the ac load line will be at the origin. As the driving current \( I_b \) increases sinusoidally, the various time values of current will progress along a line comprising intersections with load lines related to corresponding time values of reference voltage. This line will terminate where the base current associated with the peak value of the base current drive intersects the load line related to the peak value of the reference voltage.

A separate line would be obtained for different

peak values of driving current. If the current gain were constant for all values of driving current, a family of straight lines radiating from the origin would be obtained. However, since current gain decreases at large signals, the response lines related to large-amplitude drive will be nonlinear, as shown by curves \( C, D, \) and \( E \).

The transistor operates in the discriminator circuitry in a manner which enables it to handle load power well in excess of maximum effective collector dissipation ratings. The primary power output limiting consideration appears to be the maximum current and voltage rating of the transistor insofar as these ratings contribute to the maximum collector dissipation rating.

As an example of effective power dissipation per transistor, take a value of reference voltage, \( V_R = 30 \) v rms and \( R_L = 1 \) kilohm. The transistor conducts for one-half cycle and is cut off for the other half-cycle. For an effective differential or load current of 20 milliamperes for the full-wave discriminator, the current furnished by each transistor during its conducting half-cycle would be 20 ma effective or a peak current of 28.28 ma. During the conducting half-cycle,

(Continued on following page)

---

**Fig. 2. Characteristics of a common emitter transistor as a half-wave discriminator.**
Also manufacturers of IF transformers (1/4", 1/8", 1/4") for both tube and transistorized circuit applications.

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CIRCLE 39 ON READER-SERVICE CARD
In the saturated region, the maximum power dissipation in the transistor is limited to a value of the form:

\[ P_T = \frac{1}{2} V_R^2 R_L \]  

(1)

The unit of the dissipation is in watts, and the units of the voltages are in volts and the units of the resistance are ohms. 

The dissipation of power is given by the following equation:

\[ P_T = \frac{1}{2} i^2 r \]  

(2)

For the transistor, the constant \( k \) is given by

\[ k = \frac{1}{2} \frac{1}{r} \]  

(3)

Solving Equation (4) for \( P_T \) indicates that the effective load current related to this maximum dissipation point is

\[ I_L = \frac{V_R}{2R_L} \]  

(5)

Solving Equation (4) for \( P_T \) brings out that the value of the maximum transistor dissipation can be determined quickly for any combination of values for \( V_R \) and \( R_L \). Use of Equation (5) will establish the load current at which the maximum transistor dissipation will occur.

For most efficient operation of the discriminator with three-terminal or split load, it is essential that the input signal be in phase or 180 deg out of phase with and at the same frequency as the power supply. If the input signal were at some other frequency or at some other intermediate phase angle with respect to the power input, then there would tend to be current flowing in both arms of the load at the same time. Since it is the difference between the two arm currents which is utilized, it is obvious that, with respect to a given signal amplitude, currents flowing in both arms will result in less differential than current flowing in just one arm.

Using diode-controlled base bias, the temperature stability of the transistorized discriminator has been found to be extremely good. Using silicon transistors can result in essentially constant gain from 55 to 125 C.

The semiconductor associated with the transistor will be sensitive to the temperature. The units described can operate with as low as 10 mv of signal and produce output currents limited only by the current rating of the transistors.

The full-wave unit is found to be a high-sensitivity, temperature-stable device capable of utilization in automatic control systems and a variety of other control applications. Conversion of the full-wave discriminator with three-terminal (or split) load to two-terminal load results in a considerable loss of useful power due to use of bleeder resistors which dissipate 5-6 of the total power output. However, a respectable useful power output can be obtained with the two-terminal load depending upon the maximum ratings of the transistors. The manner in which the transistor is operating in the full-wave circuit permits power outputs many times the maximum effective power dissipated per transistor.

**References**


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**Sylvanias**

**MICROWAVE AND SPECIAL TUBE NEWS**

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Counter Tubes Set Life Records

Field experience indicates a minimum life expectancy of 10,000 hours and a capability of 20,000 hours for Sylvanias counter tubes.

Under actual operating conditions in the field, Sylvanias counter tubes are achieving new records in reliability and life. Field reports show a life of 10,000 hours in a wide range of applications, while Sylvanias life tests indicate a capability for continuous operation in excess of 20,000 hours.

These outstanding records of reliability have been achieved because of qualities inherent in the design of these cold-cathode tubes, and extremely close control and testing during manufacture. Some of the important process steps are: high degree of component treatment at elevated temperatures to remove material impurities and foreign gases; precise control of gas mixture and pressure to assure reliable and repeatable operation; exacting exhaust and sealing techniques to retain cleanliness of parts and gas; 100% test of all electrical parameters; two 100% aging and stand-by tests; and further mechanical, electrical and life testing by the Quality Control department of Sylvanias.

Portable Scaler Uses Counter Tubes

Nuclear-Chicago's new d/M-Gauge, a completely portable scaler, makes possible fast, accurate density and moisture measurements directly in the field. The new scaler uses five Sylvanias counter tubes that can accumulate up to 99,999 counts. It illustrates how Sylvanias counter tubes are helping designers achieve maximum portability in otherwise bulky counting equipment.

Sylvania is your leading source for both medium and high speed counter tubes. Write for full information on the complete line listed below.

<table>
<thead>
<tr>
<th>Type</th>
<th>Freq.</th>
<th>Output Cathodes</th>
<th>Base</th>
<th>Min. D.C. Supply Voltage</th>
<th>Max. Anode Current</th>
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<td>100 KC</td>
<td>4(0.8,9)</td>
<td>Octal</td>
<td>400 V</td>
<td>1.3 ma</td>
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<td>3(0.8,9)</td>
<td>7-pin</td>
<td>425 V</td>
<td>1.3 ma</td>
</tr>
</tbody>
</table>

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CIRCLE 41 ON READER-SERVICE CARD

Floating Input and Output DC Amplifiers

Neff Unit

The amplifier, developed by the Neff Instrument Corp., 2211 East Foothill Blvd., Pasadena, Calif., is basically a carrier type utilizing an electromechanical chopper as an input modulator. Thus a 400-cycle square wave is produced with an amplitude proportional to the magnitude of the dc input signal.

To achieve isolation, the resultant ac signal is transformer coupled to a four-stage R-C amplifier, and the output is again transformer coupled to two identical ring-demodulators. These demodulators reconstitute two high-level dc signals from the ac output signal.

Since the demodulators are transformer coupled, the final dc outputs are floating. One of the outputs is passed through an output filter into an internal load and presented to the connector without being grounded. The other demodulator output is passed through a feedback filter and attenuator, and is inserted in series with the input signal. Because the feedback signal is isolated from the output signal and the input signal is transformer coupled after being modulated, the input is truly floating.

Over-all feedback is provided from output to input with the exception of the output demodulator, which is identical to the feedback demodulator and consists of wire-wound resistors and low-impedance diodes. These stable components are the only ones outside of the feedback loop, thus assuring maximum stability.

The amplifier accepts inputs of 0-5 mv and produces an output of 0.5 v into a 100-ohm load. Linearity is 0.05% of full scale. Long-term stability is ±0.2% of full scale, and long-term drift is less than ±5 µv referred to the input. Noise level is less than 5 µv peak-to-peak referred to the input.

For further information on the Neff dc amplifier circle 42 on the Reader-Service card.

Block diagram illustrates the true floating input feature of the new amplifiers, with input and output isolated from each other and from ground.
TRUE FLOATING input means the user can amplify minute voltages from thermocouples, strain-gage bridges, and resistance-bridge transducers. The input is isolated to prevent ground loops in thermocouple circuits, and to prevent paralleling active arms of bridge transducers. Two manufacturers are offering similar units. The Neff amplifier described is an early model and latest specs show a greater output.

**Kin Tel Unit**

The Kin Tel 114A unit includes an output amplifier to isolate the demodulator output from the load. This permits the use of demodulator circuits which are identical insofar as output filter characteristics are concerned, since the output impedance is unaffected by their operation and the output stage furnishes a constant load for the signal demodulator.

To adequately control a diode demodulator more power is required than is necessary to drive the output load. Transistor demodulators are used in this amplifier since considerably less power is required to control them. More important, the use of demodulator filters with similar characteristics allows overshoot to be held within 3 percent.

The latest Kin Tel units are completely transistorized. Total power consumption is less than 10 w. The use of an emitter-follower transistorized output stage results in a low output impedance of less than 1 ohm, as compared to the usual 50 to 60 ohm output impedance. Because of this low value of output impedance it is possible to drive loads of 20 ohms and capacities of 0.5 µfd with satisfactory results.

The Kin Tel amplifier has an output of 10 v peak at peak output current of 10 ma. Gain is fixed steps of 10, 30, 100, 300, 1000. There is vernier control of X0.1 to X1 for variation between fixed steps.

Bandwidth is rated at down 3 db at 15 cycles or greater.

For more information on this Kin Tel unit, turn to the Reader-Service card and circle 43.
Pitfalls in
Precision AC Measurements

Dr. H. A. Poehler
Section Head
General Precision Lab., Inc.
Pleasantville, N. Y.

Part 2

Fig. 1. The circuit illustrates errors introduced by cable capacity and the use of the shield as a conductor.

Fig. 2. Cable capacity errors, and the error resulting from the use of a cable shield as a conductor have been eliminated.

All-too-common neglect of the techniques for high precision ac measurements, have often resulted in substantial errors. The first article of this two-part series investigated those errors introduced by ground loops, loading effects, and harmonics in the null. This article discusses three other frequent error sources.

Among the common errors encountered in precision measurements are: improper connection of cable shields; calibration at an impedance different from that used in the measurement; and cancellation of errors in systems measurements. These errors are examined here in conjunction with the precautions to be observed for avoiding their appearance.

Improper Connection of Cable Shields

Two errors are often made in connecting cable shields because:
- the cable capacity is not considered as an element in the circuit;
- the cable shield is used as a conductor.

Both errors are illustrated in the circuit of Fig. 1, which is used to measure the transformation ratio of a transformer. Since the transformer is at some distance from the resistance divider, a shielded cable is employed. The cable capacity effectively shunts R and causes the voltage at A to have a lagging phase shift. The capacity of C of the cable cannot be neglected unless the reactance \( \frac{1}{\omega C} \) is sufficiently larger than R at the operating frequency.

It is poor practice to ground both ends of a shielded cable in a measuring circuit since cable shields should not be intended for use as current-carrying elements. Only one side of the cable should be connected, and the circuit completed by an additional wire.

It was suggested in the previous article, that a disturbing impedance can be eliminated in a measurement circuit by arranging the circuit so

Fig. 3. [below] Bridge method measurement of transformer transformation ratio where capacity loading errors have been eliminated using a cathode follower to drive the shield.
that the voltage across this impedance is zero at the null.

Excellent application of this principle can be made by using a cathode follower to drive the shield at the potential of the inner conductor as in Fig. 2. The voltage across the cable capacity will be reduced to a very small value, and this capacity can be considered nullified. Moreover, the shield does not serve as a conductor.

The same procedure is often helpful in minimizing the capacitance effects in bridge circuits. Consider the bridge circuit of Fig. 3. With a cathode follower gain of 0.98, the capacitance loading of the bridge transformer, and associated cable shields is reduced to 2 per cent. With high gain and feedback, the capacitance effects can be kept at any desirable low.

**Calibration Errors**

Since calibration equipment is generally operated at very low impedances, appreciable errors can result when this equipment is used to calibrate a test set that normally operates at a high impedance level.

In Fig. 4 the known voltage of a Gertsch voltage divider (accuracy 0.02 per cent) has been substituted in place of the unknown output voltage of the tachometer. In this case, the calibration equipment has a higher input impedance and a lower output impedance than the tachometer that the circuit is designed to measure. As indicated in Fig. 5 errors arise from:

- the internal resistance $R_i$ of the leads feeding the input terminals $L_i$ and $P_2$ of the tachometer;
- the impedance loading of the tachometer out-
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Hyfen meets or exceeds MIL specifications for voltage drop, dielectric strength, contact engaging force, and contact retention force. It provides high corrosion resistance since there are no fluxes or dissimilar metals involved. Floating contacts in both plug and receptacle make for uniform mating and disconnecting force by the alignment flexibility provided.

Hyfen principle is not limited as to size, shape of plug and receptacle nor to number or size of connections.

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Put by the input impedance of the test cable which is connected at $S_1$.

A circuit designed to simulate the input and output impedance of a tachometer is shown in Fig. 6.

A check of the impedance errors can be obtained by connecting the 1000 ohm, 0.31 henry impedance branch in shunt at terminals $L_1$ and $P_2$, in Fig. 5, and by connecting the 680 ohm, 0.54 henry impedance in series with the test lead at $S_1$. The insertion of either one should not cause any change in the reading. The former measures the series resistance $R_s$ in the lines feeding $L_1$ and $P_2$. In this example, the tachometer draws 100 ma, and as little as 0.01 ohm in the lines leading to $L_1$ and $P_2$ will cause a 1 mv error.

The second impedance at $S_1$ measures the loading effect of the capacity $C_s$ of the measuring lead. In a typical case, a cable capacity of 100 µf has caused as much as a 2 mv error.

Neither of the errors above are apparent in the calibration circuit of Fig. 4, which neglects the difference in the impedance levels.

Experience has shown that test sets which were designed to measure to within 0.5 mv were found to be in error by as much as 6 mv when tested by a method which made allowance for the difference in impedance levels between the measuring and calibrating circuits.

Cocclusion of Errors

By accepting component performance in a system as the only criterion for evaluating the com...
 ponent, one may be a victim of error cancellations within the system. Often it is assumed that cancellation of errors is so rare an event that it may safely be neglected. In precision measurements, this assumption is not valid.

A few examples uncovered by the author in certifying the accuracy of vendors' test equipment are cited to point up this potential source of error.

**Linearity Measurement of Tachometers:** Manufacturer A preferred to measure the performance of his tachometer by observing its behavior in an integrator loop. Careful measurements of linearity repeatedly gave values of less than 0.05 per cent. Measurement of tachometer linearity on a direct basis (not in a loop) gave values of 0.12 per cent. A check of the integrator loop was eventually made and revealed non-linearities in the integrator loop were cancelling tachometer non-linearities. The manufacturer now advertises a linearity of 0.12 per cent.

**Loading Errors:** The network of Fig. 6 was designed to test the circuit of Fig. 5 for possible loading effects of the test lead. The network is excited at terminals $L_1 - P_2$ and the output is measured at terminals $S_1 - S_2$ using the circuit of Fig. 5. To check for loading errors of the test leads, the output is measured at terminal $TR$. Any loading error of the test cable will become evident by a difference in reading at terminals $TR$ and $S_1$ of Fig. 6. No difference was obtained by Manufacturer B in readings at these terminals. However, the existence of a cancelling error was suspected because a presumably identical network gave a different answer. On investigation it developed that the 0.54 henry toroid had just the required magnetic coupling with respect to the 115/6 transformer to supply a voltage equal and opposite to the loading error of the test cable. When the coupling was removed, the loading effect of the test cable was revealed.

**Fig. 6.** This circuit simulates the input and output impedance of a tachometer.
NEW PRODUCTS

To provide a complete coverage of ALL new products generally specified when designing electronic original equipment, the New Product section has been extended. To include the larger number of items, products which are best suited to a brief description have been noted at the end of the section.

PANEL METERS

Zero set has been eliminated on several dc types of a series of ac and dc panel meters recently made available. Using a moving magnet design, all dc meters with sensitivities below 5 ma are equipped with a control magnet instead of a spring. When no current is passing through the meter, the moving magnet, along with the attached pointer, is aligned by the control magnet at the zero point. Meters with higher sensitivities use the company’s standard movement. All the meters in this series feature longer scales, in standard 2-1/2 and 3-1/2 in. sizes, larger numerals, and self-shielding. Accuracy is 2 per cent for all types.

General Electric Co., Instrument Dept., Dept. ED, Schenectady 5, N.Y.

CIRCLE 48 ON READER-SERVICE CARD

SAMPLING SWITCH

Less than 15 μV of total contact noise is achieved in this data sampling switch. Operation is based on the successive depression of metal reeds against a common ring by a freely revolving non-metallic wheel. No wipe is required and there is no motion between the reed and the common ring during the conduction period. Speeds of 3000 contacts per sec and up to 200 contacts per revolution can be provided. Contact arrangement can be either make-before-break or break-before-make.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

CIRCLE 49 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
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By measuring shock and vibration in three mutually perpendicular directions simultaneously, this accelerometer saves space in tests normally requiring three accelerometers. The standard 400-TX series and miniature 500-TX series employ piezoelectric ceramics in compression for the sensing element. Sensitivities up to 27 mv/g are available to provide an acceleration response from 0.03 to 40,000 g.

Columbia Research Labs., Dept. ED, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.

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Millivac Instruments Div., Cohu Electronics, Inc., Dept. ED, P.O. Box 997, Schenectady, N.Y.

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For further information please contact Rheem Electronics marketing department direct.

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NEW PRODUCTS

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These units produce a well filtered 0-5 v dc output voltage in response to frequency deviation. Two representative models of the line are the FD-400 for 400 cps power sources and the FD-2000 for inverters operating at 2000 cps. The units are available for frequencies up to 10 kc.

Output variation is less than 1/2 per cent for line voltage variations from 105 to 125 v. Linearity of frequency to voltage conversion is better than ±0.5 per cent for standard models. Output voltage variations at constant frequency is less than ±3 per cent of full scale for ambient temperature changes from −20 to +71 C, slightly higher for operating temperature extremes of −40 to +105 C.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.
CIRCLE 54 ON READER-SERVICE CARD

X-Band Magnetrons
For short range doppler radars

The MA-213 series of fixed-tuned magnetrons are lightweight, integral magnet tubes which are particularly useful in short range pulsed doppler radars. The MA-213

CIRCLE 53 ON READER-SERVICE CARD
series may be used as cw local oscillators when a high degree of frequency stability is unnecessary. In such applications the new tubes normally replace klystrons which operate at lower operating efficiency.

Typical pulsed rf output power is 5 w or 1 w cw, with a 450-500 v mode supply. Six frequency ranges from 8800 to 10,000 mc are available. A UG-40 A/U choke flange terminates the waveguide output. Approximate weight of the MA-213 units is 14 oz.


CIRCLE 55 ON READER-SERVICE CARD

Magnetic Amplifier
Low error instrument type

These amplifiers for instruments and automatic controls have initial standoff errors of less than about one part in twenty thousand of full power output. The units operate directly from 115 v 60 cps line and require no bias or compensating supply. Fluctuations in operating conditions change null by less than about two parts in ten thousand of full power output. This precision and stability is obtained by using a push-pull magnetic amplifier with the two half amplifiers in each pair accurately matched to each other. Such units amplify polarity-reversible dc and low-frequency signals from thermocouples, strain gauges, and similar low-impedance sources. The amplifiers have linear response to at least ±7.5 dc v output into 1000-ohm loads.

Air-ux Products Co., Dept. ED, Middle River, Baltimore 20, Md.

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Precision-built computer gear trains must have uniformly low torque and minimum backlash; mounting surfaces for the bearings should be simple to manufacture.

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Barden Precision means not only dimensional accuracy but performance to match the demands of the application.

Your product needs Barden Precision if it has critical requirements for accuracy, torque, vibration, temperature, or high speed. For less difficult applications, the predictable performance of Barden Precision bearings can cut your rejection rates and teardown costs.

Write today for your copy of Catalog Supplement M1 which gives dimensions, performance and engineering data on Barden Precision ball bearings 5/6" O.D. and smaller.

THE BARDEN CORPORATION

47 E. Franklin St., Danbury, Connecticut • Western office: 3850 Wilshire Blvd., Los Angeles 5, California
THIS STOCK PAYS DIVIDENDS

Helipot declares a 3-in-1 potentiometer dividend for you:
Quality: blue chip!
Price: best buys!
Delivery: same day!

Every Helipot representative carries these market-leaders on his shelf for over-the-counter sales:
Series A...10 turns, 1-13/16" diameter. Total resistance: 15 standard values from 25 to 300,000 ohms. Linearity ±0.5% or ±0.1%.
Series C...3 turns, 1-13/16" diameter. Total resistance: 10 standard values from 10 to 50,000 ohms. Linearity ±0.5%.
Series RB Dualial® turns-counting dials...accuracy 0.01 turn. A perfect match for Series A potentiometers.

Most reps also stock Series AJ, 10-turn, 7/8" diameter miniatures...Helipot® single-turns...Dualial series 900, R and SR.
All can provide modified Helipot precision potentiometers in 10 days or less, at no extra cost!
As you can see, your Helipot representative is a man to see...you'll find him listed in the adjoining column.

Beckman/Helipot

Helipot Corporation
Newport Beach, California
A division of Beckman Instruments, Inc.
Engineering representatives in 57 cities

CIRCLE 58 ON READER-SERVICE CARD
Model 12A simulation table provides a single degree of freedom roll for angularly displacing gyroscopes, accelerometers, and small guidance packages, either statically or dynamically. The unit features a much larger load capability than models previously produced. Smooth operation is obtained by using a driven pendulum mechanism to minimize friction and backlash.

The servo controlled table can be used in conjunction with an analog computer to make flight testing of one axis of a complete aircraft or missile stabilization system possible on the ground, as contrasted to such programs where gyro and accelerometer dynamics are linearly simulated.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., Culver City, Calif.
CIRCLE 59 ON READER-SERVICE CARD

Connectors
For high temperature and radiation resistant application

These connectors have been designed for high temperature and radiation resistant applications for extreme conditions of 1000 F and altitude of 100,000 ft. The component has a square sided case to permit single conductor units to be stacked as a single package.
CIRCLE 60 ON READER-SERVICE CARD
CIRCLE 61 ON READER-SERVICE CARD

Marion's new MM-5 meter* . . . heavy gauge brass housing with MEDALIST® meter styling and satin (camera) chrome or other finishes . . . permits greater scale length . . . improved visibility and conservatively attractive styling while preserving panel area requirements of conventional 4 5/8" instruments and mounting requirements of ASA MIL 312" instruments. For further information, write Marion Electrical Instrument Company, Grenier Field, Manchester, N. H.


"WHERE ELECTRONICS MEETS THE EYE" Trademark

Copyright© 1958, Marion

MM-5 "HI-FI"
MOVING COIL MECHANISM
This new Marion mechanism combines the best features of core type and external magnet type mechanisms in a new magnetic system which is self-shielded and provides higher flux levels with more symmetric flux distribution than can be attained in either the core or external magnet types. This mechanism permits special instrument scales to be prepared without regard to meter error curves. Tracking error for the "HI-FI" mechanism can be held to 1/2 of 1% of full scale when plotted linearly or with a protractor reference for deflection angles up to and including 100 degrees. Other features include:
1. One piece pole structure broached after magnet assembly is soldered, assuring perfect alignment of pole faces.
2. Marion "Coaxial" core and yoke assembly.
3. Rugged interlocking structure for positive, permanent alignment.
4. Mechanical assembly of pivot structures—NO cements used in positioning any components.
5. Osmium alloy tipped pivots in all ranges.
NEW PRODUCTS

Transformers
Transistor application

These miniature transformers are designed for transistor application, including transformers for interstate, driver and output service.

James Vibrapowr Co., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

CIRCLE 62 ON READER-SERVICE CARD

Half Loop Antenna
Horizontally polarized type

Type DM N4-2 electrically balanced loop antenna is designed for use with AN/ARN-14 equipments. The antenna may be installed on the vertical tail or the sides of an aircraft fuselage to provide substantially omnidirectional sensitivity to horizontally polarized radiation in the band of 108 to 122 mc. A high degree of discrimination against vertically polarized signals is achieved assuring more accurate bearing information. The loop shells are of welded steel construction. The center gap is supported with a heavy wall fiberglass tube, and all internal spaces are foam-filled to exclude moisture. This type meets the environmental requirements of MIL-T-5422C and is capable of withstanding severe ice loads. Weight is approximately 2 lb 3 oz.

Dorne & Margolin, Inc., Dept. ED, 29 New York Ave., Westbury, N.Y.

CIRCLE 63 ON READER-SERVICE CARD

CERAMIC TUBES MEAN GENERAL ELECTRIC!
A G-E technician is weighing the ceramic spacers of the 7077 triode before firing, to check their density—one of a whole series of special methods developed by General Electric to make practical the use...in tubes...of tough, heat-resistant ceramics.
Advanced UHF systems had critical need for this tube in radar, communications, navigation. General Electric designed and built it.

**NEW G-E MILITARY**

**SHOWN ACTUAL SIZE.** The 7077 is so small (only .44" long and .48" wide) that the tube can be used in compact circuitry or miniaturized equipment.

**CATHODE ASSEMBLY BY MICROSCOPE** The G-E production worker above is welding the nickel cap on a tantalum cathode sleeve only 1/10 inch in diameter. Note the white Dacron lint-free dress and rubber finger cots! These help protect 7077's from dust and lint—the most common causes of short-circuits.

**ONLY ITS COUNTERPARTS CAN NOISE-TEST A 7077** Evidence of Type 7077's low-noise, high-gain performance, is the use of five more of these General Electric triodes in a specially-developed multi-stage test amplifier that provides 90 db total gain. Every 7077 built receives this noise test!
7077 TRIODE TOPS ALL TUBES IN UHF-AMPLIFIER ADVANTAGES!

- High gain: 14.5 db
- Low noise: 5.5 db
- Low capacitance
- Low inductance
- Low power input
- Light weight
- Small size
- Ceramic ruggedness

This low-price tube is in regular production now. Compare the 7077 with other tubes A and B, which you can obtain for efficient high-gain, low-noise amplifier service at 450 megacycles! (See chart at right)

No tube like this existed. The industry asked for a UHF amplifier tube for new and critical military applications in radar, communication, and navigation systems. General Electric creative design took it from there. Working with a list of “musts”—such as small size, light weight, top performance, and initial and operating economy—General Electric tube engineers developed new materials and processes that made possible new design approaches.

Now the 7077 is ready—electrically, mechanically and life-tested—coming from a factory in volume production. It meets all design specifications for performance. The 7077 is built for rugged operation up to 100,000 feet altitude, and up to 300 C envelope temperature. No forced-air cooling is required.

Phone your nearest General Electric Receiving Tube Department office listed below for further information about this newest, smallest, best-performing UHF triode...including the low price.

**EASTERN REGION**
200 Main Ave., Clifton, N.J. 
Phones: (Clifton) GREGory 3-6387 
(N.Y.C.) W. 7-4065, 6-7 8

**CENTRAL REGION**
3800 N. Milwaukee Ave. 
Chicago 41, Illinois 
Phone: SPRing 7-1600
Phones: GReg 9-7765 
BRadshaw 2-8566

**WESTERN REGION**
11840 W. Olympic Blvd. 
Los Angeles 64, Cal. 
Phones: GReg 9-7765 
BRadshaw 2-8566

**Speed Control**
Detects multiple speeds

Up to eight separate speed sensing switches can be incorporated into a compact housing measuring 5 in. in diam x 4 in. deep. The multiplex switch is particularly suited for control of multiple speeds on machine tools, control of inter-related speeds in automated systems, and synchronization of separate drives.

Torq Engineered Products, Inc., Dept. ED, 32 W. Monroe St., Bedford, Ohio.

**Computer Translator**
Adapts different type computers

Rapid interchange of data is made possible between different types of computers and data processing equipment by means of this computer language translator model ZA-100. Magnetic tapes recorded in the format of one computer can be translated and recorded on another magnetic tape directly usable by a different computer. The computer translator can also convert punched cards or punched paper tape to magnetic tape. Data recorded on magnetic tape can be converted to punched cards, paper tape, or line printer. The needs of a particular system are met by providing the proper combination of available modules. Internal parity checking, marginal checking, and error control features are provided throughout the system. The equipment is available on outright purchase and lease.

Electronic Engineering Co. of California, Sales Dept., Dept. ED, 1601 East Chestnut, Santa Ana, Calif.

**CIRCLE 64 ON READER-SERVICE CARD**
NRG-200 series of fast discharge, energy-storage capacitors for thermonuclear equipment and similar applications, have a life expectancy of 1000 operations. They can be discharged into a very low-impedance load with complete safety and can be operated at ambient temperatures up to 40°C. Maximum permissible reversal voltage is 90 per cent.

To connect unit, index the pins and push on. A click assures you that unit is connected. To disconnect, pull an actuating ring. Connector adapts to AN3100, 3101 and 3102 receptacle and AN3106 and 3108 plug in types A, C and E.


Information concerning any termination problem will be forwarded on request. For literature on the above products, write, giving bulletin numbers desired to:

AMP Incorporated
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA
TECHNIQUES . . . SPECIFY AMP

PRINTED CIRCUIT TECHNIQUE

(A) AMP-EDGE TERMINALS . . . assure excellent electrical contact with friction grippage and positive wiping action . . . apply easily to any section of the perimeter of the printed circuit board . . . reduce cost of application to wire conductor and to board.

(B) AMPin TERMINALS . . . eliminate loose leads during solder-dip operation . . . promote good capillary action during soldering . . . accommodate solid or stranded conductors . . . are self retention and self-aligning.

(C) AMP COMPONENT TIPS . . . prevent movement of components during solder dipping cycle . . . permit bridging or offsetting of components . . . protect semi-conductor leads from solder dipping heat . . . eliminate need for eyelets and thru-plating on two-sided boards, by excellent solder wicking characteristics and uniform solder deposit.  

Bulletin Number 81

TERMINALS AND SPLICES

(A) TERMASHIELD SHIELDED WIRE FERRULES . . . assure positive grounding of wire shield . . . eliminate solder, danger of burning insulation and uncertain attachment . . . feature one-piece construction . . . accommodate one or more grounding wires.

(B) TERMASHIELD SHIELDED WIRE SPLICES . . . join sections of shielded wire so that both the inner conductors and outer shields are firmly spliced, with the two effectively insulated.  They eliminate multi-stage assembly or soldering . . . color coded for matching with application tooling and wire sizes.

(C) TERMASHIELD 7MM SHIELDED CABLE FERRULES . . . permanently ground shielded high tension cables . . . prevent wire damage during attachment . . . won’t loosen or vibrate to cause poor ground or rf noise . . . no move danger of sparking . . . offer easy, four-step attachment . . . seal precisely into applicable joints.  

Bulletin Number 24

SHIELDED WIRE PRODUCTS

(A) STRATO-TERM TERMINALS AND SPLICES . . . for high temperature and heat resistant requirements . . . accommodate a wide range of wire sizes, either solid or stranded, both . . . with or without fully circumferential wire insulation support as desired.

(B) CERTI-SEAL MOISTURE PROOF WINDOW SPLICES . . . seal out vapors and fluids even at altitude to assure dry splice . . . accommodate over 100 insulation thicknesses . . . resist heavy vibration and shock.

(C) OTHER AMP TERMINALS AND SPLICES . . . designed for the most diverse circuitry requirements . . . stringently tested for corrosion resistance, vibration resistance, conductivity and long life . . . ideal for all types of electronic equipment.  

Bulletin Number 37

Potentiometers

Only 1/4 in. diam by 11/32 in. long

These microminiature trimmer potentiometers are available as the model MS-1 for stud mounting and as the model MS-2 for lead mounting on printed wiring boards using 0.1 in. grid spacing.  Rated at 1/4 w, these units measure 1/4 in. diam by less than 11/32 in. in body length.  The units weigh only 0.03 oz.

Miniature Electronic Components Corp., Dept. ED, Plymouth St., Holbrook, Mass.

CIRCLE 71 ON READER-SERVICE CARD

AC Millivoltmeter

300 μv to 1 kc

MV-32A ac vacuum tube voltmeter employs vacuum thermo-couple as its rms-responsive meter-rectifier.  Accuracy within the basic frequency range of the instrument (50 cps-5 kc) is better than 1/2 per cent, at other frequencies 2 per cent.  Total frequency range is 10 cps to 500 kc and total voltage range from 300 μv to 1 kv.  Calibrator accuracy is 0.1 per cent.

Millivac Instruments, Div. of Cohu Electronics, Inc., Dept. ED, 2315 Second Ave., Carman, Schenectady 3, N.Y.

CIRCLE 453 ON READER-SERVICE CARD

A-AMP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

CIRCLE 69 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
If you consider all the properties of a silicone rubber:

- **Seals and cushioning delicate circuits**
- **RTV Silastic**

Design better products with...
**SILICONE-Glass Laminates Increase Life and Dependability**

Laminates made by bonding glass cloth with Dow Corning silicone resins have high arc resistance, low loss factor, low moisture absorption, excellent retention of dielectric properties at high temperatures. Strong, lightweight—produced by leading laminators.

**Silicone Fluids Protect Assemblies from Moisture**

A protective film of Dow Corning 200 Fluid spray coated on electronic assemblies protects terminals, clips, switches and other exposed connections from the harmful effects of condensation. Glass and ceramic insulators coated with silicone fluid have low current leakage and a high degree of surface resistivity, even under very humid conditions.

**Silicone Compound Prevents Arches, Grounds, Shorts**

Nonmelting, nongumming Dow Corning 3 Compound stays in place... provides an effective, moisture-proof dielectric seal for all types of electronic equipment. As a potting or filling material for electronic components and assemblies, silicone compounds flow into place with gentle pressure... have a serviceable temperature range of -40 to 205 C. Free sample available.
Subminiature Glass Types
Transitron's Subminiature Glass Silicon Rectifiers now pack ratings to 600 volts and 400ma (150ma at 150°C). Rugged and reliable at temperatures to 175°C, these units are thoroughly tested under the most severe operating conditions. They give excellent service in subminiature power supplies, D.C. blocking, high voltage series strings and other applications where space is a premium.

Miniature Types
Ratings of 600 volts and 450ma (200ma at 150°C) are now available in the economical Miniature package — constructed without the wide flange that often interferes with compact mounting in printed circuits. These Miniature types serve well in blocking circuits, power supplies, and such critical applications as magnetic amplifiers, where low inverse leakage is essential.

NEW PRODUCTS

Antenna Selector
Improved model smaller in size

This instrument eliminates the effects of antenna shading in aircraft and makes possible uninterrupted inflight communications by automatically selecting exposed antennas. The S7B antenna selector, shown, is an improvement over the S7A produced early in 1957. The principal changes include an overall size reduction approximating 50 per cent, resulting in a 64 cu-in. model, as compared with a 120 cu-in. first model. This was made possible mainly by the elimination of the need for external shock mounts. An improved connector also results in better environmental capability. The instrument’s memory function has been extended to provide improved performance when used in connection with the Tacan navigation system.


CIRCLE 78 ON READER-SERVICE CARD

Relay
Measures 0.23 cu in.

This subminiature relay is equipped with a single operating winding and two change-over contacts. It has been designed for operation from a standard 28 v regulated dc supply. Its size, excluding connection pins, is approximately 0.77 x 0.55 x 0.55 in., corresponding to a volume of 0.23 cu in. Weight is 12.5 gram.


CIRCLE 79 ON READER-SERVICE CARD
Magnetic Modulators
Low millisecond time constant

The Mag Mod magnetic modulator delivers a
phase reversing fundamental frequency ampli-
diate modulated envelope proportional to the po-
arity and amplitude of an input dc or low fre-
quency signal. Hysteresis amplitude is less than
±0.5 per cent of full scale signal input. Null or
zero drift is less than ±0.5 per cent for ambient
temperature range of -65 to +135 C.
General Magnetics, Inc., Dept. ED, 135 Bloom-
field Ave., Bloomfield, N.J.
CIRCLE 80 ON READER-SERVICE CARD

Selenium Rectifiers
Rated from 2.5 to 25 ma

Three selenium rectifiers, 50 per cent smaller,
are rated at 2.5, 8, and 25 ma. All three models
are available in ratings of from 37 to 378 v piv.
These rectifiers will operate at temperatures rang-
ing up to 110 C.
General Electric Co., Dept. ED, Schenectady
N.Y.
CIRCLE 81 ON READER-SERVICE CARD

Oscillator
Measures one cubic inch

Model 0-22 voltage-controlled subcarrier tele-
metering oscillators, little over a one inch cube,
draws a total of only 25 mw. One volt gives
7-1/2 per cent frequency change. Input is 1/2
meg and output up to several volts on RDB chan-
nels. Resistance to vibration and shock up to 20 g
and 2000 cps is specified for most units.
Dorsett Labs., Inc., Dept. ED, 401 E. Boyd
St., Box 562, Norman, Okla.
CIRCLE 251 ON READER-SERVICE CARD

CONVENIENT CIRCUIT COUPLING
and BYPASSING ... with the
simplest, most inexpensive
capacitor design yet produced

Pioneered by Stackpole, these sturdy little
units make ideal low-cost coupling, bypass
and neutralizing capacitors for TV, radio and
military electronic equipment.
Insulated bodies, dielectrics and electrodes
are integrally molded for maximum stability
and durability. Securely anchored leads are
treated for easy soldering. Ranging in size from
only 0.330" to 0.170" in length, Stackpole GA
Capacitors have adequate stability and T.C.
characteristics for a host of TV, radio and mili-
tary electronic equipment uses.

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pennsylvania

46 E.I.A.
"preferred" values
0.10 TO 10.0 μF
5%, 10% or 20% tolerances.
Standard 3- or 4-band color code.

STACKPOLE
"GA" FIXED COMPOSITION
CAPACITORS

CIRCLE 82 ON READER-SERVICE CARD
PERMANENTLY STABLE, 100% TESTED
Resistors
PRECISION WIRE FIXED
FAR EXCEED PROPOSED MIL-R-93B* 

COMPARATIVE DATA REPORT
Note Exceptional Stability. Note extent that MIL-R-93B is exceeded.

<table>
<thead>
<tr>
<th>MIL-R-93B (proposed) Tests</th>
<th>MIL Requirement</th>
<th>CTS Maximum</th>
<th>CTS Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Time Overload</td>
<td>0.5%</td>
<td>.05%</td>
<td>.02%</td>
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<tr>
<td>Temperature Cycling</td>
<td>0.2%</td>
<td>.05%</td>
<td>.02%</td>
</tr>
<tr>
<td>Moisture Resistance</td>
<td>100 megs</td>
<td>1000 megs (min)</td>
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<tr>
<td>Salt Water Immersion Cycling</td>
<td>0.5%</td>
<td>.03%</td>
<td>.015%</td>
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<tr>
<td>Load Life at 125°C or 85°C (500 hours)</td>
<td>0.5%</td>
<td>.1%</td>
<td>.05%</td>
</tr>
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<td>Temperature Coefficient</td>
<td>Up to 75 PPM/°C</td>
<td>30 PPM/°C</td>
<td>20 PPM/°C</td>
</tr>
<tr>
<td>Less than 2000 ohms</td>
<td>30 PPM/°C</td>
<td>20 PPM/°C</td>
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<td>2000 ohms and over</td>
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<td>Low Temperature Storage</td>
<td>1.0%</td>
<td>.05%</td>
<td>.005%</td>
</tr>
<tr>
<td>Low Temperature Operation</td>
<td>1.0%</td>
<td>.05%</td>
<td>.02%</td>
</tr>
<tr>
<td>High Temperature Exposure (145°C)</td>
<td>1.0%</td>
<td>.05%</td>
<td>.02%</td>
</tr>
<tr>
<td>Acceleration</td>
<td>0.1%</td>
<td>.02%</td>
<td>.008%</td>
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<tr>
<td>Shock</td>
<td>0.1%</td>
<td>.02%</td>
<td>.008%</td>
</tr>
<tr>
<td>Vibration</td>
<td>0.1%</td>
<td>.02%</td>
<td>.008%</td>
</tr>
</tbody>
</table>

- No Wire Strain. Unique CTS “floating element” needs no bobbin or winding form. permits resistance elements and contacts to be firmly embedded in epoxy resin forming a monolithic mass with a smaller space factor.
- Permanent Stability—Less than .05% average change under most environmental conditions and shelf life.
- 5PPM/°C Temperature Coefficient available.
- 100% Tested—High temperature exposure and short time overload tests are run on all resistors before shipment.

Available in a wide variety of tubular, rectangular or square shapes. Special dimensions, tolerances, wattage ratings, resistances, etc. can be made to your precise requirement. Either axial or radial leads available.

For help in solving your fixed resistor problems, phone or write your nearest CTS office today.

* MIL-R-93B (proposed) soon to be issued, superseding MIL-R-93A.

NEW PRODUCTS

Ammeter
100 amp range, 0.2 per cent accuracy

Model CHC dc ammeter has an accuracy of 0.2 per cent and plug-in ranges to 100 amp. The double diamond pivoted, permanent magnet type ammeter has a 6.3 in. hand drawn, mirrored scale. Sensitivity is 50 mv, temperature coefficient is negligible between 20 and 30°C and period is 1 sec.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N.Y.

CIRCLE 84 ON READER-SERVICE CARD

Branching Amplifier
Provides six output branches

This Branching Amplifier makes possible the connection of several communications receivers to a single antenna without objectionable interaction or degradation of individual circuit performance. The amplifier is designed to terminate properly a 75 ohm coaxial transmission line over the band of frequencies extending from 2 to 32 mc; produce a gain over this band of between 6 and 12 db; exhibit a noise figure of four; limit the amplitude of any spuriously generated signal component to a level not in excess of 60 db below a 10 mv. input reference level.

CIRCLE 83 ON READER-SERVICE CARD
in addition, the branch-to-branch isolation is such that any leakage from the local oscillators of the associated receivers is attenuated by at least 35 db at the highest frequency in the usable band. Six output branches are provided each capable of feeding a 75 ohm resistive load. A high-pass filter in the input circuit attenuates all components in the region below 1.8 mc by at least 30 db.

Siegler Corp., Hallamore Electronics Div., Dept. ED, Anaheim, Calif.

CIRCLE 85 ON READER-SERVICE CARD

Circuit Interruptor

Bimetal strip construction

This line of medium-lag fractional amperage circuit interruptors, called Guardsets, can be used for loads up to 5 amp, 250 v or less. A built-in visual indication of a broken circuit, a pop-up button, as well as provision for additional visual or auditory alarms are provided. Reset is manual.

Littelfuse, Inc., Dept. ED, Des Plaines, Ill.

CIRCLE 86 ON READER-SERVICE CARD

Multiplexer

For airborne applications

This series of Minimultiplexers uses transistors, diodes and ferrite elements in such a way that a unit is asynchronous with any sampling rate from 0 to 20,000 samples per second, if one channel is being used, while ±0.1 per cent of full-scale transfer accuracy is maintained. A 40 channel combination will operate with a maximum frame rate of 500 frames per second.


CIRCLE 87 ON READER-SERVICE CARD

CIRCLE 88 ON READER-SERVICE CARD

A new era of electronic enterprise continues to place greater and greater emphasis upon engineering design and creative production. New tape recorder and turntable applications have required hysteresis motors unusually precise in their performance, rugged construction to withstand continued use, built within smaller and smaller frames...all this to meet the competitive price requirements of the end product.

A large order...but Induction Motors has done just that in its line of hysteresis motors—compact in size, precision manufacture with assured reliability. Typical of these design achievements are the types which today find themselves in such fine recorders as those made by Ampex.

Induction Motor's reputation of quality has been proven over the years in their manufacture of a complete line of precision subfractional horsepower motors.

For complete information on IMC hysteresis and torque motors for tape recorders and turntables, write for catalogue HT.
from CLEVITE... with PROVEN RELIABILITY...

SILICON JUNCTION
SILICON-GERMANIUM ALLOY
GOLD BONDED GERMANIUM

GLASS DIODES and POWER TRANSISTORS

HIGH FREQUENCY AUDIO
HIGH SPEED SWITCHING
MIL-T-12679 A/32 (Sig C)
10 WATT & 4 WATT

NEW PRODUCTS

Test Set
Low waveform distortion

K series of high voltage test set are available in ranges from 5 to 150 kv. Some of the features include high power capacity, low waveform distortion and metering directly at high voltage output.

Peschel Electronics, Inc., Dept. ED, Towners, Patterson, N.Y.
CIRCLE 90 ON READER-SERVICE CARD

Mercury Switch
Resists shock, chemical splash

This nylon-enclosed mercury switch designated 7 MPI-2, has a small operating force and the ability to repeat operation at the same angle of tilt. Assures precision performance. Dependable switching is offered from -32 to 200 F. Contact arrangement is single-pole single-throw. The switch position, as mounted, determines whether the circuit is to be normally open or normally closed. The switch is rated electrically at 3, 115 v dc, resistive load.

CIRCLE 91 ON READER-SERVICE CARD

Clutch-Brake
Clutch torque range of 100 oz-in.

This magnetically set clutch has a torque range of 100 oz-in. The torque of the brake is 8 oz-in. The unit weighs 15-1/4 oz and can be wound for any dc voltage up to and including 28 v dc.

Stearns Electric Corp., Dept. ED, 120 N Broadway, Milwaukee 2, Wis.
CIRCLE 252 ON READER-SERVICE CARD
Silicon Rectifier

Easily assembled

The A750 expandable rectifier can be used singly, or assembled instantly into series chains for higher voltage applications. The individual unit is sealed and threaded at each end, so that it can be screwed into bushings or a chassis heat sink, or plugged into a clip holder.

Each unit is one in. long with an inverse voltage rating of 400 v and maximum forward current of 750 ma. To produce a high-voltage rectifier in a matter of minutes, a number of the units are connected end-to-end with the bushings to form a series chain. Threaded units with current ratings up to 5 a may also be had for similar assembly.

Audio Devices, Inc., Dept. ED.
620 E. Dyer Rd., Santa Ana, Calif.

CIRCLE 92 ON READER-SERVICE CARD

Galvanometer Analyzer

Features turnover case for \( ±1 \) g
static balance test

GA-101 portable galvanometer analyzer features a complete check of all galvanometer parameters, including damping, frequency response, static balance, and dc sensitivity.

North Atlantic Industries, Inc.,
Dept. ED, 603 Main St., Westbury,
N.Y.

CIRCLE 93 ON READER-SERVICE CARD
CIRCLE 94 ON READER-SERVICE CARD

THREE steps forward in rectifier design by

Amperelex®

designers and manufacturers of the world’s most complete line of rectifiers

THE NEW 7136 single-anode, high-voltage mercury-vapor rectifier. A plug-in replacement for the 575A, surpassing it in capacity and dependability, with higher peak inverse voltage. Offers trouble-free operation in induction and dielectric heaters.

Peak Inverse Voltage: 15 kv
Average Anode Current: 3 amps

THE NEW 869 BL heavy-duty mercury-vapor rectifier. Uses short, flexible filament leads to eliminate possibility of high contact resistance. This prevents under-emission and tube damage, and insures proper voltage drop across the filament at all times. Preferred by equipment manufacturers and users for broadcasting, induction and dielectric heating equipment.

Peak Inverse Voltage: 15 kv
Average Anode Current: 5 amps

THE 6786 super-power, grid-controlled, mercury-vapor rectifier. Guarantees precise electronic control for industrial oscillators up to and in excess of 100 kw output. Proven long life in actual field tests.

Peak Inverse Voltage: 15 kv
Average Anode Current: 10 amps continuous;
15 amps intermittent

ask Amperelex

about mercury-vapor, inert gas and grid-controlled rectifiers for communications and industry

AMPERELEX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, LONG ISLAND, N. Y.
In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17, Ont.
Sylvania RF-IF Transistors

Five new PNP Drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544, for radio frequency amplifier service

Sylvania's new PNP Germanium Drift transistors feature high output resistance for increased gain at 1.5 mc to 20 mc, low feedback capacitance and high alpha cutoff frequency.

Designed for RF-IF circuits, they open the door to more transistorized electronic equipment operating from the broadcast band to the higher frequencies.

The new Sylvania drift transistors incorporate a diffused base on an intrinsic germanium layer for improved control over base thickness, more uniform base region, lower base resistance and reduced collector capacitance. The end result is superior performance at higher frequencies.

The new PNP drift transistors feature Sylvania welded hermetic seal construction for maximum protection in rugged environments. They are encased in a modified JETEC class 30 case with four flexible in-line leads. The additional center lead is connected to the metal case providing a complete unit shield and interlead shield. Coupling to adjacent circuit components is reduced to a minimum.

Call your Sylvania Sales Representative or write direct for information on new Sylvania PNP drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544.

---

NEW PRODUCTS

Delay Line
Features a mechanical driving system

This variable ultrasonic delay line employs a fused quartz as the delay medium. The unit features a mechanical driving system. The unit has been designed for special purpose use, including target simulator applications and all operations in which control in setting the delay time is vital and bandwidth is required.

Andersen Labs., Inc., Dept. ED, 501 New Park Ave., West Hartford, Conn.
CIRCLE 96 ON READER-SERVICE CARD

Power Transistors
For converter and switching circuits

These transistors have a 5 a maximum current rating and can switch power up to 250 w. Current gain ranges are 15 to 30, 20 to 40 and 30 to 60 at a collector current of 3 a. The transistors have collector-to-emitter breakdown voltage ratings of 40, 70 and 80 v.

Bendix Aviation Corp., Semiconductor Prod., Dept. ED, Long Branch, N.J.
CIRCLE 97 ON READER-SERVICE CARD

Multiplex System
Unitized construction

Multiplex system, model FMC consists of an exciter unit, model FME-1, one or two sub-carrier generators, model FMX-1, a power supply for the multiplex exciter, model FS-11, and a separate power supply for each sub-carrier gener-

---

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal

SYLVANIA
LIGHTING  TELEVISION  RADIO  ELECTRONICS  PHOTOGRAPHY  ATOMIC ENERGY  CHEMISTRY-METALLURGY
CIRCLE 95 ON READER-SERVICE CARD

80
"How would YOU measure RF power accurately... reliably?"

... Lou G. Dameson,
Chief Design Engineer, Cubic Corporation

Transistorized flip-flop model SF 101 is designed for use in digital shift registers and does not require the use of additional components or circuitry in such applications. The model SF 101 is intended for slow speed shift register applications. Maximum shift rate is 2 kc. Power requirements are 5 ma at +20 v and 0.5 ma at -90 v.


CIRCLE 454 ON READER-SERVICE CARD

Manufacturers of radar and other high frequency pulse equipment have long felt the need for a primary standard laboratory instrument to measure RF power in the microwave region. The Cubic Calorimetric Wattmeter, Model MC-1B, was designed particularly to provide you with a highly precise instrument of this type, and one with simple and fundamental instrumentation methods to establish long calibration life.

For example, precision thermometers are used, since they are far more stable and reliable than thermocouple or thermistor temperature-indicating circuits. The high accuracy of the MC-1B is maintained without frequent calibration.

Our Calorimetric Wattmeter consists of two units - a liquid circulator and a water load termination. The circulator unit controls the flow of metered amounts of distilled water through the termination, where RF output is converted to heat by means of a water load. Heat absorbed by the distilled water calorimetric fluid is measured on precision thermometers. A power scale on the termination permits direct, precise power readings in watts.

Distilled water is used as calorimetric fluid because of its high dielectric loss characteristics above 1000 mc's. The circulator permits visual monitoring of the fluid flow rate at all times. All parts of the circulator are designed and fabricated to prevent fluid contamination.

Through the use of RF adapters, a match better than 1.15 in VSWR from 2600 to 26,500 mc's is achieved without problems associated with the excitation and propagation of higher order waveguide modes.

Metered fluid flow, precision temperature readings and well designed control of heat transfer permit extreme accuracies of power measurement.

Cubic Calorimetric Wattmeters are being used extensively by industrial and government laboratories. For example, RCA has over 30 of these instruments in use to check out and calibrate magnatrons and radar systems. Hughes Aircraft Company uses the Calorimetric Wattmeter in its laboratories.

Cubic's Calorimetric Wattmeter will prove its accuracy - as no other wattmeter can - in your laboratories, in your plant, or in the field.

For a prove-it-yourself demonstration of how you can obtain consistent, repetitive results in RF measurement, telephone or write...
Three A to reduce Glow attractive DIALCO may in
Recommended power and for (3) 2,421,321)

Addres^ Stewart on Send DIALIGHT All

DIALIGHT Neon colors; New moulded Pilot of
Advance Brighter NE-51H. This lamp may be operated at about 3
times the level of current that may be applied to the standard lamp, and it will pro-
duce 8 times as much light—with long life! Very low power is required, less than 1 watt on 250 volt circuit. Recommended for AC service only.

In the DIALCO assembly, the built-in current limiting (ballast) resistor (18,000 ohms) is completely insulated in moulded bakelite and sealed in metal (U. S. Patent No. 2,421,321) … Small space required—units are available for mounting in 9/16" or 11/16" clearance holes … A wide choice of optional features includes lens styles, shapes, and colors; terminal types; metal finishes, etc. … Meet applicable MIL Spec and UL and CSA requirements.

All Assemblies Are Available Complete with Lamp

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

DIALIGHT CORP., 46 Stewart Ave., Brooklyn 37, N. Y. Send brochures on Pilot Lights □ for NE-51H Neon lamp □ Sub-Miniatures □ O.H.Tight Name: ____________________________________________ Position: __________________________ Company: __________________________ Address: ____________________________________________

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

46 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600

CIRCLE 101 ON READER-SERVICE CARD

One-Cycle Response

Voltage Regulator

FEED A 10-VOLT line drop into this voltage regulator and the 1.2-volt deviation at the output will be corrected before one cycle, or 0.02 seconds, can elapse. In other words, input line surge is reduced by a factor of about 8:1, and the resulting output surge is out of the ±0.25 per cent regulation band for no longer than the one-cycle response time.

Besides response time, the FRLD750 regulator, manufactured by Sorensen & Co., South Norwalk, Conn., provides an unusual amount of distortion attenuation. Unlike many regulators which often add to input line distortion, this

instrument maintains a distortion reduction equal to the transient attenuation of 8:1.

How distortion attenuation and regulation are achieved simultaneously can be seen in the block diagram. First, the input voltage is compared to a fixed ac voltage reference signal. The resulting difference is amplified by the power amplifier and added in series with the input. This difference signal is composed of a waveform of all harmonics present in the input line, plus some fundamental voltage necessary for regulation. The fundamental voltage is then added either in phase or out of phase to the input, depending

Block Diagram

Regulation and distortion attenuation are provided simultaneously by the regulator. The error signal from the amplifier is added to the input either in phase or out of phase, but the harmonic content of the signal is always subtracted from the input.
upon a negative or positive variation in the input voltage. A null point is chosen at the center of the range at which the signal is pure distortion. The distortion is always subtracted from the input voltage. Load regulation is achieved by means of feedback through the driver transformer and the power amplifier.

The ac reference circuit provides a fixed, distortion free ac voltage. This is accomplished by taking a portion of the input voltage and changing it to a pure ac signal. The circuit consists of a phasing network to adjust the signal 180 deg. out of phase with the input line, a limiter network which clips the incoming wave form to a fixed level, a filter circuit which eliminates all harmonics, and an amplifier stage to obtain the proper amplitude.

The amplifier in this regulator is a Class B audio type possessing a high degree of negative feedback. The purpose of the amplifier is solely to bring the difference error signal to the proper power level to achieve voltage regulation and distortion reduction.

The secondary of the output transformer is connected in series 180 deg out of phase with the input line. The action of this transformer either buck or boosts the input line to achieve regulation. By being out of phase with the input, the amplified difference signal which is fed into this transformer is always subtracted from the input, thus attenuating its distortion.

The ±0.25 per cent regulation of the FRLD750 voltage regulation is defined for any combination of load and line changes within load and line limits. These consist of 105-125 v ac input for the 750 va output range and 110-120 v ac for the 1200 va range. In conditions of high input distortion, (2.5 per cent to 10 per cent), regulation accuracy is given as 0.5 per cent over these same ranges.

For more information on this voltage regulator, circle 102 on the Reader-Service card.
NEW PRODUCTS

Pressure Transducer
Capable of withstanding 50 g shock

This transducer, measuring only 2.85 by 1.91 by 1.06 in., can provide pressure altitude, true angle of yaw or attack, jump angle, dynamic, or other pressure data to missile autopilot or navigation systems. The low range, 50 psi units are designed for accuracy under high humidity, and in temperatures ranging from —65 to 165 F. Vibrations of 2000 cps at 15 g register less than 1 per cent full scale transducer error. These transducers are able of mechanically amplifying motion 2.8 to 8 times.


CIRCLE 104 ON READER-SERVICE CARD

Event Recorder
Permits 500 signal changes per sec

Model RE 3610 00 permits recording of 100 channels of sequential or operational information simultaneously. A record of events, their duration and their time relationship to each other, appears on a chart less than 1 msec after the electrical current is switched through the stylus. Rapid response permits up to 500 signal changes per sec. Instantaneous electric selection of eight standard chart speeds with on site or remote operation and a chart speed accuracy within 0.25 per cent of established speed at constant line frequency are featured.

Clevite Corp., Brush Instruments Div., Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

CIRCLE 105 ON READER-SERVICE CARD
TO NEST IN THE SAND

They try to “make life difficult”

The brittle cold of the stratosphere... the heat of air-skin friction... the acceleration and vibration of launch and flight... the unfavorable conditions inherent to storage and handling... all these factors can play havoc with a guided missile.

Hughes Research and Development engineers have designed the Falcon air-to-air guided missile to operate under the most severe conditions. Environmental testing (see Sand & Dust Test at left) subjects missiles to extremes in temperature, shock and other trouble-making conditions.

The Falcon missiles, with either infrared and radar guidance systems, measure only about 6½ inches in diameter. Complex guidance, control and auxiliary systems of each missile are installed in a space no bigger than a stovepipe.

The research and development skill required to successfully engineer the Falcons typifies the challenge present today in other Hughes guided missile assignments of a more classified nature. A few of the areas being emphasized by the Hughes Research and Development Laboratories include missile launchers and power plants, guidance systems, reliability, product design, microwaves, aerodynamics, field test and telemetering, stress analysis and related areas.

High orders of engineering skill are also manifest in other Hughes activities. The commercial area, Hughes Products, has recently announced the development of a numerical control system which will automate a complete and integrated line of machine tools. The Hughes Ground Systems Division has developed a radar antenna which provides three-dimensional target data from a single antenna, transmitter and receiving channel.

Apart from the diversity of activity and the highly rewarding type of work, prospective employees may have confidence in the fact that Hughes will retain its leadership in the field of advanced electronics.

Motor Generator

Has tuning fork speed control

Model 2615 15 kva motor generator set has a 400 cps ±0.1 per cent frequency regulation. A tuning fork speed control regulates an electromagnetic clutch between a 60 cps induction drive motor and a 400 cps generator.


CIRCLE 106 ON READER-SERVICE CARD

Phase-Lock Discriminator

Eliminates suppression of signals by noise

Phase-lock discriminator HEC-0162 eliminates suppression of signals by noise, non-linearities introduced by filtering, and thresholding at low signal-to-noise levels. Standard models include all IRIG channels, including the optional wide band (15 per cent deviation) channels.

Hallamore Electronics Co., Dept. ED, Anaheim, Calif.

CIRCLE 107 ON READER-SERVICE CARD

Rotary Actuators

Load ratings to 100 psi

Designated R-12, this line of aircraft rotary actuators combines 12 standard interchangeable components to provide 40 different units in load ratings to 100 psi and speeds from 0.5 through 50 rpm. Units are available for 115 v, 400 cps ac, or 26 v dc. On either current, maximum operating load is 100 in.-lb, ultimate static load up to 200 in.-lb. Actuator weights are approximately 0.9 lb for the dc unit, 1.1 lb for the ac.

Airborne Accessories Corp., Dept. ED, 1414 Chestnut Ave., Hillside, N.J.

CIRCLE 108 ON READER-SERVICE CARD

An immediate need now exists for engineers in the following areas:

- Circuit Design
- Reliability
- Communications
- Environmental
- Vacuum Tubes
- Computer Engineering
- Crystal Filters
- Microwaves
- Field Engineering
- Aerodynamics

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY

Calver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

CIRCLE 350 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
When RELIABILITY in Printed Wiring is ESSENTIAL...

DSP is the answer

One of the most important advantages to users of the Dry Screen Process in producing printed wiring boards is this method's uncanny ability to consistently turn out thousands of panels that need no retouching or reworking. With DSP rejects are practically nil.

DSP's thermoplastic resist is deposited so thoroughly that pinholing, distortion and broken lines are rarely encountered.

Our engineering staff can design and lay out for you a complete system for your specific requirements, incorporating The Dry Screen Process in such a way as to realize its maximum effectiveness in reliability, flexibility, and capacity at low unit cost. Single-source responsibility for both design and equipment such as we offer will result in a system made up of matched units—all at a savings in capital outlay.

Thousands of printed wiring boards used in the SAGE computer were dry screened at the Kingston, N. Y. plant of I.B.M.'s Military Products Division.

Photos show panel before and after dry screening, and a section of the computer.

Printed Wiring Engineering and Equipment Division of:

DRY SCREEN PROCESS, INC.

1020 MADISON AVENUE • PITTSBURGH 12, PA.

West Coast Office: 9121 Long Beach Blvd, South Gate, Los Angeles, California Phone LDrain 9-6547

CIRCLE 109 ON READER-SERVICE CARD

NEW PRODUCTS

Terminals
For snap-acting switches

These male quick-connect terminals are 1/4 in. wide, made of 0.032 in. half-hard brass, and are indented for tight connection on switches. They are furnished for straight-on or up to 90 deg angle connection, and fit standard female quick-connect terminals.

W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Wallingford, Conn.

CIRCLE 110 ON READER-SERVICE CARD

Relay
For 30 a contactor applications

Loads up to 30 a at 30 v dc are switched by the dual coil magnetic latching KG11DG relay. A high shock and vibration relay, it operates on 2.6 w, 12 msec pulses. The contacts transfer in two µsec. The relay operates in ambient temperatures from -65 to +125 C.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 111 ON READER-SERVICE CARD

Semiconductor Diodes
Utilize unusual materials

The availability of two semiconductor diodes utilizing materials with unusual environmental characteristics has been announced. The first type, FR-1426, employs an internal crystal of aluminum antimonide and has been assigned EIA type no 1N1549. The second type, FR-1731 assigned EIA listing 1N1550, employs indium antimonide as the crystal material. This is the first listing of semiconductors using these materials with the EIA.

ELECTRONIC DESIGN • June 11, 1958
Although no other technical details on these diodes were available, the company stated that in addition to time switching applications, these diodes will find wide application where variation in temperature effect must be held to a minimum and where high temperature conditions are encountered making it impossible to use presently available diode types.

Fretco Inc., Dept. ED, 406 N. Craig St., Pittsburgh 13, Pa.

CIRCLE 112 ON READER-SERVICE CARD

**Magnetic Shift Registers**

For digital computers

Known as type 92Z, this shift register is intended for use with printed wiring boards in commercial digital electronic equipment. The shift register is protected by a heavy dip coat of a moisture-resistant resin.


CIRCLE 113 ON READER-SERVICE CARD

**Servo Motor**

Size 8, measuring 1 in. long

The 700 series size 8 servo motors feature short length with high-torque-to-inertia ratio. Length is 1.062 in. and diameter is 0.750 in. Inputs range from 6 to 57 v and the units operate in an ambient range of -55 to +125 C. Frequency is 400 cps; stall torque, 0.3 oz; inertia, 0.65 gm cm²; maximum power output, 0.45 w; theoretical acceleration (measured at stall), 32,600 rad/sec². Weighs 1.6 oz.

Induction Motors Corp., Dept. ED, 570 Main St., Westbury, N.Y.

CIRCLE 114 ON READER-SERVICE CARD

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**A Wide Range of Ratings ... Choice of Mounting**

**High Efficiency ... Low Cost ... Prompt Delivery**

**Tarzian SILICON RECTIFIERS**

Offer These Advantages — and Many More!

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**SPECIFICATIONS**

<table>
<thead>
<tr>
<th><strong>J SERIES</strong></th>
<th><strong>D. C. Current</strong></th>
<th>Range: 1.5A(J-1) to 10A(J-2)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Peak Inverse</strong></td>
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<tr>
<td></td>
<td>Voltage Range: 100V to 400V</td>
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<td></td>
<td>Approx. Rectifier</td>
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<td></td>
<td>Voltage Drop: 1.25V</td>
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<tr>
<td></td>
<td>Approx. Weight</td>
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<tr>
<td></td>
<td>(Ounces): 0.2 oz.</td>
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<tr>
<th><strong>L SERIES</strong></th>
<th><strong>D. C. Current</strong></th>
<th>Range: 1.5A(L) to 5A(LF)</th>
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<tr>
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<td><strong>Peak Inverse</strong></td>
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<td>Voltage Range: 100V to 400V</td>
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<td></td>
<td>Approx. Rectifier</td>
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<td></td>
<td>Voltage Drop: 1.5V</td>
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<td></td>
<td>Approx. Weight</td>
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<td></td>
<td>(Ounces): 0.35 oz.</td>
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<tr>
<th><strong>HIGH CURRENT SERIES</strong></th>
<th><strong>D. C. Current</strong></th>
<th>Range: 20A to 200A</th>
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<tr>
<td></td>
<td><strong>Peak Inverse</strong></td>
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<tr>
<td></td>
<td>Voltage Range: 50V to 400V</td>
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<td></td>
<td>Approx. Rectifier</td>
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<td></td>
<td>Voltage Drop: 1.25V</td>
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<td></td>
<td>Approx. Weight</td>
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<tr>
<td></td>
<td>(Ounces): 1.3 oz. to 7.0 oz.</td>
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<tr>
<th><strong>TUBE REPLACEMENT SERIES</strong></th>
<th><strong>D. C. Current</strong></th>
<th>Range: 0.25A(HW) to 0.75A(FW)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Peak Inverse</strong></td>
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<tr>
<td></td>
<td>Voltage Range: 1600V to 4500V</td>
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<td></td>
<td>Approx. Rectifier</td>
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<tr>
<td></td>
<td>Voltage Drop: 8V to 10V</td>
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<td></td>
<td>Approx. Weight</td>
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<tr>
<td></td>
<td>(Ounces): 4 oz. to 8 oz.</td>
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<tr>
<th><strong>SM SERIES</strong></th>
<th><strong>D. C. Current</strong></th>
<th>Range: 0.25A to 0.45A</th>
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<td></td>
<td><strong>Peak Inverse</strong></td>
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<tr>
<td></td>
<td>Voltage Range: 800V to 2800V</td>
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<td></td>
<td>Approx. Rectifier</td>
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<tr>
<td></td>
<td>Voltage Drop: 2V to 15V</td>
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<td></td>
<td>Approx. Weight</td>
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<tr>
<td></td>
<td>(Ounces): 0.3 oz. to 0.9 oz.</td>
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Write, wire or phone for complete information

SARKES TARZIAN, INC., RECTIFIER DIV., Dept. C-3, 415 N. College, Bloomington, Ind.

In Canada: 700 Weston Rd., Toronto 9, Tel. Rogers 2-7535 • Export: Ad Auriema, Inc., New York City

CIRCLE 115 ON READER-SERVICE CARD
This is a FOTOCERAM printed circuit
...an unusual new type of printed circuit board

Reliable through-plate holes • The good adhesion of the circuit runs applies also to the through-plate holes because both are produced with one plating operation.
Excellent resolderability • We have removed and resoldered components over twenty times on a FOTOCERAM board without damage to circuit runs or through-plate holes. And this is without using adhesives to bond the copper to the board.
Dimensional stability • Rigid structure of FOTOCERAM prevents unusual design considerations—eliminates problem of warp and twist.
Good adhesion • It takes 12-25 pounds to peel a one-inch copper strip from a FOTOCERAM board.
Exceptional pull strength • 1400 pounds per square inch.
No water absorption • FOTOCERAM's nonporous—zero water absorption.
Non-flammable
No blisters • FOTOCERAM never blisters. We put it through repeated 15-second cycles of copper metallizing at 500°F. and could not find a single blister or sign of peeling or failure.

Other properties:
Dissipation factor
1 mc @ 20°C. 0.006
1 mc @ 200°C. 0.014
Dielectric constant
1 mc @ 20°C. 5.6
1 mc @ 200°C. 6.3
Loss factor
1 mc @ 20°C. 0.034
1 mc @ 200°C. 0.088

For more information, write for our Data Sheet on FOTOCERAM.

CORNING GLASS WORKS, Bradford, Pa.
Electronic Components Sales Department
CIRCLE 116 ON READER-SERVICE CARD

NEW PRODUCTS

Duplexing Element
Low arc loss

Known as the Attenutron, this duplexing element has been successfully tested at 40 mw peak, 80 kw average, and has a very low arc loss. Design and performance characteristics are: recovery time of 3 to 40 µsec; broad band; high level attenuation of 30-35 db; and low Q. The Attenutron is available in single or dual gas switching tubes, in all wave guide sizes greater than RG 52.

CIRCLE 117 ON READER-SERVICE CARD

Krypton
In rare gas mixtures

Krypton 85 as an additive to non-radioactive rare gases such as argon, helium, neon, krypton and xenon individually or as mixtures is now available. Kr-85 is not available in pure or concentrated form. The other rare or inert gases, with Kr-85 added, will be available only in Atomic Energy Commission-approved especially marked cylinders.

Linde Co., Div. of Union Carbide Corp., Dept ED, 30 E. 42nd St., New York 17, N.Y.
CIRCLE 118 ON READER-SERVICE CARD

Control
Utilizes radioactive material

Betatrol, a liquid level sensor which utilizes a radioactive material in the sensing element, has been designed to provide an actuating signal to control or indicate a predetermined level.

Robertshaw-Fulton Controls Co., Dept. ED, 401 N. Manchester, Anaheim, Calif.
CIRCLE 119 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
These threaded ferrite slugs are designed for permeability tuning of inductors, filters and transformers used over the frequency range of 1 kc to several megacycles. These cores are designed for use where a high Q, high permeability core is desired and space is at a premium.

Ferroxcube Corporation of America, Dept. ED, 50 E. Bridge St., Saugerties, N.Y.

CIRCLE 120 ON READER-SERVICE CARD

Relays

Features temperature compensation

Type MTRH time delay relays are available from 10 msec to 120 sec. The relays feature temperature compensation and for special applications, voltage compensation and high speed recovery. Overall dimensions are approximately 7.8 x 1-1/2 x 1-3/4 in., and the relay weighs 3 to 4 oz.

Branson Corp., Dept. ED, S. Jefferson Rd., Boonton, N.J.

CIRCLE 121 ON READER-SERVICE CARD

Pulse Generator

Produces 1 μsec pulses

This transistorized pulse generator 1015A produces 0.1 μsec pulses of 30 v amplitude, when triggered by external voltage transients. The output amplitude is variable from zero to 30 v, and in both positive and negative polarities. The input is ac coupled and may be triggered by any negative transient of at least 1 μsec per 1 v.


CIRCLE 122 ON READER-SERVICE CARD

A plane's best friend is Reliability

Almost anyone who flies spells "Reliability" with a capital "R". Which is one reason why the aviation industry is a good customer for Synthane laminated plastics. There are other reasons.

Synthane is a material with many useful properties in combination. It's light in weight (half the weight of aluminum). It's an insulator with high dielectric strength, low dielectric losses, excellent insulation resistance. It's easily machined and resistant to chemicals. You'll go far to find one material with all these desirable characteristics.

But Synthane is more than a material. It is an investment in reliability. Quality control from the raw materials to the finished product assures you of uniformity and rigid compliance with your most exacting requirements.

Synthane is people. People who have grown up with our company and take pride in turning out a first-class job. People to whom promises of delivery mean something. People who are specialists in working with laminated plastics. In short, people you can count on. What does all this cost you? Little or no more than you are now paying for other plastic laminates.

If you are interested in a reliable source of laminated plastics, you might remember that after "R" for Reliability comes "S" for Synthane ... and Service.

SYNTHANE

SYNTHANE CORPORATION, 42 RIVER ROAD, OAKS, PA.
PRINTED CIRCUIT MANUFACTURERS

...are you plagued with these problems?

NOW... NORTHEAST WILL SHOW YOU HOW TO ELIMINATE THESE PROBLEMS AT NO COST TO YOUR ORGANIZATION!

NORTHEAST CIRCUIT LABS CORP. DOES NOT MANUFACTURE PRINTED CIRCUITS, BUT DOES HAVE 32 YEARS' EXPERIENCE IN THE METAL ETCHING TRADE.

NORTHEAST IS NOW OFFERING TO THE ELECTRONIC TRADE A COMPLETE LINE OF ETCHING SOLUTIONS, PHOTO-RESISTS, COPPER CLEANING COMPOUNDS, ETC., WHICH HAVE BEEN MAINTAINED AS TRADE SECRETS FOR OVER 3 DECADES.

1. LACK OF SKILLED PERSONNEL
2. PHOTO-RESIST TOO EXPENSIVE, NOT ADAPTABLE FOR PRODUCTION
3. ETCHING TIME TOO SLOW FOR EFFICIENT PRODUCTION RUNS
4. OXIDATION OF CIRCUIT BOARD PREVENTING PROPER DIP SOLDERING
5. UNDERCUTTING OF COPPER LAMINATES, PREVENTING PRODUCTION OF CIRCUIT BOARDS WITH CRITICAL DEFINITION
6. REJECTION RATE OF MORE THAN 5%

MANUFACTURERS' REPRESENTATIVES AND JOBBERS URGENTLY NEEDED NATIONWIDE. POSITIONS OPEN FOR QUALIFIED PHOTO-ENGRAVERS.

NORTHEAST CIRCUIT LAB'S PRODUCTS ARE SOLD UNDER THE NECLA® TRADEMARK.

CIRCLE 124 ON READER-SERVICE CARD

NEW PRODUCTS

Toroids
Tolerances from 5 to 1 per cent

Toroid sizes range from 7/8 to 3 in. with frequencies from 1000 cps to 200 kc. They are available with inductance and Q values to specification. Tolerances range from 5 per cent to 1 per cent.

Barker & Williamson, Inc., Dept. ED, Canal St. & Beaver Dam Rd., Bristol, Pa.

CIRCLE 125 ON READER-SERVICE CARD

Event Recorder
68 or 44 recorder channels

This recorder is a multi-channel instrument for recording occurrences of an on-off nature. Two recorder sizes are available, either 68 or 44 recording channels.

Lindly & Co., Inc., Dept. ED, 248 Herricks Rd., Mineola, N.Y.

CIRCLE 126 ON READER-SERVICE CARD

Test Systems

Modular units for automatic systems

The purpose of the series 1000 automatic test system is to perform go-no-go tests of electrical or electromechanical equipment on an automatically programmed basis. It supplies control and data signals to the equipment under test, converts the equipment's response signals to a form suitable for evaluation, and evaluates the con-
you get fast delivery on these

BROWN COMPONENTS

for instrument, servo or control circuits

NEW!
Brown Motors*

for chart drives, servos, balancing circuits

These newly-designed synchronous and two-phase Brown motors have many maintenance saving features: new, sectioned die-cast housing...new wicking to prevent oil leakage...printed circuits...ball bearings to reduce friction. You can replace any part in two minutes, usually without disconnecting the leads from your installation.

TWO-PHASE INDUCTION

<table>
<thead>
<tr>
<th>RPM</th>
<th>Gear Ratio</th>
<th>Pull-in Torque, Min. (lbf-in.)</th>
<th>Continuous Torque (lbf-in.)</th>
<th>Power (watts)</th>
<th>Current (amps)</th>
<th>Temp. Rise (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>330</td>
<td>4.6/1</td>
<td>4</td>
<td>10</td>
<td>7.6</td>
<td>.11</td>
<td>70</td>
</tr>
<tr>
<td>148</td>
<td>10/1</td>
<td>5</td>
<td>5</td>
<td>7.0</td>
<td>.11</td>
<td>70</td>
</tr>
<tr>
<td>44</td>
<td>30/1</td>
<td>15</td>
<td>15</td>
<td>7.6</td>
<td>.11</td>
<td>70</td>
</tr>
<tr>
<td>22</td>
<td>60/1</td>
<td>30</td>
<td>120</td>
<td>7.6</td>
<td>.11</td>
<td>70</td>
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</table>

SYNCHRONOUS

<table>
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<th>RPM</th>
<th>Gear Ratio</th>
<th>Pull-in Torque, Min. (lbf-in.)</th>
<th>Continuous Torque (lbf-in.)</th>
<th>Power (watts)</th>
<th>Current (amps)</th>
<th>Temp. Rise (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>10/1</td>
<td>12</td>
<td>12</td>
<td>19</td>
<td>.21</td>
<td>100</td>
</tr>
<tr>
<td>180</td>
<td>10/1</td>
<td>3.5</td>
<td>4</td>
<td>13</td>
<td>.11</td>
<td>65</td>
</tr>
<tr>
<td>90</td>
<td>20/1</td>
<td>14</td>
<td>12</td>
<td>11</td>
<td>.095</td>
<td>55</td>
</tr>
<tr>
<td>60</td>
<td>30/1</td>
<td>13.5</td>
<td>12</td>
<td>13</td>
<td>.11</td>
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<tr>
<td>30</td>
<td>60/1</td>
<td>27.5</td>
<td>12</td>
<td>13</td>
<td>.11</td>
<td>65</td>
</tr>
</tbody>
</table>

1/6 fast at 50 cycles. Some speeds available at 25 cycles.
16.0 watts in field winding, balance in amplifier winding.

BROWN Electronik AMPLIFIERS

Amplify a d-c or a-c microvolt input signal sufficiently to drive one field of a two-phase balancing motor. Brown amplifiers have extremely low stray pickup, excellent stability, adjustable sensitivity and fast response. Proved in thousands of Electronik instruments.

SELECT FROM THESE BASIC MODELS

<table>
<thead>
<tr>
<th>Model</th>
<th>Sensitivity (Microvolts)</th>
<th>Nominal Input Impedance (Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 10^6</td>
<td>4.0</td>
<td>370, 1400, 50,000</td>
</tr>
<tr>
<td>4 x 10^6</td>
<td>1.0</td>
<td>370, 2500</td>
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<tr>
<td>12 x 10^6</td>
<td>0.4</td>
<td>2500</td>
</tr>
<tr>
<td>40 x 10^6</td>
<td>0.1</td>
<td>1400</td>
</tr>
</tbody>
</table>

POWER SUPPLY

115 v., 60 cycles (fused power line)

OUTPUT

2 to 18 ma. into 12,000 ohm load

SENSITIVITY

Continuously variable screwdriver adjustment. Recessed slot protects setting

MOUNTING

Operation unaffected by mounting position

BROWN ELECTRONIK AMPLIFIERS

For additional details, call your nearby Honeywell field engineer. He's as near as your phone.


Honeywell

First in Controls
minimizes transistor derating for thermal conditions...

UAP cold plate U-521330, designed for Collins Radio Company, dissipates heat generated by power transistors used in ground and airborne electronic circuits. The heat is transferred across a pressure thermal contact to cooling air. The cold plate controls the transistor junction temperature within operating limits compatible with the installation. Therefore, transistor derating is minimized.

The cooling air, which is forced through the cold plate, can be ducted from an air cycle refrigeration system; a ram air supply; an air manifold within the electronic compartment or a pressurized equipment package.

The aluminum cold plates are bonded by UAP's dip braze method which produces extremely lightweight assemblies with maximum heat transfer area within the core. Cold plates can be used individually or assembled in manifolded banks.

For complete information call the nearest UAP Contractual Engineering Office

Magnetic clutch model SAC 181 has a flexible membrane pole shoe assembly, which provides a torsionally rigid unit having zero backlash and zero residual drag and allows an angular misalignment up to 3 deg between the driving and driven shafts. The overall diameter of the clutch is 1-13/16 in., and the axial length, including mounting hubs, is 1-15/16 in. Rated to deliver a torque of 7 in-lb at full power, its power consumption is under 4 w.

Dial Products Co., Dept. ED, 9 Avenue E, Bayonne, N.J.

NEW PRODUCTS

Clutch
Minimum torque of 7 in.-lb.

Accelerometer
Ranges of ±1 g to ±70 g

Three miniature linear accelerometers are accurately oriented to measure acceleration in three different directions. Only one input is required to all three units. The accelerometers are available in ranges from ±1g to ±70g, or unsymmetrical ranges are available in any combination desired. Output potentiometers can be provided with from 500 to 5000 ohm resistance. Accuracy is from 1 to 2 per cent, depending on range. Total weight is about 1 lb.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

For complete information call the nearest UAP Contractual Engineering Office

a famous family of aircraft essentials since 1929

UNITED AIRCRAFT PRODUCTS, INC.
1116 BOLANDER AVENUE, DAYTON, OHIO
CIRCLE 131 ON READER-SERVICE CARD
STANDARD BORG COMPONENTS
TO MEET YOUR SPECIAL
DESIGN NEEDS

MICROPOTS — Precision Potentiometers
1-turn, 3-turn, 10-turn, single or ganged, with or without rear shaft extension, single or double servo mount or bushing mount to meet your special design needs. Complete line of Trimming Micropots.

MICRODIALS — Precision Turn-Counting Dials
Direct-reading dials in 10-turn, 100-turn and 1,000-turn models. Concentric scale 10-turn dials.

BORG-MOTORS — Precision Instrument Motors
Synchronous or induction, with or without gear-trains, 2-pole or 4-pole for your precision equipment.

SEE FOLLOWING PAGES FOR DETAILS
ON THESE BORG COMPONENTS
A QUALITY MICROPOT* WITH MANY ADVANTAGES
BORG 205 SERIES, 10-TURN MICROPOTS

Borg’s 205 Series 10-Turn Micropots have proved themselves exceptionally rugged and dependable through years of service in many different mobile and stationary applications. The Borg 205 Series is designed to meet more exacting electrical and environmental specifications for both commercial and military applications. Study the advantages of Borg 205 Series 10-Turn Micropots...

1. Permanent accuracy because resistance wire is precision positioned and moulded integrally with housing...it’s locked in place.
2. Terminals are exceptionally rigid because they too are moulded integrally with housing.
3. Two bearings support rotor assembly assuring precise positioning of moving contact.
4. Permanently accurate settings due to double thread, precision lead-screw guiding the moving contact.
5. Terminals are soldered to ends of resistance element before moulding.
6. Anti-backlash spring in contact guide gives accurate setting and resetting.
7. Fine resolution because of 43½″ Kohraush winding in helical element.
8. Each Micropot is machine tested for linearity at 100 points.

A PRECISION MICROPOT AT A COMPETITIVE PRICE
BORG 1100 SERIES, 10-TURN MICROPOTS

Borg 1100 Series, 10-Turn Micropots enable you to mass-produce precision equipment with greater price advantage in your markets. High quality commercial Micropots at competitive prices. Reduce your production costs with Borg 1100 Series Micropots!

TRIMMING MICROPOTS FOR SUBMINIATURE CIRCUITS
990 SERIES

Borg 990 Series Trimming Micropots provide accurate voltage adjustments in critical electronic circuits. Extremely small, they fit readily into subminiature circuits. They are wire wound and adjustable...permanently sealed against dust or salt laden air. Can be mounted individually or stacked to give designers the greatest possible latitude.

SUBMINIATURE...PRECISE RESOLUTION...
STABLE UNDER ADVERSE ENVIRONMENTS

1. Screw-driver adjusts complete range in 40 turns.
2. Contact carrier assembly drive prevents damage when either end of linear excursion is reached.
3. Wide range of resistance values from 10 to 50,000 ohms. Other values on special order.
BORG 900 SERIES MICROPOTS PROVIDE A FLEXIBILITY TO MEET SPECIAL DESIGNS

Single-Turn, 3-Turn, 10-Turn Models

Borg 900 Series Micropots have long been preferred for many applications in aircraft instruments, radar and sonar equipment, missile launching controls, electronic devices, computers and various types of scientific and industrial apparatus.

Borg offers a complete line of these high-precision, linear Micropots in 10-turn, 3-turn and single-turn models. The 900 Series created a new standard for multi-turn potentiometers. Borg 900 Series Micropots are more accurate, offer finer resolution, lower torque, longer life and greater versatility of application. Available in any quantity.

The following options of standard Borg 900 Micropots illustrate the extreme flexibility in this series. These standard models meet most special needs.

- Ten-turn Micropots in one, two or three gang models.
- Three-turn Micropots in one, two, three, four or five gang models.
- Single-turn Micropots in one, two or three-gang models.
- Single or double shaft on all models.
- Servo mount on either or both ends of all 3-turn and 10-turn models.
- Bushing mount on either or both ends of all 3-turn and 10-turn models.
- Any of three standard types of linearity.
- Available in all common resistance values.
- As many as nine additional taps available.

The flexibility of Borg 900 Series Micropot design enables standard models to fit special design needs.
DIRECT-READING MICRODIALS

Research proved that forced-fast-reading and setting of turn-counting dials is the primary cause of error in reading perception. Human engineering studies determined that inline digital presentation provides the highest accuracy of perception when forced-fast-reading and setting is required. These facts led to the development of Borg 1300 Series Direct-Reading Microdials.

To provide greatest sensitivity and accuracy, the control knob is mounted directly on the shaft to be controlled. This eliminates backlash. A finger-tip brake was developed to retain settings.

Borg 1300 Series Direct-Reading Microdials are available in 3-digit, 10-turn models counting from 0 to 999, 4-digit, 100-turn models counting from 0 to 9999 and 5-digit, 1000-turn models counting from 0 to 99999.

CONCENTRIC SCALE MICRODIALS

Borg Concentric Scale Microdials have an indexed accuracy of one part in 1000. They indicate the position of any multi-turn device of 10-turns or less. Direct-reading concentric scales indicate full turns and increments. Finger-tip brake retains any setting. Knob fastens directly to shaft . . . no backlash. Accurate . . easy to read . . easy to install.

BORG 1000 SERIES INSTRUMENT MOTORS
SYNCHRONOUS AND INDUCTION
WITH AND WITHOUT GEAR TRAIN

Borg-Motors bring to the electrical industry a line of fractional horsepower motors for recorders, instruments and timing devices. They have a long history of excellent performance in the Borg Time-O-Graph Watch Rate Recorder and other precision equipment. Borg-Motors are totally enclosed, using precision machined die cast alloys for end bells and gear train cases.

The die cast rotor, mounted on two ball bearings, assures longer life and continued accuracy. Standard gear train models have only the gear train shaft extension.

Capacitors are priced separately for each Borg-Motor.

 Bulletin BED-A92

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
120 SOUTH MAIN STREET • JANESVILLE, WISCONSIN

Printed in U.S.A.
Potentiometers
Values up to 100,000 ohm

Model HP 101-AD ten-turn potentiometer is available in resistance values up to 100,000 ohm and with linearity up to 0.5 per cent. These potentiometers are low-noise types and will dissipate 3 w at 40 C derated to 0 at 100 C. The case measures 1 in. diam and 1-19/64 in. long. The potentiometers perform over a temperature range of -85 to 185 F and under extremes of shock, vibration and acceleration. These potentiometers are also available in 5-turn, 3-turn and single-turn types with servo mounting as well as various shaft configurations.

Hubbard Potentiometers, Inc., Dept. ED, 1242 E. Transit St., Pomona, Calif.
CIRCLE 134 ON READER-SERVICE CARD

GLOBE A.C. MOTORS / GEAR REDUCERS / PACKAGES

In precision miniature motors, gear reducers, and small-package devices using clutches, brakes, and other components, Globe Industries has the hardware to meet your requirement. From a single source you can get fast 2 to 4 week prototype delivery of standard units. Modular design, interchangeable precision parts, and an efficient special order department are specific, unique reasons why you get what you need before your design grows cold.

Three basic A.C. motors are shown above. With their integral gear reducers they reliably span the torque range to more than 2000 in. oz. Custom modifications are a specialty.

Globe motor packages were chosen for the Army's Jupiter C and as you read this, at least one such package is circling the earth. Ask the largest precision miniature motor manufacturer first. Request the Globe A.C. Motor Catalog now.
GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio. Baldwin 2-3741.
CIRCLE 136 ON READER-SERVICE CARD
new!...printed circuit

Continental Connector

designed for use in one of the country's largest military data processing systems

Again, Continental Connector proves its reliability and engineering know-how with this remarkable new printed circuit connector. Overall length is actually 9 7/8",...the longest single piece precision molded connector known!

Standard molding compound is high impact reinforced glass Alkyd (other molding materials available on request). 34 contacts have .250" spacing including heavy barriers for extra protection and long creepage path. Patented "Bellows Action" contacts are conservatively rated to accept printed circuit board thickness of .054 to .072", while maintaining low contact resistance and positive spring action grip over entire printed circuit contact area. Maximum board length is 8 3/4".

Self-alignment of "Bellows" Contacts allows for any residual warpage of printed circuit board. An anodized aluminum shield for dissipating heat is available as an optional accessory when required (see illustration).

Our engineering staff is available for developing other unique design printed circuit connectors that may solve your special connector problems. For complete technical specifications, write to Electronic Sales Division, DeJUR-Amaco Corporation, 45-01 Northern Boulevard, Long Island City 1, New York.

NEW PRODUCTS

Analog-Digital Converter

Speed of 6000 conversions per second

This transistorized analog-to-digital converter operates at the rate of 100,000 bits per second (a 13 bit word would require 130 μsec), has an accuracy of ±0.05 per cent of full scale (±1/2 digit), and a minimum full scale of 5 V. Acceptance of bipolar inputs from -5 to +5 V dc with automatic indication of polarity is optional. Output is in 1-2-4 binary decimal code; however, any other conventional code can be supplied. Both serial and parallel outputs are available. Parallel data output is 500 μa at 4 V. Higher power output can be supplied.


CIRCLE 138 ON READER-SERVICE CARD

Oscilloscope

Screen area of 1-1/4 x 3 in.

Panelscope model P-1 consists of a cathode ray tube having a usable screen area of 1-1/4 x 3 in., a high-voltage power supply, a cathode ray tube escutcheon with positioning, beam and focus controls and a variable edge lighted graph screen with an ambient light filter. The indicator panelscope model P-100 consists in addition a selenium rectifier type low-voltage power supply for positioning and second anode adjustment only. Thus the spot may be positioned. The sensitivity of both models is 56 v peak to peak per inch vertical and 80 v peak to peak per inch horizontal.


CIRCLE 139 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
**Accelerometers**

Employs torque generator restraint for accuracy

Torque generator linear accelerometers measure only 2 in. diam. Accuracy is assured in these units through use of torque generator restraint in place of the usual torsion bar. The unbalance weight is housed in a hermetically sealed cylinder, which, in turn, is fully floated in exact equilibrium in a high density viscous fluid. This floatation process serves to remove all load from the jewelled bearings, while at the same time providing viscous damping and shock absorption. Torque generators can be supplied for either ac or dc operation.

Reeves Instrument Corp., Commercial Products Dept., Dept. ED, 207 E. 91st St., New York 28, N.Y.

**Pot Cores**

*Has ± 1 per cent tolerances*

These ferrite pot cores have permeability tolerances of ±1 per cent. Cores are available in diameters ranging from 5/8 to 1-3/4 in. for frequencies from 1 kc to 4 mc. Typical permeability values and tolerances are: 150 ± 3 per cent, 80 ± 2 per cent, 45 ± 1 per cent.

Ferroxcube Corporation of America, Dept. ED, Saugerties, N.Y.

**Switch**

*Stay-on, stay-off feature*

This waterproof switch has a stay-on, stay-off feature similar to a toggle switch without the conventional toggle switch mechanism. Electrical rating is 15 amp resistive at 115 v ac with an expected life of at least 25,000 cycles.

Control Products, Inc., Dept. ED, 306 Sussex St., Harrison, N.J.
HEATING BLANKETS
and Other Woven Heating Elements

by Safeway

for MYRIAD USES

Inherent in the rapid, unremitting advance of present-day technology is a growing need for accurately controlled delivery of heat in many industrial and military applications. SAFEWAY heating blankets or woven-wire heating elements can be designed specifically to fill countless of these needs. Indicative of their broad potential are the diversified purposes they are already serving with complete success.

In the field of missiles and rockets, fuels, propellants and launchers are kept at operational temperatures with controlled heat.

Airframe manufacturing utilizes heating blankets for both honeycomb and metal-to-metal bonding.

Component aircraft parts ... gyros, cameras, computers, servos, batteries, antennas, to name just a few ... must be heated when exposed to the freezing environment at the altitudes at which jets fly. Also needed at low operating temperatures are de-icing units for propellers, wings, vertical fins and horizontal stabilizers.

Apparent, too, is the marked growth in the usage of heating blankets to satisfy winterization needs and demands of certain types of refrigeration units for satisfactory defrosting methods.

If it has to be heated (and the "it" can be just about anything), you can rely on SAFEWAY engineers to study your problems and — without any obligation — submit an appropriate recommendation.

NEW PRODUCTS

In-Line Display
Any number, letter or symbol

This in-line display unit displays any letter A through Z, any number 0 through 9, and + or — symbols. Characters are of uniform size and intensity, and good readability is insured from any angle of viewing. The size of the character displayed is approximately 7/8 in. high and 5/8 in. wide. Size of the viewing screen is 1-15/16 in. high and 1-9/16 in. wide.

CIRCLE 145 ON READER-SERVICE CARD

Power Supply
Features short-circuit protection

These transistorized power supplies feature electronic short-circuit protection, 100 per cent wire-wound MIL-type resistor complement, at least 25 per cent derating of all components, and internal blower cooling.

NEJ Corp., Dept. ED, 345 Carnegie Ave., Kenilworth, N.J.
CIRCLE 146 ON READER-SERVICE CARD

Capacitors

Tantalum and electrolytic aluminum types

The polarized type dry electrolytic foil tantalum capacitor has capacity ratings from 0.3 to 200 mf and working voltages from 6 to 150 v at 50 C and 4 to 100 v at 85 C. The monopolarized types have capacity ratings from 0.15 to 100 mf at the same voltage ratings. The wet electrolytic sintered anode tantalum polarized capacitor has...
capacity ratings from 3.5 to 325 mf at 6 to 75 v operating from -55 to 100 C. The solid electrolyte sintered anode tantalum polarized capacitor has capacity ratings from 2 to 240 mf and the working voltage from 4 to 35 v. The line of dry electrolytic aluminum capacitors have capacities from 1 to 200 mf at 3 to 250 v operating over a temperature range of -40 to 70 C.

International Telephone & Telegraph Corp., Components Div., Dept. ED, P.O. Box 412, Clifton, N.J.

CIRCLE 147 ON READER-SERVICE CARD

Converter
Changes 28 v dc to 400 cps

Model D-400 converts a dc voltage of 24 to 30 v to 400 cps with an output of 10 w. Other models provide for various dc input voltage between 100 v and 19 v.


CIRCLE 148 ON READER-SERVICE CARD

Circuit Breaker
Compensates for ambient temperature

Klixon D6752-5 circuit breaker will carry rated current at 250 F, and 115 per cent of rating at 77 F and -60 F. Other features include: maximum weight of 0.2 lb; standard life of approximately 10,000 cps; high rupture capacity at 2500 v; 400 cps, 115/200 v ac and 6000 a, 28 v dc; and designed to trip at not more than 135 per cent at 230 and 77 F, and 160 per cent at -60 F.


CIRCLE 149 ON READER-SERVICE CARD

Now... new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies... savings in space and weight... important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Silicon components can operate in ambient from -65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps, and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use... with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont... pioneer producer of semiconductor-grade silicon.

NEW BOOKLET ON DU PONT HYPERPURE SILICON
You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy: E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

CIRCLE 150 ON READER-SERVICE CARD

PIGMENTS DEPARTMENT

DU PONT HYPERPURE SILICON

BETTER THINGS FOR BETTER LIVING
THROUGH CHEMISTRY
The Switch Design That Says
"NO FOOLIN"
No Tease . . . No Deceptive Clicks
Higher ratings in smaller, lighter-weight switches are made possible by this little beryllium device . . . the heart of every Hetherington snap-action switch.
A polished tapered rod operates through two compression springs in the shorting bar and against the return spring. Its lightning-fast, double-break snap action reduces arcing and contact welding to negligible proportions—even with high momentary loads. Contact pressure is actually greatest at the point of “make” or “break” thus preventing deceptive “clicks” or contact teasing.

Space-Saver Toggle
Gives Big Switch Performance
When it comes to making a real saving in space, this new SP-DT Hetherington Toggle Switch is the answer. It is only 1\(\frac{1}{4}\)" in diameter by 1\(\frac{3}{4}\)" long. It weighs less than \(\frac{1}{4}\) oz. Yet it breaks 5 amp. resistive loads at 28 volts dc (2\(\frac{1}{2}\) amps @ 115 v ac) for 50,000 operations.
Best of all, Hetherington’s tease-proof cam-roller snap-action gives the T3103 the “feel” of a real heavy-duty switch. Details are in Data Sheet S-3a.
CIRCLE 200 ON READER-SERVICE CARD

Relay, Switch, and Pilot Light Functions in One Unit Only 1\(\frac{3}{8}\)" x 3\(\frac{3}{8}\"
This “control engineer’s delight” does the work of two conventional switches plus a holding relay and an indicator light. All of this is accomplished in only a fraction of the space, weight, and wiring needed for separate components.
Once the button is pressed, a built-in 28-volt solenoid holds the switch on contact until either the coil circuit is externally interrupted or the button is pulled out. A built-in indicator light shows when the coil circuit is energized.
Modifications of this basic Hetherington Holding Coil Switch design include a variety of circuit arrangements. Pull-on and push-on pushbutton types as well as a toggle type are available. Their many aviation and industrial uses center around jobs where the switch is manually “closed” to start an operation; then electrically “opened” at the end of the sequence. In an emergency, the switch may be manually opened in the middle of the sequence if desired.
CIRCLE 201 ON READER-SERVICE CARD

NEW PRODUCTS

Centrifuge Slip Ring
For voltages of 10 kv dc
This centrifuge slip ring has three high voltage circuits capable of 10 kv dc continuous and has been tested at 20,000 v hi-pot. Instrumentation circuits are unaffected by adjacent high voltage circuits. Minimum noise is accomplished by the use of precious metals. Dual brushes, riding on each ring, are tuned to different resonant frequencies, providing uninterrupted circuits despite severe shock and vibration. The assembly is rated at 350 F continuous operation. All 15 slip rings and shielded wires are high pressure molded into one integral assembly. The units provide 10 to 15 million revolutions of noise-free operation at 6000 rpm.
CIRCLE 152 ON READER-SERVICE CARD

Test Shield
Substitutes for screen-room
Type G-1 is engineered to replace a full-size, calibrated radio compass screen room. Weighing only 35 lb, the test shield can be powered by any standard signal generator. It produces a source of calibrated field strength together with dummy sense antennas of 25, 50, 100 and 150 \(\mu\)f.
Transdyne Corp., Dept. ED, 58-15 57 Drive, Maspeth 78, N.Y.
CIRCLE 153 ON READER-SERVICE CARD

Over 455 PRECISION push-button Switch Types
CIRCLE 151 ON READER-SERVICE CARD

HETHERINGTON INC.  DELMAR DRIVE, FOLCROFT, PA. • 139 Illinois St., El Segundo, Calif.

ELECTRONIC DESIGN • June 11, 1958
Hi-Mode Series D four and five bladed all-aluminum fans, available in six diameters from 4 to 8 in., have been tested without blade resonance under applied frequencies of 1000 cps. These fans not only will not resonate at any external vibration excitation below this frequency, but will permit continuous operation at higher speeds and consequently higher air outputs.

Torrington Manufacturing Co., Air Impeller Div., Dept. ED, Torrington, Conn.

CIRCLE 154 ON READER-SERVICE CARD

Silicon Rectifiers

Feature 750 ma to 55 C

Type K silicon rectifiers feature 750 ma to 55 C. Voltage ratings are 100, 200, 300 and 400 piv.

Tarzian, Inc., Sarkes Rectifier Div., Dept. ED, 45 N. College Ave., Bloomington, Ind.

CIRCLE 155 ON READER-SERVICE CARD

Rheostat

Features fine adjustment

Mikrohm rheostats of the 310 series are available in resistance ranges of 0.25 to 3.0 ohm with maximum current ratings of 0.25 to 1.0 a. The minimum insertion resistance is approximately 10 per cent of the maximum resistance of the rheostat.

Superior Electric Co., Dept. ED, Bristol, Conn.

CIRCLE 156 ON READER-SERVICE CARD

A very high reject ratio was strangling magnetic amplifier production at the plant of a large eastern manufacturer. Analyzed by the company's own engineers, the problem was found to be a case of inadequate core matching. A core-matching specification based on sine current dynamic testing was attempted. However, since the application was a voltage regulator using voltage reset, the problem of matching maximum permeability to the required tolerances was practically insurmountable for production-line testing.

After Westinghouse engineers analyzed the problem, it was decided that matching cores at zero control point with the Roberts tester would help obtain the desired high yields.

Production-run cores matched by this procedure were flown to the manufacturer from the Westinghouse Greenville plant. These cores resulted in an immediate improvement in production-line performance.

The Roberts core-matching technique provides the closest approach to magnetic amplifier design for commercial testing of cores that exists today. This testing technique on standard Hipermag cores provides performance tailored to your magnetic amplifier application.

Let our engineers help you with your magnetic amplifier production problems. Call your Westinghouse representative... or write Specialty Transformer Department, Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pa.

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

CIRCLE 157 ON READER-SERVICE CARD
NEW PRODUCTS

Annunciator
Operates without relays

This annunciator for monitoring complex automatic systems uses static-magnetic controls instead of the relays used in conventional annunciators. The annunciator's plug-in design makes it possible to change sequences without rewiring.

Panellit, Inc., Dept. ED, 7401 N. Hamlin, Skokie, Ill.
CIRCLE 159 ON READER-SERVICE CARD

Erase Head
55 db erasure

This low power erase head is especially suited for use with transistor circuitry. With 0.5 va current, 55 db erasure is obtained. The unit is designed to permit ganging to obtain 2-track and 4-track erasure.

CIRCLE 160 ON READER-SERVICE CARD

Plugs
Varied 7 and 9 pin types

Model M-1037 is available in 7 and 9 pin versions. Model M-1000-1 accommodates 300 ohm...
Relay Analyzer
Tests relays under actual contact loading

Model 140 has been designed to check every phase of relay operation. A cycling circuit permits automatic cycling of the relay at a rate selected by the operator. Adapters to accommodate various relay types may be plugged into the front panel. These are designed so they may contain switches for special measurement, such as analyzing relays with 8 from "C" contacts.

Schmeling Electronics, Dept. ED, 20 First St., Keyport, N.J.

CIRCLE 162 ON READER-SERVICE CARD

Bandpass Filter
Gives sharp low-high cutoff

This toroidal bandpass filter is available with a flat response through a 3 kc passband and sharp low-high cutoff. Frequencies range from 17.2 to 20.2 kcs. Designated as model 360B, unit hermetically sealed and measures 2-1/4 x 2-3/4 x 3-7/8 in. Input impedance unbalanced is 20,000 ohms, output 20,000. Maximum operating voltage 500. The 360B has an insertion loss at 15.5 kcs of 6 db with a minimum stop-band attenuation of 45 db.

Barker & Williamson, Inc., Dept. ED, Canal St. & Beaver Dam Rd., Bristol, Pa.

CIRCLE 163 ON READER-SERVICE CARD

Sprague Transulator
FOR TRANSISTOR CIRCUIT DESIGNING
MODEL LF-1

Eliminate Breadboard Layout!
SPEED DESIGN OF TRANSISTOR CIRCUITS
With the SPRAGUE TRANSIMULATOR

Bring transistor circuits to life in a matter of minutes with the Sprague LF-1 Transimulatator. This new instrument lets you simulate any amplifier stage, a-c or direct-coupled, short of high power audio output; also multivibrator, switching, phasing, push-pull, Class A and B, and many others using cross-coupled Transimulators . . . whether the circuit is common or grounded emitter, base, or collector . . . whether the transistors are PNP, NPN, or Surface Barrier. You can simulate circuits stage-by-stage for cascade operation . . . or use a separate Transimulator for each stage to get simultaneous multi-stage operation.

Bring Circuit Diagrams To Life In Minutes
Everything you need for RC amplifier circuits is built right into the LF-1, including coupling capacitors . . . bias and load resistors . . . battery voltage supplies . . . Base Collector—Voltage Divider stabilization circuits . . . 5-way binding posts for transformer coupling and metering.

Whether you're designing audio circuits or switching circuits, you'll get a true picture of operating parameters minutes after you've drawn the circuit diagram . . . without wasting valuable time with breadboard and soldering gun.

Pays For Itself In A Matter Of Weeks
An ideal laboratory instrument, Transimulators are inexpensive enough to justify several on every bench. You can even use the LF-1 to test transistors in the circuit . . . the only real proof of design parameters. And a complete step-by-step instruction manual makes operation fast, simple, and easy.
NEW PRODUCTS

Solenoid Valve
Quick disconnect features

Model P/N 220155 plug-in valve is a four-way, three-position solenoid actuated unit rated at 100 psi service pressure and operated by 115 v, 60 cps ac. Designed for operating pressures of 100 psi, this valve will withstand surge pressures of at least 250 psi.

Whittaker Controls, Div. of Telecomputing Corp., Dept. ED, 915 N. Citrus Ave., Hollywood, Calif.

CIRCLE 166 ON READER-SERVICE CARD

Power Supply
0.3 per cent regulation

Model 721A power supply has an output of 0 to 30 v. Regulation, no load to full load, is 0.3 per cent or 30 mv, whichever is greater.


CIRCLE 167 ON READER-SERVICE CARD

Noise Figure Meter
Employs test facility for system errors

Model 501 automatic noise figure meter operates at 30 mc input with sensitivity sufficient to measure TWT noise figure without external amplification. Noise figure is read directly for a 15.2 db noise source. A test facility for system errors

CIRCLE 168 ON READER-SERVICE CARD

RELIABLE regulated DC power supply

Here's a regulated dc power supply that will protect its load and itself from a fault or short beyond the primary of its power transformer. If you're interested in a simple, reliable source of regulated dc power, you'll like the Sola Constant Voltage DC Power Supply.

This very desirable load protection characteristic results from the current-limiting action of the Sola Constant Voltage Transformer. It is combined with a semiconductor rectifier, and a high capacitance filter. The current-limiting action protects both the rectifier and capacitors from damage by preventing excessive charging current.

This unique combination of components results in a power supply that is unusual in many other ways as well. Regulation is within ±1 per cent with up to 10% line voltage variation . . . ripple within 1% rms . . . efficiency is high. It's particularly well-suited for intermittent, variable, and pulse loads.

The Sola dc supply is reliable, simple, compact, and moderately-priced.

Available from stock, or as a custom-designed unit.

Write for Bulletin 31F-DC-235

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.

CIRCLE 169 ON READER-SERVICE CARD

Solenoid Valve
Quick disconnect features

Model P/N 220155 plug-in valve is a four-way, three-position solenoid actuated unit rated at 100 psi service pressure and operated by 115 v, 60 cps ac. Designed for operating pressures of 100 psi, this valve will withstand surge pressures of at least 250 psi.

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CIRCLE 167 ON READER-SERVICE CARD

Noise Figure Meter
Employs test facility for system errors

Model 501 automatic noise figure meter operates at 30 mc input with sensitivity sufficient to measure TWT noise figure without external amplification. Noise figure is read directly for a 15.2 db noise source. A test facility for system errors
is employed for the first time in an automatic noise figure meter. Operating voltage for a gas noise source is provided at a BNC connector. Recorder output supplies noise figure information for either 100 mv or 1 ma recorder movements. Scope output permits optional monitoring of zero reference, noise figure and infinity reference as a three-step wave form.

Brocker Labs., Box 967, Dept. ED, Sunnyvale, Calif.

CIRCLE 169 ON READER-SERVICE CARD

Diode Function Generator
Features punched card memory

Model 100 diode function generator is used to generate either nonlinear functions of an independent input voltage, or of any parameter which may be converted to a voltage, or it may be used to generate nonlinear functions of time by using either an internal or an external time base. The fact that a complete library of nonlinear functions may be created for future use as necessary, makes the unit useful for data correction and data handling operations.


CIRCLE 170 ON READER-SERVICE CARD

Frequency Oscillator
Range from 100 cps to 100 kc

Model 110-A variable frequency oscillator has an adjustable output frequency range of 100 cps to 100 kc with an accuracy of 5 counts or 0.005 per cent. The unit may be automatically programmed by use of paper tape or patch programming, thereby permitting 11 or 18 point calibration.


CIRCLE 171 ON READER-SERVICE CARD

FOR WIDER USEFULNESS ... IMPROVED PERFORMANCE
... GREATER RELIABILITY IN OSCILLOGRAPHIC RECORDING

THE NEW SANBORN 350 SERIES
6- AND 8-CHANNEL
DIRECT WRITING SYSTEMS

Here are the completely new, instantaneous direct writing 6- and 8-channel Sanborn “350” oscillographic recording systems designed to give you the most useful possible combination of performance accuracy—flexibility—reliability—and operating convenience.

Consider first some characteristic performance figures and features: essentially flat response to 100 cps at 10-div. peak-to-peak amplitude, down 3db at 120 cps; limiter circuit ahead of Amplifier assures damping at all times; current feedback Power Amplifier design to prevent thermal drift; true damping by velocity feedback; galvanometer natural frequency 55 cps; hysteresis level less than 0.2 div.; linearity 0.20 div. over entire 80 divisions; permanent, inkless, direct writing in true rectangular coordinates on plastic coated Permapaper.

Now notice the packaging: an entire 6- or 8-channel “350” system—Preamplifiers and their own Power Supplies, Recorder assembly with built-in Power Amplifiers and Power Supplies, and other components—is housed in one mobile cabinet. Preamplifier modules are separated from Recorder-Power Amplifier unit, so that either can be used separately. Self-contained Recorder package uses transistorized, plug-in Power Amplifiers, Power Supplies with solid state rectifiers, low impedance, low voltage enclosed galvanometers; when used as a separate unit, sensitivity is 0.1 volt chart division.

Add to these “350” performance and packaging features the value and convenience of extremely easy chart loading from the front; nine electrically controlled chart speeds, selected by pushbuttons, with contacts for remote control; built-in paper take-up, paper footgage indicator and timer-marker stylus; four presently available interchangeable Preamplifiers (Carrier, DC Coupling, Servo Monitor-demodulator, True Differential DC), with several more to follow.

These are highlights of the new “350’s”—duplicated by no other equipment in existence today. Ask your local Sanborn Engineering Representative for more information, or write Sanborn directly.

(All data subject to change without notice)

INDUSTRIAL DIVISION
SANBORN COMPANY
175 Wyman Street, Waltham 54, Mass.

CIRCLE 172 ON READER-SERVICE CARD

Quick, simple paper loading is done from front; hinged viewing window is removable. About 8” of record visible. All controls on front panel.

Recorder back plate holds eight plug-in Power Amplifier modules (one shown unplugged), four on either side of Power Supply section. Entire back plate removable for servicing.
New, Improved
Wobbulator
Model 7200

Features
New Technique
In Electronic
Swept Frequency
Signal Generators!

One of the objectives in the design of the Canoga Wobbulator 7200 is to obtain high sensitivity without the "hum" problems normally experienced with other swept frequency generators. The swept frequency output voltage of the Wobbulator 7200 is modulated at approximately 50 Kc; the probes, with their internal diodes, detect this modulation which is then amplified in the vertical CRT band-pass amplifier. This new principle allows the use of swept generator techniques for evaluation of low gain or lossy circuits where point by point frequency measurements were previously necessary.

- **Frequency Range:** 2.0 to 1000 mc
- **Swept Frequency Band:** 2.0 to 55 mc, continuously variable
- **Output:** More than 0.03 volts, 50 ohms
- **Sweep Circuit:** All electronic
- **Swept Output:**
  1) Constant within ± 1 db over 40 mc
  2) Constant within fractions of db over 30 mc
- **Attenuator Dial:** Calibrated in 1 db increments
- **Probe Detectors:**
  1) Low impedance 50 ohms
  2) High impedance
- **High Sensitivity Vertical Amplifier:**
  - 50 microvolts input gives at least 2" deflection
- **Cathode Ray Tube:**
  - SUP1, with camera mounting bezel
- **Calibrated Panel Controls:**
  - Center frequency
  - Output Attenuator
- **Panel Controls:**
  - Deviation
  - Vertical Amplifier Gain Control
  - Vertical Amplifier Gain Switch, high-low
  - CRT intensity, focus
  - CRT Vertical & Horizontal Centering
  - On-off switch
- **Power:** 115V, 60 cps, 175 Watts
- **Output Impedance:** 50 ohms, BNC connector

WRITE TODAY FOR COMPLETE DETAILED INFORMATION

Radar Systems
Antennas
Receivers
Test Equipment
Microwave Components

CANOGA CORPORATION
5955 Sepulveda Boulevard
Van Nuys, California

CIRCLE 173 ON READER-SERVICE CARD
NEW PRODUCTS

Circuit Breaker
Has transparent cover

Named the Saf-T-Vue, the breaker has a removable transparent cover through which one may see at a glance whether the contacts are open or closed.

American Cyanamid Co., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 174 ON READER-SERVICE CARD

Power Supply
0.5 to 30 v dc output

Model 30-500 transistorized power supply has a dc output from 0.5–30 v dc at 50 ma max. Ripple and noise is 2 mv rms at full load.


CIRCLE 175 ON READER-SERVICE CARD

Recorder
Permits remote servo-control applications

SR-100 potentiometer-recorder, with plug-in servo amplifier and horizontal writing surface, records any phenomenon from which a dc vol-

GET THE EXACT TERMINAL YOU NEED AT NEW LOW PRICES!

FROM THE LARGEST STANDARD and CUSTOM LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types - male, female or rivet mountings - molded or metal base. Feedthrough terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

Body Materials: Standard as follows - melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MM1); and phenolic, electrical grade (Mil-P-14, Type MFE).

Plating Combinations: Twelve terminal and mounting combinations, depending on electrical conditions, furnished as standard.

Specials: Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

PROMPT DELIVERY IN ECONOMICAL QUANTITY RUNS

Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.

CIRCLE 176 ON READER-SERVICE CARD
CIRCLE 184 ON READER-SERVICE CARD
SUBMINIATURE

is furnished as standard, depending on standard requirements. "Two" terminal applications are molded from standard materials and meeting specifications.

Standard as follows—male, female, end, MIFI Phenolic, electrical grade male, female, Teflon, or metal bánhinals are furnished standard. Male and female terminals are molded from molding materials to provide electrical properties.

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Wire and Cable Insulated With DuPont TFE-Fluorocarbon Resins Offer Unmatched Reliability... With an Opportunity for Cost Savings... Here are some of the ways you benefit—

No time limit on reliability... eliminates heat aging

Extends service life... reduces chafing and cracking

Unaffected by lubricants, corrosive atmospheres or outdoor weathering

Plus excellent, highly stable electrical properties

In laboratory tests of wire insulation, even after moderate accelerated aging, the TFE resins alone remained unchanged... other insulations cracked, charred, and even disintegrated.

Standard abrasion tests prove that after even moderate aging, the abrasion resistance of insulation of TEFLO! fluorocarbon resins is superior to that of all other high-grade wire insulations.

Insulation of TFE resin is unaffected by corrosive atmospheres, such as those found around this chemical equipment. Very low permeability reduces danger of shorts caused by splashing.

The dielectric strength of TFE resins is high and ranges from 400 to 4,000 volts per mil, depending on thickness. These values are unchanged by heat aging.

Both the dielectric constant and dissipation factor remain constant from below 60 cps to above 10,000 mc. The extremely low dissipation factor insures low signal attenuation, minimum energy losses.

Volume and surface resistivities are exceptionally high and are not affected by time or high temperature. Volume resistivity is greater than 10^16 ohm-cm, while surface resistivity is more than 10^17 ohms even at 100°F, relative humidity. Exposure to a surface arc leaves no carbonized conducting path. Because insulation of TFE resin contains no plasticizer which might alter these excellent electrical properties, consistently reliable performance is assured.

Heat aging, which results in the cracking and embrittlement of most other high-grade insulations, is completely eliminated at temperatures up to 260°F by the use of TFE resins.

In lab tests of 7 different wire insulations, only TFE-fluorocarbon resins maintained an insulation resistance above 25,000 ohms per 1,000 feet after an aging period of 500 hours at 150°F. The TFE resins maintained their initial value of over 25 million megohms per 1,000 feet.

Consider what the elimination of heat aging means to you. For example, in home appliances, new designs are now being achieved. In plants, expensive down-time and maintenance can be reduced by the installation of TFE resin in hot spots, or as temporary electrical overloads may occur.

Even at tight bends, the extremely low surface friction of TFE resins prevents chafing of harnessed wires and twisted pairs. Fraying is no longer a problem where vibration, flexing or shock are present. Standard tape abrasion tests show that, after moderate aging, TFE resins are more durable than other wire insulations. This same low coefficient of friction makes it easy to slip spaghetti tubing over long conductors.

Tests also indicate that TFE resins have superior flex life. Even at extremely low temperatures, they will not crack when flexed.

Both of these properties of TFE resins mean longer service life and reduced maintenance time on equipment where vibration or flexing are encountered. Where ambient temperatures are high, TFE resins can eliminate chafing and cracking.

TFE resins are among the most chemically stable materials known. Wire and cable insulation remains 100%, effective even when exposed to corrosive atmospheres—for example, in the control-panel wiring of chemical plants. This property is vital in electrical power installations, where the insulation may contact penetrating fluids, such as hot transformer oils.

In addition, TFE resins are relatively impermeable to nearly all chemicals. They have less than 0.01", water absorption by ASTM test. Their waxy surface is actually water-repellent.

With TFE resins there are no weathering problems. Even freezing cold, ultraviolet rays, or salt spray are harmless to them. Exposure to Florida weather for over 10 years resulted in no measurable change in their properties.

The dielectric constant and dissipation factor of TFE resins are unchanged by time or temperature, making them ideal for use in high-frequency circuits.

Resistances of TFE resins to common chemicals are presented in the chart on this page. The chart indicates that TFE resins are unaffected by exposure to a wide range of chemicals, including acids, alkalis, solvents, and even water.

This page presents only a small portion of the data available. For complete information, consult the manufacturer's literature or contact the DuPont Technical Service Department.

See page 4 for the story on cost savings to you.
It's easy to tell which is the insulation of TFE resin as other insulations melt, smoke and char during this simple test.

No other organic insulating material can match the properties of DuPont TFE-fluorocarbon resins. They have virtually ideal electrical properties. Their temperature ratings are unsurpassed by any other flexible insulation. TFE resins are steadily becoming more attractive to electrical and electronics engineers for economic reasons.

The two inside pages of this folder show you some of the ways you can benefit from the stable characteristics and reliability of TFE-fluorocarbon resins. On the back page you will learn how TFE resins speed fabrication and aid miniaturization... at cost savings to you!
Here's how Du Pont TFE resins provide easier assembly and space savings ... with cost reductions for you

Wire insulated with TFE resin is unaffected by potting temperatures or soldering iron heat. Soldering time is shortened, inspection costs reduced, reliability improved.

DIFFICULT DESIGN PROBLEMS can be solved by TFE resins in areas where more power must be transmitted through the same space, such as underground wiring in municipalities, or increased power for existing structures. Since it is a superior moisture and electrical barrier, TFE resin permits design of wire and cable using less total insulation. Abnormal power surges are no problem because of mechanical strength and nonflammability of TFE resin at high temperatures.

MINIATURIZATION of electrical and electronic components is made possible by the heat resistance and high dielectric strength of TFE resins. For example, they solve the problem of getting more ampere turns into a winding. Finer wire can be used, so that miniaturized coils are possible. Smaller conductors transmit the same amount of power with less insulation.

IN ASSEMBLY, particularly of tightly spaced equipment where there is danger of injuring insulation, TFE resins are unsurpassed. They are unaffected by soldering iron temperatures, thus reducing danger of shorts. The insulation will not shrink back when soldering a connection. It can even be submerged indefinitely without damage during dip-soldering operations. This means economies for you, because assembly time is lowered, and wiring rejects are greatly reduced. Also, the cost of rejecting an entire potted assembly because of heat damage to the insulation is completely eliminated. One manufacturer of electronic components cut his inspection force to one-fourth its original size by changing to wire insulated with TFF resin.

Use of TFE resins in place of standard insulation in coaxial cable permits space saving of 4 to 1 and weight saving of 2 to 1. Smaller conductors transmit equivalent power with less insulation.

SEND FOR INFORMATION
Discover how well wire and cable insulated with Du Pont TFE resins help solve your design problems. For further information, contact a processor of fluorocarbon resins (listed in the Yellow Pages under "Plastics") or write to:

E. I. DU PONT DE NEMOURS & CO. (INC.)
POLYCHEMICALS DEPARTMENT, ROOM 146
DU PONT BUILDING, WILMINGTON, DELAWARE

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec

TFEFLON

TFE-FLUOROCARBON RESINS

TFEFLON is the registered trademark of the Du Pont Company for its fluorocarbon resins, including the TFE resins discussed herein and the new melt processable FEP resins.
This trimmer system performs idle adjustment, jet engine trimming and the water-injection flow adjusted to provide maximum augmentation. Making these adjustments normally required three men. Now one man can perform the entire operation from the cockpit, at a safe distance from the operating engine.

Lear, Inc., Dept. ED, 110 Ionia N.W., Grand Rapids, Mich.

CIRCLE 178 ON READER-SERVICE CARD

Self-retaining "U" and "J" SPEED NUTS® cut assembly costs up to 50% or more!

If you are worried about rising assembly costs, let one-piece "U" and "J" Speed Nuts keep costs down ... and improve your product.

They can't fall off, once they've been pressed into screw-receiving position. No welding, staking or other secondary fastening devices needed. You eliminate lock washers - spring steel Speed Nuts are self-locking, make vibration-proof attachments.

Speed Nuts are ideal for blind assembly or hard-to-reach locations. Apply them before you paint panels without danger of paint-clogging. Or after porcelainizing, without damage to finishes. The "U" type is similar to the "J" type, shown above, but is used where full bearing surface on the lower leg is required.

A free Fastening Analysis can tell where Speed Nut brand fasteners belong on your products. Call your Tinnerman representative - he's listed in most major telephone directories. Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

Another Tinnerman Original...

CIRCL e 179 ON READER-SERVICE CARD

CIRCLE 184 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
have you checked this Remote Actuator for jobs under Shock and Vibration?

NEW PRODUCTS

Sound Components
For pretesting aircraft and missile parts

An acoustic chamber has been designed to help determine causes of malfunction of electronic equipment in flight. It is energized by a number of 100 w loudspeakers covering the range from 40 cps to 10 kc and able to bombard the components with sound equal to that received by the equipment in high speed flight. The plane wave tube shown is capable of producing 166 db sound pressure levels. The tube is 2 in. in diam, 10 ft long, and is powered by two 100 w loudspeakers. A 5000 w amplifier will be used to drive the loudspeakers, which are especially designed for this purpose and are of 100 w capacity.

Altec Lansing Corp., Dept. ED, Anaheim, Calif.

CIRCLE 182 ON READER-SERVICE CARD

Capacitors

Ratings up to 125 C

Available with ratings to 125 C, these type CY glass capacitors have voltage ratings of 300 v and 500 v dc. Volume of the capacitors range from 0.005 cu in. for the CY10 to 0.080 cu in. for the CY30. Temperature coefficient is within the limits of +140 -25 ppm per deg C. The difference in temperature coefficient between any units at any given temperature is less than 15 ppm.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 183 ON READER-SERVICE CARD

most complete

- Design Forum
- Product Features
- Ideas for Design
- Engineering Review
- Standards and Specs
- Russian Translations
- Background for Design

More and more electronic engineers report: "I read Electronic Design first. It's complete, timely, easier to read, and I can depend upon getting all the new product information."

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NEW MICO ISOMICA® AND SAMICA® DIELECTRICS

ADVANTAGES

- New Design Possibilities
- Cut Material Costs
- Eliminate Pin Holes and Voids
- Uniform Thickness and Properties
- Mica Component Stable Up to 1000°F

Now you can design more efficient rolled and stacked capacitors at lower cost. Capacitor Grade SAMICA sheet can be rolled and handled like paper, yet will withstand operation up to 1000°F.

ISOMICA continuous sheet is available in virtually any size at a fraction of the cost of imported mica films.

Both are production-proved and readily available.

WRITE FOR COMPLETE DATA OR SAMPLES to the nearest Minnesota Mining & Manufacturing Company sales office or to Mica Insulator Division, Minnesota Mining & Manufacturing Company, 714 Broadway, Schenectady 1, N. Y.

MICO INSULATOR
DIVISION OF MINNESOTA MINING & MFG. CO.
SCHENECTADY 1, NEW YORK

MICANITE® AND ISOMIC® PRODUCTS LAMICOL® LAMINATES & FABRICATED PARTS SILICONE & TEFLON COATED CLOTHS & TAPE

CIRCLE 185 ON READER-SERVICE CARD

Capacitors
Features new impregnants and dielectrics

The XMP Series capacitor develops 100 percent rated voltage from -60 to 85°C. The GMP capacitor finds wide application in high temperature ac and dc circuits, as low current power supply filters and as audio coupling and bypass condensers.


CIRCLE 189 ON READER-SERVICE CARD

Rate Gyroscope
Provides constant damping

This rate gyroscope provides constant damping over a wide range of temperatures, without the use of heaters. Identified as RGB rate gyroscope, the unit measures angular velocity and converts it to an ac voltage output. Nominal damping ratio variation is ±0.1 over the range -30 to 100°C.

Sanders Associates, Inc., Dept. ED, Nashua, N.H.

CIRCLE 190 ON READER-SERVICE CARD

Control Reactors
From 15 to 450 w

Control reactors for magnetic amplifiers are available covering 15 to 450 w. Four series cover sensitivity range from 1.5 to 3 a-turns. 117 v and 240 v are both standard. The military series meets all MIL-T-27-81 specifications, undergoing 2000 g shock tests.


CIRCLE 191 ON READER-SERVICE CARD

NEW 150°c

high-temperature, low-power

SWITCH SECTIONS

TESTED IN ACTUAL OPERATION FOR OVER 800 HOURS AT A CONTINUOUS AMBIENT TEMPERATURE OF 150°C

Here's a new development in low-power, rotary switch wafers that gives high reliability at 150°C. They show a safety factor of 5 to 1 over the life requirements of MIL-S-3786. This unusual performance is due to a special alloy we have developed for the contact clips. Under all test conditions applied to date, these clips have demonstrated a remarkable ability to maintain spring tension at elevated temperatures. As a result, electrical contact remains uniformly excellent for the life of the switch. Currently, most Oak sections in ceramic or Mycalex insulation can be supplied with this high-temperature clip, offering you a selection of sizes and circuitry to handle most applications.

Contact the Oak Representative in Your Area for Details or Send Us a Description of Your Application

OAK MFG. CO.
1260 Clybourn Ave., Dept. D, Chicago 10, Illinois
Phone: MOhawk 4-2222

CIRCLE 192 ON READER-SERVICE CARD
PRINTED CIRCUIT TRIMMERS

This new subminiature trimmer is designed for printed circuit assembly.

SLIM and TRIM, they fit neatly with diodes and transistors.

FEATURES:

- Reliability and performance in operations up to 225°C.
- Resistance Ranges from 100 to 30,000 ohms.

Environmental testing has proven these rugged, compact trimmers meet or exceed the military specifications required for airborne and missile applications.

Bulletins with full details available upon request.

TECHNOLOGY INSTRUMENT CORPORATION

555 Main St., Acton, Mass. - P.O. Box 3941, No. Hollywood, Calif.

CIRCLE 193 ON READER-SERVICE CARD

NEW PRODUCTS

Test Chamber

Range of -100 to +600 F

Model EP-125 high-low temperature test chambers for use in combination with vibration test equipment, has a 5 cu ft test space and a temperature range from -100 to +600 F.


CIRCLE 194 ON READER-SERVICE CARD

Switch

Operates safely in class I hazardous atmosphere

This switching device permits exposed contact switches to be operated in class I hazardous atmospheres. Maximum electrical spark energy available at the remote exposed switch contacts is far less than the minimum required to ignite the surrounding hazardous atmospheres. Switching control distances up to 1000 ft are possible.

Brookdale Engineering and Services Co., Dept. ED, 6 Beacon St., Boston 8, Mass.

CIRCLE 195 ON READER-SERVICE CARD

Digital Position Indicator

Utilizes Datex encoders

This series of digital position indicating equipment, is designed to provide a continuous indica-
THE NATIONAL SCENE

TEN-TO-ONE THE
Copper Clad Laminate
YOU WANT IS HERE!

From these ten basic PHENOLITE® Grades, you can select the base material, resin, properties and price to fit your present printed circuit need.

If your problem is finding a suitable cold-punch material, try samples of XXXP-470.1. It's designed for use in automated production equipment. If you are looking for higher heat resistance, check Grades G-10 and G-11.

Out of National's research laboratories come new advances every day. See your National Representative about new products and applications. He can keep you posted on the full line of PHENOLITE Laminated Plastic, Vulcanized Fibre and National Nylon for electronic applications across-the-board. In the meantime, write for our new "PHENOLITE Copper Clad Data" folder. Address Dept. E-6.
**NEW PRODUCTS**

**Current Limiter**

*Has high interrupting capacity*

Called the Form 101, this circuit protective device has high interrupting capacity and becomes current limiting at about four times its normal current rating. It anticipates and prevents the rise of fault currents to high destructive maxims. It can be connected directly into circuits where the available current on short circuit is very high, even up to 100,000 A. Depending on its rating, this current limiter will continuously carry from one to 10,000 A of normal current. It limits on overload but blows instantly on short circuit before damage can be done.

Chase-Shawmut Co., Dept. ED, Merrimac St., Newburyport, Mass.

*CIRCLE 205 ON READER-SERVICE CARD*

**Accelerometer**

*Ranges from ±5 to ±50 g*

Utilizing gas damping, model A501 accelerometer operates at temperature extremes of -65 to 200 F. The unit offers ranges from ±5 to ±50 g.

Statham Instruments, Inc., Dept. ED, 12401 Olympic Blvd., Los Angeles 64, Calif.

*CIRCLE 206 ON READER-SERVICE CARD*
Angular Acceleration Generator

Generates angular and near-linear acceleration motion

This angular acceleration generator is capable of generating closely controlled angular and near-linear acceleration motion. The instrument imparts sinusoidal angular motion to a test table by means of a cylindrical rotor motor, with a single phase, two-pole winding placed at right angles to a dc field.

Statham Development Corp., Dept. ED, 12411 W. Olympic Blvd., Los Angeles 64, Calif.
CIRCLE 186 ON READER-SERVICE CARD

Audio Plug

Protection against mechanical noise

XLR plug offers protection against mechanical noise, accomplished through resilient inserts with rubber cushioning ribs and latching mechanism. These audio plugs are available in a full range of shell styles with either three 15 a contacts or four 10 a contacts.

Cannon Electric Co., Dept. Ed, 3208 Humboldt St., Los Angeles 31, Calif.
CIRCLE 187 ON READER-SERVICE CARD

Tube Socket

Provides blind positioning of tubes

These 7- and 9-pin miniature tube sockets are designed to provide blind positioning of tubes. This is accomplished by a polarization key.

CIRCLE 254 ON READER-SERVICE CARD

new complete line of

GERMANIUM SUBMINIATURE GOLD BONDED DIODES

You may be assured that this new product line has the same high quality and reliability that has made General Transistor the Fastest Growing Name in Transistors. Experienced design engineers, quality materials, proven production techniques, and strictly enforced quality controls are your guarantees.

These diodes have been designed for computer, industrial and military applications where high reliability is of prime importance. They are hermetically sealed in a glass case with tinned leads. Their rugged construction makes them resistant to humidity, shock and vibration, and impervious to extreme environmental conditions.

Write today for Bulletin GD-10 showing complete specifications, diagrams and other engineering data.
immediate delivery...

phase-lock discriminators

by Hallamore

Ready, as a “building-block” for your system application...Hallamore Model 0162, phase-lock discriminator, a compact plug-in type unit, has been thoroughly proven in telemetering systems of major missile programs. Designed around a concept entirely new to telemetry, it eliminates signal suppression by noise...non-linearity as a result of filtering...thresholding, common at low signal-to-noise levels. For quick action, wire Hallamore Electronics Company, Dept. 24P, 8352 Brookhurst Avenue, Anaheim, California/TWX: AH-9079.

NEW PRODUCTS

Frequency Standard

Stability of one-part in one billion

Model LA90 5 mc frequency standard offers stability to better than one-part in one billion. Long term operation results in temperature shifts of less than 0.01 C. The environmental temperature range is 0 to 50 C.

Lavoie Labs., Inc., Dept. ED, Matawan-Freehold Rd., Morganville, N.J.

CIRCLE 209 ON READER-SERVICE CARD

Electrical Disconnect

For use with 55-circuit Bendix pygmy connector

Used in missile operations for umbilical disconnects of other severing functions where guillotine choppers are not feasible, model 2011A explosive electrical disconnect is designed around the 55-circuit Bendix pygmy connector. It converts this unit into a reusable explosive-actuated device without altering in any way the electrical characteristics of the original connector.

Beckman & Whitley, Inc., Dept. ED, 1085 San Carlos Ave., San Carlos, Calif.

CIRCLE 213 ON READER-SERVICE CARD

Wirewound Resistors

Maintain ±0.01 per cent tolerances

Available in any value from 1 ohm to 20 meg, these wirewound resistors possess a high degree of stability. The resistors are made up of multiple...
SELL HARDER AT...

WESCON 1958—in Los Angeles
America's 2nd Largest Electronic Market

Well over half of the nation's aircraft and missile contracts are held by Southern California firms. Supporting them are hundreds of manufacturers of electronic equipment and components up and down the coast.

WESCON attracts more than 30,000 interested electronic engineers, scientists, and businessmen—and you can alert these men to your booth and products before the show in Electronic Design's pre-show issue.

Electronic Design has more circulation among manufacturers on the West Coast than any other electronic publication. WESCON has become one of America's greatest electronic industry events. Sell harder at WESCON beginning August 6th by reserving space now in Electronic Design. Final closing date is July 7th.

830 Third Avenue, New York 22, N.Y., Telephone PLaza 1-5530
Now you can order from stock... the new BRYANT MAGNETIC STORAGE DRUM

Unequaled for precision, versatility, and low cost

The new 512A Bryant general purpose magnetic storage drum meets the exacting demands of all permanent storage problems, yet is versatile enough to be used as a laboratory instrument. These 5" dia. x 12" long drums are stocked for immediate shipment at a price that is far below the cost of customer-designed drums.

Features: Guaranteed accuracy of drum run-out, 00010" T.I.R. or less; Integral motor drive; Capacities to 625,000 bits; Speeds up to 12,000 R.P.M.; 500 kilocycle drum operation possible; Accommodates up to 240 magnetic read/record heads; For recirculating registers as well as general storage.

Special Models: If your storage requirements cannot be handled by standard units, Bryant will assist you in the design and manufacture of custom-made drums. Speeds from 60 to 120,000 R.P.M. can be attained, with frequencies from 20 C.P.S. to 5 M.C. Sizes can range from 2" to 20" diameter, with storage up to 6,000,000 bits. Units include Bryant-built integral motors with ball or air bearings. Write for Model 512A booklet, or for special information.

BRYANT GAGE and SPINDLE DIVISION
P. O. Box620-M, Springfield, Vermont, U. S. A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

CIRCLE 219 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supplies
Wide current ranges

These units offer a fast response time of less than 50 μsec recovery to load transients. Regulation on the Model CCS-1/1000 is ±1 per cent to load variations 5 ma to 1 a; ±2 per cent to load variations 1 ma to 5 ma; ±1 per cent to line variations. The Model CCS-1/5 offers a regulation of ±1 per cent to line and load variations. Ripple is less than 1 per cent on both units.

Ultradyn, Inc., Dept. ED, P.O. Box 3308, Albuquerque, N.M.
CIRCLE 220 ON READER-SERVICE CARD

Modulation Meter
For a-m generators and transmitters

This a-m modulation meter model MM-120 uses two interchangeable plug-in tuning units to measure modulation depths, envelope distortion, amplitude noise and hum modulation at frequencies from 15 kc to 1000 mc.

Empire Devices Products Corp., Dept. ED, Amsterdam, N.Y.
CIRCLE 221 ON READER-SERVICE CARD

DC Amplifier
Dual Channel

Du amplifier model M-220 for use with electronic recorder model GA-1023, provides a...
portable two-channel direct inking or electric recording system for measurement over the frequency range from dc to 200 cps. Sensitivity range for each of the two-channels is separately adjustable in 12 steps from 5 mv/mm to 20 v/mm chart deflection. The combination of amplifier and recorder results in flat writing response from dc to 200 cps. The amplifier delivers 80 ma rms into 1000 ohm at max power output.

Massa Labs., Inc., Dept. ED, 5 Fottler Rd., Hingham, Mass.

**CIRCLE 224 ON READER-SERVICE CARD**

**Indicating Meters**

Ranges from 1 ma to 100 a

Indicating meters are available in ranges of dc sensitivities from 1 ma to 100 a, and in voltmeters up to 300 v.

Hoyt Electrical Instrument Works, Inc., Dept. ED, 42 Carleton St., Cambridge 42, Mass.

**CIRCLE 225 ON READER-SERVICE CARD**

**Relay**

Thermal time delay type

Actuated by heater and hermetically sealed, thermal time delay relay model T-99 operates on ac or dc, or pulsating currents of 2 sec to 3 min delay periods. When subjected to ambient temperature changes from -60 to +85 C, the relay delay interval varies slightly from room temperature delay periods.

R.C.O. Electronics, Dept. ED, 145 Valley St., Belleville, N.J.

**CIRCLE 226 ON READER-SERVICE CARD**
Now! a standardized line
CONTROL Reactors
rated to fit the job...

Control! You name it. CMC has a
unit for it. Designed to do one job
. . . better, more efficiently, at less
cost!
The curves show the principle . . .
but for complete details—see the one
manual that tells the whole story!
Write for it today!

"a look inside tomorrow's engineer-
ing." Concise, easy-to-read perfor-
ance data. Choose the exact unit to
fit your need.

NEW PRODUCTS

Power Supply
Delivers up to 125 a

Model MA28-125 dc power supply can feed
entire systems drawing up to 125 a at 18 to 36 v
dc. Specifications include 208, 230 or 460 v,
3-phase, 60 cps input; ±0.1 per cent typical
regulation accuracy; 1 per cent maximum ripple;
and less than 0.1 sec response time.
Sorensen & Co., Inc., Dept. ED, Richards Ave.,
S. Norwalk, Conn.
CIRCLE 230 ON READER-SERVICE CARD

Shaft Encoders
1024 positions in one revolution

Series 700 shaft encoders features compact
units with up to 1024 positions in one revolution
of the input shaft. The C-711 series is available
with discs coded in Gray code or a cyclic binary
coded decimal. Accuracy is better than ±1 bit
and the transition points of each bit are held to
within ±0.05 deg. The C-711 is designed to have
a minimum life of 10⁶ revolutions of the input
shaft. Torque is less than 0.4 in.-oz and inertia
is less than 150 gm-cm².
ED, 918 E. Green St., Pasadena 1, Calif.
CIRCLE 231 ON READER-SERVICE CARD
Voltmeter
Frequency range from 1 to 400 kc

Model 2174 frequency selective voltmeter has a frequency range from 1 to 400 kc. A direct reading meter is calibrated for db or rms voltages, from -90 dbm to +32 dbm with accuracy of ±0.5 db over the tunable range of 1 to 400 kc. The input circuit is provided with a selector switch for 600 ohm terminating or high impedance bridging balanced or unbalanced lines. Spurious response below 60 db, and low intermodulation are also featured.

Rycom Instruments, Div. of Railway Communications, Inc., Dept. ED, 9351 E. 59th St., Raytown, Mo.
CIRCLE 210 ON READER-SERVICE CARD

LC Filter
Frequency range of 0.4 to 60.0 mc
This LC filter covers the range from 0.4 to 60.0 mc with center frequency stability of ±0.1 mc per mc from -55 to +105 C; shape factor: \(BW_{0d}/BW_{o}=2.1\).
Daven Co., Dept. ED, Livingston, N.J.
CIRCLE 211 ON READER-SERVICE CARD

AC Voltage Divider
0.002 per cent linearity

This ac voltage divider called Dekatran employs a special tapped toroidal transformer, and coaxial switches. Four coaxial dials give a simple straight line reading to five significant figures. Overall linearity is better than 0.002 per cent.
Electro Measurements, Inc., Dept. ED, 7524 S. W. Macadam Ave., Portland 1, Ore.
CIRCLE 255 ON READER-SERVICE CARD

HOW TO PLATE PRINTED CIRCUITS
FASTER, BETTER, AT LOWER COST
...with B&A Fluoborates

First step—use B&A copper fluoborate for high-speed copper plating of thick, high quality circuits.

Second step—use B&A lead-tin fluoborate for maximum solderability (60:40 tin-lead deposit).

Advantages: Both of these high purity fluoborate plating solutions come in concentrated solution form. They give you easy bath make-up and easy control. Since anode and cathode efficiencies approximate 100%, you get easy maintenance, too. They require no mixing or dissolving, and offer excellent bath stability, good anode corrosion.

BAKER & ADAMSON® Fine Chemicals

Result: You produce better printed circuits, faster and at lower cost—more easily, too!

Mail coupon now for comprehensive technical bulletins giving complete information on these improved plating techniques for printed circuits.

BAKER & ADAMSON® Fine Chemicals
GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Please send technical bulletins on the use of B&A Fluoborates in the production of printed circuits.

Name ____________________
Title ____________________
Company ____________________
Address ____________________
City ____________________ Zone ______ State ______

CIRCLE 212 ON READER-SERVICE CARD
HAZELTINE relies on Photocircuits

“Tuf-Plate” plated-thru holes

HEART OF ADVANCED AIRBORNE RADAR

Strategic military decisions stem from reliable knowledge of an entire situation. To gather reliable information, our nation depends on airborne radar. Hazeltine’s universal radar indicator...the advanced AN/APA-125...displays signal data of many types: Submarine detection, AEW, IFF, AMTI, LAB, beacon and others. With this electronic plotting board, an operator can plot any tactical problem and accurately interpret the solution for evaluation and action.

For the compact, lightweight AN/APA-125, Hazeltine specifies space-saving, double-sided printed circuit boards with “TUF-PLATE” plated-thru holes by PHOTOCIRCUITS. Here is reliability never before possible in two-sided thru circuitry.

“TUF-PLATE” reliability is guarded by rigid process engineering controls, developed by PHOTOCIRCUITS and unmatched in the printed wiring industry. Proper design, precision production and advanced quality control techniques assure consistently dependable performance...often at lower cost.

Get the detailed “TUF-PLATE” story today from PHOTOCIRCUITS...the largest and most experienced manufacturer in printed circuitry. Write our Engineering Department PS-3.

NEW PRODUCTS

Digital System
Easy maintenance

This digital system includes a 4 and 5 digit voltmeter, a master scanner, auxiliary scanners, an ac converter, control unit, remote readout as well as an ohmmeter ratiometer. The cubic digital system units feature easy access to replaceable parts and adjustments.

Cubic Corp., San Diego Electronics Firm, Dept. ED, 2841 Canon St., San Diego, Calif.
CIRCLE 233 ON READER-SERVICE CARD

Silicon Rectifier
For high current applications

This diffused silicon junction rectifier has ratings up to 400 a. Power supply applications of 5000 a capacity can be handled by stacked combinations. Chief features are low forward resistance and wide temperature range of operation to 150 C.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.
CIRCLE 234 ON READER-SERVICE CARD

Vibration Pickups
High temperature stability

The TD-series of vibration pickups combines the temperature stability of magnetic damping...
Coaxial attenuators are available for 1000 to 11,000 mc range, at 3, 6, and 10 db attenuation. 20 db models are available for 2000 to 11,000 mc. All have an impedance of 50 ohm. Calibration accuracy is ±0.2 db for 20 db models; ±0.1 db for others.

Narda Microwave Corp., Dept. ED, 160 Herricks Rd., Mineola, L. I., N.Y.

CIRCLE 366 ON READER-SERVICE CARD

RELIABILITY or

The Wonderful One-Hoss Shay

A Logical Story

Have you heard of the wonderful one-hoss shay.
That was built in such a logical way
It ran a hundred years to a day?

"For," said the Deacon. "It's mighty plain
That the weakest place must stand the strain;
And the way to build it is only jest
To make that place as strong as the rest."

The Deacon followed the two cardinal principles for reliability.

1. Know the stresses your component will be subject to (in other words know the environment).
2. Build faithfully to the specifications that cope with this environment.

At CPPC we feel one of our great assets is careful manufacture by a skilled and conscientious crew.

Reprints of the complete, original poem—
The Deacon's Masterpiece or The Wonderful One-Hoss Shay by Oliver Wendell Holmes sent upon request.

LOOK TO CPPC FOR SYNCHRO

CLIFTON PRECISION PRODUCTS COMPANY, INC.
Clifton Heights
Pennsylvania
Why
Redesign
It?

Electro Tec
solves the toughies

If longevity is a problem with your miniature slip ring and brush assemblies, chances are Electro Tec has the answer for critical circuits operating in the -46°F to +260°F ambient range.

Electro Tec brush assemblies exceed performance specifications because—every brush wire is individually hand polished to better than a 3 microinch finish in the contact area to reduce significantly both friction and ring wear!

Because of Electro Tec’s precision manufacturing techniques, you can be sure that each and every brush assembly will be uniformly top quality and will be held to absolute tolerances. Exact control of tolerances provides unparalleled uniformity, including contact pressures and space alignment. Because of the interchangeability of these parts you can standardize your inventory at lower cost!

There is an Electro Tec sales engineer near you. He will be glad to visit you and help with your design problems.

Write for illustrated literature.

ELECTRO TEC CORP.
P.O. Box 37B, SOUTH HACKENSACK, N.J.

CIRCLE 369 ON READER-SERVICE CARD

NEW PRODUCTS

Demodulator
Lowers receiver threshold by 6 db

Model 8-100 receiver phase-lock demodulator lowers the improvement threshold by at least 6 db. This lowering of the receiver threshold provides system gain which may be traded for increased range, reduced transmitter power, decreased antenna gain, or increased safety factor.

Radiation, Inc., Dept. ED, P.O. Box 37, Melbourne, Fla.

CIRCLE 370 ON READER-SERVICE CARD

Printed Circuit Connector
Features floating mounting bobbins

This printed circuit connector features floating mounting bobbins which insure good alignment between printed circuit board and connector. Connectors are available in 10, 15, 22 and 28 single row contacts and in 30 and 44 double row contacts.

Viking Industries, Inc., Dept. ED, 21434 Roscoe Blvd., Canoga Park, Calif.

CIRCLE 371 ON READER-SERVICE CARD

Delay Lines
8 to 30 μsec

A series of distributed constant delay lines has been made in delays ranging from 8 through
For fast, easy removal and replacement you can get Stromberg-Carlson Type “A” Relays with plug-in mountings.

The Stromberg-Carlson Plug (illustrated above) automatically locks the relay in place and guarantees a low-resistance connection between plug and socket. Its 36 terminals provide enough connections for practically all relay applications. Coils and contacts are wired to terminals as your needs dictate. Contacts can be furnished in silver, palladium, gold alloy or palladium-silver alloy.

Spring combinations possible with this assembly are 17 Form A or Form B; 10 Form C or Form D.

Also available in an “A” Relay is a plug used with commercial radio type sockets. It can mount relays with 8, 9, 12 or 20 connections.

For technical details and ordering information, send for Bulletin T-5000R, available on request. Write to:

STROMBERG-CARLSON

For plug provide ELECTRONIC

B; with connections.

5000R, tails

Also for DIVISION

plug-in plug

Spring

Electronic

CIRCLE

Also

For

DIVISION

plug

Spring

116

TROMBERG-CARLSON

Box 1278, San Jose, Calif.

CIRCLE 375 ON READER-SERVICE CARD

Vacuum Relay
10 kv voltage rating

The spdt RBI relay is a miniature unit designed for high voltage and high current operation. Measuring 2-1/2 in. long and 1-3/4 in. in diam, it has a voltage rating of 10 kv and continuous current rating of 15 a rms.

Jennings Radio Mfg. Corp., Dept. ED, P.O. Box 1278, San Jose, Calif.

CIRCLE 375 ON READER-SERVICE CARD

Geiger-Mueller Tube
Detects beta radiation of 0.1 mev

Type GM4LB Geiger-Mueller tube is capable of detecting minute amounts of beta radiation at energy levels of 0.1 mev and above. Background response is low as 0.4 counts per minute. Operation is at 1200 to 1400 v, with a plateau length of 150 to 200 v and an average slope of 0.05 percent per v. Approximate overall dimensions are 2-1/2 in. long x 1-1/2 in. diam.

British Industries Corp., Dept. ED, 80 Shore Rd., Port Washington, N.Y.

CIRCLE 376 ON READER-SERVICE CARD

From General Electric . . .

PLAIN TALK ON TANTALYTIC* CAPACITOR AVAILABILITY

It's time for plain talk on the facts of tantalum electrolytic capacitor availability. There is no "availability" problem as far as General Electric is concerned.

Here's why:

- No metal shortage—Stocks of capacitor-grade tantalum have doubled within the past year.
- No production capability shortage—General Electric's production facilities have tripled in the past year.
- No delivery bottlenecks—General Electric's improved manufacturing processes and techniques have virtually eliminated production rescheduling.
- Few military directive priorities—Since the supply of Tantalytic capacitors has met demand, the military requirements can be met without directive priorities.

This is why we say—now and in the future, General Electric will continue to provide Tantalytic capacitors in the types and ratings you want—when you want them.

For specific information on Tantalytic capacitor ratings, prices, deliveries, contact your nearest General Electric Apparatus Sales Office or write to General Electric Co., Section 449-4, Schenectady 5, N. Y.

*Registered trade mark of General Electric Co.
**Trade mark of General Electric Co.

SOLID TANTALYTIC CAPACITORS—For transistorized circuit applications—rated up to 60 volts, polar units only—sized down to 0.125 inches by 0.350 inches.

125C TANTALYTIC CAPACITORS—For aircraft electronic systems—ratings 10-180 mfd, 30 to 100 volts, Sizes 1/2 to 7-1/2 inches in height. Also tubular, double-ended units.

125C TANTALYTIC CAPACITORS—For applications requiring high quality but where temperatures are less severe.

CIRCLE 377 ON READER-SERVICE CARD
From the launching pad to machine controls—
NAVCOR completely transistorized pulse programming equipment is being utilized to do many military and industrial jobs, and do them well! The original concept of functional units pioneered by NAVCOR, and already proven in thousands of hours of use-test, feature quickly interchangeable modular blocks creatively engineered for multi-purpose operations. Write for data and specifications that will show how NAVCOR transistorized pulse programming equipment can be effectively used in your current computer project.

This line of predesigned mechanisms and mechanical components for the servo and instrument includes clamp-on gears, anti-backlash gears, pin couplings, and slip clutches. These, in conjunction with a predesigned ball bearing gear plate assembly and 0.125 in. diam shafts of various standard lengths, provide a versatile precision gear box with as many as six shaft extensions on either side.

Precision Mechanisms Corp., Dept. ED, 577 Newbridge Ave., East Meadow, N.Y.
CIRCLE 379 ON READER-SERVICE CARD

Discriminator
For use in radio telemetry ground station

Subcarrier discriminator model GFD-2 and associated bandpass and lowpass filters is available for use in radio telemetry ground stations and data reduction centers. Model GFD-2 converts frequency modulated subcarriers into intelligence signals at output levels suitable for recording with penmotos or galvanometers.

Data-Control Systems, Inc., Dept. ED, 39 Rose St., Danbury, Conn.
CIRCLE 380 ON READER-SERVICE CARD

Core
Structure with complex surfaces
This core development known as the Stalagmite process, makes possible structures with complex surfaces heretofore impracticable when using honeycomb elements. Distribution of the core ma-
material can be varied to handle unequal loading on the surfaces and predecorated surfaces can be joined without marring or other damage. Passageways can be constructed in the core material for heat exchange systems, gas type conduits, and other similar uses.

Arvin Industries, Inc., Dept. ED, Columbus, Ind.

CIRCLE 455 ON READER-SERVICE CARD

**Interval Timer**

**Features low contact bounce**

This fixed position interval timer limits contact bounce to within a range of 50 to 300 μsec. Timing cycles may be as short as one second or as long as several hours. With up to five independent channels available in the standard unit, events may be sequenced simultaneously or in a series, or in a combination of both.

U.S. Industries, Inc., Western Design & Manufacturing Corp. Div., Dept. ED, 5947 Sheila St., Los Angeles 2, Calif. 2

CIRCLE 456 ON READER-SERVICE CARD

**Time Delay**

**Thermal unit combines with magnetic relay**

This time delay is instantly reset by the type DM thermal timing element when combined with a small magnetic relay in the circuit illustrated. Type DM thermal timing elements are available for any delay period from 5 sec to 6 min and for operating voltages from 6.3 to 230 v. Load rating is 5 a to 125 v ac; 3 a to 250 v ac; 1 a resistive to 32 v dc.

G-V Controls, Inc., Dept. ED, 28 Hollywood Plaza, East Orange, N.J.

CIRCLE 457 ON READER-SERVICE CARD

**Vitramon® CAPACITORS PROVED**

Up To 12 Times More Reliable Than Mil Specifications

All "VITRAMON" Capacitors ordered under High Reliability Specification S-1002 have a proven A. Q. L. life reliability 12 times higher than Mil Specifications. In qualification tests, for which Mil Specifications allow a failure rate of 4 out of 34 — "VITRAMON" CAPACITORS CANNOT EXCEED 4 OUT OF 354. While Mil Specs do not require requalification, S-1002 calls for complete retesting at least once every six weeks.

Group A Tests are made and results submitted on a sampling of pieces shipped to the customer under Specification S-1002; recently run Group B and C test results are also furnished with every shipment under that specification.

The high reliability of "VITRAMON" Capacitors is achieved by building inherent characteristics into the piece through the fusing of quality porcelain enamel and fine silver to produce a dense, homogeneous, truly monolithic unit that requires no case or hermetic seal. Quality control, including a LIFE TEST ON EVERY LOT, and rigid testing during and after manufacture assure near-perfect dependability.

"VITRAMON'S" High Reliability Specification S-1002, describing materials used, manufacturing process, as well as all tests and failure rates, is now available on request.

**Vitramon® INCORPORATED**

IN BOX 546 - BRIDGEPORT 1, CONNECTICUT
**NEW PRODUCTS**

**Relay**

Anti-chatter feature

Model P215 polarized relay has sensitivity as low as 20 μV. It features spdt with anti-chatter feature. Value of resistances are up to 1400 ohm for single windings or parallel windings of 825 ohm each.

Kurman Electric Co., Dept. ED, 191 Newel St., Brooklyn, N.Y.

CIRCLE 460 ON READER-SERVICE CARD

**Flutter Meter**

For accurate measurements of flutter and wow

This flutter meter is designed to indicate wow and flutter content of all types of tape recorders and playback equipment including 33-1/3, 45 and 78 rpm discs and 16 and 35 mm sound film mechanisms.

Amplifier Corp. of America, Dept. ED, 398 Broadway, New York 13, N.Y.

CIRCLE 461 ON READER-SERVICE CARD

**Ball Bearings**

Feature miniature size

Midget T series bearing requires less than 15 per cent of the volume required by counterpart
bore sizes in conventional ball bearings. The ratio of load capacity to unit volume of bearing is much higher than in conventional inch series instrument bearings. Four sizes have bores of 3/8, 1/2, 5/8, and 3/4 in. The cross-section of the bearing from bore to OD measures 1/8 in. Widths on the four sizes are held to 5/32 in. Close manufacturing tolerances are maintained. Standard material is 440C stainless steel for rings and balls, with one-piece retainer of machined phenolic.

MBP Inc., Split Ballbearing Div., Dept. ED, Lebanon, N.H.

CIRCLE 464 ON READER-SERVICE CARD

Keyboard
Contains 10 decimal keys

Decimal keyboard model 410 provides rapid manual digital input to a variety of devices. Each of its key-operated, spdp throw switches (125 v ac, 5 amp and 30 v dc, 2 amp) has three taper pin terminated leads for flexibility in terminal strip installation.

ElectroData Div. of Burroughs Corp., Dept. ED, 460 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 465 ON READER-SERVICE CARD

Power Supply
10 to 32 v, 0 to 15 a

Model SC-32-15 transistorized power supply delivers 0.32 v, 0.15 a. Regulation for line or load is less than 0.01 per cent or 0.001 v, whichever is greater. Ripple is less than 500 µv rms. Recovery time is less than 50 µsec. Operating ambient temperature is 50 C max. Output impedance is less than 0.001 ohms.

Kepco Labs., Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 466 ON READER-SERVICE CARD

SANDERS FLEXPRINT WIRING

New, flat, flexible wiring sharply reduces weight, bulk and cost of electronic and electrical assemblies.

Sanders Flexprint Wiring brings to commercial and military applications a combination of field-tested advantages unmatched by conventional wiring and ordinary printed circuits.

- Completely flexible ... exactly reproducible.
- Available in all lengths and current-carrying capacities.
- Weighs less than half as much as conventional wiring ... occupies less than one-third the space ... conforms to any housing shape or layout.
- Designed and produced in straight cables or complex harnesses ... in single or multiple layers or bonded to rigid materials as a replacement for printed board.
- Permanently bonded in insulating plastics to meet environmental and reliability requirements.
- Withstands effects of vibration and flexing ... allows interconnected assemblies to move independently.
- Speeds up assembly ... permits automatic production ... eliminates error.
- Easily cut, stripped and connected.
- Available in vinyls, polyethylene, polyesters, silicones, Kel-F, Teflon, or other insulations.

Write today for complete data about capabilities, prices and deliveries.
NEW PRODUCTS

CAPACITOR CAPS.—These mylar capacitor caps, when used as an insulator placed over each end of the capacitor winding, will not shrink or twist after it has been formed.

Mlam Electric Mfg. Co., Dept. ED, 1100 Elmwood Ave., Providence, R. I.
CIRCLE 238 ON READER-SERVICE CARD

PRESSURE TRANSDUCER.—PSC-1 series, including absolute, gage and differential pressure types, is supplied in standard ranges from 25 to 300 psi, for performance in temperatures ranging from -100 to +300 F.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.
CIRCLE 239 ON READER-SERVICE CARD

PLUGS.—These teflon-insulated plugs may be used in conjunction with type SKT-10 jacks which mount directly on metal panels as close as 1/4 in. between centers, for tight assemblies.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y.
CIRCLE 240 ON READER-SERVICE CARD

PYROMETER.—Model DR35 surface pyrometer has a 4-3/4 in. indicator with two scale ranges: the low range from 0-500 F read in 5 deg divisions, and a high range from 0-1500 F.

The Pyrometer Instrument Co., Dept. ED, Bergenfield, N. J.
CIRCLE 241 ON READER-SERVICE CARD

TIMER.—This reset timer features a cycle progress pointer and is available in time ranges from 10 sec to 10 hr in 115 or 230 v models.

Eagle Sognal Corp., Dept. ED, 202-20th St., Moline, Ill.
CIRCLE 242 ON READER-SERVICE CARD

ANCHOR NUTS.—Configurations are a two-lug anchor nut type LHA3006, a one-lug anchor nut type LHA3207 and gang channel assembly type G15 which were designed for service at temperatures up to 550 F.

Elastic Stop Nut Corp. of America, Dept. ED, 2330 Vauxhall Rd., Union, N. J.
CIRCLE 243 ON READER-SERVICE CARD

VOLTAGE VARIABLE CAPACITORS.—With maximum operating range of 100 v, the new types are rate 7, 10, 12, and 15 uF.

CIRCLE 244 ON READER-SERVICE CARD

FASTENER.—This seal-sealing fastener has a thin shim of Teflon set in a specially designed “O” ring groove which absorbs a maximum amount of friction between the metal and the “O” ring during installation, preventing cold-flow and abrasion.

Uniseal Co. of Calif., Dept. ED, 8021 S. Western Ave., Los Angeles, Calif.
CIRCLE 245 ON READER-SERVICE CARD

AVAILABLE PERFORMANCE

Nuclear temperature, sizes or bifurcated material
Industries, USECO with meet and
ELECTRONIC humidity a result
Available advantages radiation
Insulated now...THREE
UNI-MOLD
a
in
of
USECO
Insulated
completely
variety
configurations.
For the water
1800° F.
Dept.
requirement.
CIRCLE
Hardware
—
LITTON
LITTON INDUSTRIES, INC.
Components Division

LITTON PRECISION COMPONENTS: Potentiometers  Ferrite Isolators  Rotary Joints
USECO ELECTRONIC HARDWARE: Hardware & Terminals  Terminal Boards  Printed Circuits
CIRCLE 237 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
PREAMPLIFIER.—Model 201 extends instrument sensitivity by a factor of 10 or 100. The line-powered unit achieves good hum reduction by utilizing a well-filtered dc filament supply together with a VR tube-regulated and filtered plate supply.
EO Electronics, Dept. ED, Mountain Lakes, N.J.
CIRCLE 248 ON READER-SERVICE CARD

PRESSURE SWITCH.—Designed for high temperature, close operating tolerance for liquid or gaseous applications.
Carleton Aviation Co., Inc., Aeronautical Div., Dept. ED, 411 North St., East Aurora, N.Y.
CIRCLE 249 ON READER-SERVICE CARD

DATA WRITER TESTER.—Automatically operates keyboard solenoids in a predetermined sequence, permitting malfunctions and momentary hangups to be isolated and identified by comparing the printed test record with a master record.
Hanson-Gorrill-Brian, Inc., Dept. ED, 85 Hazel St., Glen Cove, N.Y.
CIRCLE 250 ON READER-SERVICE CARD

POWER OSCILLATOR.—Model 150 has an internal oscillator that generates a fixed frequency of 400 cps ±0.25 per cent or a variable frequency from 350 to 450 cps.
Industrial Test Equipment Co., Dept. ED, 55 East 11th St., New York 3, N.Y.
CIRCLE 258 ON READER-SERVICE CARD

MEGPOT.—This is a combination megohm-meter and high potential test set, with variable voltage ranges to 10,000 v.
General Hermetic Sealing Corp., Dept. ED, Valley Stream, N.Y.
CIRCLE 259 ON READER-SERVICE CARD

SERVO.—Measuring 3 x 1-1/4 in., this servo meets the needs for an isolation servo between synchro components, or a synchro controlled servo drive for indicators, potentiometer, or shaft to digital converters.
LibraScope, Inc., Sub. of General Precision Equipment Corp., Dept. ED, 808 Western Ave., Glendale 1, Calif.
CIRCLE 260 ON READER-SERVICE CARD

BALUN COIL KIT.—Suitable for connecting either 75 ohm unbalanced to 300 ohm balanced, or 75 ohm unbalanced to 75 ohm balanced.
Barker & Williamson, Inc., Dept. ED, Canal St. & Beaver Dam Rd., Bristol, Conn.
CIRCLE 261 ON READER-SERVICE CARD

PRESSURE PICKUP.—Operating from 0 to ±300 psi with a nominal output of 40 mv, type 4-323 pressure pickup measure up to 5000 psi.
Consolidated Electrodynamics Corp., Dept. ED, 300 North Sierra Villa, Pasadena, Calif.
CIRCLE 262 ON READER-SERVICE CARD

POWER SUPPLY.—Designed to test 400 cycle servo systems and motors. The unit has three continuously variable outputs: two at 0 deg and one at ±90 deg.
Pacific Technical Co., Dept. ED, 2047 Sawtelle Blvd., Los Angeles 25, Calif.
CIRCLE 263 ON READER-SERVICE CARD
'Diamond H'

**SERIES W**

**General Purpose Relays**

**MEASURE ONLY:** 1 3/4" x 1 3/4" x 1 3/8"

**BUT CARRY:** to 25 A. resistive at 115-230 V., A.; 1 h.p., 125 V., 2 h.p., 250 V., A.C.; D. C. and other higher ratings on request.

**CONTACTS:** DPDT, Double Break-Double Make (Form Z). Special arrangements and sequence on request.

**MOUNTINGS:** Socket, panel and sidewall arrangements standard; others to meet special needs.

"Diamond H" engineers are prepared to work out variations of these rugged, dependable relays to meet your specific requirements in such applications as automation controls, appliances and air conditioning equipment, or what you will. Just ask.

**THE HART MANUFACTURING COMPANY**

210 Bartholomew Ave., Hartford, Conn.
Phone Jackson 5-3491

CIRCLE 265 ON READER-SERVICE CARD

**NEW MATERIALS**

**Cleaning Solvent**

For gyroscopes, precision instruments

Gyroclean solvent No. 113, a purified trichlorotrifluoroethane, is a cleaner for use with gyroscopes and other precision instruments. The solvent has low toxicity, evaporates quickly, is non-flammable, has low residue, and is compatible with gyroscope sealing and potting resins.

Bacon Industries, Inc., Dept. ED, 192 Pleasant St., Watertown 72, Mass.

CIRCLE 266 ON READER-SERVICE CARD

**Glass Screens**

For storage and image orthicon tubes

Automatically produced glass screens with 562,500 precisely etched holes per sq in. are available. Having good dielectric properties, the screens are particularly suitable for electronic storage tubes and for targets in image orthicon tubes. Transmission of these screens can be as low as 40 per cent or as high as 70 per cent, depending on width of the holes. These range from 0.00085 to 0.00112 in. For certain seal operations the screens are available with metalized perimeters.

The screens are made of Fotoform, a strong, chemically etchable photosensitive glass. Thickness of the circular screens after etching is 0.003 to 0.005 in. Largest size now available is 1.75 in. diam, with a screen diameter of 1.5 in.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 267 ON READER-SERVICE CARD

**Hook-up Wire**

For high temperature use

Made with silver-plated, stranded copper conductors type 500 is insulated with Teflon tape by a process which increases flexibility at low temperatures. The wire is made in awg sizes 20, 18, 16, 14, 12, and 10, and is available in all colors, solid, and striped combinations.

Western Insulated Wire Co., Dept. ED, 2425 E. 30th St., Los Angeles 58, Calif.

CIRCLE 268 ON READER-SERVICE CARD

**HIGH SPEED TESTING**

**CAPACITORS**

**RESISTORS**

**INDUCTANCES**

**AUTO-BRIDGE**

The newest addition to Industrial Instrument Auto-Bridge line of automatic and semi-automatic test equipment is the Model AB3X2 manual-feed, manual-sort bridge. Fully automatic hopper or tape-fed equipments have definite place in component testing, but they are not the most efficient system whereby a large variety of small and medium-size lots of components can be tested.

The Model AB3X2 is manually loaded and unloaded. One of the two colored lights indicates whether the component under test is "in" or "out" of preset tolerance. Plug-ins are used set the "high" and the "low" limits and the standard jig supplied with the equipment accepts most wire lead components. There are meters to read...the only interpretation required by the operator is to determine which of the two colored lights is lit. A true limit bridge principle is used. There is no drift in the operation point and daily calibrations are not necessary.

**TABLE OF SPECIFICATIONS**

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For complete details on this economical Auto-Bridge as well as our full line of associated equipment, write...
Plating Process
Plates copper on ceramic

A process of plating high conductivity copper on ceramic directly out of solution is proving both economical and more efficiently electrically because of the close chemical bond achieved. Called the Kemetal process, it is used in the manufacture of disc capacitors and feed-thrus. The copper plates uniformly on irregular or complex surfaces.

CIRCLE 271 ON READER-SERVICE CARD

Ceramic Components
Thickness down to 0.005 in.

These ceramic parts are made of vitrified, vacuum-tight AlSiMag Alumina. Thicknesses as low as 0.005 in. are practical. Besides the usual applications, the semi-transparent ceramics have also been found highly satisfactory for use as micro-wave windows, transistor platforms, insulators for hearing aids, and in digital counter tubes.

American Lava Corp., Dept. ED, Cherokee Blvd. & Manufacturers Rd., Chattanooga 5, Tenn.
CIRCLE 272 ON READER-SERVICE CARD

Ductile Bismuth
For instrument components

The development of pure bismuth and special bismuth alloys in ductile form now make its use in instruments practical. The natural sensitivity of bismuth to changes in temperature and magnetic field make the material useful in thermocouples and devices for measuring Gauss and Hall effects. The pure metal is available in strip, grid and film form for Gauss and Hall measurements, and in two alloys formed into wires for use as the negative and positive legs of thermocouples. Wires, grids, films, and strips are available in a variety of standard sizes.

Fitzpatrick Electric Supply Co., Dept. ED, 444 Irwin St., Muskegon, Mich.
CIRCLE 273 ON READER-SERVICE CARD

Super-Temp
American Super-Temperature Wires, Inc.
20 West Canal Street, Winooski, Vermont • University 2-9636
General Sales Office: 195 Nassau St. • Princeton, N. J. • Walnut 4-4450
Agents in principal electronic manufacturing areas

SUPER-TEMP makes teflon insulated wires and cables perform to all kinds of tricky specifications... with wide margins of reliability. But the performance our customers like best is the SUPER-FAST DELIVERY. Need it fast... see us first... SUPER-TEMP'S management team will take personal interest in your problems.
IMPORTANT NOTICE TO PHYSICISTS AND ELECTRONIC ENGINEERS:

INFRA-RED OPTICS
RADAR SYSTEMS ANALYSIS
ELECTRONIC SUPPORT EQUIPMENT DESIGNERS
MISSILE GUIDANCE SYSTEMS
CONTROL SYSTEMS ANALYSIS

SEVERAL UNUSUAL CAREER OPPORTUNITIES:
We have a high priority need for qualified men experienced in any of these fields. Requires Bachelor's Degree in electrical engineering or physics plus 3-6 years' experience. Or an advanced degree plus 2-5 years' experience in design and analysis of communication, detection or control systems.

CONTINUED EXPANSION IN ELECTRONICS & AVIONICS:
Emerson Electric has completed a record-setting year and the pace is not slackening at all! Already a leading manufacturer of missiles and electronic equipment, Emerson has a firmly outlined program for the future. We anticipate increased volume and diversity in 1958, and doubling these figures over the next few years. Therefore, a new, broader organizational structure has created these excellent career openings with complex challenges.

CURRENT PROJECTS AT EMERSON ELECTRIC:
B-58 fire control system, mortar locators, radar components and assemblies, servomechanisms, missiles and rockets, ground support equipment, microwave antennas, F-101 Voodoo structures, plus a host of other electronic devices for the supersonic era. We emphasize research, design and development, with a healthy balance in production.

CONSIDER THESE EMERSON BENEFITS:
- Excellent salary
- Outstanding advancement opportunities
- Advanced education program
- Moving expenses fully paid
- Plus other top-level benefits


YOUR FUTURE IS OUR BUSINESS!

Electronics and Avionics Division
EMERSON ELECTRIC
8100 W. Florissant Ave. • St. Louis 21, Mo.

NEW MATERIALS

Epoxy System
For dip encapsulation

This resin system, type 6-02, is applied at room temperature by dipping. Resin cure can be attained in 5 hours with virtually no coating drain at oven temperatures and yet the bath life extends for more than a day at room temperature. The resin is particularly well suited for automatic conveyor dipping.

Michell-Rand Manufacturing Corp., Dept. ED, 51 Murray St., New York 7, N.Y.

CIRCLE 276 ON READER-SERVICE CARD

Colloidal Graphite
A list of electronic applications

Colloidal graphite consists basically of a high-purity graphite processed down to colloidal size and dispersed in a wide variety of fluid carriers. The characteristics of the material can be best described by a listing of some of its applications. The largest single application is for vacuum tubes, where it can be applied directly to parts which need not have undergone such preliminary treatments as acid etching, sand blasting, or oxidation. Specific examples are as follows:

- Tube shielding: tubes which acquire surface charges merely by handling (the FP-54 Piotron, for example) are coated with an appropriate dispersion of colloidal graphite to within an inch of the control-grid connection. This shielding is then connected to a source of potential equal to that of the grid;
- Phototubes: since graphite, being non-metallic, does not react with selenium to form selenides, it is ideal for light-sensitive cells. In this instance, it is useful as electrode material in selenium-tellurium phototubes. Colloidal graphite has a marked physical affinity for cesium and, therefore, finds application in phototubes and half-wave rectifiers where surplus cesium can be absorbed by the graphite coating;
- Cathode ray tubes: special dispersions of colloidal graphite in deionized water are available to be applied to the inside surfaces of TV and oscilloscope tubes. These graphite films serve as ray-focusing anode materials to prevent stray electrons from being reflected back into the electron beam and distorting the image;
- Instrument applications: instrument windows

23 DIFFERENT RATIO SET-UPS...

WITH HI-PRECISION GEAR REDUCTION KIT

A Link Gear Reducer with 16 interchangeable precision-class gear and pinion clusters make up Link's new Gear Reduction Kit. This kit, which provides 23 different ratio set-ups, is ideal for experimental and development work where designs are fluid and changes anticipated.

Now there is no further need to order several gear reducers for each development job or to assemble makeshift gear trains. After designs have been frozen, simply order production quantities of factory-assembly Link Model 012 gear reducers.

There are Link Servo Motor Mounting Adapters available for coupling most of the commonly used servo motors to the Model 012 Gear Reducer.

Specify Link Model 012 Gear Reduction Kit, priced at only $375 F.O.B. Binghamton.

For complete catalog, write Department ED

Let Link help you with the design and assembly of all your servo mechanism projects.

LINK AVIATION, INC.
BINGHAMTON, NEW YORK

CIRCLE 277 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958
in low-torque meters are made conductive and protected from the accumulation of static charges by thin, buffed films formed from dilute colloidal graphite.

Bolometers: when heat radiation falls on a thin sheet of cellophane painted on each side with a colloidal graphite dispersion, the electrical conductivity measured through the sheet changes sufficiently so that the cellophane can be used as the sensitive element in a bolometer.

Acheson Colloids Co., Dept. ED, Port Huron, Mich.

CIRCLE 439 ON READER-SERVICE CARD

PROTECT FILAMENTS

Application of voltage to tubes in receivers, transmitters, computers, and other electronic equipment subjects their filaments to initial current surges (top oscillogram).

These surges cause premature failure or unsatisfactory service life. Bottom oscillogram shows how a G-E thermistor can suppress the surge and protect the tube filaments.

The thermistor has a large negative temperature coefficient of resistance. The high resistance holds surge current to a low value during initial application of voltage. As the cold filament gradually heats up—raising its resistance to normal level—the thermistor's resistance lowers to a negligible value, permitting full current to flow after a brief period.

G-E thermistors can also be used to prevent surges from operating relay's or disturbing sensitive apparatus. They can provide time delay, control warning circuits, sequence switching.

For more information, or thermistor test kits, write: Magnetic Materials Section, General Electric Company, 1950 N. Neff Ave., Edmore, Michigan.

CIRCLE 438 ON READER-SERVICE CARD

Ceramic Coated Wire

Continuous operation at 1000 F

This insulated wire, called Ceramicite, is ceramic coated and rated for continuous operation to 1000 F. The wire is flexible, and can be wrapped repeatedly around a mandrel three times its own diameter without damage. It has excellent electrical characteristics and abrasion resistance, as compared to normal insulating materials. Ceramicite is presently applied to solid conductors only, the conductors being nickel-clad copper or solid nickel. For hook-up wire which must be made with flexible stranding, the strands are individually insulated.

Sequoia Wire and Cable Co., Dept. ED, Redwood City, Calif.

CIRCLE 441 ON READER-SERVICE CARD

A reinforced Teflon, called Fluorosint, exhibits a two to fourfold improvement in dimensional tolerances over unmodified Teflon. In addition to close tolerances in molding, the material has a thermal coefficient of expansion approximately one fifth that of Teflon. Fluorosint may be quenched in water from 700 F with negligible change in dimensions. The addition of the high temperature inorganic reinforcing agent has a negligible effect on dielectric strength, volume or surface resistivity, or density. Pilot quantities of Fluorosint, in the form of molded parts and in standard stock shapes such as bars, tape and tubular bars, are available.

Polymer Corporation of Pennsylvania, Dept. ED, 2140 Fairmont Ave., Reading, Pa.

CIRCLE 440 ON READER-SERVICE CARD

All Kennedy wave guide components for microwave applications are precision engineered to attain the highest level of performance, with highest transmitted power, lowest standing wave ratio. They are fully tested for trouble-free operation.

- COMPLETE FEED SYSTEMS designed and installed. For any antenna, anywhere.
- HORMS—both single and dual polarization. Exceptional low VSWR.
- TRANSITIONS—better bandwidth and lower VSWR.
- DUPLEXERS—rejection ratios better than 100 db
- STRAIGHT SECTIONS—Length 3" to 20'
- BENDS—E-plane or H-plane
- COMPLETE HARDWARE and accessories

For the most efficient use of your antenna, let Kennedy engineers design your feed system. Complete, detailed specification data is yours for the asking. Write today for your free copy of the handy file size Kennedy Antenna Equipment folder.
NEW MATERIALS

Spiral Cable Lacing
Tool permits easy application

Spirally-cut wiring tube is easily applied using a simple tool, called the Cable-Former. As the tool is moved along the length of the wires, it unwinds the tightly formed spiral tube and wraps it over the wires with uniform pressure. This makes a secure free-running cable which is flexible yet firmly held.

Panduit Co., Dept. ED, 14461 S. Waverly Ave., Midlothian, Ill.
CIRCLE 444 ON READER-SERVICE CARD

Encapsulating Shells
Odd shapes custom molded

Custom molded odd-shaped epoxy encapsulating shells are available. They are manufactured with a high degree of accuracy and eliminate the need for expensive temporary molds, release agents, and patching. The shells have excellent chemical and solvent resistance.

Epoxy Products, Inc., Dept. ED, 137 Colt St., Irvington 11, N.J.
CIRCLE 445 ON READER-SERVICE CARD

Photo-Recording Paper
Provides instantaneous visible image

Designated as Linagraph direct print paper, this photo-recording material provides an instantaneous visible record of instrumentation test data, such as that of moving-mirror galvanometer oscillographs. At low recording and writing speeds, a legible record is visible immediately. At higher recording speeds, the trace becomes visible within ten seconds after post-exposure to fluorescent light. When multiple work prints of the original records are desired, intermediates may be made on Autopositive materials.

In Electronic Design, engineers find not only more new products, but all the new products normally encountered in the design of electronic original equipment. 26-time publishing frequency brings this information quickly to the engineer's attention, timed to a fast-moving industry. Electronic Design is more up-to-the-minute, more complete, more helpful, and easier to read than any other electronic publication. No wonder more and more engineers read Electronic Design first!

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a HAYDEN publication
830 THIRD AVENUE, NEW YORK 22, N.Y.
CIRCLE 446 ON READER-SERVICE CARD
for use in direct process reproduction. Pen or pencil notations may be made on the paper's surface as desired. Although sharpness and legibility are maintained adequately, a high degree of permanence may be obtained by chemically fixing the paper by conventional photographic means.

Eastman Kodak Co., Dept. F.D., Rochester 4, New York.

CIRCLE 448 ON READER-SERVICE CARD

![Ceramic Rod](image)

Ceramic Rod
Custom-metalized for delay line cores

Precision-metalizing (with high-fired conductive silver and other metals) of very small diameters and very short lengths of Steatite rod and tubing has been developed for delay line cores and other applications. Several examples are illustrated, all of which are made with silver soldering bands. Custom-metalizing is also done on flat and certain eccentric shapes.

Ceramet Corp., Dept. ED, 451 West 216th St., New York 34, N.Y.

CIRCLE 449 ON READER-SERVICE CARD

![Epoxy Compounds](image)

Epoxy Compounds
Foam-in-place types

Foam-in-place potting compounds are available in two forms. Sealfoam 601 is a two-component liquid which when mixed in proper proportions and heated will expand and cure to a rigid, closed-cell structure with good electrical characteristics and mechanical strength. This compound protects components from moisture, fungus, vibration and shock loading. Sealfoam 603 is a single-component, free-flowing powdered material which requires the relatively low foaming temperature of 175°F. The cured material has a compressive strength of 110 psi, maintains good electrical resistivity even at 350°F and is also an excellent thermal insulator.

Minneapolis-Honeywell Regulator Co., Dept. ED, 2753 4th Ave., S., Minneapolis 8, Minn.

CIRCLE 450 ON READER-SERVICE CARD

Tobe now announces the availability of a series of reliable, low-cost energy-storage capacitors for thermonuclear equipment and similar applications. The NRG-200 series capacitors have a minimum life expectancy of 1000 operations, and may be operated at ambient temperatures up to 40°C. Maximum permissible reversal voltage is 90%. They can be discharged into a very low-impedance load with complete safety.

For further technical information or engineering aid, write Tobe Deutschnann Corporation, Norwood, Mass.
**NEW LITERATURE**

**Inertia Calculation**

Literature is available which provides a tabulated table to supply data pertaining to mass moment of inertia for precision potentiometers. An experimental method is described to serve as a guide in the compilation of mass moment of inertia of other related components within a system. Designated as Technical Bulletin #20, this literature is complete with formula, schematic, and graph. Technology Instrument Corp. of Calif., 729 Atoll Ave., North Hollywood, Calif.

**Switching Reactors**

A 16-page catalog on a complete line of standard switching reactors for one-step, low-cost static control is now available. The switching reactor catalog contains tables of electrical characteristics and several typical application circuits, as well as complete descriptions of the units, their applications, and physical dimensions. Control, Div. of Magnetics, Inc., Butler, Pa.

**Insulated Wire and Cable**

A complete up-to-date catalog on insulated wire and cable is now available. Applications, specifications and temperature ratings are given. Plastoid Corp., Hamburg, N.J.

**Strain Gage Measurements**

A resistance bridge indicator and its applications are explained in a four-page technical brochure. The instrument can be calibrated to indicate in microinches of strain, psi, pounds, ft pounds, etc., etc.

**NEW SYNCHRONOUS TIMERS**

by Cutler-Hammer

- 1-minute timer adjustable in 1 second intervals—0 to 60 seconds.
- 3-minute timer adjustable in 3 second intervals—0 to 180 seconds.
- 5-minute timer adjustable in 5 second intervals—0 to 300 seconds.
- No guesswork... exact time intervals set by positioning bronze pointer.
- Sweep-second pointer provides visual count-down during timing operation.
- Automatic reset returns pointer to start position after each cycle.
- Models interchangeable without disturbing mounting base or wiring.
- Rugged timing mechanism guarantees accurate, trouble-free performance.

For complete information, write today for descriptive bulletin 1033B.

**NEW ELECTRODES**

NE-2E LONG ELECTRODES SMALLER BULB

Three diameter enlargement

**NEW "SNUB-NOSE" DESIGN PERMITS LONG ELECTRODES IN SMALLER BULBS FOR BETTER PERFORMANCE**

The new General Electric NE-2E is as small in length as the NE-2B—yet has electrodes fully as long as those in the larger NE-2. The exclusive molded tip permits use where space is restricted—performs better and provides better indicator viewing—especially end-on.

Only glow lamps offer small size, low wattage, long life, wide voltage tolerances, rugged construction. And they don’t fail suddenly—so there’s almost no chance of false indications.

Any G-E Glow Lamp can be used in many ways. A single lamp may serve as a relaxation oscillator, a leakage indicator, a switch, a voltage regulator, or a voltage indicator. Send for the folder, "G-E Glow Lamps As Circuit Control Components". Write: General Electric Co., Miniature Lamp Dept. ED-58, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

**GENERAL ELECTRIC**

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ELECTRONIC DESIGN • June 11, 1958
and commercial application of these products. Freed Transformer Co., Inc., 1727 Weirfield St., Brooklyn, N.Y.

Accelerometer Calibration 288

Methods and accuracies of crystal accelerometer calibration are featured in a 25-page manual. Frequency response, linearity with temperature, mounting methods, and many other topics are covered. The “Accelerometer Manual” is illustrated with graphs and photographs. Endevco Corp., 161 E. California St., Pasadena, Calif.

Grid Construction 289

“Framelok Grid” describes design and performance advantages of this electron tube construction technique. The 12-page brochure lists structural features of the grid design and points up their effect on other tube elements. Featuring an introduction on the evolution of “Framelok,” the booklet contains an actual grid sample. Sylvania Electric Products, Inc., 1100 Main St., Buffalo, N.Y.

Douglas Aircraft Co. uses Phaostron RUGGEDIZED Panel Meters
NEW LITERATURE

Electronic Parts

Components and equipment for the electronic industries are presented in a catalog of 108 pages. Complete lines are covered with details and prices. Blowers, motors, synchros, capacitors, resistors, and controls are some of the items the catalog contains. Persons requesting a copy should write on company letterhead and give their title. Requests should be sent to Electro Sales Co., Inc., 50-58 Eastern Ave., Boston 13, Mass.

Silicon Diodes

A 24-page brochure describing microwave silicon diodes has been issued. The catalog includes up-to-date technical data and receiver design information for low noise mixer and video diodes for applications in the 300 mc to 70,000 mc frequency range. A recently developed diode for test equipment applications is also described. Performance curves, nomographs, outline drawings, and photographic illustrations are given. Microwave Assoc., Inc., Burlington, Mass.

Fasteners

Detailed specifications, engineering drawings, applications, and installation information are provided in a 30-page catalog. Data as well as complete details on special fasteners is given. Simmons Fasteners Corp., North Broadway, Albany 1, N.Y.

Meter Mountings

Bulletin 601 features a low-cost bonded rubber meter mounting for protecting sensitive instruments against shock and vibration. The 4-page text outlines the design features and performance of the mountings, and installation photographs show typical applications. Complete meter mounting specifications include an application cross-reference table listing meters from various manufacturers. Lord Mfg. Co., Erie, Pa.

Armature Winder

A high speed small armature winder with a self-resetting automatic counter is introduced in a catalog page. Details are...
Disc Capacitors

Bulletin C-81 is a 6-page folder about ceramic disc capacitors. It covers types for general use, temperature compensating, and deflection yoke applications. Also listed with specifications are high voltage types in standard and printed circuit styles. The folder is illustrated with dimensional drawings and temperature characteristics curves. The Gude-man Co. of California, Inc., Dilectron Div., 2669 S. Myrtle Ave., Monrovia, Calif.

Plastics

Fabricators and suppliers of a complete line of plastic sheets, rods, and tubes have now issued a 52-page plastics catalog and price list. Among the wide range of products covered in the catalog are Plexiglas, vinyl, acetate, phenolics, polystyrene, Nylon, Kel-F, and Lucite in all commercial forms. Prices, sizes, and other specifications are listed. Also included in the catalog is a complete table of properties of plastic materials. Almac Plastics, Inc., 600 Broadway, New York 12, N.Y.
NEW LITERATURE

**Summing Amplifier**

A bulletin which lists several applications of a magnetic summing amplifier together with the basic circuit for each is available. Performance data, electrical, mechanical, and environmental specifications are also given. The amplifier is designed for missile guidance, analog controls, telemetering, null balance detectors, and similar uses. The unit is completely self-contained, plug-in magnetic amplifier and power supply weighing less than nine ounces. Aeromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich.

**Radar Reflectors**

According to an eight page bulletin "Radar Reflectors of Sandwich Design", tracking and scanning radar reflectors can be designed and fabricated of lightweight sandwich materials at a fraction of the cost of conventional tubular truss structures. The bulletin gives construction, installation, and operation of the reflector. Narmco Mfg. Co., 5159 Baltimore Dr., La Mesa, Calif.

**Relays**

A 20-page booklet catalogs all types of relays. It contains complete engineering specifications, operational data, and detailed drawings for all major subcategories and microminiature types. Tilton, Inc., Port Washington, N.Y.

**Epoxy Encapsulation**

Bulletin G6 describes in four illustrate pages a low-temperature melting (280°F) bismuth-tin alloy for making extremely accurate and inexpensive dip or vacuum cast molds for encapsulating electronic components with epoxy resins. Cerro Pasco Sales Corp., 300 Park Ave., New York 2, N.Y.

**Capacitance Bridge**

The Model 74-C Capacitance Bridge is a self-contained, precision instrument designed for measuring either two or three terminal capacitance configurations. As a three terminal device it can measure the capacitance and conductance between any two conductors on a printed circuit board, disregarding capacitance to all other conductors. This feature, in conjunction with its high accuracy and resolution, provides an ideal means for analyzing printed wiring capacitance.

**SPECIFICATIONS**

- **CAPACITANCE RANGE:** .0002 to 11,000 mmf
- **CONDUCTANCE RANGE:** .01 to 1000 micromhos
- **ACCURACY:** ±0.25% to 0.01 mmf
- **TEST FREQUENCY:** 100 kilocycles
- **Price:** $395

Boonton ELECTRONICS Corp.
Morris Plains, N. J.  • Phone: JEFFERSON 9-4210

**ANALYZE PRINTED CIRCUIT WIRING CAPACITANCE**

Another of the Many Applications for the Model 74-C CAPACITANCE BRIDGE
Anechoic Chambers

Literature on a series of anechoic chambers has been announced. An 8-page brochure contains a description of electro-magnetic energy absorbers for vhf, uhf, and microwave frequencies. Details of construction and illustrations of various types of chamber installations designed to meet specific requirements of frequency range, shielding, and working conditions, are shown. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Transducers

A 16-page catalog, T-10, describes a company's two standard transducer designs; one open for bus bar use, and one enclosed for cable service. Both are available in nine sizes. Titled, "Control Standard Transducers," the catalog describes transducer capabilities and includes typical applications. It contains tables listing detailed electrical characteristics and outlining physical dimensions for each size in both models. Control, Div. of Magnetics, Inc., Butler, Pa.

Capacitors

This literature is a 17-page catalog, RC-100, showing complete specifications and engineering data on precision film capacitors in Mylar, Polystyrene, polycarbonate, and metallized Mylar. It includes tubular, Mylar wrap, bathtub, adjustable, decade, and special configurations. Con- fessor Research Corp., Seymour, Ind.
NEW LITERATURE

Crystal Filter 319

Characteristics of a company's high frequency crystal filter, both in the steady state and under transient conditions, are summarized in this 6-page illustrated memorandum. The pulse response and optimum point for sampling filter output with a pulse input are described. Hycon Eastern, Inc., 75 Cambridge Pkwy., Cambridge, Mass.

Inductive Devices 320

Catalog 102 lists 390 transformers, chokes, filters, and other inductive devices. The 28-page booklet illustrates each unit and offers descriptions and specifications. Hermetic Seal Transformer Co., 555 N. 5th St., Garland, Tex.

Counters 321

A diversity of counters is described in a 20-page extract of Catalog 57. Dimensions, specifications, ordering directions, and photographs are presented for each model. Covered are electromagnetic, printing, predetermining, measuring, small stroke, and revolution counters. Presin Co., 12128 W. Pico Blvd., Los Angeles 64, Calif.

Fan Motors

This 12-page bulletin contains design, dimension, rating, performance, and application data on shaded pole motors for a number of applications. The two-color bulletin includes information on the "slim" motor that is thirty-three percent lighter in weight than previous models. General Electric Co., Schenectady, N.Y.

Glass-to-Metal Seals 323

A brochure has been issued to introduce a line of glass-to-metal seals included are many precision-made compression and Kovar designs. The brochure also depicts and describes facilities for production, quality control, inspection, and environmental and qualification testing. Networks Electronic Corp., 1480 Oxnard St., Van Nuys, Calif.
Printed Circuitry
A 6-page brochure discusses printed circuits. It gives data on materials, specifications, design tolerances, and applications. It also discusses a patented process for plating holes and equipment which can produce prototype circuits in minutes. The brochure is illustrated with photographs. Printed Electronics Corp., 17 North St., Natick, Mass.

Waveguide Windows
This brochure describes waveguide pressure windows and their uses. Performance curves, outline dimensions, and drawings, and complete electrical and mechanical data are given for each window type. Helpful installation instructions are also included. Microwave Associates, Inc., Burlington, Mass.

Infrared Analyzers
This 6-page brochure describes Model 15-A Infrared Analyzer for continuous laboratory and pilot plant analysis, and Model 21 Infrared Analyzer for continuous process stream analysis. Included in this bulletin, IR-4005, are specifications, features, operating principles, applications, accessories, and applications engineering. Illustrations include both instruments and accessories, as well as instrument mounting dimensions. Beckman/Process Instruments Div., Fullerton, Calif.

Hermetic Terminals
Technical Data Sheet EC-1225 features a line of metallized ceramic hermetic terminals which withstand temperatures of 260 C. The sheet lists types and sizes along with specifications. Thermo Materials, Inc., 4040 Campbell Ave., Menlo Park, Calif.

Production Controls
Bulletin GET-2676, 14 pages, describes the functions of numerical position control, giving a detailed breakdown of the three major elements: data input; director; and servo drive. Accumulated data from particular applications on a variety of machines using this type of control are provided. General Electric Co., Schenectady 5, N.Y.

marconi
Get-2676
FM Telemetering equipment is quickly and accurately checked with the unique instruments described below. All are immediately available against DX Priorities.

FM Deviation Meter model 928/2
Freq. Range: 215 to 260 Mc, directly calibrated.
Modulation Freqs: 50 cps to 120 kc.
Deviation Ranges: 0 to 100, 200 and 400 kc, or to order.
Accuracy of Measurement: 2%.
Built-in crystal standardization, aural and visual monitoring, counter type discriminator. Instrument is ruggedized and waterproof.

FM Deviation Meter model 928.
similar to 928/2, covers 20 to 500 Mc.

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Freq. Range: 10 to 470 Mc in 5 bands.
FM, continuously variable:
0 to 100 kc. Higher to order.
1% Frequency: 1 to 200 kc, calibrated.
Stability: 0.025% per 10 min.

Amplitude Modulator model 1102 For use with any Sig Gen, gives monitored AM, 0 to 80% with zero FM. Handles any wave shape.

Endstone FM/AM Receivers,
models 770 R, 770 U
Model 770U covers 150 to 500 Mc, 770R covers 19 to 165 Mc. Both are sensitive, stable, directly calibrated and have excellent logging scales.

As supplied to: US Signal Corp., Wright Patterson AFB, Navy Electronics Lab, AEC, Convair, Martin, Douglas, McDonnell, GM, Chrysler, etc, etc.

Gries Reproducer Corp.
40 Second St., New Rochelle, N. Y. • New Rochelle 3-8600
CIRCLE 330 ON READER-SERVICE CARD
NEW LITERATURE

Templates
Catalog No. 60 carries photographs and a description of a line of 91 templates. The catalog index lists templates by number and category. The catalog is divided into seven sections: electrical; ellipses; mechanical engineering; general; architectural; processing; and miscellaneous specialized. A price list is also given. RapiDesign, Inc., P.O. Box 429, Burbank, Calif.

Ballizing Process
The ballizing process, forcing a ball through a part for hole sizing and/or finishing, is explained in detail in this 16-page combination technical bulletin and catalog. Typical applications are described, and tables are included giving performance, production, and cost saving data. A complete line of ballizing equipment is shown in actual use, ranging from a service and repair tool to a semi-automated operation. Industrial Tectonics, Inc., 3686 Jackson Rd., Ann Arbor, Mich.

Optical Comparators Movie
A 31-minute movie about the operation of optical inspection and measuring machines may be booked free. The 16-mm sound and color film shows how the machines are used in electronics and other fields. Arrange bookings direct with Jones & Lamson Machine Co., Advertising Dept., Springfield, Vt.

Ceramics
"Thermal Properties of Ceramics," Engineering Research Bulletin No. 40 is a report on the findings in some phases of research in ceramic dielectrics which has been carried out by a research station over the past 12 years. The subject matter of the bulletin is divided into five sections: Melting and Safe Operating Temperatures of Ceramic Materials; Thermal Conductivity of Ceramics; Thermal Expansion of Ceramics; Thermal Endurance of Dense Ceramics; and Thermal Conditioning. Each section has its own bibliography. Included also in the publication are 17 illustrations and 8 tables. "Thermal Properties of Ceramics" is available from the Bureau of

Machlett ML-C19K Scriptron®
Character Writing Display Tube
Machlett Laboratories, Inc. announces the availability of the ML-C19K Scriptron, a 19" beam forming display tube for alphanumeric situation display. The Scriptron is designed for applications requiring maximum writing speed—up to 20,000 characters or symbols per second—(over five times faster than functionally similar mechanical devices currently available) and high speed readout.

The ML-C19K Scriptron converts coded information into situation display and is especially useful in applications where simultaneous identification of radar targets together with an indication of normal plan position is required.

Current applications include—Aircraft Surveillance (target position and identification)

Computer readout
Situation display of air or surface targets.
Maximum Voltages
Anode
First Second Screen

Pertinent technical data follows:

Dia. Defl. method Storage Phosphor
Scriptron
C19K 19" magnetic no (any) 1,300 3,600 15,000
usually P11,
P14

For full technical information on this or any other Machlett tube type, write:
Machlett Laboratories, Inc., 1063 Hope Street, Springdale, Connecticut

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CIRCLE 326 ON READER-SERVICE CARD
Pushbutton Switches

This 8-page data sheet describes a modular-mount series of lighted pushbuttons-switches that can bring new simplicity and efficiency to control panels. Data Sheet 143 gives complete information, photos of typical applications, and dimension drawings of the new series. Pushbutton colors and types are detailed. Electrical characteristics and prices are also covered. Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Infrared Optics

TDS-4, an 8-page booklet, describes arsenic trisulfide glass for use in infrared instruments. The text covers the optical, chemical, physical, and thermal properties of the glass and describes available coatings. It also lists optical flats and single element and achromat lenses carried in stock. Drawings and photographs provide illustration. Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, N.Y.

Measuring Units

A 32-page catalog describes a line of more than 40 accelerometers; high-temperature strain gages, and associated equipment. A series of engineering drawings, tables and graphs are employed to specify sensitivities, natural frequencies, acceleration, and temperature ranges for the accelerometers. Also given are gage factors, resistances, drift rates, temperature ranges, and card sizes of the strain gages. Columbia Research Labs., MacDade Blvd. and Bullens Lane, Woodlyn, Pa.

unprecedented...

TRUE RMS VTVM

with 1/4% accuracy

Exclusive from Trio Labs—laboratory precision measurement of complex waves with VTVM versatility... New Model 120-1 overcomes the errors of spikes and harmonics in peak responding and average-reading meters (5% harmonics can effect errors as high as 1.7%) and of phase of harmonic shift in both types. Deflection is directly proportional to square of current through dynamometer meter movement—hence true RMS direct-readings.


Write for FREE "how-to" ENGINEERING GUIDE on Trio Labs complete line to Dept. ED-4, Trio Laboratories, Inc., Seaford, N.Y.

THE SINGLE SOURCE FOR ALL MISSILE CABLE SYSTEMS

Available now—RFC-303
Custom Electronic Cable Specifications

Robertshaw-Fulton CONTROLS COMPANY
SANTA ANA FREEWAY AT EUCLID AVENUE • ANAHEIM, CALIFORNIA
CIRCLE 341 ON READER-SERVICE CARD
with Chassis-Trak slides
WEIGHT is no problem...

The slides above are only .250" thin and weigh only 9 lbs., yet they are supporting a man weighing over 200 lbs. This is a graphic illustration of rigid support at the full open position.

And, Chassis-Trak slides give smooth slide action! They are produced from cold rolled steel. The permanent-dry, dust-repellent finish is a special 400° "baked on" epoxy phenol formulation that eliminates maintenance... the longer you use Chassis-Trak slides, the smoother they operate.

A new design feature on Chassis-Trak slides increases the bearing area by almost 113% over previous models. This makes the slide even stronger, and is especially important on military or aircraft equipment, where extreme vibration or shock conditions exist.

Chassis-Trak slides are available in nine lengths, designed to support from 175 lbs. to 275 lbs. in either the "basic" model (pictured above), which tilts freely upward, or the "detent" model, which tilts and locks in seven different positions... and they are available from stock now!

Before making a slide selection, investigate the extra-strong, pencil thin slide that is built for standard racks and cabinets... Chassis-Trak.

"Detent" model, locked in one of seven different positions.

For further information contact:

525 South Webster, Indianapolis 19, Indiana
CIRCLE 361 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication. Full information and an "entry blank" can be obtained by circling #278 on the Reader's Service Card.

Saving Tantalum Capacitors

Tantalum capacitors, frequently used in transistorized circuits, often cost more than the transistors themselves, and often take more space. It's worthwhile to use a few extra components to reduce the size of these capacitors and protect them against failure.

In many circuits, a tantalum capacitor is used as an emitter bypass. A common way to temperature stabilize a grounded emitter stage against $I_{ce}$ variations is to use a resistance in the emitter circuit, about the same size as the resistance in the base circuit.

If the emitter resistor is grounded, as in Fig. 1, the voltage across it and its bypass capacitor is quite high. Capacity required, in the audio range, sometimes exceed 100 µf, so the bypass capacitor must be quite large.

Sometimes the emitter resistor is returned to a bias voltage. Then the emitter to ground voltage can be quite small, so, in theory at least, the capacitor voltage rating can be small, too. The capacitor is polarized as shown in Fig. 2, while the emitter is held positive by biasing the base.

But if the transistor opens up, or is removed from its socket with voltage on, the full bias voltage is applied to the capacitor. Here, also, conservative design calls for a high voltage capacitor.

Furthermore, at high temperatures, the emitter stabilization circuit causes the emitter to become more negative. So, unless lots of bias is used on the base, a reverse voltage of a few volts may be applied to the capacitor, possibly causing failure.

The New Scheme

A diode is connected across the capacitor, in such a direction as to be normally nonconducting. With pnp transistors, the base bias is adjusted a few tenths of a volt negative with respect to ground. The cathode of the diode and the positive terminal of the capacitor are grounded as shown in Fig. 3.

If the transistor opens, or is removed from the circuit, the diode limits the positive voltage across the capacitor to a fraction of a volt. This is not harmful to most tantalum capacitors since they can stand a small reverse voltage. Some are actually formed with an auxiliary film, good for a few reverse volts.

Notice in Fig. 3, that when $I_{ce}$ causes the emitter to become more negative, the voltage is applied to the capacitor in the forward direction. This effect may determine the capacitor voltage rating.

Stabilizing for AC

If ac degeneration is required, and the emitter resistance should be smaller than that required for dc stabilization, it is common practice to tap the emitter bypass capacitor down on the emitter resistance as shown in Fig. 4. Unfortunately, this requires much more negative bias on the transistor base, if the capacitor voltage is always to be negative.

If the additional bias is undesirable, the circuit of Fig. 5 can be used. This requires no additional bias.

**DELCO'S FAMILY OF HIGH POWER TRANSISTORS**

Typical Characteristics at 25°C

<table>
<thead>
<tr>
<th>Transistor</th>
<th>DT100</th>
<th>DT80</th>
<th>2N174A</th>
<th>2N174</th>
<th>2N173</th>
<th>2N443</th>
<th>2N278</th>
<th>2N442</th>
<th>2N277</th>
<th>2N441</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Collector Current</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
<td>13 amp</td>
</tr>
<tr>
<td>Maximum Collector Voltage (Emitter Open)</td>
<td>100 volts</td>
<td>80 volts</td>
<td>80 volts</td>
<td>60 volts</td>
<td>60 volts</td>
<td>50 volts</td>
<td>50 volts</td>
<td>40 volts</td>
<td>40 volts</td>
<td>40 volts</td>
</tr>
<tr>
<td>Saturation Resistance (13 amp.)</td>
<td>0.02 ohm</td>
<td>0.02 ohm</td>
<td>0.02 ohm</td>
<td>0.02 ohm</td>
<td>0.02 ohm</td>
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<td>0.02 ohm</td>
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<tr>
<td>Max. Square Wave Power Output at 400-μP-P*</td>
<td>400 watts</td>
<td>310 watts</td>
<td>310 watts</td>
<td>225 watts</td>
<td>225 watts</td>
<td>180 watts</td>
<td>180 watts</td>
<td>135 watts</td>
<td>135 watts</td>
<td>135 watts</td>
</tr>
<tr>
<td>Max. Sine Wave Power Output at 400-μP-P*</td>
<td>180 watts</td>
<td>140 watts</td>
<td>140 watts</td>
<td>100 watts</td>
<td>100 watts</td>
<td>80 watts</td>
<td>80 watts</td>
<td>60 watts</td>
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<td>60 watts</td>
</tr>
<tr>
<td>Power Dissipation (Stud Temperature 25°C)</td>
<td>70 watts</td>
<td>70 watts</td>
<td>70 watts</td>
<td>55 watts</td>
<td>55 watts</td>
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<td>55 watts</td>
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<td>55 watts</td>
<td>55 watts</td>
</tr>
<tr>
<td>Thermal Gradient from Junction to Mounting Base</td>
<td>1.0°C/watt</td>
<td>1.0°C/watt</td>
<td>1.0°C/watt</td>
<td>1.0°C/watt</td>
<td>1.2°C/watt</td>
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<td>1.2°C/watt</td>
<td>1.2°C/watt</td>
<td>1.2°C/watt</td>
</tr>
<tr>
<td>Nominal Base Current</td>
<td>19 mA (Vcc = -2 volts, IC = -1.2 amp.)</td>
<td>-13 mA</td>
<td>-19 mA</td>
<td>-19 mA</td>
<td>-13 mA</td>
<td>-24 mA</td>
<td>-13 mA</td>
<td>-24 mA</td>
<td>-13 mA</td>
<td>-27 mA</td>
</tr>
</tbody>
</table>

*Designed to meet MIL-T-19550/13 (USAF) 18 JUNE 1957

**Performance characteristics to meet your switching, regulation or power supply requirements**

These ten Delco Radio alloy junction germanium PNP power transistors are now in volume production. They are characterized by high output power, high gain, and low distortion. And all are normalized to retain superior performance characteristics regardless of age.

Check the data chart above—see how they fit your particular requirements in current switching, regulation or power supply. Write for detailed information and engineering data. Delco Radio maintains offices in Newark, N. J. and Santa Monica, Calif. for your convenience.

**DELCO RADIO**
Division of General Motors
Kokomo, Indiana

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**Ideas for Design**

![Circuit Diagram]

**Transistor Priority System**

Fig. 1 shows the circuit of a microphone. The unit has a pushbutton to activate the microphone. The "push-to-talk" button completes a circuit to the microphone element and closes a control circuit to activate other equipment, such as transmitters or audio amplifiers.

Where more than one microphone is used, it is convenient to establish a priority system so that one microphone has precedence over others. The second microphone has precedence over the third and so on.

This has been done, in the past, with multi-contact relays, connected so each microphone has the proper priority.

The disadvantages are that the relays use a large number of contacts, they're heavy, and they waste power and space.

The transistor priority system overcomes these disadvantages to a high degree.

Referring to Fig. 2, assume 20 v is applied as shown. Voltage divider \( R_7 \) and \( R_{11} \) places a somewhat lower voltage (say 18 v) on the three emitters which are connected in parallel. When no microphone control circuit is activated the base voltage of all three transistors will be about 20 v. This is a reverse bias so the transistors are completely deactivated. If a signal exists at any of the inputs it is not transferred through the system.

When the control of microphone number 3 establishes a circuit through to ground, the voltage divider \( R_7 \) and \( R_8 \) establishes a voltage at the base of \( Q_1 \) such that \( Q_1 \) becomes active. Consequently, any audio voltage present at the input to \( Q_1 \) is transferred to the output. Thus \( Q_1 \) is connected in a common collector or, as sometimes called, an emitter follower circuit.

\( R_7 \) is the load resistor. The signal coupled through \( C_1 \) drives the base, and resistor \( R_8 \) isolates the input audio from the divider system \( R_1 \) and \( R_2 \).

The bases of \( Q_2 \) and \( Q_3 \) are still at very nearly 20 v and therefore are reverse biased and cannot contribute to the output.
Fig. 2. Transistor priority system. Microphone #1 has priority over microphone #2 which has priority over microphone #3.

Now, if the push button of number 1 microphone is depressed, control circuit number 1 is completed to ground, and a voltage is established at the base of Q3 by voltage divider R5 and R6.

The divider R5-R6 is so arranged that it produces a voltage at the base of Q3 which is considerable less than that at the base of Q1. The emitters will come to the potential dictated by the base of Q3 and, consequently, the base of Q1 will be reverse biased regardless of whether control number 3 is on or not activated.

Furthermore, any audio present at the input from microphone number 1 will be transferred through the system to the output. Audio from microphone number 3 cannot get through the system, because transistor Q1 is reverse biased.

The dividers associated with number 1, 2, and 3 controls are arranged so that the derived voltages go down in "staircase fashion," being highest at number 3 and lowest at number 1. This establishes a priority system such that number 1 has priority over numbers 2 and 3 while number 2 has priority over number 3.

In a practical model which has been built and tested, the isolation achieved between desired and undesired inputs is about 80 db. The voltage gain of the system is approximately "one," while its power gain is about 17 db.

This circuit is used in Bendix Radio's Passenger Address Amplifier, AMA-10A.


Steel Wool Finds Bad Joints

Newly designed microwave plumbing is often plagued with rf leakage from loose joints. Rf probes often cannot pinpoint the leakage source, since the rf leaks all over the plumbing. Even wrapping the joints with aluminum foil doesn't suppress enough leakage to allow the source to be pinpointed.
IDEAS FOR DESIGN

But ordinary household steel wool, packed around the suspected joints, can almost completely suppress the leaks. Then, by a process of elimination, faulty joints can be quickly located and corrected.

Robert Marie, Project Engineer, Perfect Circle Corp., Hagerstown, Ind.

Fig. 1. Conventional VR tube won't work if load is too heavy.

Silicon Diode Helps Gas Diode Get To Work

Conventional gas diode regulator circuits, like the one in Fig. 1, often don't regulate when a heavy load is permanently tied at the output, $E_o$. As the drive voltage comes up, the load draws too much current, so too much voltage drops across the series resistor, $R_1$, rather than across the gas tube. The gas tube can't fire because it never gets enough starting voltage.

The addition of a silicon diode and a resistor, as in Fig. 2, solves the problem neatly. Since the gas diode is initially off, any negative drive voltage is applied through the 200 K ohm resistor to the negative drive voltage (high ripple)

Fig. 2. This scheme assures enough starting voltage for the gas tube.
Simple Network Reduces Power Supply "Down Time"

Large capacitive loads switched onto regulated power supplies will blow out protective fuses, causing expensive "off" time.

A foolproof, automatic, and inexpensive protective system can be incorporated in electronically regulated power supplies by the addition of a resistor, a capacitor, and a diode. The diode can be either a vacuum or semiconductor device, with a high peak transient current rating.

If switching on is done by switch S1, the RC combination prevents the grid voltage of the series regulators, and hence the output voltage, from rising rapidly. If switching is done by S2, the output of the regulator is momentarily "shorted" by the capacitive load. The output voltage must drop, causing diode D1 to conduct, thereby partially discharging capacitor C.

After this initial transient, the grid voltage of the series regulator tube again cannot rise faster than the RC time constant permits, since diode D1 is now reverse-biased.

Resistor R is made sufficiently small so that diode D1 is normally conducting. A small neon lamp (NE-2) can also be used instead of a regular vacuum or semiconductor diode.

These modifications permitted the use of regular fuses in a 285 v, 1 amp regulated supply which would blow out "slow-blow" fuses when subjected to sudden heavy capacitive loads of over 200 μF.

Sergio Bernstein-Bercovy, 205 S. Broadway, Tarrytown, N.Y.

Modified electronically regulated power supply to prevent fuse blow outs due to large capacitive loads.
IDEAS FOR DESIGN

Transistorized Electronic Filter

Most transistorized equipment requires a low voltage, high current power source. In many airborne applications, power comes from a 28-volt primary power system. Since this primary power source is connected to other equipment, the voltage is subject to fluctuations and noise.

When a transistorized circuit is connected to this primary voltage source, there is a tendency for the line noise to feed through the circuit and appear in the output as a spurious response. Usually, the practice has been to reduce spurious voltages with filters in series with the primary source of power. These filters are large, heavy, and costly, since they use high-current inductors and large capacitors.

The filter described here is entirely electronic, and uses only 2 transistors, 2 capacitors, and 3 resistors. It permits savings in size, weight and cost.

Referring to the figure, the current from the power source passes through the 2N235A transistor and is delivered at the output terminal. The output current, however, is subject to control of the 2N235A base, which, in turn, derives its voltage from the remainder of the circuit to produce the filtering action.

Assume that the output voltage starts to rise. The instant this occurs, the emitter of the 2N43 senses the minute change in voltage. Its base potential cannot change instantly because of the 50 mf capacitor. Therefore, the 2N43 acts as a common base amplifier. The small rise in emitter voltage, greatly amplified, is impressed across the 1.8 K load resistor in the collector circuit. This amplified voltage is coupled through the 5
Miniature plug-in Relay for printed circuits

...millions of operations without attention!

Need a dependable relay for direct insertion into printed circuits? Automatic Electric's new Printed-Circuit Relays run up to 120 million operations without a single readjustment or relubrication!

Miniaturized without sacrifice of ruggedness, these SQPC Relays, with reinforced mounting, deliver reliable performance under extreme conditions—dependable contact operation at up to 10.5 G's, 25 G's shock, and temperatures from -55° to +85°C.

SQPC Miniature Printed-Circuit Relays are available with many different contact spring arrangements—can be permanently secured with any acceptable soldering technique.

First Choice*
of design engineers...

Photo 4 times life-size

*According to the latest independent surveys.

HAMMARLUND

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Judge for yourself! Send your name and address on your company letterhead and we will send you a sample Hammarlund Variable Capacitor.† Look at the construction. Test it electrically. Test it mechanically. Inspect the centerless ground shaft. Check the materials and the workmanship. Submit it to every test, and you too, will see why Hammarlund Capacitors are the No. 1 choice among design engineers . . .

†Sample will be available, standard catalog number, representative of Hammarlund quality.

Write for complete catalog on Hammarlund Variable Capacitors . . .

HAMMARLUND MANUFACTURING COMPANY, Inc.
460 West 34th Street, New York 1, N. Y.
CIRCLE 382 ON READER-SERVICE CARD
Magnetic Amplifiers for Feedback Control

This consists of Chapter IV, Experimental investigation of the self-saturating ac output circuit, including: (1) circuit components; (2) dynamic behavior of the B-H loop; (3) steady-state transfer characteristics compared to "exact" analysis; and (4) to approximate linear analysis; Chapter V, Transfer function of the n-winding magnetic amplifier, includes: (1) derivation of the transfer function of the self-saturating (ac output) magnetic amplifier; and (2) self-saturating (ac output) magnetic-amplifier with n control windings. Dynamic Operation of Magnetic Amplifiers for Feedback Control Systems. Scientific report No. 2 for period June 1-August 31, 1956 under Contract AF 19(604)-1813, Henry C. Bourne, Jr., Takashi T. Kadota and David Nitzen, California University, Div. Electrical Engineering, Electronics Research Laboratory, Berkeley, Calif., August, 1956, 48 pp., microfilm $3.30. Order PB 125984 from Library of Congress, Washington 25, D.C.

Feedback System Testing

An analog method of servo system performance testing applicable to experimental analysis and system development and to go-go production and maintenance testing has been devised. The analog method described, as distinguished from transient and sinusoidal methods, uses time-domain signals (a step-function signal generator input is found suitable) to obtain frequency-domain parameters in a method effectively making an open-loop test of a closed-loop servo system. The 1-μ signal generator is conveniently realized using an analog computer of the operational amplifier type. An alternative mechanization of the signal generator uses only passive elements. Nonlinear as well as linear servo systems may be tested by the method. Single-integrator, angle tracking, and range-tracking servo systems, have been analyzed. The range-tracking transfer function was employed in an analog computer experiment. A study of these recordings revealed potentials for control of adaptive servo systems. Feedback System Testing, Charles F. White, U.S. Naval Research Lab. Nov., 1957, 31 pp, $1.00. Order PB 131345 from OTS, Dept. of Commerce, Washington 25, D.C.

Magnetic Modulators For Radar

The basic theory of the cascaded magnetic-modulator circuit is extended to include the effects of copper and core losses, and a magnetic pulse-shaping technique is described. Experimen-
Radar Receiver Shock Excitation

Electrical shock excitation of the input circuits of the intermediate-frequency amplifier of a radar system is discussed. The deleterious effects of shock from the trailing edge of a high-amplitude pulse is shown to be related to the frequency at which the amplifier input circuit is resonant. The pulse fall time is shown to be an important factor in the choice of an intermediate frequency. Although the report is written with reference to a marine navigational radar having high definition at short range, it may be of value in the design of other radar systems where shock effects following a high-amplitude pulse cannot be tolerated.


Digital Pulse-Width Modulation

The results of a search for more efficient means of telemetering quantitative data are presented here. This work was undertaken to explore the possibilities of a technique for transmitting continuous data that would enable efficiencies analogous to the saving of recording space achieved with "unitary" and "incremental" notations for continuous data. It has resulted in the formulation of a digital pulse-width technique of modulating telemetering carriers which is applicable to transmissions of alphabetical text messages as well as all kinds of quantitative data. The theory underlying these investigations, the experiments performed to determine the effects of transmission characteristics, and an analysis of possible applications to various kinds of meteorological data are presented in that order. Digital Pulse-Width Modulation, John C. Bellamy, S. Clifford Henjum, Robert F. Bosshart, and Eugene A. Reich, Cook Electric Co., Cook Research Labs., Chicago, Ill. Sept., 1956, 50 pp., microfilm $3.60, photocopy $9.30. Order PB 124694 from Library of Congress, Washington 25, D.C.
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Microwave Broadband Amplification

The research work carried out under the auspices of this contract was concentrated on three major areas: (1) thermodynamics of the pure electron gas, (2) analysis of uhf-modulated electron beams; and (3) general problems connected with the production of sub-millimeter waves. General Problems of Broadband Amplification in The Microwave Frequency Range, H.M. von Foerster, Engineering Experiment Station, Electrical Engineering Research Lab., Electron Tube Research Section, Urbana, Ill. March, 1955, 9 pp, microfilm $1.80, photocopy $1.80. Order PB 125574 from Library of Congress, Washington 25, D.C.

High Sensitivity Multiplier Phototube

The multiplier phototube described here has cathode sensitivity over 100 ma/l primarily in the blue similar to S-11, stable output over four hours of continuous operation, rugged antivibration construction, moderate gain, low dark current, high collection efficiency, and uniformity over large areas of the cathode. The tube is particularly well suited for detection of a weak signal against a high background. Many of the individual features and the combination of characteristics are new in a production-type multiplier phototube. Summarizes research from July 1, 1955-Jan 31, 1957. Development of a High Sensitivity Multiplier Phototube, D.A. Bly, Radio Corporation of America, Tube Div., Lancaster, Pa. Oct., 1957, 33 pp. $1.00. Order PB 131561 from OTS, U.S. Department of Commerce, Washington 25, D.C.
Nonmetallic Ferromagnetic Materials

The work presented in this report describes the effort expended in the various areas of ferrite development covered by the subject contract. These areas include the development of ferrite materials for high power applications, low signal applications, and dynamic magnetostrictive applications for operation in the temperature range 265 to −250 °C, and at a high frequency, narrow and (30 mc) modulated delay line. Nonmetallic Ferromagnetic Materials and Devices, John M. Blank, Robert W. Johnston, Harold W. Katz, Gerald G. Palmer, and Nathan Schwartz, General Electric Co., Defense Electronics Div., Syracuse, N.Y., Oct., 1957, 143 pp, $3.75. Order PB 131559 from OTS, U.S. Department of Commerce, Washington 25, D.C.

Russian-English Aeronautical Glossary


Upper-Atmosphere Research

In 1946 the Naval Research Laboratory initiated a program of basic research in the physics of the upper atmosphere by means of high-altitude sounding rockets. Since that time the Laboratory has instrumented and flown 104 rockets carrying upper-air research experiments. This effort has resulted in the publication of approximately 300 scientific papers in the open literature and in a number of notable initial measurements of high-altitude physical parameters. On the practical side, there have been a number of applications which have developed as a result of this upper-air rocket-research program. Since the program is on a continuing basis, it can be expected that further scientific results will be forthcoming, not only from future rocket flights but from data past firings which have been analyzed in the light of current data. Upper-Atmosphere Research Report No. XXXII: History of the Upper-Air Rocket-Research Program at the Naval Research Lab., 1946-1957, J. W. Townsend, Jr., H. Friedman, and R. Tousey. U.S. Naval Research Lab. Feb. 1958, 52 pp, photos, graphs, $1.50. Order PB 131521 from Office of Technical Service, U.S. Department of Commerce, Washington 25, D.C.

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Ammeter, 3 amperes to 10−11 amp full scale,
Ohmmeter, 10 ohms to 104 ohms full scale,
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Pulse Counting Circuit

Patent No. 2,822,471. Howard L. Foote. (Assigned to General Dynamics Corp.)

The invention comprises a scale-of-two pulse dividing circuit using two-element gaseous discharge devices in cascade. The simple circuit should provide exceptional stability. Each of the gaseous discharge devices, 11 thorough 14, shown in the diagram, may be a neon lamp such as a NE-96 which has a minimum specified firing voltage of about 135 v and sustains conductive discharge at about 70 v.

The pulse counter as a scale-of-two pulse divider operates in the following manner: Initially all neon lamps are extinguished. A positive pulse applied to the INPUT added to the supply voltage fires lamp 11. Lamp 12 will also conduct. A positive pulse will be delivered through condenser 26 firing lamps 13 and 14. At the end of the input pulse lamps 11 and 13 will be conducting at about 70 v. Lamps 12 and 14 will become extinguished since resistor 15, lamp 12, and discharge resistor 24 are selected such that lamp 12 is non-conducting. It will fire only for the interval that the voltage across lamp 11 raised by an input pulse initially fires lamp 11. A second positive going pulse to be counted applied to the INPUT will not affect lamp 11 which is conducting but will charge condenser 23. At the end of the second pulse, condenser 23 discharges through resistors 21 and 15 and the additional drop across resistor 15 lowers the voltage across lamp 11 below 70 v and lamp 11 is extinguished. Thereafter, a third positive going pulse causes lamps 11.

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The apparatus permits the magnitudes and phase angles of both positive and negative impedances to be measured accurately without using active elements.

The magnitude of the impedance $Z_e$ is measured by adjusting the standard decade resistor $R$ until the detector current for $i_2 = 0$ (switch B open) equals the detector current for $i_1 = 0$ (switch A open).

Phase angle is determined by measuring the difference in detector current as the polarity of secondary winding 18 is reversed from the position shown in the diagram. Switches A and B are kept in the closed position and resistor R is set to the magnitude of impedance $Z_e$. The difference between the two detector readings is, in effect, a return loss measurement of the unknown impedance $Z_e$ against a known resistance of equal magnitude which is a measure of the phase angle of the unknown impedance. To find the sense of the phase angle, a condenser is alternately connected across unknown impedance $Z_e$ and standard resistor R. The direction of the change of transmission is noted. An increase in transmission indicates a positive reactance.

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Especially engineered as high current switching devices for DC-DC converter circuits and DC-AC inverter circuits, these transistors are capable of switching up to 250 watts. Available in three current gain ranges for optimum matching, the transistors also have three voltage breakdown ratings to eliminate burn out. Easy to design into circuits, easy to mount, Bendix Power Switching Transistors come in the standard transistor "package". Some other common applications are: relay replacements, drivers for relays, magnetic clutches, solenoids, and other loads requiring high current.

For a wide choice in performance and price to meet your transistor needs exactly, select Bendix Power Switching Transistors. Write for further information to SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

<table>
<thead>
<tr>
<th>Current Gain At 3 Adc</th>
<th>Collector-to-Emitter Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-30</td>
<td>2N639 2N639A 2N639B</td>
</tr>
<tr>
<td>20-40</td>
<td>2N638 2N638A 2N638B</td>
</tr>
<tr>
<td>30-60</td>
<td>2N637 2N637A 2N637B</td>
</tr>
</tbody>
</table>

West Coast Sales and Service:
117 E. Providence Ave., Burbank, Calif.
Canadian Affiliate: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ont.
Export Sales & Service: Bendix International, 305 E. 42nd St., New York 17, N. Y.

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**Output:** 800-2000 VDC, 0-25 Ma.  
**Regulation:** ±0.15% for line; ±0.15% for load, NL to FL.  
**Ripple:** Less than 25 mV.
Amplifying Apparatus


This multistage transistor a-c amplifier having less than unity d-c gain is temperature stable and relatively independent of individual transistor characteristics. As illustrated, the transistor stages are direct coupled and connected in parallel resistive networks across the power supply 53. The collector electrode of each transistor is directly coupled to the base electrode of the succeeding stage so that these electrodes are at the same voltage. The emitter electrode of each transistor is connected to power supply through resistor 14, which is larger than the resistor connecting the collector electrode to the opposite side of the power supply. The operating points of the transistors are chosen so that the amplifier is independent of power supply variations. The d-c gain may be made so low that differences between transistors which affect their operating characteristics are not amplified. The emitters operate at constant current and the collectors at constant voltage.

Under these conditions, with the amplifiers and junctions similar to that shown in Figure 12, the a-c gain of the amplifier is independent of the characteristics of the individual transistors.
...fer stages direct coupled, and change the zero-emitter collector current of the transistor stage will be cancelled in a collector circuit resistor of that stage a similar change in the zero-emitter collector current of the next stage. This prevents the cascading of the effects of such changes.

Although the amplifier is not a dc amplifier, it is very practical in a-c operation. A small signal applied to the input will by the emitter-base voltage of the first amplifier. This changes the base current that stage causing a large change in the collector current flowing through resistor R12. The emitter-base voltage of the first stage changes effecting a still larger increase in that transistor's collector current. The process of amplification is repeated in the succeeding stages.

Transistor Push-Pull Amplifier

Patent No. 2,816,179. Ralph Gittleman and Jacob Tellermaen. (Assigned to Bosch and Corp.)

The amplifier consists of a single input signal source and a pair of similar type transistors with the input signal source connected across the bases of the transistors. One of the transistors is connected as a grounded base transistor. The emitters are connected through a short circuit; the collectors are connected to the output circuit. Bias for the collector is provided between the output circuit and the base of the grounded base transistor. A relatively high impedance is provided between the emitters and ground external to the transistors. The collector current of one transistor is caused to flow through both emitters. The collector currents of each transistor are made equal without the necessity of matching the transistors.

Selenium Rectifier


A selenium rectifier is improved by polymono-chlorotrifluoroethylene. The normal rectifier has a layer of selenium on a base plate, and a counter-electrode on the selenium layer. The intermediate layer goes between the selenium and the counter-electrode.

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Drawing, MIL-STD MS24115 (USAF)

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28 Volts D.C. Resistive
Ambient Temperature
Range . . . . —65° C to 125° C
Vibration . . . . 15g to 2,000 c.p.s.
—no contact chatter
Shock . . . . 50g, 11 milliseconds

FOR FURTHER DETAILS WRITE FOR HUSKY BULLETIN 11
Current Control Regulator

Patent No. 2,824,276 Harvey Stump. (Assigned to Hughes Aircraft Co.)

A transistor, connected as a variable impedance in series with the current source and the load, maintains the current supplied to the load constant in this patent. The dynamic impedance is of the order of 16,000 meg while the transistor presents a small resistance to steady-state d-c flow.

Referring to the diagram, the current generator 11 consists of a triode 31, in this instance a 6j5 vacuum tube, connected to the load 37 through the n-type transistor 41. Biasing battery 23 is inserted between the emitter electrode 43 and the base electrode 44. Variable resistor 22 adjusts the quiescent condition of transistor 41. The voltage difference between cathode 32 and grid 31 is determined by the voltage across the collector 42 and the base 44.

If, for example, the value of resistor 37 decreases, the plate current through triode 31 tends to increase. This increase causes the current flowing through transistor 41 to increase. As a result, the voltage across collector 42 and base 44 will increase. The grid to cathode bias of triode 31 will also increase, causing the current flowing through triode 31 to increase.
increase to the value existing before the load 37 was changed.

The negative feedback will maintain the load current constant when the value of the load 37 increases. Finally, should the plate voltage of triode 31 change, this would be the same effect as a change in the load current compensated in magnitude and phase by negative feedback.

A typical design of the current regulator uses a Raytheon CK721 transistor with a 6J5 tube operated at 300 v. The transistor bias supply is a 1.5 v battery in series with an adjustable resistor 1000 to 10,000 ohms.

Phase Shifting Circuit


The phase of the output potential may be varied over a wide range with the circuit shown. The circuit is readily adjusted to give the desired phase of the output voltage. A vector diagram of the potential across the various elements of and at various points in the circuit is also illustrated. The particular potentials are indicated by reference to the part number of the circuit, i.e., EX21 is the potential of the reactive component of the inductor 21 and ER21 is the potential of the resistive component of the inductor. Locus of the variation in potential of the inductive component of the inductive element 21 is a circle 34 and a similar locus 36 gives the variation of the potential EM28 across the inductor 28 which is inductively coupled to inductor 21. The phase of the potential vector EM28 is always parallel with the vector EX21.

The condenser 19 and resistor 18 may be dispensed with in the broader aspect of the circuit, however, the resistor 18 provides the base potential E18 shown. Also the resonant circuit, which includes inductor 21 and condenser 22, may consist of one adjustable element. A wider range of phase variation, however, is secured by making both of these elements adjustable. As long as the ratio of inductances to resistance remains constant, the output potential remains constant. It does not matter how the resistance is distributed in the circuit. The phase change capabilities of the circuit is well in excess of 180 deg.

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<thead>
<tr>
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<th>Fundamental frequency, 15-470 mc, cont. variable in 10 switched overlapping bands. Direct-reading frequency dial.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep Width</td>
<td>60% of center freq to 50 mc; at least 20 mc max 50-400 mc, approx. 20 mc max above 400 mc.</td>
</tr>
<tr>
<td>Sweep Rate</td>
<td>Cont. variable, 10-40 cps, lock to line freq.</td>
</tr>
<tr>
<td>RF Output</td>
<td>1.0 V rms (metered) into nom 70 ohms (50 ohms on request) to 320 mc; 0.5 V rms to 470 mc. AGC'd constant over widest sweep and entire range to +0.5 db.</td>
</tr>
<tr>
<td>Attenuators</td>
<td>Switched 20, 20, 10, 6 &amp; 3 db plus cont. variable 6 db.</td>
</tr>
<tr>
<td>Sweep Output</td>
<td>Reg. sawtooth in sync with oscillator. Amplitude 7.0 V approx.</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Input approx. 100 watts, 117-V (±10%), 50-60 cps ac, 8± electronically regulated.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>9 1/4&quot; x 19 1/4&quot; x 13&quot;.</td>
</tr>
<tr>
<td>Weight</td>
<td>34 lbs.</td>
</tr>
<tr>
<td>Price</td>
<td>$795.00 f.o.b. factory.</td>
</tr>
</tbody>
</table>

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Process Instruments and Controls Handbook

Although this comprehensive handbook has a definite slant, both in its broad and detailed technical content toward the process industries, the fundamental instrumentation techniques and automatic-control principles described are equally applicable to other non-process fields, such as medical, military, and aircraft instrumentation.

It serves as a ready review of the principles of many different types of measurement and control processes, a guide to the selection of instruments and automatic controls for specific jobs, and a handy compilation of formulas, constants, and critical and other engineering data to help solve instrumentation problems.

Among the subjects covered are measurements systems, indicators and recorders, automatic controllers, timers and program controllers, electric and pneumatic telemetering, final control elements, and fundamental principles of process control, and mathematical techniques for solving automatic control problems.

Calculus for Electronics

This basic book describes the practical applications of calculus to electric-circuit
In the papers presented at the Symposia, important studies. Subjects presented included functions, derivatives, differentials, maxima and minima, higher derivatives, and definite and indefinite integrals; the calculus of trigonometric functions, of logarithmic and exponential functions, and hyperbolic functions; partial derivatives, double integrals, integration techniques, infinite series, and an introduction to differential equations. Each subject is closely related to electricity and electronics.

Proceedings of The Fourth Annual Computer Applications Symposium

eight Research Foundation of Illinois Institute of Technology, Technology Center, 10 West 35th St., Chicago 16, Ill. 1958 pp, $3.00.

The sessions of the Fourth Annual Computer Applications Symposium pressed new areas of application, use of few computers and accessories, and recent developments in automatic programming. The dual structure of the conference emphasized business and management applications and engineering practical and research applications. The two

Russian-English Glossary of Acoustics and Ultrasonics

Consultants Bureau, Inc., 227 W. 17th St., New York, N.Y. 170 pp, $10.00.

This glossary contains the most up-to-date Russian-English vocabulary in the fields of acoustics, electro-acoustics, and ultrasonics. There are over 10,000 terms taken from numerous articles. These articles appeared in several thousand pages of the most recent issues of Soviet physics and engineering journals, especially Journal of Acoustics, Journal of Technical Physics, and Radio-Engineering. Also included are many terms found in Russian texts and English texts which have been translated. A special effort has been made to emphasize the rapidly growing field of ultrasonics. This preliminary glossary will eventually be considerably enlarged and improved.

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What The Russians Are Writing

J. George Adashko

PROPAGATION


Exact and approximate formulas are derived for dimensions of scattering volume and scattering angle. An expression is derived for scattered power in the form of an integral over the scattering volume. The extremum of this integral leads to the determination of dimensions of the effective scattering volume for broad directivity patterns. The choice of antenna dimensions for communication by diffuse propagation are considered. Fundamental geometrical characteristics of scattering volume for narrow directivity patterns are also given. Refers to "Theory of Radio Scattering in the Troposphere" by Booker and Gordon (Proceedings IRE, Volume 38, April, 1950), "Radio Scattering in the Troposphere" by Gordon (Proceedings IRE, January 1955), "The Use of Angular Distance in Estimating Transmission Loss and Fading Range for Propagation Through a Turbulent Atmosphere over Irregular Terrain" by Norton, Rice, and Vogler (Proceedings IRE, October 1955) and "The Rate of Fading in Propagation Through a Turbulent Atmosphere" by Norton, Rice, Janes and Barsis (Proceedings IRE, October 1955).

Choice of Routes for Sections of Radio Relay Lines by A. I. Kalinin. EC 9/57, pp 20-29, 7 figs.

The choice of routes for maximum line stability is considered. Formulas are given for the minimum heights of an-
tenna towers and for the maximum lengths of line sections. The effect of the terrain of the locality and the statistical distribution of the vertical gradient of the dielectric constant of air are taken into account.

COMPONENTS


Report of results of the investigation of fully reversible changes in the detecting properties of crystal silicon detectors operating at microwave frequencies. This type of temporary deterioration of the properties is called "coarsening" of the detector. It is due to the change in the capacity of the barrier layer. The observed recovery times are attributed to multiple capture of electrons in one part of the contact region. Reference is made to work by Hornbeck and Haynes. Physical Review, 1955, Vol. 96, pp 311-321. Fig. 1 shows the experimental setup.

Influence of the Speed of Recombination at the Non-Rectifying Electrode on the Frequency Properties of the p-n Junction for the Case of Small Alternating Voltages by N. A. Penin. REEE 8/57, pp 1053-1061, 6 fgs.

An expression is derived for the voltage-current characteristic, and also for the total conduction of the p-n junction with alternating current for small voltages, with allowance for the speed of recombination on the non-rectifying electrode.

To improve the frequency characteristics of a semiconductor diode, the thickness of the p and n regions should be reduced to a minimum. However, at small distances between the junction and the non-rectifying electrode the influence of the rate of recombination at the electrode on the properties of the p-n junction becomes substantial. The author calculates the voltage-current characteristic of the p-n junction and the total conductivity of the diode with alternating current for low voltages. The original Shockley theory applies to an infinite distance between the junction and the electrode, and naturally must be modified in this case.

TELEPHONY

Additional Induction Between Circuits

Due to Presence of Insulators in the Line by N. P. Volnova. EC 9/57, pp 65-73, 7 fgs.

The distribution of insulators along transposed and untransposed lines, and its effect on the values of the wave impedance of the line are given an extensive mathematical treatment.

RECEPTION


Formulas are derived for the degree of suppression of the non-working sideband frequency in three- and four-phase systems as a function of the amplitude and phase errors in the voltage supplying the system. The calculated results are presented in the form of curves from which it is possible to estimate the possibility of a practical realization of systems in various particular cases.

CIRCUITS


A brief article, in which the fundamental considerations that require a special approach to many semiconductor circuits are discussed. A concise formulation is given of the methods in use now, together with a brief survey of several other articles published in the same issue of the journal on the investigation of transistor circuits and the features of the transistors themselves. Certain trends in future developments in this field are noted.

This is a report of a survey made at the Moscow State University on various transistor circuits in which the nonlinear properties of the transistor are investigated. The summary given in this article touches upon the specific nature of transistorized systems, possible methods of investigation of such circuits, and the contents of recently published articles in the USSR on these subjects.

Analysis of a High Frequency Self-Oscillator Employing Junction Transistors by L. N. Kaptsov and V. V. Yabloonskii. REEE 9/57, pp 1136-1145, 7 fgs, 2 tables.

The authors determine the limits to which the simplified equivalent circuit of a transistor can be used to analyze a high frequency oscillator.
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RUSSIAN TRANSLATIONS


Fig. 2. Circuit used to investigate slow and fast processes in junction transistor multivibrators.


An investigation of slow and fast processes in a free-running junction-transistor multivibrator. The dependence of the amplitude and duration of the generated pulses on the circuit parameters, on the transistors, and on the supply voltage is established. Refers to work by A. P. Thomas (Electronics, 1955, Vol. 28, Page 168), J. E. Flood (Wireless Engineer, 1955, Vol. 32, Page 122), D. F. James (Electronics, 1953, Vol. 26, Page 112) and E. W. Sard (Conention Record of the IRE, Part II, 1954, Page 110). Fig. 2 shows the circuit, and Fig. 3 the waveforms.


Report of a theoretical and experimental investigation of the non-stationary processes at the base of a transistor during the transmission of an electric signal. The transient characteristics of common-emitter and common-base connections are theoretically derived from physical considerations. It is shown experimentally that the theory of small-signal amplification can be applied to a transistor even when the small-signal conditions are not satisfied. Refers to work by Schaffner and Suran (Journal of Applied Physics, 1953, Vol. 24, Page 1355), Steele (Proceedings IRE, 1952, Vol. 40, Page 1424), and Pritchard (Proceedings IRE, 1955, Vol. 43, Page 1075).

The authors analyze the processes that take place in a blocking oscillator using high frequency p-n-p type transistors in the cut-off mode to form the leading edge of the pulse. Transistor and circuit parameters are studied in forming the leading edge and the transient from the stage where the capacitor is overcharged to the leading front. Refers to work by Sulzer (Electronics, August 1953, Vol. 28, Page 173), J. E. Flood (Wireless Engineer, May 1955, Vol. 32, Page 112), and Linvill and Mattson (Proceedings IRE, 1955, Vol 43, Page 1632).

Fig. 3. Waveforms in the multivibrator of Fig. 2.

Certain Features of Self-Oscillators Employing Transistors by L. N. Kaptsov. REE 9/57, pp 1127-1137, 12 figs.

A qualitative examination of the waveforms of currents and voltages in various points of a transistorized oscillator with nearly harmonic oscillations. The methods used to calculate the amplitudes and the settling time of the oscillations in vacuum tube oscillators are applicable to semiconductor oscillators only in a narrow range near the excitation threshold. Refers to "Frequency Stability of Point Contact Transistor Oscillators" by C. C. Cheng (Proceedings IRE, 1956, Vol. 44, Page 219) and "Isocline Diagrams for Transistor Circuits" by R. Oakes (Electronic Engineering, July 1955, Page 27, Page 312).

Correction of Transistor Amplifiers by K. S. Rzhevkin and Y. S. Andrianov. REE 9/57, pp 1157-1169, 8 figs.

An analysis of the single-stage transistor amplifier, in which formulas are derived for the engineering computations of correcting elements which can extend the amplifier bandwidth above critical frequencies. Refers to work by Sawels, Early, and Pritchard.

Application of Quasi-Linear Method to the Analysis of a Transistor High Frequency Generator by L. N. Kaptsov, M. A. Abdyukhanov, and A. A. Kashir. REE 9/57, pp 1170-1173, 5 figs, 1 table.

The high frequency RC transistor oscillator was treated by L. N. Kaptsov in the November 1956 issue of Radiotekhnika i Elektronika (Page 1413). (ED 7/15/57). The inertia (time-delay)

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| Operation | Surface speed | Feed :
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<td>Cutoff 140-160</td>
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1 For cemented-tipped tools, speeds may be increased by 25-50%.

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properties of transistors manifest themselves even at relatively low frequencies. Consequently the nonlinear characteristics of transistors, obtained at low frequencies without allowance for time-delay, cannot be directly used to calculate the amplitudes of high frequency generators employing such transistors. In fact, the input and output impedances and the current (or voltage) gain coefficients of transistors contain reactive components at high frequencies, and the breakdown of such parameters into real and imaginary parts for the purpose of providing an equivalent circuit is possible only for sinusoidal voltages and currents, since the real and imaginary parts are functions of frequency. Consequently, such a breakdown is permissible only in the linear or quasi-linear approximation, a procedure to which this article is devoted.

Fig. 4. A bistable trigger circuit using junction transistors.


The collector current of a junction transistor is calculated with allowance for the effect of variation of the thickness of the base layer under the influence of variable voltage on a resistive collector load. This is for a case when a small sinusoidal signal is applied to the emitter circuit. The solution of this nonlinear problem, using the small-parameter method in the first approximation, contains the second harmonic of the collector current.


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characters of the Russian type PZV power transistors in the saturation region are given.

Analysis of Trigger Circuit Using Junction Transistors by T. N. Yastrebtsjeva. REE 9/57, pp 1146-1156, 10 figs.

Circuits of this type were studied by Linvill "Non-Saturating Pulse Circuits Using Two Junction Transistors." (Proceedings IRE, 1955, Page 926) and by Suran-Reibert "Two-Terminal Analysis and Synthesis of Junction Transistor Multivibrators." (IRE Transactions, 1956, Page 26.) Linvill analyzed a symmetrical binary counting circuit under the conditions when the transistors are not saturated. He gave an estimate of the value of the input signal required to trigger the circuit. Suran and Reibert considered a circuit that can have one or two stable equilibrium states, but is also capable of self-oscillation. They gave only an approximation of the maximum oscillating frequency and the maximum repetition frequency of the triggering pulses. This article considers a trigger circuit having two stable equilibrium conditions (Fig. 4), triggered by positive rectangular pulses, applied once to the base of each transistor through diodes. Certain simplifying assumptions are made in the calculations.

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

- AT Automation and Telemechanics (Avtomatika i Tekhnehanika)
- CJ Communications Journal (Vestnik Svyazi)
- EC Electrical Communications (Elektrosvyaz)
- IET Instruments and Experimental Techniques (Pribori i Tekhnika Experimenta)
- R Radio
- RE Radio Engineering (Radiotekhnika)
- REE Radio Engineering and Electronics (Radiotekhnika i Elektronika)

TRANSLATIONS AVAILABLE

Electronic Design is gratified to learn of the growing availability of full translations of important Russian electronics journals.

Consultants Bureau, Inc. of 227 W. 17th St., New York 11, N.Y. translates Automation and Telemechanics regularly.


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Resonant Absorbers for Microwaves

Fig. 1. Singly Resonant Absorber. $\lambda_0$ is the freespace wavelength.

Fig. 2. Doubly Resonant Absorber.

Zener Diodes

Silicon diodes to which a voltage in the reverse direction is applied, pass currents which are only a fraction of a $\mu$A until application of a voltage exceeding 4 v. There upon the "Zener current" is observed, i.e., the current increases rapidly with only very small increases in voltage. This effect suggests the possibility of using such a "Zener" diode as a reference voltage source. In this connection small variations of voltage with current and variations of voltage with temperature are of interest.

The variation of voltage with current can be described through the internal resistance variation. Temperature dependence can be described through a temperature coefficient ($\text{mv/deg C}$). Typical curves for both effects are illustrated. It is noted that both effects are substantially independent of each other.

The temperature coefficient is zero in the neighborhood of 5 v. It is exceedingly difficult to produce Zener diodes which have a 5 v (or less) Zener voltage. It is however, possible to compensate for this effect by using, in conjunction with the Zener diode, silicon diodes which carry a current in the forward direction. These have a negative temperature coefficient.
ably larger bandwidths than the singly resonant system.

In Fig. 3 a triply resonant system is shown. Two dipole layers are used in this structure. They are spaced an eighth of a wavelength apart (in the dielectric). With this arrangement a frequency range which exceeds 2:1 is possible.

The three systems are compared by means of the graph shown in Fig. 4. These curves were calculated from the equivalent circuits. Experimental results using actual microwave structures are in agreement with the calculated curves.

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**Fig. 1.** Block diagram of function generator which produces an output that is a function of two independent input variables.

**Fig. 2.** Block diagram of one channel of voltage-controlled attenuator.
EIA Issues Spec for Military Components

The Electronic Industries Association has increased its engineering effort to include specifications for component parts for military equipment. The first spec issued was SMC-1, entitled Fixed Ceramic Capacitors, Low Loss (High Reliability). This program [See "Designing For Reliability," ED, Feb. 19, p. 3, insert] was undertaken by EIA after they recognized the need for up-to-date reliable component parts specs for use in military equipment and the fact that ASEA, due to its lack of authority and agreement between the Services, was about three years behind in this program. The program was considered necessary due to the difficulties being encountered by end-equipment manufacturers in obtaining the components they needed of sufficient quality to meet the end-equipment reliability requirements. Many of these end-equipment manufacturers were forced to expend considerable engineering and testing effort to write their own procurement documents, while at the same time the differences in the various manufacturers' procurement documents and the extra testing requirements contained therein caused hardships to the parts producers.

The EIA program for specs for military component parts is presently divided into three parts: (1) the preparation of specs for parts now available; (2) the preparation of specs for parts not immediately available, but which are within the accomplishment of the present state of the art; and (3) the preparation of "blue sky" specs for future needs.

To date, the action has been concerned with category (1) items, and preliminary work is now being directed to category (2) fields. At present, work under category (1) is concerned with eight specific areas: capacitors, connectors, resistors, relays, switches, transformers, wire, and cable.

The primary objective in preparing specs for parts now available is to combine the procurement documents of various end-equipment manufacturers (most of which are based upon MIL specs with various requirements added) into common EIA component parts specs for use in military equipment. These specs are limited to components available from at least two makers. This is a practical program, an administrative job which should result in one spec and one number for each given part without excessive delay.

**STANDARDS AND SPECS**

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<td>F160-I-O</td>
<td>0-160 inch ounces</td>
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**STANDARDS AND SPECS**

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EIA Issues Spec for Military Components

The Electronic Industries Association has increased its engineering effort to include specifications for component parts for military equipment. The first spec issued was SMC-1, entitled Fixed Ceramic Capacitors, Low Loss (High Reliability). This program [See "Designing For Reliability," ED, Feb. 19, p. 3, insert] was undertaken by EIA after they recognized the need for up-to-date reliable component parts specs for use in military equipment and the fact that ASEA, due to its lack of authority and agreement between the Services, was about three years behind in this program. The program was considered necessary due to the difficulties being encountered by end-equipment manufacturers in obtaining the components they needed of sufficient quality to meet the end-equipment reliability requirements. Many of these end-equipment manufacturers were forced to expend considerable engineering and testing effort to write their own procurement documents, while at the same time the differences in the various manufacturers' procurement documents and the extra testing requirements contained therein caused hardships to the parts producers.

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EIA SMC-1, Fixed Ceramic Capacitors, Low Loss (High Reliability), November, 1957

Primarily designed for military end-equipment manufacturers, this spec covers high reliability, fixed ceramic capacitors, of up to and including 500-volt rating. The type capacitor is specifically suited for resonant circuit application or any other application where high figures of merit Q and stability of capacitance are essential. The objective reliability is defined as that which will result in an in-service failure rate of less than 0.01% per 1000 hours. A typical type designation for capacitors meeting this spec follows: CCR22-U2J470G. The basic format of this spec follows the format established by the military. Copies of this spec are available from the Electronic Industries Association, 11 West 42nd Street, New York 36, N.Y., for $1.10 per copy.

Resistors
MIL-R-19A, Resistors, Variable, Wirewound, (Low Operating, Temperature), Amendment 1, 16 December 1957

Hardware is no longer to be assembled on the resistor unless specified. However, for direct Government orders, the hardware is to be assembled on the resistors. Footnotes 3 and 4 under table IV are clarified by indicating the type bushing and style resistor involved.

Use of Non-Standard Specs
ANA Bulletin No. 147q, Specifications and Standards of Non-Government Organizations, 1 December 1957

Subject to the limitations imposed by ANA Bulletin No. 143 and in the absence of an applicable Government spec or standard, those non-Government specs and standards listed in this bulletin may be used without further approval by the Service. For example, a spec or standard listed may be used or specified by the contractor based on his engineering determination of its application. Satisfactory operation of equipment manufactured to these specs and standards is still the responsibility of the manufacturer.

AF Specs
The Air Force has announced the release of the following specs:
MIL-D-9310A, Data for Guided Missile Weapon Systems, 20 November 1957
MIL-R-25717B, Reliability Assurance Program for Electronic Equipment, 13 November 1957

Electronic Design • June 11, 1958
STANDARDS AND SPECS

CAPACITORS

MIL-C-19624(SHIPS), CAPACITORS, Fixed, BY-PASS, METAL-ENCASED, HERMETICALLY SEALED, ALTERNATING AND DIRECT CURRENT (INTERFERENCE REDUCTION), AMENDMENT 1, 16 January 1958

The graph showing insertion losses (Fig. 2) has been deleted.

MIL-C-25A, CAPACITORS, Fixed, PAPER-DIELECTRIC DIRECT-CURRENT (HERMETICALLY SEALED IN METALLIC CASES), SUPPLEMENT 1G, 12 December 1957

This supplement lists the fifteen military spec sheets which form a part of this spec.

MIL-C-12899A, CAPACITORS, BY-PASS, RADIO-INTERFERENCE REDUCTION, PAPER DIELECTRIC, AC AND DC (HERMETICALLY SEALED IN METALLIC CASES), GENERAL SPECIFICATION FOR, AMENDMENT 1, 10 January 1958

The "life test voltage" in Table II has been clarified. A requirement that the dissipation factor shall not exceed 1.5% has been added to the life test.

ASA Price List and Index

The American Standards Association has released the 1958 price list and index of all ASA standards. Included in this publication are publications of the International Organization for Standardization and the International Electrochemical Commission. Copies of this 68-page publication may be obtained without charge from the American Standards Association, 70 E. 45th St., New York 17, N.Y.

Canadian Standards

CSA C22.2 No. 02-1958, USE OF FLEXIBLE SUPPLY CORDS AND FIXTURE WIRES WITH ELECTRICAL APPLIANCES

The minimum grades of flexible supply cords that may be used on cord-connected electrical appliances of many kinds are specified by this standard. Also included is information as to when a grounding conductor is required for grounding the appliance when in use. Additional data on the various types of flexible supply cords are also given in order to assist in the selection of other acceptable types. Copies of this standard may be obtained from the Canadian Standards Association, 235 Montreal Road, Ottawa 2, Canada, for $1.00 per copy.
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Mechanical Charts
SAMA RC11-1-1958, MECHANICAL CHART DRIVES, JANUARY 16, 1958
Spring-driven chart drives for recording instruments employing circular charts are covered by this standard. This standard establishes a minimum number of limiting dimensions so that chart drives complying with the standard can be used interchangeably in recording instruments made by different manufacturers. Also established are minimum performance requirements so that chart drives complying with the standard may give adequate service in average recording industrial instrument applications. Copies of this standard may be obtained without charge from the Scientific Apparatus Makers Association, 522 Fifth Ave., New York 36, N.Y.

Testing
MIL-STD-271(SHIPS), NONDESTRUCTIVE TESTING REQUIREMENTS FOR METALS, 2 JANUARY 1958
The entire section dealing with the use of liquid penetrants for detecting the discontinuities in ferrous and nonferrous materials has been revised.

Test Points
MIL-T-25453A(ASG), TEST POINTS AND TEST FACILITIES, AIRBORNE AND ASSOCIATED ELECTRONIC EQUIPMENT, 12 NOVEMBER 1957
Test points and facilities to be utilized in the testing of airborne and associated electronic equipment are covered in this spec. The purposes of these test points are to provide optimum operation, expedite alignment and maintenance, and to permit continuous monitoring by observation of significant voltages, currents, and waveforms. This spec defines a test point as a convenient safe access to a circuit in a system or equipment for the introduction, measurements, or display of a significant quantity or parameter in order to facilitate monitoring, calibration, repair, or maintenance. Thirty-one test points are listed as desirable for consideration where practicable and applicable to the equipment. Ten test points are listed for consideration where applicable for providing display of waveforms in the operation or adjustment of the equipment. Sufficient test points shall be made available to facilitate the location of the most probable circuit malfunctions which may reasonably be expected to occur within the equipment. These built-in test facilities shall be incorporated to the fullest extent to permit monitoring of performance on a "go, no-go" basis. This spec has been approved by the Department of the Air Force and the Navy Bureau of Aeronautics and supersedes the earlier Air Force spec.
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New -hp- 120A Oscilloscope and -hp- 120AR Rack Mount Oscilloscope. Note space-saving 7" high panel on rack mount instrument.
this all-new
\textit{\textit{-hp-} $\$435$ oscilloscope!}

- Check the simple panel.
  Few controls—faster, easier measuring!

- Check the specs; DC to $200$ KC, automatic
  trigger, high stability, accuracy

- An \textit{-hp-} thoroughbred; finest quality,
  rugged, dependable, portable

Let's spell out this new \textit{-hp-} oscilloscope very fast.
It's medium priced, deliberately engineered for simple operation, ac-
curacy and dependability. Lightweight, only 32 pounds.

There's absolutely no compromise with quality or features to bring you
tthe attractive price.

It has automatic triggering, no adjustment over entire range. Yet a
front panel adjustment can cut out automatic triggering and base line
to provide a bright, steady trace for photography. Only \textit{-hp-} offers this.
The oscilloscope has sweep speed range from $1 \text{ microsec/cm}$ to $0.5 \text{ sec/cm}$.
Speeds are slow enough for mechanical or medical work, fast enough for
most rapid transients. There's a "times-5" sweep expansion and a vernier
to give continuous control of sweep speed. There are 15 calibrated
sweps, 1-2-5 sequence.

Instantaneous automatic synchronizing is available on any internal or
external voltage; instrument may also be triggered by line voltage.
The DC-coupled vertical amplifier has a pass band of $200$ KC. Cali-
btrated vertical and horizontal amplifiers have identical bandwidths for
phase measurements. High sensitivity permits working directly from
transducers in many cases.

High stability is insured by regulated power supplies, including a trans-
istor regulated vertical amplifier filament supply.

The 5AQP1 cathode ray tube comes out easily through the front panel:
you change filters in 30 seconds. The 5AQP1 is the same CRT used in
more expensive \textit{-hp-} scopes. It provides linear response, uniform trace
intensity and perfect focus over the entire tube face. Fully illuminated
graticule, CRT beam adjusting lever.

You might call the \textit{-hp-} 120A the first \textit{multi-purpose deluxe} oscilloscope
ever offered at medium price. Here is calibrated performance for pre-
cision lab work and brute ruggedness for the production line. \textit{-hp-}
120AR Rack Mount is ideal for fixed installations and test console
applications.

Call your \textit{-hp-} engineer for a demonstration, or write direct for details.
Fast delivery!

\textbf{BRIEF SPECIFICATIONS}

**SWEEP**

- Trigger selector: internal, external, line.
- Triggers automatically on 0.5 cm. display
  internal or 2.5 volts peak-to-peak external.
- Displays base line in absence of signal.
- No sync controls required.
- 15 calibrated sweeps in 1-2-5 sequence.
- 5 microsec/cm to 200_msec/cm
- \(\pm 5\%\) accuracy; vernier 2.5/1 range (lowers
  sweep speed). 5 times sweep expansion,
  applicable on all ranges.

**VERTICAL AMPLIFIER**

- Bandwidth: DC Coupled – DC to $200$ KC.
- AC Coupled – $2$ cycles/sec to $200$ KC.
- 4 calibrated sensitivities: $10$ mv/cm, $100$
  mv/cm, $1$ v/cm, $10$ v/cm; \(\pm 5\%\) accuracy;
  $10/1$ vernier.
- Balanced input available on $10$ v/cm
  range.
- Internal amplitude calibration provided.

**HORIZONTAL AMPLIFIER**

- 3 calibrated sensitivities: $0.1$ v/cm, $1$ v/cm,
  $10$ v/cm; $10/1$ vernier.
- Bandwidth same as vertical amplifier.

**GENERAL**

- Cathode Ray Tube: 5AQP1 with $2500$ v ac-
celerating potential.
- Intensity Modulation: terminals on rear.
- Power Input: approximately 120 watts.
- All DC power supplies regulated.
- Size: Cabinet, $9\frac{1}{4}$ x $15\frac{3}{4}$ x $21\frac{1}{4}$; $32$ lbs.
- Price: \textit{-hp-} 120A or 120AR (Rack Mount),
  \$435.00.
- Data subject to change without notice.
- Prices f.o.b. factory.

\textbf{HEWLETT-PACKARD COMPANY}

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Cable HEWPACS • Davenport S-4451
Field engineers in all principal areas

-hp- provides industry's newest, most complete oscilloscope line!
Now...RCA 2N301 2N301-A

deliver 85% more

Power Output!

New, improved RCA-2N301 and RCA-2N301-A—now can provide an audio-frequency power output up to 5 watts in class A service at a mounting-flange temperature of 80°C—a significant increase (85%) over the original class A power output of 2.7 watts! These two units offer high reliability, high power efficiency, and low-distortion characteristics in power output stages of automobile radios, high-fidelity amplifiers, juke boxes, intercoms, PA systems, marine and mobile communications equipment, and electronic musical instruments.

RCA also announces the addition of three types to its expanding line of POWER OUTPUT TRANSISTORS: 2N176, 2N351, 2N376. For additional information on these types and the complete line of RCA transistors, contact your RCA field representative at the field office nearest you. For technical data on RCA POWER TRANSISTORS listed above, write RCA Commercial Engineering, Section F-18-NN1, Somerville, N. J.

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