Nuclear Detector for Oil Surveys  ... p 61
Alarm Uses Neon Warbler  ... p 74

Airborne Tv System  ... p 66
UTC products are the most copied in the world. This is only natural, since we maintain the largest laboratories and engineering staff in our field. However, copying alone cannot provide the measure of uniformity and reliability inherent in UTC units. To provide for the maximum in quality and reliability, continuing programs of quality control and quality improvement are constantly maintained in our laboratories.

WHAT MAKES A TRANSFORMER FAIL?
Illustrated are a few views of the UTC Reliability Laboratory in action...finding the answers.

IS THIS PROVEN RELIABILITY AND UNIFORMITY IN THE COMPONENTS OF YOUR EQUIPMENT?

A large aircraft company..."Our vendor analysis for past year (thousands of tests) shows zero rejects."
A large electric company..."Consistent quality has placed you as our #1 source...are grateful for the aid you have given our own quality control staff."
A large military electronics company..."Switching from former vendor to UTC has saved us 18% of transformer and filter cost by reducing manufacturing costs."
A large instrumentation company..."We haven't had one field failure in fifteen years' use of UTC parts."*"*Over 100,000 units.

UNITED TRANSFORMER CORPORATION
150 Varick Street, New York 13, N.Y.
PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"
Airborne Tv System. Ultrahigh-frequency f-m television transmission system developed by Philco for U.S. Navy provides military reconnaissance link from helicopter to surface command post. See p. 66. COVER

Gamma-Ray Detector Aids Oil Field Surveys. Radioactive tracers introduced into water in an oil-producing formation are detected by G-M tubes feeding transistor circuit. Instrument is self-contained in a 1-in. diameter tube. p 61
By F. E. Armstrong

Transistor Chopper Drives Accurate Clock. Synchronous clock motor is driven by a-c pulsed output of a transistorized chopper control circuit. p 64
By Richard H. Williams

Airborne Tv System for Military Reconnaissance. Helicopter-mounted i-o camera output is relayed over 50 mile range by 30-w uhf f-m transmitter. p 66
By N. Sher and J. F. Fisher

Automatic Speech Amplitude Control. Increases amount of intelligence transmitted over radio communication system under adverse conditions by altering energy distribution of speech. p 71
By Lyle R. Battersby

Alarm System Uses Gated Neon Warbler. Conelrad alarm generates own warning signal, monitors key-station modulation and turns off local carrier. p 74
By Ronald L. Ives
DIGEST continued

Photoformer Solves Sound Barrier Problems. Photoelectric function generator provides smooth reproduction of complex curves for use in simulating analog computer problems................................. p 79
By Robert W. Maloy

Cathode-Ray Tube Adds Third Dimension. Fluorescent screen is motor-driven toward and away from observer along Z-axis. Electromagnetic pickup gives signal corresponding to instantaneous position of screen .............................................................................. p 81
By Edward L. Withey

Transistor A-C Amplifier Uses Multiple Feedback. Use of multiple feedback loop in single stage produces reliable and versatile transistor a-c amplifier ................................................................. p 84
By Howard Lefkowitz

Multicoupler Nomograph for TV Antenna Networks. Resistance and power loss of nonreactive n-set multicoupler are determined by using straightedge on chart .............................................................................. p 86
By Anthony Paolantonio

Electrons At Work ................................................................. p 88
Photocell Checks Raindrop Size .......................................... p 88
Conel Shows CRT Beam Direction ..................................... p 88
By J. J. Wotmayer
High-Speed Data Handler .................................................. p 88
Whip Antennas Track Missiles ............................................ p 90
Chopper Uses New Photocells ............................................ p 90
By Richard C.Seed

Component Design ............................................................. p 100
Electrostatic Oscilloscope .................................................. p 100
Automatic Assembly Resistor ....................................... p 100
Pen Recorder ........................................................................ p 102
Metal Film Attenuator ........................................................ p 106

Production Techniques ....................................................... p 108
Chassis Design Cuts TV Costs ......................................... p 108
Jets Cleanse Transistors .................................................... p 111
By W. R. Patrick and L. R. Travis
By James E. Greener
Design Trends ...................................................................... p 108

New Products .................................................................... p 114

Literature of the Week ....................................................... p 144

Plants and People ................................................................. p 146

News of Reps ........................................................................ p 151

New Books ........................................................................... p 152

Comment .............................................................................. p 154

Index to Advertisers ........................................................... p 162
Sprague, the pioneer in the production of solid-electrolyte tantalum electrolytic capacitors, now offers prompt delivery on production quantities of all standard ratings. New expanded facilities end production delays in your assembly of minified transistor circuits.

Typical of these Tantalex Capacitors is the Type 150D shown above. Its tiny sintered anode is impregnated with a solid, non-corrosive, semi-conductor material which cannot leak under any circumstance. It combines true miniaturization with electrical stability previously unobtainable in an electrolytic capacitor of any type.

Thermal coefficient of these capacitors is sufficiently low and linear so that for the first time a circuit designer can think of an electrolytic in terms of parts per million capacitance change. Nominal value is +500 ppm/°C. The capacitor may be used without derating over a range from +85°C to as low as -80°C, a temperature at which no other electrolytic has proved useful.

Solid construction permits the Type 150D to withstand the severe shock and vibration encountered in missile and ballistic applications. Hermetic sealing makes it completely immune to humid atmospheric conditions.

Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 3520B, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

Sprague, on request, will provide you with complete application engineering service in the use of Tantalex Capacitors.

DON'T FORGET! — Sprague also offers prompt delivery on all other types of tantalum capacitors including tubular foil and sintered anode designs.
At Temco titanium is keeping its promises to the aircraft industry. No longer the intransigent metal, titanium in precision assemblies has become routine here. Through the development of Temco's Ti-Brite process, the tough titanium scale which once limited the material's usefulness is electrolytically removed without etching or disturbing the most precise dimensions.

And at Temco a successful process for chrome-plating titanium may be the major breakthrough in the feasibility study for extending its temperature resistance beyond the 800-1000°F range. Forming, spot welding, precision machining are everyday operations. Temco's proven capabilities in precision automatic fusion welding have proved especially effective in the assembly of titanium parts. A case in point: the front compressor casings of Pratt & Whitney's J-57 engine, produced at Temco.

Quality and reliability of assemblies produced at Temco are assured by the extensive facilities of the Quality Control Department and Metallurgical Laboratory. These include the newest non-destructive spectographic and large X-ray equipment.

Capabilities in advanced metallurgy... in titanium, aluminum, austenitic steel, stainless steel... are typical of Temco progress. And now research and development capabilities are challenging the rare earths... beryllium, columbium, tantalum, molybdenum... for tomorrow's needs. As the aircraft industry grows, so do Temco's capabilities to design, tool and produce for it. Whether your need is for a component, a subsystem or a complete system... an inspection of Temco will be informative and profitable.
For HIGH VOLTAGE DC Supplies—
Call BETA...High Voltage HEADQUARTERS

Voltage ratings to 150 KV and continuous currents up to 1000 MA

Whatever your need in High Voltage—whether it’s a rugged, portable unit, or an elaborately instrumented supply for wide-range operations... Beta is your best source.

Beta’s many years of specialization in the design, production, and application of AC and DC high voltage equipment—in all kinds of applications, ranging from electrostatic smoking of meats to nuclear particle acceleration—assure a level of quality and performance in apparatus and instruments that is exceptional. Equally outstanding is the famed line of Beta overpotential testers capable of testing transcontinental cables to individual AC and DC circuits.

All the advantages of this distinctive leadership in the growing field of electrostatics and other high voltage operations are immediately available to you through your Beta representative.

Or you are cordially invited to call or write directly to Beta headquarters for full information—on the most complete line of DC high voltage equipment, some of which are illustrated.

200 Series, Portable
Light-weight, easily carried, air-insulated. Output from 0 to 30 KV continuously variable, 2 to 5 ma, with reversible polarity. Ripple, 1% per ma at 30 KV.

1000 Series, Rack-Mounted DC Supplies
0-1 to 0-60 KV, 2-500 ma. Rugged construction, conservative design, with full self-protection. Selenium rectifiers in models below 10 ma rating. Ripple; below 2.5% rms for max. current at max. voltage. Polarity reversible, with center-tap provision if desired.

2000 Series
0-1 and 0-250 KV; 5 to 3000 ma. Two unit design, for remote operation and maximum safety for personnel and equipment. Conservative rating, simple operation. Polarity reversible.

9000 Series, "HI-SEL" DC Power Packs
Five models, from 0-5 KV and 5 ma up to 0-30 KV and 5 ma. Low ripple at all ratings. Selenium rectifiers and air-insulated design. Can be mounted in any position.

BETA ELECTRIC COMPANY
division of SORENSEN CO., INC.
Richards Avenue
South Norwalk, Conn.
TEmple 8-6571
These Raytheon Tubes are designed, constructed and tested for severe military environment, including temperature ratings to 165°C, and shock and vibration resistance. Raytheon custom designed gas filled tubes are backed by over thirty years of design, development and production experience. It will pay you to get in touch with Raytheon for gas filled tubes that meet your specific needs.

### RAYTHEON GAS FILLED TUBES

<table>
<thead>
<tr>
<th>Voltage Reference Tubes</th>
<th>Voltage Regulator Tubes</th>
<th>Cold Cathode Rectifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK5651, CK5651WA</td>
<td>CK5517, CK5651WA</td>
<td>CK5517</td>
</tr>
<tr>
<td>85 volts, 1.5 to 3.5mA</td>
<td>85 volts, 1.5 to 3.5mA</td>
<td>PIV = 2800</td>
</tr>
<tr>
<td>CK6213</td>
<td>CK6213</td>
<td>l₀ = 8mA</td>
</tr>
<tr>
<td>130 volts, 1 to 2.5mA</td>
<td>Submin.</td>
<td></td>
</tr>
<tr>
<td>CK6542</td>
<td>Submin.</td>
<td></td>
</tr>
<tr>
<td>150 volts, 5 to 25mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK5783WA</td>
<td>CK6174</td>
<td>CK6174</td>
</tr>
<tr>
<td>98 volts, 5 to 25mA</td>
<td>Submin.</td>
<td>Submin.</td>
</tr>
<tr>
<td>CK6542</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 volts, 5 to 25mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK6174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>108 volts, 5 to 30mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK5787WA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 volts, 5 to 30mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OA2, OA2WA, CK6626</td>
<td>CK6659 (CK1042)</td>
<td>CK6659 (CK1042)</td>
</tr>
<tr>
<td>Miniature, 150 volts, 5 to 30mA</td>
<td>Miniature, 150 volts, 5 to 30mA</td>
<td>Miniature, 150 volts, 5 to 30mA</td>
</tr>
<tr>
<td>OB2, OB2WA, CK6627</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miniature, 108 volts, 5 to 30mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK6213</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submin.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>130 volts, 1 to 2.5mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK6763</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submin.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 volts, 5 to 25mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK6659 (CK1042)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miniature, 150 volts, 5 to 30mA</td>
<td>Miniature, 150 volts, 5 to 30mA</td>
<td>Miniature, 150 volts, 5 to 30mA</td>
</tr>
</tbody>
</table>

### RADIAC TUBES

Raytheon offers Corona Voltage Regulator Tubes for higher voltages in a wide range of ratings; also a variety of Radiation Counter Tubes.

### THYRATRONS

<table>
<thead>
<tr>
<th>Thyratrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>RK61</td>
</tr>
<tr>
<td>Submin.</td>
</tr>
<tr>
<td>For control receivers in model aircraft, boats, etc.</td>
</tr>
<tr>
<td>CK1054</td>
</tr>
<tr>
<td>Submin.</td>
</tr>
<tr>
<td>For general purpose military use</td>
</tr>
<tr>
<td>CK5643</td>
</tr>
<tr>
<td>Submin.</td>
</tr>
<tr>
<td>Low drain, grid controlled indicator for semiconductor circuitry</td>
</tr>
</tbody>
</table>

### LIGHT INDICATOR

<table>
<thead>
<tr>
<th>Light Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK1050</td>
</tr>
<tr>
<td>Submin.</td>
</tr>
<tr>
<td>Newton, Mass.: 55 Chapel St., Bigelow 4-7500</td>
</tr>
<tr>
<td>New York: 589 Fifth Ave., Plaza 9-3900</td>
</tr>
<tr>
<td>Chicago: 9501 Grand Ave., Franklin Park, National 5-6130</td>
</tr>
<tr>
<td>Los Angeles: 5236 Santa Monica Blvd., Normandy 5-4221</td>
</tr>
</tbody>
</table>

May 23, 1958 — ELECTRONICS engineering edition
BUSINESS BRIEFS

ELECTRONICS NEWSLETTER

RUSSIA'S THIRD SPUTNIK, launched last week, appears from first reports to be carrying instruments similar to those on a USSR rocket fired Feb. 21 (ELECTRONICS, May 2, p 19).

ELECTRIC-POWERED MAGNETIC PROPULSION system looms as a strong possibility for maneuvering a manned satellite in outer space. New concept stems from studies and experiments in magnetohydrodynamics sponsored by USAF Office of Scientific Research at the Avco Manufacturing Corp.'s Research Laboratory (ELECTRONICS, Jan. 24, p 17 and Apr. 11, p 14). Magnetic thrust engine would take over after launching of spaceship by chemical propellant rockets; the magnetic engine would alter the craft's orbit altitude while it circled the earth or would power it to the moon or other planets. Thrust is produced by using a magnetic field to accelerate and expel a neutral plasma of fully ionized gas. Device would eliminate need to separate ions, an integral part of an ion rocket system, and might have other advantages.

NEW ENGLAND ELECTRONICS FIRMS are cheered by optimistic reports from two quarters. First National Bank of Boston says the industry's growth is favorably influencing the region's economic foundation and offers special promise for the year ahead. Associated Industries of Massachusetts, which quizzed 100 Massachusetts electronics firms and got 61 replies after last fall's defense stretchouts, reports: Electronics production employment by June 1 will be three percent ahead of last October. Survey also showed: (1) there has been no reduction in number of persons in basic research; (2) there will be a 10 percent overall increase in the number of engineers and a five percent rise in technicians by June 1 over Oct. 1957.

INFORMATION THEORY IN RUSSIA continues to get priority attention, it is indicated by a Tass report about a recent meeting of the Moscow Engineers Club. More than 200 Soviet scientists and engineers were told that "on a frequency of 3,000 cycles, with a certain amount of interference, 300 telephone conversations, and not just one, can be held simultaneously on one line." Mathematician Vladimir Siforov said that in the future radio stations will be able to use dozens of times more short-wave bands for broadcasting than at present.

EARTH SATELLITE-BORNE TELESCOPE and tv equipment weighing about a ton require solution of the problems of automatic stabilization and control, says James H. Doolittle, chairman of the National Advisory Committee for Aeronautics. He told the Senate's Special Committee on Space and Astronautics that the job was a straightforward one that "could be accomplished with reasonable promptness if sufficient scientific and technical manpower is assigned to the work."

---

FIGURES OF THE WEEK

RECEIVER PRODUCTION
(Source: EIA) May 2, '58 Apr. 25, '58 May 3, '57
Television sets, total 77,344 64,999 81,864
Radio sets, total 149,604 162,421 280,490
Auto sets 39,754 46,574 103,015

STOCK PRICE AVERAGES
(Source: Standard & Poor's) May 7, '58 Apr. 30, '58 May 8, '57
Radio & electronics 64.24 45.57 51.88
Radio broadcasters 61.21 59.16 69.26

FIGURES OF THE YEAR
Totals for first two months
1958 1957 Percent Change
Receiving tube sales 56,466,000 82,031,000 -21.2
Transistor production 6,061,955 3,221,000 +88.2
Cathode-ray tube sales 1,178,046 1,489,223 -21
Television set production 804,396 914,887 -12.1
Radio set production 1,903,418 2,350,294 -19.0
TV set sales 1,030,213 1,148,796 -10.3
Radio set sales (incl. auto) 954,705 1,088,392 -12.3

MORE FIGURES NEXT PAGE
Military Backlog $4.9 Billion

Prime contracts run four percent ahead of last year. Subcontracts are down about 16 percent.

Electronics producers should rack up sales of $58.3 billion this year—$600,000 million above the record 1957 high of $7.7 billion. Existing military backlogs give good reason for predicting this increase in business.

The Office of Naval Material reports current military backlog figures in its recently released sixth annual survey of electronics industry capabilities.

As of Jan. 1, 1958, the total military contract backlog of the electronics industry amounted to $4.922 billion, about one percent ahead of the backlog of Jan. 1, 1957. However, the 1958 prime contract backlog of $4.206 billion was four percent ahead of the 1957 figure; while the subcontract backlog trailed the 1957 one by 16 percent.

Average military backlog per employee for Jan. 1958 was $10,088. This is an increase of $718 over the average military backlog per employee figure of Jan. 1957.

The backlog-per-employee figures vary according to company size. As of Jan. 1, 1958, firms with over 5,000 employees averaged $11,413 in backlog per employee. Firms with 51 to 100 employees averaged $4,485. In most cases, size of backlog as well as backlog per employee was, as might be expected, larger for larger firms.

On the average, 85.4 percent of military backlogs were in prime contracts. However, the proportion of prime and subcontracts varied considerably with company size.

Firms with over 5,000 employees had an average of 92.0 percent of their military backlogs in prime contracts. The survey also shows that companies with 51 to 100 employees had an average of 58.2 percent of their military backlogs in prime contracts.

Reveals USAF's Weapons Plans

Air Force weapon system planning was revealed in considerable detail by Lt. Gen. C. S. Irvine, Deputy Chief of Staff, Materiel, at Sylvania's formal opening ceremonies recently for its new Amherst Engineering Laboratory in Williamsville, N. Y.

The evolution of manned aircraft is planned as follows:

Mach 2, above 75,000 ft altitude: Convair's electronics-laden B-58 Hustler will replace the B-47 intermediate-range bomber and provide support for long-range B-52's, conceivably as electronic countermeasures planes. Eight or 10 B-58's are currently operable. Flight tests prove that speed (and it is assumed, range) is better than expected.

An air-to-surface guided missile is in the works for the Hustler. It will have to be faster than the B-52's Hound Dog missile since the B-58 flies faster than Hound Dog will. North American's Hound Dog will be ready for flight testing next summer.

Mach 3, above 100,000 ft altitude: North America's B-70 (ELECTRONICS, Feb. 21, p 15) and F-108 will reveal a radical departure from present configuration. Radar systems will have to possess far greater range than is currently possible with present airborne sets. The B-70 will carry and air launch an MRBM (Medium Range Ballistic Missile). Three companies are currently working on design details of this 500-mi range ballistic bird.

Mach 5 or 6: Not yet being designed, this later generation of supersonic vehicles will be introduced into the program only in the event that the gap between operational B-70's and manned space...
Used where clean high vacuums are required... processing vacuum tubes... evacuating accelerator sections and ionization chambers... laboratory and industrial applications.

**SIMPPLICITY ITSELF**

The VacIon high vacuum pump operates entirely electronically—no moving parts.

**NO OIL VAPORS**

Cold traps or vapor traps are not necessary.

**ULTRA HIGH VACUUM**

Creates vacuum in excess of $1 \times 10^{-9}$ mm Hg; one trillionth of an atmosphere. This small compact unit has a pumping speed of 10 liters/second at $10^{-7}$ mm Hg.

**LOW POWER CONSUMPTION**

At $10^{-6}$ mm Hg power consumption is only 0.24 watts. No continuously running fore-pump is required.

**MEASURES ITS OWN VACUUM**

The current indication on the power supply meter provides a practical measurement of pressure.

**SIMPLE INSTALLATION**

Complete unit consists of the VacIon Pump shown above, a permanent magnet, and a power supply.

**ONLY FROM VARIAN**

The VacIon high vacuum pump has no equal for simplicity, cleanliness, and compactness. Get the complete story in the VacIon High Vacuum Pump Engineering Bulletin—write for your copy today.

**LONG LIFE**

Operating life in excess of 10,000 hours at $10^{-6}$ mm Hg has been obtained. Lifetime expectancy is almost limitless at $10^{-6}$ mm Hg.
Heart of a gyroscope is the rotor made of new Mallory 1000 Gyromet®—a high density alloy especially developed to withstand the extreme rotational speeds in tomorrow's inertial guidance systems. Mass elements such as counterweights, balances, dummy warheads, can be made extra compact by designing with Mallory 1000 metal—a unique powder alloy with twice the density of lead and excellent machinability.

Sub-assemblies made to order, in Mallory's Electronic Assembly Department, Frankfort, Indiana, receive the attention of a skilled staff well experienced in every phase of circuit research, component development, assembly and testing. Now qualified under the U.S. Army Signal Corps Reduced Inspection Quality Assurance Plan (RIQAP), this Mallory department is ready to undertake production of single units or complete systems.

For Greater Reliability...

Ideal power for transistors is the mercury battery, pioneered by Mallory. High energy in small volume, long life and constant discharge characteristics make this battery valuable in miniaturized, self-powered equipment. Another Mallory development is the Solidion® solid state battery, capable of storage for over 15 years. It is ideal for stockpiled systems.

New high temperature miniature wirewound control...only 3/16" in diameter, is designed for ambient temperatures of 200°C and up. It has exceptionally high power dissipation for its size—rated 5 watts at 145°C. Control is gold plated to assure maximum shelf life, resistance to corrosion and high heat transfer. Easily adaptable to hermetically sealed mounting.
High temperature tantalum capacitors, pioneered by Mallory for -55°C to +200°C service, include special designs for extreme acceleration. Newest models are even smaller in size, to fit miniaturized missile-borne telemetering circuits. In addition, Mallory manufactures a full line of subminiature and solid electrolyte tantalum capacitors.

In today's accelerated defense programs, electronic missile guidance systems need an extra measure of dependability in order to perform a critical service at a precise moment. You can build this extra dependability into research circuits, prototypes and production models—when you specify Mallory precision-made components.

When your problems are new or unusual, you can get expert assistance from the experienced Mallory application engineering team. Because of the wide range of components we supply, you can count on us for engineering consultation not only on component design and application, but also in other important areas such as contact metallurgy and sub-assembly manufacturing.

Shown here are just a few of the Mallory products and services that can help put peak reliability in your missile guidance circuitry. It will pay you to check your needs against the broad Mallory line. Write today for a consultation on your specific projects. For prompt delivery of stock components, call on your nearby Mallory distributor.

Serving Industry with These Products:
Electromechanical — Resistors • Switches • Tuning Devices • Vibrators
Electrochemical — Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical — Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.
flight (Dynasoar) drags out for too long a period.

First step toward space: North American's X-15, early next year, will carry Capt. Iven Kincheloe to over 100-mi altitude and faster than 3,600 mph. A transponder beacon carried in the nose of the plane will help ground radar stations track the test flights. Major electronic equipment to be used consists of transducers and telemetering gear to measure, record and transmit flight data.

Dynasoar: After the X-15, Dynasoar, or a similar type project, should result in a vehicle that will safely put a man in orbit for one or more trips around the earth before landing. Presumably the Dynasoar vehicle will require advanced-type electronic telemetering and control equipment.

Space vehicles: As a natural outgrowth of knowledge gained from these experiments, the Air Force will probably develop piloted space vehicles with weapon deployment and counter-offensive capabilities. These will perform within the earth's gravitational field but well outside 99 percent of its atmospheric envelope.

10,000-Transistor Computer Out

Transistors are mounted on 332 printed-circuit cards for ease of access

TRANSISTORIZED computers are beginning to appear in the marketplace.

Philo Corp.'s Transac, now being delivered to its first customers after almost three years of development and field tests, uses 10,000 surface-barrier transistors in 332 all-transistor printed-circuit cards. The

WASHINGTON OUTLOOK

The Administration's proposal to set up a new civilian space agency to run our electronics-laden space exploration program seems to be in trouble on Capitol Hill. On one hand, the proposal is beset by charges that broad civilian authority over space research could sorely restrict vital military projects. But it is also criticized for establishing too limited civilian powers over space exploration.

Both Pentagon spokesmen and congressional leaders such as Sen. Styles Bridges (R., N.H.) believe that the Defense Dept.'s role in space operations is downgraded by expanding the National Advisory Committee on Aeronautics into a new civilian space research with overall control over the program.

Still, men such as Sen. Clinton P. Anderson (D., N.M.) lament the fact that civilian considerations, in their opinion, are being pushed to the side under the proposed new setup.

These opponents are peeved over provisions putting the new agency under the direction of a committee consisting of only eight government representatives and nine nongovernment specialists (NACA is run by a committee dominated by government officials) and barring the civilian space agency from space programs peculiar to or primarily associated with military weapon systems or military operation.

Says Anderson: "So few things in modern life could not be described as peculiar to military operations that if the same test were used in the rest of our national affairs, we would have a military dictatorship."

The crux of the squabble over civilian vs military control of space is the question of who is to determine whether a specific space project is of a military nature, and thus a function of the Defense Dept.'s Advanced Research Projects Agency, or a nonmilitary nature to be put under the aegis of the newly proposed National Aeronautics and Space Agency.

Deputy Defense Secy. Quarles told the Senate Space Committee that ultimately the questions would be answered by the President. Quarles's statement, of course, begs the question. The President's decisions will be based on advice from his technical advisers. The general consensus is that the Pentagon-NASA relationship on space will be comparable to the Pentagon-NACA relationship on aeronautical research.

The outlook is that the new agency will be engaged mostly in basic research in its own laboratories and in contractor facilities. The Defense Dept. will continue to pull the strings on the more costly phases of hardware development.

The Defense Dept.'s ARPA now has before Congress budget requests totaling $520 million for fiscal 1959, starting July 1. Of this sum, all but $72 million is earmarked for military space projects.

ARPA wants to push work on improved guidance systems to put artificial earth satellites into more precise orbits. It wants to develop satellites to provide communication relay stations, to survey weather patterns, to serve as navigational aids and to act as early warning reconnaissance stations against enemy attack.

Other key space electronics projects are to develop satellite tracking and monitoring systems and to speed up work on ballistic missile early warning systems. Of next year's budget, $137.4 million is earmarked for the latter project—in addition to sums in the Air Force's budget.

May 23, 1958 — ELECTRONICS engineering edition
HERE'S WHY KIN TEL'S DIFFERENTIAL DC AMPLIFIERS FIT IN INSTRUMENTATION SYSTEMS

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input  ■ Input completely isolated from output  ■ Input and output differential and floating  ■ 5 microvolt stability for thousands of hours  ■ .05% linearity, 0.1% gain stability  ■ Gain of 10 to 1000 in five steps  ■ >5 megohms input, <2 ohms output impedance  ■ 120 cycle bandwidth  ■ Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier...features that make this amplifier really work in instrumentation systems...features that will help solve your instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads, and can be used inverting or non-inverting.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL – the world's largest manufacturer of precision, chopper-stabilized DC instruments.

KIN TEL 114A differential DC amplifiers...convenient, interchangeable plug-in mounting in either 6-amplifier 19" rack mount modules or single-amplifier cabinets.

5725 Kearny Villa Road, San Diego 11, Calif.
Phone: BRowning 7-6700
Representatives in all major cities
circuit cards in the arithmetic and control circuits are stacked library-fashion behind the control console face for easy accessibility (photo, p 12).

The new unit is an all-binary, parallel, asynchronous computer with magnetic-core storage. It comes in two models. The smaller model operates on 8-bit words, uses punched paper tape or punched cards as input-output media. The larger model’s word is 48 bits long. The bigger machine can work with up to 256 magnetic-tape transport units besides punched cards and paper tape.

Tape units will operate at 150 in./sec, read or write 90,000 alphanumeric or 150,000 numeric characters per second. The 16-channel tape will contain 12 numeric bits (or two 6-bit coded alphanumeric characters), plus two parity-check channels and two timing channels. Magnetic tape also makes possible the use of off-line high-speed printers and other transcribing gear.

Magnetic-core storage for both models is a basic unit of 4,096 words. The memory of the larger computer can be expanded in 4,096-word blocks of 65,536 words.

**MILITARY ELECTRONICS**

- New light weight, highly accurate Doppler radar navigation set, to be designed and developed by General Precision Labs, will go into IBM’s bomb-nav system (AN/ASQ-28) for North America’s B-70.
- Raytheon is supplying Doppler radar for Sperry’s bomb-nav system in Convair’s B-58 (Electronics, Feb. 21, p 15).
- An improved solid-propellant Bomarc, ground-to-air electronically guided interceptor missile with a 400-mi range (Electronics, Feb. 21, p 36), is scheduled to begin a several-years-long test program soon. Program will be carried out by USAF and prime contractor Boeing. The current Bomarc model, which has a 200-mi range, has been fired approximately 40 times to date. Four Bomarc launching sites are under construction in the U.S.
- First step toward putting a 100-ft balloon into orbit took place last month when NACA successfully sent a 12-ft balloon to 50 miles by rocket. Having a 100-ft balloon in orbit will be useful in studying long range communications, NACA director Hugh L. Dryden says.

- "Introduction of single side-band (SSB) radio equipment into the fleet is being accelerated," Rear Admiral H. C. Bruton, Director of Naval Communications, says. Also, "We have great hopes for meteor scatter as a means of solving some of our ship-to-shore communications problems."

- British IRBM under development by de Havilland Propellers is now officially confirmed. Firm says the missile, which eventually will be test fired at Australia’s Woomera range, could carry a thermonuclear warhead “with extreme accuracy over a range of several thousand miles to a surface target.”

- New light weight, highly accurate Doppler radar navigation set, to be designed and developed by General Precision Labs, will go into IBM’s bomb-nav system (AN/ASQ-28) for North America’s B-70.

**BBC Perfects Video Recorder**

**British Broadcasting Corp. engineers** have designed and built a video tape recorder after two years of development in the BBC research lab.

Known as VERA (Vision Electronic Recording Apparatus), the new recorder uses 1-in. wide tape.

The British recorder utilizes longitudinal recording. BBC tape travels at 200 ips, carries a 15-min program on a 204-in. diam reel.

The new unit records on three tracks, two for video and one sound, to produce the 2.5-mi bandwidth required for the BBC 405-line, 25-frame tv system. Longitudinal technique offers the advantage of easy splicing, is conducive to simultaneous recording and monitoring.

There’s no color tv broadcast in Britain at present, but BBC engineers feel VERA is not limited to black and white.

**Electronic Cars: How Soon?**

A GM spokesman told **Electronics** a few days ago that if current prototypes of electronic auto controls prove practical and salable, an enormous new market will open for component manufacturers.

Conventional operator’s controls, he said, may be completely eliminated within the next few years.

Two new developments giving weight to this prediction were announced by GM and Ford at the Governors’ Committee for Highway Safety conference last month.

In the system demonstrated by GM’s Research Staff, a single con-
Hughes medium power, silicon rectifiers

The exceptionally high efficiency of these rectifiers, obtained by advanced development and construction techniques, makes possible power supply design which was previously impossible. Efficiency like this means less power loss in the rectifier and, for a given size of rectifier, more power to the load. Cooler operation also results, thereby contributing increased life since there is less heat to dissipate.

In most instances, the voltage drop across the rectifier is so small—and it is constant throughout the life of the rectifier—that it may be neglected in power supply design. The low drop improves regulation of the power supply too.

So specify the types listed at right and capitalize fully upon the advantage of high rectifier efficiency. In addition to the types shown, Hughes has two groups of 1N-numbered units, one with a lead-mount configuration and the other in the standard JETEC 7/16" hex package.

For literature or a visit from one of our sales engineers, please write: HUGHES PRODUCTS, Semiconductor Division, International Airport Station, Los Angeles 45, California

More Power to the Load

<table>
<thead>
<tr>
<th>STUD-MOUNT TYPES</th>
<th>Peak Inverse Voltage (Volts)</th>
<th>Average Rectified Current (Amps max.)</th>
<th>Average Inverse Voltage (Volts)</th>
<th>Average Inverse Current (mA, max.)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR10621</td>
<td>100</td>
<td>3.0</td>
<td>150</td>
<td>0.5</td>
</tr>
<tr>
<td>HR10673</td>
<td>200</td>
<td>3.0</td>
<td>150</td>
<td>0.5</td>
</tr>
<tr>
<td>HR10675</td>
<td>300</td>
<td>3.0</td>
<td>150</td>
<td>0.5</td>
</tr>
<tr>
<td>HR10677</td>
<td>400</td>
<td>3.0</td>
<td>150</td>
<td>0.5</td>
</tr>
<tr>
<td>HR10679</td>
<td>500</td>
<td>2.0</td>
<td>135</td>
<td>0.5</td>
</tr>
<tr>
<td>HR10681</td>
<td>600</td>
<td>2.0</td>
<td>135</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEAD-MOUNT TYPES</th>
<th>Average Rectified Current (mA max.)</th>
<th>Average Inverse Voltage (Volts)</th>
<th>Average Inverse Current (mA, max.)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR10422</td>
<td>100</td>
<td>350</td>
<td>100</td>
</tr>
<tr>
<td>HR10423</td>
<td>200</td>
<td>350</td>
<td>100</td>
</tr>
<tr>
<td>HR10424</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>HR10425</td>
<td>400</td>
<td>350</td>
<td>100</td>
</tr>
</tbody>
</table>

* Averaged over one cycle at full rated conditions of current, voltage, and temperature with a resistive load.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

© 1958, HUGHES AIRCRAFT COMPANY

ELECTRONICS engineering edition — May 23, 1958

CIRCLE 9 READERS SERVICE CARD
Electronic Tracer

No templates are needed by electronic tracer control, which scans line drawings and steers steel-cutting torches. Trace system consists of vibrator-type scanner, phototransistor, and a closed-loop servo.

Mobile Radio to Double by 1968

DETROIT—Mobile radio use will double in next ten years, $14 million will be spent on equipment, and licenses will exceed 600.

These are predictions by the National Mobile Radio System which held its 10th annual meeting in Detroit last week.

Among design features shaping up for the future in the growing medium are message recorders, direct dial systems, personal paging devices and smaller transistorized units working automatically.

System president, Norman Medlar, says mobile radio is "definitely booming," especially in western U.S. He says future developments must entail educating potential users to the values of mobile radio.

Tomorrow's customers are expected to include a growing number of municipal and medical users, as well as industrial services needing rapid links between field and base personnel.

NMRS membership today draws on 286 license holders. In 1949
THE FIRST POTENTIOMETER
to satisfy CHARACTERISTIC "Y"
of MIL-R-94

The Type J (RV-4)
The popular Type J potentiometer is designed for operating continuously at 70°C ambient at full rating of 2 watts. Control is always smooth—without abrupt resistance changes—because of the solid, hot molded resistance element that is used. Even initially, noise characteristics are extremely low, but actually improve with use. The Type J potentiometer is made in single, dual, and triple units with various types of shafts, and with a built-in line switch. It is also furnished encapsulated in epoxy resin. Total resistance values range from 50 ohms to 5 megohms. Taps can be supplied. Type J is available in all standard tapers.

ALLEN-BRADLEY
Hot Molded Composition POTENTIOMETERS

The Type G (RV-6)
This tiny potentiometer—only 3/4 inch in diameter—is designed for use where space must be conserved without sacrificing performance. The solid, hot molded resistor element assures long operating life, and low noise level which improves with use. Full rating of 3/2 watt at 70°C ambient. Available with plain or lock type bushings, and with line switch. The Type G can also be supplied encapsulated in epoxy resin. Total resistance values from 100 ohms to 5 megohms. Available in all standard tapers.

When you want the ultimate in performance—potentiometers that not only satisfy—but exceed—the most rigid moisture resistance and thermal cycling requirements of MIL-R-94B, Characteristic "Y"—insist on Allen-Bradley.
**TYPE K**
**HIGH TEMPERATURE**
Hot Molded Composition Potentiometer

Especially designed for high temperature applications, the Type K has ultraconservative ratings of 1 watt at 125°C, 2 watts at 100°C, and 3 watts at 70°C ambient temperatures. It can be operated at 150°C—under "no load" conditions. Thus, the Type K potentiometer far surpasses the requirements of characteristic "Y," of MIL-R-94B. The solid, hot molded resistor element assures long life, smooth operation, and low "noise"—particularly after long use. Identical in size and physical construction to the well-known Type J potentiometer. Also furnished in the same types and resistance ranges.

**For Industrial Electronic Applications**
**Rugged...Reliable!**

**TYPE H** Hot Molded Composition Potentiometer

The Type H variable resistor is especially designed for applications requiring smooth control and long life—in a 5-watt rating. The dual track, solid resistance element eliminates all moving metal-to-metal electrical contacts, making it outstanding for its low "noise" characteristics, both initially and after long use. It provides an operating life of over 100,000 cycles with no appreciable change in resistance. The Type H is rated 5 watts at 40°C, with a maximum continuous voltage of 750 volts. Total resistance—50 ohms to 2.5 megohms.
A new device invented at Bell Laboratories "reads" a numeral while it is being written and instantly converts it into distinctive electric signals. The signals may be employed to make a numeral light up in a display panel, as above, or they may be sent to a computer or to a magnetic "memory" for storage.

The writing is done with a metal stylus on a specially prepared surface. Two dots, one above the other, are used as reference points. Seven sensitized lines extend radially from the dots. Transistorized logic circuits recognize numerals according to which lines are crossed.

The concept of a number-reader has interesting possibilities as a new means of communication from humans to machines. For example, in an adjunct to a telephone, it might provide inexpensive means of converting handwritten data into signals which machines can read. The signals could be transmitted through the regular telephone network to a teletypewriter or computer at a distant point. In this way, a salesman might quickly and easily furnish sales data to headquarters, or a merchant might order goods from a warehouse.

Modern communication involves many more fields of inquiry than the transmission and reception of sound. The experimental number-reader is but one example of Bell Telephone Laboratories work to improve communications service.
there were only 43. Today’s operator runs an average of 30 mobile units.

**Microwave Group Probes Solid State**

EFFECTS of ferrites and solid-state amplifiers on microwave were demonstrated this month at a three-day symposium sponsored by the IRE Professional Group on Microwave Theory and Techniques at Stanford University.

One paper told about ferrite phase shifter for 200 to 600 mc. The two-dimensional design exhibits less than 1 db loss, is capable of 0.5 degree phase shift.

Also disclosed was a ferrite serrodyne that makes possible translation of X-band signals up to 50 kc.

Other new ferrite devices introduced at a session included broadband rotators using quadruply ridged circular waveguide, a high-power load isolator with power capacities of 5 kw at S-band and a low-energy ferrite switch. Switch uses a rectangular ferrite ring in transverse plane of the rectangular waveguide and a single wire loop in H-plane for magnetizing.

Specific solid-state devices discussed included a uhf inverter amplifying at 500 mc and pumped at 5,500 mc. The amplifier gives a 10-db gain and a 100-ke bandwidth. It uses chromium-doped potassium cobalticyanide at 1.6 K.

**Follow the Sun**

![Heliosat](image)

Heliosat which deflects sunlight into solar furnace is centered on sun by group of phototubes and servo controls. Furnace is stationary so its instrumentation is not disturbed. Operator at GE missile lab checks temperature (6,000 F) with pyrometer.

**New Computers Shown on Coast**

LOS ANGELES—Highlights of the Western Joint Computer Conference held recently were the unveiling of three digital computers and a mechanical translation system.

Rapid handling of large amounts of complex data is feature of Sperry Rand’s M-460 stored-program computer. Synchronous logic with a 2-mc clock rate is used. The computer operates in the parallel binary mode with 30-bit instruction and 15 or 30-bit data words.

A model of a special-purpose digital computer using diode and resistor logic and approximately 1,000 high-speed transistor pulse amplifiers was announced by Bell Labs. Quartz ultrasonic delay lines are used in its entirely solid-state storage unit.

Primary advantage of the RCA 501 transistor computer system, described at the conference, is its high tape and data speed.

The University of Washington demonstrated this month at a three-day symposium sponsored by the IRE Professional Group on Microwave Theory and Techniques at Stanford University.

MEETINGS AHEAD


May 27-28: Second EIA Conf. on Maintainability of Electronic Equip., Univ. of Penn., Phila.

June 2-4: National Telemetering Conference, AIEE, ISA, ARS, Lord Baltimore Hotel, Baltimore, Md.

June 2-4: Automation and Computers, Short Course and Conf., Univ. of Texas, College of Engineering, Austin, Texas.

June 4-6: Armed Forces Communications and Electronic Assoc., Exhibit, Hotel Sheraton Park, Washington, D. C.

June 5-6: Second National Conference on Production Techniques, IRE, PGP1, Hotel New Yorker, New York City.


June 16-18: Military Electronics Second National Convention, Sheraton Park Hotel, Washington, D. C.


July 6-18: Underwater Missile Engineering, Graduate Course, Penn State Univ., University Park, Pa.

1/2-AMPERE FAST SWITCHING DIODE

NEW FROM SPERRY is this high-temperature S-130 series silicon diode which gives you greater current-handling capability than germanium diodes—with no sacrifice in recovery time!

Check for yourself the performance characteristics of this new diode in the graphs at left, then compare them with our minimum specifications below.

1 FAST RECOVERY. Maximum recovery time is 0.8 microseconds to return to 10 K ohms. Recovery test switches from a forward current 2 microsecond pulse of 500 ma, to a reverse voltage of −50 volts with a loop impedance of 1 K ohm.

2 HIGH FORWARD CONDUCTANCE. The forward current specification is 400 ma at 25° C with 1.0 volt maximum drop under static (d-c) conditions. Conductivity increases with temperature—diagram shows typical “x-y” plots at 25° and 150° C.

3 LOW LEAKAGE at high inverse voltage. Specification at 25° C is maximum 0.25 μa at rated voltages.

4 HIGH INVERSE VOLTAGE. Saturation voltages can be supplied in a range from 40 to 200 volts for this high current series.

5 HIGH-TEMPERATURE OPERATION. Typically, leakage current is no greater than 30 μa at working inverse voltage and 150° C. Diodes are rated for both operation and storage at temperatures from −65° to +150° C.

Address all inquiries: Marketing Department, Great Neck, N. Y., or Sperry Gyroscope offices in Brooklyn, Cleveland, Seattle, San Francisco, Los Angeles, New Orleans, Boston, Baltimore, Philadelphia.
For mobile electronic equipment —

**New Cathodes Lick The Overvoltage Threat**

High heater voltages ordinarily doom electron tubes to a short life. But Superior's new cathode alloy, Cathaloy® A-31, gives them a resistance to overvoltage damage unmatched by any other alloy.

This has been proved in car radios and other mobile electronic equipment. Voltages commonly range upwards of 25% over specification. And tubes with these new Superior cathodes consistently outlast others—by hundreds of hours.

This significant advance in electron tube performance is one of the practical benefits that keep coming your way from the laboratories of Superior Tube... world's leading independent supplier of cathodes for electron tubes. For information on Superior cathodes, write for Catalog Section 51, Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

Survives high heater voltage. New Superior Tube cathode prolongs electron tube life in mobile electronic equipment.

Superior Tube
The big name in small tubing

**NORRISTOWN, PA.**

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts, such as those used in the electron guns that go with this new cathode.
thousands of "SPECIALS" without DELAY!

THESE 22 SERIES OF STANDARD SWITCHES WILL HANDLE ALMOST ANY LOW-CURRENT APPLICATION...

- **GENERAL PURPOSE**: Up to 12 positions; 30°, 45°, 60° throw.
  - Series H
- **LOW COST**: Up to 12 positions; staked or strut screw construction.
  - Series OH
- **18-POSITION**: Single or double eyelet fastening of clips.
  - Series L
- **CONCENTRIC SHAFTS**: Dual and triple shafts with many wafer types.
  - Series MF
- **SIMPLE SWITCHING**: Up to 12 positions combined with AC switch.
  - Series 52, 54
- **LEVER OPERATED**: 2 to 5 positions; numerous versions using std. wafers.
  - Series 185
- **SOLENOID SWITCH**: Oak wafers with G. H. Leland type of Rotary Solenoid.
  - Series 170, 175
- **SLIDE**: 2-POSITION: Shorting type with floating slider.
  - Series 70
- **COMPLICATED SWITCHING**: 2 to 4 positions; up to 20 poles; very thin.
  - Series 150
- **ULTRATHIN**: 1 to 12 buttons; up to 14 contacts per button.
  - Series 131

For Recommendations on Unusual Applications, send us a sketch and short description.

OAK MFG. CO.
1260 Clybourn Ave., Dept. G, Chicago 10, Illinois
Phone: MOhawk 4-2222

For Reader's Service Card, circle 15 on the subscription reply card.

Electronics engineering edition — May 23, 1958
A NEW APPROACH TO OLD FASTENING PROBLEMS!

NYLO-FAST ALL-NYLON FASTENINGS OPEN NEW HORIZONS IN ELECTRONIC DESIGN AND FABRICATION

NYLO-FAST's low dielectric constant and high dielectric strength reduce the number of components in many assemblies by eliminating the need for insulating bushings, washers and couplings.

Consolidating several functions in one fastening, (NYLO-FAST also offers high resistance to heat, shock, vibration and chemical solvents) this new product cuts assembly costs and permits space saving by reducing "safety arc" space.

Recognizing these advantages, designers throughout industry and in several government departments now specify "NYLO-FAST fastenings."

Don't just take our word for it. Make your own most rigorous tests. Determine the value of these new fastenings to you, in design engineering and practical, profitable fabrication. Write today for the NYLO-FAST sampling kit.

ANTI-CORROSIVE PLASTICS DIVISION

METAL PRODUCTS CO., INC.
CASTLETON-ON-HUDSON, NEW YORK

May 23, 1958 — ELECTRONICS engineering edition
This new fast-rise oscilloscope with the Tektronix Plug-In Feature is extremely versatile and easy to operate. With a single Type 53/54 fast-rise plug-in preamplifier the Type 543 handles the usual applications in the DC-to-30 MC range. Many other inexpensive plug-in units are available for the more-specialized jobs, including one for transistor rise, fall, delay and storage time testing.

**VERSATILITY**
Nine Available Plug-In Preamplifiers—Wide Band, Dual Trace, Low Level, Differential, and others for specialized applications.

**HIGH PERFORMANCE**
DC to 30 MC with fast-rise plug-in units.
DC to 24 MC with dual-trace plug-in unit.
0.02 ps/sec/cm to 15 sec/cm sweep range.

**EASY OPERATION**
24 Calibrated Direct-Reading Sweep Rates.
Sweep Magnification—2, 5, 10, 20, 50, and 100 Times.
Preset Triggering—Eliminates triggering adjustments in most applications.
Single Sweep Operation—Lockout-Reset Circuitry for one-shot recording.

**MAIN CHARACTERISTICS**

**VERSATILITY**
Nine Available Plug-In Preamplifiers—Wide Band, Dual Trace, Low Level, Differential, and others for specialized applications.

**HIGH PERFORMANCE**
DC to 30 MC with fast-rise plug-in units.
DC to 24 MC with dual-trace plug-in unit.
0.02 ps/sec/cm to 15 sec/cm sweep range.

**EASY OPERATION**
24 Calibrated Direct-Reading Sweep Rates.
Sweep Magnification—2, 5, 10, 20, 50, and 100 Times.
Preset Triggering—Eliminates triggering adjustments in most applications.
Single Sweep Operation—Lockout-Reset Circuitry for one-shot recording.

**HIGH WRITING RATE**
250 cm/ps sec. 10-kv accelerating potential assures bright trace for operation in single-sweep applications, and with low sweep repetition rates.

**TYPE 543 PRICE**, without plug-in units .................................................. $1200
Type 53 54K Fast-Rise Unit ........................................................ $125
Type 53 54C Dual-Trace Unit ......................................................... $275
Type 53 54R Transistor Test Unit ................................................... $300

Prices f.o.b. factory.

Please call your Tektronix Field Engineer or Representative for complete specifications and, if desired, to arrange for a demonstration at your convenience.

**Tektronix, Inc.**
P. O. Box 831 • Portland 7, Oregon
Phone Cypress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

**ADD SWEEP LOCKOUT** to your Tektronix Type 531 and 541 Oscilloscopes—order Modification Kit K531 Sweep Lockout, Tek. 040-118 ........ $25
for Type 532
K532 Sweep Lockout, Tek. 040-147 ........ $25

ELECTRONICS engineering edition—May 23, 1958
There's a "one-best voltmeter" for every job... and you'll find it here!

Makeshift measurement—where you stretch a faithful but outdated instrument to or beyond its limitations—this takes time. Save engineering time by choosing and ordering now the "one-best" -hp- voltmeters fitting your measurement need. -hp- offers a complete array of precision, dependable voltmeters, each specifically suited to a given type of voltage measuring job. Check the brief data here, then ask your -hp- representative for demonstration—on your bench and on your problems!

WIDE RANGE—10 cps to 4 MC
-hp- 400D, probably the best -hp- voltmeter ever built. Covers all frequencies 10 cps to 4 MC. Extremely sensitive, accurate within ±2% to 1 MC, measures 0.1 mv to 300 v. Direct reading in dbm. 10 megohm input impedance insures negligible loading on circuits under test. New amplifier circuit with 56 db feedback insures maximum stability and freedom from change due to external conditions. $225.00.

MULTI-PURPOSE to 600 KC—$200
-hp- 400AB, unique value, broad utility and long-term dependability in a low cost laboratory instrument. Covers 10 cps to 600 KC, measures from 0.3 mv to 300 v in 11 ranges. High stability, high sensitivity, accuracy ± 2% full scale from 20 cps to 100 KC. 10 megohm input impedance; 25µf shunt. Meter reads direct in volts and dbm. $200.00.

EXTREME ACCURACY of 1%
-hp- 400H, designed for users who need highest accuracy within ± 1% to 500 KC, ± 2% to 1 MC and ± 5% full range. Covers frequency range 10 cps to 4 MC. Has 5" meter with mirror scale, measures voltages 0.1 mv to 300 v. High 10 meghm resistance minimizes circuit disturbances; amplifier with 56 db feedback insures lasting stability. Direct reading in db or volts. Extremely high quality throughout. $325.00.

-hp- also offers a broad variety of voltmeter accessories including voltage dividers, connectors, shunts and multipliers to extend the useful range of your equipment. Details on request from your -hp- representatives or direct; or see page 46 of current -hp- catalog.

CIRCLE 18 READERS SERVICE CARD

May 23, 1958 — ELECTRONICS engineering edition
NEW!
-hp- 400L
Logarithmic Voltmeter

High accuracy
10 cps to 4 MC
5" true log voltage scale
Linear 12 db scale
10 db range steps
Generous scale overlap

New, convenient -hp- 400L is a unique instrument combining a specially designed logarithmic meter movement with the many desirable features of -hp-400D and 400H voltmeters.

Model 400L's logarithmic voltage scale plus unusually long scale length provides an instrument of maximum readability and an accuracy which is a constant percentage of the reading. Voltage scales are more than 5" long, with a 12 db scale spread across the full scale length. The meter is mirror backed for maximum accuracy. A range switch changes voltage sensitivity in 10 db intervals. This feature, together with the 12 db scale, provides generous overlap and is of particular convenience in work involving decibel levels.

Other features of the new 400L include exceptional long term stability, high sensitivity, high input impedance, large overload capacity, compact size and highest quality construction.

Model 400L may also be used as a stable amplifier.

**SPECIFICATIONS -hp- 400L**

<table>
<thead>
<tr>
<th>Voltage Range:</th>
<th>0.3 mv to 300 v, 12 ranges, 1-3-10-30 sequence.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range:</td>
<td>10 cps to 4 MC</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>± 2% of reading, or ± 1% of full scale, whichever is more accurate, 50 cps to 500 KC; ± 3% of reading, 20 cps to 1 MC; ± 5% of reading, 10 cps to 4 MC (includes line voltage changes 103 to 127 volts.)</td>
</tr>
<tr>
<td>Long Term Stability:</td>
<td>Calibrated in RMS value of sine wave. Log voltage scale, 0.8 to 3 v and 0.3 to 1 v. Db scale - 12 to 10 db, 10 db intervals between ranges.</td>
</tr>
<tr>
<td>Calibration:</td>
<td>Output terminals permit 400L to amplify small signals or monitor waveforms with an oscilloscope.</td>
</tr>
<tr>
<td>Input Impedance:</td>
<td>10 megohms shunted by 15 μF, 1 to 300 v, 25 μF shunt on 0.001 to 0.3 v range.</td>
</tr>
<tr>
<td>Amplifier Usage:</td>
<td>Output terminals permit 400L to amplify small signals or monitor waveforms with an oscilloscope.</td>
</tr>
<tr>
<td>Power Supply:</td>
<td>115/230 v ± 10%, 50/1000 cps, approx. 100 watts.</td>
</tr>
<tr>
<td>Price:</td>
<td>-hp- 400L (cabinet) $325.00. -hp- 400LR (rack) $330.00.</td>
</tr>
</tbody>
</table>

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

**HEWLETT-PACKARD COMPANY**
4650A PAGE MILL ROAD * PALO ALTO, CALIFORNIA, U.S.A.
Cable "HEWPACK" * Davenport S-4451
FIELD ENGINEERS IN ALL PRINCIPAL AREAS
Lumped-constant
DELAY LINES
the way you want them!

Epsco has met these limits — what are yours?

* Delays from 20 millimicroseconds to 200 milliseconds or longer, if desired.
* Delay to rise time ratios up to 50.
* Delay tolerance of 0.1% or 10 millimicroseconds, whichever is greater.
* Characteristic impedance tolerance of 1% from 50 to 5,000 ohms.
* Spurious signals measured at the terminated input after twice delay time can be held to less than 1%.
* Temperature compensation to ±10 ppm/°C over a range of -50°C to +150°C. (Patent pending)

If you’re involved with lumped-constant delay lines, draw closer. Epsco has application-engineered a wide range of such devices for coding, decoding, telemetering systems, speech synthesis, auto and cross-correlation, trigger delay, pulse forming circuits, etc.

Unique packaging is our meat: just tell us your space, configuration and mounting requirements and performance specifications. If you are concerned with environmental problems, we will test your delay lines for shock, vibration, moisture, altitude, temperature, etc., in Epsco’s own in-plant environmental laboratory.

Custom engineering-production of electronic components (shift registers, magnetic logic elements, delay lines, special pulse transformers, etc.) is our specialty. You can count on Epsco’s cooperation and conscientious service right down the line. Your inquiry will receive prompt action. Write for Delay Lines Technical Bulletin DL-55.


START-TO-FINISH cooperation . . . an Epsco guarantee

Epsco
COMPONENTS

May 23, 1958 – ELECTRONICS engineering edition
New 5-megawatt ferrite isolator for high-power radars

FORCED AIR COOLED!

Another Sperry contribution to improved performance of radar systems is this new Model D44S1 ferrite isolator. It boosts efficiency of S-band radars by allowing optimum operation of high-power tubes.

In addition, this isolator protects high-power tubes from load mismatches, and eliminates frequency and power variations due to changing load impedances. It is rated at 5 megawatts peak, 5 kilowatts average, and features insertion loss of less than 0.3 db. Compact and small, the Model D44S1 measures only 6 inches in length and 8 inches in diameter. And its air-cooled design eliminates the extra expense and weight of liquid-cooling accessories.

Currently Sperry has under development or in production a wide variety of ferrite devices in addition to those shown here. These include megawatt duplexers, coaxial duplexers, octave-plus bandwidth isolators and attenuators, high-speed switches, modulators and choppers.

Sample quantities of the listed units are available immediately from our stock for test and evaluation in your system, with a view to production tailored to your specific requirements. Contact our nearest district office for further information.

**MODEL D44S1 SPECIFICATIONS**

- Power: 5 mw peak, 5 kw average
- Frequency: 2700-2900 mc
- Insertion loss: less than 0.3 db
- Isolation: 10 db min.
- Cooling: Forced air

**COAXIAL FERRITE ISOLATORS**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>USE</th>
<th>FREQ. RANGE</th>
<th>MAX. AV. POWER</th>
<th>INSERTION/ISOLATION</th>
<th>DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A44L1</td>
<td>Radar</td>
<td>1250-1365 mc</td>
<td>400 w</td>
<td>1 db</td>
<td>10 db</td>
</tr>
<tr>
<td>A44S1</td>
<td>Radar</td>
<td>2700-3100 mc</td>
<td>10 w</td>
<td>1 db</td>
<td>10 db</td>
</tr>
<tr>
<td>D44L1</td>
<td>Relay</td>
<td>1700-2400 mc</td>
<td>30 w</td>
<td>1.5 db</td>
<td>21 db</td>
</tr>
<tr>
<td>A44S4</td>
<td>ECM</td>
<td>2000-4000 mc</td>
<td>400 w</td>
<td>1 db</td>
<td>10 db</td>
</tr>
</tbody>
</table>

**X-BAND FERRITE COMPONENTS**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>USE</th>
<th>FREQ. RANGE</th>
<th>MAX. AV. POWER</th>
<th>INSERTION/ISOLATION</th>
<th>DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A44X1</td>
<td>Isolator</td>
<td>8200-12400 mc</td>
<td>400 w</td>
<td>1 db</td>
<td>10 db</td>
</tr>
<tr>
<td>A43X1</td>
<td>Variable Attenuator</td>
<td>8500-9600 mc</td>
<td>10 w</td>
<td>1 db</td>
<td>30 db var.</td>
</tr>
</tbody>
</table>

**MICROWAVE ELECTRONICS DIVISION**

**SPERRY**

**GYROSCOPE COMPANY**

Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES • SAN FRANCISCO • SEATTLE • IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

ELECTRONICS engineering edition — May 23, 1958

CIRCLE 21 READERS SERVICE CARD 27
Accurate, rapid microwave power measurements

Calorimeter, X-Band Water Load!

Now Sierra offers a new and highly convenient means of obtaining accurate measurements of power from a few watts to kilowatts—at any frequency 7 KMC to 10 KMC.

Model 190A Calorimeter, together with Model XB187A Water Load, measures rf power with approximately 2% accuracy. The Meter consists of a differential thermopile, millivoltmeter, long flow-path valve, water calibrator heater, and appropriate calibrating switches, meter damping resistors, etc. It operates by measuring the temperature of water before and after power has been dissipated in the water load, and presenting the differential on the millivoltmeter.

Model XB187A Water Load, designed for use with 190A Calorimeter, has frequency range of 7 KMC to 10 KMC, VSWR less than 1.2 over full range.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Model 190A Calorimeter</th>
<th>Model XB187A X-Band Water Load</th>
<th>Model 189A Differential Thermopile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale Ranges: 300, 600, 1,500, 3,000 w.</td>
<td>Frequency Range: 7 KMC to 10 KMC.</td>
<td>Converts differential temperatures in flowing liquids to electrical energy. Has 30 pairs of copper-advance junctions enclosed in watertight case. Electrical connections through sealed banana jacks. Water connections to ¼&quot; tubing through Uniflare fittings. Internal resistance approx. 5 ohms; output voltage approx. 1 mv per °C; max. pressure 75 psi; wt. 15 oz. Write for bulletin!</td>
</tr>
<tr>
<td>Max. Pressure: 50 psi.</td>
<td>VSWR: Less than 1.2 full range.</td>
<td></td>
</tr>
<tr>
<td>Meter Sensitivity: 1.5 millivolts.</td>
<td>Power: 1 Kw cw, 300 Kw peak.</td>
<td></td>
</tr>
<tr>
<td>Thermopile Sens.: 1 mv per °C.</td>
<td>Coupling: UG-52/U choke flange.</td>
<td></td>
</tr>
<tr>
<td>Weight: Approx. 21 lbs.</td>
<td>Probe: Fixed, BNC UG-290/U.</td>
<td></td>
</tr>
<tr>
<td>Dimensions: 8½&quot; x 9&quot; x 17&quot;.</td>
<td>Size, Weight: 18½&quot; long. Approx. 2½ lbs.</td>
<td></td>
</tr>
</tbody>
</table>

Sierra 186A series loads are designed for use with 190A Calorimeter, calibration can be made with 60 cycle line current. The dissipative element in the load is a metallic film resistor which insures extreme time and temperature stability.

Sierra 186A series loads are designed for use with rigid 1½" coaxial transmission line (matching with UG-50/U.) Request Bulletin.
Can this experience in unique cooling applications help solve a problem for you?

Custom designed cooling is our business at Ellis and Watts. For example, we have recently engineered and built highly specialized equipment for the following applications:

- Liquid coolers for electronic components (bulletin 94)
- Cooling Klystrons with air to liquid heat exchangers (bulletin 95)
- Special units to cool airborne electronic gear (bulletin 99)
- Cooling equipment for huge complex electronic computers (bulletin 102)
- Electronic console and rack coolers (bulletin 105)
- Small portable field units to cool huts filled with electronic gear for missile ground support, battlefield television, communications and radar (bulletin 106)
- Conditioning systems for Radome shelters (bulletin 108)
- Mobile cooling units for trailer-mounted electronic systems for missile and aircraft ground support (bulletin 111)
- Units to cool automatic landing devices for carrier and land-based aircraft (bulletin 122)
- Cooling equipment for fixed or mobile flight training simulators (bulletin 124)
- Dewpoint control equipment for pressurized radar waveguides (bulletin 128)

These are but a few examples. On land (MIL-E-5272A), on the sea (MIL-E-16400B), in the air (MIL-E-5400B)—even in outer space (MIL-E-8189A)—E&W specialized cooling equipment guarantees the performance of your electronic systems, independent of environmental conditions, for military or commercial applications.

If your project involves cooling... it's a job for Ellis and Watts. We are staffed with specialists who will analyze your requirements, submit a proposal, design and build equipment promptly and to your complete satisfaction. Field installation and maintenance services available.

Ellis and Watts Products, Inc., Dept. E, Cincinnati 36, Ohio
Please send the following information:
- Bulletin 94 95 99 102 105 106 108 111 122 124 128 (circle numbers desired)
- Cooling load calculating Nomogram
- Booklet "How to determine requirements for cooling electronic equipment"

Name.......................................................... Title..........................................................
Company..........................................................................................................................
Address............................................................................................................................
City.......................................................... Zone...... State.............................................

ELLIS AND WATTS PRODUCTS, INC.
Cincinnati 36, Ohio.
Designers and builders of MIL-AC Units
Encapsulated Inductances

Millen DESIGNED for APPLICATION encapsulated coils provide another advance in the r-f inductor field. Modern application requires miniature, heat and cold resistant, hermetically sealed, and abrasion resistant r-f inductor assemblies. The James Millen Manufacturing Company has pioneered many advances in the r-f inductor field, including the now standard 4 pi r-f choke, the axial lead r-f choke, and the miniature r-f choke. Developments have now made possible another advance, the No. 34301 and No. J301 encapsulated inductors—hermetically sealed—miniature size. Ambient temperature minus 55 degrees to plus 100 degrees C.

**NO. J301 MINIATURE ENCAPSULATED INDUCTANCES**

Designed for APPLICATION miniature inductances are: extremely small (see table at right)—hermetically sealed—wound on axial lead Carbonyl cores—color coded. Coils are available in RETMA standard values plus 25, 50, 150, 250, 350, 500, and 2500 microhenries. Coils are three layer solenoids up to 350 microhenries. From 360 to 2500 microhenries coils are pi-wound. Current rating 50 to 600 milliamperes depending on coil size. Inductance ± 5%. Special coils on order.

<table>
<thead>
<tr>
<th>COIL NUMBER</th>
<th>INDUCTION</th>
<th>DIAMETER</th>
<th>LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>J301-25</td>
<td>25</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-33</td>
<td>33</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-47</td>
<td>47</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-50</td>
<td>50</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-82</td>
<td>82</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-100</td>
<td>100</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-120</td>
<td>120</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-150</td>
<td>150</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-200</td>
<td>200</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-220</td>
<td>220</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-250</td>
<td>250</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-300</td>
<td>300</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-330</td>
<td>330</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-350</td>
<td>350</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-360</td>
<td>360</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-390</td>
<td>390</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-430</td>
<td>430</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-470</td>
<td>470</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-500</td>
<td>500</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-510</td>
<td>510</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-560</td>
<td>560</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-620</td>
<td>620</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-680</td>
<td>680</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-750</td>
<td>750</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-820</td>
<td>820</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-910</td>
<td>910</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-1000</td>
<td>1000</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-1200</td>
<td>1200</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-1300</td>
<td>1300</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-1500</td>
<td>1500</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-1800f</td>
<td>1800</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-2000</td>
<td>2000</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-2200</td>
<td>2200</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-2400</td>
<td>2400</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>J301-2500</td>
<td>2500</td>
<td>1/4</td>
<td>1/4</td>
</tr>
</tbody>
</table>

**NO. 34301 STANDARD ENCAPSULATED INDUCTANCES**

Encapsulated DESIGNED for APPLICATION axial lead phenolic form r-f inductances. Hermetically sealed—heat resistant—abrasion proof—color coded. Coils are available in RETMA standard values plus 25, 50, 150, 250, 430, 500, and 2500 microhenries. Inductance ± 5%. Values available in same progression as J301 coils listed in the table at the right. Solenoid winding for 1 to 15 microhenries. Universal pi winding from 20 microhenries to 350 microhenries. Current rating 250 to 1500 milliamperes, depending on coil size. Ambient temperature range—minus 55 degrees to plus 100 degrees Centigrade. Size: 5/32 inches diameter x 7/16 inches long. Special coils on order.
NEW
HI-LO
RELAY

ONLY RELAY WITH
DRY CIRCUIT and 10 AMPS

HERMETICALLY SEALED • 4 PDT

Here is the only relay known to combine dry circuit and 10 amps in a single enclosure. It's available, in stock, for 24 hour delivery from Relay Sales, the world's largest relay distributor. We now have in stock 33 different EMS relays in one, two, three and four pole models.

BALANCED ARMATURE MAKES EMS RELAY COMPLETELY VERSATILE. ALL MODELS SURPASS MIL R SPEC 5757C, 6106C, 25018

Write for Complete Details in Bulletin 8601.
AMP-EDGE HAS THE EDGE ON PRINTED CIRCUITS

The new AMP-Edge Connector gives you...

greater flexibility—your printed circuit area and completed unit are not limited by the size of connection, as found in alternate methods of edge connection.

greater design versatility—they can be applied in any arrangement to any section of the perimeter of the printed circuit.

two-way cost reduction—production time and material costs are reduced through solderless termination of the connector to the wire (4,000 terminations per hour) and the ease of applying the Edge Connector to the printed circuit without molded parts.

Additional information is available upon request.
A really NEW drawing material...

Ozalid DURATRACE®

superior to cloth for pencil, other drafting—at far less cost

Extremely durable, practically ageless—that's new Ozalid Duratrace drawing film. Duratrace can speed your drafting operations, insure greater accuracy and finer prints. It can be used under all climatic conditions and it will still maintain its exceptionally high-dimensional stability. And Duratrace saves you money! Not only will it outperform the highest quality, moistureproof pencil tracing cloths in every respect—it actually costs 15% to 20% less!

HERE ARE A FEW OF ITS OUTSTANDING ADVANTAGES:

- **Makes drafting easier, improves accuracy**
  Duratrace has an exclusive new fiber-free matte surface that takes pencil better than any cloth available. It lets you use hard pencils for greater accuracy, cleaner drawings. It erases easily and quickly without smudging. And Duratrace lies flat, won't curl—even after being rolled for long periods.

- **Gives you better prints, faster**
  The very high translucency of Duratrace means faster copying in your whiteprint or blueprint machine—copies with maximum contrast. Duratrace won't stretch, melt or peel in your copying machine. Distortion of drawings is ended.

- **Stands up to roughest usage—indefinitely**
  Easy to handle and file, Duratrace resists wear and tear—is almost ageless! Its fold and tear strengths far exceed those of cloth, most other films. Duratrace can't fray, become “dog-eared,” crack, chip, or turn brittle. It's nonyellowing...really waterproof; can be filed indefinitely, without deterioration!

Why not test this advanced new drawing material and discover for yourself its many advantages and applications? Just mail the coupon and you will receive free sample and price information.

DURATRACE, Division of Ozalid
Dept. L-523
Johnson City, New York

Please send me a free test sample of Ozalid DURATRACE.
I understand there is no obligation.

Name__________________________
Company__________________________
Position__________________________
Address__________________________
City__________________________ State__________________________

ELECTRONICS engineering edition—May 23, 1958

CIRCLE 29 READERS SERVICE CARD 33
How BUSS fuses can help you solve electrical protection problems

BUSS offers the widest possible selection of fuses to meet your exact electrical protection requirements. The complete BUSS line of fuses includes:

- Single-element, quick-blowing type;
- Single-element for normal circuit protection type;
- Dual-element, slow-blowing type;
- Signal or visual indicating types...

...ranging in sizes from 1/500 ampere up — plus a companion line of fuse clips, blocks and holders.

**Electronic Testing Assures Dependability:** With BUSS fuses, dependable electrical protection is not left to chance. Every BUSS fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

By operating as intended, BUSS fuses provide maximum protection against damage due to electrical fault and — BUSS fuses eliminate shutdowns caused by needless blows. Hence, BUSS fuses help the good name of your product for service and reliability.

**Fuse Engineering Help:** If you have a special problem in electrical protection, BUSS engineers are at your service — and in many cases can save you engineering time by helping you choose the right fuse for the job. Whenever possible, the fuse selected will be available in local wholesalers' stocks that your device can be serviced easily.

For more information on the complete line of BUSS and FUSETRON Small Dimension Fuses and Fuse holders, write for bulletin SFB.

Bussmann Mfg. Division McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.

**BUSS fuses are made to protect...not to blow, needlessly**
High Efficiency — 30%  •  Wide Bandwidth — 12%
High Gain — 30 db  •  High Peak Power — Over 1 Mw

Varian is first with a commercially available megawatt Traveling Wave Tube amplifier. This tube gives system engineers greater freedom in radar design—a full megawatt of power over a major portion of the S-band without tuning. Interchangeable with the 1 Megawatt VA-87 Klystron for broadband operation.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Tests and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy.

Varian associates
Palo Alto 22, California

Representatives throughout the world

Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, High Vacuum Pumps, Linear Accelerators, Microwave System Components, R.F. Spectrometers, Magnets, Magnetometers, Stabilos, Power Amplifiers, Graphic Recorders, Research and Development Services.


Circle 31 Readers Service Card
bacteria... bombs... bumblebees

Broad, comprehensive engineering experience is the firm foundation for advanced thinking and scientific development for the future.

Bendix-Pacific has developed unique instrumentation for biological testing... created devices which have contributed materially to the state of the bombing art... has extensive missile guidance experience dating back to the start of Navy's Bumblebee Program.

Current active developments include servo valves for missiles and their launchers, actuators for turbo prop pitch control, sonic altimeters for low flying aircraft, submarine sonar systems, and high resolution radar for helicopters. These programs provide only a few of the building blocks used at Bendix-Pacific in advanced work on many types of weapons systems.

Exceptional career opportunities for skilled engineers are available. The day-to-day association with challenging problems in many and varied scientific fields at Pacific Division will be rewarding. You are invited to write R. A. Lamm, Director of Engineering, and obtain more information about Bendix-Pacific and your future.

ADVANCED THINKING FOR SYSTEMS AND PRODUCTS IN AIRBORNE RADAR... HYDRAULICS...
MISSILE GUIDANCE... ELECTRO-MECHANICS... DECCA NAVIGATION... SONAR... TELEMETRY
Andrew Corporation offers a wealth of engineering experience in the field of super power RF transmission devices. A broad line of standard equipment is offered and Andrew facilities for the development and production of special equipment are without equal.

Available on a production basis is antenna equipment in all of the new, very large waveguide and transmission line sizes, including high power coaxial lines designed with specially shaped inner conductors and insulators to substantially increase voltage ratings.

Typical too, of this equipment are patch panels such as the 9" line model shown above, used for occasional rearrangement of antenna and transmitter connections.

For high speed circuit switching, Andrew has developed peak reliability, non-contacting waveguide switches such as the 21" model above. Similar switches are also supplied with transitions for use with coaxial line.

Of definite advantage to you is the completeness of the Andrew line which permits a systems approach with integrated equipment for best performance of the overall system.

Our newly expanded production facilities assure prompt deliveries.

We would welcome your inquiries for product information and engineering assistance on:

- Antennas
- Feed Horns
- Switches
- Patch Panels
- Duplexers
- Power Dividers
- Filters
- Coaxial Line
- Waveguide
- Transitions
- Adaptors
- Bends
- Hangers
- Dehydrators

WRITE FOR BULLETIN
HOW TO SEE IN
ALL DIRECTIONS AT ONCE

They add new dimension to defense

Three dimensional radar...it is a positioning of radar beams in space by electronic rather than mechanical means. It provides three-dimensional target data from a single antenna, transmitter, and receiving channel. It is a radical new weapon for national defense.

Engineers at the Hughes Ground Systems Division in Fullerton are responsible for pioneering this advancement (see antenna at left). But even more importantly, these same engineers are working on an elaborate radar warning system which will not only provide this complete radar data, but also translate it into meaningful information and relay it to central communications centers.

Other Hughes activities offer similar engineering challenge. The Research and Development Laboratories in Culver City, for example, are probing into the effects of nuclear radiation on electronics equipment, studying advanced microwave theory and applications, examining communications on a global scale, and developing new methods for insuring product reliability.

The Hughes Products engineering team makes electronics useful in solving industrial problems. For example, this group has just unveiled an industrial electronics system which will automate a complete and integrated line of machine tools.

The diversity of Hughes activity offers prospective employees opportunity to build a rewarding career in a highly progressive and expanding environment.

New commercial and military contracts have created an immediate need for engineers in the following areas:

- Communications
- Reliability
- Circuit Design
- Systems Analysis
- Vacuum Tubes
- Microwaves
- Crystal Filters
- Computer Engineering
- Field Engineering
- Semiconductors

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 17B-1, Culver City, California.

© 1958, HUGHES AIRCRAFT COMPANY
ARC installed first radio range receiving equipment, with six foot rigid rod antenna, which was used on "Mailwing" biplanes by Pitcairn Aviation, 1928.

ARC's laboratory and flying field at Boonton, N. J., 1929.

ARC developed and manufactured first practical radio shielding for spark plugs, 1929.

ARC radio range receiving equipment went to Antarctica with Admiral Byrd on polar expedition aboard his Ford Tri-motor, 1929.

Early radio altimeter work was carried on by ARC in 1929.

First Blind Flight was by Jimmy Doolittle in aircraft equipped with ARC radio range receiver, 1929.
The first successful two-way voice radio equipment standardized for use on Army and Navy fighter aircraft was another important ARC communications development, 1931.

ARC designed first beacon receivers for Douglas M-2 mail planes of National Air Transport, later part of United Air Lines. An historic milestone in the development of today’s radio aids to navigation.

CELEBRATING 30 YEARS OF PROGRESS IN AIRBORNE ELECTRONICS

Pilots wore goggles in 1928... cockpits were open to the weather and biplanes still resembled box kites. Flying the Atlantic was so new it was front page news and air mail routes were the newest thing in communications. That was the year a group of radio engineers got together to develop instruments to help pilots navigate with more precision than “seat of the pants” flying. That’s when Aircraft Radio Corporation was born. On these pages some of the organization’s accomplishments over the past 30 years are noted, along with a few of today’s precision instruments of navigation and communications. These are the mileposts that testify to a rich fund of experience and engineering skill... of a group dedicated to the science of airborne electronics for greater safety and progress in aviation.

Dependable Airborne Electronic Equipment Since 1928

Aircraft Radio Corporation BOONTON, NEW JERSEY

OMNI/LOC RECEIVERS • MINIATURIZED AUTOMATIC DIRECTION FINDERS • COURSE DIRECTORS • LF RECEIVERS AND LOOP DIRECTION FINDERS UHF AND VHF RECEIVERS AND TRANSMITTERS (5 TO 360 CHANNELS) • INTERPHONE AMPLIFIERS • HIGH POWERED CABIN AUDIO AMPLIFIERS 10-CHANNEL ISOLATION AMPLIFIERS • OMNIRANGE SIGNAL GENERATORS AND STANDARD COURSE CHECKERS • 900-2100 MC SIGNAL GENERATORS

ARC TYPE 21A DIRECTION FINDER
ARC TYPE H-14A SIGNAL GENERATOR
ARC TYPE 210 360-CHANNEL TRANSCEIVER

ELECTRONICS engineering edition – May 23, 1958
How CDF Di-Clad\textsuperscript{\textdagger} can solve your printed-circuit problems

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed-circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 28E. For high mechanical strength, low moisture-absorption, and good insulation resistance, CDF Di-Clad laminates of epoxy resin laminated with glass fabric offer the designer a strong, reliable combination.

Di-Clad 112T. A Teflon\textsuperscript{\textregistered} glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

\textsuperscript{\textdagger}Trademark of Continental-Diamond Fibre Corporation

\textsuperscript{\textregistered}Du Pont trademark for its tetrafluoroethylene resin.

## TYPICAL Di-Clad PROPERTY VALUES

<table>
<thead>
<tr>
<th></th>
<th>Di-Clad 2350</th>
<th>Di-Clad 26 (NEMA XXXP)</th>
<th>Di-Clad 28 (NEMA XXXP)</th>
<th>Di-Clad 28E (NEMA G-10)</th>
<th>Di-Clad 112T Teflon*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bond Strength</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0014&quot; foil</td>
<td>6 to 10</td>
<td>6 to 10</td>
<td>6 to 10</td>
<td>8 to 12</td>
<td>4 to 8</td>
</tr>
<tr>
<td><strong>Maximum Continuous Operating Temperature (Deg. C.)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td><strong>Dielectric Strength</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Maximum voltage per mil for 1/16&quot; thickness)</td>
<td>800</td>
<td>900</td>
<td>850</td>
<td>650</td>
<td>700</td>
</tr>
<tr>
<td><strong>Insulation Resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Megohms) 96 hrs. at 35°C &amp; 90% RH (ASTM D257, Fig. 3)</td>
<td>500</td>
<td>150,000</td>
<td>600,000</td>
<td>100,000</td>
<td>75,000</td>
</tr>
<tr>
<td><strong>Dielectric Constant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10\textsuperscript{th} Cycles</td>
<td>4.5</td>
<td>4.0</td>
<td>3.6</td>
<td>4.9</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Dissipation Factor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10\textsuperscript{th} Cycles</td>
<td>0.040</td>
<td>0.026</td>
<td>0.027</td>
<td>0.019</td>
<td>0.0015</td>
</tr>
<tr>
<td><strong>Arc Resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Seconds)</td>
<td>5</td>
<td>10</td>
<td>10</td>
<td>130</td>
<td>180</td>
</tr>
<tr>
<td><strong>Tensile Strength</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(psi.)</td>
<td>18,000</td>
<td>16,000</td>
<td>12,000</td>
<td>48,000</td>
<td>23,000</td>
</tr>
<tr>
<td><strong>Flexural Strength</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(psi.)</td>
<td>27,000</td>
<td>21,000</td>
<td>18,000</td>
<td>70,000</td>
<td>13,000</td>
</tr>
<tr>
<td><strong>Izod Impact Strength</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>edgewise (ft. lbs. per inch of notch)</td>
<td>0.30</td>
<td>0.45</td>
<td>0.42</td>
<td>12.0</td>
<td>6.0</td>
</tr>
<tr>
<td><strong>Compressive Strength</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flatwise (psi.)</td>
<td>32,000</td>
<td>28,000</td>
<td>25,000</td>
<td>62,000</td>
<td>20,000</td>
</tr>
<tr>
<td><strong>Base Material of Laminate</strong></td>
<td>Paper</td>
<td>Paper</td>
<td>Paper</td>
<td>Medium-weight, medium-weight glass cloth</td>
<td>Fine-weight, medium-weight glass cloth</td>
</tr>
<tr>
<td><strong>Color of Unclad Laminate</strong></td>
<td>Natural</td>
<td>Natural greenish</td>
<td>Natural</td>
<td>Natural</td>
<td>Natural</td>
</tr>
</tbody>
</table>

*Du Pont Trademark

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.
Here at last is a portable all-electronic digital voltmeter that measures DC voltages from .001 to 1000 volts with 0.1% accuracy. In less than 1/10 of a second the measured voltage is presented in clear numerical form on a digital in-line readout that even unskilled personnel can read quickly and accurately, with little possibility of error. Direct voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in the delicate, complex and expensive instruments.

Extremely stable operation—continuous calibration against an internal reference. The low price of the Model 801 allows you to put one on every bench. Its accuracy and reliability are assured by KINTEL's years of design and manufacturing experience...experience gained in the manufacture of more than 10,000 precision electronic instruments.

**BRIEF SPECIFICATIONS (model 801)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ranges</strong></td>
<td>.000 to 1.599; .000.0 to 15.99; 000.0 to 159.9; 0000.0 to 1000 volts (manual ranging and polarity)</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>.01% of full scale</td>
</tr>
<tr>
<td><strong>Readout</strong></td>
<td>4 digits plus decimal point</td>
</tr>
<tr>
<td><strong>Input Impedance</strong></td>
<td>20,000 ohms per volt*</td>
</tr>
<tr>
<td><strong>Conversion Rate</strong></td>
<td>10 per second</td>
</tr>
<tr>
<td><strong>Conversion Time</strong></td>
<td>Approximately 70 milliseconds</td>
</tr>
<tr>
<td><strong>Display Time</strong></td>
<td>Adjustable from approximately .1 second to infinity (plus push-button read once control)</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>11&quot; high x 7½&quot; wide x 20&quot; deep</td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>105 to 125 volts, 60 cycle AC, 180 watts</td>
</tr>
</tbody>
</table>

The Model 802 provides 10 megohms input impedance. Price $1190. In other special models the binary coded decimal and decimal outputs are externally available to permit use as an analog to digital converter.

Representatives in all major cities. Write today for demonstration or literature.

5725 Kearny Villa Road, San Diego 11, California. Phone BRowning 7-6700

KINTEL
A Division of Cohu Electronics Inc.
MAJOR INTERNATIONAL CARRIERS SELECT

LORAN

FOR JET-AGE LONG RANGE NAVIGATION

LORAN has long been recognized as the reliable, highly accurate system of long range navigation. LORAN is already implemented and in service over North Atlantic and Pacific air routes, with immediate expansion planned to cover other important areas, too.

Now, LORAN becomes an even more practical navigation system, with the development by Edo of a simplified, lightweight, pilot-operated unit. This compact equipment, weighing only 26 pounds installed, can be mounted in the cockpit.

From it the pilot obtains directly read line-of-position information, without having to consult tables or make complicated calculations.

Thoroughly tested in trans-oceanic operation, Edo LORAN has been ordered by Pan American World Airways, BOAC, Qantas and Cubana for installation in their upcoming fleets of Boeing and Douglas jet aircraft.

Many other international carriers have also indicated their intention to use LORAN to assure precise, reliable long range navigation.

EDO AIRBORNE LORAN, Model 345
Control panel and 3-inch scope are mounted in cockpit for operation by pilot or co-pilot. Receiver (left) occupies 3/4 ATR rack. Installed weight of complete system is only 26 lbs., and compact unit requires only a small fraction of space formerly required. Designed and manufactured by Edo, a major supplier of advanced electronic systems for the U.S. Navy—sonar, radar, ASW equipment.

For the complete data on Edo Model 345 Airborne Loran, send for Technical Manual #501, Dept. T-5.

EDO Corporation
College Point, Long Island, New York

Manufacturers of a Trusted Line of Marine and Airborne Electronic Equipments
Amperex® proves there’s room for extra engineering even in standard replacement tubes!

The hard core of the Amperex line has always been a group of electrically unique “proprietary” types, available from no other manufacturer. However, the Amperex name has come to mean concrete engineering benefits even in standard communications and industrial tubes, above and beyond plug-in interchangeability. Thanks to a manufacturing philosophy of untiring perfectionism – combined with the most recent techniques of production, quality control and applications research – the Amperex replacement tubes shown here offer tighter tolerances, greater uniformity, extra ruggedness in critical applications, plus remarkable freedom from common defects and failures: in short, an extra dimension of quality.

Amperex C3J/5632 THYRATRON
with these Amperex extras:

1. hard glass envelope
2. rigid anode connection
3. rugged grid cylinder
4. anti-grid-emission slot
5. heat shield prevents excessive grid temperatures
6. reinforced cathode with special emitting material
7. ceramic insulators
8. heavy leads allow high peak-currents
9. highly effective getter
10. rugged powder-glass base
11. 8 supports give mechanical strength

other Amperex replacement tubes with extra engineering:

ask your distributor about Amperex replacement tubes with extra engineering for Industrial/Communications applications

Amperex C3JA/5864
THYRATRON
(same as C3J/5632 above, but with increased inverse peak voltage rating)

Amperex 6146
HIGH-SENSITIVITY BEAM POWER TUBE

Amperex 4X500A Tetrode

AMPEREX ELECTRONIC CORP., 230 Duffy Avenue, Hicksville, L. I., N. Y. In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17.
Clip Assembly Vac-u-Sel* Rectifiers priced up to 75% less, with space savings up to 50%.

Three new clip assembly selenium rectifiers are now being produced in quantity by General Electric using the Vac-u-Sel process.

Sizes and Ratings—Type 6RS6 uses 5/32" diameter cells and is rated 2.5 ma; Type 6RS5 uses 9/32" cells and is rated 8 ma; Type 6RS20 uses 15/32" cells and is rated 25 ma. Each size can take from one to six cells depending on the voltage rating (from 37 to 378 volts PIV).

Applications—Vac-u-Sel clip assembly rectifiers are designed for applications on half-wave, doubler, center-tap or bridge circuits. They are low in cost—from 20 to 35 cents each in quantity lots. They are designed to replace rectifiers up to twice as large in applications such as small household appliances, instruments, low power control devices and other electrical and electronic equipment.


*Registered Trade-mark General Electric Company

The advantages of Vac-u-Sel rectifiers lie in General Electric's precision vacuum process for obtaining a pure, more even deposition of selenium over the entire cell surface. This results in longer life—even at high operating ambients and better-than-normal rated current. Performance can be reliably predicted from unit to unit.

Encircled is the tiny Vac-u-Sel clip assembly rectifier now being used in the compact Sleep-Guard® Control of the General Electric Automatic Blanket.
Specify **BARDEN** Precision miniature ball bearings

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

*Barden Precision* miniature-size bearings have the required low torque. Their low eccentricity and closely controlled radial play assure minimum backlash. Precision flanges provide accurate positioning surfaces and permit through-boring, eliminating the need for housing shoulders.

*Barden Precision* miniature bearings are built to the same high standards of consistent quality as Barden's larger instrument sizes.

*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 ≤ 3/8" O.D. and smaller.

**THE BARDEN CORPORATION**

45 E. Franklin St., Danbury, Connecticut • Western office: 3850 Wilshire Blvd., Los Angeles 5, California
COMPLETE LINE 125° C

SERVO MOTOR TACH GENERATORS
to your precise specification

- Both Damping and Integrating types available with parameters to your requirement.
- Complete size range: 8, 10, 11, 15, 18. Can be designed with gear train.
- 54°C to +125°C ambient temperature range.
- Designed to MIL-E-5272.
- Assembled under closely controlled environmental conditions.

400 CPS SERVO MOTOR - TACHOMETER GENERATORS

<table>
<thead>
<tr>
<th>Oster Type</th>
<th>Size</th>
<th>Length</th>
<th>Wt. Oz.</th>
<th>Rotor Inertia gm cm^2</th>
<th>Rated Voltage</th>
<th>No load speed RPM</th>
<th>Watts per phase</th>
<th>Stall Torque OZ. IN.</th>
<th>Exct. Volt.</th>
<th>Output Volts per 1000 RPM</th>
<th>Lin.% to 3600 RPM</th>
<th>Null MV</th>
<th>Phase Shift @ 20°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>8MTG-6201-01</td>
<td>8</td>
<td>1.850</td>
<td>2.3</td>
<td>0.77</td>
<td>26</td>
<td>40/20</td>
<td>6,500</td>
<td>2.2</td>
<td>0.16</td>
<td>26</td>
<td>0.25</td>
<td>0.5</td>
<td>15 ± 5°</td>
</tr>
<tr>
<td>10MTG-6228-02</td>
<td>10</td>
<td>2.157</td>
<td>4.2</td>
<td>0.72</td>
<td>115</td>
<td>115/57.5</td>
<td>9,500</td>
<td>2.8</td>
<td>0.26</td>
<td>115</td>
<td>0.45</td>
<td>1.5</td>
<td>19 ± 10°</td>
</tr>
<tr>
<td>10MTG-6229-12</td>
<td>10</td>
<td>2.100</td>
<td>2.9</td>
<td>1.09</td>
<td>33/16.5</td>
<td>52/26</td>
<td>9,500</td>
<td>3.0</td>
<td>0.28</td>
<td>26</td>
<td>0.45</td>
<td>1.5</td>
<td>13 ± 10°</td>
</tr>
<tr>
<td>10MTG-6229-03</td>
<td>10</td>
<td>2.100</td>
<td>2.9</td>
<td>1.09</td>
<td>26</td>
<td>26</td>
<td>10,500</td>
<td>3.0</td>
<td>0.26</td>
<td>18</td>
<td>0.3</td>
<td>1.5</td>
<td>12 ± 10°</td>
</tr>
<tr>
<td>10MTG-6229-15</td>
<td>10</td>
<td>2.100</td>
<td>2.9</td>
<td>1.09</td>
<td>26</td>
<td>26</td>
<td>10,500</td>
<td>3.0</td>
<td>0.26</td>
<td>26</td>
<td>0.3</td>
<td>1.5</td>
<td>12 ± 10°</td>
</tr>
<tr>
<td>10MTG-6232-08</td>
<td>10</td>
<td>2.104</td>
<td>4.2</td>
<td>1.1</td>
<td>115</td>
<td>36/18</td>
<td>6,500</td>
<td>3.5</td>
<td>0.26</td>
<td>115</td>
<td>0.30</td>
<td>1.5</td>
<td>15 ± 10°</td>
</tr>
<tr>
<td>11MTG-6251-13</td>
<td>11</td>
<td>2.531</td>
<td>7.0</td>
<td>1.3</td>
<td>115</td>
<td>115/57.5</td>
<td>6,500</td>
<td>3.5</td>
<td>0.63</td>
<td>115</td>
<td>0.55</td>
<td>0.5</td>
<td>19 ± 10°</td>
</tr>
<tr>
<td>11MTG-6251-00</td>
<td>11</td>
<td>2.531</td>
<td>7.0</td>
<td>1.1</td>
<td>115</td>
<td>40/20</td>
<td>6,500</td>
<td>3.5</td>
<td>0.63</td>
<td>115</td>
<td>0.55</td>
<td>1.5</td>
<td>19 ± 10°</td>
</tr>
<tr>
<td>11MTG-6254-01</td>
<td>11</td>
<td>2.200</td>
<td>6.0</td>
<td>1.1</td>
<td>125</td>
<td>115/57.5</td>
<td>6,500</td>
<td>3.5</td>
<td>0.63</td>
<td>115</td>
<td>0.55</td>
<td>1.5</td>
<td>19 ± 10°</td>
</tr>
<tr>
<td>15MTG-6280-10</td>
<td>15</td>
<td>3.281</td>
<td>14.0</td>
<td>5.3</td>
<td>115</td>
<td>115/57.5</td>
<td>5,000</td>
<td>6.2</td>
<td>1.5</td>
<td>115</td>
<td>3.0</td>
<td>0.2</td>
<td>13 ± 5°</td>
</tr>
<tr>
<td>15MTG-6276-03</td>
<td>15</td>
<td>3.875</td>
<td>15.0</td>
<td>4.4</td>
<td>115</td>
<td>57.5</td>
<td>8,500</td>
<td>5.8</td>
<td>0.70</td>
<td>115</td>
<td>2.75</td>
<td>0.2</td>
<td>13 ± 0.5°</td>
</tr>
<tr>
<td>18MTG-6302-02</td>
<td>18</td>
<td>3.680</td>
<td>20.0</td>
<td>5.7</td>
<td>115</td>
<td>115/57.5</td>
<td>9,000</td>
<td>16.0</td>
<td>2.7</td>
<td>115</td>
<td>3.0</td>
<td>0.2</td>
<td>13 ± 5°</td>
</tr>
<tr>
<td>18MTG-6302-04</td>
<td>18</td>
<td>3.680</td>
<td>20.0</td>
<td>5.7</td>
<td>115</td>
<td>115/57.5</td>
<td>4,800</td>
<td>9.2</td>
<td>2.4</td>
<td>115</td>
<td>3.0</td>
<td>0.2</td>
<td>13 ± 5°</td>
</tr>
</tbody>
</table>

*These units designed for 85°C ambient but same characteristics can be designed for 125°C. Additional 21.4 watts for heater, the values given are independent of ambient temperature.

Other products include servos, synchros, resolvers, motor-gear-trains, AC drive motors, DC motors, servo mechanism assemblies, reference and tachometer generators, servo torque units, actuators and motor driven blower and fan assemblies.

MANUFACTURING CO.
Your Rotating Equipment Specialist
Avionic Division
Racine, Wisconsin

EASTERN OFFICE
237 North Main Street
Hempstead, L. I., New York
Phone: IVanho 3-4653
TWX Hempstead N. Y. 705

WESTERN OFFICE
5033 So. Sepulveda Blvd.
Culver City, California
Phones: EXmont 1-5742 TExas 0-1194
TWX S. Mon 7671

Engineers For Advanced Projects:
Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Robert Burns, Personnel Manager, in confidence.
Out-of-this-World

SOLUTIONS

to closure problems

1400 STANDARD SIZE CLOSURES —
6 STANDARD METALS AVAILABLE

The most complete line of standard cases
and covers in the industry... in stock for fast
delivery. Hudson offers designers and
production engineers the economy of over
1400 standard size closures with both inside
and outside covers in six standard metals.
And Hudson is fully equipped to put ANY
modification in ANY closure in ANY position.
Hudson mass production methods and
standard tooling save you time and money!

BOTH SPECIAL AND STANDARD
CASES AND COVERS

Available in — Mu Metal, Aluminum,
Steel, Stainless Steel, Brass, Copper.
Tolerances available to ±.005".

HUDSON
STANDARDIZED

PRECISION-DRAWN

CLOSURES

Metal Stampings and Sub-assemblies

TO CRITICAL REQUIREMENTS FOR
MILITARY, COMMERCIAL APPLICATIONS

Ask for catalog on standard cases and
covers or send drawings and specifications
for quotations on custom closures, metal
stampings or sub-assemblies.

HUDSON
TOOL & DIE CO. INC
18-38 Malvern Street, Newark 5, N. J.

Telephone: MARKet 3-7584
Teletype No. NK 1066
These shielded coil forms offer the utmost in reliability due to their unique design and construction. Dimensions when mounted, including terminals, are: LS -9, 9/16" diameter x 3/4" high; LS -10, 11/16" x 9/16"; LS -11, 11/16" x 5/8".

Each form mounts by a single stud. Single layer or pie-type windings to your specifications. LS -14 is double-ended for primary and secondary windings with separate tuning slugs for independent tuning of each section; its overall length excluding tuning slugs is 1 1/2", OD is 5/8". See photograph below for new aluminum housing shielded coil forms.

Reliability – under any condition!

Cambion® miniaturized shielded coil forms are highly shock resistant. With mechanically enclosed, completely shielded coil winding, they bring all the ruggedness and dependable performance you require for your “tight spot” applications – IF strips, RF coils, oscillator coils, etc.

Cambridge Thermionic Corporation combines quality control with quantity production to supply exactly the components you need, in any amount. Our quality control includes material certification, checking each step of production, and finished product. And Cambion quantity production means we can fill your orders for any volume, from smallest to largest.

Any Cambion coil form may be wound to your specifications in any desired quantity. For samples, specifications and prices, write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 39, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16 and 1560 Laurel St., San Carlos, Cal.

New aluminum housing shielded coil forms with anodized finish. Available in three sizes, as variable tamper-proof units with positive locking mechanism and more precise tuning, or as fixed shielded coil forms. Flange mounted by means of two number 2-56 screws. Mounted heights above chassis are 1 5/8", 1 1/2", and 1 3/4" (in variable units exclusive of tuning element).

Cambridge Thermionic Corporation
Makers of guaranteed electronic components, custom or standard
New high power transistors have just been added to the Transitron line, increasing power ratings to 85 watts. Now, whatever the application, you can choose from the broadest power range in the industry... with Transitron reliability built into every transistor.

### HIGH POWER
- Ratings to 85 watts
- Operation to 5 amps
- Low Rs, 1.5 ohms typical
- Voltage Ratings to 60V
- High Current Gain
- High Speed Switching

### MEDIUM POWER
- Operation to 500 mA
- Ratings to 5 watts
- Low Rs, 6 ohms typical
- High Speed Core Driving
- Heat Sink Mountings available

### SMALL SIGNAL
- Operation to 175°C
- Low Ic at Rated Vc max.
- High Current Gain
- Three package sizes available

WRITE FOR BULLETIN TE-1353
These new 50 mil O.D. cores are now available in General Ceramics S-4, the material that has proven so successful in such vitally important systems as the SAGE computer. Switching time is less than one microsecond with 550 ma full drive. At recommended operating conditions, the “ONE” output voltage is greater than 60 millivolts; the “ZERO” output voltage is less than 6 millivolts. Cores are provided in two quality levels, to .015 AQL and to 6.5 AQL. Dimensions are .050” O.D., .030” I.D. and .015” in height, all with tolerances of ± .002”. General Ceramics has designed and built special equipment for core testing to insure that each unit meets established electrical properties. 50 mil O.D. cores are supplied in production quantities in two quality levels. Parts are shipped according to MIL Specification 105A to 0.015 AQL or 6.50 AQL. For complete information on this core write General Ceramics Corporation, Keasbey, New Jersey, for Bulletin 326; address Dept. E.

**GENERAL CERAMICS**

Industrial Ceramics for Industrial Progress... Since 1906
The broad frequency coverage and wide range of power levels now offered by Eimac amplifier klystrons is shown in the accompanying charts. Frequency coverage extends into the SHF range and multi-megawatt pulse output powers are available.

The exceptional ability of Eimac amplifier klystrons to conveniently and reliably generate high RF power at ultra-high and super-high frequencies has led to their widespread use in tropo-scatter communications, high power radar, UHF television broadcasting, linear accelerators and many other applications.

For more detailed information on Eimac's reliable, simplified approach to high power at high frequencies, write for a copy of Klystron Facts Case Five. The Eimac Application Engineering Department will gladly assist you in planning new systems using Eimac power klystrons.
New VEEDER-ROOT
Electronic "Count-Pak"*

A COMPLETE COUNTING PACKAGE!

High Speed . . . Electric Eye
 . . "Pulse Stretcher"
 . . Instant Reset

First of a new series of electric and electronic counting "packages" is this Model C "Count-Pak" consisting of the new V-R instant-reset, high-speed (3,000 counts per minute) electric counter combined with a light source and photo cell. Cell and light source can be adapted to any application . . . and are permanently assembled so vibration can't jar them out of focus. Pulses as short as .0002 seconds will actuate this device, which means that a ¼" object or space moving at 6,000 feet per minute will be counted. "Count-Pak" is transistorized throughout (no tubes) and utilizes printed circuits . . . double assurance of instant action and long trouble-free life. Rugged, compact case: 8¼" wide; 5¼" high; 6¼" deep. Panel includes pilot light, reset button, and power switch. And prices are unexpectedly low. Write:

EVERYONE CAN COUNT ON
Veeder-Root
INCORPORATED
HARTFORD, CONNECTICUT
Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities
Here you will find industry's widest choice of advanced technical ceramics—dense or porous—key components in thousands of applications in widely diverse fields. Top performance is assured by careful matching of physical and electrical properties to end use requirements.

If heat is a problem: AlSiMag technical ceramics have higher insulation values at elevated temperatures than fused quartz. Excellent thermal shock resistance. Great strength. Low loss. Rugged AlSiMag Aluminas, for example, deliver superior performance at temperatures beyond the melting points of most commonly used metals.

There are AlSiMag materials which withstand higher compressive loads than steel... with lower coefficients of expansion than any general-use metal. Chemically inert... will not rust, oxidize or corrode. Permanently rigid... will not deteriorate. Some have unusual abrasion resistance. Some are hard as 9 on Mohs' scale.

No matter what your problem, AlSiMag ceramics may help solve it. And, this source has the machines and experience to produce precision parts in any quantity. Send blueprint with details of operating procedure for complete data on the AlSiMag material best suited for your application.

MORE SPECIALIZED ENGINEERING TALENT...
MORE FACILITIES...... MORE "KNOW HOW"
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 Rate</th>
<th>Intermittent Rated Load (oz-in.)</th>
<th>Max. Starting Torque (oz-in.)</th>
<th>Power (watts) Loaded</th>
<th>Current (amps) Loaded</th>
<th>Temp. Rise Deg. F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>330</td>
<td>4:1</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>20</td>
<td>7.0</td>
<td>.11</td>
<td>70</td>
</tr>
<tr>
<td>44</td>
<td>30:1</td>
<td>15</td>
<td>80</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>
</tr>
</tbody>
</table>

SYNCHRONOUS

<table>
<thead>
<tr>
<th>RPM</th>
<th>Gear Rate</th>
<th>Pull-in Torque Min. (oz-in.)</th>
<th>Continuous Torque (oz-in.)</th>
<th>Power (watts) Loaded</th>
<th>Current (amps) Loaded</th>
<th>Temp. Rise Deg. 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>
<td>65</td>
</tr>
<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 less at 50 cycles. Some speeds available at 25 cycles.

160.0 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>Nominal Gain</th>
<th>Sensitivity (Microvolts)</th>
<th>Nominal Input Impedance (Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 10^4</td>
<td>4.0</td>
<td>370, 1400, 30,000</td>
</tr>
<tr>
<td>4 x 10^4</td>
<td>1.0</td>
<td>370, 2200</td>
</tr>
<tr>
<td>12 x 10^4</td>
<td>0.4</td>
<td>2500</td>
</tr>
<tr>
<td>40 x 10^4</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

OPTIONAL FEATURES
(a) thermocouple burnout protection, (b) without desensitizing adjustment, (c) parallel T feedback, (d) velocity damping, (e) special connecting cables and plugs, (f) without tubes, shields, and converter, (g) for 25 cycles, (h) 220-110 volt transformers.

*The sale of this device does not carry with it a license under any of our combination patents covering apparatus in which this device may be used.

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


Honeywell First in Controls

May 23, 1958 — ELECTRONICS engineering edition
An announcement

Do you want to break into the big European electronic market at the lowest capital cost to yourself?

The United Kingdom offers a first-class opportunity for doing so. Labour is comparatively cheap and there is a ready demand for American ‘know-how’ in the whole area. Now comes the chance to tie up with an established British manufacturing company equipped to carry out economically many types of electronic assembly, wiring, and testing operations.

For the past 12 years we have been working exclusively as trusted sub-contractors to some of the best known companies in the United Kingdom, for whom we have manufactured to rigid government standards all types of equipment—small, large, simple and complex. As sub-contractors we have no conflicting interests of our own to get in the way of what we do for the firms who employ us, and our record will stand the closest investigation, both technically and financially.

We are now ready to expand and diversify our activities by providing similar assembly, wiring and testing facilities for a suitable American principal. Initially we can offer 25% of our full capacity, combining high productive efficiency with low labour charges. Fuller details of the specialised service we can offer in our new plant close to London, and of our past history and present financial set-up, can be given in direct correspondence.

If you are interested, please mail
A. T. IZZARD, MANAGING DIRECTOR,

BROXLEA PRODUCTS LIMITED
PARK LANE, BROXBOURNE, HERTFORDSHIRE, ENGLAND
Cables: Hoddesdon 4455
For career men it is almost impossible to tell where mental climate leaves off and physical climate begins. Like the Moebius strip, properly joined, they present a single-sided situation that is most benign. At Link Aviation the climate is ideal...

Pioneers of flight simulation, Link’s modern electronic laboratories now bracket our continent. The facilities in Binghamton, New York, have been supplemented by the energetic Research & Development Laboratories at Palo Alto, California. At both places, primary consideration was given to the importance of climate to you...the very engineer we now seek.
The mental climate at Link Aviation, Inc., is ideal for your growth. Its facilities, its attitude, its personnel provide a congenial, purposeful atmosphere.

The physical climate furnishes you with the maximum in comfortable suburban living. And you have your choice between the full-seasoned stimulation of Binghamton in upstate New York, or the temperate California living in Palo Alto.

The climate of learning is here, too. If you are the man we want, you will never claim that your education is finished. Link Aviation does more than give lip service to this concept. As a participant in the Honors Cooperative Programs at outstanding universities, you can advance your education by attending regular classes with time and tuition provided by Link.

In addition to providing you with the ideal climates, Link also assures you that your material benefits will be commensurate with today's most enlightened practices; good pay, ample vacations, hospital, health and retirement benefits.

If this entire work-live-study setup at Link sums up the ideal you have established in your mind, we urge you to respond immediately.

Write:
Mr. Ken Viall
Link Aviation, Inc., Dept. P-I
Binghamton, New York

Or:
Mr. Joe Larko
Link Aviation, Inc., Dept. P-I
P.O. Box 1313
Palo Alto, California

Link Aviation, Inc. Binghamton, New York
PHILCO MICRO ALLOY TRANSISTOR 2N393

...Most easily driven, high-speed switching transistor... for modern computer circuitry!

- Exceptionally Good Life Characteristics, Reliability and Stability
- Low Hole Storage
- Low Saturation
- High Beta at High Currents

Philco's new 2N393 transistor is exceptionally well suited to the special branching requirements of high speed computer circuitry. Wherever multiple circuits must be driven from a single unit, the new 2N393 significantly outperforms ordinary driven-stage transistors.

The 2N393 combines high gain with excellent high-frequency response at frequencies up to 50 megacycles. Beta linearity is extremely good at currents as high as 50 milli-amperes. The new 2N393 micro alloy transistor provides high frequency switching plus low saturation resistance.

This new transistor design is particularly well adapted to direct-coupled logic circuitry. Polarities of the emitter and collector voltages are similar to PNP junction-type transistors.

Make Philco your prime source for complete transistor application information...

The 2N393 is also excellent for use in video amplifiers up to one megacycle. For complete specifications and prices on the 2N393, write Dept. E558.

PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA
Gamma-Ray Detector Aids Oil Field Surveys

Transistorized probe, using Geiger-Muller tubes, detects and measures gamma radiation from radioactive tracers applied to waters and brines in petroleum reservoirs. Instrument is self-contained in a 1-in. diameter steel pipe and operates for as long as 250 hours at depths of 5,000 feet and hydrostatic pressures of 2,000 psig. It has good stability between 70 F and 130 F


Application of radioactive isotopes as tracers in the study of the flow of waters and brines in petroleum reservoirs is aided by the instrument described in this article. It was designed for use in experiments by Bureau of Mines engineers. Such experiments involve adding a gamma- or beta-emitting radioisotope to water being injected into an oil-producing formation, and detecting and measuring the radioactivity of the water upon its appearance at an oil well.

Instruments suitable for this work must have a sensitivity greater than that required for uranium prospecting; must fit into small-diameter wells, and be capable of reliable operation under ambient conditions that may be normally expected in shallow, water-flooded petroleum reservoirs ranging from 500 to 4,000 feet in depth. Operating pressures exceeding 2,000 psig are not uncommon at the bottom of such comparatively shallow wells. Maximum temperatures seldom exceed 135 F.

The sensitivity of a gamma-ray
well-logging probe may be defined in several ways. With Geiger or scintillation-detection units, counts per minute per milliroentgen per hour is probably the most easily understood and useful presentation of information although not the one most commonly used by industry. Since most radioactivity measurements made within wellbores by or for the petroleum industry need be only relative, little or no attempt is made generally toward absolute calibration of gamma-ray logging tools. The sensitivity of most commercial logging equipment is given in terms of inches of deflection of the pen on the recorder chart versus radioactivity, usually in milliroentgens per hour, at the probe. Actually, the accuracy of any quantitative determination made within a wellbore is questionable because hole-size variation, heterogeneity of the media, self absorption and well-fluid absorption detract greatly from the reliability of the determination. The statistical nature of any radiation measurement also becomes of great importance in gamma-ray well logging. By proper adjustment of the time constant of the recording instrument and logging speed of the probe, the effect of low sensitivity may be in large measure compensated, although at the cost of logging speed. It is not, however, possible to correct for the effects of poor instrumental stability; thus, in the final analysis, stability is the most important single criterion in the design of a gamma-ray logging tool.

Detector Choice

Sensitivity of a radiation-detection device is essentially a function of the product of sensitive volume and detection efficiency. In other words, the sensitivity of a G-M tube with an effective volume of 100 cubic in. and an efficiency of 2 percent is the same as that of a scintillation crystal of 4 cubic in. and an efficiency of 50 percent. Practically, however, in a comparison of logging instruments using these two detectors, the scintillator would have the greater output because of the difference in spectral energy sensitivity. In general, the output of scintillators decreases and that of G-M tubes increases with an increase in spectral energy. This fact alone makes the scintillator a logical choice in logging detectors, because of the lower energies present in the radioactive constituents of rock formations. Ionization chambers, almost universally used in the larger diameter commercial logging instruments, are neither sensitive enough nor amenable to miniaturization to the degree that they may be used in instruments of 1-in. diameter.

Temperature

Although the inherent sensitivity of the scintillation detector makes it the first choice in selecting a suitable detection device for the small-diameter logging instrument, other characteristics rule it out as a practical choice. The temperature sensitivity of the multiplier phototubes that must be used with the scintillation crystal require that they be cooled if the ambient temperatures in which the instrument is to be operated appreciably exceed 100°F. The high-voltage supply for the tube must be more stable by a factor of 10 to 100 than that required for G-M tube operation. The low output-pulse amplitude of the device requires incorporation of wide-band amplifiers to increase the pulse amplitude up to a level that may be transmitted to the surface without becoming lost in the circuit noise. It is quite possible to solve these problems and still maintain the required 1-in. outside diameter of the instrument. However, with the exception of a need for spectral-energy determinations within the wellbore, it is questionable whether the added sensitivity would be worth its cost in complexity and added maintenance. The problem of cooling the multiplier phototube is extremely difficult in probes of this size, although many applications are apparent in wells where temperatures do not exceed 100°F.

Thus, G-M tubes were decided upon for this probe. A choice exists in a design of this nature between one large tube and a cluster of smaller tubes. The large tube is a simple, rugged unit but has the disadvantage of lower sensitivity and a higher operating voltage. Sensitivity may be improved somewhat by complex cathode-design features, but it is difficult to reduce the operating voltage level much below 900 or 1,000 v and maintain reliability. The smaller tube has the advantage of a higher volume sensitivity and a lower operating voltage. The disadvantages of the small tube are a higher total cost, a somewhat steeper plateau for the bundle of tubes than for a single large tube, and greater difficulty in mounting. The operating voltage of the smaller tube is less than 700 v resulting in fewer problems in power-supply design and leakage or corona effects. The output pulse of the smaller tube is considerably shorter in duration and somewhat smaller in amplitude. This, of course, is an advantage where high counting rates may be
encountered because of the reduction in dead time. The matter of dead time of the detection unit is important because it is the principal limiting function in attempting to increase sensitivity by simply increasing the number of G-M tubes used. The response of the unit becomes quite nonlinear at higher counting rates where large numbers of G-M tubes are employed. For this reason, the number of G-M tubes used in the described instrument is limited to five.

**Description**

The probe consists of a cluster of five small G-M tubes, a transistor high-voltage supply, a transistor pulse-shaping and amplifying stage, and a mercury-cell battery pack, housed in a stainless-steel tube. The various components of the probe circuit are assembled on small terminal boards that plug together to form the complete circuit unit. This kind of construction allows rapid substitution of spare units for field maintenance.

Figure 1 is a schematic drawing of the probe circuit. The G-M tubes are halogen-quenched and operate at about 650 v. They are about \( \frac{3}{4} \) in. in diameter and 8-in. long, and were designed particularly for geophysical work. Five 33,000-ohm isolation resistors \( R \), through \( R_2 \), are used, one between each G-M tube and the coupling capacitor \( C \). A 1-megohm resistor \( R_6 \) provides quenching. A subminiature audio transformer \( T \), used as a voltage step-up device, a miniature high-voltage selenium rectifier \( D \), and a simple R-C filter. Similar supplies have been described. Because of the frequencies involved and the low current drain, enough filtering is achieved by two small capacitors. Although the capacitors are rated at 600 v no difficulty has been experienced during long periods of operation at 700 v. A second simple R-C filter isolates the power-supply oscillator from the battery source and prevents coupling with the pulse amplifier. A thermistor that shunts decoupling resistor \( R_m \) provides an effective temperature compensation. Regulation of the output voltage is satisfactory over the normal operating range of the instrument which is 80 to 125 F.

The power supply for the circuit is three mercury batteries in series supplying 22.5 v at 1.1 ma. The rated capacity of the batteries used is 350 milliamper-hours, allowing a practical useful life of more than 250 hours. Slide switch \( S_1 \) in the head of the probe is used to energize the circuit when the cable is connected.

The outer shell of the probe is a welded stainless-steel tube with a 1-in. outside diameter and a 0.064-in.-thick wall. The ends of the shell are sealed with O-ring assemblies. The inner conductor of the logging plug at the bottom of the probe is a solid steel section 10-in. long, added to increase the weight of the instrument.

The complete assembly rests upon a coil spring in the bottom of the probe, which maintains pressure upon the contact between the cable terminal and the probe circuit. The spring also serves as a shock absorber if the instrument should strike an obstacle in the hole or the bottom of the well while being lowered. A screen-covered container in the probe holds a desiccant to reduce the amount of moisture accumulated in the assembly as a result of opening the probe under field conditions.

The instrument has been used intermittently in the field for more than a year with satisfactory results. About 20,000 feet of hole was logged during this time.

**Power Supply**

The high-voltage supply consists of a blocking oscillator, a subminiature audio transformer \( T \), used as a voltage step-up device, a miniature high-voltage selenium rectifier \( D \), and a simple R-C filter. Similar supplies have been described. Because of the frequencies involved and the low current drain, enough filtering is achieved by two small capacitors.

The complete cross-section of cable head assembly shows details of method used to seal probe against pressures which may rise as high as \( 2,000 \) psig.
Transistor Chopper

Transistorized control circuit including a frequency-determining crystal oscillator feeds a voltage chopper which doubles the 28-v d-c supply and divides the driving frequency. The a-c pulsed output then drives a synchronous clock motor. System measures time intervals from 10 sec to minutes with an accuracy of 0.02 percent over a temperature range from -55 to +70°C.

RICHARD H. WILLIAMS Electronic Test Equipment Department, Sandia Corporation, Albuquerque, New Mexico

A ccurate measurement of time intervals from 10 sec to several minutes when the only source of electrical power is 28 v d-c is occasionally necessary in military applications. Generally, the problem is solved by using mechanically governed d-c motors to operate a clock through an electromechanical clutch. Expected system errors are ±0.20 percent of the measured time interval over a temperature range from -55 to +70°C and an additional error of ±0.01 sec per start and stop for clutch variations. For some applications, the accuracy of this system is inadequate.

With a moderate increase in clock size, a long-time-interval measuring clock operating on ±28 v can be made almost as accurate as the clutching error. Besides increased accuracy, the more accurate clock can replace less accurate clocks already in the field on a retrofit basis.

A schematic diagram of an improved time-interval clock system is shown in Fig. 1. The transistorized crystal oscillator generates an 800-cps square-wave signal. A pulse train enters the bistable voltage-doubling chopper which provides the a-c power necessary to drive a synchronous clock motor.

Voltage-Doubling Chopper

Operation of the voltage-doubling chopper is described by reference to its circuit removed from the system and shown in Fig. 2. This back-to-back flip-flop is a result of the complementary nature of pnp and npn transistors. Resistor R is the load. When transistors Q1 and Q2 are biased on and consequently collector-to-emitter impedance is near 1 ohm, transistors Q3 and Q4 are biased off and their collector-to-emitter impedance is greater than several hundred thousand ohms. In this state the potential at point B is +E while at A it is zero. Since

FIG. 1—Time-interval clock uses bistable voltage doubling chopper to provide a-c power necessary to drive synchronous clock motor with 0.02-percent accuracy.

FIG. 2—Voltage-doubling chopper utilizes complementary symmetry feature of transistors (A) to double input voltage to that appearing across the load in (B).
the circuit is bistable, the two pairs of transistors can be switched and the potentials at A and B can be reversed.

When the circuit is triggered by a pulse train of frequency \( f \), the waveforms obtained at A and B are shown in Fig. 2B where \( T \) is the reciprocal of the frequency. The voltage across \( R \) is the voltage at A minus the voltage at B as shown in Fig. 2B, and has a peak-to-peak magnitude of \( 2E \).

When the circuit is triggered at frequency \( f \), it chops the supply voltage at frequency of \( f/2 \) and the peak-to-peak output voltage across load \( R \) is double the magnitude of the d-c supply. Since low-power trigger pulses control a much greater a-c power level in load \( R \), circuit efficiency is good. When supply voltage \( E \) in Fig. 2A is ±28 v the square wave across load \( R \) has a peak-to-peak magnitude of 56 v.

For a 300-cps frequency, the frequency of the square wave across \( R \) is 400 cps. The Fourier series of the square wave yields the rms magnitude of a fundamental voltage component \( E_{\text{rms}} \) as \( 2(2)^{1/2} E_{\text{p}} \). With \( 2E \) equaling 56 v, \( E_{\text{rms}} \) equals 25.4 v.

Synchronous Motor
Small synchronous clock motors run at synchronous speed with square wave excitation as well as with sinusoidal excitation. Therefore, when transistors of sufficient current rating are used, load \( R \) can be replaced by a 25-v, 400-cps, 6.5-w synchronous motor as shown in Fig. 1. Square wave harmonics higher than the fundamental are absorbed as losses within the synchronous motor.

Oscillator
In choosing an oscillator for the time-interval clock system, resistors, inductors, capacitors, a fork or a crystal could have been used for frequency control. The crystal oscillator was chosen because the development of low-frequency duplex crystal blanks has made available crystals which are small, trouble free, and stable in the anticipated environments of military applications. Using a duplex crystal without an oven, a stability greater than ±0.02 percent of the output frequency over a temperature range from −55 to +70 C is expected.

The steering circuit is composed of transistors \( Q_2, Q_8, Q_6, \) and \( Q_5 \). If \( Q_6 \) and \( Q_8 \) of the voltage-doubling chopper are on, then \( Q_2 \) of the steering circuit is biased on and \( Q_8 \) is off. When a trigger pulse from the oscillator pulse train occurs, transistors \( Q_2 \) and \( Q_6 \) which normally are off, are biased on for the duration of the pulse.

No output appears at the collector of \( Q_2 \) since parallel transistor \( Q_8 \) is already on. However, since \( Q_6 \) is off, a negative pulse appears at the collector of \( Q_2 \), which biases \( Q_8 \) on. When \( Q_6 \) is on, the voltage-doubling chopper changes to its other bistable state so that \( Q_2 \) and \( Q_8 \) are off and \( Q_6 \) and \( Q_5 \) are on. The circuit can switch back to its original stable state by application of another trigger pulse.

Time accuracy of the chopper is a function of the oscillator frequency which can be controlled to ±0.02 percent. The original mechanically governed d-c clock motor had a time accuracy of ±0.2 percent. For the temperature range −55 to +70 C, the chopper circuit provides an operating accuracy improvement by a factor of ten while the clutching error remains the same. The improved accuracy was great enough to make a decrease in the clutch errors unnecessary. Extra components illustrated in Fig. 1 can be packaged as an extension to the back of existing d-c clock geometry.

Reliability
The system satisfies the military requirements of reliability. Crystal-controlled oscillators and synchronous motors are among the most reliable devices. Transistor circuits can, with design care, be made reasonably reliable too. Should any failure occur which prevents trigger pulses from reaching the voltage-doubling chopper, a-c signals do not appear across the motor so that free-running operation is impossible in the absence of trigger pulses.

The author thanks G. S. Mills, R. A. Richards and those individuals in the Military Test Equipment Department who aided him with their advice and criticism.
Composite video signal from helicopter-carried image-orthicon camera chain is transmitted to ground or surface-vessel installations within 50-mile line-of-sight range by 30-w frequency-modulated transmitter operating in 780 to 900-mc frequency band. Besides military use, system supplies pickup for commercial network telecasts of conventions, parades and the like.

Airborne Tv System for

By NISSON SHER Research Section Manager, Research Division

JOSEPH F. FISHER Engineering Section Manager, Government & Industrial Division


Compared to conventional a-m techniques, frequency modulation of a television transmitter can result in higher efficiency, improved signal-to-noise ratio for lower video frequencies and a more compact physical unit. For these reasons it was decided to employ f-m in an air-to-ground uhf tv system for military reconnaissance from a helicopter. Transmission can be on any of ten 12-mc channels in the range of 780 to 900 mc.

System Description

Figure 1 shows a block diagram of the transmitting and receiving equipment. The image orthicon camera chain is a commercial unit which produces a 525-line interlaced picture having a field frequency of 60 cps. Its output is a composite video signal, having a level of 1v p-p on a 75-ohm coaxial cable. Applied to the input of the transmitter, this signal produces a radiated signal having a maximum deviation of 10 mc.

The transmitter includes a deviator operating at a frequency of 30 mc, a crystal-controlled frequency converter, tripler, doubler, driver and output stage. The final stage delivers approximately 30 w of r-f power to a 50-ohm load. One of the transmitting antennas is an omnidirectional vertically polarized array having a power gain of 6 db which results in an effective radiated power of 120 w. Under line-of-sight conditions, the transmission range is approximately 50 miles.

Power for the transmitter and sync generator are obtained from an inverter which converts the 28-v d-c available from the generator on the helicopter to 115-v, 400 cps. The receiving equipment which may be ground based or installed on a surface vessel, comprises an antenna, wideband f-m receiver and a bank of 17-inch monitors.

Various types of vertically polarized receiving antennas, including a quarter-wave stub, a 4-ft dish, a 2-ft dish, a helix and a three-bay stacked array, are used with the receiver. The antenna used for a particular installation depends on the distance and altitude of the transmitter and the proximity of objects which create multipath. Under multipath conditions, f-m eliminates ghost or repeat images. However, in their place, the picture has a scintillating appearance commonly called prune wrinkle.

Deviator

The composite video voltage from the camera chain contains frequency components up to 5 mc. This voltage is applied to the 6AK5 input tube of the deviator, shown in Fig. 2, to frequency modulate the three-tube deviable frequency oscillator composed of a

May 23, 1958 — ELECTRONICS engineering edition
Military Reconnaissance

404A and two type 5725 tubes.

The frequency of oscillation is determined by the phase characteristic of the feedback path. For video voltages at sync-tip level, the deviator oscillates at a frequency of 29.17 mc, while for video voltages at white level the oscillator frequency is 30.84 mc.

Frequency deviation with video input level is linear and a deviation of 1.67 mc (30.84 to 29.17 mc) results in a total deviation of 10 mc after tripling and doubling in the succeeding stages of the transmitter.

The d-c restorers set the frequency for sync-tip level close to one edge of the band and hold it there for video signals having different average values. The video voltages applied to the d-c restorers are approximately 6 v p-p for good restoration. Compensated attenuators in the feeds to the modulator tubes set the video signal level applied to the suppressor grids at 1 v.

The r-f voltage from the oscillator's plate circuit is fed to the control grids of the two modulator tubes through 45-deg phase-shifting networks. As a result the plate currents of these tubes are 90 deg out of phase when operating at 30 mc and the total plate current is the vector sum of the individual plate currents. This current develops a voltage at the grid of the oscillator that is in phase with the plate current of the modulator tubes since the parallel-resonant circuit connected to the grid of oscillator is tuned to 30 mc. Under these conditions the circuit will oscillate at 30 mc.

Since video signals of equal am-
FIG. 3—Transmitter exciter consists of local oscillator, mixer, three amplifier stages and driver that provides 3-w to tripler stage.

FIG. 4—Double-tuned coaxial tanks provide selectivity for receiver tuner. Unit provides 40 db rejection of image frequency.

The local oscillator is a crystal-controlled oscillator-doubler. Control for 894-mc operation is provided by a 59.5-mc series-mode crystal; L1 resonates the shunt capacitance of the crystal while L2 tunes the stray circuit capacitance at 59.5 mc. The double-tuned circuit consisting of L3, L4, C2 and stray capacitance is sharply resonant at 119 mc. This interstage coupling rejects unwanted oscillator harmonics and provides higher gain than a single-tuned circuit. Proper tuning of the oscillator is indicated by a peak in the grid current of the mixer.

The 30-mc signal from the deviator, with a maximum deviation of 1.67 mc, is applied to grid three of the mixer. The sum of 30 mc and 119 mc is produced at the grid of V1 by the T-coupled type double-tuned interstage network comprised of L3, C2, L4 and R1 along with stray capacitance. Primary and secondary tuning are provided by L3 and L4 respectively, C2 controls the degree of coupling and load resistor R1 determines bandwidth. Plate current is supplied through R1, a 1,000-ohm resistor with negligible r-f loading effect.

Interstage response is maximally flat, with a 3-db bandwidth of 32 mc. Similar interstage networks are used at the outputs of the first and second voltage amplifiers. The T-coupled interstage network was selected in preference to the pi-coupled because the distribution of stray coil capacitance in the former yields a higher gain-bandwidth product.

The output circuit of the third...

May 23, 1958 — ELECTRONICS engineering edition
amplifier is of a different form since it must be coupled through the coaxial cable to the driver. The circuit is double-tuned and consists of $L_n$, a short length of RG-55/U, $L_n$, $C_n$, and stray capacitance. Capacitor $C_n$ acts as an impedance step-up transformer with the input capacitance of $V_n$ to transform the low input resistance of $V_n$ to a higher value across $L_n$. $L_n$ and $L_n$ are modified Mallory flat-spiral tuning elements, the former controlling the coupling to $L_n$ and the latter tuning the secondary circuit. The RG-55/U cable affects both coupling and tuning.

A signal level of 0.3 w drives the grounded-grid driver stage to an output of 3 w to feed the frequency tripler which follows. The driver operates class A with zero bias and a plate current of 110 ma. The coupling between $V_n$ and the tripler is similar to that between $V_n$ and $V_n$.

A frequency tripler and doubler, using grounded-grid 5876 pencil triodes, raise the center frequency to 894 mc and increase the deviation to 10 mc. A 2C39A first power amplifier delivers 6 w to the input of the transmitter output stage, another 2C39A. All coupling interstage networks from the output of the tripler through the antenna circuit are double-tuned pi-equivalents with capacitance coupling, transitionally coupled for a flat response of 10 mc in each stage and an overall response of 10 mc between 1-db points.

Output Stage
The 2C39A output stage is operated with a plate voltage of 900 v and a plate current of 110 ma. The input drive of 6 w produces an output power of 30 w across a 10-mc band into a 50-ohm antenna. The input signal is applied through a fixed tap on the center conductor of a grid-cathode coaxial line. Tuning of this circuit is accomplished by a sliding shorting plunger with spring finger contacts to both inner and outer conductors.

The antenna coupling circuit is double-tuned and transitionally coupled; its primary is formed by the grid-plate coaxial line, with an adjustable shorting plunger. Coupling is provided by an adjustable capacitive probe inserted into the plate line and by a short length of RG-55/U. The secondary of the double-tuned circuit comprises a coaxial filter cavity with variable-capacitance end loading for tuning and a sliding contact connection to the 50-ohm antenna line to control loading.

The 30-w output from the filter cavity is fed to the transmitting antenna through several feet of RG-9/U.

Receiver
As shown in Fig. 1, the superheterodyne receiver consists of two passive tunable preselector stages, a local oscillator and crystal mixer, a low-noise i-f preamplifier, a high-gain i-f amplifier of ten stages, two cascaded limiters and an f-m detector. The i-f center is 45 mc and the overall bandwidth is 10 mc between the 1-db down points. Video output for maximum transmitter deviation is approximately 1.4 v into a 75-ohm load.

The received signal at the antenna is coupled to the receiver tuner in Fig. 4 by low-loss RG-17/U coaxial cable, 50 to 150 feet in length. Selectivity ahead of the 1N21C mixer diode is provided by a double-tuned coaxial circuit. The antenna signal is coupled to the first tank by a grounded loop, which presents a 50-ohm load to the coaxial cable.

Coupling between the two preselector tanks is through a transitional rectangular aperture with a 3-db bandwidth of 18 mc, so as to provide 40 db of rejection at the image frequency, which is 90 mc above the signal frequency. The insertion loss of the preselector is about 0.5 db. Secondary loading is furnished by the mixer diode through a grounded loop.

The local oscillator is a subminiature triode operated as a grounded-plate Colpitts oscillator with coaxial tuning, operating at 45 mc above the signal frequency. Local oscillator drive to the crystal is furnished by a grounded loop and capacitance-T divider $C_n C_n C_n$, which permits adjustment of oscillator injection without affecting the tuning of the r-f tank. The injection level is controlled by $C_n$ and tuning of all three coaxial circuits of the tuner is obtained through a variable loading capacitance at one end of each line.

I-f Amplifiers
The i-f preamplifier, also in Fig. 4, receives the 45-mc output of the mixer by a plug-in coaxial fitting. The first stage of the preamplifier is a grounded-grid triode having a
broadly resonant single-tuned input circuit because of the low input resistance of the grounded-grid stage. This type of input stage was selected so the constant loading on the i-f side of the mixer diode would minimize the interaction with the tuning on the r-f side.

To preserve a good noise figure, the input stage is followed by an overcoupled double-tuned circuit and a series amplifier composed of two 417A tubes. The double-tuned input network to the series amplifier, $L_n$, $L_o$, $L_t$, and single-tuned output $L_r$ comprise a flat triangle with a response 0.3 db down at 40 and 50 mc and a 3-db bandwidth of approximately 15.5 mc.

Single-tuned circuit $L_n$, between the two sections of the series amplifier is broadly resonant because of the heavy loading by the grounded-grid 417A. Neither this circuit nor the one containing $L_o$ has a serious effect on overall preamplifier response.

The preamplifier is followed by the main i-f amplifier, limiters, and a wide-band discriminator. All i-f and limiter stages are inductive pi-equivalent double-tuned circuits, transitionally coupled, with an overall response 0.3 db down at 40 and 50 mc. The response of the entire receiver is 10 mc between 1-db points and is 25 db down at adjacent channel centers.

The noise figure of the i-f preamplifier is about 2.6 db and 8.5 to 10 db for all ten channels of the entire receiver, as measured at the input connector.

**Sync Generator**

A block diagram of the airborne sync generator is shown in Fig. 5. By eliminating the equalizing pulses and serrations in the vertical sync pulse, relatively simple circuitry has been achieved. In all other respects the sync, blanking, and drive waveforms are identical to the standard EIA signals used for commercial TV broadcasting.

Under these conditions of operations, sync performance including interference has been good. Standard EIA sync and the simplified sync signal are illustrated.

**Application**

This airborne system, including the simplified sync generator, was used to supply video from the camera pickup in the helicopter to the NBC network for two Wide World telecasts in the spring of 1957.

Technical operation of the airborne transmitting equipment and receivers was under the control of engineers from the Bureau of Ships and the Philco Corporation. In both telecasts it was possible, using standard television broadcast equipment, to strip the nonstandard sync in a stabilizing amplifier, lock a ground-based sync generator to the nonstandard sync and reinstate standard EIA sync for the network broadcasts.

The first air pickup was from the San Diego area where the receiving equipment was ground based and the second was from over the Atlantic Ocean near Miami, Florida, where the receiving equipment was located on the aircraft carrier U. S. S. Franklin D. Roosevelt.

**Alternate Operating Modes**

During the course of development, the use of sine-wave subcarrier synchronization in place of impulsive sync was investigated. In this method 1.3-mc carrier bursts (extending from blanking to white level) replace the horizontal and vertical sync pulses.

Elimination of the blacker-than-black region required for conventional impulse sync permits greater deviation of the transmitter by the video information and results in slightly better receiver signal-to-noise ratio. Comparative tests of the two methods of synchronization under conditions of severe multipath indicate more stable performance for impulsive sync. Under normal propagation conditions, there is no observable difference in performance between the two.

Tests were also performed using a 525-line, 2-to-1 interlaced, 20-frame system for the purpose of investigating the potentialities of operation with either narrower bandwidths or greater deviation ratios. Performance under various propagation conditions was at least as good as that obtained with the 30-frame system.

To reduce the effects of flicker arising from the lower frame rate, experimental 17-in. picture tubes using phosphors with longer persistence than P-4 were fabricated and installed in the monitors. Some evidence of smearing of rapidly moving objects was obtained because of the longer persistence.

The authors gratefully acknowledge the efforts of the many Bureau of Ships and Philco Research personnel who contributed to the successful development and testing of this system which was developed for the U. S. Navy Bureau of Ships under Contract No. NOBSR-63394 (1714).
Automatic Speech Amplitude Control

Two miniature vacuum tubes and four crystal diodes provide automatic amplitude control for speech frequencies to increase amount of intelligence transmitted over radio communication system under adverse conditions. Differentiating network changes energy distribution of speech so that input amplitude variations of up to 35 db over range of 300 to 3,000 cps are reduced to only about 1 db at output, with relatively little distortion.

By LYLE R. BATTERSBY
Senior Project Engineer, Radio Communication Research Section, SCEL, Fort Monmouth, N. J.

IN RADIO communication systems it is essential that the r-f carrier be modulated fully to obtain maximum transmitter efficiency and to provide the best signal-to-noise ratio at the receiver. This is not possible with ordinary speech which contains strong as well as weak signals unless some means are provided for modifying the speech amplitude characteristics.

Devices presently used for this purpose include companders, volume limiters, clippers, peak limiters and others, used singly or in combination. The dynamic control range obtained and the distortion introduced by such devices varies widely, as does their complexity. For military application such a device should preferably have small size, weight and power drain, provide a wide dynamic control range and have a minimum of distortion.

The automatic speech amplitude control to be described is such a device and includes means for modifying the amplitude characteristics of speech to modulate an r-f carrier more effectively with a maximum of the intelligence to be transmitted and a minimum of distortion.

The speech wave is first differentiated and then applied to an automatic amplitude control circuit of unique design which preserves the waveform over a wide dynamic input range. Input speech variations of 35 db or more are thus reduced at the output to approximately 6 db with negligible distortion. To further reduce these output variations and to limit rapid noise peaks, the speech wave is then lightly clipped. The resultant output variations are only about 1 db.

Basically, this method of speech amplitude control has much less dis-
tortion than that of systems which utilize clipping of 35 db or more to obtain a wide dynamic control range. In practice, it has been demonstrated that the distortion introduced by this method is too small to be detected by the listener and it also provides much larger dynamic range than that obtainable with systems which use relatively light clipping alone to reduce the speech amplitude variations.

Circuit Description

A circuit diagram of the automatic amplitude control is shown in Fig. 1. For convenience, the circuit operation will be described in terms of sine-wave input. It will prove helpful to think of electron tubes $V_1$ and $V_2$ as separate amplifiers fed from a common source.

The sine-wave input acting across differentiating inductor $L_1$ is applied through voltage divider network $R_1 - R_2$ to the grid of $V_1$ and through $C_1$ to the grid of $V_2$.

On the positive alternation of the input cycle the grids of both tubes become less negative and an amplified negative-going voltage is developed across load resistor $R_1$ of $V_1$. This voltage is applied through $C_1$ to a voltage divider network consisting of $R_1$, $C_1$, and $R_2$ in parallel with $L_1$ and $R_1$ and $R_2$. The amplified negative-going signal appearing at the junction of $R_1$ and $C_1$, which would normally be applied to the control grid of $V_1$, in the absence of $C_1$, is returned to the input circuit. As this feedback voltage is in opposition to the applied signal voltage, the signal voltage is reduced and the dynamic range of $V_1$ is thus extended. Simultaneously the amplified signal appearing at the plate of $V_1$ is effectively reduced at the control grid of $V_2$. Diodes $D_1$ and $D_2$ do not operate as rectifiers but only as high resistances during this positive alternation of the input cycle.

Reducing Output

During the negative alternation of the input cycles, diodes $D_1$ and $D_2$ provide, in conjunction with $C_1$, a negative bias for the control grid of $V_2$, which is derived from the amplified signal of $V_1$. This bias for any input amplitude is much larger than the signal voltage applied through $C_1$. As a result, the change in plate current of $V_2$ caused by the signal is small, and the output voltage varies only within small limits.

On the negative alternation of the input cycle, as the control grids of $V_1$ and $V_2$ become more negative, the amplified voltage across $R_1$ moves in a positive direction. When the positive-going voltage exceeds the voltage on $C_1$, crystal diodes $D_1$ and $D_2$ operate as rectifiers. The current through the diodes increases the charge on $C_1$ and thus increases the negative bias applied to the control grid of $V_1$. At the same time, the amplified signal voltage on the plate of $V_1$ is electrically disconnected from the grid of $V_2$, which now receives the signal voltage through $C_1$. Because the negative input signal applied through $C_1$ to $V_2$ is small compared to the negative d-c bias remaining on this grid, the change in plate current of $V_2$ is small and the output voltage again varies only within small limits.

To further reduce the output variations, crystal diodes $D_1$ and $D_2$ are used to lightly clip the positive and negative peaks of the output wave. The resultant output signal then varies in the order of 1 db for an input level variation of 35 db. Diode bias batteries determine the minimum level (3 v) at which the diodes will conduct, and the potentiometer serves to adjust the output voltage to the desired clipping level.

The total power consumption of the unit is 11 watts. Plate power input is about 6 watts at 250 volts with no signal applied, and decreases with increasing signal to 1 watt at maximum input levels. Plate power input at normal speech levels is approximately 3 watts.

The time constant governing the attack time in amplitude control devices operating at speech frequencies is usually a compromise between two requirements: action fast enough to control the peaks and action slow enough so as not to compress later portions of speech after early portions have caused the gain reduction. In addition, the release time must be slow enough to insure quick recovery after strong signal input.

Peak Clipping

The amplitude control described, without peak clipping, meets the above requirements satisfactorily in systems in which the output variations can be in the order of 6 db. Such applications include sound systems and radio receivers. For transmitter application, however, where maximum modulation capability is a requirement, these variations should be reduced to a minimum. For this reason, peak clipping is used.
clipping is provided in the unit. To keep the circuitry as simple as possible and minimize the number of components required, no special provision has been made for balanced peak clipping. In practice it was found that crystal diodes of the type utilized are quite uniform and therefore the selection of diodes having similar characteristics is not a problem. For optimum results, however, the diodes should have a forward resistance of 100 ohms or less and a back resistance of about 400,000 ohms.

**Speech Wave Modification:**

In tests conducted to determine the effects of harmonic distortion on the intelligibility of speech, it has been established that the low-frequency vowels contain the major portion of speech power, yet contribute very little to intelligibility. The higher frequency consonants carry little power but are the principal means of conveying intelligence. If the maximum of the intelligibility in speech is to be transmitted, some means must be provided to raise the energy level of the consonants to a value comparable to or preferably above that of the vowels. This may be accomplished by filtering or, more simply, by applying the speech wave to a R-C or R-L differentiating network.

By differentiating the speech wave, the energy distribution is changed so the energy in any one component is proportional to the square of the frequency; the energy of the consonants is thus increased.

**Speech Energy**

The energy distribution curves for normal conversational speech and differentiated speech are shown in Fig. 2. The differentiated curve shows the degree to which the energy in the frequency components above and below 1,000 cps is accentuated or suppressed relative to the 1,000-cps component.

It is seen that the energy distribution in the pass band of 300 to 3,000 cps is considerably more uniform for differentiated speech than for normal speech. Whereas the higher frequency components are increased in energy, those at the lower frequencies are attenuated. The latter is of particular importance in systems involving speech clipping. Because of the reduced level of the low-frequency components, they are clipped to a lesser degree resulting in a reduction in amplitude of the harmonics that fall in the pass band.

From the foregoing, it can be seen that speech differentiation, as used in combination with the described speech amplitude control, provides an effective method of speech transmission. In addition to providing high modulation capability, a maximum of the speech intelligence is transmitted with a minimum of distortion.

**Experimental Results**

The unclipped steady-state output levels were measured at two different input levels and at 300 and 3,000 cps. For 38 db input amplitude, the difference in output levels was only about 1.5 db at both frequencies.

With peak clipping, noise peaks and rapid input variations in the order of 37 db are reduced at the output to approximately 1 db. As the frequency response of the amplitude control unit is flat in the pass band of 300 to 3,000 cps, the output variation to be expected for any frequency within the pass band is less than 0.1 volt for a 2-volt output.

While only the speech pass-band has been considered here, measurements have shown the device to be useful at frequencies up to 250 kc. The waveform in Fig. 3 show the degree of clipping required to limit normal output variations to about 1 db. The sine wave resulting from an input level approximately 35 db above the amplitude control threshold (0.1 volt) is clipped less than 6 db. Rapid changes in input level, or noise peaks requiring more than this amount of clipping, are usually of short duration and therefore the distortion introduced by such clipping is small.

**Intelligibility**

Extensive tests to determine the degree to which voice peaks can be distorted without adversely affecting intelligibility show that 6 db of peak clipping is barely noticeable, 12 db is not objectionable, and 24 db of clipping can be tolerated. These tests indicate that the described method of amplitude control, normally requiring less than 6 db of peak clipping, should have little effect upon speech intelligibility. That this is the case has been verified by numerous listening tests.

The effectiveness of differentiated, compressed, lightly clipped speech in the presence of noise has been demonstrated in laboratory tests. These tests have shown that the effect of noise upon intelligibility under conditions of a -6 db signal-to-noise ratio is negligible.

Recent field tests with portable f-m transceivers show that a marked increase in received audio output power is obtained when the transmitter is equipped with the amplitude control unit. On the basis of listener reports, the improvement in audio recovery resulting from full frequency deviation of the transmitter appears to be greater than 3 db.
Standard relay-rack construction is used, with 3½-in. front panel. Connections to rear of chassis include remote power control (left).

Alarms System Uses

Two neon oscillators, alternately keying at 2 cps in gated amplifier, provide locally generated warble alarm in Conelrad or carrier-off warning system. Modulation of monitored signal is audible only in case of alert or prolonged carrier interruption. System is controlled by avc voltage of 1.5 v or more from any receiver. Power to external circuits may be removed automatically when receiver avc voltage is off more than ten seconds.

By RONALD L. IVES Palo Alto, California

The radio operator at the time of a Conelrad alert is necessarily a busy person, and the alarm system should avoid adding to his burden. The complete alarm should therefore have all of the following features:

1. Warn operator of Conelrad alert,
2. Shut off controlled carrier promptly on alert, or on extended failure of key-station carrier, but not on momentary carrier interruptions,
3. Indicate plainly what is taking place,
4. Fail safe.

To perform these functions certain standardized signals are emitted from the key station. Those detectable at the receiver are shown in Fig. 1. A one-chassis assemblage to perform all desired functions with optimum fail-safe provisions, can be constructed using standard components, and will operate dependably on an avc voltage of as little as 1.5 v.

The warning device turns on an audio system if the avc of the monitor receiver fails for more than 0.5 sec, and turns the alarm off but not the audio when avc resumes. Power controlled by the system is shut off on receipt of a sustained 1,000-cps note or loss of avc for more than 10 sec. These functions are detailed in Fig. 2. The arrangement enables the operator to hear all Conelrad and similar announcements subsequently to a carrier shut-off while relieving him of the necessity of monitoring key-station program continuously.

Test and reset controls are provided on the panel, as are pilot lights indicating both normal and abnormal operation. Failure of most critical components will shut off the controlled power. A block diagram of the complete system is shown in Fig. 3.

AVC Control

Referring to Fig. 4, control of this system is by the avc output of almost any receiver. Required voltage excursion from no-signal to full-signal can be anything above 1.5 v and the no-signal voltage need not be exactly zero. Close-differential operation of the alarm is avoided by using amplified avc through control-tube $V_{in}$, which is cut off by normal avc voltage but draws plate current when avc fails.

This plate current biases off oscillator $V_{out}$, with no avc but permits oscillation when avc is normal. The oscillator output is amplified by conventional triode $V_{out}$, and its output in turn is rectified by dual ger-
Gated Neon Warbler

The output of the avc amplifier is fed to a-f control tube $V_n$, alarm-control tube $V_p$ and half of power-control tube $V_{1u}$ through 1-megohm isolating resistors. The audio system will operate from the detector output preceding the volume control of any standard receiver and provide enough output to override room noises up to about 100 dbm. The audio is silent under normal conditions, but turns on and stays on until reset whenever the audio output of the receiver fails for more than 0.5 sec. The main audio amplifier is conventional and capable of 10 w output. Volume control is provided for setting level.

A branch takeoff is provided at the plate of $V_p$, to feed the 1,000-cps amplifier. A secondary input for the alarm signals from $V_{1u}$ appears at the grid of phase inverter $V_{3a}$. No volume control is provided for the alarm signals, which should be audible as far from the speaker as possible under all conditions. Tested range of audibility is about 1,000 feet under business-district conditions of ambient noise and more than 250 feet under airport conditions.

Audio Control

Control of the audio system is by thyratron $V_n$ and its associated relay. Under normal conditions the avc amplifier provides more than adequate hold-off voltage for the tube. Failure of the avc allows the tube to fire, closing the relay contacts and completing the ground return of the entire audio system.

Resumption of avc output thereafter has no effect on this circuit, which must be manually reset before it can be silenced.

Panel indication of alarm operation is provided by a neon bulb connected between the audio system plate supply and return. When the system is inoperative voltage across this bulb is zero. As soon as the system becomes operative, voltage across the bulb and resistor is about 200 v, giving visual indication of the condition.

To guard against the effects of tube aging, the screen of the thyratron is biased at $+8$ v. This insures firing even when the tube has operated cut off for extended periods.
Fig. 4—Schematic of signal-selective Conelrad alarm. Fail-safe provisions are maximized when all tubes are pre-aged in non-
or has aged nearly to the replace-
ment point. The relay is essential
because the series thyatron intro-
duces a roar into the audio system
and tends to sputter and cut off
when strong a-f signals are re-
ceived. Capacitive filters adequate
to eliminate this also cause strong
R-C oscillation in the control-tube
circuit.

Alarm Signal

The audible alarm must not be
confused with anything else in the
environment. Steady tones are
therefore ruled out in most in-
stances, as there are too many of
them already present in industrial
areas. Intermittent beeps are bet-
ter, but resemble too closely the
fire-alarm signals in many rural
areas as well as a number of aero-
nautical stall alarms. The simplest
alarm seems to be a two-tone
warble, and the hearing response
of most of the population indicates
that both tones should be below
1,000 cps. A number of experi-
ments indicate that the two tones
will be a more effective alarm if
their frequencies do not have a
common factor.

The alarm signal generator con-
stit of multivibrator $V_n$, operating
at about 2 cps, controlling gated
audio amplifier $V_a$ which in turn
feeds a straight audio amplifier $V_{av}$. Signals are generated by two neon
oscillators tuned to around 400 and
600 cps but having no common fac-
tor. They are capacitively coupled
to the gated amplifier so that the
tones are alternately fed into $V_{av}$
and thence into the audio power
stage. This generator is controlled
by the amplified avc through
ground-return gate $V_{av}$. Whenever
the avc from the receiver fails, and
only then, the alarm is operative.
When the avc voltage is restored
the alarm stops, but the thyatron-
controlled main audio system re-
mains in operation so that an-
nouncements can be heard.

The multivibrator has plate-to-
plate and cathode-to-cathode capaci-
tors in addition to those usually
present. These make minor changes
in the switching rate of the multi-
vibrator but also markedly reduce
thumps in the output of the gated
amplifier. Other combinations of
C, R and L will perform the same
process, but usually at considerably
higher cost.

1,000-cps Amplifier

To use the sustained 1,000-cps
tone which is in integral part of the
Conelrad alarm signal sequence,
a selective amplifier is employed.
This consists of series amplifier $V_n$
the upper grid of which is the sig-
nal input, and the lower grid the
feedback input. Feedback is nega-
tive for all frequencies except the
fundamental of the twin-T network,
and zero at that frequency. A cath-
odal follower, $V_{av}$, fed from the plate
of $V_n$, reduces circuit loading. The
other half of twin triode $V_n$ is part
of the full-wave output rectifier
along with $V_{av}$. The other half of
$V_{av}$ is the avc amplifier control tube.

With a 0.5-v tone input to the
main audio system, output of the
tuned amplifier after rectification is
$+25\text{ v}$ when the input frequency is
from 950 to 1,050 cps, $+1\text{ v}$ at 900
and 1,100 cps, and negligible at all
other frequencies. Bias for this

Careful layout permits chassis size of 10
by 17 by 2 in. with recessed speaker
critical service 200 hours, then installed six months only and finally replaced by another similar batch

frequency-selective amplifier is provided by a tap on the avc amplifier bleeder. In consequence the selective amplifier is out of operation when the key station carrier is off due to saturation of triode $V_{an}$. The system is therefore immune to background heterodynes and other extraneous tones. Voltage output of this amplifier is nearly constant through a wide range of inputs, so the signal produced by the 1,000-cps tone is substantially immune to fading and similar troubles.

Control of External Circuits

Power control is accomplished by two tubes. In the first a relay is held closed by the cathode current of dual triode $V_{an}$, whose two halves are paralleled and whose grids are normally held positive. One set of relay contacts is in series with the plate supply, so if the circuit is broken power will not be restored until the control is manually reset. Release of the relay armature switches on a front-panel flashing neon indicator, giving clear indication that external power is off.

The grid of this tube is connected to the plates of control tube $V_{an}$, both halves of which are normally cut off. Any sustained positive d-c output from the 1,000-cps amplifier causes $V_{an}$ to draw plate current, discharging the 8-$\mu$F plate capacitor and drawing down the grid voltage to cut off $V_{an}$ in about 3 sec. This time can be altered by changing the capacitance from cathode to ground of $V_{an}$.

Continued failure of the avc likewise shuts off the power control circuit through a time-delay system. When the grid of $V_{an}$ fails to ground potential the tube draws plate current, immediately lowering its plate voltage and slowly discharging the 8-$\mu$F plate capacitor of $V_{an}$ through the 1-megohm variable resistor. After a definite time lapse (here set at 10 sec) the grid voltage of $V_{an}$ is reduced to cutoff value, the cathode relay drops out, and external power circuits are opened. As all of these circuits will operate with relatively great voltage differentials, minor shifts in tube sensitivities have little effect.

The power supply is conventional as to plate voltage, but the filament supply is dual. The high-filament circuit is connected through its center tap to the return of the audio system so that heater voltage is always within safe limits. The low-filament circuit is biased at about $+80$ v with respect to ground for the same reason.

Failure of any tube filament will immediately light one of the two filament-alarm lights on the main panel and also the interior light adjacent to the failed tube. Failures of main power-control tube $V_{an}$ or of main avc amplifier tube $V_{an}$ will immediately shut off the controlled power, as will a power-supply failure. Other failures will be apparent through routine test procedures.

Operating experience with this alarm shows that its response to both Conelrad test broadcasts and continued power failures from both local and remote key stations meets all of the specifications outlined at the beginning of this article.

ELECTRONICS engineering edition – May 23, 1958
Photoelectric function generator provides smooth reproduction of complex curve slopes up to 90 degrees, with slopes greater than 90 degrees simulating switching with backlash. Distortion generated by nonlinearity of crt sweep and spot-to-phototube distance is corrected on an aluminum loft layout.

By ROBERT W. MALOY

PHOTOFORMERS are function generators used with analog computers to simulate problems containing a variable which is an arbitrary function of another variable. Examples of problems simulated include transition from laminar to turbulent flow and drag versus air speed while crossing the sound barrier.

To use the photoformer a curve of the desired function must be drawn on graph paper and the area above the curve must be rendered opaque. The graph is then photographed and developed to provide an image that is opaque below the curve and transparent above. This enables the phototube to distinguish between a positive and negative error.

When the area below the curve of the developed plate is opaque the phototube senses spot-position error by failure of the light from the crt to pass through the opaque area, or by overabundance of light with the spot in the transparent area. Photographing and developing these plates for use in the photoformer also offers opportunity for recheck at a later date.

When used in the photoformer, the plate is placed between a crt and a phototube. A voltage is impressed on the horizontal plates of the crt to position the spot on the graph. The phototube, vertical amplifier and deflection plates, shown in Fig. 1, are connected in a closed loop and drive the spot up until the phototube is able to see approximately half of the spot. The output voltage is taken from the vertical amplifier and fed to computer.

Design Consideration

Measurement of crt linearity and spot-to-phototube distance effects can be made with a precision-notched aluminum plate. Output voltage can be measured at the various steps with a precision potentiometer. A number of horizontal sweeps are made using an aluminum graph set at various heights to give the variation in output for different inputs.

The results of these tests indicate the existence of an error curve composed of two major components, the greater being approximately proportional to \((X^r + Y^r)^{1/2}\) and directed upward as a result of variation in spot-to-phototube distance with variation in spot position.

Although the Y equals zero line can be made to show unmeasurable distortion by offsetting the phototube or the photographic plate from the scope axis, the advantage is outweighed by increased distortion at the edge of the graph. Inaccuracies as high as 1,200 mv exist as a result of this nonlinearity.

To correct this, instead of using the customary 10 in. by 10 in. square of graph paper, a master set of coordinates is layed out on a 20 in. by 20 in. aluminum loft layout with distortion built in to correct for these defects. Tracing paper is placed over these coordinates when drawing a graph for recheck.

FIG. 1—Block diagram of photoformer crt deflection system. Photoplate, containing image of waveshape, is placed between phototube and crt. Closed loop deflection system enables phototube to sense crt spot-position error. Spot is then driven to the point on plate where phototube sees it.

FIG. 2—Frequency response, phase error and gain error curves of photoformer. Response is flat to about 300 cps.
production. Since loft layouts are readily capable of accuracies of 0.005 in., these errors can be reduced to an equivalent 50 mv. Also it is impractical to draw the graph to greater accuracy than ± 0.005 in. With 20 in. equal to 200 volts, this represents an error of ± 156 mv.

In discussing the inaccuracies of the system the light output of the CRT must also be considered. Because of the lack of phosphor homogeneity, light output of the CRT varies with spot position to give about 300 cps of 10 percent variation per sweep. Since about one half of a 3-v diameter spot is exposed, this represents about an equivalent ± 75-mv error. Thus, the total system error is 330 mv. This is favorable when compared with the errors that occur as a result of straight-line approximations in other types of function generators.

Fig. 2, is within 1 percent at 300 cps. To have a flat frequency response it is necessary for the gain of the system feeding the CRT plates to be constant for all frequencies of interest. To accomplish this, capacitors are provided across input and feedback resistors in the \( -Y \) amplifier to counterbalance the reactances of the scope plate and \( Y \) gain control.

Common with analog computing equipment, the frequency response values are only valid if the amplitude-frequency product is low enough to stay within the rise-rate limitation of the system. In this case it is possible to have a 200-v peak-to-peak swing at 300 cps.

Drift of the unit must properly be divided into two parts since the total drift will be the curve slope times the drift of the input section plus the drift of the output section. Drift in the output section is dependent on spot size, variation in spot intensity, and phototube sensitivity. The \( Y \) amplifier and phototube drift is within 150 mv per hour and drift of the \( X \) amplifier is within 15 mv per hour.

Stability is a problem with photoformers because the feedback loop is only closed when the spot is partially hidden by the graph. Consequently, a certain amount of drift in one direction or the other, dependent on the portion of the spot that is originally set to peek over the edge of the graph, will cause the system to lose control and come to rest at either the upper or lower output limit.

With this unit it is customary for at least 5 of the 6 channels to operate continually for 24 hours without losing position on the graph. Also, the door may be opened and shut and the spot can be expected to return to its proper position. A diode network, sensitive relay and neon light are provided to warn the operator in case the spot does leave its position on the graph. External connections for this warning are provided as additional indication at the main console.

Noise was found to be about 50 mv rms without phototube selection. Since the sum of the \( Y \) and \( -Y \) amplifier outputs cause the spot to remain on the graph, reduction of \( -Y \) amplifier output of noise frequencies causes an increase in output noise. Consequently, a lead network is used in the \( -Y \) amplifier in contrast to the lag network in the \( Y \) amplifier.

Chassis layout is based on sev-
eral different requirements. It must be convenient to use, easy to service, and must have sufficient crt-to-phototube distance to make the spot-to-phototube distance nearly constant. Nine inches was chosen somewhat arbitrarily as a suitable compromise. Also, close proximity of the phototube to its amplifier is required to reduce the line capacity to achieve the best possible frequency response.

The K1112P15 crt was chosen because it was designed for photoformer use. The P15 phosphor has the highest speed that the manufacturer recommends for the purpose. It is installed directly behind the door, supporting the photo-graphic plate, so that it can be conveniently removed. The phototube, a type 6291, is mounted to the right of the door for the same reason. This type of phototube was chosen because smaller tubes have insufficient gain, and larger tubes enhance the spot.

Phototube voltage divider resistors, wirewound for stability, are mounted directly outside the phototube compartment on a piece of micarta that is used as a side of the compartment. Resistors mount on screws that also serve as feed-through terminals. A Plexiglas cover over the resistors protects maintenance personnel against shock.

The door has a permanently-attached photographic plate holder mounted about 4 in. from the front. A mirror is placed between the door front and the plate holder to reflect the light sideways from the crt to the phototube. The door also supports the graph-tilt control and is three-shoulder constructed to prevent entrance of light.

The X and Y amplifiers are mounted on a separate chassis that plugs into a receptacle adjacent to the phototube. Spare amplifier chassis are provided to reduce lost-operating-time cost. To further reduce maintenance costs, photoformer chassis, power supply and control chassis were made plug-in units.

Possible variations in crt beam current, which might adversely affect the stability of the system, are eliminated by a 4-megohm resistor placed in series with the crt cathode. See Fig. 3. A neon tube was connected from the heater to the cathode to avoid possibility of this voltage exceeding the manufacturer's rating. Although use of such a large cathode resistor may appear objectionable, each of the 12 tubes have operated for an average of over 5,000 hours in this circuit with only one failure.

Filament transformers were mounted on the photoformer chassis to avoid the need for connectors with extra high-voltage terminals and to reduce line loss. Input to the Y amplifier is a cathode follower with the shield tied to the cathode to minimize phototube output capacitance. Low capacitance is necessary for bandwidth due to the use of a 1-megohm phototube load resistor, which was used to achieve high output with low spot intensity. Low spot intensity is necessary to avoid burning the phosphor since the spot may rest in the same position for hours.

**Amplifier Gain**

Although the gain of the Y amplifier alone is in the order of 250, this must be multiplied by the spot-to-phototube gain to get the loop gain. The effective spot diameter is 3 v and the voltage generated by the phototube in moving the spot from the dark to fully in view is 15 v. Thus, the effective Y amplifier gain is 1,250. To produce the 200-v peak-to-peak required output, the spot shifts from 44 percent in view to 56 percent.

Since the closed loop gain must be set up for each graph and rechecked daily and the spot shift is not sufficient to effect stability, this gain is entirely adequate.

The calibration panel contains a precision potentiometer for setting input voltages for calibration to any desired value between 0 and ±150 volts and a triple scale output voltmeter that may be referenced to 0 or ±100 volts. The potentiometer is a 15-turn dual-tapped unit with external resistor network to provide about four times as much linearity with load as is available with a single unit as seen in Fig. 4.
Cathode-Ray Tube Adds Third Dimension

Cathode-ray screen is mounted within vacuum tube behind transparent viewing globe. Screen is driven in oscillation toward and away from the observer along the Z-axis. Electron gun illuminates screen from the rear. Electromagnetic pickup on moving assembly gives output signal proportional to instantaneous position of screen along Z-axis. Beam is gated on for small portion of cycle and phasing of gate permits spot to appear in any plane in Z-axis. Possible uses in air-traffic control applications are discussed.

By Edward L. Withey

Data can be presented in true three dimensions with an experimental cathode-ray tube called the Peritron. The fluorescent screen of the tube is harmonically displaced with respect to an electron gun. Three-dimensional images are produced by X, Y, and Z-gating.

For effective operation, persistence of the screen phosphor (and duration of the beam gate) must be short in comparison with the period of screen oscillation. Also, the screen must oscillate at a frequency equal to or greater than the flicker fusion frequency of the eye. Both of these conditions are met easily in practice.

A large screen can be driven through an appreciable amplitude with comparatively small driving power if the system is in a vacuum since there is then no air load. Large-amplitude oscillation at frequencies up to about 30 cps is facilitated if the mass of the moving structure is kept at a minimum. Since sound is not transmitted by a vacuum, proper acoustic isolation of the drive assembly results in essentially silent operation.

The first experimental model of the tube, as illustrated, has a screen consisting of a mica disk 1 mm thick and 18 cm in diam. It is coated on the under surface with a General Electric P-11 phosphor having a short decay characteristic. Light output is limited to ess...

conventionally. The electron-gun deflection elements used to generate three-dimensional patterns for the display. The X- and Y-input amplifiers drive the screen per cycle. Improvements include: induction motor with stator outside vacuum system; barrel-cam screen-drive for true harmonic screen motion; larger screen moving through a greater amplitude; glass dome; and sound isolators.

Display Generation

Figure 1 shows the essential elements used to generate three-dimensional patterns for the display. The X- and Y-input amplifiers drive the electron-gun deflection plates conventionally. Output from the electromagnetic Z pickup on the moving-screen assembly is fed into a pickup amplifier. Deflection and focus corrections and the Z-gate signal are derived from the output of this amplifier. Correction signals are mixed with the X- and Y-input signals in the amplifiers in the correct proportion to balance out apparent lateral spot deflections caused by screen oscillation. Signals are phased correctly by the adjustable phasing networks.

A third pickup amplifier output passes through a phasing network to provide a modulation voltage for the first anode. This voltage maintains a constant spot diameter throughout the amplitude of screen travel.

The fourth pickup amplifier output used in the Z-gate circuit allows time selection of the positive grid gate pulse for the Z-axis. To allow speed-control flexibility in the experimental model, a d-c motor is operated by an adjustable d-c supply to drive the oscillating assembly. The Z pickup, Fig. 3, consists of a small stationary coil surrounding the screen pushrod. A permanent magnet mounted in the pushrod generates an output voltage which relates in time and phase to the instantaneous screen position. The pickup voltage is fed to a preamplifier consisting of two 12AX7 sections, V4 and V5, in cascade. Phase-shift control is provided by V4, driving a phase bridge made up of an interstage transformer, capacitor and potentiometer.

Output from the bridge drives a cathode follower, V, Fig. 2. Outputs of V, are mixed with the X- and Y-input voltages in the cathode potentiometers of the input tubes. Phase and mixing controls are adjusted to give a deflection signal capable of balancing out the deflection component due to screen displacement.

The amplified pickup voltage at the output of V, Fig. 3, is fed to V, to provide focus correction. Correction amplitude is set by the grid-circuit gain control. Phase is adjusted by the series capacitor and potentiometer shunting the tube. This a-c modulation voltage is mixed with the d-c voltage at the first anode of the electron gun.

Z-Axis Control

Tubes V, V5, and V, comprise the Z-axis control circuit. This circuit places a spot on the Z-axis at a Z position in the screen cycle determined by a d-c Z-input signal. Tube V5 impresses the amplified Z-pickup voltage across a phase bridge consisting of a transformer, potentiometer and saturable reactor.

The d-c Z-input signal drives d-c amplifier V15 which varies the reactance. This action results in a signal of adjustable phase at the grid of thyratron V. Flexibility is provided by a reversing switch in the primary of the bridge transformer to allow a 180-deg phase shift. The thyratron is wired in

FIG. 1—Logic employed for generating three-dimensional patterns on display tube described in text
an R-C discharge circuit. When the tube fires, the shunt capacitor discharges through the tube to provide a short, large-amplitude, positive pulse across the 1,000-ohm cathode resistor. This pulse passes to the control grid of the electron gun and gates the beam on for several use per cycle of screen travel. The on portion of the cycle and the spot position on the Z-axis are determined by the magnitude of the Z-input voltage.

**Air Traffic Control**

One method of translating altitude and position data from the airport radar into a three-dimensional display is shown in Fig. 4. The system uses a storage tube with independent electron guns for reading and writing and a storage matrix capable of maintaining discrete levels of charge.

The airport radar drives the sweep of the writing gun. The altitude signal for the corresponding X-Y target is placed on the storage matrix as a quantity of charge. The storage tube provides scan (sweep) conversion between the radar and the display tube as well as independence of time base between the two systems.

An X-Y sweep generator develops a raster-type scan to drive the reading gun and the display tube in synchronism. The Z-axis signals from the display-tube pickup and from the storage tube are fed to an amplitude comparator containing appropriate amplifying and shaping circuits. The comparator produces a Z-gate pulse. This pulse turns on the display-tube grid at the instant of amplitude identity between the stored Z charge and the Z-pickoff signal.

The Z-pickoff voltage also drives the XYZ error modulator, which provides the X-Y sweep and Z-focus corrections. A portion of the voltage is returned to the Z-drive circuit providing a closed-loop feedback system for maintaining constant screen frequency.

Assume that a single-target aircraft will be at any one of 10 discrete altitudes from 1,000 to 10,000 ft. Assume next that the reading gun will recognize one of the 10 corresponding discrete levels of charge placed on the storage tube by the altitude signal from the radar. Assume, further, that the vibrating screen passes sequentially through 10 discrete positions. Each of these positions has a corresponding level of pickup voltage. For each position, one complete X-Y scanning frame is generated.

Ten frames are presented to the screen as it passes through its 10 levels from one amplitude extreme to the other, each half cycle. Assume, finally, that a target aircraft at 6,000 feet causes a charge of six units to be placed on the storage matrix at a certain X-Y position. This Z signal of six will be presented to the comparator 10 times per half cycle of screen travel. Coincidence will be obtained only when the screen is at level six and generates a six on the pickup output. Coincidence produces a grid gate, placing a spot on the screen.

In an actual system, the levels would be integrated into a smooth, continuous function. Actual resolution on all axes would be a function of the parameters of the radar set, storage tube, display tube, system bandwidth and other factors.
Asistor A-C Amplifier

Versatility and reliability are gained in transistor a-c amplifier using multiple feedback loop. Shunt and series loop used in a single stage enable such circuit properties as voltage and current gain, input and output impedance to be preselected and accurately controlled independent of variable transistor parameters. Preselection of circuit properties permits amplifier to be adapted to fit a particular application.

By HOWARD LEFKOWITZ, Electronic Engineer, U. S. Naval Ordnance Laboratory, Silver Spring, Maryland

ONE POSSIBLE METHOD used in designing reliably stable transistor circuits is to employ negative feedback in each stage. Since overall feedback loops around three or more stages present considerable stability problems, the use of negative feedback about each stage virtually eliminates problems of oscillation and substantially reduces design effort.

In addition, the use of both shunt and series feedback loops in each stage makes the amplifier versatile by enabling the circuit designer to preselect several circuit properties, such as voltage gain and input impedance or current gain and output impedance, to fit a particular application. With a large amount of negative feedback the amplifier properties may be made independent of the active device.

Circuits for Analysis

The steps in designing a transistor a-c amplifier are: analysis of a-c circuit (small-signal approximation), selection of operating point (large-signal considerations) and analysis of d-c circuit (bias-point stability).

Shown in Fig. 1 is the circuit to be analyzed. It uses both shunt and series feedback loops. Also illustrated is a possible method of obtaining bias-point stabilization through the use of both collector-voltage feedback, $R_v$, and collector-current feedback, $R_c$. For a-c analysis, if $R_e$ is not much greater than $R_v$, then the effective shunt a-c voltage feedback loop resistance may be considered the equivalent resistance of resistors $R_s$ and $R_f$ in parallel.

Figure 2 illustrates the a-c equivalent circuit derived from Fig. 1 and is based on the assumption that $R_s >> R_m$, $R_s >> R_m$ and resistor $R_r << R_c$. Using this equivalent circuit and reducing the transistor and its associated feedback loops to four-terminal networks valid in small-signal approximation, the circuit in Fig. 3 may be obtained. Matrix analysis techniques may be used for reducing the Fig. 3 circuit to one four-terminal network so that relations for the circuit properties may be found.

Using the assumptions of a good junction transistor, the small-signal voltage gain may be derived as follows:

$$A_v = \frac{R_f R_c (R_s - \alpha_f R_f) + R_d (h_{11} + R_1)}{R_f R_c (R_s + R_d) + R_d (h_{11} + R_2) (R_s + R_f)}$$

where $R_s$ is equal to $r_s + R_s$ and $h_{11}$ is equal to $r_s + r_f (1 - \alpha_f)$.

Assuming $\alpha_f >> R_s$, the small-signal voltage gain may be simplified to

$$A_v = \frac{R_f R_c (R_s - \alpha_f R_f) + R_d (h_{11} + R_1)}{R_f R_c (R_s + R_d) + R_d (h_{11} + R_2) (R_s + R_f)}$$

Assume $R_r >> h_{11} + R_s$ and $r_s >> R_s$, the small-signal voltage gain becomes

$$A_v = \frac{-\alpha_f R_f}{h_{11} + R_s} \times \frac{R_f R_c (R_s - \alpha_f R_f) + R_d (h_{11} + R_1)}{R_f R_c (R_s + R_d) + R_d (h_{11} + R_2) (R_s + R_f)}$$

If the two above assumptions hold and $R_s >> R_f$, for example, large amount of shunt voltage feedback; and $R_r >> h_{11}$, for example, large amount of series current feedback, then

$$A_v = \frac{-\alpha_f R_f}{h_{11} + R_s} \times \frac{R_f R_c (R_s - \alpha_f R_f) + R_d (h_{11} + R_1)}{R_f R_c (R_s + R_d) + R_d (h_{11} + R_2) (R_s + R_f)}$$

$$A_v = \frac{-\alpha_f R_f}{h_{11} + R_s} \times \frac{R_f R_c (R_s - \alpha_f R_f) + R_d (h_{11} + R_1)}{R_f R_c (R_s + R_d) + R_d (h_{11} + R_2) (R_s + R_f)}$$

For good junction transistors alpha is about 0.95 or better. Therefore

$$A_v = \frac{-\alpha_f R_f}{h_{11} + R_s} \times \frac{R_f R_c (R_s - \alpha_f R_f) + R_d (h_{11} + R_1)}{R_f R_c (R_s + R_d) + R_d (h_{11} + R_2) (R_s + R_f)}$$

Small-Signal Current Gain

To compute the small-signal current gain additional assumptions
Uses Multiple Feedback

The small-signal output resistance may be determined as follows:

\[ R_{out} = \frac{(1 - \alpha_f R_f)}{R_f (h_{ics} + R_s)} \]  

(12)

With following assumptions: \( R_f \gg R_s \), \( \alpha_f \approx 1 \), \( R_i >> h_{ics} \), then

\[ R_{out} \approx \frac{R_f R_s}{R_f + R_s} \]  

(13)

If \( R_f \gg R_s \), then the output resistance approaches the value of the shunt feedback resistor, \( R_f \).

Practical Amplifier

Given the following specifications for the design of a reliable transistor amplifier: Minimum transistor short-circuit current gain \( \alpha_m = 0.97 \), transistor short-circuit input impedance, \( h_{mss} = 30 \) ohms, generator impedance = 1,000 ohms, load impedance = 3,000 ohms, desired voltage gain = 15 and desired input impedance = 1,000 ohms.

Using Eq. 3 and assuming that \( R_f \gg R_s \):

\[ A_v \approx \frac{(3,000 + R_f)(160)}{3,000 + 160 + 0.03R_f} \]  

(14)

With \( R_f \), equals to 1,000 ohms, \( R_f \), equals 20,600 ohms. Let \( R_f \) equal 20,000 ohms, then \( A_v \), equals 15.8. From Eq. 9, \( R_{in} \), equals 980 ohms. Using \( R_f \), equal to 20,000 ohms and

\[ R_{in} \approx \frac{(3,000 + R_f)(160)}{3,000 + 160 + 0.03R_f} \]  

(15)

With \( R_{in} \), equal to 1,000 ohms, \( R_{in} \), equals 20,600 ohms. Let \( R_{in} \) equal 20,000 ohms, then \( A_v \), equals 15.8. From Eq. 9, \( R_{in} \), equals 980 ohms. Using \( R_f \), equal to 20,000 ohms and

\[ R_f \approx \frac{(3,000 + R_f)(160)}{3,000 + 160 + 0.03R_f} \]  

(16)

With \( R_{in} \), equal to 1,000 ohms, \( R_{in} \), equals 20,600 ohms. Let \( R_{in} \) equal 20,000 ohms, then \( A_v \), equals 15.8. From Eq. 9, \( R_{in} \), equals 980 ohms. Using \( R_f \), equal to 20,000 ohms and

\[ R_{in} \approx \frac{(3,000 + R_f)(160)}{3,000 + 160 + 0.03R_f} \]  

(17)

The small-signal output resistance may be determined as follows:

\[ R_{out} = \frac{(R_f + R)_i h_{ics} + R_f}{R_f (h_{ics} + R_s)} \]  

(18)

For the following assumptions: \( h_{ics} = 1 \), \( R_f \gg h_{ics} \),

\[ R_{in} \approx \frac{(R_f + R)_i}{R_f + R_s} \]  

(19)

For large shunt feedback \( R_s \gg R_f \), the input resistance becomes

\[ R_{in} \approx \frac{R_f R_s}{R_f + R_s} \]  

(20)

and if \( R_f \gg R_s \), the input resistance approaches the value of the series feedback resistor, \( R_s \).
Multicoupler Nomograph for Tv Antenna Networks

Resistance and power loss in multicoupler connecting two or more tv receivers to one antenna is determined quickly using straightedge. Parameters required are network characteristic impedance and number of receivers

By ANTHONY PAOLANTONIO
Research and Engineering Division, Airborne Instruments Laboratory, Inc., Mineola, N. Y.

MASTERTV antennasystems usually consist of one or more antennas, one or more distribution amplifiers and transmission lines for coupling antennas to receivers. The multicoupler network discussed here is shown in Fig. 1A. It replaces the electron-tube distribution amplifiers and can be used with either twin lead or coaxial transmission lines as shown in Fig. 1B and 1C. Symmetrical construction of the network is based on the assumption that the characteristic impedance of the tv receivers and the antenna are the same.

Prior to connecting receivers to an antenna, it is advantageous to know the multicoupler network resistance, the power loss incurred, and the isolation between receivers. These quantities may be computed quickly using the nomograph shown in Fig. 2.

To determine circuit characteristics when four receivers are connected to one antenna, draw a straight line from 4 on the n scale through 300 on the Z scale and extend the line until it crosses the R scale. The multicoupler network resistance is found to be 180 ohms; the power loss and isolation are read as 12 db opposite 4 on the n scale.

Field tests conducted in a metropolitan area indicate that within a 5, 10 and 20-mile radius from a transmitting antenna, eight, four and two receivers respectively can be coupled to one antenna without loss of picture contrast range. These figures are conservative ratings based on the use of an in-line, folded-dipole antenna having one high-band and one low-band element with a single reflector. Illumination from the transmitting antenna was direct line-of-sight.

The value of R is noncritical. Closest standard 10-percent EIA value is sufficiently accurate for all applications. Since R becomes small as n increases beyond a value of eight, R can, for all practical purposes, be made equal to Z whenever n > 10.
CINCH UNIVERSAL EDGE CONNECTORS

...AVAILABLE IN FOUR BASIC MATERIALS, AND IN ANY NUMBER OF CONTACTS FROM 6 THROUGH 25

24585—15 C-1 G. P. BLACK

After the basic part numbers under the components shown, the number designates the number of contacts. The letters A, B, C, or D, designate melamine, orlon filled diallyl phthalate, General Purpose black or asbestos filled diallyl phthalate respectively. All contacts are phosphor bronze with P-92-3-03 finish (.0003 silver followed by .00003 gold flash). Type one contact, reproduced here, which takes a standard #20 stranded copper wire for conventional soldering is ready for delivery.

Parts with wire wrap contacts and/or contacts for dip soldering to a printed board will be available for future requirements.

Pre-assembled polarizing key (illustrated) in any connector in any contact position when desired is designated by the last letter of the connector assembly, e.g., 24585-15D-1-T designates a connector with 15 contact positions with Asbestos filled Diallyl Phthalate insulator body and a polarizing key in contact cavity T, thus there will be only 14 usable contacts.

CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois

CIRCLE 53 READERS SERVICE CARD
Photocell Measures Raindrop Size

Determining raindrop size is regarded by the University of Michigan as one of the first steps toward possible weather control. A $26,000 grant from the National Science Foundation is being used for the study. Electronic equipment will play a major role.

A. Nelson Dingle, associate professor of meteorology, is directing the two-year investigation, which began this month. He indicated that there is little scientific knowledge of raindrop sizes. He believes results of his work will be useful for a variety of things, such as helping to reduce erosion of newly planted land and improving radar detection of storms so as to determine the amount and type of rain in them.

Findings also may help to evaluate artificial rainmaking by distinguishing artificially generated rain from natural rain on the basis of drop size differences.

Chief tool of the investigation is the raindrop-size spectrometer, a device that measures and counts raindrops without disturbing them. It consists mainly of two black boxes mounted at the ends of two arms. One box contains a light source, the other a photoelectric cell and an electronic amplifier.

As the arms whirl about three times a second, the photocell watches a spot in the light beam. When a raindrop passes through that spot, the amount of light that falls on the photocell tells the size of the drop. In the heaviest rain, the device records about 50 drops per second. The recording apparatus consists of a panel of electronic instruments in a nearby room.

Comet Shows CRT Beam Direction

By J. J. WORMSER
Electrical Engineering Dept., Southwest Research Institute, San Antonio, Texas

Knowing the direction of beam travel in cathode-ray oscillography can aid in some types of testing. In studying Lissajou patterns, for example, trace direction can indicate phase relationship of vertical and horizontal deflection voltages.

Trace direction can be determined by intensity modulating the electron beam of an oscilloscope. This method does not disturb the horizontal and vertical input circuits. Furthermore, intensity modulation is relatively independent of display size.

A sawtooth signal is used for modulation because, when properly used on the Z-axis, the resulting comet-shaped pulse clearly indicates trace direction. Although practically any type of sawtooth generator can be used, it should supply at least 15 volts peak modulating voltage. For measurements in the audio range, it should supply pulse lengths of from 20 milliseconds to 20 microseconds with a flyback time of less than one microsecond.

Free-running oscillations are usually satisfactory, but, if external synchronization is desired, either of the deflection voltages can be used to synchronize the sawtooth oscillator at fundamental frequencies. For harmonic synchronization a suitable triggering circuit must be included.

The circuit in Fig. 1 is a free-running multivibrator-type sawtooth generator. It is isolated from the synchronizing signal source and modulation load by emitter-follower circuits. Output waveform is a series of positive-rising negative-decaying sawtooths with peak amplitudes of 17 volts across 10,000 ohms.

Controls are provided for adjusting amplitude of the synchronizing signal and sawtooth pulse lengths. Pulse lengths can be varied from 22 milliseconds to 15 microseconds.
Keep Up-to-Date on Magnetics

Now—guaranteed maximum and minimum performance limits for tape wound cores!

For the first time you can order tape wound cores with guaranteed performance to published limits.

All tape wound cores coming from the hydrogen atmosphere annealing furnaces at Magnetics, Inc. are tested by flux reset as proposed by the AIEE Working Group on Core Matching and Grading*. Thus, standard cores are given a standard test to give engineer-designers a standard component whose performance is guaranteed within fixed limits.

Magnetics, Inc. has established the limits to provide maximum, minimum and nominal $B_m$, $B_r/B_m$, $H$, and gain performance data. It is published for one, two, four and six mil tape thickness for Orthonol® and Hy Mu 80.

Now it is possible for you to select and order cores specifically suited to your design (just as with any other standardized component). You'll save many hours of experimenting, and because the reliability of the data is guaranteed, you'll be sure at every stage of design and production.


*Magnetics, Inc.*


Flux Reset Test is one of two tests proposed for standardization.
with flyback time of 0.5 microsecond. The circuit drains 5 milliamperes total current from a 22.5-volt dry cell battery. Free-running frequency stability is adequate for most uses.

Most commercial oscilloscopes when used with this circuit indicate trace direction oriented with the comet nose. Orientation of the comet depends not only upon trace direction but also upon polarity of Z-axis modulation.

A direct method for determining initial orientation is to connect the marker output to the oscilloscope vertical input. Use the internal sweep at a low frequency. In this instance, the steep slope of the waveform indicates inverse horizontal trace direction. Then reconnect the marker output to the Z-axis input. Adjust the marker frequency controls until one or more stationary comet appears. Comet orientation respective to the known trace direction can then be noted.

Phase determination can be accomplished in the conventional manner by constructing a centered Lissajou on the screen and measuring the ratio of Y intercept to Y maximum which ratio equals the trigonometric sin of the phase angle between deflection signals. This technique by itself provides only information respecting phase magnitude.

By using the trace marker to indicate direction, phase position can be determined quickly without disturbing either deflection circuit. If the oscilloscope deflection is standard with upward and right-hand directions corresponding to positive input deflection voltages, vertical input voltage leads horizontal voltage if the trace rotation, as indicated by the marker, is found to be clockwise. Conversely, the horizontal leads the vertical for a counterclockwise rotation.

### Whip Antennas Track Missiles

**ELECTRONIC and analog computer techniques are combined in a recently announced system for tracking missiles optically and photographically (see ELECTRONICS, April 4, 1958, p. 49). The system can also indicate when a missile has departed from its planned course and must be destroyed.**

**Called Electronic Missile Acquisition system (EMA II), it is undergoing evaluation by the Army at Aberdeen Proving Grounds.**

A prime feature of the equipment is that it provides instant acquisition. The time required for scanning and locking on a target is eliminated. In addition, total response time is also reduced since it is not necessary to drive a dish-type antenna.

The system consists of an antenna array, preamplifiers, two radio receivers, data transmission and comparison circuits for telescope tracking and an analog computing system developed by Magnetic Amplifiers, Inc.

An array of whip antennas is spaced around the theodolite. They receive an unmodulated r-f signal from a beacon in the missile. A phase difference in the r-f received by each antenna corresponds to the propagation time from the source.

These phase-related signals are amplified in phase-stabilized preamplifiers and delivered to the receivers. The receivers convert the r-f to audio frequency, maintaining phase intelligence. The a-f signals are also amplified in phase-stable amplifiers.

Outputs from the receivers are delivered to two phase-angle computers. These, in turn, produce two output signals that are proportional to the phase differences in the input signals.

The theodolite computer receives the output signals from the two phase computer channels and, in conjunction with resolvers attached to the azimuth and elevation axes of the theodolite, derives signals proportional to the angular deviation of the theodolite axes from the computed target angles.

The theodolite computer circuitry would produce an error signal varying widely as a function of target angle. In order to maintain a constant error voltage per degree of angular error, compensating amplifiers are also incorporated into the system.

### Electronic Chopper Uses New Photocells

**BY RICHARD G. SEED
Sensiton Corp. * Lexington 73, Mass.**

Photoconductive choppers have been of considerable recent interest, and a number of firms have been exploring both their design and application. This is possible because of the increased knowledge of solid-state devices in the past decade, including the development of several simple, highly sensitive photocells, especially cadmium sulfide and cadmium selenide.

The photoconductive chopper is a narrow class within the larger class **

*Now with Sylvania Electric Products, Inc., Woburn, Mass.*
INET tailor-made
400-cycle ground
power unit serves
ATLAS missile

...meets Convair's tough requirements

Used for pre-flight calibration of the Atlas electrical systems, Leach's 400-cycle unit met all Convair's specifications...performed as one of the most successful pieces of test equipment used in this USAF project.

There's a custom-built engine generator or motor generator set for every 400 or 1600 cycle application. Write for Bulletin 400cycle Power.

LEACH CORPORATION
INET DIVISION 18435 Susana Road, Compton, California
DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA
For critical applications, many of our customers have saved years of trial and error in YOKE selection by specifying Celco YOKES.

The construction of our yokes makes it possible to achieve sensitivities, linearities, responses and distortion-free deflecting fields not possible with the usual types of yoke.

For precision military and commercial displays, Celco also offers standard yokes in 7/8", 1", 1 3/8", 2", & 2 1/2" CRT neck diameters.

Write for CELCO DEFLECTION YOKE Catalogue & Design Sheets or for immediate engineering assistance Call your nearest CELCO Plant:

Constantine Engineering Laboratories Co.

Mahwah, N. J. Miami, Fla. Cucamonga, Calif.
Davis 7-1123 Plaza 1-9083 Yukon 2-2688

of nonmechanical choppers also now receiving wider attention. Other examples include magnetoresistive, Hall-effect, rectangular hysteresis, magnetic-core, modulated-diode and transistor choppers.

The basic photoconductive chopper arrangement is illustrated in Fig. 1. $R_s$ is usually fixed and serves to prevent burn-up of the photocell. A value of 0.3 megohms is used. $R_4$ is a variable resistor that can be adjusted for maximum conversion efficiency. A value of about 2.2 megohms seemed best. Resistors $R_s$ and $R_4$ may be combined.

FIG. 1—Photoconductive chopper offers low noise level and resistance to vibration.

$R_s$, the photocell parallel impedance, may be 5 to 100 megohms and serves as an upper limit on effective photocell resistance. Output impedance is determined by the cell and the impedance $R_s$ in parallel. In the dark condition photocell resistance increases to values as high as thousands of megohms, and the output impedance thus cannot exceed $R_s$. As the high dark resistance tends to vary largely among cells and is reached only very slowly, this arrangement tends to produce more uniform and a consistent output signals. In many cases $R_s$ may be omitted.

$C_3$ averages d-c signal input fluctuations so that they do not exceed light source chopping frequency. The light source should be mounted in immediate contact with the photocell with the filament lined up with the sensitive area of the detector. A thin electrostatic shield was found to reduce a-c pickup from the light source. The entire closed unit of light source, resistors and photocell should also be enclosed in a light tight and electrostatic shield.

The varying intensity of the
NOW **tan-TI-cap**

**SOLID TANTALUM CAPACITORS**

...immediately available in production quantities!

YOU get precision performance, tough mechanical construction and clean, compact design when you specify *tan-TI-cap* solid-electrolyte tantalum capacitors — available immediately in production quantities!

YOU are assured of the stability your high reliability applications require with *tan-TI-cap* capacitors. Capacitance and impedance parameters remain within 5% of rating throughout entire temperature range... from -80 to +85°C... and stable throughout extra-long shelf and service life!

Solid, no-leak construction of *tan-TI-cap* capacitors provides pellet with a hard surrounding foundation of high temperature solder that resists high impact and vibration. You simplify printed circuit assembly with *tan-TI-cap* capacitors ... firmly anchored leads can be bent sharply close to the case for easy mounting in subminiature circuits.

**SELECT FROM 18 RATINGS**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>6-Volt</th>
<th>15-Volt</th>
<th>25-Volt</th>
<th>35-Volt</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 µF</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>33 µF</td>
<td>15</td>
<td>10</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>47 µF</td>
<td>22</td>
<td>15</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>68 µF</td>
<td>33</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 µF</td>
<td>100</td>
<td>55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ASK YOUR NEAREST TI SALES OFFICE FOR BULLETIN DL-C 859

*Trademark of Texas Instruments Incorporated*
P&B PROGRESS
IMPROVED! SEALED COIL, TELEPHONE-TYPE RELAY.

NEW! DUAL HERMETIC SEAL INCREASES RELAY RELIABILITY AND TEMPERATURE RANGE

Look at these great new features

- New bobbinless coil saves space, permits use of more ampere turns of Teflon coated wire with no increase in coil diameter.
- Mycalex stack, Teflon wire and end washers and ceramic pushers, plus sealed coil, permit high temperature operations. (Tested up to 125° C.)
- Hermetically sealing the coil of the MH “Seal-Temp” substantially increases the reliability and life of this popular telephone-type relay. Considered a major reason for relay failure, contact contamination due to outgassing of the coil has been eliminated by this sealing process.

Hermetically sealing the coil of the MH “Seal-Temp” substantially increases the reliability and life of this popular telephone-type relay. Considered a major reason for relay failure, contact contamination due to outgassing of the coil has been eliminated by this sealing process.

The “Seal-Temp” has a temperature range considerably broader than ordinary relays... from -65° C to +125° C. This is achieved by constructing the stack of Mycalex, employing ceramic pushers, and by using Teflon coated wire throughout.

For applications where reliability, long life and broad temperature ranges are required, the MH “Seal-Temp” relay could well be the answer. Write, wire or call today for complete information.

POTTER & BRUMFIELD, INC., PRINCETON, INDIANA / SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
MH "SEAL-TEMP" RELAY


P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

Potter & Brumfield, inc.
PRINCETON, INDIANA
SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N.H.

light source causes the photocell resistance to vary substantially, and the impressed d-c signal voltage drop appears mostly across load R, or mostly across the photocell PC, depending on their relative resistances.

Conversion efficiency is defined as the ratio of peak to peak a-c output voltage signal to d-c input signal in percent. The most efficient circuit for modulation consists of a photocell in series with a resistor whose value is the square root of the product of maximum and minimum photocell resistance. Using the circuit arrangements described, conversion efficiencies of 20 percent have been obtained and more than 40 percent with miniature tungsten filaments. For resistance variations of 100 to 1, the maximum conversion efficiency is 80 percent.

Several problems exist in photovoltaic cells. One is the noise or spurious signal produced by the light source in the load from the self-generating effect in the photocell when there is no d-c signal. This has been as low as 25 microvolts at room temperature. There is no reason to believe that this could not be reduced considerably.

Unfortunately there is a tendency for this photovoltaic signal to increase with temperature in cadmium sulfide. However, it can to a very large extent be canceled by an appropriate d-c bias on the photocell and series resistors R1 and R2. For long term stability the light source and self-generating effect should be stable.

Some self-generating effects can also be caused by thermal gradients. The photovoltaic effect originates mostly at the contacts to the crystalline material. It can be reduced by carefully shielding the contacts from radiation and by use of suitable contact materials deposited in suitable ways. These include indium and aluminum deposited by evaporation or alloying or both. Some self-generating effect can result from crystalline inhomogeneities. These can only be reduced by careful crystal growth or by crystal selection after growth.

Nonlinearities in the voltage-current characteristic, at some reasonable fixed illumination level, can
The answer to your problem in the measurement of Rpm & Rps, Frequency, Period, Velocity, Flow, Pressure, Temperature.

Calibration of Transducers, Filters, Oscillators (Audio, Sub-Carrier), Intervalometers.

Timing of Relays, Valves, Actuators, Mechanical Devices, Projectiles, Sporting Events, Camera Shutters.

Model 400
Price $695.00

is an ERIE INSTRUMATION® Digital Electronic Counter-Timer

Featuring:

- Small Size—Light Weight—
  19" x 3\(\frac{1}{2}\)" panel, 16\(\frac{1}{2}\)" wide, 10" deep. Weighs only 17 pounds.

- Low Cost—
  The low price ($695.00) of Model 400 instrument results from the simplicity of circuit design.

- Wide Range of Measurements—
  Time intervals from 500µS to 278 hours. Frequencies from 1 cps to 100,000 cps.

- Accuracy—
  Temperature controlled crystal provides time base accuracy to ±0.001%. Resolution is ±1 count or ±10µS at 100 KC.

- Electronic Reset—
  Eliminates troublesome mechanical relays.

- Simplicity of Design—
  Each scaler consists of one triode driver and one glow transfer tube only. This replaces conventional 4 dual triode, 10 neon tube in-line display.

Other ERIE Digital Instruments are available from $395.00. Write for additional information.

Conversion efficiency depends on light intensity, and with efficient light input power, conversion efficiency can be as high as desired, probably up to about 95 percent. However, this may reduce bulb life. The neon light source is a poor match for cadmium sulfide, better for cadmium selenide. Argon works better with cadmium sulfide, whereas the tungsten filaments are convenient sources of intense light for both cadmium sulfide and cadmium selenide.

Filaments, however, are very sensitive to vibration. In addition care must be exercised in the use of tungsten filament light sources since even a low-power bulb may heat the photocell and cause a 15-20 percent change in resistance. This can be avoided by adequate thermal shielding even though the bulb and photocell are almost touching.

Temperature sensitivity may also be considered a problem. The impedance of the cadmium sulfide...
6 Taylor-Fabricated Laminated Plastic Insulators Protect Control Elements of GE Automatic Toaster

These insulators for the pop-up mechanism, color control unit, and heating element in the General Electric Automatic Toaster are made of continuous filament woven glass fabric with melamine resin bond. This Taylor Fibre Co. material was selected for its ability to withstand the temperatures encountered in the toasting operation, its excellent arc resistance and mechanical strength, and its cost, which is lower than that of the mica insulators formerly used.

Another factor in the decision was the capacity of Taylor Fibre Co. to produce the fabricated parts to specification, and in the large quantities required, at reasonable cost.

You, too, may have applications which can utilize the combination of physical, mechanical and electrical properties found only in laminated plastics. Our application engineers will be glad to discuss them with you, offer engineering assistance, and recommend a Taylor grade that will fit your specific requirements. Our plants at Norristown, Pa., and La Verne, Calif., are both fully equipped for fast supply of basic materials and finished parts. Write us for detailed information or to arrange for a Taylor Fibre man to call on you. TAYLOR FIBRE Co., Norristown 40, Pa.
Double-barrel solution to all wiring problems!

 Longer lasting CHESTER Plasticord-Plasticote wires, and nylon and teflon* insulated conductors, are available in standard or custom constructions for every requirement. All are service-proven for complete reliability for the specific application for which they are engineered. And equally reliable, is the service behind them... from "crash" deliveries to engineering assistance on the design of special purpose constructions!

CHESTER
plasticord-plasticote
WIRES & CABLES

QUALITY plus — SERVICE

CHESTER CABLE CORP.
A Subsidiary of Miami Copper Company

40 HILL STREET, CHESTER, NEW YORK, U.S.A.

PIONEER PRODUCERS OF PLASTIC INSULATED WIRES AND CABLES

PHOTOCHEL

CHESTER
plasticord-plasticote
WIRES & CABLES

QUALITY plus — SERVICE

CHESTER CABLE CORP.
A Subsidiary of Miami Copper Company

40 HILL STREET, CHESTER, NEW YORK, U.S.A.

PIONEER PRODUCERS OF PLASTIC INSULATED WIRES AND CABLES

*DuPont Trade Name

photocell may vary as much as 15 percent from -80 to 60°C, which variation will adversely affect output but at less than a linear dependence. Short-term amplitude output changes up to 5 percent have been observed apparently because of slight resistance changes with temperature and of instability in neon lamp output.

The time constant for photocell response of cadmium sulfide is inversely proportional to illumination. Thus at low levels of illumination the conversion efficiency may be limited by low-frequency response.

A complete design theory for photoconductor choppers needs to be worked out. Such a design theory must include design for maximum conversion efficiency and minimum noise level.

Any unit will have a fundamental noise limit. Noise will comprise two terms, the Johnson noise in resistor R, and photocell noise. The photocell noise may contain two terms, a random fluctuation term and a self-generating term.

The self-generating term might be limited by random thermal gradients. The random fluctuation term can be expected to comprise two components: the Johnson noise of an equivalent resistor and an excess noise, in power proportional to 1/f and sometimes called semiconductor noise.

In exceedingly good units the 1/f noise may be less than the Johnson noise of an equivalent resistor. But this has not been observed in cadmium sulfide or selenide at line frequencies.

A noise voltage as low as 6 microvolts across 6.3 megohms at 50 cps with a 4-cycle bandwidth has been obtained. This noise level compares favorably with the best precious metal mechanical choppers, which is about 1 microvolt across 0.1 megohm.

Photoconductive choppers, when properly designed and built, would appear to have the following advantages: low noise level (at least competitive with mechanical choppers), more economical (especially for low-noise signals), insensitive to shock and vibration and long life (with suitable nonfilament light source).
IT'S A MUST!

If you sell to the $7 billion electronics industry, you'll want a free copy of electronics MARKET MEDIA FILE.

What are the prospects for:
MILITARY ELECTRONICS?
REPLACEMENT ELECTRONICS?
HOME ELECTRONICS?
INDUSTRIAL ELECTRONICS?

Who are the BUYING INFLUENCES?

Why are more than 9,000 men who make the buying decisions for 30 giant companies subscribers to electronics? ... and what does that mean to your advertising dollar?

The 1958 electronics MARKET MEDIA FILE gives the answers in 12 fact-packed pages that you will refer to time and again throughout the year.

Send for your free copy today.

ABC electronics ABP
A McGRAW-HILL PUBLICATION
330 W. 42nd St., New York 36, N. Y.
COMPONENT DESIGN

Oscilloscope Without a Direct Connection Probe

If the desired information is wave-shape, rather than precise electrostatic signal is picked up. In order to prevent any random wave-magnitude, the absorption analyzer is probably the most convenient instrument to use. Its loading on the circuit under test is an absolute minimum and the speed and ease of testing are far greater than any other known method.

No direct connection is made with the circuitry being tested. Instead the pick-up is brought near the tube or component and a true charge from being picked up, a common negative conductor is connected to the circuit of the tube under test. The common negative is between the pick-up grid of the test circuit and ground of the circuit under test. With this arrangement a capacitive coupling is created and difficulties of stray charge are eliminated.

Since glass envelopes of most electron tubes are cylindrical, a ring-type conductor is used at the end of the pickup. It is surrounded by a phenolic substance, which in turn is surrounded by an outer metallic shield. The outer ring, or shield, is grounded to eliminate stray signals. The inner conductor and plate of the tube form the capacitive coupling.

Tuned Circuit

At the high frequencies, where the circuit under test would become heavily loaded, a tuned circuit is used in the coupling circuitry to maintain high impedance. Since coupling capacity is inversely proportional to distance between the plate of the tube under test and the inner ring of the pickup, loading of the circuit can be controlled to a great degree by the person using the instrument.

With coupling pulses or square waves, allowances must be made for the fact that the coupling becomes

Resistor for Automatic Assembly

A rectangular ceramic case with bench-like legs at either end has been built around a 5 w resistor by International Resistor Company. The resistor was designed for easy feed and mounting in automatically assembled printed circuit boards. Because of their simple shape, they sell for less since they cost less to make. The automatic assembly design permits the user to mount the resistors for less money and thereby receive a further cost reduction.

Resistor Legs

The legs decrease the heat conducting contact area between the printed circuit board and the resistor. The resistance element is uniformly and tightly wound on a glass fibre core. Tinned copper leads are sealed in a rectangular ceramic case with special cement to protect and insulate the resistor. Induction is 0.17 µh for the 5 ohm resistors, 8 µh for the 2,400-ohm resistors and 33 µh for the 9,000-ohm resistor. International Resistance Company, Boone Plane, Box 393, North Carolina.

Ease of Testing

Considerable time is saved with the oscilloscope since it is not necessary to pull any tubes or remove the chassis to check the signal at a particular tube. Performance of
When increased power allocations by the FCC resulted in the need for a switch to handle greater powers and higher frequencies, engineers of Thompson Products, Inc., were faced with a major redesign problem. It looked as though the higher requirements would make their new multi-position switch for 3\(\frac{1}{8}\)" rigid coaxial line obsolete. Needed were models that could handle 55,000 watts of average RF power and could cover the full UHF band to 1000 megacycles. The problem was solved by changing to a TFE-fluorocarbon resin for the dielectric.

Both electrical and mechanical properties of TFE resins proved important in this design. The resin is used to make sheet dielectric for backing the grounded connector plate and a strong shaft for turning the switching bar. One of the biggest problems—impact cracking—was entirely eliminated. In addition to their unique UHF properties, TFE resins have a Class H temperature rating. 260°C. continuous rating permits increased operating temperatures in the switch. The extremely low dielectric constant of TFE resins is a natural for this microwave design. TFE resins have a minimum dissipation factor, unexcelled by any other solid. Characteristic curves for these electrical factors show that they remain flat with regard to both temperature (see graph) and frequency (60 cps to 3000 mc).

This remotely controlled, motor-operated switch is another example of the use of Du Pont TFE resins to assure RELIABILITY and SAFETY in electronic operations. We will be glad to send you information covering design data and applications of these outstanding dielectric materials.

Write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 175, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.
each tube can be observed while operating in its own circuit and all checking can be done from top-side—the most accessible place to test the signal at a tube.

**Sensitivity**

Any combination of 12 tuned circuits from 3 mc to 240 mc, with band widths up to 5 mc can be installed in the unit. These tuned circuits add to the unit a sensitivity of 200 µv per inch at most frequencies. Built-in detector circuits preclude the necessity for an external detector. Both the tuned circuits and detector can be by-passed with a switch on the front panel. This allows the input to be applied directly to the scope vertical amplifier which has a sensitivity of 2 mv per inch or approximately 10 to 1 over conventional oscilloscope sensitivity.

**Testing Shielded Circuits**

Making a test which requires physical contact is often very difficult with shielded equipment. An example is a weather radar IF strip in air-borne equipment which has a shield plate on the bottom of the IF section. When this plate is removed it upsets the circuitry so a definite check of the defective stage by conventional methods is time consuming and often mislead-

Pen Recorder

**Accessory Transducers Add Versatility to Pen Recorder at Practical Cost**

The recording mechanism of a pen recorder is the same regardless of whether it displays a d-c voltage or an a-c line frequency. It is the transducing element which must be changed to record different kinds of information.

Ordinarily a complete recorder must be purchased for each different type of measurement. The complete recorder, because of its precision must be much more expensive than the transducing element which converts the desired measurements into a suitable recorder input.

Texas Instruments felt they could expand their customer potential by manufacturing accessory transducers and eliminating this unnecessary added expense. Each accessory, when connected to a parent-re

**FIG. 1—Jeweled pivots convert curvilinear motion of the galvanometer movement to rectilinear motion. Rectilinear pen recordings have the same shape as a plotted graph and can be measured with a straight edge ruler.**

A direct probe can be used to convert to a highly sensitive direct-contact scope.
e·con' o·my: when round-trip missiles save taxpayers $102,950,000

Most missiles land head-first—and, like a bomb, just once. This destruction is desired in a missile strike, but it makes development costly. Scores of missiles often are expended before development problems are solved.

Vought's Regulus I and II reduce this expense by their dual application. Tactical versions of these guided missiles can strike head-on, with a devastating nuclear wallop. Test and training versions, used in development, can be recovered to fly again.

One Regulus was flown and recovered 18 times... another made 16 successful flights. Six hundred recoveries of both missiles have saved $102,950,000 and gained an inestimable quantity of technical data.

Regulus I has armed submarines, cruisers and carriers with a nuclear punch since 1955. Regulus II, with a range of more than 1,000 miles and able to exceed twice the speed of sound, soon will join the Navy's underwater and surface Nuclear Fleet.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. R-7.
As you know, the rating and size of a variable resistor depends upon the speed with which heat can be transferred from the resistance element to the atmosphere. Centralab "thermo-pass" insulation combines exceptional heat transfer with a dielectric strength of 4500 volts per mil at 25° C. Result: WW and WN Series variable resistors—conservatively rated 5 watt units that are smaller than conventional 2 watt units.

- Only 1½" diameter by 3½" deep.
- Resistance range, 1 ohm to 15K ohms; linear taper.
- 295° rotation, stop strength 15 inch pounds.
- Minimum life, 25,000 complete cycles.
- Totally enclosed elements.

For a detailed list of the 33 values in either long shaft (WW Series) or short shaft (WN Series) available from your distributor, ask him for a copy of Catalog 30, listing the full line of Centralab products . . . or write to us for your free copy.

**Centralab**

**WW Series**

Miniature Wirewound Radiohms

5 watt capacity — 2 watt size

**In Stock at your Distributor**

**Electrical Parameters**

Accessories for recording seven different electrical parameters are available at the present time. A seven range ac-de voltage monitor with a minimum of 1 v to give a 10 percent deflection and a maximum of 1000 v to give full-scale deflection; a seven range ac current monitor which measures from a minimum of 250 ma full-scale; a line frequency monitor to measure frequency deviation in three ranges, 45-55, 55-65 or 375-425 cps; an expanded scale a-c line voltage monitor to measure 80-130 v, 160-260 v or 320-520 v rms; an a-c current monitor in any single range of the seven range a-c monitor; and a line service monitor which combines in a single accessory a line voltage, current, and frequency monitor.

**Parent Pen Recorder**

A galvanometer movement is used to drive the writing pens.
The leading contender in the sensitive relay class!

**KURMAN'S MIGHTY SERIES "T"**

Compare it and you'll know why

- .975" x .975" x 1 3/4" high
- Up to DPDT - 2 amp, 28V. DC, 115V AC
- Sensitivity down to 6 milliwatts
- Coil Resist. up to 20,000 ohms
- Will meet MIL-R-5757C

The latest addition to a line of miniature hermetically sealed sensitive relays, the new Kurman Series "T" weighing only 3 1/2 oz., is now available—the mighty midget of the sensitive class. Radically different in design, you will find the Series "T" to be superior in performance — economically priced with excellent delivery service.

Why not specify the Series "T" for your next sensitive relay application and check its performance for yourself? Write to Dept. E for detailed specification sheet.

**KURMAN ELECTRIC CO.**
Division of Norbute Corp.
Quality Relays Since 1928
191 Newell Street, Brooklyn 22, New York

**SAVE ½ — PAY PART-BY-PART — HAVE FUN**

Assembling the SCHOBER ELECTRONIC ORGAN in KIT form

Now you can afford a real, full concert organ, just like those made by the foremost organ manufacturers. Because over ½ the cost is saved when you assemble it yourself. And it's REALLY EASY only 24 separate units, all with printed circuits, and detailed-to-the-smallest step instructions. In addition, you purchase each of the 24 kits when you are ready for it — and can afford it. You'll get a real kick out of putting the Schober Electronic Organ together — and then sitting down and pulling the stops for Strings, Trumpets, Clarinets, Brassicas, Flutes, etc. Electronic Percussion optional; chimes available.

**Compact CONSOLE**

One of the many exclusive features of this exceptional organ is the handsome console, in a wide variety of finishes. It is equally at home in a traditional or modern setting, and takes little more space than a spinet piano.

**Free Literature**

Complete descriptive booklet and price list are available on request. And, if you wish to hear the glorious pipe organ tone of the Schober Electronic Organ, a 10" long-playing demonstration recording is available for $2. This is refundable when you order. Write today and see what a fine instrument you can get at such a great saving.

**The SCHOBER ORGAN CORP.**

224BM Broadway, New York 24, N. Y.

"Engineers in Plastics"

**V. H. Swenson co., inc.**

556 Elm Street
Arlington, N. J.

**INJECTION MOLDING**
**MOLD MAKING**
**all SECONDARY OPERATIONS**

Precision plastic molding to meet your engineering and production requirements. Specialists to the radio, electronic, electrical manufacturing, and allied industries.

Save money and improve appearance by having more of your parts and products injection molded.

Write today for new color folder showing examples of our work and facilities. Also send sketches, drawings or samples of work you would like to order in plastic for 'engineer's recommendations at no obligation.

"Engineers in Plastics"

**V. H. Swenson co., inc.**

556 Elm Street
Arlington, N. J.

**MILITARY**
**MODEL 355-C METER-RELAY**

Rugged 355-C control relay meets or exceeds the following:

- Shock test: Total of 18 impact shocks of 15 G's.
- Water tightness: submerged in tap water at a pressure of 2 1/2" mercury for 5 minutes.
- Dielectric strength: 1000 volts RMS at insulated parts.

Want 'em RUGGED?

Vibration: Survives 10-55-10 cps, .060 amplitude, 1 minute cycle, 1 hour, 3 axes.

Corrosion: Passes 50 hour salt spray (QQ-M-151A).

Contacts: Rated 100 Ma, insulation to signal coil rated 300 volts DC.

Description: Has a set of contacts in series with locking coil. Signal and locking coil, both on moving structure, lock pointer contacts positively. Resets when contact circuit is interrupted.

**UP TO 20,000,000 OPERATIONS!!!**

Assembly Products Inc.
Chesterland 4, Ohio

CIRCLE 134 READERS SERVICE CARD
CIRCLE 135 READERS SERVICE CARD

**ELECTRONICS engineering edition — May 23, 1958**
FREE facts brochure on the elin®
Ultra-Stable Voltage Source!

Here's a product brochure you will appreciate for its straight-forward contents and practical application information. The illustrated excerpts, shown here, indicate the type of clear, organized, tradeworthy material it contains. ELIN stability and characteristics specifications, while unusual, are realistic. The advanced circuitry and techniques which make these possible are revealed in the new ELIN brochure.

The outstanding voltage stability described and the fact that the ELIN equipment meets or exceeds these values, has made it preferred equipment for “systemating” with other equipment wherever an ultra-stable voltage source must play a critical role. Brochure information further proves ELIN's performance, compatibility for systems integration, reliability and trouble-free service!

For your copy of this helpful ELIN information—write for Free ELIN Brochure #1614.

elin®/ELECTRONICS INTERNATIONAL CO.
145 West Magnolia Boulevard • Burbank, California

Metal Film Microwave Attenuator Cards

RESISTANCE CARDS have been extended to include highly stable microwave attenuator material. The base is a fine weave glass cloth impregnated with high temperature thermosetting resin. It meets MIL-P-18177. The resistance material is a thin metal film, approximately 50 millionths of an inch thick, uniformly deposited on one surface of the plastic. A protective coating is provided over the metal film.

The combination—of a metal resistance film, deposited on a laminated fibre glass plastic base which is dimensionally stable and has low moisture absorption—offers good microwave attenuator material. Maximum surface temperature should be limited to 130°C.

Standard resistance cards are 5 x 12 inches and 0.025, 0.032, or 0.062-inches thick. Filmohm Corp., 48 W. 25 Street, N. Y. 10, N. Y.
Now **POSITIVE ACTION SWITCHES**

... another first from 

**Cutler-Hammer**

- Wiping contacts insures perfect switching for very low energy circuits
- Positive-break action insures safe, reliable switching with high energy circuits
- Direct toggle-to-contact mechanism guarantees switching action
- First totally enclosed, environment proof toggle switch
- 1st lever throw opens circuit
- Positive detent action prevents switch teasing
- New insulating material gives 3 times greater arc tracking resistance
- Greater terminal clearance for easier wiring
- Improved bushing seal is molded in place.

**Cutler-Hammer** single, double, and four pole Positive Action Switches are available in unlimited circuit arrangements... single throw, double throw, momentaries, etc. For detailed information, write for Publication EA-168.

**CUTLER-HAMMER** Inc., 1230 St. Paul Avenue, Milwaukee 1, Wisconsin.

---

**YOUR BEST BUY!**

Vitreous Enameled

**RESISTORS**

MIL 26 GRADE AT COMMERCIAL PRICES

Your inquiry or drawing will bring quotations—samples on request.

**MILWAUKEE RESISTOR CO.**

702 W. Virginia Street • Milwaukee 4, Wisconsin

---

**Precision Potentiometers**

by **RATTRAY**

- including
  - MINIATURE TYPES
  - SUB-MINIATURES
  - MULTI-GANG UNITS
  - STANDARD TYPES

- featuring
  - HIGH ACCURACY
  - LOW TORQUE
  - EXCELLENT RESOLUTION
  - LOW NOISE

Rattray experience-engineered precision potentiometers are supplied in types that meet most electronic applications. Complete research and development facilities, and unique winding techniques, make it possible to produce custom designs to the most critical military and commercial specifications. All-metal construction of mounting and aligning surfaces provides precise mechanical interchangeability. Precise electrical performance is obtained by detailed quality checks throughout production. Special winding machines assure high resolution and function accuracy.

**New Handbook Available**

- 28 pages of engineering data on Rattray precision potentiometers with helpful technical information for designers and engineers.

**GEORGE RATTRAY & COMPANY**

A Division of Hardwick, Hindle, Inc.

116-08 MYRTLE AVENUE

RICHMOND HILL, N. Y.

---

**McGraw-Hill Mailing Lists Will Help You**

- Merchandize your advertising
- Conduct surveys
- Get inquiries and leads for your salesmen
- Pin-point geographical or functional groups
- Sell Direct
- Build up weak territories
- Aid dealer relations

Direct Mail is a necessary supplement to a well rounded Business Paper advertising program. Most progressive companies allocate a portion of their ad budgets to this second medium at the same time as they concentrate on the best business publications. 400,000 of the top buying influences in the fields covered by the McGraw-Hill publications make up our 150 mailing lists. Pick your prospects out of our Industrial Direct Mail catalogue.

Write for your free copy of our Industrial Direct Mail catalogue with complete information.
Triangular Chassis Cuts TV Production Costs


Lighter, more economical television receiver chassis design has evolved from the concept of a triangular structure to support the cathode ray tube, use of printed circuit boards and elimination of conventional deflection yoke supports.

The triangle consists of the chassis as the base, the CRT as one leg and channel section brace as the other leg. A triangle is inherently rigid. Further, each leg of the design is functional: the chassis carries most components, the tube strengthens the chassis and the tuner is mounted on the brace.

This design concept and subsequent refinements have decreased weight 3 pounds and lowered chassis costs some 20 per cent in 3 years, despite a steady rise in the cost of basic materials. Tooling costs are lower because of parts standardization. The one basic chassis (with varied side support and brace lengths) is used in 4 TV set models: manual and power tuned 90 and 110-degree tube models. The horizontal chassis simplifies wiring and service.

Printed circuit boards permit the frame to function as a chassis, promoting lightness, flexibility, low tooling costs. However, since the board does not carry all components, a small plate is provided on the frame. The plate also stiffens the frame.

The board is mounted with trimount studs, which are relatively low in cost, easy to assemble and prevent board cracking by allowing motion between the board and the frame. Large board size (8 13/16 inches by 11 1/8 inches) is made possible by metal supports joining the center shields of each tube socket. These provide rigidity needed for tube insertion and extraction, prevent warping during dip soldering and give a good electrical ground.

Using a single large board rather than several smaller boards reduces board processing costs and waste space and also avoids interconnection costs and errors.

To use the CRT as one triangle leg, a tube mounting was devised.

DESIGN TRENDS: High Density Component Sticks

Extreme miniaturization through maximum component density and elimination of module racks and support structures is the aim of this packaging design developed by Francis Associates, Marion, Mass. The project is supported by Massachusetts Institute of Technology’s Instrument Laboratory. Technique allows density up to 130 components a cubic inch. A 5,000-transistor computer would occupy 1/4 to 1/3 cubic foot. Sticks of components are built up by subminiature tube welding techniques. At left is experimental stick containing 38 interconnected digital switches. At right are subassemblies. Potting sticks in resin gives them a strength like reinforced concrete. End equipment would be assembled as diagrammed. Interlaced sheets of foil would carry heat to cold plate which would also act as mounting base.
YOU’VE GOT TO HAND IT TO ENGINEERING!

You’ve got to hand it to the engineering profession. The “slide-rule” boys know quality when they see it ... and they won’t be satisfied with anything less. Take solder, for example. Engineers depend on KESTER FLUX-CORE SOLDER in their work because they know Kester’s reputation for quality and precision manufacturing ... a reputation built up over more than 50 years. That’s why Kester’s the preferred choice of a great majority of electronic manufacturers. Engineers know that a few pennies saved on a “second-line” solder product can waste dollars!

KESTER SOLDER

4204 Wrightwood Avenue, Chicago 39, Illinois
Newark 5, New Jersey, Brantford, Canada

Now Even Smaller

New Sub-Miniature Size

FANSTEEL

STA Capacitors
SOLID TANTALUM

SPECIFICATIONS AND ORDERING REFERENCES

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Capacity In MFD</th>
<th>Working Voltage</th>
<th>Surge Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>STA-157</td>
<td>3.5</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>STA-162</td>
<td>2.0</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>STA-167</td>
<td>1.5</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>STA-172</td>
<td>1.2</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>STA-177</td>
<td>1.0</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>STA-457</td>
<td>7</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>STA-462</td>
<td>4</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>STA-467</td>
<td>3</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>STA-472</td>
<td>2.4</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>STA-477</td>
<td>2</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>STA-257</td>
<td>17</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>STA-262</td>
<td>11</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>STA-267</td>
<td>8</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>STA-272</td>
<td>6</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>STA-277</td>
<td>3</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>STA-357</td>
<td>70</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>STA-362</td>
<td>45</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>STA-367</td>
<td>35</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>STA-372</td>
<td>22</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>STA-377</td>
<td>30</td>
<td>35</td>
<td>42</td>
</tr>
</tbody>
</table>

Write for NEW bulletin 6.112 on new sub-miniature size capacitors.

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

RELIABLE TANTALUM CAPACITORS SINCE 1930

110 CIRCLE 73 READERS SERVICE CARD
May 23, 1958 — ELECTRONICS engineering edition
Jet Spray and Soak Cleanse Transistors

By JAMES E. GREEVER

Jet spray (top) leaves electrolyte in pores for later removal by soaking (bottom)

WASHING ELECTROLYTES from semiconductor devices after junctions have been etched pose several production problems. Determinations must be made of final cleanliness, while bearing in mind production requirements for speed in cleaning and water conservation.

The best method of washing semiconductor devices is a water jet spray followed by a soaking. The jets remove the bulk of the electrolyte and soaking cleans out the residue in the metals' pores. Deaerated water is needed to avoid air bells which would block water from the pores.

Four to 6 commercial jet sprays arranged in a circle suffice for preliminary cleaning of a normal pn germanium rectifier. Two-dot transistors, such as GE’s npn, require that the jets cover both dots at once and the germanium itself. Soft or tap water may be used in some

Jet Spray and Soak Cleanse Transistors

By JAMES E. GREEVER

Jet spray (top) leaves electrolyte in pores for later removal by soaking (bottom)

WASHING ELECTROLYTES from semiconductor devices after junctions have been etched pose several production problems. Determinations must be made of final cleanliness, while bearing in mind production requirements for speed in cleaning and water conservation.

The best method of washing semiconductor devices is a water jet spray followed by a soaking. The jets remove the bulk of the electrolyte and soaking cleans out the residue in the metals' pores. Deaerated water is needed to avoid air bells which would block water from the pores.

Four to 6 commercial jet sprays arranged in a circle suffice for preliminary cleaning of a normal pn germanium rectifier. Two-dot transistors, such as GE’s npn, require that the jets cover both dots at once and the germanium itself. Soft or tap water may be used in some
Another NEMS-CLARKE first

RECEIVER FREQUENCY COVERAGE
40 to 900 megacycles

Now available...
receiver frequency coverage to 900 mc

Nems-Clarke Type REU-100 and
Type REU-200 Range Extension Units
permit extension of frequent ranges
up to 900 mc when used with
Nems-Clarke Special Purpose Receivers

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Frequency Range REU-100</th>
<th>250-475 mc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range REU-200</td>
<td>475-900 mc</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>12-14 db</td>
</tr>
<tr>
<td>IF Frequency</td>
<td>60 mc</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>Output Impedance</td>
<td>50-75 ohms</td>
</tr>
<tr>
<td>Power Requirement</td>
<td>110-220 volts AC</td>
</tr>
<tr>
<td>Size</td>
<td>19&quot; x 7&quot; x 12&quot;</td>
</tr>
<tr>
<td></td>
<td>(standard rack mounting)</td>
</tr>
<tr>
<td>Finish</td>
<td>Gray Enamel</td>
</tr>
</tbody>
</table>

AM, FM, or CW, according to the receiver with which the range extension unit is operating.

Transistor is removed from electrolyte and quickly placed in jet spray. Dried electrolyte is hard to remove.

cases to reduce water cost, since the final wash is in deionized water. However, careful analyses must be made of the pH and purity of the water and the electrochemistry of the metals involved. Formations which might occur on the metals would cause failure of the device.

Sequenced beakers of water, cascade baths or free-flowing troughs are all usable for soaking, depending on production rates and water cost. Beakers are suitable for laboratory quantities and for evaluation, the others for production.

A cascade is 2 or more trays joined in step-fashion. Fresh water is fed into the topmost tray, overflows into the second tray and so on until it reaches the drain. Units to be cleaned are put into the lowest tray first and moved successively upward. The final wash is in the top tray. Water must flow into the top tray fast enough to be completely replaced during the washing cycle. Otherwise, the semiconductors will be subject to contamination. Flow rate can be judged by the continuous addition of NaOH and prepared phenolphthalein indicator, which makes water pinkish.

Free-flowing troughs have the added advantage of a forceful stream of fresh water contacting the units. Tests indicate that washing time, compared with cascades, is 300 percent less. However, a trough cannot be used at full efficiency except in some type of etching automation.

Purity of water, flow rates, temperature and time cycles must be determined. For exceptional clean-

NEMS-CLARKE COMPANY
619 JESUP BLAIR DRIVE SILVER SPRING, MARYLAND JUNIPER 8-1000
FOR FURTHER INFORMATION, WRITE DEPT. E4
Transistor assemblies are placed in wire baskets for easy handling in cascade.

Cleanliness, water with resistance of 500,000 ohms and higher is required. This is achieved in production by commercial deionizers since distillation is costly.

Electrical evaluation of the devices over a period of time will establish the purity required. Ph readings indicate cleanliness and are balanced against the end electrical yield for a standard of minimum quality.

Laboratory tests show efficiency of various washing cycles. For example, 20 etched subassemblies were rinsed for 1 minute in each of 4 beakers of pure hot water. Another 20 got 2-minute rinses. The 2 groups were soaked 24-36 hours in stoppered flasks of pure water. A third flask of water served as a standard. The group rinsed 1 minute increased the pH of the pure water by 1.74. The 2-minute rinse gave a superior pH increase of 0.56.

A similar test indicated efficiency of cascade washing cycles. The pH difference over pure water was: 5-minute wash, 1.70; 10-minute wash, 0.89; 15-minute, 0.43, and 20-minute, 0.41. The optimum washing cycle was judged to be 15 minutes.

CIRCLE 76 READERS SERVICE CARD
NEW PRODUCTS

Introduce More New Relays


Confronted with the complex circuitry in today's military equipment, design engineers must have the most reliable components at their beck and call. Small, rugged, precision relays play a big role here.

Line Electric Co., 271 So. 6th St., Newark 3, N. J., (300), announces a miniature thermal time delay relay with high shock and vibration characteristics. It offers delays as low as 250 milliseconds. The $\frac{1}{4}$ in. diameter contacts can carry 3 amperes at 115 v, 60 cps noninducting current, for a minimum of 250,000 operations.

Now available from Jordan Electronics Div. of The Victoreen Instrument Co., 3025 W. Mission Rd., Alhambra, Calif., (301) are time delay relays featuring transistorized circuitry with RC network which permits intervals from 50 milliseconds to several hours.

Magnecraft Electric Co., W. Grand Ave., Chicago 51, Ill., (302), announces that in order to provide protection against dust, combined with convenient accessibility, removable metal enclosures have been developed for Class 22 relays. The enclosures may be mounted on customer's strip, panel or chassis.

A tiny relay for missile use is in production by Iron Fireman Mfg. Co., 2838 S.E. Ninth Ave., Portland 2, Ore., (303). It can withstand temperatures ranging from 100 deg below freezing to 45 deg above the boiling point of water.

General purpose relays offered by Struthers-Dunn, Inc., Pitman, N. J., (304), combine high contact reliability with small size and light weight. Grade 5 melamine bonded fibre glass insulation is used for contact supports. The relays are available in spdt, dpdt and 3 pdt types.

Revere Corp. of America, Wallingford, Conn., (305), reports contacts of the new spst Glaswitch relays are hermetically sealed in glass envelopes containing dry nitrogen and a helium tracer, preventing contact contamination from volatiles.

Counter-Timer transistORIZED

Potter Instrument Co., Inc., Sunnyview Blvd., Plainview, L.I., N. Y. Featuring preset interval generating, timing and counting functions in a compact package, the model 860 frequency time counter is a transistORIZED unit with visual, in-line readout. Timing and frequency features include direct measurement of frequency from 0 to 150 kc, frequency ratio determination, period measurements for 1
NEW SOLID-STATE ELECTROLYTE CAPACITORS BY CORNELL-DUBILIER - SOLITAN capacitors are specifically designed for transistor application in computer and military circuits. Solid electrolyte tantalum assures extreme resistance to shock and vibration, wider useful temperature characteristics, stability of capacitance in spite of aging or temperature variations, freedom from corrosion or leakage. Cornell-Dubilier has SOLITAN tantalum capacitors in production quantities. Write for 4-pg. Bulletin No. 537 to Dept. 000, Cornell-Dubilier Electric Corp., South Plainfield, N.J.
or 10 cps, predetermined counting to any number up to 9,999 with extension in steps of 10 or 100 to 999,900, and external count gating. Circle 306 on Reader Service Card.

Bobbins withstand 250 C

Form-It Products, Inc., 1619 W. Walnut St., Chicago 12, Ill., announces a recently developed high temperature bobbin that meets and exceeds military specifications for class H insulation. The bobbin has been tested and approved to withstand temperatures up to +250 C. The unit is in use now for windings in airborne equipment, aircraft and missiles.

Specifications include material thickness from 1/32 in. to 1 1/2 in. round, square, or rectangular shapes. Bobbins are available for 3/4 in. to 1 1/4 in. i-d coil sizes and any diameter of flange. Circle 307 on Reader Service Card.

Low Pass Filters miniaturized

Maury & Associates, 10373 Mills Ave., Pomona, Calif. Series A2 low pass filters feature low insertion loss, miniaturization and rugged construction. They have BNC connectors on both ends, and can be obtained with or without mounting flanges. The filters can be obtained to meet any cutoff frequency between 100 and 1,000 mc. Circle 308 on Reader Service Card.

Servo Amplifier transistorized

John Oster Mfg. Co., 1 Main St., Racine, Wis., has developed a compact - 55 C to +125 C transistorized servo amplifier with variable damping or feedback control and a wide range of input impedances. Output power is up to 10 w. Type AMP-9616 can be designed to drive a servo motor-generator with
Frequency Changers use semiconductors

Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J., announces new Transpac transistorized frequency changers. These new static designs convert any input frequency to a new frequency at power levels and eliminate the disadvantages of vacuum tube or mechanical conversion equivalents. The new models are ideal for powering all a-c operated equipment, gyro and servo mechanisms, magnetic amplifiers, and are intended for all types of laboratory and industrial applications. Circle 310 on Reader Service Card.

Stampings flat sheet metal

Techniques, Inc., 52 Jackson Ave., Hackensack, N. J., has available a new service for providing flat sheet metal stampings in any size, shape, or metal in thicknesses up to 0.006 in. Parts are free of burrs, accurate, and concentric. Tolerances are normally ± 0.005 in. Closer tolerances can be provided where required. Circle 311 on Reader Service Card.

Multiplexer for pdm telemetry

Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif., has developed a new device for pdm commutating and coding. The 40-101 Plexicoder commutates signals from up to 90 For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>

For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>

For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>

For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>

For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>

For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>

For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>

For your prototypes... sample miniature Westinghouse selenium rectifiers shipped in 10 days

Westinghouse Electric Corporation
356 Collins Avenue
Pittsburgh 6, Pennsylvania

Gentlemen:

Please send me a sample Westinghouse miniature selenium rectifier... which I need for prototypes now under design.

I understand that this sample will be supplied free of charge (within reasonable limits, of course) and that my request must be postmarked not later than July 1, 1958.

This rectifier should be built to the following specifications:

<table>
<thead>
<tr>
<th>Voltage (from 1 to 100,000v)</th>
<th>Amps (1 to 100 ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half wave</td>
<td>Full wave</td>
</tr>
<tr>
<td>For printed circuits: Yes</td>
<td>No</td>
</tr>
<tr>
<td>Production quantity required: per month</td>
<td>per year</td>
</tr>
<tr>
<td>Name</td>
<td>Company</td>
</tr>
<tr>
<td>Address</td>
<td>City and State</td>
</tr>
</tbody>
</table>
transducers at 112.5 samples per second and converts them into duration-modulated pulses suitable for telemetering or magnetic tape recording.

In the Plexicoder, low-speed magnetic switching at the input, with high-speed commutation and coding accomplished by interrupting a light beam, replaces rotating wiper-arm assemblies and wide-band choke-stabilized amplifiers. Circle 312 on Reader Service Card.

H-F Counter
high reliability

NORTHEASTERN ENGINEERING, INC., Manchester, N. H., announces a new high-frequency 10 mc electronic counter. It features an eight place digital readout with no meters.

Reliability not heretofore obtained in h-f counters is achieved by improved circuitry which has eliminated many troublesome diode circuits, the company claims. Weight, size and heat are considerably reduced through the use of a silicon rectifier power supply. Circle 313 on Reader Service Card.

Power Transistors
used in converters

BENDIX AVIATION CORP., Long Branch, N. J., announces a new series of power transistors for converter and switching circuits. They have a 5-ampere maximum current rating and can switch power up to 250 w. They are provided in current gain ranges of 15-30, 20-40 and 30-60 at a collector current of 3 amperes d-c. Collector-to-emitter breakdown ratings are 40, 70 and 80 v to eliminate burnout in h-v applications. Circle 315 on Reader Service Card.

Sliding Shorts
noncontacting

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. New sliding shorts which can be accurately adjusted to any reactance, are available in frequency ranges from 12.4 to 75 kmc. With short-circuit vswr’s of up to 100:1, they are said to be the most useful terminating impedances in waveguide measurements, apart from matched loads. The new units consist of a section of waveguide in which a short-circuiting plunger can be moved by means of a micrometer drive. This is a noncontacting short of the two-section coaxial-filter type. Circle 314 on Reader Service Card.

Frequency Meters
cover wide range

THE JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden, Mass. The No. 90650 series of in-
indicating frequency meters cover the range of 170 kc to 700 mc. This range is covered by five basic units (heads), each designed specifically for its own frequency range. Each head has three or four plug-in inductor/probes and the same number of individual frequency calibrations. A single 500 µA, end-indicating, plug-in instrument is used with each of the heads. The indicating circuit is so sensitive that even the output from a grid dip meter is enough for full scale deflection at most frequencies. Circle 316 on Reader Service Card.

Pressure Pickup for test stand use

CONSOLIDATED ELECTRODYNAMICS Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Type 4-323 pressure pickup, designed for a wide range of gage and absolute pressure measurements, is particularly suited to rocket and engine test stand uses. Operating without damage at temperatures from -300 F to +300 F it provides nominal output of 40 mv. Pressure ranges from 7.5 to 5,000 psi gage or absolute are available in one unit without configuration changes. Circle 317 on Reader Service Card.

R-F Attenuators for laboratory use

JERRILD ELECTRONICS CORP., 23rd and Chestnut Sts., Philadelphia 3, Pa., has introduced two variable attenuators offering 0 to 62.5 db attenuation.

NEW SUBMINIATURE HIGH TEMPERATURE TRIMMER

Now available as a wirewound or film type trimmer that is moisture proof, subminiature in size and withstands a temperature of 225°C, in a higher resistance range.

FEATURES:
Type RTW (wirewound) Resistance Range 100 ohms to 100,000 ohms
Type RTF (film) Resistance Range 100 ohms to 25,000 ohms, providing infinite resolution
25 turn lead-screw adjustment
Unique stop-override safety mechanism
Housing of High Temperature Molded Plastic
Variety of mountings: Printed Circuit Lugs
Printed Circuit Wires
Tinned Leads
Virtually hermetic sealed meets Mil std. 202 Procedure 106 Humidity Test with rated power applied
Precious metal take off and end tabs
Dual stainless steel contacts on winding and slip ring for extra reliability
Power rating of .83 watts at 80° C., .1 watt at 200° C.
Engineered, quality controlled manufacture and environmental tested to meet the exacting demands of missile and other military applications, make these new low cost trimmers a long-sought contribution to design and production problems.

Write wire or call for full details and technical data.

TECHNOLOGY INSTRUMENT CORP.
569 Main St., Acton, Mass., COlonial 3-7711
North Hollywood, California
POplar 5-8620 STanley 7-0286
APPLICATION GUIDE FOR SILICON RECTIFIERS...

If you work with rectifiers, this free design handbook will help you with your application problems.

PARTIAL CONTENTS
- Selection procedure and data.
- Seven typical, effective rectifier circuits and design factors for each.
- How to provide for transient loads, series operation, magnetic amplifier circuits, stacks.
- Curves on current ratings vs case temperature and current ratings vs air temperature.
- Electrical measurements.
- Rectifiers built to required specifications.

MILITARY RELIABILITY
Four types of rectifiers that meet the MIL-E-1/1024, 989, 990 and 991 are fully described with curves and tables.

GET YOUR FREE COPY
MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS • BRowning 2-3000

120 CIRCLE 81 READERS SERVICE CARD

May 23, 1958—ELECTRONICS engineering edition

SILICON POWER RECTIFIERS

APPLICATION GUIDE FOR SILICON RECTIFIERS...

If you work with rectifiers, this free design handbook will help you with your application problems.

PARTIAL CONTENTS
- Selection procedure and data.
- Seven typical, effective rectifier circuits and design factors for each.
- How to provide for transient loads, series operation, magnetic amplifier circuits, stacks.
- Curves on current ratings vs case temperature and current ratings vs air temperature.
- Electrical measurements.
- Rectifiers built to required specifications.

MILITARY RELIABILITY
Four types of rectifiers that meet the MIL-E-1/1024, 989, 990 and 991 are fully described with curves and tables.

GET YOUR FREE COPY
MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS • BRowning 2-3000

120 CIRCLE 81 READERS SERVICE CARD

May 23, 1958—ELECTRONICS engineering edition
signed for solder connection, may be installed in any position. Circle 319 on Reader Service Card.

Magnetic Amplifier for airborne uses
CHASE ELECTRONICS, INC., 82-31 51st Ave., Elmhurst 73, N. Y.
Model CE-LL-400 low-level magnetic amplifier is especially developed for airborne applications in which the input power derives from thermocouple, strain gages, thermistor bridge, photovoltaic cell, current shunt and the like. Price for sample is $65; per lots of 100, $30 each. Circle 320 on Reader Service Card.

Test Chambers
30 cu ft space
TENNEY ENGINEERING, INC., 1090 Springfield Road, Union, N. J., offers temperature test chambers with 30 cu ft of work space, and

Heart of TITAN ICBM Inertial Guidance System
When the Titan's electronic umbilical cords are severed, the giant missile begins life. With no ground contact, its unjamtable inertial guidance system must work...there's no second chance.
Arma Division of American Bosch Arma Corporation, maker of the Titan's computer brain, demands printed circuit boards that must function the first time...every time. A defect, at any assembly point, means discarding the board and the costly components mounted on it.
That's why Arma relies on PHOTOCIRCUITS printed circuit boards with plated-thru holes to do the job.
PHOTOCIRCUITS pioneered plated-thru holes...manufactures them with built-in reliability for military and industrial applications.
Plated-thru hole reliability is based on PHOTOCIRCUITS' unequalled experience in every phase of printed circuitry. Consistent dependability is the result of proper design, precision production and advanced quality control techniques.
Check the advantages of plated-thru holes by PHOTOCIRCUITS...the largest and most experienced manufacturer in printed circuitry. For complete information, write our Engineering Department PS-2 today.
This new Speer Packaged Assembly Circuit offers you a wide variety of custom, preassembled units of high-quality components for use in conjunction with printed board applications.

P.A.C. permits the insertion, as a group, of a full range of capacitors and resistors in simple or complex circuitry. Each P.A.C. is based on components of uniform dimensions, \( \frac{3}{4} \)" diameter and \( \frac{3}{4} \)" long. Component availability includes Jeffers tubular ceramic capacitors and Speer fixed composition resistors, providing wide circuit flexibility in a single P.A.C. unit.

**ADVANTAGES OF SPEER P.A.C.**

- Simplifies chassis design and assembly
- Reduces printed circuit board area and insertion operations
- Permits easy and low-cost component change-over to accommodate circuit revisions
- Broad choice of characteristics—low capacitance temperature compensating units and high capacitance bypass capacitors mounted in same P.A.C. unit
- Isolation of individually mounted units provides low shunt capacitance across resistors
- Pretested components achieve unusually close tolerance assembly

Learn more about the new Speer P.A.C.
For information write to:

JEFFERS ELECTRONICS DIV.
Speer Carbon Co. Du Bois, Pennsylvania
diodes are encapsulated in epoxy. Units are provided with solder lug headers, plug-in bases, and solder pins for printed circuitry. Circle 323 on Reader Service Card.

**D-C Amplifier**

**true differential**

SANBORN CO., Industrial Div., 175 Wynnman St., Waltham 54, Mass. Model 450-1800A amplifier is designed to drive an optical galvanometer, oscilloscope or tape recorder. Input characteristics include an impedance of 200 K differentially between terminals (balanced), or 100 K each input lead to ground (single-ended); common mode rejection at d-c is 100 dB, to 400 cps 80 db, and from 400 cps to 50 kc 74 db; equivalent input drift is ± 2 µv; equivalent input noise is 5 µv peak to peak (0-10 cps), 20 µv (0-1,000 cps), 50 µv (0-30 kc). Two outputs provide either ± 8 v into 5,000 ohms at fixed gain or ± 50 ma swing with 8 smoothly adjustable gains. Circle 324 on Reader Service Card.

**Manometer and microphone**

TELCO INc., 47 rue de la Division, Leclerc, Gentilly, France, announces an electronic micro-manometer and microphone for

**FOR A DEVILISH ENVIRONMENT**

Available now...THREE completely new lines of USECO Insulated Terminals. They cover a wide range of operating conditions, including the most severe environments.

The result of exhaustive materials research and terminal design evaluation, these new USECO Insulated Terminals are closely controlled in production to assure reliable performance in your equipment.

USECO HI-ALUMINA—For the ultimate in resistance to shock, vibration and extreme temperature, from 800° F. to 1800° F. ratings. Bonus advantages include resistance to nuclear radiation and zero water absorption. Available in subminiature and standard size with both turret and bifurcated terminal configurations.

USECO TEFLOM—For low constant electrical loss and excellent dielectric characteristics, coupled with mechanical resiliency at a service temperature range up to 500° F. Design advantages include the high pull strength of 37 pounds. Available in standard sizes and in a wide range of configurations.

USECO UNI-MOLD—For outstanding electrical and mechanical characteristics under high humidity and up to 300° F. These new terminals incorporate a mineral-filled alkylal material in a one-piece molded construction, and provide exceptional dimensional stability. Available in a wide variety of stud, female and swage types with both turret and bifurcated terminals.

There is a USECO Insulated Terminal, and other USECO Electronic Hardware that best meet your specific requirement. Write for detailed information, no obligation. Litton Industries, Components Division, Dept. 2, 5873 Rodeo Road, Los Angeles 16, California, or Litton Industries, Dept. 1, 215 South Fulton Avenue, Mount Vernon, New York.
Multi-Channel Link Test Equipment

The three groups of instruments featured below are representative equipments from the wide variety of Marconi measuring facilities for both baseband and rf circuits in multi-channel links. These designs have been specifically evolved by Marconi engineers to meet the exacting test requirements in this specialized field of telecommunications.

**WHITE NOISE TEST SET OA 1249**
Noise generator and receiver for the measurement of baseband intermodulation and noise by slot technique covering from 24- to 960-channel bands (12 kc to 4028 kc).

**U.H.F. TEST SET OA 1248**
Signal generator, receiver and noise generator for general rf tests in the 1700- to 2300-Mc band.

**DERIVATIVE TEST SET OA 1259**
Sweep generator and display unit for fast and accurate adjustment of linearity controls on modulator and demodulator stages. Sweep width: ±20 Mc; center frequency, 65 to 75 Mc.

**D-C Power Supplies wide-range units**
Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn., offers two Magnetic Rangers, tubeless wide-range regulated 5-36 v d-c power supplies, the MR36-15 with 0-15 ampere output and the MR36-30 with 0-30 ampere output. Units feature ±0.25 percent regulation accuracy, 0.2 sec response time, 105-125 v a-c input, 150 mv ripple, and continuously variable outputs. They have magnetic amplifier control circuits with transistorized power references and zener diode comparison circuits. Circle 326 on Reader Service Card.

**Frequency Standard long term stability**
Lavoie Laboratories, Inc., Matawan-Freehold Road, Morganville, N. J. The LA00 5-mc frequency...
standard offers long term stability to better than one part in one billion (1 x 10^-18), in a compact package. In its design, the unit incorporates a new approach to precise crystal oven regulation.

Due to the inherent stability of the quartz element and proper crystal aging, long term operation results in temperature shifts of less than 0.01°C. Environmental temperature range is 0°C to 50°C. Circle 327 on Reader Service Card.

Wideband Amplifier bilateral unit

INSTRUMENTS FOR INDUSTRY, INC., 150 Glen Cove Road, Mineola, N.Y. The Super Video amplifier model M-395A is a new and improved version of the M-395. The company has improved the 1-f response from 1,000 cycles to approximately 250 cycles, increased the gain from 70 db to 80 db, improved the output voltage capabilities from 1 v rms to 2 v rms and reduced the hum output from 40 mv to 25 mv. The cutoff characteristic has been changed so that there is a gradual falloff from 50 mc to approximately 70 mc. Weight is reduced from 45 to 30 lb. Circle 328 on Reader Service Card.

Connectors high temperature

AMP Inc., Harrisburg, Pa., has available connectors employing high temperature stainless steel, high temperature silver alloy contacts, special temperature resistant

WILBUR B. DRIVER CO.
Main Office: NEWARK, N. J. Tel. HUMBoldt 2-5550
For Over 40 Years Melters and Manufacturers of Precision Alloys for All Industries

Mfg. Plants: 1875 McCARTER HWY., NEWARK 4, N. J. • 2734 INDUSTRIAL WAY, SANTA MARIA, CAL.
In Canada: CANADIAN WILBUR B. DRIVER CO., LTD., 85 KING STREET EAST, TORONTO 1, CANADA

ELECTRONICS engineering edition — May 23, 1958
ENGINEERS: Electronic & Mechanical Physicists  
Research - Development - Pilot Production

ds^2 = dx^2 + dy^2 + dz^2 - c^2 dt^2

Is today the same as yesterday?

Every now and then a man stops and takes stock of himself and his career. He sizes up what he has accomplished. Where he is heading.

If you are doing just that and find that you are ready for a long step forward—for increased responsibility and stature—it may pay you to consider Melpar.

These forces will be working for your advancement when you join our organization: diversified and stimulating programs with an opportunity to follow projects from inception to prototype completion or production; an atmosphere of professionalism and regard for your individual ideas and contributions; a promotion policy based solely on your ability; a steady program of expansion which continually creates new positions.

Our well equipped laboratories and manufacturing facilities are located near suburbs that promise gracious living for your family and easy commuting for you.

For details about career opportunities at Melpar, write:
Technical Personnel Representative.

MELPAR Incorporated
A Subsidiary of Westinghouse Air Brake Company
3037 Arlington Boulevard, Falls Church, Virginia
10 miles from Washington, D. C.
Openings are also available at our laboratories in Boston and Watertown, Massachusetts

ceramic dielectric materials, and fine silver seals for high altitude and extreme atmospheric conditions. The 7-contact radiation resistant connector for 7-16 Awg wire is illustrated. It features crimped on contacts. The connector was developed for use in an operating environment of 100,000 ft plus altitude, a minimum corona starting voltage of 560 v and flashover voltage of 960 v. Circle 329 on Reader Service Card.

Transformers molded construction
MICROTRAN CO., INC., 145 E. Mincolla Ave., Valley Stream, N. Y., has available a line of transistor driver and transistor output transformers in molded construction. They are designed to meet the requirements of MIL-T-27A class R and S grade 2 or 4. Reliable life is 10,000 hr minimum. High temperature epoxy is used in the molding of these units for protection against temperature extremes. Mounting is by means of standard channel ears, threaded studs, or inserts. Terminal pins are arranged for use with dip soldered printed circuitry. Circle 330 on Reader Service Card.

Solid Pin Headers for tube bases
ADVANCED VACUUM PRODUCTS, Inc., 122 Liberty St., Stamford, Conn., announces a new line of
solid pin headers, for use as electronic tube bases, that can withstand temperatures of 700°C. Pins of molybdenum, Vionel, Kovar, copper-cored nickel can be hermetically sealed to 95 percent Al,0, by brazing with silver, copper or nickel gold. Circle 331 on Reader Service Card.

Sweep Generator has high output

Tel- Instrument Electronics Corp., 728 Garden St., Carlstadt, N.J., announces the type 1105 radar-video sweep generator, a new test instrument for radar sweep checking. Featuring high output and very low harmonic distortion, the instrument provides for the observation of frequency-vs-amplitude characteristics of wide-band circuitry, such as radar and video amplifiers and filters. Ten crystal-controlled frequency markers of 0.01 percent accuracy are provided to indicate one to 10-mc points. Circle 332 on Reader Service Card.

Terminals and connectors

AMP Inc., Harrisburg, Pa., announces a new line of Strato-Therm high temperature, heat resistant terminals and connectors for

How to buy RELIABILITY* In A Precision Potentiometer

Answer: ONLY FAIRCHILD CAN DELIVER ALL OF THESE RELIABILITY FEATURES at the lowest price in the industry!

1. Welded terminal and taps. A positive electrical and mechanical bond to withstand high temperatures, shock and vibration.
2. Machined metal case for retention of accuracy, especially under high temperature and/or humidity.
3. Metal inserts in molded wiper hubs for positive wiper positioning, for accuracy under shock, vibration, acceleration.
4. Precious metal resistance wires where needed for extremely low noise values, especially in corrosive atmospheres and for long storage life.
5. Precious metal contacts for low noise and high temperature.
6. One piece wiper construction for life, accuracy, low noise and low torque.
7. Stainless steel clamp bands capable of withstanding high torque, and the stresses and strains of shock, vibration and acceleration.
8. Precision stainless steel ball bearings — for low torque, high temperature, high vibration and shock characteristics.

PLUS 100% inspection AND a separate Quality Control program which puts 1 out of every 100 production units through complete environmental torture tests.

Since the ultimate price of a potentiometer is directly related to the reliability built into it ... you only get what you pay for in a "pot".

Only Fairchild Linear and Non-Linear High Reliability Pots incorporate all of the above features. This High Reliability group can be had in ¾" to 2" diameters, single and multi-turn, in standard and high temp versions and with accuracies as high as .009%.

For more information write Dept. 11T.

*Fairchild's Built-in SAFETY FACTORS Beyond the Specs for Reliability in Performance.
PRINTED CIRCUITS??

YOU CAN ETCH A CIRCUIT BOARD in 2 MINUTES!

LET NORTHEAST SHOW YOU HOW TO TRIPLE YOUR PRODUCTION AND PROFITS.

- 32 years experience in the metal etching trade.
- A complete line of chemicals including photo-resist, acids, inks, oxide inhibitors and touch-up solutions, etc., which have been proven in over 3 decades of constant service.
- A free consulting service to our clients.
- A completely integrated service from start to finish.

POSITIONS OPEN FOR QUALIFIED PHOTO-ENGRAVERS AND SALESMEN

CONTACT MR. ROBERT GIGLIO PERSONNEL MANAGER

For information write, wire or phone:

NORTHEAST CIRCUIT LABS CORP.
454 MAIN STREET WILMINGTON, MASS. PHONE OLIVER 8-2024

ATTRACTION AND HOLD TECHNICAL PERSONNEL

SERVE FLORIDA'S METROPOLITAN AREAS FROM A DAYTONA BEACH INDUSTRIAL SITE

Daytona Beach, the east-to-west terminal on the north-to-south route of the projected Federal Limited Access Freeway System, gives industry a plus for the future.

Write for new 96 page Industrial Brochure

INDUSTRIAL DEPARTMENT CHAMBER OF COMMERCE
DAYTONA BEACH, FLORIDA

Ultrasonic Cleaner for lab, production

ALCAR INSTRUMENTS, INC., 17 Industrial Ave., Little Ferry, N. J., has a new ultrasonic cleaner for small part cleaning, blind hole washing, removal of radioactive contamination, p-c cleaning and the like. The electronic generator delivers 50 w of power to crystal transducers mounted on the bottom of the 6 in. by 6 in. by 6 in. stainless steel tank. It holds 2 quarts of liquid. Price is $350. Circle 334 on Reader Service Card.

Force Transducer with high output

EDCLIFF INSTRUMENTS, P.O. Box 565, Monrovia, Calif. Model 9-1 differential transformer type force transducer features the high output
of 1.68 v full scale with input of 115 v a-c at 60 cps into a 5,000 ohm resistive load. Temperature drift and sensitivity at zero are maximum of 2 percent at full scale per 100 F. Present units have 75-lb or 240-lb capacity with a ring element design. Units weigh a maximum of 3 lb and are packaged in a case 3 1/4 in. diameter by 2 in. (excluding connections). They meet or exceed the environmental requirements of MIL-E-005272B. Circle 335 on Reader Service Card.

Diode Board for computers
Techniques, 52 Jackson Ave., Hackensack, N. J. Computer designers will find packaging problems simplified by integrating the new compact diode board into equipment. It will find use in such applications as converting binary to decimal, straight decimal to binary coded decimal, and other notations. As many as 48 diode and resistor elements can be mounted on the p-c, 22 terminal plug-in board. Overall board dimensions are 3 1/4 in. by 4 in. by 5/8 in. Circle 336 on Reader Service Card.

H-V Capacitors
plastic film type
H. D. & K. Labs, Inc., P.O. Box 172, Shelburne Falls, Mass. Synsep

NEW MINIATURE RF FILTERS

1/2 Space...
1/2 Weight...

Model 524

DESIGNED TO REJECT INTERFERENCE IN "L" BAND

When size and weight are important factors in your rf filter selection, turn to Bird Electronic for your source of supply. Our engineers will design an rf filter to serve your exact requirements with particular attention to component density, accuracy, ease of application and long-life performance.

Our physical facilities to produce and deliver quantity orders dependably can be relied upon to meet your production schedules.

**SPECIFICATIONS**

**Model 524**

SIZE: 4-3/4" x 3/4" x 1-1/4"
WEIGHT: 5 ounces
PASS BAND: 225 to 400 mc
CUT-OFF FREQUENCY: 400 mc
POWER RATING: 50 watts
RF INPUT IMPEDANCE: 50-ohm nominal
ATTENUATION: Less than 1/2 in pass band, 80 db in stop band
VSWR: Insertion loss and VSWR are very low in pass band
CONNECTORS: Most miniature types

ELECTRONIC CORP.
Express 1-3535
1800 E. 38 St., Cleveland 14, Ohio
Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.
NEW

KLEIN

shear cutting plier

207-5C shear cutting oblique plier 5½ inches long. Coil spring keeps jaws apart ready for use.

Here is the greatest advance in oblique cutters. This new Klein tool with shear blades is ideal for cutting hard wire such as tungsten filament or dead soft wire. Also recommended for cutting small bundles of wire. The shearing action assures easy, positive cutting at all times.

Regular cutters at the nose give added usefulness and convenience. The shear blade is easily replaceable. Plier never needs sharpening.

This plier is supplied with a coil spring to keep the handles in open position. Can also be had with Plastisol dipped handles if desired.

Write for full information

FREE POCKET TOOL GUIDE

100 years of service to linemen, electricians and industry is back of this new Pocket Tool Guide No. 100. A copy will be sent you on request without obligation.

ASK YOUR SUPPLIER

Foreign Distributor:
International Standard Electric Corp.
New York

is the trade name for a new line of glass encapsulated, hermetically sealed, h-v, plastic film capacitors. They were developed for use in low current power supplies, oscilloscopes, audio coupling and bypass, electronic computers and other h-v applications. Standard units are available in a voltage range of from 600 v d-c to 20,000 v d-c and with capacitance values of from 100 µf to 1 µf. Temperature range is from -55 C to 65 C at full voltage rating, and may be extended to 85 C by derating to 70 percent. Circle 337 on Reader Service Card.

D-C Motor miniaturized

Cramer Controls Corp., Centerbrook, Conn. Type 800 d-c motor offers an extended range of output speeds, coupled with high torque, low current drain, and excellent speed stability. Output speeds range from 900 rpm to 2 rpd with gear train, and from 960 to 3,000 rpm without gear train, providing maximum torques of 30 oz in. and 0.6 oz in., respectively. Current drain may be as low as 30 ma, depending on the particular application. Voltage ratings are from 3 to 30 v d-c. Circle 338 on Reader Service Card.

H-V Power Packs transistORIZED

Electronics Research Associates, Inc., 67 Factory Place, Cedar...
Grove, N. J. New miniaturized models of high voltage regulated power packs incorporate advanced circuitry and improved transistor types which permit full input voltage to be rapidly applied and disconnected abruptly without deterioration of performance. High surge current such as produced by sudden connection or disconnection of capacitances will not cause transient burnout. The units may be completely short circuited without damage to the semiconductors or other components. Circle 339 on Reader Service Card.

F-M Receiver covers 55-260 mc

NEMS-CLARKE Co., 919 Jesup-Blair Drive, Silver Spring, Md., announces type 1701-A f-m special purpose receiver. It is designed to cover a 55 to 260 mc range with an i-f frequency of 21.4 mc and an i-f bandwidth of 2 mc. Video response is 100 cps to 2 mc. It is constructed for standard relay rack mounting. Circle 340 on Reader Service Card.

Wire Wound Windings simplify design

BRYS INSTRUMENT CO., 7026 Sixth Ave., Brooklyn 9, N. Y., has announced a service created to provide greater flexibility for electronic

HEATHKITS GIVE YOU TWICE AS MUCH equipment for every dollar invested

The famous model V-7A Vacuum-Tube-Voltmeter is a perfect example of the high-quality instruments available from Heath at 1/2 the price you would expect to pay! Complete, only $24.50

Get the most out of your test equipment budget by utilizing HEATHKIT instruments in your laboratory or on your production line. Get high quality equipment, without paying the usual premium price, by dealing directly with the manufacturer, and by letting engineers or technicians assemble Heathkits between rush periods. Comprehensive instructions insure minimum construction time. You'll get more equipment for the same investment, and be able to fill your needs by choosing from the more than 100 different electronic kits by Heath. These are the most popular "do-it-yourself" kits in the world, so why not investigate their possibilities in your particular area of activity! Write for the free Heathkit catalog now!

FREE catalog
Mail coupon below for your copy—Now!

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM, INC, BENTON HARBOR 14, MICHIGAN

Name
Address
City & Zone
State

Contains detailed descriptions of Heathkit models available, including VTVM's, scopes, generators, testers, bridges, power supplies, etc.

Also describes Heathkit ham gear and hi-fi equipment in kit form, 700 interesting and profitable "do-it-yourself" projects.
THE ELEMENT OF ENVIRONMENT

and the System Designer

To one looking beyond the four walls of his office, environment might be defined as the sum of (1) work responsibilities and (2) colleague personalities.

The System Designers we seek could not fail to be stimulated by (1) assignments of a most advanced nature and by (2) colleagues with considerable attainments in systems engineering, behavioral science and computing.

The advanced nature of the assignments requires at least four years' experience, including circuit design or development, equipment construction and a knowledge of logical design for computers. Moreover, the position also calls for a sound background in computer programming, the ability to write programs and familiarity with the IBM 700 series or similar single address parallel machines.

You are invited to write for more information or phone collect. Address R. W. Frost, System Development Corporation, 2408 Colorado Avenue, Santa Monica, Calif.; phone EXbrook 3-9411.

Audio Tube

hum-free

CBS-HYTRON, A Division of Columbia Broadcasting System, Inc., 100 Endicott St., Danvers, Mass., announces the 7025 twin triode with folded-coil heaters. The new tube was developed for original equipment and replacement use in high-fidelity amplifiers where it is said to minimize hum and noise generation.

A high-mu double triode, the 7025 is ruggedly constructed and utilizes precise grid and mica tolerances for consistently low microphonism. Circle 342 on Reader Service Card.

Inverters

transistorized

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 Factory Place, Cedar
Get out your pencil and . . .

Help yourself to electronics’ READER SERVICE

it's free—it's easy—it's for your convenience

Each Advertisement and New Product item is numbered.

For more information, simply . . .

(1) Circle number on postpaid card below that corresponds to number at the bottom of Advertisement, or New Product item.

(2) Print your name, title, address, and firm name carefully.

It is impossible to process cards that are not readable.

Additional postage MUST be added to cards for all FOREIGN MAILINGS

MAY 23 - 58
CARD EXPIRES JUL 23 - 58

electronics • ENGINEERING EDITION • READER SERVICE CARD

CIRCLE THESE NUMBERS ONLY WHEN YOU ARE INTERESTED IN ALL ITEMS SHOWN OR DESCRIBED

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

* FOR SPECIFIC ITEMS IN MULTI-PRODUCT ADVERTISEMENTS

An occasional Advertisement cannot be numbered for the READER SERVICE CARD due to lack of space and must be indicated by writing the Advertisers’ name in the space at the bottom of the card . . .

MAY 23 - 58
CARD EXPIRES JUL 23 - 58

An occasional Advertisement cannot be numbered for the READER SERVICE CARD due to lack of space and must be indicated by writing the Advertisers’ name in the space at the bottom of the card . . .
MEMO:
NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS
FROM: electronics

electronics publishes all new product items of interest to makers and users of electronic and allied equipment.

The reverse side of this card provides a service to subscribers by facilitating the flow of additional information between manufacturers and our readers.

Take advantage of Reader Service—and the readership of electronics...keep the industry informed about your New Products and New Literature via their mention in the editorial pages of electronics.
Grove, N. J., has a line of high power transistorized inverters with ratings from 100 w up to several kva. These units transform low voltage d-c to either 60 cps or 400 cps a-c and completely eliminate the drawbacks of vibrating or mechanical equivalents. They are self-starting, diode stabilized designs, which use special "E" core magnetic circuits. Circle 343 on Reader Service Card.

Pushbutton Switch
wide selection

Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill., announces the 50PB line of precision lighted push button switches. Short-stroke momentary, long-stroke momentary, alternate-action, two position alternate-action, magnetically held and turn-to-hold switches are available. Circle 344 on Reader Service Card.

Circulator
light and rugged

Rantec Corp., P.O. Box 18, Calabasas, Calif. Model RX810C circulator is a broadband, compact, four part device utilizing the principle of Faraday rotation of the plane of polarization of microwave

Search... detect
... measure vibration
whether STRONG or FAINT

MB vibration detection systems
pinpoint vibration, help you determine its characteristics.

The MB Vibration Pickups are a first essential to any effort to eliminate vibratory motion as a source of trouble, or to correct for it. They're both sensitive and rugged — to meet testing needs for aircraft, missiles, airborne components and general laboratory.

Fixed type pickups are electrically damped, and are fastened to specimen in any position from vertical to horizontal. Probe type is hand-held for exploring large surfaces. Adding but a negligible gram of mass to the test specimen, it indicates actual resonant modes of lightweight objects.

Converting velocity into voltage, MB Pickups also provide data on acceleration and amplitude. Output can be fed into various accessories, including oscilloscope, wave analyzer, magnetic tape recorder, stroboscopes (for synchronizing light with the motion and permitting direct visual study). One of the most useful of accessories is an MB M1, M3 or M6 Vibration Meter. It gives direct readings in terms of acceleration, velocity and amplitude and accommodates several pickup inputs.

Send for detailed bulletin 124.

MB manufacturing company
A DIVISION OF TEXTRON INC.
1075 State Street, New Haven 11, Connecticut
HEADQUARTERS FOR PRODUCTS TO ISOLATE...EXCITE...AND MEASURE VIBRATION
4 Ounce Contact Force Gives Relay Reliability

Contact force of 4 ounces per contact on 50 "G" models and 2 ounces per contact on 30 "G" models of "Diamond H" Series R and Series S miniature, hermetically sealed, aircraft type relays is one of the most important factors in their proven high reliability.

Though absolute reliability of any similar device is impossible to guarantee—a bitter fact of life recognized by all electronic engineers—close approach to this goal by the relays manufactured by the Hart Manufacturing Company is the basic reason they are found today on many of this country's headline-making missiles.

In addition to contact force far beyond that found on other relays, "Diamond H" relays have greater contact cleanliness. Self-contamination is virtually eliminated by a completely inorganic switch mechanism, as well as use of coil materials which will not dust, flake or out-gas.

Finally, the high degree of reliability that is designed into these relays is maintained in their manufacture by high quality workmanship and a stringent inspection policy at every stage.

In addition to missiles, and their ground control systems, Series R and S relays are designed for use in jet engine controls, computers, fire control, radar and similar critical applications.

4PDT units, they offer an extremely broad range of performance characteristics, including temperature ranges from −65° C. to 125° and 200° C.; ratings to 10 A., 120 V., A. C., and 26½ V., D. C., with special ratings to 400 ma. at 350 V., D. C., or down to millivolts and milliamperes. Dry and wet circuits may be safely intermixed.

For more information, write today for Bulletins R250 and S260. For quick facts about "Diamond H" switches, thermostats and other devices, ask also for a copy of the "Diamond H" Check List of Reliable Controls.

THE HART MANUFACTURING COMPANY
202 Bartholomew Ave., Hartford 1, Conn.
Phone JAckson 5-3491

Magnetic Amplifier push-pull types
CHASE ELECTRONICS, INC., 82-31 51st Ave., Elmhurst 73, N. Y.
Model CE-21 is a sensitive push-pull magnetic amplifier for operating twin loads such as p-p magnetic amplifier power stage, having two control coils differentially connected, a polarized relay of differential type, etc. Complete specifications are available. Circle 346 on Reader Service Card.

D-C Amplifier differential type
KINTEL, a division of Colu Electronics, Inc., 5725 Kearny Villa Road, Box 623, San Diego 12, Calif., announces the model 114A
differential d-c amplifier in which the input and output are each completely isolated and completely floating. The transistorized unit provides extremely high common-mode rejection, very low drift, high output capability, and excellent stability and linearity... all unaffected by load or gain changes. Complete specifications are available. Circle 347 on Reader Service Card.

Balun Coil Kit with wiring data
Barker & Williamson, Inc., Canal St. & Beaver Dam Rd., Bristol, Pa. Model 3976 balun coil kit utilizes a single compact mounting bracket with coils mounted at 90 deg. It is suitable for connecting either 75 ohms unbalanced to 300 ohms balanced, or 75 ohms unbalanced to 75 ohms balanced. The air-wound bifilar coils are designed for operation on the 80 through 10 meter bands without tuning. Unit has a rating of 1 kw on ssb, 500 w c-w and 250 w maximum a-m phone. Circle 348 on Reader Service Card.

Measuring Bridge for high voltage
Renupp Co., 3437 Greenfield Ave., Los Angeles 34, Calif., announces type 2801 Schering's commutable...
How to keep informed on the
"with what" part of
your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information — advertising. You might call it the "with what" type — which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better — save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit you and your company, he is taking his most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools ... product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL PUBLICATIONS

Lab Drying Oven priced at $55
Grieve-Hendry Co., Inc., 1401 W. Carroll Ave., Chicago 7, Ill. Model LO-200-C is a constant temperature laboratory oven with temperature range to 200 C (400 F), with shelves adjustable for height every half inch. The oven has features which make it ideal for drying, baking, annealing, sterilizing, evaporating and heat treating. Inside dimensions are 12 in. wide by 10 in. deep by 10 in. high. Circle 350 on Reader Service Card.

Power Supplies for transistor field
Ferrotran Electronics Co., 693 Broadway, New York 12, N. Y., has developed two series of tubeless power supplies with special application to the transistor field. Used in the transistor lab, they can operate high powered audio amp-
Relay Analyzer
fast and accurate

SCHMELING ELECTRONICS, 20 First St., Keyport, N. J. Model 140 universal relay analyzer provides fast, accurate testing of relays under actual contact loading including dry circuit switching. It checks 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. Circle 352 on Reader Service Card.

Charging Chokes
new design

OSBORNE ELECTRONICS CORP., 712 S. E. Hawthorne Blvd., Portland.

LONG-LIFE CHOPPERS
are now in quantity production at Airpax. Standard miniature choppers have demonstrated the ability to remain within specification 2½ times their previously rated life.

Standard Choppers now rated
in excess of 5,000 Hours Life

Life testing in dry and nearly dry circuits shows that Airpax miniature choppers remain within ratings for over 10 times the life required by MIL-C-4856 (USAF). Your replacement costs will be greatly reduced by using new Airpax choppers; same low price as last year's units.

CHOPPER CHARACTERISTICS
Airpax long-life choppers are miniature plug-in or solder-hook units for operation at 40 or 400 CPS (other frequencies on special order).

CONTACTS: up to 2 ma at up to 100 volts
RESISTANCE: same as other miniature choppers
PHASE ANGLE: depending on type. Typical ratings: 55° or 65°, 40 CPS 55° or 65°, 60 CPS 20°
DRIVE: 6.3 volts RMS

Airpax Products Company, Cambridge Division, Jacktown Road, Cambridge, Maryland
S. S. White Flexible Shafts are now used in hundreds of industrial applications to simplify manufacturing and assembly operations. They save space and reduce weight ... cut costs by eliminating gearing, universals and other parts ... allow more efficient positioning of controls and controlled parts.

For more complete details, write for Bulletin 5601. It has full information on how to select and apply flexible shafts.

Fuel Gage Tester accurate to 0.1%

TELECTRO INDUSTRIES CORP., 35-16 37th St., Long Island City 1, N. Y. The MD-1 is designed to test and calibrate aircraft capacitance type fuel gauges, and qualifies under MIL-T-8579. It is a direct reading, precision variable capacitor with a range from 10 to 6,200 µf. Through the use of a main dial and a vernier dial, the technician can easily read all capacitance values in increments of 0.1 µf. Circle 354 on Reader Service Card.

Inverter Supply transistorized

MAGNETIC AMPLIFIERS, INC., 632 Tinton Ave., New York 55, N. Y. Model SIS-40311 static inverter

Manufacturers of electronic equipment have come to depend on Curtis for precision-made non-magnetic universal joints of 18-8 Type 303 stainless steel, in the sizes most frequently used in the industry. Other sizes are also readily available; also bronze joints. Curtis joints benefit by a rigid insistence on uncompromising inspection and quality control at every stage of manufacture, insuring minimum backlash.

Curtis torque and load ratings are entirely dependable, since they are based on continuous testing under actual operating conditions.

Not sold through distributors. It will be to your advantage to write or phone (REpublic 7-0281) for free engineering data and price list.
supply is a high accuracy d-c to 400 cycle inverter. Frequency accuracy as high as 0.01 percent is offered. The diminutive size (2 lb), ruggedness and high accuracy of this component make it valuable for use with computers, ballistic missiles, radar systems and aircraft. Further details are given in bulletin S864. Circle 355 on Reader Service Card.

Selenium Rectifiers
high temperature

International Telephone and Telegraph Corp., 100 Kingsland Road, Clifton, N. J., has a new line of Federal high temperature selenium rectifiers, engineered for specific applications to 28 v d-c aircraft power supplies, where ambient temperatures range from -65 to +125 C. They provide high electrical output per unit of weight and volume, and good voltage regulation from 20 to 200 amperes typical output. Circle 356 on Reader Service Card.

Plug-In Relay
erugged device

Hi-G. Inc., Bradley Field, Windsor Locks, Conn. New HG-2SMP series relay is a plug-in unit with an

TELREX LABORATORIES

NEW, FOR 2-WAY RADIO!

A Complete Series of Precision Tuned, Matched and Calibrated Antennas for Every 2-Way Frequency or Need!

New broad-band ground-plane antennas and fixed or rotated Twin Yagis for increasing range and decreasing interference.

Illustrated—Unity gain broad-band ground-plane antenna for omni-directional general coverage, mounted atop mast supporting Twin Yagis producing high gain uni-directional pattern.

Also Available—Rotator and Indication Systems, Towers, Support Masting, Accessories.

Telrex is equipped to design and supply to our specifications or yours, Broadband or single frequency, fixed or rotary arrays for communications, FM, TV, scatter propagation, etc.

Consultants and suppliers to communication firms, universities, propagation laboratories and the Armed Forces.

ASBURY PARK 25
NEW JERSEY, U.S.A.
Tel. Prpect 5-7252

CIRCLE 102 READERS SERVICE CARD

PROTECT Delicate ELECTRONIC COMPONENTS
While Handling in Production and Shipment with RONDO

RONDO, a cardboard device, holds and protects inserted objects by the spring-clip action of its fluted partitions. Easy to load and handle. Various sizes and styles have been developed for many parts, such as tubes, resistors, capacitors, diodes, fuses, etc., with diameters from 8 to 26mm and up.

Maximum efficiency and economy are accomplished when the same RONDO device is used throughout production, storage, shipping and display. RONDO is a paper product, sold at paper prices.

Send for leaflet and suggestions regarding your specific packing need.

RONDO PROCESS AND DESIGNS ARE COVERED BY PATENTS IN ALL MAJOR COUNTRIES

RECOGNIZED ALL OVER THE WORLD

AMERICAN RONDO CORP., 100A SANFORD ST., HAMDEN 14, CONN.

CIRCLE 103 READERS SERVICE CARD
PORTABLE D'ARSONVAL
GALVANOMETER

FOR MEASURING HEMOGLOBIN content of blood samples, the Fisher Scientific Co. of Pittsburgh uses a Model 100 G-M Galvanometer in its popular Electro-Hemometer (at left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

CIRCLE 104 READERS SERVICE CARD

Specializing in Beryllium Copper
Tools - Dies
Metal Stamping
Short Run Parts

OUR SHORT RUN STAMPINGS ARE CHEAPER THAN YOURS!

That's how we invite prospects ... and we keep them by proving it!

Irving Tool can save you money, too, on short run stampings. The reason is we're geared for inexpensive short runs. Costly short run experiments and modifications eat up your profits — let us show you now how to save on this essential phase of your operation.

Start cutting expenses today by sending your specifications for a free estimate by return mail.

IRVING TOOL & MFG. CO.
1315 Levee St. • Dallas 7, Texas

CIRCLE 105 READERS SERVICE CARD

asbestos filled melamine socket designed specifically for performance exceeding standard socket units. Rotary action and rugged construction make this unit suitable where reliability and rapid interchangeability are required. Contacts are rated up to 5 amperes and 250 v with coil operating voltages of 6 to 115 v a-c or d-c. Contact arrangement is 1 or 2 pdt. Sockets are available with several types of gold plated terminals, and can be mounted above or below chassis. Circle 357 on Reader Service Card.

Induction Heaters
wide applications
Robotron Corp., 21300 West Eight Mile Road, Detroit 19, Mich. A full line of induction heating units is available in three frequency ranges: low frequency, 7½ to 1,750 kw, 1-10 kc, motor generator powered; medium frequency, 3 to 50 kw, 450 kc, electronic generator equipped; and high frequency, 3 to 20 kw, 27.1 mc, electronic generator equipped. Circle 358 on Reader Service Card.

Magnetic Modulator
miniaturized unit
General Magnetics Inc., 135 Bloomfield Ave., Bloomfield, N. J. A new line of miniaturized magnetic modulators is especially engi-
needed for printed circuit wafer designed structures and circuit assemblies. New "Mag Mod" components offer design advantages including: (1) faster time relay; (2) negligible hysteresis; (3) extreme stability - ambient temperature range from -65°C to +135°C; (4) compact size; (5) light weight; (6) infinite life for complete reliability. Circle 359 on Reader Service Card.

**Strip Chart Recorder direct-writing**

**Manfred Industrial Instruments,** 5154 Glenmont Drive, Houston, Texas. The ER-20 direct-writing strip chart recorder is designed for recording electrical data from d-c to 100 cps. Featuring direct-coupled amplifiers which give a sensitivity of 2 mv/mm, it is priced at $550 including amplifiers. Stylus deflection on each channel is 40 mm, with an accuracy of 2 percent. Electrosensitive paper eliminates the need for any inking system. Circle 360 on Reader Service Card.

**Capacitor Test Chamber self-contained, portable**

Conrad Inc., 141 Jefferson St., Holland, Mich., has a new design capacitor coefficient testing chamber. It has an adjustable indicating temperature control for the range of +150°C to -70°C with proportioning action for heating or cooling demand, whichever is being controlled. This equipment permits stability of items on test to

**Specify Linde Sapphire**

**Linde Sapphire is . . .**
Hard - Moh 9
Transparent, single crystal, pure aluminum oxide
Nonporous - 0% porosity
Easily sealed to metals and ceramics
Priced competitively with sintered materials

**Linde Sapphire has . . .**
Strength at elevated temperatures
High melting point - 2040°C
Excellent IR transmission at high temperatures (above 500°C)

For more information about Linde Sapphire . . . Write "Crystals Dept. BD-54." Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

**ENGINEERS AND SCIENTISTS** interested in working in Synthetic Crystal Sales & Development, contact Mr. A. K. Seemann, Linde Company, 30 E. 42nd St., New York 17, N.Y.
In such precision operations as automation programming, you can now eliminate the risk of pushing more than a single button at a time.

This new interlock feature is based on a simple arrangement of sliding cams. Only one button at a time can be depressed. This feature is available in all multiple-pushbutton assemblies (7, 10, 12 and 20 button arrangements).

All "telephone-quality" advantages of Stromberg-Carlson keys continue as before. You may apply "make," "break," "break-make" and "make-before-break" combinations as required. You get standard spring combinations with Form A, C or D contacts—or you may order special strips of keys with intermixed contacts.

Buttons are available in white or colors—blank or with letter or number designations.

For complete technical data on Stromberg-Carlson Key Switches send for our illustrated Bulletin T-5002R.
receptacles—the DM5600 and DM5606—are available. Units are designed to give true hermetic sealing against high g forces, heat and cold extremes, pressure and atmospheric variations, vibration and corrosion.

The hermetic seal is obtained by a Deutsch process in which special alloy conductor pins are fused in a furnace with compression glass insulation into a specially designed steel shell.

Available in standard and square flange types, the units mate with the DM6502 rack and panel plug and DM9700 series miniature push-pull plugs. Circle 363 on Reader Service Card.

Beam Power Tube compact, economical

CBS-Hytron, Parker St., Newburyport, Mass., announces the new USN-3D21B pulse modulator, a compact, economical beam power tube capable of delivering 21 kw in 10 usec pulses. The 3D21B may also be used as a h-v blocking oscillator, hard switch tube, deflection amplifier, and regulator or pass tube in h-v supplies.

The tube features an open-type plate of large area for high thermal dissipation, a non-warping cathode, and gold-plated special alloy grids with heavy side rods and oversize heat radiators.

A button stem and large leakage slots in the support micas contribute to its h-v capabilities; the tube is rated to withstand a plate pulse voltage of 5 kv. Circle 364 on Reader Service Card.
stoddart coaxial attenuators and terminators

made with exclusive Stoddart Filmistors for highly accurate and stable resistive values

6 position TURRET ATTENUATORS with simple "pull-turn-push" operation

Extremely precise resistance values from dc to 3000 mc are maintained by Stoddart-developed Filmistors — thin metallic films in ceramic forms which are assembled in properly designed coaxial sections. Turret units are small, and built for long service.

ATTENUATOR PADS
Uniform size, many combinations

You can specify these small "in-the-line" pads in any conceivable combination of male and female Type C and Type N connectors. Single pads with female connectors can be provided with flange for panel mounting. Convenient to use... pads have maximum length of only 3" for any attenuation value. Electrically, pads are the same as those in turret model above.

COAXIAL TERMINATIONS
small, stable — 50 or 70 ohm

½-watt terminations — 50 ohms impedance, TNC or BNC connectors, to 3000 mc. Low cost. VSWR less than 1.20.
1-watt terminations — 50 ohms, DC to 3000 mc or DC to 7000 mc. VSWR less than 1.20.
Type N or Type C connectors, male or female. 70 ohm. Type N, male or female terminations available.
Platinum film resistors, gold-plated electrical contacts, durable satin chrome exterior finish. Wattages are continuous sine wave ratings.

All items immediately available from stock
Send for Attenuator Catalog A-2

stoddart aircraft radio co., inc.
6644 Santa Monica Blvd., Hollywood 38, Calif. · Hollywood 4-9294

Literature of

MATERIALS

Infrared Transmitting Materials.
Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y. A new brochure provides revised comparative information on 15 different infrared transmitting materials suitable for use as optical elements. Transmission curves are included for the 11 most important materials. Circle 365 on Reader Service Card.

COMPONENTS

Crystal Filters. Burnell & Co., Inc., 10 Pelham Parkway, Pelham, N. Y. A 4-page brochure includes technical data, typical and representative curves of crystal filters that have been developed and are manufactured by the company. Symmetrical band pass filters, asymmetrical or ssb filters, narrow band and wide band filters are described. Circle 366 on Reader Service Card.


P-C Standards. Cleveland Metal Specialties Co., 1783 E. 21st St., Cleveland 14, Ohio, has published a book entitled "Military Standards For Printed Circuits". Price is 75 cents to defray handling and postage charges. Circle 368 on Reader Service Card.

are also included. Circle 369 on Reader Service Card.

Solid Delay Lines. Anderson Laboratories, Inc., 501 New Park Ave., West Hartford, Conn., has issued a 4-page bulletin describing their facilities for research, design and manufacture of specialized high quality ultrasonic solid delay lines. Circle 370 on Reader Service Card.

EQUIPMENT

Digital Modules. Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass. Catalog T contains 14 pages of descriptive information and technical specifications on the new transistorized T-PAC one megacycle digital modules. Availability of the company's services is also noted. Circle 371 on Reader Service Card.

Ferromagnetic Computing Amplifier. Airpax Products Co., City of Plantation, Ft. Lauderdale, Fla. A four-page folder has been issued as a supplement to bulletin 221. It contains tentative ratings and specifications for 60-cps Ferromax amplifiers. Circle 372 on Reader Service Card.

Pulse Handling Instruments. Rutherford Electronics Co., 8944 Lindblade St., Culver City, Calif., has issued a comprehensive catalog of their pulse handling instruments. It lists two types of time delay generators and four basic types of pulse generators with several modifications thereof. Circle 373 on Reader Service Card.

FACILITIES

Cable Systems. Robertshaw-Fulton Controls Co., 401 N. Manchester, Anaheim, Calif. Facilities and capabilities of a new custom electronic cable manufacturing center for missile and aircraft requirements is explained in technical bulletin RF-582. Circle 374 on Reader Service Card.
EAI Enters Control Fields

ELECTRONIC ASSOCIATES, INC., Long Branch, N. J., enters the automatic data processing and process control fields by forming a control instrumentation section within the company's engineering department. Heading the new group is German physicist Wolfgang Harries, pictured (second from left) with other members of the new section—Irving Bogner, D. A. Baumann and Stephen Marcy.

EAI president Lloyd F. Christianson points out the company has gained much information about process operation and control requirements in various industries. The firm's experience over the years came largely through simulation and analysis of customers' problems at its various computation centers. Present plans call for close liaison between the control instrumentation section and the computation center personnel, to offer maximum benefit to customers.

In speaking of the control instrumentation group, Harries said it would be concerned with data logging, closed loop control systems, computer entry, and computer linkage systems.

He revealed that for more than a year EAI has been conducting an intensive development program on such items as low level amplifiers, transducer calibration units, electronic multipliers, voltage-digital converters, universal digital logic elements, and controlled format digital tape recorders. All of these systems building blocks employ solid state techniques and are designed for maximum flexibility.

Typical of contracts in process says the company, is a system which automatically scans and digitizes the outputs of numerous vapor chromatographs and prepares the digital information for computer analysis. "This system is particularly interesting because it will significantly increase reactor efficiency in a petroleum plant by faster and more precise analysis of reactor products," Harries explains.

He notes that his group will also be concerned with military applications.

Set Up New Firm In California

Having left their positions with the U. of California Radiation Laboratory, W. M. Brobeck and C. E. Andressen, Jr. recently formed their own organization in Oakland, Calif. The new firm, William B. Brobeck & Associates, will specialize in engineering research, design and development.

MM&M Appoints

New manager of application engineering for the industrial controls division of Manning, Maxwell & Moore, Inc., is Edmund R. Lehmann. Previously, he was with Fisher & Porter (Canada) Ltd., and McColl-Frontenac Oil Co. He is a past president of the Montreal, Quebec, chapter of the Instrument Society of America.

Name Schooley To New NRL Post

APPOINTMENT OF Allen H. Schooley (picture) as associate director of research for electronics at the U. S. Naval Research Laboratory is announced. He succeeds Robert M. Page, now director of research.

Schooley had recently resumed his position as superintendent of assistant to the president.

Data-Controls Adds to Staff

Five personnel additions to the recently formed Data-Control Systems Inc., Danbury, Conn., are announced.

F. E. Farris, formerly with Philips Electronics Inc., becomes
### Mandrel Industries Offers a Source of Graphic Recording Instruments

Mandrel Industries offers a source of graphic recording instruments based on a realistic philosophy - functional equipment at a reasonable price! To provide you with such equipment our Industrial Instruments division has been created. Behind Mandrel’s guarantee of workmanship is twenty-seven years of experience manufacturing specialized electronic devices for thousands of customers and an annual sales volume of $8,000,000.

We would like to send you more detailed specifications for the instruments pictured. May we?

Write:

Mandrel Industrial Instruments
5124 Glenmont Drive
Houston (36), Texas

---

#### X-Y Recorder

**ER-90**

- 8½” x 11” graph paper, 10 mv./in. standard, one second full scale, Accuracy - Better Than 0.75%.

- Two channel with amplifiers

- $550.00

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Y Recorder ER-90</td>
<td>8½” x 11” graph paper, 10 mv./in. standard</td>
<td>$550.00</td>
</tr>
</tbody>
</table>

#### Strip Chart Recorder

**ER-20**

- Response D-C to 100 c-p-s, 2 mv./mm. — 40 mm. total deflection, Electro-sensitive paper, 2 speed chart drive, 9” x 12” x 9”, 17 lbs.

- $350.00

#### D-C Amplifier

- Chopper stabilized drift-free d-c preamp for meter-movement type recorders. 10 mv. across 1 megohm produces 1 ma. in 1500 ohms.

- $120.00

#### Galvanometer Oscillograph

**ER-102**

- Time-proven design from geophysical industry now available for industrial use.
- Photographically records up to 50 traces, crystal or externally controlled flash timing.
- Wide choice of light-beam galvanometers provides performance to your specifications.

- $750.00

#### Dynavolt Vibrator Pickup

- Moving-coil, self-generating, 0.5 volt / inch / second.

- $35.00

#### PV-2 Inverter

- 12 or 24 volt d-c input produces 115 volt 50, 60 or 400 c-p-s output, 150 v-a.
- Frequency accuracy and stability: 0.01%.

- $750.00

#### Dynastroke Linear Force Motor

- 0.5 milliwatts / gram, 0.05% accuracy, moving-coil movement.

- $35.00
THINK SMALL - THINK MICRODOT

MICRO-MINIATURE COAX CABLES & CONNECTORS
Reliability and high performance with a minimum of size and weight. Proven by applications in military and commercial fields, one million combinations of Microdot micro-miniature coaxial cables and connectors available from stock. Assemblies made by the exclusive Microdot technique to assure prompt delivery on standard and custom designs.

Write for new 36 page catalog.

Name Harcher
Works Manager
Recent appointment at Clevite Transistor Products, Waltham, Mass., moves Albert J. Harcher (picture) from production manager to the position of works manager. Harcher was formerly associated with CBS-Hytron, as plant manager for both the Newburport and Kalamazoo tv picture tube operations. Earlier he had served the company as temporary plant manager in Lowell, Mass., and as chief engineer in charge of developing rectangular tv picture tubes.

Sylvania Buys More Land
Twenty-six acres of land in Santa Cruz, Calif., were recently purchased by Sylvania Electric Products, Inc., for future expansion of its computer component manufacturing operations. Since last November, the company's Sylvania Electronic Systems division has been operating a small facility, employing 25 manufacturing people.

NRL’s electronics division after a year’s leave of absence. During this time, he served under the terms of the Mutual Assistance Pact as an advisor to the Brazilian Navy in matters related to the establishment of a Brazilian Naval Research Institute in Rio de Janeiro.

Sylvania Electric Products, Inc.
220 PASADENA AVENUE
SO. PASADENA, CALIFORNIA
CIRCLE 115 READERS SERVICE CARD
in leased quarters at Santa Cruz.

Gordon McClure, manager of the present operation, said the company has no immediate plans for construction. Size of the operation and number of employees needed are still to be determined.

Helms Joins Giannini
New chief engineer of the Giannini Transducer Division, Pasadena, Calif., is Walter Helms. He comes to his new post from Dallas, Texas, where he held a number of design and supervision engineering positions with Chance Vought Aircraft, Inc.

Fenwal Gets New Sales Manager
H. J. Andrews (picture) has been promoted from sales engineer to sales manager of Fenwal Electronics, Inc., Framingham, Mass. He will be responsible for all company sales, including precision thermistors, custom designed thermistor probes and assemblies and special high precision temperature indication and recording instruments.

Little Takes New Position
PHILLIPS PETROLEUM Co. hires Richard I. Little as electronics engi-
Executive Moves

Carroll M. White, manager of EIA's Mobile Radio Communication, has resigned to accept a position as executive secretary of the Special Industrial Radio Services Association (SIRSA), effective July 1, 1958.

Harry P. Troendly is upped to group vice-president of Borg-Warner Corp., Chicago, Ill. He comes to the central office management group from the corporation's Spring Division where he had been president since 1953.

Plant Briefs

Pecar Electronics, sound equipment distributors, has moved to larger quarters at 11201 Morang at Somerset, Detroit 24, Mich. The new location, with 7,000 sq ft of floor space marks the seventh major expansion in the past 12 years.

Nems-Clarke Co., Silver Springs, Md., announces expansion of floor space 21,000 sq ft in an adjacent building.

Eo Electronics, Inc., manufacturers and developers of electronic instruments, has moved into its newly completed plant located at Morris Ave., Mountain Lakes, N. J.

Peschel Electronics, Inc., h-v test equipment specialists, moves its office and plant to a newly acquired 204-acre site in Towner's, N. Y.

F. J. Stokes Co. of Canada, Ltd., Canadian subsidiary of F. J. Stokes Corp., Philadelphia, Pa., has moved its Toronto headquarters to 4198 Dundas Street West.

Heath Co., a subsidiary of Daystrom, Inc., moves to a larger plant with its atomic energy division.

The company operates the Idaho chemical processing plant, the engineering test reactor, the materials testing reactor, and the special power excursion reactor test facilities for the AEC at the National Reactor Testing Station west of Idaho Falls.

Electrical Coil Windings

For 40 years... specializing in all types of coils to customers' specifications. Design or engineering assistance available on request.

COTO-COIL CO., INC.
SINCE 1917
65 Pavilion Avenue Providence 5, Rhode Island
Using Thermistors

Edited by FENWAL ELECTRONICS

Thermistors are "thermal resistors" with a high negative temperature coefficient of resistance — semiconductors — with amazing sensitivity.

Thermistors discussed here — for liquid level measurement and as altimeters.

Liquid level measurement: When a thermistor is suspended in air in series with a light bulb and battery, the bulb lights, because the thermistor heats and resistance drops, permitting current to flow to the bulb. Reversing this process, a thermistor submerged in a liquid (Fig. 1) cools, extinguishing the light. This is a liquid level indicator. A liquid level control substitutes a relay for the light bulb.

Altimeter: A hypsometer, an extremely sensitive altimeter, is a thermistor placed at a liquid's surface (Fig. 2); thermistor resistance is a function of the liquid's boiling point, which depends on the altitude. A hypsometer of this type can measure altitude from sea level to over 125,000 feet with precision better than 1% of the measured pressure.

News of Reps

Manufacturer's reps, Mosher & Peyer of Needham, Mass., now handles sales of fabricated plastic and metal parts in the six New England states for Universal Unlimited of Glen Cove, L. I., N. Y.

William J. Herbert is appointed by the T. Louis Snitzer Co., electronics manufacturers' reps of Los Angeles, Calif., to head the company's new San Diego area office in La Jolla, Calif. He was formerly an electronic engineer with the U. S. Navy Electronics Lab in San Diego.

Electro Tec Corp., South Hackensack, N. J., slip ring assembly and precision component manufacturer, names Service Equipment Electronics Co. as representative for its Ohio and Michigan territory.

The Carl G. Chafin Co. is appointed by WYCO Metal Products of North Hollywood, Calif., to represent them in San Diego and Imperial counties. Rep firm will sell WYCO's line of racks, panels, cabinets and chassis for the electronic industry.


Sales of General Transistor Corp. products will be handled by Hollingsworth and Still in the southeast U. S., including Alabama, Georgia, Florida, Tennessee, North and South Carolina.

in Benton Harbor, Mich. The manufacturing operation, formerly occupying seven buildings, is now carried on in a new 140,000-sq ft building.

Remington Rand Univac, Division of Sperry Rand Corp., relocates its purchasing division to Plant One in Univac Park, St. Paul, Minn. At this time, its facilities in Plant Eight on North Prior Ave. are closed.

For complete details on new Bendix Gear Head Motors and Motor Generators, and other precision components, write—

**Eclipse-Pioneer Division**

Teterboro, N. J.

District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C. Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 123 READERS SERVICE CARD

**new and full of advantages**

BENDIX GEAR HEAD MOTORS AND MOTOR GENERATORS

One-source engineering of complete package • Volume-production prices • Wide range of frame sizes with immediate delivery on size 8s • 18 standard size 8 gear ratios from 10:1 to 5250:1 — lower, higher, and intermediate ratios available on special order • High operating torque capacities • Compact, lightweight packaging • Corrosion-resistant gears • Ball bearings—ABEC 5, or better • AGMA precision 2 gears, or better.

Another reason why...

**You Can’t Beat The Bendix Supermarket.**

**For complete details on new Bendix Gear Head Motors and Motor Generators, and other precision components, write—**
Need resistors in a hurry for a production rescheduling, a prototype or what not? That's what Stackpole local distributors are for! Over 50 of them in leading centers carry complete industrial stocks. Write, wire or phone for name of nearest one.

A major resistor development designed for the most stringent requirements... at ordinary resistor prices.

Distributors’ Division, STACKPOLE CARBON CO. 26 Rittenhouse Place, Ardmore, Pa.

TYPE RC-20  TYPE RC-32  TYPE RC-42
(1/2 watt)  (short-length 1 watt) (2 watts)

Victoreen Company has ordered over 100,000
New Phaostron PRESTIGE Panel Meters to be used in their equipment in 1958.

The new Phaostron Prestige Panel Meters provide shielding from magnetic fields. Simplified Ringcor Movement and structural improvement insures consistent accuracy, long life. Precision cast elements for increased mechanical stability. Prestige meters have shock mounted jewels, ground and polished pivots. Meters can be mounted on magnetic or non-magnetic panels without recalibration. Colors are available in your choice of combinations for scale and case.

PHAOSTRON Instrument & Electronic Co. 151 Pasadena Avenue, South Pasadena, California

Passive Network Synthesis

By J. E. STORER

In recent years network synthesis has become an essential part of electrical communications; strangely, however, in the last decade not a single text has appeared on the subject. As a result, a great need has existed for some time, both in industry and in the graduate schools, for such a text. Storer’s book is the first to fulfill this need; others are in preparation.

The author assumes familiarity with network analysis, he discusses the realizability conditions giving simple proofs. He covers the basic synthesis techniques for driving point and transfer functions, and treats briefly the approximation problem.

Driving Point Impedance—The book is divided into four parts. In the first part the properties of the driving point impedance are stated and proved from energy considerations. These proofs establish the desired results in a simple way; however, since they do not show the relationship between the impedance function and the network matrix, they lead only to limited results. Methods for testing the realizability conditions are covered briefly.

Driving point synthesis of two element networks leading to the Foster and Cauer forms is given and their relationship to Hurwitz polynomials is established. The Brune and Bott-Duffin method of synthesis is discussed with a brief mention of the Miyata approach.

Realizability conditions of a two-pair-terminal matrix are developed and the Cauer method of synthesis of a reactive matrix is presented, followed by the Darlington method.

The second part of the book covers the image parameter method, frequency transformations, lattice analysis and properties, constant resistance synthesis, and maximally
WIDE SPECTRUM CRYSTAL CONTROLLED
FREQ. CALIBRATOR
50 mcs to 11,000 mcs

an accurate, secondary frequency standard for
CALIBRATING and TESTING

MICROWAVE RECEIVERS
* The Model 7712 can also be used as a quick means of determining sensitivity of receivers in the field.

RADAR SYSTEMS

NAVIGATIONAL BEACONS & AIDS

SIGNAL GENERATORS

RF PRE-SELECTORS AND FILTERS

WIDE FREQUENCY RANGE:
Covers entire spectrum from 50 mc to 11,000 mc without the use of tuning controls.

EASE OF OPERATION:
A flick of the switch delivers the full spectrum. A switch provides a choice of 50 mc or 100 mc spacing. The amplitudes of the marker signals are adjusted by an output level control.

ACCURATE:
±0.005% at any frequency, unaffected by temperature or input power variations.

COMPACT; RUGGED; LIGHT WEIGHT:
Provides a choice of 50 mc or 100 mc spacing. The amplitudes of the marker signals are adjusted by an output level control.

SYNTHESIZED IN OSCILLATOR.
Serves as a basic reference to the practicing engineer.

APPLICATIONS:
The Model 121 can also be used as a quick means of determining sensitivity of receivers in the field.

WANTED: Sales Reps - Key reps in metropolitan areas.

AMERICAN ORDNANCE ASSOCIATION
P.O. Box 416, Elizabethtown, Pa.

CIRCLE 140 READERS SERVICE CARD

ELECTRONICS engineering edition — May 23, 1958

flat delay lines. The purpose of this part is not clear; the image-parameter method is treated in many undergraduate texts and the topics on frequency transformation and delay lines are part of the approximation problem.

Synthesis Techniques—The third part gives a good coverage of the important synthesis techniques for transfer functions; however, their properties are treated lightly. The realizability conditions are first established, followed by the Darlington and Weinberg methods. The ladder forms of LC and RC networks are developed and the Gillem and method for general RC networks is presented. A brief discussion of synthesis using active networks is also included.

Approximations—In the last part the approximation of a given response by realizable functions is considered; the approximation problem in the frequency domain is introduced and its solution by expansion into orthogonal polynomials is attempted. The potential analogy method is presented and applied to the filter problem with the Butterworth and Chebyshev functions as applications. The final chapter gives a short discussion of time domain approximations.

The last part is not as clearly and simply presented as the other three: with the phase and time domain synthesis neglected, the material is not well balanced and the selection of the various methods is arbitrary. However, this is due mainly to the state of development of this relatively new field.

The book is well written and can be easily read without much preparation: its simple and complete coverage of the important realization techniques illustrated with many examples and developed with the minimum of supporting material will make it a valuable reference to the practicing engineer. For the graduate student it will serve as an introduction to the basic concepts of network synthesis. — Athanasios Papoulis, Polytechnic Institute of Brooklyn, N. Y.
The article "Selection of Modulation for Speech Communications" by George J. Kelley (Mar. 28, p 56) covered the various aspects of F-M, A-M, suppressed-carrier SSB and suppressed DSB quite thoroughly. However, no mention was made of an SSB system which transmits a small pilot carrier for the purpose of phase-locking the receiver oscillator. This system, known as synchronous single-sideband, has many applications in communications systems. Its main advantage lies in the fact that, because of the transmission of the pilot carrier, the frequency stability required of the system can be reduced considerably.

Because the receiver oscillator is phase-locked to the transmitted pilot carrier, the frequency of the receiver oscillator is made identical to the frequency of the pilot carrier, with the result that the sidebands are detected with no frequency error. It is our experience that this system rates very highly on the many characteristics that are evaluated by Mr. Kelley.

The synchronous single-sideband system has its main application in the vhf region where the application of suppressed-carrier SSB would require a frequency stability which is beyond the present state of the art.

It is not clear why the author assigns equal bandwidth to every system covered in the paper. It would seem feasible to make the bandwidth of the SSB system one half of the bandwidth of the other three. Since spectrum conservation is extremely important, this could be a most important factor in the decision as to which system should be employed for a given communication problem. Instead of being assigned a weighting factor of zero as indicated in Fig. 3 of the paper, it could probably carry the greatest weight of any of the various factors listed.

With regards to the performance of the various systems for various degrees of speech clipping, it seems impractical to consider clipping below the 11 db clipping level as indicated in Table II of the paper. The amount of distortion introduced by clipping below this level increases rapidly with the result that the reproduced speech signal has a very definite disagreeable quality.

Roy A. Richardson
Motorola Inc.
Chicago, Ill.

and Standing Waves

An error has been noted in "Standing Wave Ratio Conversion Chart" by John Lory (Jan. 31, p 56). Equation 5 derived by the author does not apply to power standing-wave ratios as he asserts, but rather to voltage standing-wave ratios.

The expression for the measured value of the power standing-wave ratio is

$$\rho' = \frac{P_1 + P_2}{P_1 - P_2}$$

where $P_1$ and $P_2$ are the magnitudes of the incident and reflected powers at the measuring site. The incident and reflected powers at the load are $P_i$ and $P_r$. Mr. Lory erred when he used $P_i$ rather than $P'$, in his equation 3, corresponding to the equation above.

Accounting for an insertion loss $K$,

$$P_i' = \frac{P_i}{1-K} \text{ and } P_r' = (1-K)P_r$$

The standing-wave ratio characterizing the load is

$$\rho = \frac{P_i + P_r}{P_i - P_r}$$

and the correct relationship between the measured and actual values of power standing-wave ratios becomes

$$\rho' = \frac{2\rho - (\rho - 1)(K)(2 - K)}{2 + (\rho - 1)(K)(2 - K)}$$

William H. Nester
General Electric
Syracuse, N. Y.

I have checked the derivation of my equations, and as Mr. Nester points out, an error was made.

Although the equations as they appear in the article are erroneous, the chart is correct if the axes are relabeled MEASURED VOLTAGE SWR and ACTUAL VOLTAGE SWR.

John Lory
Sperry Gyroscope
Great Neck, L. I., N. Y.
DOPPLER NAVIGATION SPECIALISTS

Work on advanced doppler radar navigation and guidance projects at Raytheon.

Some of the most interesting and vital projects of the day are now in the works at Raytheon's Maynard Laboratory.

Challenging assignments are given to engineers with specialized radar experience in doppler navigation and guidance systems... and to others with backgrounds in radar interested in working with these new systems.

Are you a circuit design engineer, microwave design engineer, product design engineer, or systems engineer with radar experience?

PLEASE CALL COLLECT. Ask for John J. Oliver at TWin Oaks 7-2945, Ext. 246, or write him for details. He'll be glad to arrange an appointment at your convenience.

RAYTHEON MANUFACTURING COMPANY
Maynard Laboratory
P. O. Box 87E, Maynard, Massachusetts

RAYTHEON
Excellence in Electronics
INERTIAL GUIDANCE ENGINEER John V. Prikazsky tells why airborne computer development at IBM Owego, N. Y., offers him the creative engineering career he always wanted.

"Inertial guidance," explains John Prikazsky, "means aerial navigation without recourse to external reference. As an inertial guidance engineer with IBM, I have the opportunity to work on completely integrated bombing-radar-navigational systems. My work is broad—from lab studies to the analytics involved in system design—everything from shooting the North Star to heat transfer problems. That's why I like it—plus the chance I have to take on as much responsibility as I can handle."

Other challenging assignments at IBM Owego
- Airborne analog and digital computer systems
- Units and systems
- Test equipment development
- Radar circuits and systems
- Transistor circuit design

Qualifications
B.S. or M.S. degree in electrical or mechanical engineering, physics, or mathematics, and
Proven ability to assume a high degree of technical responsibility in your sphere of interest.

FOR DETAILS, just write, outlining background and interests, to:
Mr. R. E. Rodgers, Dept. 554 Q
Mgr. of Technical Recruitment
International Business Machines Corp.
590 Madison Ave., New York 22, N. Y.

IBM, a recognized leader in the electronic computer field, offers a stable balance of military and commercial work. You will find ground-floor opportunities for professional achievement at IBM Owego. Liberal company benefits set standards for industry today, and salaries are commensurate with your abilities and experience.
ENGINEERS, E.E.

A program that is attracting some of the best minds in electronics now calls for additional creative engineers.

GUIDANCE SYSTEM FOR AIR FORCE ICBM ATLAS

UNDER DEVELOPMENT AT GENERAL ELECTRIC

There is an unprecedented challenge for electronic engineers in developing the command radio-radar system for Atlas.

Portions of this system must achieve accuracies on order of 1 part in 10 million ... and maintain them without degradation under the extreme conditions of shock, vibration and temperature encountered during an ICBM's blast off and acceleration along the initial portion of its trajectory.

Men who can work to these stringent operational requirements will be well equipped to handle still more demanding "command" problems. As the Manager of General Electric's Missile Guidance Section said recently: "With this job behind us, there will remain no significant obstacle to the practical guidance and navigation of other space vehicles."

Current opportunities at the Section are at all levels ... and exist in practically every phase of the program.

If your field of special competence appears in the list below there may be a position open to you, with high professional implications for the future.

- Systems analysis, evaluation & integration
- Systems and component reliability
- Transistorized circuits, pulse circuitry, IF-Video circuits
- RF and Microwave components & plumbing
- Communications control devices
- Doppler radar design & development
- Digital data processing techniques
- Data transmission involving D & D of ground-based & airborne antennas, transmitters, receivers; application of transducers, transponders, etc.
- Test operations, including planning, range instrumentation & test execution; development & application of automatic test equipment.

Positions are at Syracuse and Utica, N.Y. facilities.

Please address your resume to Mr. E. A. Smith, Dept. 5-E

If your qualifications approximate job "specs," he will arrange a convenient interview.

MISSILE GUIDANCE SECTION

GENERAL ELECTRIC

Court Street, Syracuse, N.Y.
ELECTRONIC ENGINEERS at TI are beating the semiconductor heat barrier with devices that will operate at 200 degrees centigrade and higher — twice the boiling point of water! Working closely with other scientists on the TI team, they continually explore new fields in electronics. Under the hot glare of infrared light which simulates extreme operating conditions, the engineer shown above is testing the newest TI silicon power transistor operating in conjunction with the totally new Sensistor temperature-sensing silicon resistor.

On this frontier, there is plenty of room for electronic engineers, physical chemists, solid state physicists, and others to build America's electronic future. If you are interested in joining other leading engineers and scientists at the industry's most modern research, development and production facilities — write or call for more information on 28-year-old Texas Instruments, recognized leader of the semiconductor industry. You will discover up-to-date supplemental benefits — profit sharing, insurance, retirement programs, and company-sponsored educational assistance.

Semiconductors and Other Components — Transistors, diodes, rectifiers, capacitors, resistors, transistor circuit applications, test equipment, mechanization. Write Harry Laur.


Research and Manufacturing — PhD level for research, development and applications: solid state device technology, ferromagnetics, infrared, microwave, magnetics, digital computers, radar, sonar, telemetering, etc. Engineers for production, planning, purchasing, cost analysis, etc. Write A. E. Prescott.
EMPLOYMENT OPPORTUNITIES

ENGINEERS (EE), PHYSICISTS, MATHEMATICIANS

Is this your idea of “wish fulfillment”?


Doing Applied Research in Communications in a New Lab with a Company Growing Steadily on a Basis of Its Creative Contributions to Science and Engineering

The work of the Communications Research Staff is concentrated on the application of tomorrow’s radically new theoretical concepts to communications theory and systems development.

Some of our equipment, already developed, for air-to-air communications is so tradition-breaking in technique that even our customers could not believe in its final capabilities.

Now our new expanded lab facilities permit operations to grow in a major way. If work in advanced communications research, under ideal conditions, is your career-aim, and you have an Advanced Degree in EE, Physics or Mathematics or the equivalent in graduate course work, investigate these positions in Applied Research:

Novel Circuity—This is a high level position requiring the ability to invent practical circuits to bring to fruition new, basic concepts in the field of communications. Ability eventually to form a 10-20 man circuits team desired. Candidate must have a sound understanding of the field of military communications systems and a broad technical background.

Novel Communications Systems—Vision and creative ability of a high order are needed for this important assignment. Candidate must be able to derive and direct applications of new techniques developed in the Ambert Laboratory to existing and new communications systems. Man we seek should have a sound understanding of the field of military communications systems and a broad technical background.

Also a few research positions open in the field of Probability & Information Theory and Electromagnetic Propagation. Work involves both experimental and theoretical research. Ph.D. required.

Please write E. F. Culverhouse

AMHERST LABORATORY

ELECTRONIC SYSTEMS DIVISION

SYLVANIA S

SYLVANIA ELECTRIC PRODUCTS INC.

1100 WHEELER DRIVE, BUFFALO 21, NEW YORK
EMPLOYMENT OPPORTUNITIES

RECONNAISSANCE
and
DATA PROCESSING

programs at
The Ramo-Wooldridge Corporation

have created the following new openings:

Display Development. EE, ME, or psychology background with experience in creative development of large-scale information displays.

Optical Design. Significant experience in high-acuity optics.

Console Design. Creative experience in design of operating consoles utilizing electronic, mechanical, and optical techniques.

Wire Communications. Senior design experience in teletype, associated switchgear, message centers. Knowledge of inventory and terminal equipment desirable.

Please address inquiries to Mr. W. J. Coster at

The Ramo-Wooldridge Corporation
P.O. Box 45215, Airport Station • Los Angeles 45, California

MANUFACTURER'S REPRESENTATIVES

Minimum 5 years Industrial Sales Experience Only

Complete Line Of
INDUCTION HEATING UNITS
For All Types of Industries
Now Ready For Marketing
By Well Known Manufacturer

Write or Wire:
(Please state territory covered and lines carried)

P.O. Box No. 255
Hawthorne, N. J.

NOW! AT AMAZINGLY LOW PRICES—

GLASS CAPACITORS

FLAT—ALL GLASS—WIRE LEADS

MIL-C-11272 A Types: CY-10-15-20 issued June 53. All have ±10% CAPACITY TOLERANCE.

These are all NEW, UNUSED. Tested and approved. Minimum Order—20 Capacitors (Any combination of values desired may be ordered).

Choose your own values.

<table>
<thead>
<tr>
<th>CY-10</th>
<th>19¢ each</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMF</td>
<td>MMF MMF</td>
</tr>
<tr>
<td>10</td>
<td>33 56</td>
</tr>
<tr>
<td>20</td>
<td>36 62</td>
</tr>
<tr>
<td>22</td>
<td>39 68</td>
</tr>
<tr>
<td>25</td>
<td>43 75</td>
</tr>
<tr>
<td>27</td>
<td>47 82</td>
</tr>
<tr>
<td>30</td>
<td>51 100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CY-15</th>
<th>24¢ each</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMF</td>
<td>MMF MMF</td>
</tr>
<tr>
<td>220</td>
<td>330 510</td>
</tr>
<tr>
<td>240</td>
<td>360 560</td>
</tr>
<tr>
<td>270</td>
<td>430 620</td>
</tr>
<tr>
<td>300</td>
<td>470 750</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CY-20</th>
<th>29¢ each</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMF</td>
<td>MMF MMF</td>
</tr>
<tr>
<td>1100</td>
<td>1600 2000</td>
</tr>
<tr>
<td>1300</td>
<td>1800 2200</td>
</tr>
</tbody>
</table>

FILM PRECISION RESISTORS

± 1% TOLERANCE—½ Watt

Plastic Sleeve. MIL-R-10509A. Mil Type: RN20X issued Sept. 52.

These are all NEW, UNUSED. Tested and approved. Minimum order—20 of a Value. (Any combination of values desired may be ordered).

<table>
<thead>
<tr>
<th>RN-20X</th>
<th>8¢ each</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHMS</td>
<td>OHMS OHMS OHMS</td>
</tr>
<tr>
<td>.36K</td>
<td>9.1K 47K 100K</td>
</tr>
<tr>
<td>1.0K</td>
<td>10K 51K 220K</td>
</tr>
<tr>
<td>1.5K</td>
<td>20K 56K 240K</td>
</tr>
<tr>
<td>2.2K</td>
<td>22K 62K 270K</td>
</tr>
<tr>
<td>2.4K</td>
<td>24K 68K 330K</td>
</tr>
<tr>
<td>2.7K</td>
<td>27K 82K 390K</td>
</tr>
<tr>
<td>3.6K</td>
<td>30K 91K 470K</td>
</tr>
<tr>
<td>4.3K</td>
<td>33K 110K 560K</td>
</tr>
<tr>
<td>5.1K</td>
<td>36K 120K 680K</td>
</tr>
<tr>
<td>6.8K</td>
<td>39K 130K 820K</td>
</tr>
<tr>
<td>8.2K</td>
<td>43K 1 MEG.</td>
</tr>
</tbody>
</table>

TERMS: Orders for less than $10.00 cash prepaid. For orders above $10.00, we will absorb shipping charges in return for prepayment; or shipped net 10 days to rated firms. F.O.B. our warehouse. IMMEDIATE DELIVERY will be made from stock. Write for quantity discounts!

DELECTO MFG. CORP.
128 Lafayette St., New York 13, N. Y.
Tel: Canal 6-7544. TWX: NY 1-3263

NOW! AT AMAZINGLY LOW PRICES—

CAPACITORS

FLAT—ALL GLASS—WIRE LEADS

MIL-C-11272 A Types: CY-10-15-20 issued June 53. All have ±10% CAPACITY TOLERANCE.

These are all NEW, UNUSED. Tested and approved. Minimum Order—20 Capacitors (Any combination of values desired may be ordered).

Choose your own values.

<table>
<thead>
<tr>
<th>CY-10</th>
<th>19¢ each</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMF</td>
<td>MMF MMF</td>
</tr>
<tr>
<td>10</td>
<td>33 56</td>
</tr>
<tr>
<td>20</td>
<td>36 62</td>
</tr>
<tr>
<td>22</td>
<td>39 68</td>
</tr>
<tr>
<td>25</td>
<td>43 75</td>
</tr>
<tr>
<td>27</td>
<td>47 82</td>
</tr>
<tr>
<td>30</td>
<td>51 100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CY-15</th>
<th>24¢ each</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMF</td>
<td>MMF MMF</td>
</tr>
<tr>
<td>220</td>
<td>330 510</td>
</tr>
<tr>
<td>240</td>
<td>360 560</td>
</tr>
<tr>
<td>270</td>
<td>430 620</td>
</tr>
<tr>
<td>300</td>
<td>470 750</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CY-20</th>
<th>29¢ each</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMF</td>
<td>MMF MMF</td>
</tr>
<tr>
<td>1100</td>
<td>1600 2000</td>
</tr>
<tr>
<td>1300</td>
<td>1800 2200</td>
</tr>
</tbody>
</table>

TERMS: Orders for less than $10.00 cash prepaid. For orders above $10.00, we will absorb shipping charges in return for prepayment; or shipped net 10 days to rated firms. F.O.B. our warehouse. IMMEDIATE DELIVERY will be made from stock. Write for quantity discounts!

DEFLECTO MFG. CORP.
128 Lafayette St., New York 13, N. Y.
Tel: Canal 6-7544. TWX: NY 1-3263

May 23, 1958 — ELECTRONICS engineering edition
TECHNICAL SYSTEMS CORP.

1201 43rd Ave., L. I. C., 1, N. Y.
RA 9-0652-3

AN/APN-2-CPM-2
Shoran Precision Navigation System. APN-2 uses two overlapping signal sets to provide a navigation accuracy of 0.5 to 30 ft. up to 250 miles. Widely used for surveying, oil prospeclng & mapping.

AN/APC-33-4
255-100 MC Airborne Transceivers providing 1,750 possible channels in its range. This is a basic equipment in present service. This set is compact and lightweight.

AN/AR-19
This is the Air Force One - Band Airborne Course in dicipating equipment. Operates in range of 100-135 MC 200 channels. MC version of Collins Commercial equipment. Input 21 V D.C.

AN/AP-10
X-Band Airborne Navigation and Search Radar. The APS has a search range of up to 50 miles in 4 ranges. This equipment utilizes a 27 T.T. Weight approx. 120 lbs. enabling it to be used in a light plane. Input 110v 600w.

ANTENNA PEDESTALS
We have Antenna Pedestals with a capacity of up to 5,000 lbs. Silica rings & data & take-off systems are included. Heavy construction & engineering make them ideal for experimental interior systems.

WRITE FOR OUR CATALOG

SALES ENGINEERS WANTED
For Chicago and Houston.

ENGINEERS • FEE PAID

ENGINEERS
Analog or digital computers, pulse, printed, transislor circuitry, microwave, UHF & VHF communications, radar, reliability, environment, components, servo, antenna, infra-red, systems, gyroscopic, standards, platform, propulsion, jet engines.

7,000 - 12,000

PROGRAMMERS—MATHEMATICIANS
Data processing, test trajectories, IBM 704, systems analysis, closed loop simulation tech, ballistic analysis, logic, servomech theory, coding & debugging systems.

7,000 - 10,000

ELECTRONICS SALES
EXCLUSIVE TERRITORIES for manufacturers' representatives (except New York & New England). An above average component line, several items without competition, selling to both manufacturers and distributors who use or deal in transistors. Write fully, listing all your experiences and experience.

TRANSPORT ELECTRONICS CO.
3357 Republic Avenue., Minneapolis 26, Minn.

ELECTRONIC ENGINEER PHD.
10 years business experience seeks supervisory position instrumentation industrial controls, systems engineering.

Fw-2600, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

SALES ENGINEERS WANTED
For Chicago and Houston.

ENGINEERS • FEE PAID

ENGINEERS
Analog or digital computers, pulse, printed, transistor circuitry, microwave, UHF & VHF communications, radar, reliability, environment, components, servo, antenna, infra-red, systems, gyroscopic, standards, platform, propulsion, jet engines.

7,000 - 12,000

PROGRAMMERS—MATHEMATICIANS
Data processing, test trajectories, IBM 704, systems analysis, closed loop simulation tech, ballistic analysis, logic, servomech theory, coding & debugging systems.

7,000 - 10,000

ELECTRONICS SALES
EXCLUSIVE TERRITORIES for manufacturers' representatives (except New York & New England). An above average component line, several items without competition, selling to both manufacturers and distributors who use or deal in transistors. Write fully, listing all your experiences and experience.

TRANSPORT ELECTRONICS CO.
3357 Republic Avenue., Minneapolis 26, Minn.

ELECTRONIC ENGINEER PHD.
10 years business experience seeks supervisory position instrumentation industrial controls, systems engineering.

Fw-2600, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

SALES ENGINEERS WANTED
For Chicago and Houston.

ENGINEERS • FEE PAID

ENGINEERS
Analog or digital computers, pulse, printed, transistor circuitry, microwave, UHF & VHF communications, radar, reliability, environment, components, servo, antenna, infra-red, systems, gyroscopic, standards, platform, propulsion, jet engines.

7,000 - 12,000

PROGRAMMERS—MATHEMATICIANS
Data processing, test trajectories, IBM 704, systems analysis, closed loop simulation tech, ballistic analysis, logic, servomech theory, coding & debugging systems.

7,000 - 10,000

ELECTRONICS SALES
EXCLUSIVE TERRITORIES for manufacturers' representatives (except New York & New England). An above average component line, several items without competition, selling to both manufacturers and distributors who use or deal in transistors. Write fully, listing all your experiences and experience.

TRANSPORT ELECTRONICS CO.
3357 Republic Avenue., Minneapolis 26, Minn.

ELECTRONIC ENGINEER PHD.
10 years business experience seeks supervisory position instrumentation industrial controls, systems engineering.

Fw-2600, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

SALES ENGINEERS WANTED
For Chicago and Houston.
new Microsecond Indicator

INDEX TO ADVERTISERS

AMP Inc. ........................................ 32
Ad-Yu Electronics Lab., Inc. .................. 167
Aircraft Armaments, Inc. ................. 139
Aircraft Radio Corporation .............. 10, 11
Airpax Products Co. ...................... 157
Allen-Bradley Co. ........................... 16A, 16B
American Lava Corporation ............ 55
American Ordnance Association ....... 133
American Rondo Corp. ................. 129
Amperex Electronic Corp. .............. 45
Amphenol Electronics Corp. .......... 113
Andrew Corporation ...................... 157
Anti-Corrosive Metal Products Co., Inc. 72
Art Wire & Stamping Co. ............... 148
Assembly Products Inc. ................. 165

Harden Corp., The ........................... 47
Hansch & Lamb Optical Co. ........... 133
Bell Telephone Laboratories ............ 17
Boeing Aviation Corp. .................... 132
Pacific Division ........................... 132
Eclipse-Pioneer Div. ...................... 151
Bird Electronic Corp. ..................... 129
Broksen Products Limited ............... 57
Bausmann Mfg. Co. ....................... 34
Cambridge Thermonic Corp. ............ 50
Ceto-Constantine Engineering Labs. Co. 97
Centralab, A Division of Gide-Union, Inc. 101
Chance Vought Aircraft Co. .......... 102, 103
Chester Cable Corp. ....................... 98
Cinch Mfg. Corp. ......................... 87
Clarkson Laboratories .................... 161
Continental-Diamond Fibre Div. of the Budd Company, Inc. 42
Control Electronics Sales Co., Inc. ... 153
Cornell-Dubilier Electric Corp. .......... 135
Cosmic Controller Corp. ............... 150
Coto-Cotl Co., Inc. ....................... 150
Carroll Universal Joint Co., Inc. .... 138
Cutler-Hammer ................................ 107

DA-YU ELECTRONICS LAB., INC., formerly ADVANCE
249 TERENCE AVE. • PASSAIC, N. J.

CIRCLE 128 READERS SERVICE CARD

Heavy Duty Miniature Relays

for Industrial Reliability

Special heavy duty contact arms and contacts switch 10 amperes (non-inductive) reliably in heavy duty service.

Contact combinations up to 4PDT for DC operation and DPDT for AC. Operating voltages to 230 V, DC and 440 V, 60 C. Resistance to shock, vibration and temperature change to meet military specifications.

Heavy duty contacts can also be furnished in combinations with normal or low level signal load contacts.

Available with plug-in mounting, also dust tight or hermetically sealed enclosure.

Class 22P 6PDT Relay

with 20-pin Plug.

Magnecraft Plug-in Relays

- Simplify wiring — may be plugged in after equipment is installed.
- Easily removed or replaced — no special skill or equipment required.
- Permit inspection, testing or adjustment with negligible down time.

Available for wide range of requirements. Tell us what you need or send for catalog.

MAGNECRAFT
Electric Company

33508 W. Grand, Chicago 51, Il.
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

WRITE TODAY

YOUR FUTURE IS OUR BUSINESS!

Emerson Electric Division
8100 W. Florissant Ave. • St. Louis 21, Mo.
NEW HEAVY CURRENT D. C. AMMETER

MODEL CHC

DIAMOND PIVOTED

ACCURACY 0.2%
SELF CONTAINED
Ranges: 1/5/10/20/50/100 Amperes
or 1.5/3/7.5/15/30/75 Amperes.
Type: Permanent Magnet.
Period: 1 Second.
Scale Length: 6.3" hand drawn mirrored scale.

Electrostatic and Magnetic Shielding. Ranges
switched by changing a single plug connection.

SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, N.Y. ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

CIRCLE 131 READERS SERVICE CARD

Perfect Soldering when

CLARCO CPC is used to
clean your printed circuits

CPC is a Fast, Efficient,
Cleaner, Copper Brightener

CPC is applied by brushing,
spraying or dipping
at room temperature.

CPC does not damage plastic
or copper circuit
components.

Send for complete information and samples.
The Clarkson Laboratories, Inc.
930 N. Darien St., Philadelphia 23, Pa.
Attention Distributors: we need representation
in some areas.

CIRCLE 132 READERS SERVICE CARD

WHY MAKE IT DIFFICULT
WHEN THERE'S AN EASY WAY
WITH SYSTRON
IN-LINE READOUT
In a SINGLE UNIT

In just one glance you have the answer —
and you get the answer in just one unit.
With Systron's single package IN-LINE
readout digital counter, there's no trans-
posing, no confusion, no second look. Large
1-inch IN-LINE digits are clearly readable
at distances up to 40 feet, overcoming
fatigue and error factors. One unit elim-
inates auxiliary boxes; increases accuracy
as well as speed.

Other Important SYSTRON Features:
- Magnetron Beam Switching Tubes
- Level or Remote Indication
- Adjustable Trigger Controls
- Drives Digital Recorder Directly

For complete specifications and
prices, please write

SYSTRON CORPORATION
950 GALINDO STREET • CONCORD, CALIFORNIA
REPRESENTATIVES IN PRINCIPAL CITIES

CIRCLE 138 READERS SERVICE CARD

CIRCLE 131 READERS SERVICE CARD

Sierra Electronic Corp. .................................. 28
Sorensen & Co., Inc. .................................. 5
Sperry Gyroscope Company, Division of
Sperry Rand Corp. .................................. 19, 27
Sprague Electric Co. .................................. 3
Stackpole Carbon Co. .................................. 152
Stevens Arnold, Inc. .................................. 150
Stoddart Aircraft Radio Co., Inc. ........... 144
Strawbridge-Carlson Company ............. 142
Superior Tube Co. .................................. 29
Swann Co., Inc. .................................. 116, 117
System Development Corp. .............. 132
Systron Corp. .................................. 164
Taylor Fiber Co. .................................. 97
Technology Instrument Corp. .............. 119
Tektronix, Inc. .................................. 22
Telrex Laboratories .................................. 139
Temco-Aircraft .................................. 4
Texas Instruments Incorporated ......... 93
Transistor Electronic Corp. .............. 51
Tri-Laboratories, Inc. ................. 119

United Transformer Co. .................. 2nd Cover

Varian Associates .................................. 9, 35
Vetter-Rout, Inc. .................................. 54

Vitramon .................................. 142

Westinghouse Electric Corp. ............ 116, 117
White Dental Mfg. Co., S. S. ............. 138

Professional Services .................................. 159

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 156-161
(Used or Surplus New)

For Sale .................................. 159-161

ADVERTISERS INDEX
Barry Electronics Co. .................. 161
Bennett Personnel Assoc. .............. 161
Bristol Co., The .................................. 161
Deflecto Manufacturing Corp. .......... 160

Engineering Associates .................. 161

General Electric Co. .................. 157
International Business Machines Corp. 156
Ramo-Weedridge Corp., The ............. 160
R. W. Electronics .................................. 159
Sylvania Electric Products Inc. ....... 159
Technical Systems Corp. ............... 161
Telephone Engineering Corp. ......... 159
Transistor Electronics Co. ............. 161
Texas Instruments Incorporated .......... 158

Universal Relay Corp. .................. 161
(Formerly Universal General Corp.)

This index is published as a service. Every care is taken
to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omission.
WHERE DEPENDABILITY IS VITAL

DAVEN

ROTARY SWITCHES

ARE SPECIFIED

Here's why: Positive solutions to critical rotary switch requirements can be found within the thousands of combinations of poles, positions and decks available from DAVEN's complete line of precision rotary switches.

- Patented knee-action rotor—ensures low and uniform contact resistance. It also provides tamper-proof and trouble-free operation over the life of the switch.

- One-piece combination contact and solder lug—solid-silver alloy contacts, gold plated to resist corrosion.

- Turret-type solder lugs for excellent mechanical and electrical connections.

- Roller-type detent gives positive indexing action.

- As many as Eight poles available on each deck—where minimum space is a factor.

Write for complete data, catalog and engineering information.

TODAY, MORE THAN EVER, THE DAVEN® STANDS FOR DEPENDABILITY!
Generate the full excitement of High-Fidelity!

Specify the new RCA-7027 for your amplifier designs

Stronger and stronger grow the chords, the fervent expression of the artist—yet the sound is sweet, most pleasing to the listener's ear. The Concert Grand makes stringent demands upon high-fidelity amplifiers for high power and low distortion. Can your designs meet these demands? They can if you "design around" the RCA-7027! RCA-7027 is a glass-octal type beam power tube. Two 7027's in Class AB, push-pull service with 450 volts on the plate can handle up to 50 watts of audio power with only 1.5 percent distortion. Structural features contributing to the exceptionally high plate dissipation (25 watts) of this compact tube are: button-stem construction, heavy stem leads having high heat conductivity, heavy plate material, radiating fins on control grid, and double base-pin connections for both control grid and screen grid.

Achieve for your hi-fi designs the advantages of high dissipation, exceptionally low distortion, and high power amplification offered by the new RCA-7027. Ask your RCA Field Representative for further details. For technical data, write RCA Commercial Engineering, Section E-19-Q-4, Harrison, N. J.