Liquid-State Diodes

Worldwide Air Navigation-Aid Debate
TO MAKE YOUR EQUIPMENT SMALLER YET MORE RELIABLE

REVOLUTIONARY TRANSISTOR TRANSFORMERS, HERMETIC TO MIL-T-27A

Conventional miniaturized transistor transformers have inherently poor electrical characteristics, perform with insufficient reliability and are woefully inadequate for many applications. The radical design of the new UTC DO-T and DI-T transistor transformers provides unprecedented power handling capacity and reliability, coupled with extremely small size.

TYPICAL DO-T PERFORMANCE CURVES

Power curves based on setting output power at 1 KC, then maintaining same input level over frequency range.

DO-T unite has been designed for transistor application only... not for vacuum tube service. Patents Pending.

DO-T

High Power Rating... up to 100 times greater.
Excellent Response... twice as good.
Low Distortion... reduced 80%.
High Efficiency... up to 30% better.
Moisture Proof... hermetic to MIL-T-27A.
Rugged... completely cased.

To fully appreciate DO-T transistor transformers, the curves indicate their performance compared to that of similar size units now on the market. DI-T transformers are still smaller in size. Power rating and other characteristics are identical to DO-T, but low frequency response (3 db down point) is 30% higher in frequency.

Units are available for different impedances than those shown, keeping in mind that impedance ratio is constant. Lower source impedance will improve response and level ratings... higher source will reduce them. Units to be used reversed, input to secondary.

DI-T

MORE RELIABLE

UNITED TRANSFORMER CORP.
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"
Issue at a Glance

BUSINESS

Debate Worldwide Air Nav-Aid. Two camps air views in Montreal.

SAC Buys Automated Control. Details on new electronic system.

Off-Hours Medical Electronics. Telephone engineers make devices.

“Automatic Design” Nearer. MIT discloses its latest achievement.

Shoptalk Over The Counter.

Electronics Newsletter Market Research.

Washington Outlook Current Figures.

Financial Roundup Meetings Ahead.

ENGINEERING

Soliton Integrators. Grouped around three completed soliton integrators are electrode subassemblies and integrator units in various stages of production. See p 53. CURRENT FIGURES

Current Integration with Soliton Liquid Diodes. Units integrate fluid flows and electric currents.

Slot Antenna Array for Missiles and Aircraft. Linearly polarized radiator is converted to circularly polarized.

Carcinotron Harmonics Boost Receiver Range. Superheterodyne receiver covers 30 mc to 75 kmc continuously.

Two-Terminal Solid-State Switches. Tabulation of all commercially available solid-state switching diodes.

Amplitude Slicer for Signal Analysis. Simplified circuit for probability amplitude density studies.

Inexpensive Sound for Television Receivers. Using inexpensive components offers advantages over ratio detector.

Powder Permanent Magnets. Table rounds up salient properties of pressed and sintered magnets.

Transistors Provide Computer Clock Signals. Clock system for designing and testing large digital computers.

Diode-Compressor Data. Graphs enable basic diode-compressor circuit design.

DEPARTMENTS

Research and Development. Data Unit Transmits Over Phone Lines.


Production Techniques. Barrel Finishing Delicate Parts.


Literature of the Week. Comment.

Plants and People. Index to Advertisers.
Supplies available from:
In the U.S.A. International Electronics Corporation, Dept. E2, 81 Spring Street, N.Y.12, New York, U.S.A.
In Canada, Rogers Electronic Tubes & Components, Dept. IN, 116 Vanderhoof Avenue, Toronto 17, Ontario, Canada.

“Mullard” is the Trade Mark of Mullard Limited and is registered in most of the principal countries of the world.

MULLARD OVERSEAS LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND A16V 9J
Burnell Adjustoroids® are always new because they are always being designed for newer and broader electronic and mechanical applications.

**NEW** Burnell's complete line of encapsulated Adjustoroids are particularly adaptable to printed circuit use.

**NEW** A screw mount PC type Adjustoroid for greater durability in high acceleration, shock and vibration environments.

**NEW** 'Pot' mounting Adjustoroids for panel mounting and knob adjustment wherever slotted controls are difficult to reach.

**NEW** Continuous internal improvements including adjustment range, Q, size, etc. Burnell Adjustoroid engineers are constantly seeking solutions to space, accessibility and performance problems.

Burnell Adjustoroids and sub-miniature Adjustoroids are supplied hermetically sealed to meet government specifications MIL-E-15305A or encapsulated in many sizes and shapes to meet the application. If your Adjustoroid needs can't be met from our stock catalogue, we'll be glad to manufacture to your specifications. Additional information, write for Adjustoroid bulletin.

### Length/Max L
<table>
<thead>
<tr>
<th>Type</th>
<th>Dia</th>
<th>Width</th>
<th>Hot.</th>
<th>Wt.</th>
<th>Useful Freq. Range</th>
<th>Max Q</th>
<th>Max E in hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT-10</td>
<td>1/4&quot;</td>
<td>1&quot;</td>
<td></td>
<td>2 oz</td>
<td>1 kc to 20 kc</td>
<td>10 kc</td>
<td>.3 hrs</td>
</tr>
<tr>
<td>AT-1</td>
<td>1/2&quot;</td>
<td>1 1/4</td>
<td>.75</td>
<td>2 oz</td>
<td>2 kc to 10 kc</td>
<td>10 kc</td>
<td>.15 hrs</td>
</tr>
<tr>
<td>AT-2</td>
<td>2/3&quot;</td>
<td>2 1/2</td>
<td>.75</td>
<td>1 oz</td>
<td>Below 2.5 kc</td>
<td>2.5 kc</td>
<td>.125 hrs</td>
</tr>
<tr>
<td>AT-4</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>1 kc to 16 kc</td>
<td>16 kc</td>
<td>.6 hrs</td>
</tr>
<tr>
<td>AT-6</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>10 kc to 100 kc</td>
<td>100 kc</td>
<td>.75 hrs</td>
</tr>
<tr>
<td>AT-10</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>3 kc to 50 kc</td>
<td>50 kc</td>
<td>.20 hrs</td>
</tr>
<tr>
<td>AT-11</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>2 kc to 25 kc</td>
<td>25 kc</td>
<td>.15 hrs</td>
</tr>
<tr>
<td>AT-12</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>15 kc to 150 kc</td>
<td>150 kc</td>
<td>.60 hrs</td>
</tr>
<tr>
<td>AT-15</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>Below 2.5 kc</td>
<td>2.5 kc</td>
<td>.125 hrs</td>
</tr>
<tr>
<td>AF-51</td>
<td>1 1/4&quot;</td>
<td>2&quot;</td>
<td></td>
<td>5 oz</td>
<td>30 cps to 500 cps</td>
<td>500 cps</td>
<td>1000 hrs</td>
</tr>
<tr>
<td>AF-52</td>
<td>1 1/4&quot;</td>
<td>2&quot;</td>
<td></td>
<td>5 oz</td>
<td>50 cps to 1000 cps</td>
<td>1000 cps</td>
<td>1000 hrs</td>
</tr>
<tr>
<td>AF-87</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>90 cps to 2 kc</td>
<td>2 kc</td>
<td>400 hrs</td>
</tr>
<tr>
<td>AF-88</td>
<td>1 1/4&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>.16 kc to 4 kc</td>
<td>4 kc</td>
<td>800 hrs</td>
</tr>
<tr>
<td>ATE-11</td>
<td>1/2&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>2 kc to 25 kc</td>
<td>25 kc</td>
<td>.15 hrs</td>
</tr>
<tr>
<td>ATE-12</td>
<td>1/2&quot;</td>
<td>1 1/4&quot;</td>
<td>1 oz</td>
<td>1 oz</td>
<td>15 kc to 150 kc</td>
<td>150 kc</td>
<td>.60 hrs</td>
</tr>
</tbody>
</table>

*Special "pot" type sub-miniature Adjustoroids are not available with AT-11, AT-12, AF-87, AF-88.

*Special screw mountings are available with the ATE-11 and ATE-12 in printed circuit applications for "plug in" types. Where vibration and shock are significant considerations, mounting screws serve as terminal connections.

*Trade Name Pat. #2,762,020
SHOPTALK . . .

JET-AGE NAVIGATION. Electronics is the principal means by which jet-age air traffic will be controlled. And an important part—technically, and to this industry, economically—of the control will be in short-range navigation aids.

International Civil Aviation Organization, which settled on VOR in 1949 as standard, is up to its eyes in a hot argument about whether to keep VOR and improve it, or junk it for another system.

The argument erupted in an open technical meeting of ICAO in Montreal earlier this month. Associate Editor Leary had the background ready, and Montreal correspondent Mike Gutwillig shot a story under the wire on the shape of the argument in time to make this issue. The story begins on p 30.

OFF-HOURS LIFESAVING. Forty engineers of the Illinois Bell Telephone Co. have found a way to spend their off hours, and it beats watching TV or even bowling.

They are working with doctors at the University of Chicago to develop new electronic equipment for medical diagnosis. Results so far: portable heartbeat analyzer, cytodiagnostic trainer, electronic calorimeter and an electronic stethoscope.

The group's name is an acronym: SAVE—Service Activities of Volunteer Engineers. There is so much electronics can do to save human life—and so much that remains to be done.

See Midwestern Editor Harris' story on p 38.

Coming In Our March 6 Issue . . .

METAL FORMING. Exotic alloys frequently can be worked only within narrow bands of tension and stress. According to G. J. Crowdes, chief engineer of Assembly Products, Inc., in Chesterland, O., electronic control helps form such metals with a high degree of precision.

Crowdes describes a control which receives signals from a strain gage and elongation detector and determines the yield point of the metal being formed. Control automatically adjusts tension to form metal without fracture.

NEUTRON FLIGHT. Measurements of velocities of neutrons and other atomic particles are of great significance in nuclear research. Techniques capable of time measurements in the order of millimicroseconds are required.

H. W. Lefevre and J. T. Russell of GE's Hanford Labs in Richland, Wash., have developed a high-resolution time-interval analyzer for multichannel time measurements. Resolution of the device, known as a vernier chronotron, is better than one millimicrosecond.

SPEEDERS BEWARE. Doppler radar is currently being applied by police in monitoring the speed of motor vehicles. J. R. Barker, research director of Automatic Signal Div., Eastern Industries, Inc., in Norwalk, Conn., describes a portable transmitter-receiver unit powered by a vehicular battery system or 110 v a-c. Provisions are made for differentiating between slow and fast-moving vehicles.

PROGRAMMED INSERTER. With the development of printed circuit assemblies, the use of automatic machinery is becoming more common in our industry for the insertion of components on printed circuit boards. Special problems still arise, however, in cases where there are only small production runs involved.

With these problems in mind, IBM's S. B. Korin and F. L. Spencer have developed an automatic assembly machine with great flexibility programmed by a modified tape reader.
Sprague's new FABMIKA Capacitors can really handle the HOT ones! ... jet ignition, missile controls, atomic reactors ... any high voltage d-c power supply where high temperature, small size, and light weight are important ... especially where components are immersed in a dielectric fluid.

Sprague's new FABMIKA Capacitors rely on a specially processed dielectric for their heat resistant properties. Developed through three years of research and manufacturing, this dielectric consists of silicone-bonded mica paper which can function effectively in temperatures up to 260°C and, in special designs, up to 310°C. There's a choice of four standard temperature ranges: from −55°C to +125°C, +165°C, +200°C, and +260°C.

<table>
<thead>
<tr>
<th>Temp. °C</th>
<th>MΩ X μF</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>300 (min.)</td>
</tr>
<tr>
<td>165</td>
<td>100 (min.)</td>
</tr>
<tr>
<td>250</td>
<td>50 (min.)</td>
</tr>
<tr>
<td>260</td>
<td>10 (min.)</td>
</tr>
</tbody>
</table>

Maximum Dissipation Factor: .15% at 400 cy. 25°C.

- Radiation resistance is another outstanding characteristic of FABMIKA Capacitors. They have been application tested in reactors under high dosage rates without harmful loss of capacitance.
- Another important application is 400 cycle a-c power supplies where their low dissipation factor results in small capacitors with minimum rise in temperature under operating conditions.
- Miniature, high-reliability pulse forming networks are still another well tested application.
- FABMIKA Capacitors are available in four constructions: uncased (up to 200°C), uncased and clamped (up to 260°C), cast epoxy housing (up to 200°C), and drawn metal case (up to 260°C standard and 310°C special).
How can you prove your guarantee unless your product can COUNT?

When customers come after you with claims concerning your product's performance, can you prove your position? You can, to everyone's satisfaction, if Veeder-Root Counters are built into your product as standard, integral parts. For then your customers have Facts-in-Figures on actual performance on the job, figures that settle arguments fairly and squarely . . . in fact, often prevent misunderstandings in the first place. What's more, when you build-in V-R Counters, you build up your product's sales appeal . . . as many manufacturers have found to their profit. So can you. Write and find out how.

You always "Know the score" when you count on Veeder-Root!

NEW Panel-Mounted, High Speed Electro-Magnetic Counter
Series 1591 Counters are ideal for DC applications requiring accuracy and long life at very high speeds. 4 or 6 figures. Instant pushbutton reset or remote electrical reset.

Electrical Contactor
Assures positive actuation of 1591 Counters. Drive by lever or forked coupling.

Veeder-Root Inc.
Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities
Enclosures for portable or fixed use.

Tandem Assemblies in all three sizes of Ohmite Variable Transformers

### RHEOSTAT-TRANSFORMER TANDEM ASSEMBLIES

Exclusive with Ohmite

**Tandem Assemblies in all three sizes of Ohmite Variable Transformers**

- **VT2**
- **VT2N**
- **VT4**
- **VT4N**
- **VT8**
- **VT8N**

### Variable Transformers

**Give a "Bonus" in Current Capacity**

**OHMITE®**

**VT.**

**Variable Transformers**

EXPANDED LINE—Ohmite now offers industry six basic models with current ratings sufficient to meet a large percentage of industrial applications. The new line includes enclosed units and tandem assemblies. Two models, VT2 and VT4, offer capacity greater than competitive units of comparable size and price. An additional and sizeable "bonus" in current is given in all sizes when the overvoltage feature is not required ("N" suffix, see below).

ADVANCED FEATURES—Positive current transfer achieved with direct brush-to-slip-ring, pig-tailed connection; table or panel mounting—on VT4 and VT8 sizes, adjustable shaft moves to brush or base side; interchangeable with other popular types both electrically and "mounting-wise"; durable rhodium plating on brush track for longer life.

SPECIAL: ENGINEERED FOR YOUR NEEDS—Transformers can be modified to meet different requirements such as special shafts for nonstandard panel thicknesses, auxiliary switches, taps on transformer winding for fixed intermediate voltages, and motor drives for remote control or servo-operation. The only manufacturer in the industry concurrently producing power rheostats, tap switches, and variable transformers, OHMITE can also offer in-tandem combinations of these items.

### BASIC MODELS (with overvoltage) All inputs 120 v ac*

<table>
<thead>
<tr>
<th>MODEL</th>
<th>VT2</th>
<th>VT4</th>
<th>VT8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts output:</td>
<td>0-120/132</td>
<td>0-120/140</td>
<td>0-120/140</td>
</tr>
<tr>
<td>Amps output:</td>
<td>1.5</td>
<td>3.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

### BASIC MODELS (without overvoltage) All inputs 120 v ac*

<table>
<thead>
<tr>
<th>MODEL</th>
<th>VT2N</th>
<th>VT4N</th>
<th>VT8N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts output:</td>
<td>0-120</td>
<td>0-120</td>
<td>0-120</td>
</tr>
<tr>
<td>Amps output:</td>
<td>1.8</td>
<td>4.75</td>
<td>10.0</td>
</tr>
</tbody>
</table>

*Units available for 240-volt input also

**OHMITE®**

**QUALITY Components**

OHMITE MANUFACTURING COMPANY | 3610 Howard Street
Skokie, Illinois

RHEOSTATS RESISTORS RELAYS TAP SWITCHES R.F. CHOKES DIODES

**VARIABLE TRANSFORMERS TANTALUM CAPACITORS**

Available from Ohmite Distributors or direct from factory

Electronics—February 27, 1959

Write for Bulletin 151

CIRCLE 5 READERS SERVICE CARD
Measure impedance and other system characteristics,

500 MC to 40 KMC

hp 809B and 814B
UNIVERSAL PROBE CARRIAGES

- Coverage 3 to 40 KMC
- Sections interchange in 30 seconds
- Dial gauge accuracy, highest stability

Models 809B and 814B are rugged, precision Universal Probe Carriages designed for use, respectively, with 810B and 815B waveguide slotted sections. The 809B/810B combination covers frequencies 3.95 to 18.0 KMC, and the 814B/815B combination covers frequencies 18.0 to 40.0 KMC. For waveguide measurements involving several bands, the cost of a special probe and carriage assembly for each band is eliminated and much engineering time is saved since waveguide sections can be changed in 30 seconds. Model 809B has a vernier scale reading to 0.1 mm and can be fitted with a dial gauge for greater accuracy. Model 814B is equipped with a dial indicator reading to 0.01 mm.

Specifications

809B Universal Probe Carriage
- Carriage: Mounts 810B Slotted Sections and 806B Coaxial Slotted Section (not shown: 3 to 12 KMC, 50 ohms impedance, Type N connectors).
- Probe Required: 442B Broadband Probe plus 440A Detector or 444A Untuned Probe.
- Probe Travel: 10 centimeters.
- Accuracy: With waveguide sections, 1.02 SWR easily read. Slope error eliminated by adjustment.
- Price: $160.00

814B Universal Probe Carriage
- Carriage: Mounts 815B Slotted Sections.
- Probe Required: 446B Untuned Probe.
- Accuracy: SWR of 1.02 easily read.
- Price: $200.00

WORLD'S MOST COMPLETE LINE OF PRECISION,
quickly, accurately, with these low cost, precision instruments!

**810B Waveguide Slotted Sections—**
3.95 to 18.0 KMC.

These accurately machined sections of waveguide have a small, tapered, longitudinal slot, and fit the 809B Universal Probe Carriage in a precisely indexed position. A traveling probe mounted on the carriage samples the electric field along the slot, and permits precise plotting of variations. Slot reflection is less than 1.01 SWR. For prices, list of 810B waveguides available, see Table 1 below.

**S810A Waveguide Slotted Section—**
2.6 to 3.95 KMC.

This instrument is a conventional slotted waveguide complete with a probe carriage mounted directly on the section. It is available in the S-band only and will operate with 412B or 414A probes. SWR less than 1.01. $450.00.

**815B Waveguide Slotted Sections—**
18.0 to 40.0 KMC.

Available in K and R band sizes, these waveguide slotted sections are similar to 810B sections and, like 810B units, are accurately machined from precision castings to insure a uniform cross-section. Prices and details below.

**805A/805B Coaxial Slotted Lines—**
500 MC to 4 KMC.

For SWR, wavelength, impedance and system flatness measurements in coaxial systems. Exclusive parallel-plane design for higher accuracy, stability. Negligible slope, SWR less than 1.04, reads in cm and mm to 0.1 mm. **805A**, for 50 ohm lines, Type N connectors, $450.00. **805B**, for 46.3 ohm lines, UG-45/U male and UG-46/U female connectors, $450.00.

---

**Table 1—** 810B/815B Slotted Sections.

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range KMC</th>
<th>Fits Waveguide Size (in.)</th>
<th>Overall Length (in.)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>G810B</td>
<td>3.95 - 5.85</td>
<td>2 x 1</td>
<td>10/4</td>
<td>$110.00</td>
</tr>
<tr>
<td>J810B</td>
<td>5.20 - 8.20</td>
<td>1 1/2 x 3/4</td>
<td>10/4</td>
<td>110.00</td>
</tr>
<tr>
<td>H810B</td>
<td>7.05 - 10.0</td>
<td>1 1/4 x 7/8</td>
<td>10/4</td>
<td>110.00</td>
</tr>
<tr>
<td>X810B</td>
<td>8.20 - 12.4</td>
<td>1 x 5/8</td>
<td>10/4</td>
<td>90.00</td>
</tr>
<tr>
<td>P810B</td>
<td>12.4 - 18.0</td>
<td>0.702 x 0.391</td>
<td>10/4</td>
<td>110.00</td>
</tr>
<tr>
<td>K815B</td>
<td>18.0 - 25.5</td>
<td>0.500 x 0.250</td>
<td>4 1/2</td>
<td>265.00</td>
</tr>
<tr>
<td>R815B</td>
<td>26.5 - 40.0</td>
<td>0.360 x 0.220</td>
<td>4 1/2</td>
<td>265.00</td>
</tr>
</tbody>
</table>

---

HEWLETT-PACKARD COMPANY
5427A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A. • CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

HIGH VALUE MICROWAVE MEASURING EQUIPMENT

ELECTRONICS – February 27, 1959

CIRCLE 7 READER'S SERVICE CARD
Design better products with

SILICONE-GLASS LAMINATES

... low loss factor, high moisture resistance

ITT Laboratories use a silicone-glass laminate as the main coil form in their AN/SRT-14, 15, 16 radio transmitting set. Laminate is tubular, 5.62" dia., wound with .064" silver wire. Primary reason for specifying silicone-glass: low loss factor at high frequencies.

TYPICAL PROPERTIES OF SILICONE GLASS-LAMINATES

<table>
<thead>
<tr>
<th>Property</th>
<th>Condition A</th>
<th>Condition D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength, psi</td>
<td>24,000</td>
<td>1,368</td>
</tr>
<tr>
<td>at 25°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 260°C after 100 hr at 260°C</td>
<td>4,600</td>
<td></td>
</tr>
<tr>
<td>Water Absorption, percent</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Electrical Strength, volts mil</td>
<td>310</td>
<td>204</td>
</tr>
<tr>
<td>initial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>after 200 hr at 260°C</td>
<td>327</td>
<td></td>
</tr>
<tr>
<td>after 5000 hr at 260°C</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Dielectric Constant at 10⁶ cycles</td>
<td>3.67</td>
<td>3.68</td>
</tr>
<tr>
<td>Condition A¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition D²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissipation Factor at 10⁴ cycles</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Condition A¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition D²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As measured on samples 1.8 inch thick.
1 As received.
2 After 24 hr immersion in water at 23°C.

Laminates made with glass or asbestos cloth and Dow Corning silicone resins make excellent dielectric materials. These strong, lightweight laminates maintain their properties at continuous operating temperatures of 250°C... for short periods will withstand greater heat. Silicone-glass laminates have good mechanical strength in addition to low loss factor, low water absorption, superior resistance to arcing, corona, corrosive atmospheres and contaminants. They can be laminated in very thin sections; have fine machinability. Supplied as tubes, sheets, punched or molded shapes by leading laminators. Write for free booklet.

VISIT BOOTHS 4308-4310 AT THE IRE SHOW

Dow Corning CORPORATION
MIDLAND, MICHIGAN

February 27, 1959 — ELECTRONICS
Dow Corning Silicone Dielectrics

SILICONE COMPOUNDS
SEAL OUT MOISTURE

Highly effective as dielectrics, Dow Corning compounds are easy to apply. They provide protection against arcs, grounds, shorts ... improve surface resistivity. These silicone compounds retain their properties from —75 to 200°C. Employed as filling, potting, or coating materials for various types of electronic gear, they seal out moisture, increase reliability, retain their initial grease-like consistency.

CIRCLE 104 READERS SERVICE CARD

WIRE COVERING OF SILASTIC
INSULATES FROM —90 to 250°C

Here is a resilient dielectric that keeps its properties from —90 to 250°C. Silastic®, the Dow Corning silicone rubber, forms a durable, moisture resistant coating for wire, cable, and other electronic and electrical components. It resists arcing, corona, ozone, weathering, corrosive atmospheres, and many fuels and solvents. Meets MIL-W-8777 specifications. Available from leading wire manufacturers.

CIRCLE 105 READERS SERVICE CARD

SILICONE VARNISH MAKES
IMPROVED RESISTOR CEMENT

Heat-stable and exceptionally moisture-resistant, Dow Corning varnishes make very good bonding cements. In addition, they can take fairly high loadings of inorganic fillers without loss of properties. An appropriately filled Dow Corning varnish is often far superior to conventional materials for sealing wire wound resistors and other electronic devices. Set-up time is good.

CIRCLE 106 READERS SERVICE CARD

For further information on these products write Dept. 488

ELECTRONICS—February 27, 1959
The Westinghouse hermetically sealed, Polyclad Hipermag core is the newest development in cores for magnetic amplifier applications. Applied over a new specially designed aluminum box housing the core, Polyclad insulation hermetically seals the core and allows encapsulating, casting or impregnating without altering magnetic properties. This special core:

- Stops magnetic amplifier rejects caused by changed magnetic values.
- Is suitable for all environmental conditions—high temperatures, humidity and high-voltage stress.
- Eliminates costly core taping.
- Is tested by Roberts constant-current, flux reset technique, or to your specification.

Available in production lots with normal delivery, these cores are supplied in special sizes or in standard AIEE sizes. For more information about these or other Hipermag or Hipersil cores, call your Westinghouse representative or write Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pennsylvania.

You can be sure...if it's Westinghouse

WASHINGTON OUTLOOK

IN ITS PRIME CONTRACT AWARD to ITT and RCA for design and development of the 480L communications support system—to update and broaden Air Force worldwide communications—the Air Force has clamped unprecedented restrictions on the contractors.

The restrictions are the Pentagon's response to criticism of the weapon system management concept.

The Air Force has placed certain limitations on other system contractors in the past. But the 480L restrictions on ITT and RCA are more comprehensive and specific, and are a tip-off of restrictions to be placed on future weapon or electronic system prime contractors.

The contractors are prevented from designing or engineering the communications system so as to "accrue an advantage in subsequent procurement" over other electronics firms. They are directed to compete "where feasible" with other companies for production of components.

As to new business the 480L project may generate, the two firms are limited to a level that is "reasonably related" to the volume of Air Force contracts the companies have had in "prior years."

The 480L project is starting out on a small scale. Only $3 million has been allocated to ITT (senior contractor), to RCA (associate contractor), and to Hughes Aircraft and Hoffman Electronics (subcontractors).

The project is geared to expand and modernize the Air Force's present $491-million worldwide communications system. Pentagon strategists consider the system inadequate for future military requirements—in terms of reliability, capacity, security, compatibility with other military and commercial systems, and capabilities in data, graphics, and voice transmissions.

- A reorganization of the Navy Dept. is in the works. It's likely to change the service's system of buying electronic and other defense hardware. The reorganization is being proposed by a top-level committee of officials headed by Under Secy. William B. Franke, who's slated to become Secy. of the Navy in June.

Detailed recommendations were originally due Jan. 1. Pentagon insiders expect the report to propose a major overhaul of the Navy's traditional system of bureau organization. The bureaus—Aeronautics, Ordnance, Yards and Docks, Ships, and others—now have more autonomy than subordinate agencies in the two other services.

Each bureau is an important electronics buyer. In addition, the Office of Naval Research, which under the present system rates lower in the Navy's hierarchy, also supports a considerable volume of electronic research.

The reorganization is expected to elevate the Navy's research organization and to centralize electronic procurement responsibilities—putting the Navy's administrative operations into a more updated and streamlined appearance.

- Army officials are seething over the Defense Dept.'s recent cancellation of Sylvania Electric's Plato antimissile system. The project was recently taken out of the Army's hands and placed under control of the Advanced Research Projects Agency. ARPA failed to include funds for the project in its latest budget.

The project, using the Nike-Zeus missile, was to be a field defense against tactical ballistic missiles. The Army praises Sylvania's "very substantial contribution to the state-of-the-art" in ballistic missile defense—notably in the field of acquisition radar.
New TI High Frequency Diffused-Base Germanium Transistors

Guaranteed current gains of 12, 10 and 8 dB minimum at 100 mc with new TI 2N1141, 2N1142 and 2N1143 diffused-base germanium transistors! Alpha cutoff ratings up to 750 mc coupled with 750 mW power dissipation at 25°C case temperature make these newest TI transistors ideal for military high frequency power oscillators and amplifiers where assured reliability and performance are of primary importance.

All units are 100% production stabilized at temperatures well above their 100°C rated junction operating point . . . exceed MIL-T-19500A specifications . . . and are in stock now.

Contact your nearest TI sales office or nearby TI distributor today . . . for immediate delivery.

absolute maximum ratings @ 25°C case temperature

<table>
<thead>
<tr>
<th>Device</th>
<th>2N1141</th>
<th>2N1142</th>
<th>2N1143</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Voltage Referred to Base</td>
<td>-35</td>
<td>-30</td>
<td>-25</td>
</tr>
<tr>
<td>Emitter Voltage Referred to Base</td>
<td>-1</td>
<td>-0.7</td>
<td>-0.5</td>
</tr>
<tr>
<td>Collector Current</td>
<td>-100</td>
<td>-100</td>
<td>-100</td>
</tr>
<tr>
<td>Emitter Current</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Device Dissipation (infinite heat sink)</td>
<td>750</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Collector Junction Temperature</td>
<td>+100</td>
<td>+100</td>
<td>+100</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>-65 to +100</td>
<td>+100</td>
<td></td>
</tr>
<tr>
<td>Thermal Resistance Junction to Mounting Base</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

typical characteristics @ 25°C case temperature

- Frequency Cutoff (Common Base) | 750 | 600 | 480 MC
- Collector Reverse Current, VCE = -15V, IC = 0 | 1 | 1 | 1 µA
- Saturation Voltage, IS = 70mV, IC = 17.5mA | 2 | 1 | 1 µA
- Small Signal Short Circuit Forward Current Transfer Ratio, VCE = -10V, IC = -20mA, f = 1000cps | 0.97 | 0.97 | 0.97
Grant Slides have been the pattern for all slide designs. While Grant is flattered, it is important to point out to designers and engineers that Grant research, design and sales engineering have been and are the factors that place the nation's leading industrial manufacturers on our list of customers. If you require imaginative assistance in determining the proper slide for your equipment—or, if you'd simply like to discuss the possibilities for slides in your units, Grant sales engineers are at your service—as they have been ever since the first industrial slide (a Grant slide!) was marketed.

The nation's first and leading manufacturer of slides

**GRANT INDUSTRIAL SLIDES**

GRANT PULLEY AND HARDWARE CORPORATION / 23 High Street, West Nyack, New York 944 Long Beach Avenue, Los Angeles 21, Cal.
Announcing the Sylvania SARONG CATHODE

A NEW ERA IMPROVEMENT IN THE HEART OF THE ELECTRON TUBE
Sylvania Sarong Cathodes pave the way to new performance standards for present and future tube types

Out of the advanced research laboratories of Sylvania's Electron Tube Division comes a revolutionary innovation in cathode coating. Sylvania Sarong. Sylvania scientists and engineers have succeeded in transforming conventional cathode coating into a thin uniform film that is precision-wrapped and securely bonded around each cathode sleeve.

Now in use in nearly one million Sylvania tubes, it is already contributing to a new efficiency in electron tube performance. It promises to open the way to new tube designs that will outperform many of today's advanced devices. First tubes to incorporate the Sarong Cathode are a number of Sylvania Tuner Types.

New Cathode Uniformity
Sylvania Sarong insures that every cathode will be coated uniformly and precisely because its thickness, texture, length and weight are pre-controlled before application. The thickness of Sylvania Sarong coating is held to tolerances five times closer than conventional sprayed coatings. This new superiority in coating uniformity has already contributed to a reduction in cathode-grid shorts and intermittent short circuits.

Reduced Noise
The uniformity of Sylvania Sarong coating makes it possible to obtain an over-all uniformity in spacing between cathode and grid never before achieved in mass produced electron tubes.

Preliminary tests indicate that this results in an improved noise figure of up to 0.6 db for TV. It also contributes to more uniform and higher levels of

Here are some of the ways Sarong

1. Uniform coating thickness of Sylvania Sarong Cathode means more uniform plate current, higher and more uniform levels of Gm and reduced noise

2. Sharp even edge and greater uniformity of Sarong coating virtually eliminates the possibility of end-leakage and contributes to better cut-off
improvement in the heart of the electron tube

Photomicrograph comparison of a conventional cathode, left, and Sylvania’s Sarong Cathode in operation shows its superior coating uniformity contributing to better emission and more uniform heat distribution.

Gm and also to a more uniform plate current. Because Sarong coating can be held to much closer tolerances, new tube designs incorporating more closely spaced elements become possible . . . opening the way to standards of tube performance never before achieved.

More Uniform Emission
The even distribution and smooth texture of Sylvania Sarong assures a new uniformity in cathode emission. The possibility of hot spots is virtually eliminated. Preliminary tests have already shown that Sarong Cathodes have pulse emission characteristics some 100% greater than conventional cathodes. Interface impedance due to poor coating adherence has also been improved, promoting better electron flow.

Better Cut-Off
Because Sylvania Sarong results in a more uniform surface and a more clearly defined coating, sharper cut-off characteristics and better control are achieved. The Sarong coating also eliminates the possibility of coating particles adhering inside the cathode sleeve.

Improved Temperature Distribution
All of the physical properties of Sylvania Sarong coating contribute to a new uniformity in cathode temperature. This contributes to noise reduction and better over-all performance throughout life. It enables the tube to tolerate a wider range of operating conditions, such as varying heater voltages, without great changes in emission.

Cathodes contribute to better tube performance

3. Better diameter control with Sarong coating makes a closer spaced tube structure possible with higher Gm, more gain

4. More uniform heat distribution is possible with Sylvania Sarong Cathodes. Hot spots are virtually eliminated and the life and over-all performance of the tube is improved

5. Sylvania Sarong Cathode coating makes possible a new uniformity of cathode emission from tube to tube
Other New Sylvania Developments

New 100 ma All American Five

Radio set designers can now secure all of the performance advantages of the famous All American Five design with lower heater power and reduced heat dissipation. This opens the way to substantial economies in set components without a sacrifice of over-all set quality.

The Sylvania 100 ma All American Five includes the following types: 18FX6, 18FW6, 18FY6, 32ET5 and 36AM3. The function of each type corresponds directly in order to the standard All American Five types 12BA6, 12BE6, 12AV6, 50C5 and 35W4.

The new 100 ma All American Five tube complement is already being designed into the sets of one major radio manufacturer. Contact your Sylvania representative now for full information on the new types or write Sylvania directly.

New Spiral Accelerator C-R-T

Now ready for production at Sylvania's Industrial and Military C-R-T Department is one of the new high-quality cathode-ray tubes—the Spiral Accelerator. Designed for high-quality scope applications the advanced tube sets a new standard for high linearity and superior resolution. This is achieved through the spiral design that gives a smoother voltage gradient from deflection plates to screen.

Sylvania stands ready to produce Spiral Accelerator types to fit your specific needs. Contact your Sylvania representative or write Sylvania directly. We will welcome the opportunity to discuss your special cathode-ray tube requirements with you.
It takes a TEAM
to solve timing problems

The control of time is an extremely complex science that demands a thorough knowledge of many individual technologies. For this reason, Haydon maintains a team of engineering specialists to provide the reservoir of skill, knowledge, experience, and creative ability necessary to solve industry's timing problems.

When you submit a timing problem to Haydon, it's handled by a team of specialists—not an individual engineer. And you can be sure the Haydon Timing Team is equipped with all the electric, electronic, mechanical and manufacturing know-how needed to analyze your requirements and develop the best possible new or modified timing unit for your specific application.

Correctly designed and efficiently manufactured, Haydon timing devices are exhaustively tested before release to a customer. The results are uniformly high quality devices that are known for fine performance, and long life. May we put our Timing Team to work for you?

A few units from the complete Haydon line are shown at the right. Send now for further information, outlining your requirements.

DIVISION OF
GENERAL TIME CORPORATION
2426 EAST ELM STREET
TORRINGTON, CONNECTICUT
Headquarters for Timing

DIVISION OF
GENERAL TIME CORPORATION
2426 EAST ELM STREET
TORRINGTON, CONNECTICUT
Headquarters for Timing

ELAPSED TIME
INDICATOR
ED-71
Compact, low-cost instrument for machine tools, communications equipment and other commercial applications where an accurate record of operating time is desired. Time Registered: 9,999.9 hours. Weight: 5 oz. Voltages: 120 or 240 v, 60 cps. Power Required: 2.5 watts at 120 v, 60 cps.

A-C TIMING MOTORS
A complete line of synchronous, compact timing motors, speeds from 1/60 to 60 rpm. Guaranteed torques from 6 ounce-inches to 30 ounce-inches at 1 rpm. Voltage ranges 103-132 and 206-254 vac, 50 or 60 cps.

INTERVAL TIMER
Directly controls heavy duty electrical loads. Type AD can be supplied with up to 3 SPST switches. Type AT has 1 SPST switch only. Intervals available with dial and knob: 15, 60 and 180 minutes. Intervals to meet your specific requirements can be supplied. Voltages: 120 or 240 v, 50 and 60 cps. Switch Rating: 28 amps, 250 vac non-inductive; 1 hp, 240 vac.
Some design engineers specify PNP switching transistors because they consider them inherently more reliable. Actually NPN transistors can give you superior reliability along with their well-known higher speed. Life tests covering hundreds of thousands of CBS-Hytron NPN alloy-junction germanium switching transistors proved this during the past year. See graphs comparing these transistors with typical military-approved PNP transistors.

The superiority of CBS-Hytron NPN transistors is achieved by special processing: For example, advanced surface chemistry techniques seal out moisture and contamination. Precise control of alloying produces high back voltages. Thorough bake-out stabilizes gain. The result is reliable NPN computer-type switching transistors featuring fast switching... high voltage... low cutoff current... and low saturation resistance... in a welded JETEC TO-9 package.

A comprehensive line of these reliable CBS-Hytron NPN high-speed switching transistors is available now in production quantities. Check the table. Order types you need... or write for Bulletin E-293-302 giving complete data... today.
Companies Report Dividends

SHAREHOLDERS of a number of electronics firms are receiving or expecting to receive dividends on their holdings during this first quarter of 1959. Dividend announcements are payments in cash and in stock. Among firms announcing dividends are:

- Raytheon Manufacturing Co., Waltham, Mass., whose stockholders received a 5-percent stock dividend last week. Company earnings in 1958 amounted to $3.08 a share, as compared with $1.70 in 1957, according to company president C. F. Adams.

- Television Electronics Fund, Chicago, shareholders are slated to receive dividend of eight cents a share, payable tomorrow to stockholders of record as of Feb. 2, 1959.

- Altec Companies, Inc., Anaheim, Calif., manufacturers of audio equipment and special transformers, will be sending dividend checks next week to stockholders of record as of Feb. 24, 1959. Dividend rate is ten cents a share as a regular quarterly amount.

- On March 16, stockholders of record of Magnavox Co. Ft. Wayne, Ind., will receive their regular quarterly cash dividend of 37¢ per share. Persons holding shares as of March 25, 1959, will also receive a special 5-percent stock dividend, says R. A. O'Connor, board chairman. Payment date is April 15.

- Amphenol-Forg Electronics Corp., Chicago, announced its first dividend since the firm was formed last December from a merger of Amphenol Electronics and G. W. Borg Corp. Dividend payments will be 85 cents a share payable March 30 to common shareholders of record as of March 16.

- Shareholders of Narda Microwave Corp., Mineola, L. I., N. Y., received a dividend last week of one share of stock in Narda Ultrasonic Corp., a subsidiary of NMC, for each 100 shares held. Three additional shares of the Narda Ultrasonic stock will be issued as dividends on the same basis during the remaining three quarters of this year.

- Packard-Bell stockholders received a dividend last month of 12¢ per share on the 688,000 common shares outstanding. Dividend was payable to shareholders of record as of Jan. 9, 1959.

OVER THE COUNTER

<table>
<thead>
<tr>
<th>1958 BIDS</th>
<th>COMMON</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>HIGH</td>
</tr>
<tr>
<td>37¢</td>
<td>29¢</td>
</tr>
</tbody>
</table>

AMPEX: turning point for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision, tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurably higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium - alloy Precision Reels. Widths of $\frac{1}{4}$", $\frac{3}{8}$" and 1" are standard on either Mylar or acetate base, in the following lengths, reel diameters, and base thicknesses:

<table>
<thead>
<tr>
<th>AMPEX STANDARD TAPE LENGTHS (ft)</th>
<th>REEL</th>
<th>BASE THICKNESS (mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIAMETER</strong></td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>7&quot;</td>
<td>1800</td>
<td>1250</td>
</tr>
<tr>
<td>10&quot;</td>
<td>3600</td>
<td>2500</td>
</tr>
<tr>
<td>14&quot;</td>
<td>7200</td>
<td>5000</td>
</tr>
</tbody>
</table>

For complete specifications or additional tape literature, write

AMPEX

MAGNETIC TAPE

924 CHARTER STREET, REDWOOD CITY, CALIF.

CIRCLE 18 READERS SERVICE CARD
SPACE COMMUNICATIONS: As man’s explorations reach further into outer space, it becomes necessary to make great improvements in communications. One of Lockheed’s many contributions in this field is a miniaturized satellite tape recorder, able to store three million pieces of scientific data anywhere in its travels and on return to range of earth stations, transmit it on command. Marconi’s original sending key depicts man’s first successful attempt to communicate by wave impulse.

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed’s activities in the missile field began before World War II when the company designed and flew a pilotless aircraft for the Army Air Corps. Today the Missiles and Space Division embraces every facet of research and development, engineering, test, and manufacture. It has complete capability in more than 40 areas of science and technology, from concept to operation.

The Division is engaged in basic research and development in such major fields as: nucleonics; electronics; propulsion; physics; chemistry; mathematics; computer development; oceanography; reconnaissance; aero-thermodynamics; magneto-hydrodynamics; operations research and analysis; human factors; space communications; and materials and processes.

Programs such as the Navy Polaris FBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7 reach far into the future and require a bold and imaginative approach where only theory now exists. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share.

Write: Research and Development Staff, Dept. B-22, 962 W. El Camino Real, Sunnyvale, California.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."

NATIONAL MISSILE INDUSTRY CONFERENCE AWARD.
MARKET RESEARCH

SOLION Knowhow!

Let our scientists, with ten years experience in developing and using solions in defense projects, help you with your application of the new solion integrators announced in this issue.

In addition to Solion Development TRA conducts contract research and development for clients in the following fields.

- **ELECTRONIC DESIGN**
- **THEORETICAL PHYSICS**
- **SIGNAL PROCESSING SYSTEMS**
- **HYDRODYNAMICS**
- **THERMODYNAMICS**
- **PHYSICAL CHEMISTRY**
- **CORROSION ANALYSIS**
- **EXPLOSIVES**
- **RARE METAL WELDING**

Direct inquiries to:

TEXAS RESEARCH ASSOCIATES CORPORATION
1701-03 Guadalupe St.
Austin 1, Texas

CIRCLE 21 READERS SERVICE CARD

Firms Seek R&D Budget Data

Marketers of electronic products are intensifying efforts to determine how much competitors and other members of the industry are spending on research and development. Reason for this: Control R&D spending and keep up with competition in the new products race.

Facts on R&D expenditures for individual firms are often regarded as hard-to-get. But in cases where firms have put out a new security issue, data can be gotten from the security prospectus, available from underwriters. Moreover, Securities & Registration Commission penalties for false statements add authenticity to the figures.

- **Examples** of prospectus R&D information include Addressograph-Multigraph's listing of annual R&D expenditures from 1954-1958—ranging from 1.9 to 2.7 percent of sales. Thiokol Chemical reports that in 1957 it spent seven percent of its sales on commercial development. Smith-Corona notes that it plans to spend $1,250,000 in the 1958-1959 period for operating and capital expenses of its research and development program.

Prospectus often contains information on competitor sales by product lines and as a share of the total market. Recent Electro-Voice stock issue reports that microphones accounted for 18 percent of total sales for first nine months of its 1959 fiscal year, which ends this month, compared with 23 percent for 1958. Perkin-Elmer prospectus of Nov. 7, 1957, contains estimate that company commands two-thirds of the infrared spectrometer market, a quarter of all process control analyzer sales and about one-tenth of the market for ultraviolet spectrometers.

- **Small business** received about $4.2 billion in payments for defense subcontracts in fiscal 1958, as against $3.6 billion in fiscal 1957, Department of Defense reports. Small firms also received $3.729 billion in military prime contract awards, compared with $3.783 billion for 1957.

- **General Electric Heavy Military Electronics Department** sets up two new marketing units in an effort to better its position in winning big subcontracts from defense prime contractors. The new departments—Defense Industries Sales and Defense Industries Contract Administration—will strive to bring GE's abilities to design and produce large complex electronic subsystems to the attention of military prime contract market.

**FIGURES OF THE WEEK**

LATEST WEEKLY PRODUCTION FIGURES

<table>
<thead>
<tr>
<th></th>
<th>Change From</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1956</td>
</tr>
<tr>
<td></td>
<td>One Year Ago</td>
</tr>
<tr>
<td>Electronics</td>
<td>24.8%</td>
</tr>
<tr>
<td>Rad. &amp; I nd.</td>
<td>32.2%</td>
</tr>
<tr>
<td>Brd. &amp; B a s e s</td>
<td>72.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Change From</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1956</td>
</tr>
<tr>
<td></td>
<td>One Year Ago</td>
</tr>
<tr>
<td>Electronics</td>
<td>33.3%</td>
</tr>
<tr>
<td>Rad. &amp; I nd.</td>
<td>27.22</td>
</tr>
<tr>
<td>Brd. &amp; B a s e s</td>
<td>81.17</td>
</tr>
</tbody>
</table>

**STOCK PRICE AVERAGES**

<table>
<thead>
<tr>
<th></th>
<th>Change From</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1956</td>
</tr>
<tr>
<td></td>
<td>One Year Ago</td>
</tr>
<tr>
<td>Electronics</td>
<td>24.8%</td>
</tr>
<tr>
<td>Rad. &amp; I nd.</td>
<td>32.2%</td>
</tr>
<tr>
<td>Brd. &amp; B a s e s</td>
<td>72.2%</td>
</tr>
</tbody>
</table>

February 27, 1959 — ELECTRONICS
To assure reliability...

Sperry electronic test equipment designed to your specifications

Every engineer knows how relentless is the pressure from both military and industrial customers for increased reliability. And making sure a new weapon system, for example, is operable at an instant's notice calls for test equipment as advanced as the system itself.

You'll be glad to know that now you can obtain advanced test equipment tailored exactly to your needs from Sperry's new Microwave Electronics Company. You will save valuable design and development time...free your engineering staff for other jobs—and enjoy the benefit of Sperry's 20 years of experience in designing, developing and producing complex radar and other electronic test equipment.

Whether you need equipment for production testing, maintenance or in-use monitoring, Sperry can meet even the most rigid specifications. Built into it will be the newest Sperry concepts of dynamic system evaluation and signal simulation...the precision measuring techniques that today are providing reliable and accurate automatic testing of the B-58 Hustler supersonic bomber and similar complex systems.

With the pressure on for electronic-system reliability, now is a good time to turn over your testing equipment research and development problems to the specialists—Sperry Microwave Electronics Company. Write today for details.

SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION
Address all inquiries to Clearwater, Florida, or Sperry Gyroscope offices in New York • Cleveland • New Orleans • Los Angeles • San Francisco • Seattle

ELECTRONICS — February 27, 1959
CIRCLE 22 READERS SERVICE CARD
WHEN A COMPANY OUTGROWS ITS NAME

As the domestic research organization of the world-wide International Telephone and Telegraph Corporation, we are carrying on our tradition of pioneering in electronics. As our engineering responsibilities have increased so our organization has grown. Today, in addition to our main laboratories in New Jersey, laboratories in Ft. Wayne, Chicago and in California are pursuing projects of great magnitude and importance.

You will find in our staff the same fine creative thinking and engineering imagination which brought distinction to our old names. Formerly Federal Telecommunication Laboratories and Farnsworth Electronics research laboratories, our names have been changed to identify us clearly with our parent company, and to reflect our expanded responsibilities and growth.

Electronic engineers will find here opportunity to express initiative and competence in such areas as long range radar systems, digital computer applications to data processing and communications, space technology, microwave tube research and missile systems instrumentation. We are continuing our work in air navigation and control, and in electronic systems . . . and making new contributions to electronic theory and techniques. In fact, it would be hard to find another research organization that offers the engineer such a wide scope of activities.

Engineers interested in discussing professional positions with our staff are invited to write Mr. T. C. Allen, Manager, Professional Staff Relations.

ITT LABORATORIES
A Division of International Telephone and Telegraph Corporation
500 Washington Avenue, Nutley, New Jersey
Ft. Wayne, Indiana • Chicago, Illinois • Palo Alto, California • San Fernando, California

28
CERAMICS and METAL-CERAMICS for MISSILES

AlSiMag high-alumina ceramics offer unusual reliability. High temperature resistance, superior insulating characteristics, great mechanical strength, resistance to abrasion, corrosion and chemical attack are among the advantages particularly important when maximum performance and reliability must be packed into minimum space.

Both soft solder and hard solder terminals are available. A new technique is producing strong high temperature metal-ceramic hermetic seals.

Precision tolerances can be maintained. Custom designs are made in an unusually broad range including ultra-thin or miniature components of unusual complexity.

AlSiMag special purpose compositions based on alumina, steatite, zircon, Forsterite, cordierite, titania, aluminum silicate, magnesium silicate, silicon carbide and other materials may answer special requirements. The AlSiMag family of ceramic compositions is the largest in the industry... and it is backed by more than half a century of specialized experience over the widest area of design and production in the technical ceramic field. Your inquiries will have prompt and interested attention.

VISIT OUR BOOTH NO. 3901 AT IRE
Debate Worldwide Air Nav-Aid

International Civil Aviation Organization divides into two camps over short-range air-navigation system for world's civil airlines

MONTREAL, QUE.—Debate here over which short-range navigation standard should be adopted for worldwide implementation in the civil airways may have officially ended by the time this issue reaches readers.

But the argument won't actually be settled for quite a while. And some bitterness will be left after the settlement, no matter which way it comes.

International Civil Aviation Organization, meeting here to resolve the long-smoldering dispute between adherents of Vortac rhetheta and Decca hyperbolic systems, was divided into the two camps before the sessions even started on Feb. 9.

Pros and Cons

Britain's aviation ministry and most of the British carriers focused the argument for Decca Navigator's system. The U.S. Federal Aviation Agency (unofficially) and most American carriers plumped for the existing VOR system with Tacan-compatible distance-measuring equipment.

Thirty-two member nations attended the Montreal meeting. Included were a number of smaller countries — Colombia, Nicaragua, Ecuador, Bolivia, among others — that rarely if ever had attended an ICAO technical meeting. That fact prompted the British representatives to suspect the U.S. of packing the house.

The British argue that the Decca system is the only logical solution for high-density areas with the coming of jets. U.S. rebuttal is that most high-density areas are in this country; if Vortac works here, it can work anywhere. British counter by pointing out that New York's International Airport (Idlewild) is overloaded whenever conditions are other than ideal, and that with jets the situation would become both chaotic and costly.

VOR (vhf omnirange) has been ICAO standard as a short-range navigation aid to provide bearing data since 1949. The civil distance-measuring equipment adopted on ICAO's recommendation since then is not generally compatible with the military Tacan system. DME installed as part of this country's Vortac (or VOR-DMEET) system, however, does conform to Tacan characteristics.

Large Investments

Technical and philosophical arguments put forth at this hassle mask what are actually economic reasons.

This country and its flag carriers have a large investment in the Tacan system, in VOR, and — recently — in Vortac. Most of the commercial carriers in the International Air Transport Association back the U.S. position: for IATA members, Vortac is the easy way out. U.S. military interest in keeping distance-measuring gear compatible with Tacan gives IATA members a price break on airborne Vortac equipment.

British carriers — especially British European Airways — have invested heavily in the Decca short-range and Dectra long-range equipment. And, unlike FAA (which officially has taken no stand in the argument), Britain's government body, the Ministry of Transport & Civil Aviation, has officially been "convinced that only the Decca navigator can provide a satisfactory answer to the growing problem of crowded airways."

Decca has installed 13 "chains," of which eight are in Europe blanketing the United Kingdom and the continent from the iron curtain to the Pyrenees. Four more are in Canada, and one in the U.S. (in the New York area undergoing FAA test). Each chain comprises three or four stations: one master and two or three slaves.

By comparison, some 1,500 VOR stations are planned or operating around the world. Several European manufacturers are turning out VOR gear. NATO nations lean toward Vortac, since Tacan already serves as part of NATO's military air control.

Decca claims that it could blanket the U.S. for about the amount of money that it now costs annually to maintain the VOR and Vortac equipment here.

System Differences

Decca promoters point out that Decca works well with the long-range Dectra, now in field trial over the Prestwick-Gander air route. Vortac adherents counter that the instrument-landing systems in use all over the world work better with Vortac-type gear.

System differences are used as arguments in the hassle. Decca is a low-frequency hyperbolic system, gives cockpit data in terms of dial readings that — like loran — must be transferred to a chart. Accuracy of the system decreases with increasing distance from the ground stations. An automatic-plotting flight
log now permits the pilot to observe his course and ground position continuously on a chart.

VHF omnirange system presents cockpit data in direct-reading dials which give angle to ground beacon, and periodically identify the beacon. Related DME-T gear gives direct dial reading of miles to the beacon. There is a cone of ambiguity over the VOR station because of the antenna propagation pattern, but no ambiguity in-dial interpretation. Accuracy is ±0.2 miles independent of distance over the range of the beacon.

Decca master and slave stations, transmitting in effect continuously, set up a lattice of hyperbolas, each of which represents the locus of equal phase-difference between any two stations.

VOR broadcasts two signals from a common antenna array, one signal constant in phase, one varying in phase as the antenna array is rotated. Automatic gear reads the phase difference and derives bearing information in terms of this difference. Related distance-measuring gear is a radar beacon interrogated automatically by the craft. Transponded signal from the ground is received in the plane, its delay from interrogation-time measured, and the difference translated into a dial reading.

**Operating Ranges**

Range of Vortac beacon is about 200 miles. Range of the Decca system is somewhat greater: the ideal baseline length from master station to slave is about 70 miles, and the coverage area extends about 100 miles around each slave. This range—and the accuracy of the reading—are reduced at night as skywave characteristics change.

U.S. opinion of Decca system is colored by the lack of what aviation people here regard as exhaustive field trial. The Decca chain installed in the New York area is being tested only for helicopter traffic, and only within the triangle formed by the slave stations. One aviation expert told ELECTRONICS “we need to test the system with fixed-wing craft in fairly dense traffic, and we need to know more about what happens on the periphery of the coverage area.”
Raytheon Missile Projects

SPARROW III—the Navy's tenacious, lightning-fast, air-to-air missile—is intended for extensive use by Navy fighter aircraft in fleet air defense. Sparrow III is a Raytheon prime contract.

HAWK—the Army's defense against low-altitude attackers—carries out its destruction in the blind zone of conventional radars. Hawk development and production is under Raytheon prime contract.

TARTAR—A substantial contract for vital electronic controls for this Navy destroyer-launched missile is held by Raytheon. This equipment—a tracking radar and associated units—enables it to "lock on", cling to target's path, despite evasive tactics.

ADVANCED PROJECTS in aeronautical structures as well as missile guidance and control are now underway in Raytheon laboratories. New facilities are continually being added for this work.

PRELIMINARY NEW DESIGNS of tomorrow's missiles will result from the advanced work being done by today's missile engineers. Raytheon plays an important role in this area.

Raytheon diversification offers
JOB STABILITY FOR CREATIVE MISSILEMEN

Here is an opportunity to free yourself of worry about a job that's here today, gone tomorrow.

Diversified assignments—only possible in a company with Raytheon's wide range of missile activities—means security not found in one- or two-project companies. You apply your creative energies to the many projects you work on, and they in turn are your "insurance" against falling into a rut.

Individual recognition comes quickly from Raytheon's young, engineer-management—men who are keenly aware of the engineer's needs and contributions to missile progress.

Dynamic Raytheon growth—the fruit of this management's progressive policies—is best illustrated by the fact that Raytheon is already the only electronics company with two prime missile contracts—Navy Sparrow III and Army Hawk.

The next step is up to you. Why not get frank answers and helpful information on the type of job suited to your background and talents, its location, salary and other important details. Write, wire or telephone collect: The number is C' Restliew 4-7100 in Bedford, Massachusetts. Please ask for W. F. O'Melia.

RAYTHEON OPPORTUNITIES NOW OPEN IN:
WEAPONS SYSTEM ANALYSIS • CONTROL SYSTEMS • PACKAGING • MICROWAVE • RADAR • SPECIFICATIONS • MISSILE AERODYNAMICS • WIND TUNNEL TESTING • AERODYNAMIC HEATING • ROCKET ENGINEERING • VIBRATION MEASUREMENT and DATA REDUCTION

RAYTHEON MANUFACTURING COMPANY
Missile Systems Division, Bedford, Mass.
Silicone rubber wire insulation withstands soldering heat without damage

Thanks to silicone rubber's remarkable heat resistance, no damage occurs when you lay a hot soldering iron on silicone-rubber-insulated wire. And silicone insulation strips cleanly and easily, saving hours of assembly time in the plant. Right-angle bends are no problem. Colors are bright for easy identification.

Long service life at 500 °F Withstands 600 °F and above for shorter periods. General Electric silicone rubber insulation meets military specifications MIL-W-3777A, MIL-W-16458F, and others. When exposed to a direct flame, it forms a non-conducting ash of silicon-dioxide, releasing no toxic fumes, as do higher-priced insulating materials.

Will not cold flow Because silicone rubber is a true elastomer, it will not cold flow and subject wire to vibration, as will higher-priced insulating material. Newly developed stocks make possible thin-wall construction, have unusual abrasion resistance and physical strength. G-E silicone rubber stays flexible down to -75 °F, special grades down to -150 °F.

Greater reliability G-E silicone rubber exhibits excellent electrical properties and maintains them at both high and low temperatures, keeping its original dielectric strength for years. Moisture absorption is extremely low; ozone resistance approaches that of mica.

General Electric silicone rubber insulation matches or exceeds the vital properties of insulation costing three times as much. Find out what it can do for you. Mail coupon for technical data.

General Electric
Silicone Products Department
Waterford, New York

Section K8CC2, Silicone Products Dept.
General Electric Company, Waterford, N. Y.

Please send me more information on wire insulated with G-E silicone rubber.

Name
Position
Company
Address
City Zone State
How far can an engineer go at AC?

You can use and develop all your talents in AC’s bustling instrumentation business.

You can put the finest equipment to work for you... on interesting and varied projects... at AC’s world-wide facilities. What’s more, you can enhance your professional status by working on advanced degrees in engineering schools located near AC plants.

All this plus the comfort of long range security.

For today AC turns out the AChiever inertial guidance system and many other electro-mechanical, optical and infra-red devices.

Tomorrow you’ll help AC produce instrumentation devices for the “space age.”

If you are a physicist, mathematician, or graduate engineer in the electronics, electrical or mechanical fields—you can go places at AC, because AC is going places.

Talk to the people at AC about it soon. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin; or Mr. M. Levet, Dept. A, 1300 N. Dort Highway, Flint 2, Michigan.

Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers • Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyrosopes
Speed Sensitive Switches • Speed Sensors • Torquemeters • Vibacall • Skyphone

AC SPARK PLUG & THE ELECTRONICS DIVISION OF GENERAL MOTORS

February 27, 1959 — ELECTRONICS
SAC Buys Automated Control

Strategic Air Command's new electronic system takes data from the field, processes and displays it in one continuous automatic operation.

OFFUTT AFB, NEB.—Strategic Air Command's combat control system, already heavily electronic, is going to be even more so.

A new electronic complex, now under development, will eliminate the human steps between data acquisition, processing and display. Information will flow directly from the field to headquarters' display board—untouched by human hands.

Here's how SAC's present and future systems operate:

If America should be attacked, a single voice command of a few seconds duration would immediately throw the Strategic Air Command's plan for global retaliation into action. The order would be given from SAC's underground headquarters, over the red telephone that provides instantaneous voice contact with all SAC command posts.

**Data Required**

To integrate such an assault by bombers and tankers rising from four continents and, in the future, by surface-to-surface missiles launched from the U.S. and Europe, a staggering volume of data must constantly be on hand. Thousands of vitally relevant details must be kept current and selectively accessible within seconds. Handling this job at present is an IBM 704 electronic data-processing system.

Information stored in the 704's magnetic core includes:

- Performance characteristics of each of SAC's 3,000 planes; maximum range without and with refueling; location and operational status of each bomber and tanker; crew, supply and maintenance facilities at each base.
- Distance to all potential targets from designated bases; where tankers must intercept each bomber; where reserve tankers are located in the event a tanker base is knocked out.
- Size, configuration and importance of each target; damage yield of bombs in inventory; percentage, and sector, of each target that would be destroyed, calculated for where the bomb hits.
- Time and space interval to be maintained between planes dropping nuclear bombs. Using the 704's calculations, take-off times of all bombers can be staggered so that no two paths will cross too close to radioactive areas.

**Computer's Role**

With such information, the 704 helps to:

- **Write war plans.**
- **Control the force (keeps tabs on compliance with plan).**
- **Keep score on objectives in war plan actually realized and those aborted.**
- **Compute immediate damage assessment (IDA), and to . . .**
- **Replan the attack.**

Progress of the strike force is recorded by means of punched cards. New information is processed automatically, providing constant knowledge of the status of the strike force. A tanker base, for example, might be knocked out by an enemy ICBM after the bombers depending on the base for refueling have taken off. The computer, on interrogation, tells locations and readiness status of substitute tankers. Next question—which bombers could not be intercepted for refueling and therefore not get back from the target—is also answered.

Present system for getting data from the field into headquarters, and processed and posted on the control room's panel, will not be adequate for the added discipline a mixed missile/bomber force will require. To make the system completely automatic from field to control room panel, the International Electric Corp., a new unit set up by the International Telephone and Telegraph Corp., is developing a world-wide electronic combat control system. Designated the 465-L, the system consists of communications, data-processing and data-presentation sub-systems.

Basic information on the movement and status of SAC weapon systems is introduced into the system at operational level by an information feeder facility. Data is converted into high-speed digital bits and sent into headquarters by wire. Here, it is automatically processed and sent to animated display panels, or else stored for future use.

Data-processing subsystem for the 465-L is being developed by IBM under subcontract from ITT. Transistorized and using ultrahigh-speed magnetic memories, the new system will be far more powerful and faster than the 704 and will have greater storage capacity.

Another advantage of the 465-L over the 704 lies in a priority interrupt capability. Interrogation and/or output can be interrupted for a different and more urgent request. The 465-L will be capable of synchronous operations—input, output and computations.

For automatic communication between bases, the feeder system will provide automatic traffic control centers which will route information, recognize priorities and obtain acknowledgment from all addressees that messages have been received.

Though dollar figure for ITT's contract has never been disclosed, it probably runs close to $165 million.
Now...all sizes and shapes of SX Magnet Wire for every "hot spot" application

VERSATILE GENERAL PURPOSE APPLICATION
Thermalex-F is not a special wire but has properties required for a general purpose application and can be used through the 105°C-155°C temperature range... Class A applications as well as Class F... eliminating the need for buying more than one type of magnet wire.

OUTSTANDING THERMAL STABILITY
A.I.E.E. #57 "Procedure for Evaluation of the Thermal Stability of Enamelled Wire" which is an accepted test, indicates a 30,000 hours life at 170°C for unvarnished specimens.

Thermalex-F, a Class F (155°C) magnet wire insulation developed by Essex, is now available in round wire from 11 to 50 AWG size and all Formvar sizes of square and rectangular. This full size range gives every manufacturer the versatility he needs in one insulation type for his exact application!

VERSATILE GENERAL PURPOSE APPLICATION
Thermalex-F is a Class F (155°C) magnet wire insulation developed by Essex, is now available in round wire from 11 to 50 AWG size and all Formvar sizes of square and rectangular. This full size range gives every manufacturer the versatility he needs in one insulation type for his exact application!

THE WIRE DESIGNED WITH THE FUTURE IN MIND

Magnet Wire Division
ESSEX WIRE CORPORATION
Fort Wayne, Indiana
National network of Warehouses and Sales Offices
...Call your local "Essex Man."

CIRCLE 29 READERS SERVICE CARD
February 27, 1959 — ELECTRONICS
The Westinghouse Silicon Power Transistor pictured above is a highly efficient device which greatly increases the range of applications for transistors which must operate without high losses in the “true power range.” Thanks to a remarkably low saturation resistance—less than .750 ohms at 2 amperes and .5 ohms at 5 amperes—these transistors possess very low internal dissipation, and can be efficiently used in applications where they must handle as much as 1000 watts. For example, as a DC switch, handling 750 watts (150 volts at 5 amps) the internal dissipation is about 9 watts, with an efficiency of better than 99%.

Additionally, and unlike germanium units which are limited to approximately 85°C, these transistors can operate in ambient temperatures up to 150°C. Thus, even where the higher power rating is not required, these units may be used for their high temperature capabilities.

There are a great many applications for which this new type of silicon power transistor is ideally suited. It will find use in inverters or converters (AC to AC; AC to DC; DC to AC; DC to DC), regulated power supplies, servo output, and other aircraft circuits, as well as in certain amplifiers and switching applications.

Westinghouse Silicon Power Transistors are available in 2 and 5 amper collector ratings. Both of these are available in 30, 60, 100, and 150 volt ratings in production quantities for your immediate applications. Sample quantities are available in voltage ratings up to 300 volts. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pennsylvania.
**Off-Hours Medical**

Telephone engineers develop instruments for University of Chicago Medical School

CHICAGO—Telephone engineers here are working as an off-hours volunteer group with the University of Chicago Medical School to develop medical research instruments. Four devices are being used or tested by doctors after little more than a year since the effort began.

The group, consisting of about 40 engineers from the Illinois Bell Telephone Co., calls itself SAVE (for Service Activities of Volunteer Engineers).

Leroy J. Ryan, SAVE president, says the idea for the group came from W. V. Kahler, president of Illinois Bell and a trustee of the University of Chicago.

Ryan told Electronics he hopes that Bell System engineers in other parts of the country, as well as retired telephone engineers, may join the effort.

“We’re making the circuitry and design information available to anybody,” says Illinois Bell president Kahler. He adds that if any developments of the group have application in the communications industry, his company would reserve the right to them for such use.

So far SAVE can point to the following accomplishments:

- Three-ounce heartbeat recorder which can be worn over the chest 24 hours a day. It provides medical researchers with cumulative pulse data on a patient’s heart.

- Cytodiagnostic training apparatus. Equipment, which can be held in a suitcase, can be used to teach technicians and students to recognize about 24 factors that determine if a cell under a microscope is cancerous. Punch card is put in tester for each specimen slide. Student evaluates slide, then keys his diagnosis on tester. Gear indicates whether diagnosis of cell is correct or not.

- Cumulative electronic calorimeter. This device measures changes in body heat useful in metabolism studies. Unit weighs less than three ounces, including watch and power supply, is shock-proof and runs continuously for more than 24 hours; transistorized amplifier puts out 1 volt.

- Electronic stethoscope. Transistorized device, with circuitry similar to that of the cumulative heartbeat recorder, gives doctors quick visual or audible check on pulse rates during surgery. Beep or flashing lamp operates at same speed as the heart beats.

**X-15 to Begin Air Tests**

X-15 manned rocket ship is due for an early series of airborne tests, starting with a "captured flight" aboard a B-52. On-the-ground tests are being completed.

Sponsored by the National Aeronautics and Space Administration, Air Force and Navy, the X-15 was rolled out late last year by North American Aviation.

Spokesmen say information on the test program will be disclosed on an “after-the-fact basis.” However, it is understood that X-15 flight tests will start with glides, followed by powered flights from the B-52 at progressively higher altitudes until the craft’s maximum design limits are reached.

The flights may provide data on effects of Mach 5 speeds on radio communications. Collins Radio Co., Cedar Rapids, Iowa, designed X-15’s system for communications.
and automatic direction finding.

A transceiver in a pressurized case provides the basic communication between the X-15 pilot and the mother ship, chase planes and ground stations. This transceiver, model AN/ARC-52, has frequency range of 225.0-99.9 mc, power output of 20 watts, says firm, with 1,750 frequencies available for easy set-up of 20 channels.

Operating independently of the transceiver, but located in the same case, is a guard receiver tuned to a predetermined frequency. The guard receiver controls diversity switching between upper and lower antennas on top and bottom of the fuselage.

Collins says the communications part of its system is designed to operate this way: Ground station will transmit a carrier on the guard frequency. If the signal falls below a predetermined level, the guard receiver operates the diversity switch to unused antenna, holding to it even if signal gets stronger. Reason: to assure communication if the craft goes through unusual maneuvers.

A second unit consists of an automatic direction finder system and an auxiliary receiver. The auxiliary receiver ranges from 265.0-284.9 mc, with 20 crystal-controlled channels. For emergency back-up, the auxiliary adf receiver may be used for communications, and the receiving portion of the communications transceiver may be used for direction-finding. A transistorized control amplifier for antenna switching is part of the adf.

Another unit, a separate flush-mounted antenna assembly, contains radiating elements, antenna lobing switch, a-c drive motor, rate generator, synchro transmitter and associated gearing.

During test descents the X-15 pilot will use the adf to home on the terminal station. He'll land at Rogers Dry Lake near Edwards AFB, Calif., about 450 land miles from Wendover AFB, starting point for test.

---

**MARCONI TEST SETS FOR MOBILE RADIO**

**Designed for precision performance in**

- Receiver alignment
- Signal-to-noise measurement
- Discriminator testing
- Checking RF and audio outputs
- Deviation measurement

... All you need for fast field testing of FM transmitters and receivers is here in these two complementary instruments, tailored for mobile radio measurements.

The 1064/2 provides high-grade FM outputs in the ranges 30 to 50, 118 to 185, and 450 to 470 mc; crystal-controlled i-f outputs at five spot frequencies; and a 1 kc AF output.

The 1065 has an RF power meter and 0-15 kc deviation indicator for use up to 500 mc; a dual-impedance AF power meter; and a multi-range volt/ammeter.

Each is lightweight, portable, and quality-engineered throughout. Tubes and crystals are all American types. Send for leaflet B117/A.

---

**MARCONI INSTRUMENTS**

See you at the IRE Show Booths 3314-16-18

111 Cedar Lane • Englewood • New Jersey Tel: Lowell 7-0607
MARCONI INSTRUMENTS LTD • ST. ALBANS • HERTS • ENGLAND
GROWING HIGH PURITY CRYSTALS FOR SILICON RECTIFIERS by unique “floating zone” technique results in rectifiers with exceptionally low forward drop and reverse leakage, and with highly uniform, long life.

CERAMIC CAPACITORS RIDE IN SATELLITES. Developed by Radio Materials Company, a Mallory Division, the ceramic capacitors shown here are mounted in the power supply circuit* of the Explorer IV satellite. They are part of an extensive line of ceramic types developed by RMC for commercial and military applications.

*Developed by State University of Iowa.
Research in Depth Makes the Difference

New Mallory Silicon Rectifiers Gain Extra Performance from New Research Concepts

The source of the outstanding performance characteristics of the new line of Mallory silicon rectifiers is the same penetrating research which underlies all Mallory components. To produce a rectifier which would consistently do a superior job, solid-state physicists in the Mallory Corporate Laboratories developed a new approach to growing silicon crystals with purity far higher than previously possible. Using the Mallory-designed equipment shown here, crystals are manufactured by the "floating zone" method—with impurities of only 2 parts per billion.

Parallel research at Mallory devised an improved way to form the diffused junction that gives the rectifier its one-way conducting quality. To protect the silicon element, specialists at Radio Materials Company, a Mallory Division, contributed "Mallo-Seal"—an encapsulating compound exceptionally impervious to moisture. The result: a line of high-performance rectifiers at a price substantially lower than previously available units.

For your electronic equipment of today and tomorrow, you can look to Mallory for a constant stream of exciting products of research, coming from basic innovations in science from our Corporate Laboratories, and from the engineering ingenuity of our manufacturing divisions.

Research in Depth Makes the Difference in Mallory Components

TORTURE TEST FOR TANTALUM. Mallory tantalum capacitors, first types capable of 20°C rating, are here going through one of many research and production tests to evaluate their ability to last thousands of hours under extreme environmental conditions. From the program has been developed a line of 12 different tantalum models, including the new Type TAS solid electrolyte unit shown here.

MANY NEW MALLORY PRODUCTS, especially those developed for operation in explosive atmospheres, at high altitude and high temperatures, require new concepts in hermetic sealing. On the mass spectrometer leak detector shown above, a new Mallory hermetically sealed switch case assembly, designed for a maximum leakage rate of 3 cc of helium in 10 years, is tested for terminal leaks. Insert shows a typical standard Mallory switch.

LOGGING LIFE OF MERCURY BATTERIES. Compact, powerful Mercury Batteries, a product of pioneering Mallory research, are tested for their ability to deliver constant power for extended periods under various climatic and circuit conditions. Latest product of Mallory research in Mercury Batteries is the new RM-312 cell shown here... only .305" in diameter and .135" high.
DIFFUSED ALLOY POWER TRANSISTORS

Features
Faster Switching Times 0.5–5 µ Sec
Switching Currents up to 10 amperes
Flatter Frequency Response 40 Kc
Higher Breakdown Voltage up to 120 Volts
Current Gain of 40 at 5 amperes
Standard Power Transistor Package
Lower Base Resistance, 2 ohms
Lower Saturation Resistance, 0.1 ohm

Uses
TV Horizontal Output
Hi-Fi Amplifiers
Core Drivers
High Current Switching
Power Converters
Ultrasonic Generators
Modulators

Because no other transistor offers this combination of features and uses, you will want to try out the DAP transistor in your circuits. Get full details now on new Bendix diffused alloy power transistors by writing SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Typical Performance</th>
</tr>
</thead>
</table>
| Vdc (25°C) | Pce | B (Ic=5 A dc) | Vs (Ic=5 A dc) | fce | Рbb
| 2N1073  | 40 | 35 W  | 40 | 0.5 Vdc | 1.5 mc | 2 ohms |
| 2N1073A | 80 | 35 W  | 40 | 0.5 Vdc | 1.5 mc | 2 ohms |
| 2N1073B | 120| 35 W  | 40 | 0.5 Vdc | 1.5 mc | 2 ohms |

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Canadian Distributor: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario
Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
Scientists at MIT discuss details of automatically programmed tool system

'Automatic Design' Nearer

MIT releases details on new automatic program for machine-tool control. Firms testing it

BOSTON—Era of automatic parts design inched a step nearer this week with announcement at Massachusetts Institute of Technology of an automatic programming system for numerical control of machine tools.

The system, dubbed APT (automatically programmed tool) system, was announced jointly by MIT, USAF’s Air Materiel Command and the Aircraft Industries Association. It allows the parts designer to program his machine tool without going through the tedious stick-work of manual coding, hitherto the principal bottleneck of numerical control systems.

APT makes use of a general-purpose computer to produce the tool-control tape. It accepts a plain-language description of the part’s geometry, translates this into a taped machine-coded program which controls the machine tool.

Special Language

Key is English-like part-programming language developed at MIT Servomechanisms Lab under Air Force sponsorship. Computer, "understanding" special language, calculates all numerical data necessary for cuttings. It translates language into sequence of numerical instructions on tape.

More than 20 aircraft companies are cooperating in APT Joint Effort, organized in May 1957, with funds and technical information. Coordination has been taken over by Numerical Control Panel of AIA, enabling MIT, original coordinator, to do additional research. Advanced research is directed toward programming in terms of entire regions of surfaces in three dimensions. Current system can program three-dimensional space curves.

APT Joint Effort evolved from decision to pool computer programming manpower and resources to produce a complete system for industry-wide use. Further development of APT is open to all makers and users of numerical controls, not just in aircraft industry. APT language can produce control tapes for any of numerous machine tool systems.

APT is not the first automatic programming system for numerical control. But sponsors claim it has advantages of industry-wide compatibility and standardization and built-in expansion capabilities.

First industry-wide testing of APT started last April. Field tests, it was announced, have proved APT capable of performing "a real service for a limited but very useful class of parts."

LOW-LOSS KEL-F SOCKETS

... for high-power transmitting tubes!

Designed for use with high-power transmitting tubes, these sockets are molded of low dielectric, loss-factor Kel-F plastic. Sockets are available in several designs—with or without screen grid by-pass capacitors. Control grid contact "guide" is machined for greater alignment accuracy—all contacts are low-resistance, silver-plated beryllium copper. Tube pin contacts are heat treated to provide positive contact pressure as well as extended life—annealed soldering tabs may be easily bent or formed. High quality, heat resistant, steatite chimney also available to direct air flow through tube cooling fins.

For details and complete specifications write for free catalog listed below:

Write today for your copy of our newest components catalog, complete specifications and prices!

E. F. JOHNSON CO.
1842 Second Ave. S. W. • Waseca, Min.
CIRCLE 36 READERS SERVICE CARD
For jobs that demand utmost dependability...

NEW SOLID-STATE FREQUENCY COUNTER

Built exclusively of solid-state components, this new Beckman/Berkeley Eput® Meter exhibits dependable operation at temperatures from —5°F to 150°F. Under actual test – meets the most stringent requirements for both military and industrial use.

All circuits except the power supply are mounted on easily replaceable plug-in modules of only six different types. The time base is generated by digital circuits requiring no adjustment.

OTHER IMPORTANT FEATURES INCLUDE:

- Adapted to systems use by means of a 1-2-4-8 coded output supplied at a rear connector.
- Accurate determination of low frequencies, such as 60 or 400 cps, by making period measurements.
- Compact, lightweight, takes only 5½" rack space.
- Battery powered model available for use where line power is not always handy.

Write for technical Bulletin 5310.

See it at IRE • BOOTH 3416 and 3418

Beckman® Berkeley Division
201 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc.
OFFNER
ALL TRANSISTOR
TYPE R
the most versatile...most sensitive direct writing unit available

Illuminated canopy

Type 9800 series input couplers provide all input, control and balance functions. Input available both front and rear.

Type 481 Preamplifier provides sensitivities from one microvolt to 5 volts per mm.

Type 482 power amplifiers—may be used without preamplifiers for up to 10 mv/cm sensitivity

Zero suppression control

Combining all these features...

- stable d-c sensitivity of one microvolt per mm
- true differential input
- high input impedance
- response to beyond 150 cps.
- reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers
- deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)
- fixed precision calibration
- instant warm-up
- precision source for d-c and 400 cycle excitation, self-contained
- zero suppression, twenty times full scale, both directions

504-A paper drive—speeds from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with full unobstructed record visible from front.

Thanks for your patience in awaiting deliveries of the Type R. Schedules were temporarily disrupted by the large volume of orders received for this radically new instrument. We are now in our new plant, with 300% more space, and are rapidly increasing production capacity. Deliveries will soon be on a current basis.

All these features...plus 8 channels in only 35" of rack space. Whatever your application for direct writing records...you should investigate the ability of the Offner Type R Dynograph to do the job better and more simply. Using transistor circuits* developed and tested for over three years in thousands of channels of Offner equipment, the Type R Dynograph has already proved its superiority in practically every respect to any other direct writing oscillograph. Write on your company letterhead for literature giving details and specifications.

*Patents granted and pending

OFFNER ELECTRONICS INC.
3906 River Road, Schiller Park, Ill.
(Suburb of Chicago)
BIRD

"Termaline" DIRECT READING RF LOAD-WATTMETERS

SERIES 6100

MODEL 612

Models 61 and 611 are identical in appearance.

These popular direct reading instruments measure and absorb power in 50 ohm coaxial line systems through the range of 30 to 500 mc.

They are portable and extremely useful for field or laboratory testing ... checking installation of transmitters ... trouble shooting ... routine maintenance ... production and acceptance tests ... transmitter tune-ups ... measuring losses in transmission lines ... testing coaxial line insertion devices such as, connectors, switches, relays, filters, tuning stubs, patch cords and the like ... accurately terminating 50 ohm coaxial lines, and ... monitoring modulation by connecting phone, amplifier or audio voltmeter to the DC meter circuit.

Power scales for Model 61 Special are made to meet your requirements.

WRITE FOR BULLETIN TW606

SPECSIFICATION

RF INPUT IMPEDANCE: 50 ohm nominal.

VSWR: Standard specification 1.1 to 1 maximum over operating range.

ACCURACY: 5% of full scale.

INTERNAL COOLANT: Oil.

POWER RANGE: Model 611-0-15, 0-60 watts full scale. Model 612-0-20, 0-80 watts full scale.

INPUT CONNECTOR: Female "N".

EXTERNAL COOLING METHOD: Air Convection.

OTHER BIRD PRODUCTS

RADIATOR STRUCTURE: All Aluminum.

FINISH: Bird standard gray baked enamel.

WEIGHT: 7 pounds.

OPERATING POSITION: Horizontal.

MEETINGS AHEAD

Mar. 3-5: Western Joint Computer Conf., AIEE, ACM, IRE, Fairmont Hotel, San Francisco.

Mar. 3-7: Western Space Age Conf. and Exhibit, L. A. Chamber of Commerce, Great Western Exhibit Center, Los Angeles.


Mar. 24-25: Institute of Printed Circuits, Annual Meeting, N.Y.C.

Mar. 31-Apr. 2: Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg. N.Y.C.

Apr. 3-10: Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

Apr. 4-7: Astronautics Symposium, Air Force Office of Scientific Research, Shermont-Park Hotel, Washington, D. C.

Apr. 13-15: Protective Relay Conf., A & M College of Texas, College Station, Tex.


Apr. 16-18: Southwestern IRE Conf. and Electronics Show, SWIRECO, Dallas Memorial Aud. & Baker Hotel, Dallas.


Apr. 21-22: Electronic Data Processing, IRE Section, Cincinnati.

There's more news in ON THE MARKET, PLANTS and PEOPLE and other departments beginning on p 88.

February 27, 1959 — ELECTRONICS
THESE WR WAVE GUIDE SEALS PROVIDE POSITIVE SEALING; PREVENT R/F LEAKAGE, ARCING & BURNING

Electr-O-Seals are now available to fit all EIA (RETMA) standard WR series wave guide flanges, WR90 thru WR2300 as well as specials.

These seals not only provide near perfect sealing and complete electrical continuity, but offer many economical advantages — made by the makers of Parker O-rings, Stat-O-Seal®, and Gask-O-Seal®.

PARKER SEAL COMPANY
CULVER CITY, CALIFORNIA and CLEVELAND, OHIO
A DIVISION OF PARKER-HANNIFIN CORPORATION
How to conceive a radically improved radar scanning technique. How to integrate this technique into a superior data handling system. How to make the complete scanning and data handling system mobile.

These were the problems faced by engineers at the Hughes Ground Systems Division in Fullerton, California. Utilizing a completely new engineering concept, these engineers developed a radar scanning system which positions beams in space by electronic rather than mechanical means...thereby providing three-dimensional radar protection.

They developed high-speed data processors which monitor the action of hundreds of aircraft and store the shifting tactical situations for high-speed assignment of defense weapons. They produced compact electronic display systems which present the tactical information in symbolic and language form.

And then they made this complete radar and data handling system mobile. The radar scanning antennas (shown above) can be converted for travel on the road in minutes. The complete data processing and radar scanning systems, with all of their wide capabilities, have been engineered to occupy only a few standard size army van trucks.

The research, development and production of this advanced system is typical of the creative engineering now underway at Hughes in Fullerton. If creative engineering is your forte, you will find abundant aesthetic and monetary reward at Hughes. To investigate write to Mr. L. P. Wike at the address below.
1. Individual contacts are crimped to wires outside connector by a semi-automatic tool, then, for assembly, inserted one by one into insulation with crimped joint intact.

2. Contact retention ability of resilient insulation exceeds the requirements of MIL C-5015-D even after many reassemblies.

3. Failures due to faulty wire termination are eliminated by the single crimped joint which is stronger than the wire itself ... and superior mechanically and electrically to a solder joint.

4. Simplicity of wire termination greatly reduces errors in circuitry. Changes in circuitry are simple and speedy.

5. Up to 100 poles for wires sizes 16, 12 or 10, with no sacrifice in environmental resistance, or ability to meet and exceed MIL C-5015-D in Class A, B, C, E and R.

6. Two-piece Mod. 2 insert is interchangeable within Standard Pyle-Star-Line barrel shells with three-piece Mod. 1 insert.

Mod. 1 inserts for wire sizes up to 4/0 are available for disconnect and for current rupturing service.

---

**Environmental Limits of Pyle-Star-Line Connectors**

<table>
<thead>
<tr>
<th>Environment</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-60 F. to 225 F.</td>
</tr>
<tr>
<td>Pressure</td>
<td>300 PSI External, 200 PSI Internal</td>
</tr>
<tr>
<td>Chemical Resistance</td>
<td>Most acids, most alkalis, oil</td>
</tr>
<tr>
<td>Corrosion Resistance</td>
<td>Salt Spray: 300 days without failure</td>
</tr>
<tr>
<td>Dust Resistance</td>
<td>Exceed requirements of MIL C-5015D</td>
</tr>
<tr>
<td>Shock Resistance</td>
<td>50G Minimum</td>
</tr>
<tr>
<td>Vibration</td>
<td>Exceed 20G to Method II of MIL C-5015D</td>
</tr>
<tr>
<td>Humidity &amp; Moisture Resistance</td>
<td>Exceed Class E Spec. of MIL C-5015D</td>
</tr>
<tr>
<td>Air Leakage</td>
<td>Meet Class E Spec. of MIL C-5015D</td>
</tr>
</tbody>
</table>

---

Write for complete specifications:

1330 North Kostner Avenue, Chicago 51, Illinois
Branch Offices and Agents in Principal Cities of the U.S. and Canada
Railroad Export Department: International Railway Supply Co., 30 Church St., New York 7, N.Y.
Industrial Export Department: Rocke International Corp., 13 E. 40th St., New York 16, N.Y.
Canadian Agent: The Holden Co., Ltd., Montreal

CONDUIT FITTINGS • MOTOR CONTROLS • SWITCHES • LIGHTING FIXTURES • FLOODLIGHTS

CIRCLE 42 READERS SERVICE CARD
Temco is regarded by its customers as a *follow-through* company...with solid performance in every aspect of the contract from design to production.

One of the major reasons why the company has this reputation is that Temco considers it its business to be a partner on the job...to cooperate willingly, to communicate freely. Temco follows through by keeping top management and the customer informed on overall progress and program status. It follows through on quality control...on materials during testing without waiting for a go-ahead on the next move. It naturally follows that Temco delivers a quality product, on schedule, and at the lowest possible cost.

For many years, Temco has been considered the nation's most efficient subcontract and overhaul agency, and today is well-respected as a source of prime weapons systems. It has the capabilities, the integrated skills, the facilities and management to design, develop and produce for the aircraft, missile and electronics industries. Whether you need a component, subsystem or complete system, team up with Temco...Temco follows through.
NEW TOOL FOR HIGH VACUUM SPECIALISTS

Introducing a whole new series of ion pumps that will develop absolutely clean vacuum, better than $10^{-9}$ mm Hg. They are available in pumping capacities of 100 and 250 liters/second. Larger sizes can be supplied on special order. They offer tremendous advantages in such applications as particle accelerators, space research chambers, fusion processes, mass spectrometers, electron microscopes, vacuum tube processing — whenever uncontaminated ultra-high vacuums are required.

HIGH CAPACITY — The VacIon High Vacuum Pump illustrated has a uniform pumping speed of over 250 liters/second for room air over the range of $10^{-7}$ to $10^{-9}$ mm Hg. Pumping speed for hydrogen is over 850 liters/sec.

RUGGED — No damage to the pump will occur if the system is accidently opened to atmospheric pressure.

ULTRA-HIGH VACUUMS — In ordinary applications, VacIon Pumps will produce vacuums of up to $10^{-9}$ mm Hg. Equal to space at approximately 120 miles above the earth.

NO MOVING PARTS — VacIon Pumps operate electronically.

RUNS UNATTENDED — Does not require continuous personal attention. A distinct advantage in radiation or other hazardous test areas.

COMPLETELY CLEAN — Operates in a closed system. No vapors, no cold traps. If the power fails, no damage occurs. The vacuum in the system will be retained.

MEASURES ITS OWN VACUUM — The current indication of the power supply meter provides a practical measurement of pressure. Accuracy is comparable with that of the best ion gauges.

SIMPLE INSTALLATION — Complete units consist of a VacIon Pump, permanent magnet and power supply. A mechanical roughing pump is necessary only to bring the vacuum in the system down to about $10^{-3}$ mm Hg at which point the VacIon Pump starts operating. It will perform in any position.

LOW MAINTENANCE COSTS — If the pump becomes contaminated or at the end of its life, the internal elements can be easily removed and reconditioned or replaced.

LONG LIFE — Operating life of 20,000 hours at $10^{-7}$ mm Hg can be expected. Life expectancy is almost limitless at $10^{-9}$ mm Hg.

ONLY FROM VARIAN — VacIon High Vacuum Pumps have no equal for simplicity, cleanliness and compactness. Write for complete information today.

VARIAN'S NEWEST VacIOn
HIGH CAPACITY
HIGH VACUUM ION PUMPS

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, FISH VACUUM PUMPS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R.F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STAGS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES.
PHILCO® announces a new family of LOW COST Medium Power Alloy Junction Transistors

Introducing a completely new family of PNP germanium transistors, especially designed to meet rigid military and industrial specifications... at lowest possible prices.

These transistors are available in production quantities, for use in teletypewriters, control amplifiers, ignition systems, mobile radios and desk calculators (2N1124); servo amplifiers, voltage regulators and pulse amplifiers (2N1125, 2N1126, 2N1127); medium power audio and switching applications (2N1128, 2N1129, 2N1130).

Also available in quantities 1-99 from your local Philco Industrial Semiconductor Distributor.

Make Philco your prime source of information for all transistor applications. Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. E 259.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Vce Max. (Volts)</th>
<th>Vces Max. (Volts)</th>
<th>Peak Ic (Amps)</th>
<th>P Max. (Watts)</th>
<th>F (MC)</th>
<th>Beta</th>
<th>Applications</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N1124</td>
<td>40</td>
<td>35</td>
<td>0.5</td>
<td>0.3</td>
<td>0.4</td>
<td>40</td>
<td>For high voltage general purpose use in amplifier and switching. Small signal beta controlled.</td>
<td>$1.30</td>
</tr>
<tr>
<td>2N1125</td>
<td>40</td>
<td>40</td>
<td>0.5</td>
<td>0.3</td>
<td>1.0</td>
<td>50-150</td>
<td>0.5</td>
<td>For high voltage, higher frequency industrial amplifier and switching systems. Large signal beta controlled.</td>
</tr>
<tr>
<td>2N1126</td>
<td>40</td>
<td>35</td>
<td>0.5</td>
<td>1.0</td>
<td>0.4</td>
<td>40</td>
<td>1 watt version of 2N1124 for servo amplifiers and relay actuators. Small signal beta controlled.</td>
<td>$1.80</td>
</tr>
<tr>
<td>2N1127</td>
<td>40</td>
<td>40</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>50-150</td>
<td>0.5</td>
<td>1 watt version of 2N1125 for servo amplifiers and control systems. DC beta controlled.</td>
</tr>
<tr>
<td>2N1128</td>
<td>25</td>
<td>18</td>
<td>0.5</td>
<td>0.15</td>
<td>1.0</td>
<td>70-150</td>
<td>0.5</td>
<td>For low distortion, high level driver and output application. Small signal beta controlled.</td>
</tr>
<tr>
<td>2N1129</td>
<td>25</td>
<td>25</td>
<td>0.5</td>
<td>0.15</td>
<td>0.75</td>
<td>100-200</td>
<td>0.1</td>
<td>For high gain general purpose amplifier and switching. Typical DC beta 105.</td>
</tr>
<tr>
<td>2N1130</td>
<td>30</td>
<td>0.5</td>
<td>0.15</td>
<td>0.75</td>
<td>50-105</td>
<td>0.1</td>
<td>For higher voltage, higher level amplifier and switching applications. Typical DC beta 125.</td>
<td>$0.95</td>
</tr>
</tbody>
</table>

Available in Production Quantities—Also Available from Local Distributors

PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA
Current Integration With Solion Liquid Diodes

Complementing transistors and vacuum tubes in control applications, the solion shows promise as a useful and versatile device. Units for integrating fluid pressures, flows and electrical currents are described.


As control elements, solions have special advantages over transistors and vacuum tubes at low frequencies because they permit reduction of power requirements, simplification of circuits and increased reliability and ruggedness. In many low-frequency applications, a single solion may replace a complete circuit assembly.

Electrochemical diodes can be produced in many configurations, one of which is shown in Fig. 1. A common design employs anodes and cathodes of equal area. A typical polarization characteristic for such a diode is essentially the same for either polarity. Diodes such as in Fig. 1 in which the anode and cathode areas differ greatly exhibit the familiar rectifier characteristic shown in Fig. 2.

Forward to reverse current ratios of 500 to 1 are obtainable. The reverse current characteristic is temperature sensitive and in a typical unit is about 1.5 percent current change per deg F. Maximum reverse voltage is 0.9 v for long unit life. It may be noted that operation of solions below 0.1 v for extremely low-frequency applications is superior to that of the best semiconductor diodes. Furthermore, solions can be made quite insensitive to vibration.

Visual Readout Integrator — The solion...
Typical solion units. At left is a visual readout integrator; at right, a linear detector.

The solion takes advantage of the fact that local concentration of iodine is changed by electrochemical reaction as current passes through the diode system. Figure 3 is a sketch of a visual readout integrator. It consists of two separate electrolyte chambers of different volume. A platinum electrode is located in each chamber and the two chambers are separated by a diffusion barrier such as a porous fritted disk or simply a small capillary tube. The diffusion barrier prevents mixing of the electrolyte in the two compartments by diffusion and convection while also maintaining a conductive path of electrolyte between the compartments. The usual electrolyte employed is an iodine-potassium iodide solution.

When current passes between the electrodes, iodine is reduced to iodide at the cathode and iodide is oxidized to iodine at the anode. The concentration of iodine in the two compartments is thus changed by the current flow in accordance with Faraday's law. Measurement of the iodine concentration provides an exact value of the number of coulombs flowing between the electrodes.

Iodine concentration can be determined visually or electrically. An aqueous solution of potassium iodide is a clear, colorless liquid, while the iodine solution has the familiar brown color. A change in iodine concentration in either compartment produces a color change in the solution. By visual comparison with a color chart, it is possible to determine the integrated value of the current which has flowed. Probable error of visual determination is about ten per cent. For many applications this simple visual readout is sufficiently accurate.

**CONCENTRATION VOLTAGE**—If greater accuracy is required, the degree of integration of the visual readout integrator can be measured with an electrometer. A difference in the concentration of iodine in the two chambers of the integrator results in a concentration voltage developing between the two electrodes. Depending on the concentration difference, this voltage will be as much as 50 to 100 mv.

Since the solion employs a reversible process, the integrator can be cleared or reset by reversing the direction of current flow between the two electrodes.

An example of an application of the visual readout integrator is an integrating sound exposure meter or noise dosimeter. A circuit for such a device is shown in Fig. 4. It consists of a microphone, two-stage transistor amplifier and a rectifying diode feeding a visual readout solion integrator. This device can be worn by a person exposed to dangerously high levels of noise. Any degree of sensitivity can be obtained by adjusting the amplifier gain.

The device can be made frequency-sensitive or it can be modified to integrate noise levels above some predetermined background level.

**ELECTRICAL READOUT INTEGRATOR**—It is possible to design an electrical readout integrator in which a sensitive electrometer is not required. The integral may be read continuously while integration is taking place without affecting its value, and the equilibrium time of the integral is less than one second.

If a pair of auxiliary electrodes are placed in the integral chamber, they have the characteristics of a solion diode. Since the saturation current is controlled by iodine concentration in the electrolyte, if the auxiliary electrodes are supplied with voltage from a separate battery and a microammeter is placed in the circuit, deflection of the microammeter is a measure of iodine concentration in the integral chamber. The meter can be calibrated directly in microcoulombs.

**Solion integrators are sensitive to temperature changes.** A temperature change affects the electrical resistance of the integrator and the diffusion rate of the iodine in the integral chamber. The...
resistance change usually can be made insignificant by deriving the input from a high impedance source. In Fig. 5A, the integrator readout is compensated with varistors.

TYPICAL APPLICATIONS—The electrical readout integrator lends itself to use in the design of a simple, accurate linear time base. The readout current increases linearly with time for constant current input, and can therefore be used as the input to the axes of an X-Y recorder.

Figure 5B shows the diagram of a time-base circuit. Readout current is temperature compensated by negative temperature coefficient resistor $R_t$. Resistor $R_m$ represents the input resistance of the current range of the X-Y recorder and must be considered in calculating the value of $R_t$. Linear time bases as long as one hour for full scale can be obtained using this circuit.

An electrical readout integrator can also be used as an amplifier to obtain power gain; however, it is not an amplifier in the sense that it faithfully reproduces the input signal. For a sine wave input a sine wave output is obtained with a phase shift of 90 deg. For a square wave input, a triangular wave output is obtained. Since it is an integrator, the amplitude of the output varies as $1/f$, where $f$ is the input signal frequency. The amplifier can be made to reproduce the input with a flat frequency response from 0.1 cps to about 2 cycles/hr by placing a capacitance of about 320 $\mu F$ in series with the input.

The power gain of this integrator used as an amplifier for a sine-wave input of 0.01 cps is 27 db. The upper frequency limit of the present amplifiers is about 0.5 cps.

LINEAR DETECTORS—It is possible to use the same principle in the design of a flow or pressure detector. A solion linear detector consists of two electrolyte chambers separated by a small orifice as shown in Fig. 6. For linear response this orifice is usually a narrow slit. The detector cathode is located inside the orifice. A battery causes iodine to be reduced at the separator cathode and iodide is oxidized to iodine at the anode. This results in a concentrated iodine solution in the anode chamber and a dilute iodine solution in the separator chamber. Iodine in the orifice is reduced to iodide at the detector cathode. Lack of iodine at the cathode then causes the current indicated by the microammeter to drop to an extremely low value. This can be as low as 10 $\mu A$. This background current results from diffusion of a small amount of iodine from the concentrated solution into the orifice.

If the diaphragm on the concentrated side is deflected, iodine is forced through the orifice, producing a reaction at the cathode and causing an increase in current.

For a detector operating linearly, the current output is given by the equation $I = F N dV/dt \times 10^7$, where $F$ is the Faraday, $N$ is the normality of the reducible substance on the anode side, and $dV/dt$ is the flow rate in cm/sec. If the iodine normality is 0.1, flow rates as low as $10^{-5}$ cm/sec yield currents in the neighborhood of 100 $\mu A$, or approximately 10 times the background current. With suitable design of the detecting cathode, linear outputs can be obtained over a range of four orders of magnitude in flow rates.
Slot-Antenna Array

By E. J. Wilkinson,

This component is approximately in phase quadrature with the dipole current over the region near the center of the slot hence induces a slot aperture field which is also in phase quadrature with the dipole current.

Since the center of phase of the dipole is coincident with that of the slot, approximate circular polarization results when the tilt angle is adjusted for dipole and slot radiation of equal magnitude, radiation from dipole being orthogonally polarized to that of the slot.

Tuning

Exact circularity is achieved by tuning the slot, that is, adjusting the depth of the short-circuited rectangular waveguide section behind the aperture. Thus the phase of the vertically polarized wave reflected back to the aperture is varied. The resultant vertically polarized radiation is brought into exact phase quadrature with the horizontally polarized radiation. This compensates for two things: first, the small vertically polarized component radiated by the tilted dipole, second the lack of exact phase quadrature between the excitation field of the dipole and the dipole current.

Adjustment of depth also varies the magnitude of the resultant vertically polarized radiation, but this presents no problem since the tilt angle of the dipole varies the magnitude approximately independent of the phase when the conditions for circular polarization are approached.

Radiation Pattern

The principal plane patterns of a dipole-excited slot are shown in Figs. 2 and 3. Axial ratios are of the order of 1 or 2 db over ±45 deg of the pattern maximum. The symmetry of the patterns for the various components indicate that the orientation of the polarization ellipse remains fixed. The beamwidth for good circularity is limited primarily by the width of the dipole pattern in the plane transverse to the slot.

Figures 4 and 5 show the coverage of the circularly polarized slot when mounted in a missile. Figure 6 is a sketch of the missile configuration used for taking these patterns.

The above radiation characteristics can be maintained over about a 20-percent bandwidth. Matching to a 50-ohm line over the same 20-percent band is accomplished as follows: The dipole is folded. This action raises its radiation resistance which was initially quite low due to the proximity of the metal ground plane and slot; the length of the dipole is adjusted; and the length of the short-circuited split cylinder line used to support the dipole is adjusted. Figure 7 is a sketch of the folded dipole probe assembly. The resultant impedance characteristic is shown in Fig. 8. The vswr is less than 1.8 over the band.

Polarized Slot

The circularly polarized slot is also suitable for use as an element in an electronically scanned array. Decoupling between terminals of adjacent circularly polarized slots as a function of center-to-center spacing in wavelengths is shown in Fig. 9. Compared to other types of elements the decoupling is relatively high, especially for spacings under a half wavelength. This is important since close spacings are required for wide-angle scanning and the interaction between sources connected to the terminals of the elements should be kept small.

February 27, 1959 – ELECTRONICS
for Missiles and Aircraft

Simple modification of a linearly polarized slot radiator achieves circular polarity for antenna array used on missile. Signal mismatch, caused by motion of missile in flight is minimized, making ideal missile array

FIG. 1—Slot antenna fed by a dipole mounted in the plane of the aperture. Angular orientation is adjustable

FIG. 2—Relative one-way power in db is plotted against angle. Patterns are taken in the plane of missile axis

FIG. 3—Patterns taken in plane transverse to missile axis. Plot shows relative power in db against angle

FIG. 4—Smith chart plots show maximum and minimum coverage of circularly polarized slot taken in plane of missile axis

FIG. 5—Plots show maximum and minimum coverage of circularly polarized slot taken in plane transverse to missile axis

FIG. 6—Sketch of missile configuration shows location of slot antennas used to obtain circular polarization

FIG. 7—Sketch of folded dipole slot probe assembly for circular polarization

FIG. 8—Smith chart plot of input impedance against frequency

FIG. 9—Plot of decoupling against spacing in wavelengths

ELECTRONICS — February 27, 1959

World Radio History
Carcinotron Harmonics

Superheterodyne receiver affords continuous frequency coverage from 30 mc to greater than 75 kmc by application of harmonic mixing. Carcinotron that is voltage-tunable from 2 to 4 kmc serves as local oscillator for two separate r-f systems, providing exceptionally broad tuning range.

Use of antenna scale modeling techniques and the development of wide-frequency antenna pattern ranges have created the need for sensitive wide-frequency range receiving systems for antenna pattern measurements.

The superheterodyne receiver to be described features continuous frequency coverage from 30 mc to greater than 75 kmc without the use of plug-in units. Sensitivities better than 30 db greater than the conventional crystal-video detection system or from -70 to -90 dbm are attainable over the full frequency range. Other important features provide square-law (d-bm) detector output for the antenna pattern recorder, reception of c-w or square-wave modulated signals, 40-db dynamic range, linearity to 1.0 db and a-fc action over the full dynamic range.

Operating Principle

A block diagram of the wide range receiving system is shown in Fig. 1. The extremely broad tuning range of the receiver is obtained by the use of two separate r-f systems. The tunable local oscillator, used with both r-f systems, is a type QK518 or QK691 backward-wave oscillator or Carcinotron. This tube is voltage tunable over a frequency range of from 2 to 4 kmc with a minimum power output of 250 mw.

A 1-kc modulation component is added to a received c-w signal sweeping the Carcinotron voltage-tunable delay line with a 1-kc sawtooth voltage of sufficient amplitude to frequency modulate the local oscillator over a range of several megacycles. This voltage is synchronized with a 1-kc oscillator. During operation of the receiver from 2 to 75 kmc, the Carcinotron output is fed through an adjustable attenuator to the local oscillator arm of a frequency-selective tee. This tee couples the local oscillator signal through RG-55 U cable to an appropriate crystal mount or mixer located at the terminal of the receiving antenna. The capacitance of the crystal holder on the crystal mount is reduced to a minimum to provide low VSWR on the coaxial transmission line.

The Carcinotron delay line voltage required to tune the receiver to a specific frequency can be determined to within ± 5 percent by referring to a receiver tuning chart. The delay line voltage is metered for the purpose of tuning. The Carcinotron is tuned to obtain a 65 mc difference signal between the local oscillator fundamental or harmonic and the received signal. Normally, reception can be obtained at two local oscillator frequencies spaced 135 mc apart, either of which may be used. The 65-mc i-f signal is coupled by the coaxial cable from the crystal mount to the frequency-selective tee through which it is channeled to the 65-mc i-f amplifier.

Double Conversion

The low-frequency r-f system employs double conversion to permit reception in the frequency range of from 30 to 2,000 mc while using the Carcinotron as the tunable local oscillator. A low-frequency antenna is coupled through a 50-ohm coaxial cable to the first mixer. The Carcinotron output is fed through the variable attenuator into the local oscillator input of the first mixer. A signal in the frequency range of from 30 mc to 2 kmc reaching the first mixer is converted to a 2.1-kmc i-f signal by tuning the two 2.1-kmc higher. The high-Q cavity, located between the first mixer output and the second mixer input, provides the first i-f selectivity. The 2.035-mc second local oscillator signal is fed into the second mixer and converts the first i-f signal into a 65-mc

FIG. 1—Wide-range receiving system applied to antenna pattern recorder system
Boost Receiver Range

By C. H. CURRIE,
Chief Electronics Engineer,
Scientific-Atlanta, Inc.,
Atlanta, Georgia

second i-f which enters the i-f amplifier.

This circuit is a synchronous single-tuned amplifier with a half-
power bandwidth of 1 mc. Frequency modulation of the Carcino-
tron output, provided by a saw-
tooth voltage applied to the delay line, causes an i-f signal, de-
veloped from a c-w receiver input signal, to be swept across the pass-
band of the i-f amplifier. This action results in an i-f amplifier signal output with an envelope representing the band-pass characteristics of the i-f amplifier. The amplifier characteristic is shaped so that the output signal envelope displayed on the monitor oscilloscope has the general appearance of a half-loop sine wave.

Video Outputs

Two separate i-f amplifier video outputs are provided. The first, a linear output derived from a crystal detector, is fed to the vertical de-
fection amplifier of the monitor oscilloscope and to the afe amplifier. The second is derived from a square-law bolometer detector and is coupled through a 1-kc band-
pass filter to the output connector for the antenna pattern recorder.

The receiver includes an afe system which compares the phase of the 1-kc i-f amplifier output envelope with that of the sweep volt-
age applied to the Carcotron delay line. The afe phase detector develops an error voltage proportional to the magnitude and direction of displacement of the crest of the i-f amplifier output waveform with respect to the center of the sawtooth sweep voltage. This error voltage controls the Carcino-
tron delay line voltage so as to op-
pose a phase displacement. This results in an automatic shift of the Carcotron frequency to compen-
sate for a change in the received signal frequency. By the use of a narrow-band limiting afe amplifier, stable afe operation is obtained over a dynamic signal range of 45 db or more.

When receiving a square-wave modulated signal, the transmitted signal modulation is adjusted to a frequency of approximately 900 cps. This assures that the antenna pattern recorder pen will not re-
respond to the beat frequency be-
tween the square-wave modulation and the 1-kc internal oscillator.

Harmonic Mixing

Frequency multiplication to the microwave region is often accom-
plished by harmonic generation in a silicon crystal.

A more efficient means of using the crystal harmonic generator in a superheterodyne receiving system is harmonic mixing. Harmonic mixing is a method of generating the harmonic local oscillator signal and mixing in the same crystal.

A microwave crystal holder which may be used for this purpose is shown in Fig. 2. The fundamental local oscillator signal is introduced through the coaxial output jack and is applied across the crystal. With sufficient applied power, the non-
linear crystal characteristic results in a local oscillator signal across the crystal which is rich in harmonics. Mixing takes place by the application of the signal to this same crystal and by adjusting the local oscillator fundamental frequency for the proper harmonic relationship to provide the required i-f sum or difference frequency.

Since the frequency of the signal
and that of the local oscillator harmonic differ only by the i-f frequency, proper adjustment of the movable short provides a maximum of both signal and harmonic power at the crystal. The i-f signal appears across the coaxial output jack and is propagated down the same cable which couples the local oscillator fundamental signal to the crystal.

Harmonic mixing considerably reduces the fundamental local oscillator power that must be furnished to the crystal as compared to the method using a conventional mixer. The problems of harmonic transmission and isolation of the harmonic generator from the mixer do not arise with harmonic mixing.

**Oscillator Power**

To permit harmonic mixing for the reception of signal frequencies above 1 kmc, it is necessary to supply more local oscillator power to the crystal mixer than would normally be required for fundamental operation. Since this local oscillator signal is supplied to the mixer through a section of coaxial cable varying in length from 15 to 75 feet, power loss in this cable must be overcome. The power output of the QK518 oscillator is sufficient for this purpose.

The crystal holders used with the receiver are conventional holders normally used for video detection. It has been found that a reduction of the crystal holder output jack capacity to a minimum is required to provide a better match of the transmission line to the crystal. The 50-ohm output impedance of the QK518 is matched primarily by the adjustable attenuator and the length of 50-ohm RG-59 U cable.

While the impedance match between the QK518 and the crystal cannot be ideally maintained over the entire tuning range, a sufficient match is obtained to maintain adequate crystal current at all frequencies. During normal tuning of the receiver, the d-c crystal current variation does not generally exceed a ratio of 4 to 1. Part of this variation results from the normal power fluctuation of the QK518 during tuning.

**Current Range**

It has been found that a range of d-c crystal currents of from 1 ma at 10 kmc to 4 ma at 60 kmc is sufficient for harmonic mixing. This represents an approximate range of fundamental local oscillator power applied to the crystal of from 1 mw to 10 mw. The optimum value of crystal current is determined by adjusting the local oscillator power applied to the crystal for a maximum signal-to-noise ratio. The normal values of crystal current are not excessive for the standard crystals. Continued use of crystals operating under these conditions has shown no noticeable loss of sensitivity from effects of crystal current.

**Frequency-Selective Tee**

The use of a single coaxial input cable from the crystal mixer to the receiving system requires that two-way signal transmission take place. This consists of the transmission of the local oscillator signal from

---

**Fig. 4**—Attenuation of low-pass filter

**Fig. 5**—Vswr of frequency-selective tee

**Fig. 6**—Control unit of receiver system provides centralized control and monitoring facilities. Automatic frequency control provides dynamic
the receiving system to the crystal mixer and the transmission of the i-f signal in the opposite direction. This method of operation requires that a frequency-selective tee be employed to provide signal separation and isolation.

The frequency-selective tee developed for this purpose is shown in Fig. 3. The local oscillator signal is introduced into arm A and is coupled through the 15-puf capacitor to arm B. This section of the frequency-selective tee acts as a 50-ohm transmission line for frequencies between 2 and 4 kc. Arm C is isolated from the transmission path at these frequencies by the transmission-line filter located in arm C. This filter is a varying-impedance low-pass filter with a frequency cutoff at 1.2 kc. The filter consists of six low-pass sections which provide an attenuation characteristic as shown in Fig. 4.

The lumped capacitance located in arm A has negligible reactance to the 2- to 4-kc local oscillator signal. The vswr of the transmission line from A to B is maintained at less than 2 to 1 over the local oscillator frequency range as shown by Fig. 5.

The second transmission path of the frequency-selective tee is from arm B to arm C. The i-f signal entering arm B is partially isolated from arm A by the reactance of the lumped capacitance. The transmission-line filter located in arm C appears as a low loss, 50-ohm transmission line to the i-f signal. The isolation of arm A afforded by the 15-puf capacitor is sufficient to provide negligible i-f signal loss. The path from arm B to arm C furnishes d-c continuity permitting crystal current to be monitored in the receiving system.

Control Unit

Centralization of the controls and meters necessary for adjusting and monitoring the receiving system is provided by the control unit shown in Fig. 6.

Input to the afc amplifier circuit is obtained from the crystal detector output of the i-f amplifier. The input waveform is the 1-ke sine wave to the grid of V.. A new circuit for the afc amplifier is shown in Fig. 7. Stages V.., V., and V., are cathode-coupled clippers which symmetrically limit the 1-ke signal and furnish a 1-ke sine wave to the grid of V.. The output from the phase detector is coupled to the grid of amplifier V.. Stage V.., IT. and V., are cathode-coupled cathode follower stages with a frequency characteristic of 1 kc.

The phase shifter and the i-f amplifier input circuit is a high-gain selective stage comprised of V., and tuned circuit L.C. This selective stage removes the harmonic components from the input signal and furnishes a 1-ke sine wave to the grid of V.,. Stages V., V,, and V., are cathode-coupled clippers which symmetrically limit the 1-ke signal and provide a clean output with a constant amplitude over a dynamic range of input signals of greater than 50 db.

Afc Circuit

Input to the afc amplifier circuit is obtained from the crystal detector output of the i-f amplifier. The input waveform is the 1-ke sine wave to the grid of V.. A new circuit for the afc amplifier is shown in Fig. 7. Stages V., V., and V., are cathode-coupled clippers which symmetrically limit the 1-ke signal and furnish a 1-ke sine wave to the grid of V.. The output from the phase detector is coupled to the grid of amplifier V..

Transformer T. in the plate circuit of V., couples the 1-ke sine wave to the afc phase detector. The phase detector compares the phase of this signal with the phase reference signal obtained from the output of V.. The phase detector output is a d-c voltage which appears across afc gain control potentiometer R.. For a 90-deg phase relationship between the phase signal and the phase reference voltage, detector output is zero; for a 0 or 180-deg phase relationship, the output is either ±30 v d-c. The output voltage metered by M. is coupled to a differential amplifier in the Carcinotron power supply.

The phase detector output is a d-c voltage which appears across afc gain control potentiometer R.

Input to the afc amplifier circuit is obtained from the crystal detector output of the i-f amplifier. The input waveform is the 1-ke sine wave to the grid of V.. A new circuit for the afc amplifier is shown in Fig. 7. Stages V., V., and V., are cathode-coupled clippers which symmetrically limit the 1-ke signal and furnish a 1-ke sine wave to the grid of V.. The output from the phase detector is coupled to the grid of amplifier V..

Transformer T. in the plate circuit of V., couples the 1-ke sine wave to the afc phase detector. The phase detector compares the phase of this signal with the phase reference signal obtained from the output of V.. The phase detector output is a d-c voltage which appears across afc gain control potentiometer R.. For a 90-deg phase relationship between the phase signal and the phase reference voltage, detector output is zero; for a 0 or 180-deg phase relationship, the output is either ±30 v d-c. The output voltage metered by M. is coupled to a differential amplifier in the Carcinotron power supply.

Switch S. in the off position removes the 1-ke sine-wave signal from the grid of V.. This provides zero phase detector output voltage and permits meter balance potentiometer R. to be adjusted for a zero afc null meter reading.
Two-Terminal

Tabulation of important characteristics of commercially available \(pnpn\) and \(pnpm\) semiconductor switching diodes. Note differences between symbols

By T. P. SYLVAN, Application Engineer, Semiconductor Products Dept., General Electric Co., Syracuse, N. Y.

During the past two years, a number of solid-state switching diodes have been introduced commercially. All of the presently available diodes of this type are listed in Table 1. Specifications listed are for illustration only.

All diodes listed are \(pnpn\) or \(pnpm\) devices with two terminals. Figure 1A shows construction of the diodes together with terminology used to designate various regions and junctions. In accordance with proposed AIEE standards, the various junctions and regions are labeled according to their function and a subscript is used to designate the type of semiconductor material. This method avoids any ambiguity in identifying the regions of a \(pnpm\) device. A number of manufacturers have introduced their own symbols for their devices which are given also in the table as are the present IRE symbols. General voltage-current characteristic of a switching diode is shown in Fig. 1B. Forward voltage and current \((V_f, I_f)\) correspond to the quadrant in which the switching characteristics occur. The reverse voltage and current \((V_r, I_r)\) correspond to the opposite quadrant. Maximum forward voltage which the device can maintain is called the breakover voltage, \(V_{br}\), and the current at this point is called the breakover current \(I_{br}\).

A switching diode can be turned on by momentarily exceeding the breakover voltage. The device will then remain in the on condition as long as a forward current flows which is greater than the hold-

### TABLE I—Trade Names, Symbols, Characteristics of Commercially Available

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Manufacturer</th>
<th>Type Number and Material</th>
<th>Structure, Manufacturer's Symbol</th>
<th>AIEE Symbol</th>
<th>IRE Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynistor</td>
<td>Westinghouse</td>
<td>WX806 (Ge)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four-Layer Diode</td>
<td>Shockley Transistor Corp.</td>
<td>4N20D to 4N200D (Si)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four-Layer Diode</td>
<td>Shockley Transistor Corp.</td>
<td>4N20AD to 4N200AD (Si)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four-Layer Diode</td>
<td>General Transistor Corp.</td>
<td>(Ge)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching Diode</td>
<td>ITT Labs</td>
<td>CP-622 (Ge)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching Diode</td>
<td>ITT Labs</td>
<td>CP-624 (Si)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Solid-State Switches

If the forward current falls below \( I_f \) for a short time, the device will turn off and revert to the blocking state.

Reverse voltage-current characteristic of a \( pnpn \) diode may exhibit a blocking characteristic similar to that of a conventional rectifier as shown by the solid line in Fig. 1B. For a device having this type of reverse characteristic, the peak inverse voltage and reverse breakdown voltage are measured and specified in a manner similar to that employed with conventional rectifiers.

For some devices the reverse voltage-current characteristic exhibits a conducting characteristic as shown by the dotted line in Fig. 1B. When devices of this type are used in applications where they must withstand a reverse voltage, a series rectifier must be used. A series rectifier will increase total forward voltage drop and reduce switching efficiency.

In the next issue of ELECTRONICS, three-terminal solid-state thyatrons will be tabulated.

REFERENCES


### Solid-State Switching Diodes

<table>
<thead>
<tr>
<th>Range of ( V_{RB} )</th>
<th>Forward Voltage Drop at Rated Current</th>
<th>Turn On Time</th>
<th>Reverse Characteristic</th>
<th>Essential Characteristics</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-200 V, 10-100 mA</td>
<td>0.9 V, 50 ma</td>
<td>0.1 sec</td>
<td>Conducts</td>
<td>Low turn-on time</td>
<td>(1) (2)</td>
</tr>
<tr>
<td>20-200 V, 10-100 mA</td>
<td>1.0 V, 300 ma</td>
<td>0.1 sec, 0.3 sec, (300 ma)</td>
<td>Blocks</td>
<td>Low breakdown currents, close control of breakdown voltage, pulse currents to 2 amp</td>
<td>(1) (2)</td>
</tr>
<tr>
<td>50-100 V, 5-50 ma</td>
<td>0.5 V, 500 ma</td>
<td>Blocks</td>
<td>Same as above except pulse currents to 20 amp</td>
<td>(1) (2)</td>
<td></td>
</tr>
</tbody>
</table>

**FIG. 1—Schematic diagram and terminology for a \( pnpn \) diode (A) and characteristic curve of \( pnpn \) diode with zero base current (B)**

P-N-P N-Terminal Switches, Proc IRE, 51, p 1371, Aug. 1956


Amplitude Slicer

Rectangular waveform, obtained by simple circuit, represents a pulse width proportional to the time spent by the signal between specified voltage levels. Circuit is used to determine probability amplitude density functions

By T. A. BICKART, The Johns Hopkins University School of Engineering, Radiation Lab., Baltimore, Md.

When seeking information of probability amplitude density functions in statistical measurements of signals, noise and/or determinate signals it is necessary to design a circuit capable of yielding a rectangular output pulse that has a width proportional to the time spent by the input signal between specified voltage levels. This relationship is shown in Fig. 1.

A number of circuits have been developed to produce such characteristics, however these methods required excessive circuitry. This paper describes a simplified technique that obtains the desired output with minimum components.

The Schmitt trigger serves as the basic building block for the amplitude window. But since off-on triggering occurs at a single level, the familiar Schmitt circuit is modified so that triggering will also take place on a second and higher voltage level. Although a conventional dual control pentode such as a 5725 will work, a pentagrid amplifier was used for its higher second control grid to plate \( g_m \).

**Triggers**

In the experimental circuit developed, Fig. 2, the pentagrid amplifier \( V_1 \) turns off the plate current after the grid passes through the second voltage level. The pentagrid is operated with the second control grid clamped to the cathode during normal triggering.

The grid potential of \( V_1 \) is lifted to the triggering level by the cathode output of a phase splitter. After the input signal triggers \( V_1 \) on, it continues to increase to a second trigger level through the coupling of the plate of \( V_1 \) to the screen grids of the pentagrid. While \( V_1 \) is on, the rising input signal continues to bring the potential of the plate of \( V_1 \) down. This unclamps the suppressor from the cathode of \( V_1 \) and continues to decrease the suppressor voltage, caus-
for Signal Analysis

Circuit takes up a minimum amount of space

The rising plate voltage in $V_1$ brings $V_1$ to its grid cutoff potential. Regenerative action triggers $V_1$ on and the plate circuit of $V_1$ off. After the second trigger operation has taken place, it is necessary that the cathode current of $V_1$ not go to zero. This would occur if the cathode were to become so positive as to exceed the control grid potential by more than the cutoff potential. If this did happen, then reducing the input signal level to a point which brings the suppressor into clamp with the cathode would not cause $V_1$ to trigger on, and $V_1$ off, for there would be no screen current to switch to the plate and cause the triggering action.

Barring this situation, $V_1$ is triggered on and $V_1$ off as the signal returns through the second trigger level. After passing back through the first trigger level, the circuit returns to its normal state.

Additional circuit considerations led to the clamping of the grid of $V_1$ at a potential slightly higher than the cathode potential of $V_1$, with the cathode current of $V_1$ cut off. This, in effect, prevents the phase splitter from increasing the cathode potential of $V_1$ and $V_2$ as the second trigger level is reached through the suppressor circuit. For, if the cathode potential were to increase too far, the second trigger action could not take place, as the rising potential of $V_2$ would not bring $V_1$ to cutoff.

A caution is necessary: if the clamping potential is too low, the gain of the circuit cannot be made unity as $V_1$ is brought into the conducting stage.

The hysteresis encountered, as in the regular Schmitt circuit, can be treated in a normal manner.

**Window Width**

With the window-width adjust, $R_4$, set to maximum value thus yielding maximum window width, signals are triggered between 8.5v and 6v at the first input triggering level. At the second level, signals are triggered between 22v and 21.2v. Attempts to reduce the hysteresis below 2v have resulted in the loop gain falling below unity so that the operation is no better than a clipping and gating circuit.

Clamping the plate of $V_1$ with IN100 diodes allows a rise or decay time, $0.1 E_1$, to $0.9 E_1$, of 0.4 µsec and a minimum output pulse width of 2 µsec. Circuit waveforms at critical points are shown in Fig. 2.

The window width can be varied from about 13v to 10v by $R_4$. Further reduction results in faulty operation due to unclamping of the second control grid before the circuit has passed through its first triggering level. The window may be adjusted for a look at a given percentage of the peak-to-peak input signal at a particular level.

A circuit to obtain a trigger on the negative portion of the input signal, Fig. 3, includes a clipping network and a level-control modification: insertion of a clamp. In essence, the clipper slices a portion out of the input signal which is wider than the window width and the clamping diode clamps the negative portion of the clipped waveform at a potential just smaller than the first triggering level.

This work was carried out under contract AF33-6616-3374.

**REFERENCES**

By ROBERT B. DOME, Consulting Engineer, Television Receiver Dept., General Electric Co., Syracuse, N. Y.

Inexpensive Sound for

Readily available low-cost tubes and components are used for new sound system. Features are: a-m compression from 12 to 24 db; peak-to-peak a-f output of 60 v with cancellation of undesired a-m fundamental.

DEVELOPMENT of the Delta sound system for tv receivers was undertaken in an effort to make available a less-expensive sound system than the ratio detector.

The Delta system consists of four principal parts: The first is a 4.5-mc pentode amplifier fed from a take-off circuit connected or coupled to the plate circuit of the receiver video-frequency amplifier. Second is a diode a-m compressor connected or coupled to the plate circuit of the 4.5-mc pentode amplifier. The third part is an f-m detector consisting of a discriminator circuit and a triode operating as a power detector (bias detector or plate-bend detector) with provision for canceling out residual fundamental frequency a-m. The fourth part consists of a volume control, audio power amplifier and loudspeaker.

The three features that distinguish the system are a-m compression, high-level audio output f-m detection and fundamental frequency a-m cancellation.

Cost Analysis

An analysis of the ratio-detector system showed that expensive items were the 6T8 triple diode high-mu triode, the elaborate triple-winding discriminator transformer and the electrolytic capacitor in shunt with the detector self-bias resistor.

The ratio detector has good a-m rejection characteristics and the output is balanced for a-m. Its output is low, however, because of the relatively low impedance of the detector system. Because of this factor, it was necessary to add a stage of a-f amplification between the detector and power amplifier.

The schematic diagram of the Delta sound system as applied to a portable tv receiver is shown in Fig. 1. Inductance L, is adjusted to maximize the 4.5-mc drive to the 3AU6. Transformer T, is a bifilar coil. Its inductance is adjusted to tune the capacitance in shunt with the coil to 4.5 mc. Coil L, is tuned with its 150-µf1 shunting capacitor to a frequency slightly above 4.5 mc.

The pentode amplifies the incoming 4.5-mc signal. When the r-f voltage between grid and ground is of sufficient magnitude, the tube acts as an a-m limiter. Output of the pentode is applied to the diode circuit to reduce the percentage modulation of any a-m present. Amount of compression has been
Television Receivers

measured in the range from 12 to over 24 db.

The resultant r-f wave now only lightly modulated in amplitude, excites the grid-cathode elements of the triode. This excitation is received as follows: The 100-μf capacitor is chosen so that some r-f exists across it as part of the tuned-circuit current in transformer T. Voltage across the 100-μf capacitor is transferred to the triode grid through the 0.047-μf capacitor and tank circuit consisting of I and the 150-μf capacitor.

The tank circuit in conjunction with the capacitance between the triode grid and ground forms a frequency-selective or discriminator circuit whereby amplitude of the r-f signal at the grid is a function of the r-f. The grid-cathode region of the tube rectifies this r-f voltage and causes a bias to be developed as the result of grid-current flow through the 10-megohm grid leak. This voltage is stabilized by the relatively large 0.047-μf capacitor so that the triode can act as a power detector for r-f envelope changes at a-f rates.

Any residual a-m not removed by the diode compressor will also be detected by the triode. For example, during a positive-going a-m cycle, plate current of the triode will increase. This causes a negative-going audio pulse to appear at the audio output terminal. Cancellation of this effect is achieved as follows: The same positive-going a-m cycle at the diode rectifier will cause a negative-going audio pulse to appear across the 3,000-ohm a-m rejection control resistor in series with the 0.15-μf capacitor. Since the triode grid is coupled to this point by the 0.047-μf capacitor, the grid receives a negative-going pulse. The triode amplifies this pulse in the normal manner of an amplifier causing the plate current to decrease giving a positive-going audio pulse at the audio output terminal. By choosing the rejection control resistor to provide just the right amount of cancelling voltage, the fundamental frequency component of the disturbing a-m may be removed or reduced to a low level.

Diode Compressor

Function of the diode is to compress the undesired a-m that may be present on the incoming f-m signal. The principle upon which compression depends is that of a dynamic change of the r-f load line in the pentode plate circuit.

Figure 2 shows the elements making up the diode compressor together with the operational characteristics. Curve 1 represents the peak r-f output voltage obtainable as a function of pentode r-f grid voltage e, when the diode is made inoperative by turning off its heater supply. This load is the usual tuned circuit loss load R. Curve 2 represents the peak r-f voltage obtainable when the diode is permitted to rectify so that the additional load of supplying the diode plate loss and the power dissipated in the d-c load resistance R is placed in shunt with the initial circuit loss resistance R. Curve 3 represents the direct voltage obtained across load resistor R.

Suppose there is no a-m present and the input is e, as shown by the dotted line in Fig. 2. This dotted line intersects curves 2 and 3 as shown. If a sudden negative pulse of a-m occurs, e, drops. The diode rectifier will continue to rectify un-
til the peak r-f output voltage reaches the direct voltage stored across capacitor C. To find where this occurs on curve 1, draw the horizontal line from the intersection of the dotted line with curve 3 until it intersects curve 1. This horizontal line is shown by long dashes. Now drop a perpendicular from the last-named intersection to the $e_v$ axis at $e_v$. Thus, it is deduced that the downward modulation capability of the diode compressor before it becomes ineffective is given by

$$m = 1 - \frac{e_v}{e_v}$$

Meanwhile, the change in level of the voltage $e$ across the tank is the voltage difference between curves 2 and 3 along the dotted line. If the downward modulation by this change is called $M$, then

$$M = 1 - \eta$$

where $\eta$ is the diode rectification efficiency factor.

The modulation compression factor, expressed as a number greater than unity is

$$\eta = \frac{m}{M} = \frac{1 - e_v}{1 - \eta}$$

If $\eta = 5$, it means that the residual modulation is $\frac{1}{5}$ of the uncompressed modulation. Examination of the equation shows that the amount of compression increases as $\eta$ improves or approaches unity.

**Discriminator**

The discriminator circuit is a simple one consisting of two capacitances and one inductance. Since one of the two capacitances is the input capacitance to a tube, the physical parts of the discriminator reduce to only one capacitor and one inductor.

The r-f circuit is shown in Fig. 3. A source of f-m waves, $e_v$, feeds a network consisting of a shunt-tuned tank circuit $L_C$, in series with the tube input capacitance $C$. A resistance $R$ across $L_C$ represents the effective resistance of the tank caused by tank-circuit losses. The ratio of $e_v$ to $e_v$ is

$$\frac{e_v}{e_v} = \left(\frac{Q}{1 + (a+1)Q} + 1\right)$$

assuming that

$$a = C_1 + \left(C_2 + C_l\right) / C_1$$

or $C_1 = C_2 / (a - 1)$

$$L_C = \frac{1}{\omega_0^2}$$

$$Q = \frac{R}{\omega_0 L}$$

Figure 4 shows plots of the magnitude of $e_e$ for various $Q$'s for $a = 1.04$. Translated to 4.5-mc terms, a variation of 0.011 is equivalent to 50 kc which is the maximum peak-to-peak deviation. A reasonably linear section of the curve $Q = 50$ or $Q = 100$ curve may be used centered at about 0.986.

In the discriminator circuit, wider separation of peaks is obtainable by increasing the factor $\eta$. Flatter slopes and, at the same time, wider peak separations are obtainable with lower $Q$'s. For example, if a 3AV6 triode section is used, input capacitance (tube, socket and strays) is about 6 $\mu\mu f$. With $a = 1.04$, the tank capacitor across $L_C$ is

$$C = \frac{6}{a - 1} = \frac{6}{1.04 - 1} = 150 \mu\mu f$$

The tank is tuned to

$$L_C = \frac{1,500 k}{0.085} = 15,630 k$$

Fixed bias for the power detector may be obtained from a suitable negative voltage elsewhere in the receiver or it may be self-generated. A grid leak of 10 megohms is used. An audio coupling capacitor of about 0.05 to 0.1 $\mu f$ will keep distortion at low audio frequencies at reasonably low levels.

**A-M Cancellation**

The fundamental component of the undesired a-m is cancelled by returning the grid-leak bypass capacitor through the a-m rejection-control resistor to ground instead of directly to ground. Value for this resistor will vary depending upon other circuit values and tube characteristics. The range of values is usually somewhere between 500 and 2,000 ohms. It is suggested that in the design stage a 3,000-ohm rheostat be inserted in the circuit for this resistor and that it be adjusted for best a-m rejection or fundamental cancellation.

**Deemphasis**

The deemphasis time constant may be adjusted by selecting the proper capacitance for the capacitor which bypasses the triode anode to ground. Three resistances in parallel form the resistive component of the deemphasis network. They are the volume control, plate-coupling resistor and the internal plate resistance of the triode.

In a typical example, assuming the coupling resistor is one megohm, the potentiometer is 500,000 ohms and the tube plate resistance is 165,000 ohms, the total shunt resistance becomes 110,000 ohms. If the deemphasis time constant $\tau$ is 75 $\mu s$, the value of the plate bypass capacitor is

$$C = \frac{\tau}{R} = \frac{75 \times 10^{-6}}{110,000} = 0.80 \mu\mu f$$

**Detector Output Level**

With a B+ of 250 v for the detector tube and with a frequency deviation of $\pm 25$ kc, a peak-to-peak maximum audio voltage of about 60 v may be expected. The voltage depends on various circuit parameters so that it may be as low as 40 v or as high as 90 v depending upon the particular design. This level of voltage is sufficiently high so that a conventional audio power output tube may be driven directly from the detector.
Powdered Magnets

Recent advances in powder metals, ferrites and intermetallics have greatly increased range of pressed and sintered magnet properties

By George Sideris, Associate Editor

SINTERED or PRESSER powder permanent magnets are widely used in electronic components and instruments, particularly when large quantities of miniature magnets are required.

There has been considerable activity in this field in recent years. Table I summarizes properties reported for some of these magnet materials.

High resistivity of oxide-type magnets suits them for high frequency applications. Ferromagnetic properties of barium ferrite, particularly with substitution of iron oxide by aluminum oxide, has led to its consideration for uses at high microwave frequencies.

Research reports indicate that the full potential of superfine powders has not yet been attained with conventional materials. As with high-permeability core materials, properties can be varied widely with pressing technique.

MANUFACTURING—Conventional manufacturing techniques may be used to produce elongated single-domain magnets. Good tolerances are obtained without grinding, the magnets can be machined like cast iron, and soldered.

In processing bismahol, intermetallic crystals are produced from molten bismuth and powdered manganese. The compound is pulverized, then hot pressed in a magnetic field. Although its Curie temperature is 390°C, the bismuth will melt at 271°C and uncoated magnets corrode at room temperature.

In general, applications of sintered metals will take advantage of their physical strength, high remanence and energy product, or high-temperature stability. The oxides and ferrites give high coercive forces and resistance to demagnetization. As Table I shows, powders give a wide range of properties.

### Table I: Nominal Properties of Permanent Magnets Produced by Powder Metallurgy

<table>
<thead>
<tr>
<th>Material and Process</th>
<th>Composition (Balance: Fe)</th>
<th>Residual Induction (Kilogauss)</th>
<th>Coercive Force (Oersted)</th>
<th>BH max (Kilogauss)</th>
<th>Flux Density at BH max (Kilogauss)</th>
<th>Electric Resistivity (ohm cm)</th>
<th>Curie Density (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SINTERED ALLOYS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alnico V</td>
<td>10.8, 11.5, 12.5 Co, 6 Cu</td>
<td>10.8</td>
<td>11.5</td>
<td>1.5</td>
<td>11</td>
<td>63</td>
<td>300</td>
</tr>
<tr>
<td>Alnico V</td>
<td>12.4, 13.5, 15 Ni, 5 Co</td>
<td>12.4</td>
<td>13.5</td>
<td>1.25</td>
<td>3.1</td>
<td>63</td>
<td>760</td>
</tr>
<tr>
<td>Alnico V</td>
<td>3.1, 14 Ni, 21 Co, 3 Cu, 1 Ti</td>
<td>3.1</td>
<td>14 Ni</td>
<td>3.6</td>
<td>3.15</td>
<td>47</td>
<td>860</td>
</tr>
<tr>
<td>Bismahol, Canpol</td>
<td>12 Co, 17 Mo</td>
<td>12 Co</td>
<td>17 Mo</td>
<td>2.5</td>
<td>6.9</td>
<td>45</td>
<td>900</td>
</tr>
<tr>
<td>Canico</td>
<td>50 Cu, 21 Ni, 29 Co</td>
<td>50 Cu</td>
<td>21 Ni</td>
<td>2.5</td>
<td>0.55</td>
<td>21</td>
<td>360</td>
</tr>
<tr>
<td>Platinum-odeof</td>
<td>77 Pt, 23 Co</td>
<td>77 Pt</td>
<td>23 Co</td>
<td>1.1</td>
<td>3.3</td>
<td>23</td>
<td>600</td>
</tr>
<tr>
<td><strong>SINTERED OXIDES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vectolite</td>
<td>Fe-Co oxides</td>
<td>1.6</td>
<td>900</td>
<td>0.9</td>
<td>11</td>
<td>225×10⁶</td>
<td>540</td>
</tr>
<tr>
<td>Barium ferrite</td>
<td>Ba-Fe oxides</td>
<td>2.4</td>
<td>1,650</td>
<td>1.1</td>
<td>1.33</td>
<td>10×10⁶</td>
<td>450</td>
</tr>
<tr>
<td>&quot; oriented</td>
<td>Ba-Fe oxides</td>
<td>3.9</td>
<td>2,000</td>
<td>3.5</td>
<td></td>
<td>2×10⁶</td>
<td>360</td>
</tr>
<tr>
<td><strong>PRESSER POWDERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resin bonded</td>
<td>Fe-Co oxides</td>
<td>1.1</td>
<td>700</td>
<td>700</td>
<td>21.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bismahol</td>
<td>79 Bi, 21 Mn</td>
<td>1.3</td>
<td>3.650</td>
<td>5.3</td>
<td>2.64</td>
<td></td>
<td>475</td>
</tr>
<tr>
<td>Pure iron</td>
<td>Micropowder</td>
<td>5.6</td>
<td>300</td>
<td>600</td>
<td>1.1</td>
<td>3.65</td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>Elong single domain</td>
<td>5.7</td>
<td>4.8</td>
<td>500</td>
<td>600</td>
<td>1.1</td>
<td>3.65</td>
</tr>
<tr>
<td>Iron-odeof</td>
<td>Micropowder, 30 Co</td>
<td>6.7</td>
<td>6.8</td>
<td>500</td>
<td>425</td>
<td>1.1</td>
<td>3.65</td>
</tr>
<tr>
<td>&quot;</td>
<td>Elong single domain</td>
<td>6.8</td>
<td>6.8</td>
<td>655</td>
<td>425</td>
<td>1.1</td>
<td>3.65</td>
</tr>
<tr>
<td>Platinum-odeof</td>
<td>77 Pt, 23 Co</td>
<td>2.5</td>
<td>2,000</td>
<td>3.3</td>
<td></td>
<td>28</td>
<td>600</td>
</tr>
</tbody>
</table>

* At BH max of 1.1 * At BH max of 1.52 Mega gauss-Oersted
Circuits designed to provide clock signals for developing and testing large digital computers use readily available germanium transistors. Except for one oscillator, all transistors operate in either saturated or cutoff state. Other design techniques limit waste of transistor power so that system can provide peak load up to 5 amp.

By S. SCHOEN Data Systems, Norden Division, United Aircraft Corp., Gardens, Calif.

Transistors Provide

Development of several large digital data-processing systems required circuits to provide the basic timing and gating signals. Since the equipment is completely transistorized, use of transistors to generate the computer clock was investigated. Several system and circuit techniques that were used to provide controlling clock signals for digital computers containing several thousand transistors are described.

For this application, transistor switching circuits had to be capable of high speed and also of controlling high peak currents. Although reliability was the major design consideration, other factors included cost, component availability, ease of fabrication and interchangeability. For example, all circuits use commercially available germanium transistors.

Requirements

The clock circuits provide 0.25- to 0.6-µsec pulses with rise and fall times of about 0.1 µsec. Repetition rates are 150 to 750 kc. Peak transient load current is typically 3 to 5 amp. Load is primarily capacitive and may vary appreciably during the pulse.

The load consists mainly of normally nonconducting trigger transistor inputs to bistable circuits. Input impedance of these transistors under transient conditions is considerably influenced by whether they are cut off, active or saturated. Clock pulse amplitude (6 to 8 vt) must be kept reasonably constant, since the trigger transistors are operated as voltage-threshold devices.

Two other features are incorporated in the clock circuits to aid design and testing of large computers. One is provision for operation either as a continuous clock or as a gated clock comprised of an arbitrary number of pulses. The second, particularly useful when troubleshooting a large system, is operation at either a slightly higher or a much lower clock repetition rate. The clock circuit can be actuated by an external vfo or by a pushbutton that provides a single clock pulse.

System Design

The clock circuits may be separated into a common pulse generator and a number of individual drivers. In general, multiple drivers are needed because no single high-speed transistor that is readily available is capable of providing peak currents of 3 to 5 amp.

Multiple drivers provide several
Computer Clock Signals

other advantages. The drivers may be individually gated for an arbitrary duration. In fabricating a large system, each clock driver may be placed physically close to the circuit being triggered, reducing ground noises transmission attenuation and cross coupling. By making all driver circuits nearly identical, per unit fabrication cost is decreased.

A single oscillator and a pulse-forming network generate the basic waveform and repetition rate. Multiple outputs from the generator provide logical gating of entire groups of clock drivers.

A typical clock system is shown in simplified form in Fig. 1. The basic repetition rate of 600 kc is set by a sine-wave oscillator. Frequencies other than that generated by the oscillator may be supplied to the pulse-forming network by an external generator. Single clock operation is provided by a pushbutton-controlled flip-flop.

Signals from the oscillator or external generator are partially shaped in the squaring and timing circuit. Delay circuits, which provide for arbitrary phasing of the various clock signals, are included in this network. Also included is provision for a logical gate that in this example provides a 20-ke repetition rate.

Three different clock-generator outputs are provided: 600-ke pulses, 600-ke pulses delayed a fixed amount from the first output, and 20-ke pulses. These outputs are supplied to the clock drivers, which set the actual pulse width used to trigger the flip-flops. In the above example, two widths are required.

Circuit Design

Accurate control of clock repetition rate is obtained with a crystal-controlled oscillator. Distortion-free waveforms are unnecessary, since eventual output is a series of pulses. The oscillator is the only circuit in this completely transistorized clock system that does not use transistors as switches operated either in a saturated or cutoff state.

The squaring and generator circuits provide an output signal whose waveform is relatively independent of input signal waveform. Input may be sine or square waves at any frequency from d-c to one me. The input signal is amplified by the squaring circuit to provide a relatively fast rise time. Only the leading edge is used in determining pulse width.

Forming Pulses

One technique that may be used in forming the pulse is shown in Fig. 2. The leading edge of the input signal is amplified by Q, and applied to the base of normally cut off Q, switching it on.

The same leading edge is passed through a delay line and amplified by Q. The negative-going, delayed signal is then applied to the emitter of popup transistor Q, cutting it off again.

Although there are modifying effects, such as trigger delay and hole storage, pulse width (on time of Q) is essentially determined by the delay line. Since the delay line is a passive element, output is relatively unaffected by typical compo-
on the driver, there is a large capacitive load caused by a computer requirement for negative-polarity clock pulses, which would normally imply use of npn output transistors. However, the only readily available high-frequency transistors were pnp types.

In one application, transformer coupling was used. For applications with higher clock pulse-repetition rates, transformer coupling became increasingly troublesome. Conventional emitter followers also have limitations. With reactive loads, it is difficult to prevent the emitter follower from being cut off at the end of the pulse. The load and distributed capacitances must then be discharged through the emitted load resistor.

To obtain sufficient transient response, this resistor must be made quite small, which is wasteful of current during the pulse.

An emitter follower circuit that has provided good performance at frequencies approaching one mc is shown in the driver circuit of Fig. 3. The conventional emitter load resistor is replaced by Q. This transistor conducts when output transistor Q is cut off.

A positive pulse from the collector of Q, applied to the input of Q, switches it off. The same pulse, amplified and inverted by Q, switches on output transistor Q,. Since there is one less stage between it and the input signal, Q, is switched on slightly before Q is switched off. With the high impedance presented by Q, essentially all output current that Q can furnish is provided to the load.

At the end of the pulse, Q, is switched on and provides a low-impedance path to discharge the external load and distributed capacitances. As in the generator circuit, the 22-ohm emitter resistor of Q limits steady-state current.

Although this circuit required two transistors, performance is sufficiently better than a conventional emitter follower to warrant its use for high-frequency circuits. Load transistor Q is normally conducting in the absence of a clock pulse. However, average dissipation is negligible, since its return to the power supply is through the normally cut-off output transistor, Q. Also, since it is normally conducting, Q serves as a low-impedance clamp to maintain output dc level invariant with respect to changes in repetition rate and load.

Typical waveforms are shown in Fig. 5.

**Drivers**

When driving a high-current load, it is frequently difficult to maintain a good wave shape at the trailing edge of the pulse.

At the end of the pulse, the output transistor is cut off and load capacitance must be discharged through the collector resistor. Instead of a small collector resistance, which is wasteful of pulse power, transistor Q, provides a low-impedance path for discharging circuit capacitances.

This stage, which is normally saturated, is cut off by Q, for the duration of the output pulse. At the end of the pulse, Q, is switched on and provides the low-impedance path. The 22-ohm resistor in series with the emitter of Q, limits steady-state current through it that might result from an inadvertent short circuit between collector and ground during testing.

Individual driver circuits have been designed to trigger thirty flip-flops. In addition to transistor load on the driver, there is a large capacitive load caused by a computer requirement for integrating networks and also by wiring capacitances. Peak current supplied by each driver is 400 ma. Assuming basic pulse width is maintained by the clock generator, additional shorter-duration clock pulses may be obtained by altering reactive time constants of the input networks to the high-frequency switching transistors.

**Gating Circuits**

Since the same logical signal may be applied to a large number of clock driver circuits, loading of the gating signal by the driver must be limited. Gating should also be done at a low current level to limit load on the gating signal.

The gating circuit used in one application is shown as part of the clock driver in Fig. 3. The clock pulse is amplified by Q, and the gate controls the state of Q,. With Q, cut off by the gate, it appears as an essentially open circuit across the output of Q,. Therefore, the clock pulse is applied, unattenuated, to the base of Q,.

When the gate saturates Q, a low impedance appears across the output of Q,. If the effective input impedance of Q, is high compared to the shunting impedance of Q,, the clock signal will not exceed cutoff bias of Q,. The 47-ohm resistor in series with the base of Q, keeps the input impedance high compared to the saturated gating transistor.

This circuit provides effective gating action with negligible insertion loss. Typical waveforms are shown in Fig. 4. The upper waveform is an arbitrarily selected gating signal. The center waveform, which is the input signal to Q, at the junction of the 47-ohm and 3,300-ohm resistors, illustrates gating action. The lower waveform is the output of the clock driver circuit.

**Driver Output**

It is difficult for the driver output stage to provide a satisfactory pulse wave shape to the type of dynamic load encountered. An additional complicating factor is the computer requirement for negative-polarity clock pulses, which would normally imply use of npn output transistors. However, the only readily available high-frequency transistors were pnp types.
New Sperry klystron for $K_a$ band has 110 mc electronic tuning range

- Frequency range: 34.2 to 35.4 kmc
- Electronic tuning range: 110 megacycles
- Vibration: 1 mc p-p (10g, freq: 10-1,000 cps)
- Warm-up drift: ±10 mc (max.)

Here's a new reflex klystron—the SRV-215—developed by Sperry especially for rough assignments aboard missiles and high-speed aircraft. Easily modified for any application in $K_a$ band from 26.5 to 40 kmc, the SRV-215 is the logical choice for jobs like anti-collision radar or automatic landing systems.

In addition to its extremely wide electronic tuning range of 110 mc from 34.2 to 35.4 kmc and its low tuning torque, the SRV-215 is outstanding for frequency stability at all altitudes—a key factor in airborne applications. This new tube combines wide tuning range with exceptional frequency stability under extreme environmental conditions and features long operating life.

The SRV-215 requires only one-half the heater power of similar tubes, and the flange can be mounted to a heat sink to avoid fan-cooling.

Write or phone today for more information on this outstanding new Sperry klystron.
Diode-Compressor Data

Basic diode-compressor circuit design is possible with data presented. Diode's function in TV audio is to compress the undesired a-m that may be present on the incoming f-m signal basic circuit.

By ROBERT B. DOME, Consulting Engineer, Television Receiver Dept., General Electric Co., Syracuse, N. Y.

Downward modulation capability of the diode before it becomes effective is expressed as shown in the upper curve set. Quantity \( R_{dc} \) is the diode load resistance, \( R_0 \) is the tank-circuit resonant impedance and \( r_p \) is the diode internal plate resistance.

Modulation compression factor is shown in the lower curve set.

These equations are valid if \( r_p/R_{dc} < 0.01 \).

The upper graph shows a plot of \( R_{dc}/R_0 \) vs \( R_0 r_p \) for various values of \( m \). The lower chart shows the diode compressor circuit and performance curves of \( r \) expressed in db vs \( R_0 r_p \) for various values of \( m \).

Given a diode with a \( r_p \) of 1,000 ohms, \( R_0 \) of 68,000 ohms and desired \( m \) of 0.5:

1. Calculate \( R_{dc} \). \( r_p = 68 \)
2. Determine \( R_{dc}/R_0 \) from the upper curve set.

At \( R_{dc}/R_0 = 68 \) and \( m = 0.5 \), \( R_{dc}/R_0 = 0.22 \). Therefore, \( R_{dc} = 2.2 \times 68,000 = 150,000 \) ohms.

3. Determine \( r \) from the lower curves. At \( R_{dc}/R_0 = 0.5 \) and \( R_{dc}/R_0 = 0.7 \), \( r \) is 16 db or 6.3 times.

4. Solutions are valid because \( r_p \), \( R_{dc} \) of 1,000 150,000 = 0.0067 which is less than 0.01.

Diode load shunt capacitor equation is \( C = \frac{e}{f R_{dc}} \) where \( f \) is the lowest frequency to be protected. Assuming \( f = 140 \) cps, then \( C = 0.15 \mu F \).
Tung-Sol moves ahead!

High power transistors with new **cold-weld seal**

Improved cold-weld seal gives new Tung-Sol high-power transistors three-way quality boost

- True hermetic, copper-to-copper seal improves transistor thermal characteristics.
- Elimination of heat-damage, heat-caused moisture and "splash" increase reliability.
- Vacuum-tight, moisture-proof cold-weld seal lasts even through "breathing" over long life operation.

Photomicrograph (45X) shows circled area of cross section of Tung-Sol high-power germanium transistor cold-weld seal. Note absence of seam, indicating actual integration of copper molecules and a true hermetic copper-to-copper seal.

Once again Tung-Sol shows the way. Now, for the first time, Tung-Sol brings designers high-power germanium transistors with quality benefits of the advanced cold-weld seal.

The new Tung-Sol types feature a stud-mounted package and maximum collector current of 13 amps. Military environmental tests combine with the radioactive gas leak detection test to assure maximum reliability.

Technological advancements such as this keep Tung-Sol ahead of the field. For full data on the new high-power switching transistors ... to meet any need with the latest in transistor design and efficiency, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.
Data Unit Transmits Over Phone Lines

Transmitting data in machine language over conventional phone lines is possible with a device just developed by Western Electric. The transmitting unit, designed to complement the Dataphone system introduced last year, consists of a card reader and a multifrequency oscillator.

All power required by the transmitter is supplied from the central phone office. Power supplies, rectifiers, translation relays and serializing devices normally associated with remote data input systems are eliminated.

The card reader has a silver-plated bronze slide that is moved under a series of eutectic silver wipers by a conventional dial-phone ratchet mechanism. When a punched card is placed or the slide and the ratchet mechanism actuated, projections on the slide surface are forced through the holes and make contact with the wipers.

Oscillator

The multifrequency oscillator contains two tunable transformers, three varistors and a dual-mode transistor circuit. Each wiper in the card reader is permanently connected to a fixed-frequency tap on T, in Fig. 1 and to a different frequency tap on T.

Since there are six different voice-frequency taps and they are selected two at a time, fifteen different composite signals can be generated by the oscillator. The signals are used to represent the digits 0 through 9. One signal each is used for calling the computer attendant at the central computer, registering messages, ending messages and indicating input error. One optional signal can be used for automatically recording time or changing format of the receiver program.

Tuning Circuits

Transformers T, and T, and polystyrene capacitors C, and C, form tuning circuits which are energized by the dual-mode transistor circuit. Since the transformers have positive temperature coefficients and the capacitors negative, frequency shift resulting from temperature variations is minimized.

When a closure is made in the card reader, the two frequencies generated are combined, amplified by the dual-mode transistor circuit and fed to standard phone lines.

The dual-mode transistor circuit consists of one transistor, four diodes for polarity control, one Zener diode for voltage regulation, one varistor, five resistors and two capacitors. This circuit maintains signal intelligibility through termination impedances ranging from zero to 1,500 ohms and with phone line voltage deviations of 5 to 45 volts.

Several computer manufacturers have been licensed to make the card reader. The oscillator will be built by Western Electric and installed with the Dataphone system at a rental rate substantially less than $5 a month.

Analog Unit Tests

Fire Endurance

SPECIAL-PURPOSE analog computer makes possible rapid estimates of the transient heat flow within building materials or construction.

Fire resistance tests are often performed on portions of buildings to determine how well the construction will withstand the effects of fire. However, the expense of building the test specimen and the long time required to perform the test make desirable some high-speed method for estimating fire endurance of structures.

The analog device developed at the National Bureau of Standards provides such a method by using a direct analogy between thermal and electrical circuits. This type analogy simplifies coding problems and eliminates the large assembly...
ANNOUNCING

CONVAIR INSTRUMENTS
 designers and builders of:
 electromechanical instruments
 mechanical instruments
 ac & dc measuring instruments
 transducers

CONVAIR INSTRUMENTS
 3595 FRONTIER STREET,
 SAN DIEGO, CALIFORNIA

2900 A

DC VOLTMETER
±10 MICROVOLTS TO ±1000 Volts

Range: ±10 microvolts to ±1000 volts, in 9 decaded steps.
Zero Drift: Less than ±1 microvolt (referred to the input) over 2-hour period.
Power Sensitivity: 10^-14 watts at full scale.
Amplifier Output: Approx. ±1 volt at 0.1 milliamperes for full scale reading.

Combines direct reading voltmeter with chopper-stabilized DC amplifier...
Combination without switching or lead reversal...

Accurate within ±3% (above noise level) of full scale.
Zero-center meter movement provides polarity indication without switching or lead reversal.
Rugged, all transistor, etched-circuit construction...
Illuminated mirror scale.

A twist of a knob releases chassis from hand carrying case, for insertion in 3-unit modular rack.

Prices:

Model 2900A DC Voltmeter $395.00
Model 2901A Hand Carrying Case $90.00
Model 2902A 3 Unit Rack $175.00

For complete information, write today for Cl Bulletin No. 29-2.

* (ALL PRICES FOB SAN DIEGO)
The complete line of "Sames" electrostatic generators—the first practical industrial electrostatic power supplies—are now available in the U.S. from Sorensen & Company. They supply from 50 to 600 kilovolts dc at substantial amounts of power (2100 watts for the 600 kv model).

The Sames generators (so-called from their manufacturer, Societe Anonyme de Machines Electrostatiques, Grenoble, France) are extremely compact and safe compared to transformer-rectifier-filter-type supplies in similar kilovolt ranges. The electrostatic generators are available in highly stabilized models supplying 50, 100, 150 and 600 kilovolts that are particularly suitable for electron-microscopy and many critical nuclear physics applications. Medium stability models with outputs of 50, 80, 100, 140, 150, 250, 300, and 600 kilovolts, have found wide application in Europe for testing cable insulation, alternator windings and other dielectrics, electrostatic flocking, painting and particle precipitation, electron and nuclear particle accelerators and similar applications.

Write for complete details on Sames electrostatic generators to Sorensen & Company, Richards Avenue, South Norwalk, Conn.

The instrument is a fast-time type, in which a problem is solved repetitively at a speed much higher than can be obtained with an actual test specimen. Essentially, it applies voltages corresponding to prescribed temperature-time conditions of a standard fire test to an electrical model representing the material under study.

Resultant temperature-time curves are displayed on a cathode-ray tube.

The equipment consists of a signal-generating unit, means for applying the signal to an electrical network, and circuitry to measure the transient voltages developed within the model.

A custom-made electrical model is prepared for each thermal problem to be simulated. A plug-in unit provides 20 network elements and discharge points. A series of resistors represents a lumped approximation to the continuous thermal resistance of the prototype, and a group of capacitors shunting the resistors to ground represents a lumped approximation to its heat capacity.

**Signal Generator**

The signal generator, a photoformer unit, was selected for flexibility in choice of possible waveforms and ease with which they can be interchanged. It is basically an oscilloscope with an opaque mask covering a portion of the cathode-ray tube face. The shape of the mask corresponds to the shape of the desired waveform.

A phototube with appropriate amplifier is arranged to view the CRT. Combination of a feedback in the vertical plate circuit and a relaxation timing sweep on the horizontal plates forces the spot to follow the mask outline on the screen. Since voltage applied to the deflection plates is proportional to displacement of the spot, a voltage-time signal, controlled by the shape of the mask, can be taken from the plates.

An impedance converter combines the balanced but out-of-phase voltages applied to the deflecting
plates of the generating oscilloscope into a single-phase low-impedance output signal with ground as a reference level.

**Discharge Unit**

The discharge circuit is made up of three separate circuits. A twin triode amplifier and phase inverter supply an output that is split into two signals. A set of discharge triodes is provided for each individual section of the model.

A clamp diode functions as a reference-level generator. The last unit is necessary to balance out the potential drop across the clamp diodes and permit discharge of the network model to the ground reference level. In the original unit of 20 discharge triodes, ten twin-triode tubes were used to permit complete discharge of a 20-section electrical model.

**Read-Out Oscilloscope**

The viewing oscilloscope, on which the problem situation is displayed, is of a type suitable for driven-sweep operation from an external trigger signal. This facility together with the highly linear time sweep source for the signal generator are the only essential requirements of the unit. High linearity of the vertical amplifiers is not essential.

**Servos Control Atomic Manipulator**

Manipulator under development at Westinghouse atomic power department will permit remote dismantling of atomic equipment in nuclear power plant. Technician uses servo manipulator to take apart practice pump. In actual operation, operator would work behind shield.

NEW IDEAS IN PACKAGED POWER

3 new Sorensen transistorized d-c supplies can solve your lab, production and design problems

In the Sorensen “Q” Series, you can select from the most complete line of fully transistorized, highly regulated low-voltage d-c supplies on the market: QR-Nobatrons, (shown above, left) with output continuously adjustable down to zero volts, are ideal for labs or wherever maximum flexibility is required. Two models, QR36-4A and QR75-2, put out respectively 0-36V at up to 4 amps and 0-75V at 2 amps. Regulation of QR36-4A is ±0.025% or 4 MV for combined line and load variations. Input: 115vac 50-400 cps available for either bench or rack-panel (3½" x 19") use.

Q-Nobatrons*, with 2:1 adjustable output, can render outstanding service in semi permanent lab set-ups, in production test, or integrated into your own product. Available in 15 models up to 200 watts capacity with 6, 12 or 28 volts out. Spec and packaging are similar to QR models above. Models for ±0.25% or ±0.05% regulation are available. Lower wattages are available two to a single rack panel (3½" or 5½" x 19").

QM-Series, solder-into-the-circuit supplies (shown above, right) mount like a potted transformer or choke and come in 36 variations: nine voltages from 3.0 to 36vdc, regulated ±0.05%, and four wattages, 2, 4, 8 and 15. Input 50/60 and 400 cps at 115vac. (Incidentally, Sorensen also offers similarly packaged DC-to-DC and DC-to-AC converters.)

Ask us, or your nearest Sorensen representative, for the complete story on these precision transistorized regulated d-c supplies.

SORENSEN & COMPANY, INC.
Richards Avenue, South Norwalk, Connecticut

WIDEST LINE OF CONTROLLED-POWER EQUIPMENT FOR RESEARCH AND INDUSTRY

IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. IN WESTERN CANADA, ARVA.
IN EASTERN CANADA, Bayly Engineering Ltd. IN MEXICO, Electro Labs. S. A., Mexico City.

CIRCLE 50 READERS SERVICE CARD
Light-weight radar antenna horns were required for installation on retractable masts provided on mobile radio vans. Metal antenna horns proved to be too heavy and expensive. The problem was solved by molding the horns from high-strength plastic laminate.

**Fabrication Method**

To obtain a dimensionally accurate horn, a plaster coat was prepared, using an electro-formed horn as a model. After drying, the cast was removed from the form, sanded smooth and coated with sealing lacquer. A hard wax mold release material was applied to the cast and oven dried.

Prior to placing the fiber-glass laminate on the plaster mold, a gel coat of No. 210 epoxy resin (Applied Plastics Co.) was applied to the mold. While the gel coat was still in a partially cured condition, four layers of No. 1542 fiber-glass cloth, each saturated with 20 percent by weight of resin, were draped on the mold. After removal of all entrapped air, the laminate was allowed to cure in air at ambient temperature. The laminated plastic was then removed from the mold, trimmed to the correct size and assembled to a brass connecting flange. Three coats of Du Pont No. 4817 silver conductive coating were sprayed on the inside of the horns, each successive coat being air dried for 15 minutes at ambient temperature.

**Evaluation Test Results**

Evaluation tests were performed to determine the absolute gain and beam width of a plastic S-band horn manufactured by the procedure described. In addition, vswr of the horn was determined and a spherical coordinate system was used for interpreting directivity patterns when the field strength was measured around the Z and Y axes. Comparative plots of test results for the plastic horn and the metal horn are shown in Fig. 1-6.

A review of the data indicated that output of the plastic horn is 0.5 to 1.4 db greater than the metal horn over a frequency spectrum of 2,250 to 4,000 mc. The vswr shows the plastic horn to be comparable and, in some cases, superior to the metal horn. Summation of these advantages plus a weight advantage of three to one, indicates that this application of structural plastics is highly desirable for antennas em-
ACCURACY

Highest accuracy in rotating components is a CPPC fundamental. Our Precision Computing Resolvers are no exception. Without compensation, a recent production run of resolvers showed functional errors of .06% or less. Perpendicularity of axes was ±3 in 360°. Due to extreme symmetry of rotor and stator, nulls are excellent in these resolvers. Low phase shifts are also a feature.

VERSATILITY

CPPC Precision Computing Resolvers can be had with any of the following features: corrosion resistant construction, stainless steel or aluminum housing. Units to resist temperatures up to 450° F. The following compensation is available in any or all units: resistive, feedback winding, thermistor. Types available for transistor circuitry. Pin or screw terminals or lead wires. BuOrd type shafts and BuOrd MK 4 Mod 0 brush block obtainable.

PRICE AND DELIVERY

We ask you to review what you are paying for precision computing resolvers. In the past CPPC has been able to lower traditional prices of rotary components.

We are already tooled for many types of these resolvers and can make quick delivery in quantity or short run. Whenever you need any rotary component, think of CPPC.

Call or write Sales Department, Hilltop 9-1200 Suburban Philadelphia or our Representatives.

ENGINEERS—For a career in rotary components and computers, write David D. Brown, Personnel Director, Dept. H2.
BE SURE TO BUY E-LITES 
engineered especially for computers, control systems, military applications

You can mount almost any E-lite in a 3/8" hole. They'll fit your system application exactly because they're tailor-made for the job by system engineers. Choose from many replaceable-lamp or permanent-lamp types, with or without built-in resistors, and in a variety of lens styles, colors, and data readout capacities. 100% electrical and mechanical inspection assures you of full E-lite quality in every unit.

MULTIPLE TERMINALS—NO "HOT" CASES
Terminals are silver-plated, gold-flashed, cadmium-plated or electro-tin-plated. AMP-type 37 taper pins available.

BUILT-IN RESISTORS
Optional Genuine Allen-Bradley carbon composition.

QUALITY INSULATION MATERIALS
Glass-nylon or Melamine IM-8 per MIL-P-14.

EFFICIENT, POSITIVE ILLUMINATION
Proper lens shape in beautyrate per MIL-P-10407 for clear display. Form-tip neon lamps with electrodes exposed for maximum brilliance.

TWO-WEEK DELIVERY ON 1560 STANDARD VARIATIONS SPECIAL PRICES ON VOLUME ORDERS

REPLACEABLE-LAMP TYPES
Single-lamp holders for neon or incandescent lamps. With or without built-in resistors. Variety of replaceable lens types. Up to 3 digits available on flat lenses. 1DH holder shown. Patent applied for (resistor models).

WRITE FOR COMPLETE TECHNICAL INFORMATION
With photos, descriptions, dimension drawings for the complete line. Submit your special problem for our engineered solution. Information on our neon lamp aging service also sent on request.

Sales representatives in principal cities

CIRCLE 52 READERS SERVICE CARD

February 27, 1959 — ELECTRONICS

Hot-Cold-Light Panel Announced

THERMOELECTRIC heating and cooling are combined with electroluminescent lighting in a wall panel developed by Westinghouse. The panel is dial-controlled, exhibits a temperature change from 55 to 120°F and provides variable intensity and color range of the light source.

Artistic Semiconductors

Part of the thermoelectric assembly is superimposed in artistic designs of anodized aluminum in front of the electroluminescent screen of the panel as shown in the accompanying illustration. The remaining portion is hidden from view behind the screen. A range of hues from blue to blue-green to

employed in several frequency ranges.

The plastic horns had other desirable features including excellent resistance to weathering in harsh marine atmospheres, dimensional stability and inhibition of fungus growth.

Applications

Possible applications include airborne navigational radar, surface antennas for air search, signal receivers for checking ground beacons and Pillbox antennas for shaped beam requirements.
New Bonded-Shield Tv Picture Tube

BONDED DIRECTLY to the face plate of a new 23-in. tv picture tube is the safety panel ordinarily found as a separate component in a tv set. Developed by Sylvania Electric Products Inc., the new tube has about the same height and width as a conventional 21-in. 110-deg tube. But sharper corners and relatively flat face give about 20 sq. in. of additional viewing area.

Large Sapphire Lens

No tubes...no moving parts to weaken and fail from wear...not affected by dust, dirt, oil mist or iron filings...will even operate under water...sensing heads available for distances of ½ inch and 2 inches...also for explosion-proof applications...corrosion and vibration resistant...won't spark, pit or wear, because there are no contacts.

Sure, they cost a little more initially. But we haven't seen the application yet where the new Westinghouse proximity limit switch can't pay for itself time and again through eliminated replacements and machine down time.

GET ALL THE FACTS about new Westinghouse proximity limit switches...see how and where they can benefit you. Write to Westinghouse Electric Corporation, Director Systems Department, 356 Collis Avenue, Pittsburgh 6, Pennsylvania.

YOU CAN BE SURE...IF IT'S Westinghouse
Where Do You Fit In...

Subscriber? / Pass-Along Reader? / Forget to Renew?

In 1959 six issues of Electronics will be devoted to primary, important segments of electronic engineering, design and control. Each special issue an up-to-minute, definitive, comprehensive databook in one handy package—a reference text or point of departure—the serious electronics engineer, production, or management man will find them useful on many occasions in the coming months.

Electronics can't guarantee to supply back issues to start or re-start your subscription. To insure receiving these special issues your order must be received four weeks previous to publication date. We'll give full credit for the unexpired portion of your current subscription.

BE SURE your subscription doesn't lapse. Fill out the card below and mail it to us.

BE SURE to receive your personal copy of these SPECIALS

1. Electronics in Space — April 24th Special Issue
2. Designing for Reliability — May 29th Special Issue
3. Transistorizing Electronic Equipment — July 31st Special Issue
4. Electronic Instruments for Design and Production — September 11th Special Issue
5. Modern Communications Methods — October 23rd Special Issue
6. Materials for Environmental Extremes — December 4th Special Issue

What's in "Electronics in Space?" (April 24th Special Issue)

1. Propulsion ionic drive plasma jet photonic drive
2. Navigation determination in real time of location in space position shift due to light time collision avoidance in space inertial navigation
3. Communications position shift due to light time terrestrial to space space to terrestrial space to space communicating rear and around sun communicating around large space bodies
4. Observation of space television from space infrared radio telescopes
5. Equipment Environment measurement of temperature design for radiation shock and vibration
6. Power Generation in vehicles on space bodies
7. Control Systems
8. Electronics in Human Engineering of Space Problems

OK □ Renew my subscription for 3 more years
OK □ Enter my new subscription
U. S. subscription rates □ 3 years $12 □ 1 year $6
Canadian rates $310 for 1 year Foreign rates $2C for 1 year

Name

Company

Street

City Zone State

Mail reply to — Electronics, 330 West 42nd Street, New York 36, N. Y.

Rollers Straighten Bent Axial Leads

Axial component leads can be quickly straightened with a roller device. The photos show such a device being used to straighten bent resistor leads at Corning Glass Works' electronic components plant, Bradford, Pa. Bent leads
A pair of smooth round steel rollers rotate in 2 semicircular spring-loaded anvils, as shown in Fig. 1. As leads are fed into the space between the rollers and anvils, the springs are compressed. The resulting spring pressure is sufficient to straighten the leads as the rotation of the rollers carries the leads from right to left. The rolling action also keeps the leads round.

Get the most out of your test equipment budget by utilizing HEATHKITS 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 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. 100 interesting and profitable “do-it-yourself” projects.

CIRCLE 56 READERS SERVICE CARD
ON THE MARKET

D-C Power Supply transistORIZED

Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., has developed a 24-32 v at 10 amperes transistORIZED precision type laboratory d-c power supply. Incorporating a dual regulatory system consisting of magnetic amplifier and transistor amplifier, it is designated model No. MTR28-10. It operates from an a-c input of 105-125 v, single phase, 60 cps. For further information write directly to the company.

Signal Generator
4,450 to 11,000 mc

Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N.Y. Model PMX microwave signal generator covers the frequency range of 4,450 to 11,000 mc by use of two interchangeable plug-in tuning units. This versatile test instrument generates internal pulse, square wave or f-m signals—or can be externally modulated. Range of internal pulse capabilities include 0.2 to 10 µsec variable width; 2 to 2,000 µsec delay; and 10 to 10,000 pps repetition rate. Circle 200 on Reader Service Card.

Tv I-F Pentode
three types

CBS-Hytron, Danvers, Mass. Three heater versions of a wide-band, high-frequency pentode have been announced. The sharp-cutoff types 3DK6, 4DK6 and 6DK6 are particularly suited for use as i-f amplifiers in tv receivers. They feature a high transconductance of 9,800 µmhos. The 3DK6 and 4DK6 are designed for use in 600-ma and 450-ma series-string sets respectively; and the 6DK6, for parallel heater operation. Circle 201 on Reader Service Card.

Phase Modulator
9.75 to 10.75 kmc

Kearfott Co., Inc., 14844 Oxnard St., Van Nuys, Calif. Model W-183-1E X-Band ferrite phase modulator may be used as a frequency translator, side band generator, or as an electronically controlled phase shifter. Boasting a small volumetric enclosure and small insertion length (6 in. by 1½ in.), the new unit weighs less than 1 lb. Amplitude modulation is less than 0.3 db variation with control current. Circle 202 on Reader Service Card.

Military Tv System
all-Transistor

Dage Television Division, Thompson Ramo Wooldridge, Inc., Michigan City, Ind., has developed a completely transistORIZED ruggedized military tv system. It consists of three components: tv camera unit; tv monitor unit; and tv control unit, which provides power and synchronization to both camera and
Miracle of Precision and Uniformity

Allen-Bradley has been making precisely uniform resistors—not by the millions but by the billions—over the years. The exclusive hot molding process—developed and perfected by Allen-Bradley—uses specially designed automatic machines that incorporate precision control at every step of production. Shown here are a few of the special machines that make possible the amazing uniformity—from resistor to resistor, year after year—for which Allen-Bradley composition resistors are famous.

Allen-Bradley Co., 110 W. Greenfield Ave.
Milwaukee 4, Wisconsin
In Canada: Allen-Bradley Canada Ltd.
Galt, Ontario

Allen-Bradley Hot Molded Resistors Are Precisely Controlled at Every Stage of Production

Automatic Heading Machines form heads on the end of lead wires to make sure they will be solidly anchored in the resistor body. Wire has been previously tinned for easy soldering.

Automatic Molding Machines take the resistance powder, insulation powder, and lead wires, and hot mold them under closely controlled high temperature into one integral unit.

Automatic Color Coding Machines apply color bands and oven-bake the enamel at high temperatures to assure that the color coding will withstand the maximum operating temperatures of 150°C and all types of cleaning solvents.
LABORATORY QUALITY AT MASS-PRODUCTION PRICES

...with Bendix® temperature-compensated tachometer generators

Bendix has the facilities to give you all the precision and accuracy you want in tachometer generators—at volume production prices. And our volume production means delivery when you want it.

Most important of all, Bendix Tachometer Generators feature laboratory quality because of unique, high-precision manufacture and extensive test facilities. For example, these generators deliver accuracies within ±1/10 of 1° over a wide speed range due to calibration by specially built Bendix production test equipment. Further, they’re temperature-compensated over a range from —55°C to +125°C.

Bendix Tachometer Generators are available in frame sizes 10, 11, 15 and 23—and offer the latest developments in miniaturization, integral motors, and other desirable features.

THE STEP THAT PAYS. Find out today how the Bendix “Supermarket” gives you more tachometer generator for your money—how it can meet your needs promptly, efficiently and economically.

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.

DIFFERENTIALS

hollow shaft

FAE INSTRUMENT CORP., 42-61 Hunter St., Long Island City 1, N. Y. A line of hollow shaft miniature precision differentials are engineered for high accuracy in additive and subtractive operations. They have primary applications in angular velocity, sums, differences, sequence and other functions. Some design features include: high speed rotation, minimum backlash and low breakaway torque, and easy installation or removal from a gear train.

Circle 204 on Reader Service Card.

SOUND LEVEL METER

smaller, lighter

GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1551-B sound level meter has many new technical features and...
improvements over its predecessor. Among these are: a new microphone for better all-round performance; a new meter circuit, which more closely approximates rms response; a new calibration circuit for amplifier gain standardization, which does not require a power-line connection; improved signal-to-noise ratio and dynamic range; improved frequency response. Price is $395. Circle 205 on Reader Service Card.

Pulse Height Analyzer single channel

TULLAMORE ELECTRONICS CORP., 6055 South Ashland Ave., Chicago 36, Ill., has available model PHA-2 precision single channel pulse height analyzer for the budget-minded laboratory. It is capable of operating at counting rates in excess of 1,000,000 cpm without appreciable data distortion. Instrument utilizes a window amplifier which has excellent overload characteristics. Input amplitude range normally covered is 0 to 85 v positive. Circle 206 on Reader Service Card.

Static Inverter transistorized

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J., has developed a static inverter employing a new concept in the conversion of d-c inputs for precision a-c frequencies. It is designed for dependable and accurate power applications for use in driving rate gyro's and inertial guidance equipment and other related missile and aircraft uses. The new static inverters are designed to meet military environmental specifications per MIL-E-5272A. They are available with single phase or three phase outputs. Circle 208 on Reader Service Card.

Frequency Converter meets MIL specs

POWER SOURCES, INC., Burlington, Mass. Model PS6001 frequency converter, which meets all requirements of military specifications for ground equipment, has an input of 120 v, 60 cps, and an output of 115 v, 400 cps, 250 w square wave. The converter will operate at any temperature between −30 C and +52 C, and is not damaged by temperature extremes to −65 C and +85 C. Circle 207 on Reader Service Card.

Band Pass Filters tunable units

MAURY & ASSOCIATES, 10873 Mills Ave., Montclair, Calif. A new series of narrow band, tunable band pass filters feature miniaturized and ex-

P.S. and don’t forget these other quality products at the BENDIX “SUPERMARKET”

With our greater variety and greater volume of the precision components listed below, we have become the “supermarket” of the industry. We feature fast delivery and mass-production economy—plus the highest precision quality.

400-CYCLE SYNCHROS
(Frame sizes: 8, 10, 11, 15, 22)
Control Transformers • Differentials • Receivers • Resolvers • Transmitters

GYROS
Directional, Free, Rate, Roll and Vertical Gyro Transmitters • Stable Platforms

MOTORS AND GENERATORS
Gear Head Motors and Motor Generators • Low-Inertia Servo Motors • Motor Generators • Rate Generators

PACKAGED COMPONENTS
Analog-Digital Converters • Azimuth Counters • Coded Encoders • Clutched Synchros • Dual-Speed Synchros • External Slip-Ring Synchros • Follow-Up Mechanisms • Miniature Differential Gear Assemblies • Servo Assemblies

RADAR DEVICES
Airborne Radar Antennae • Ground Antenna Pedestals

You Can't Beat The Bendix “Supermarket”. Try us.

Eclipse-Pioneer Division

ELECTRONICS — February 27, 1959
Scientists and engineers at the Los Alamos Scientific Laboratory have access to an unusual variety of research tools: excellent technical libraries, high-speed computers, particle accelerators, experimental reactors, critical assemblies, ultra high-speed cameras, whole-body radiation counters, devices for investigating controlled thermonuclear reactions—and specialized equipment of many other kinds.

The writing and publishing of research papers is encouraged in many ways at Los Alamos. Expert editorial help is available to all staff members. More than 1300 papers have been released for publication and an additional 1700 have been presented at meetings or otherwise made public.

For information on employment opportunities write: Personnel Director, Division 59-13

For information on employment opportunities write: Personnel Director, Division 59-13

Extremely rugged construction, low insertion loss and low vswr. They are ideal for airborne as well as lab type applications. There are four types available when they are cascaded in single to quad units, which determines their skirt selectivity. The filters are available at any center frequency from 100 to 2,000 mc. Circle 209 on Reader Service Card.

Converters d-c to d-c

Sorensen & Co. Inc., Richards Ave., South Norwalk, Conn., has a new line of transistorized d-c to d-c converters designed for incorporation into a wide variety of battery-powered airborne and mobile electronic equipment. The QC series provide an economical efficient means of obtaining higher voltages from standard 6, 12 or 28-v d-c sources. Standard output voltages range from 50 v d-c (30, on 12-v models) to 1,000 v d-c. Powers to 200 w in 12 v models; to 150 w in 28 v models and to 90 w in 6 v models. Circle 210 on Reader Service Card.

D-C Amplifiers for transducers

EDIN, A Division of Epsco, Inc., 207 Main St., Worcester 8, Mass., has available the first two models of a new No. B-series line of amplifiers intended for a wide variety of both rack-panel and portable oscillograph recording needs. Units drift less than 0.5 mw equivalent input per hr.
ECONOMY and versatility distinguish our KL series relays. Contact arrangements are available up to 4 pdt in either AC or DC versions. Sensitivity of 100 milliwatts per movable arm is available.

Stationary contacts and terminals are mounted on a phenolic front of high dielectric strength, thus adding to the utility of the relay. Conveniently located terminals and easy-to-mount base greatly simplify installation on long production runs.

KL relays may be hermetically sealed or furnished in metal dust covers.

This is one of a “family” of fine P&B relays. Others, with similar configurations but various electrical and switching capacities, are shown below.

Write or call for more information or see the complete P&B catalog in Sweet’s Product Design File.
The Spot Light is on a new product

Airpax Miniature Circuit Breakers

Power Control and Circuit Protection are provided in this new Airpax Circuit Breaker. Only slightly larger than an "ON-OFF" switch it replaces a switch, fuses and overload relays. Available in ratings from 50 milliamperes to 10 amperes, AC or DC with fast or slow response.

Oscillator High Stability

Manson Laboratories, Inc., 207 Greenwich Ave., Stamford, Conn. Model RD-146, a new version of the RD-140 1-mc high stability oscillator, features a calibrated trimmer control for making accurate frequency adjustments against crystal aging, on a daily, weekly or other frequent time period basis, without comparison to WWV or other standard. Unit features drift rate less than 1 part in 10^6 per day, improved short term stability and lower power consumption. Circle 212 on Reader Service Card.

Non-Toxic Resist for P-C Production

Screen Process Laboratories, 5-33 48th Ave., Long Island City 1, N. Y. A new plating and etching resist (No. 1997B) has been developed for the production of printed circuits. It prints easily, and very sharply, with a minimum of drag. It will resist the usual platers cleaning solutions, plating baths and etchants. It is extremely dimensionally stable, expanding about 0.0005 in., com-
VARACTORS NOW!

YESTERDAY... a multiple breakthrough in the laboratory.
TODAY... a production fact from Microwave Associates.

This Microwave Associates varactor is a diffused silicon PN junction diode designed to be a variable capacitance with low loss at high frequencies. The unit complies with MIL-E-1 outline 7-1 for cartridge type crystal rectifiers and will fit most standard crystal holders.

In the standard form, the pin end of the diode is connected to P-type material on the top of a small "mesa" and the N-side of the silicon element is connected to the base. Reverse polarity units are also available. Mechanically reversible units in both polarities may be ordered but the single-ended units are generally recommended because they insure placement in holders with the proper end in contact with a heat sink.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CUT OFF FREQUENCY (MHz)</th>
<th>CAPACITY AT ZERO BIAS (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA-460A</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>MA-460B</td>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>MA-460C</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>MA-460D</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>MA-460E</td>
<td>60</td>
<td>3</td>
</tr>
</tbody>
</table>

Send for catalog 59V

MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS • Telephone: Browning 2-3000

ELECTRONICS — February 27, 1959
New availability in skin sizes, cores, and adhesive materials now make wider range of honeycomb sandwich combinations possible for the electronics engineer.

<table>
<thead>
<tr>
<th>SKINS</th>
<th>CORES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>Fiber Glass</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Titanium</td>
<td>Impregnated Paper</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>Asbestos</td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>Canvas Duck</td>
</tr>
<tr>
<td>Fiber Glass</td>
<td></td>
</tr>
</tbody>
</table>

Chances are one of the above sandwich combinations will answer your electronic housing problems relative to: minimum of weight, rigidity, thermal conductivity, vibration damping, fatigue resistance, radio frequency, dielectric barriers or "U" factor.

To that end, merely forward at a schedule of the environmental conditions, and we will, without obligation, make a recommendation. For further details write or wire:

Precision Pots

DAYSSTROM PACIFIC, 3920 Lincoln Blvd., Los Angeles 45, Calif. Model 313, first of a new series of high
This is the first public announcement of the first hydraulically-tuned pulse magnetron. It permits a powerful new capability in anti-jamming pulse-to-pulse frequency diversity operation.

Designated L-3211 and equipped with an hydraulic tuning actuator we developed, this is the fastest tuning, medium power magnetron in production today.

The L-3211 is designed for X-band operation with electrical characteristics similar to those of our standard field-proven 6543 magnetron. The principles of its design make it adaptable to other power levels and frequency bands.

Tiles of this family greatly enhance system tuning capability, approaching that of voltage-tuned tubes, with much greater efficiency and less system complexity. The L-3211 affords a means of upgrading both new and existing radar systems to operational effectiveness. (We also can provide information on a "need-to-know" basis on classified tubes that have even greater capabilities than the L-3211.)

In constructing the L-3211 we use certain techniques proprietary with us...techniques which guarantee a long operating life and a long shelf life. Ageing-in prior to full-power operation is unnecessary.

It is another one of a large number of micro-wave tubes used in radar and countermeasures built to specifications established by Litton Industries...specifications which have become recognized as standards by the military services.

Our Applications Engineering Lab is well equipped to analyze your problem. It has been remarkably successful in finding fast and accurate solutions to difficult system problems. Let it solve yours. We'll be glad to answer your specific inquiries, or to send you a copy of our catalog. Litton Industries Electron Tube Division, Office E8, 960 Industrial Road, San Carlos, California.

*Incidentally, so is our Personnel Department.
Because of the diversity and rapidly increasing demands for our products, you have the challenging opportunity here at Bendix-Pacific to constructively apply all your talents.

There are important career positions open now at all levels in our small, independent engineering groups in these fields:

- MISSILE GUIDANCE
- TELEMETERING
- AIRBORNE RADAR
- MISSILE HYDRAULICS & MARINE HYDRAULICS
- SONAR & ANTI-SUBMARINE WARFARE

Please write W. C. Walker your qualifications or fill in the coupon and mail it today:

Bendix-Pacific, Bendix Aviation Corp.

I am interested in check one:

☐ Electrical  ☐ Mechanical Engineering

I am a graduate engineer with _____ years experience.

Name __________________________
Address _________________________
City _____________________________
Zone ______ State ________________

---

Power Supply

Over-load protected

Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J. A new transistor power supply features stable output voltages from 0 to 36 v d-c at 5 amperes continuous duty. Line and load regulation is better than 0.1 percent and output can be limited to any value from 0 to 5 amperes through a front panel selector. Overshoot is not measurable, thus insuring instantaneous protection to rated components and external circuitry. Circle 217 on Reader Service Card.

---

Connector Parts

Machined Teflon

Tri-Point Plastics, Inc., 177 L. W. Willets Rd., Albertson, N. Y. Self-sealing action, size reduction, dependability at high temperatures and under submersion in corrosive missile fuels are features of the insulating parts used in aircraft connectors illustrated. Tri-Point's temperature precision units, is available in resistance values from 10 ohms to 50 K ± 5 percent. Operating temperatures of the miniature 1.5 w pot range from −55 to +200 C. One watt is dissipated at +95 C. The unit also meets or exceeds MIL-STD-202 Method 202 shock and vibration and NAS 710 noise specifications. Circle 216 on Reader Service Card.
Vigilant acquisition radar for Nike-Hercules first detects approach of distant aircraft, pinpoints its location and instantly signals to battery control.

Two tracking radar antennas, housed in radomes, take over. One feeds target azimuth, elevation, range data to computers; other tracks Hercules.

Two sets of radar data are electronically computed and plotted. Hercules is "steered" by radio signals, then detonated at precise point of interception.

From Bell Telephone Laboratories...

**Brainpower for the brawny Nike-Hercules**

The Army's newest surface-to-air guided missile—the lethal Nike-Hercules—is now operational. Because it is, no unfriendly plane will be able to fly sufficiently high, fast or evasively to escape a fatal rendezvous with it.

For Hercules has a "brain"—an intellect that makes it a prodigy among today's electronic robots. Bell Telephone Laboratories developed it. Western Electric (prime contractor for the entire missile system) is producing it. Douglas Aircraft Company is giving it its body.

This "brain" is a fully integrated guidance system, almost entirely land-based. Only the vital signal-receiving apparatus is expendable within the missile itself. Other highly practical features: it defies "jamming," is completely mobile, is designed in separate "building block" units which are replaceable in seconds—and is deadly accurate.

Bell Labs scientists and engineers designed the world's largest and most intricate telephone communications network for the Bell System. They developed about half of the Armed Forces' radar equipment during World War II. And they pioneered the nation's first successful air defense guided missile system—Nike-Ajax.

They were eminently qualified to give Hercules the brainpower it needed.

**BELL TELEPHONE LABORATORIES**
World center of communications research and development
CUSTOM DESIGNED
ELECTRONIC COMPONENTS

TIME DELAY RELAYS
Instant reset — Voltage compensated
Curtiss-Wright “IR” thermal time delay relays reset the instant they are de-energized. The second cycle will always provide the same delay as the first cycle. Variations from 22 to 32 volts will not affect the time delay of the “IR” Series.

SPECIFICATIONS
Time delay . Preset 20 to 180 seconds
Contact arrangement. SPST, DPDT, OR SPDT
Temperature comp. — 65°C to +125°C
Weight: 4.4 oz
Terminals . Hooked solder type
Mounting Bracket or stud
Variations of the above relay characteristics available upon request.

New DIGITAL MOTORS
Stepping motors for high reliability applications. Meet the requirements of assured reliability and long life for aircraft, missile and automation systems.

FEATURES
Bi-directional • Positive lock • Dynamically balanced • Simplicity of design • High pulsing rate.

New ULTRASONIC DELAY LINES
Enables development engineers to employ new concepts in existing and projected applications. Low in cost, small in size and simple to operate.

SPECIFICATIONS
Delay range . 5 to 6000 microseconds
Tolerance . ±0.1 microsecond
Signal to noise ratio . Greater than 10:1
Input and output impedance . 50 to 2000 ohms
Carrier frequency . 100 kc — 1 mc
Delay to pulse rise time . Up to 800:1

WRITE FOR COMPLETE COMPONENTS CATALOG 159
ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • WEST CALDWELL, N. J.

P-M Motor
high temperature
JOHN OSTER MFG. CO., 1 Main St., Racine, Wis., offers a new high temperature ±3 percent speed regulation continuous duty 11 inch p-m governed motor with gear reduction and filter. It features 60 oz in. load and 24 to 29 v d-c supplied under MIL-E-5272 environmental conditions. Circle 219 on Reader Service Card.

Tantalum Capacitor
shock resistant
FANSTEEL METALLURGICAL CORP., North Chicago, Ill. The PP type tantalum capacitor has been further improved by a specially designed anode base support which gives it exceptional resistance to shock and vibration. Unit is electrically stable over a wide range of operating temperatures—from -55°C to 85°C. It also exhibits outstanding frequency stability and negligible electrical leakage. Type PP consists of a sintered porous tantalum anode, hermetically sealed in a fine silver case which serves as cathode and con-
CREATIVE MINDS NEEDED to explore new fields in Space Age Electronics. Join one of the fastest growing engineering and scientific organizations in the new field of Space Electronics. Thus far, Hallamore has had a remarkable participation in nearly all of the space frontier programs...some of which are: 1. Development and manufacture of 4 tracking and telemetering stations for Explorer satellites. 2. Development and manufacture of 6 tracking and telemetering stations for United States Air Force lunar probe. 3. Development and manufacture of 4 tracking and telemetering stations for United States Army lunar probe. 4. Ultra-sensitive receivers for atomic cloud propagation studies. 5. Airborne reconnaissance TV system. 6. Underwater electromagnetic wave communications studies. 7. Automatic checkout equipment for space missiles. Some programs are on contract and equipment is in field operation at the present time. If you have a highly creative mind, with an educational background of BS to PhD and an active interest in theory, circuit development, or project engineering, we invite you to join our outstanding team, to search into the future and to share in the rewards of Hallamore's dynamic growth. For further information, please write or call: Frank W. Lynch, V.P. Engineering, Hallamore Electronics Company, 3352 Brookhurst Avenue, Anaheim, California / Prospect 4-1010: a division of The Siegler Corporation.
He knows that the answer is in the wire!

He uses Hickory Brand MW Hookup Wire exclusively

- HIGH DIELECTRIC STRENGTH
- FLEXIBLE AT LOW TEMPERATURES
- STABLE AT HIGH TEMPERATURES

Use Hickory Brand MW Hookup Wire for electronic devices, aircraft instruments, radio and radar transmitters, receivers, and lighting and power rectifiers.

Thermoplastic insulation type MW 1000 volt—80°C, military specifications Mil-W-76A. In 30 color combinations. Fungus-proof. Resistant to acids, alkalis, oil, flame and moisture.

All Hickory Brand Electronic Wires and Cables are quality-engineered and precision-manufactured to meet the most exacting requirements.

Write for complete information on the full line of Hickory Brand Electronic Wires and Cables

Manufactured by
SUPERIOR CABLE CORPORATION, Hickory, North Carolina

CIRCLE 71 READERS SERVICE CARD

Regulator Tubes

Regulator Tubes corona type

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio, has developed the M-42 miniaturized high voltage corona type regulator tubes in metal enclosures for operation at voltages from 3 kv to 12 kv. They are ideally suited for the regulation of power supplies for airborne radar due to their small size, light weight, rugged construction and ability to withstand a wide range of ambient temperatures. Circle 221 on Reader Service Card.

Strip-Chart Recorder

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif., announces a 5-in. strip-chart temperature recorder with a variety of ranges provided by easily changed plug-in elements. These match appropriate thermocouples. Automatic reference...
NOW, FROM GENERAL ELECTRIC'S NEW 6L6-GC...

Power

55 WATTS...with only 2% distortion without feedback*

Power for orchestral climaxes with full concert-hall brilliance...yet mellow in tone, undistorted! You can build this high speaker power into your new equipment at a cost one-third less than the cost of other tubes with comparable performance!

With 30 watts plate dissipation, 5 watts screen, General Electric's 6L6-GC beam pentode can take peak power demands in stride. This is a new tube throughout; designed to handle easily the speaker requirements of the finest audio systems. Type 6L6-GC has, among other features:

- Special 5-layer bonDED-metal plate, developed by General Electric for improved heat conduction and radiation.
- New large heat radiator on control grid, to minimize grid emission.
- Redesigned screen grid, for higher dissipation.
- New protective slots on micros, to reduce high-voltage inter-element leakage.
- New-design filch, to radiate heat more efficiently.

Top power output—low distortion—completely new design—economy! Four important advantages to you of General Electric's 6L6-GC. Ask any G-E Receiving Tube Department office below for further information!

| Key design-max ratings, per tube, of the new General Electric 6L6-GC are: |
|-----------------------------|-----------------------------|
| Plate voltage               | 500 v                      |
| Plate dissipation           | 30 w                       |
| Screen voltage              | 450 v                      |
| Screen dissipation          | (500 v center tap)         |
| Cathode current             | 5 w                        |

* Two 6L6-GC tubes push-pull, Class AB1 service, with 450 v on the plate.

Progress Is Our Most Important Product

GENERAL ELECTRIC
you’ll need help!

If you earnestly feel the only way to get the kind of pots you need is to build ‘em yourself — a word of caution. Don’t start off alone — gather a few choice friends around to assist with the problems you might run into. There’s the little matter of metals engineering, plastics, contact engineering, chemical, metallurgy and other assorted engineering areas. Otherwise, you might never get through all these little details!

But don’t waste time putting your friends through engineering school — Ace has a stall of specialists and consultants all recruited for just such design problems! They save us — and in turn — our customers, needless concern over the stumbling blocks which may arise. So if a unique design solution to your pot requirements is what you’re after, don’t hesitate! See your ACErep!

Here’s a typical bit of ACE collaboration: Our A.I.A. 1-1/16" size ACEPOT®, screwed mount.

Pressure Transmitter
shock resistant

INTERNATIONAL RESISTANCE Co., 401 N. Broad St., Philadelphia 8, Pa., has announced a new COMPU-TRAN zero setting differential pressure transmitter. Model 70-2900 features 0.2 percent measurement accuracy, infinite resolution, and zero output preset at any point throughout the range. The shock resistant unit is suitable for corrosive atmospheres and is available in static pressure ranges from 0-100 to 0-3,000 psi with differentials up to 100 percent of range. Circle 223 on Reader Service Card.

Diode Clips
spring loaded

CAMBRIDGE THERMIONIC Corp., 115 Concord Ave., Cambridge 38, Mass., has added three new spring loaded Teflon-insulated diode clips to its Gambion line. All three are field...

(Continued on p 108)
Get out your pencil and help yourself to electronics READER SERVICE

it's free—it's easy—it's for your convenience

Use these handy READER SERVICE CARDS for more information on:

ADVERTISEMENTS—NEW PRODUCTS—LITERATURE OF THE WEEK

1—Circle the number on the postpaid card below that corresponds to the number at the bottom of Advertisement, New Product item, or Literature of the Week selection.

2—Please print carefully, as it is impossible to process cards that are not readable.

Additional Postage MUST be added to cards for all FOREIGN MAILINGS

FEB 27 • 59
CARD EXPIRES APR 27 • 59

electronics • READER SERVICE CARD • Please Print Carefully

YOUR NAME

COMPANY

ADDRESS

CIRCLE THESE NUMBERS WHEN INTERESTED IN ALL ITEMS SHOWN IN ANY ADVERTISEMENT

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90

91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120

121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150

151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180

181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210

211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240

241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270


FOR SPECIFIC ITEMS IN MULTI-PRODUCT ADVERTISEMENTS

For more information on specific items in multi-product advertisements, print carefully on the Reader Service Card below in Box 'A' the number of the advertisement and the specific product(s) on which you desire more information.

HOW TO SUBSCRIBE—HOW TO RENEW YOUR SUBSCRIPTION TO ELECTRONICS

If you are not a subscriber, or if your subscription is about to expire, to receive electronics regularly, fill in the section "FOR SUBSCRIPTIONS" on a card below. Send no money, electronics will bill you at the address indicated on the Reader Service Card.

FOR SUBSCRIPTIONS: (CHECK ONE BOX)

□ NEW □ RENEWAL

(CHCK ONE BOX BELOW)

DOMESTIC □ 1 yr. — $ 6.00
□ 3 yrs. — $12.00
□ CANADA □ 1 yr. — $10.00
□ FOREIGN □ 1 yr. — $20.00

Product(s) manufactured:

□ or Service(s) Performed:

A □ Circle No. □ Product

□ □ □ □ □

□ FOR SUBSCRIPTIONS: (CHECK ONE BOX)

□ NEW □ RENEWAL

(CHCK ONE BOX BELOW)

DOMESTIC □ 1 yr. — $ 6.00
□ 3 yrs. — $12.00
□ CANADA □ 1 yr. — $10.00
□ FOREIGN □ 1 yr. — $20.00

Product(s) manufactured:

□ or Service(s) Performed:

A □ Circle No. □ Product

□ □ □ □ □

□ FEB 27 • 59
CARD EXPIRES APR 27 • 59

FEB 27 • 59
CARD EXPIRES APR 27 • 59

FOR SUBSCRIPTIONS: (CHECK ONE BOX)

□ NEW □ RENEWAL

(CHCK ONE BOX BELOW)

DOMESTIC □ 1 yr. — $ 6.00
□ 3 yrs. — $12.00
□ CANADA □ 1 yr. — $10.00
□ FOREIGN □ 1 yr. — $20.00

Product(s) manufactured:

□ or Service(s) Performed:

A □ Circle No. □ Product

□ □ □ □ □
In every industry there's always ONE accepted Product and Data Buying Book... in electronics it's the BUYERS' GUIDE - fundamental in any sales program aimed at the electronics and allied industries. Its 52,000 paid subscribers are important Design-Research/Production/Management Engineers, who, individually, or working in combination with one another, influence the purchase of products, materials and services... whatever is bought by the entire industry.

A McGRAW-HILL PUBLICATION
330 West 42nd Street • New York 36, N.Y.

**BUSINESS REPLY MAIL**
NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

6¢ Postage Will Be Paid By ELECTRONICS
Reader Service Dept.
330 West 42nd Street
New York 36, N. Y.

**BUSINESS REPLY MAIL**
NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

6¢ Postage Will Be Paid By ELECTRONICS
Reader Service Dept.
330 West 42nd Street
New York 36, N. Y.
Cambion® Miniature Jacks and Plugs
Ideal for computer patchwork panels

Take your pick from the large selection of Cambion miniature jacks and plugs. Varying widely in types, these top quality, precision made units are ideal for quick, tight, space-saving patchwork on panel boards.

The jacks make perfect electrical connections, thanks to their special beryllium copper compression springs, floating D keys and solid fronts. Jacks are available in shank lengths for varying panel thicknesses. Pin diameters of the plugs are .080”, .062” and .045”.

For full information, write Cambridge Thermionic Corporation, 487 Concord Avenue, Cambridge 38, Massachusetts.

B-A SEMICONDUCTOR MINORITY CARRIER LIFETIME TEST SET
Baird-Atomic Model JJ a basic tool for the TRANSISTOR LABORATORY
Provides a reproducible measure of minority carrier lifetime of both germanium and silicon samples. Measurement evaluates performance characteristics to be expected of devices made from the sample material.
Range: MCL above 10 microseconds
Accuracy: ± 10%
Method: conductivity modulation
For complete technical information request Bulletin TP 103

Baird-Atomic, Inc.
33 University Rd., Cambridge 38, Mass.

MINIATURIZATION?
LEVIN® TURRET LATHE
PRODUCE SMALL INSTRUMENT PARTS BETTER

A complete Turret Lathe for small parts. Particularly useful for second operation work. Maximum collet capacity 5/16”. Standard models provided with self indexing, six position turret, collet closer, double tool cross slide and variable speed control.
For full details of Turret Lathe and other Instrument Lathes send for catalog T.

Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, Calif.
Preset Counter

**high speed**

**Freed Transformer Co., Inc., 1722**
Weinfield St., Brooklyn 27, N. Y.

Type 2020-4-6 multiple preset counter was designed and developed for counting and sequential predetermining control applications. It is ideally suited for applications when a machine or a process is started manually and stops automatically at several preset counts in one operation. For example, one of the vital industrial operations to which the counter can be applied is the winding of tapped toroidal or transformer coils. Unit performs this and scores of similar complex operations accurately and at great speed. Circle 225 on Reader Service Card.

Capacitors

tantalum slug

**OHMITE MFG. CO., 3693 Howard St.,**
Skokie, Ill. Tan-O-Mile brand, series TS capacitors employ a porous slug of sintered tantalum for the anode. They feature the extraordinary shelf and operating life, stability and wide operating temperature range which derive from the inertness of tantalum metal and the stability of its oxide film. Capacity range is 1.75 to 30 μf. Circle 226 on Reader Service Card.
DIMCO-GRAY
SNAPSLIDE FASTENERS

PROVIDE VIBRATION-PROOF HOLDING AND QUICK, FOOL-PROOF RELEASE!

APPROVED UNDER ARMY-NAVY STANDARDS

Here's a simple, easy means of securely fastening assemblies to withstand shock or vibration, and yet allow quick removal for inspection or repair. Instant snap action engages or releases fastener...no tools are required! After installation, fasteners never need adjustment...even with repeated use.

Three sizes available for different load requirements. Large and medium sizes are made of corrosion-resistant stainless steel. Small size is made of nickel-plated brass. Stock parts fit various thicknesses of flanges and mounting plates...special parts can also be supplied.

WRITE FOR FULL DETAILS TODAY!

DIMCO-GRAY
COMPANY
202 E. SIXTH STREET DAYTON, OHIO

ELECTRONIC DIGITAL COMPUTERS

Just Published—A comprehensive picture of the principles behind computing machines in use today. Shows how basic circuits and devices are assembled and interconnected to form the main units of a computer. Includes projected information on digital-computer arithmetic, general considerations of systems, static and dynamic cells, large-scale memory devices, shifting registers, adders, accumulators, etc. By Charles V. L. Smith, Chief Computing Lab, Aberdeen Proving Grounds. 114 pp., Illus., $17.00.

ELECTRONIC SEMICONDUCTORS

A rigorous and systematic introduction to semiconductor physics as related to rectifier and transistor problems. Explains the subject in a logical and consistent manner from simple concepts, and gives a clear understanding of the conduction mechanism of electronic semiconductors within the framework of the band model. By E. Speake. Translated by D. Jenkins. 286 pp., Illus., $14.00.

CONTROL ENGINEERING MANUAL

Covering control engineering in both industry and the military, this book brings you the latest facts, methods, and engineering know-how from the nation's leading specialists in the field. Helps you analyze tentative control system configurations by means of mathematical, trial and error, computer and graphical techniques. Edited by Hyron K. Loderwood, Chief, Org. Contr. Engineering, 185 pp., 200 Illus., $17.50.

INDUSTRIAL ELECTRONICS HANDBOOK

Over 150 experts supply authoritative descriptive and reference material on all phases of industrial electronics and control. Concise and practical, this handbook covers basic engineering and mathematics, physical laws, control elements, power supplies, control circuits, circuit applications, mechanical design, ultimate utilization requirements, and technical information sources. Prepared by a Staff of Specialists. Edited by W. D. Cockett. General Electric Co. 1408 pp., Illus., $27.90.

Your Inquiries to Advertisers Will Have Special Value...

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publisher to secure more advertisers and—more advertisers mean more information on more products or better service—more value to YOU.
These circuit selectors or stepping relays, model BD2, perform dependable, remote switching jobs such as, stepping ... counting ... programming ... circuit selecting ... sequencing ... and homing. 

check these features: Small and light ... the four wafer selector switch is only 1½" wide, 2½" long and weighs only 3½ oz. ... available with 1, 2, 3, or 4 switch wafers ... 12 positions with silver alloy contacts ... 12 position floating ratchets ... anti-overthrow latch ... flange mounting ... a choice of ratings from 3 to 300 volts D.C. ... available in hermetically sealed models ... and designed to meet all applicable environmental tests of MIL-E-5272B.

immediate delivery from stock of standard model, part No. S-10019-004 ... 3 pole, 12 throw switching, 12 position, notch homing, self-interrupted, 28 volts D.C., flange mounting

White today... for engineering and stock model information ... Bulletins 55852 and 558572

G.H. Leland INC.

123 WEBSTER ST., DAYTON 2, OHIO

CIRCLE 83 READERS SERVICE CARD

** NEW SMALLEST Ledex® ROTARY SELECTION SWITCH **

light...only 3-1/2 oz. small...only 1-3/8" x 2-29/32"

Literature of

MATERIALS

Platinum Metals. J. Bishop & Co. Platinum Works, Malvern, Pa. Platinum Metals Review is a 40-page quarterly publication devoted to research of the platinum metals and their applications in industry. It can be obtained without cost by writing on company letterhead.

Ferromagnetic Materials. The Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Pa. A new 4-page bulletin is available on Ferrotron ferromagnetic materials, a line of non-memory, inductive electromagnetic core components. Circle 230 on Reader Service Card.


COMPONENTS


Silicon Rectifiers. Sarkes Tarzian, Inc., Bloomington, Ind. Catalog No. 69 is a 46-page handbook containing descriptive information and technical data on a wide line of silicon rectifiers. Circle 233 on Reader Service Card.

EQUIPMENT

Adjustable-Speed Drives. ServoTek Products Co., 1086 Goffle Road, Hawthorne, N. J. Catalog 11058 is a 16-page compilation of technical data including a discussion of the basic methods for op-
the week

erating d-c motors from a-c power sources. Circle 234 on Reader Service Card.


Dynamic Memory Processor. Genesys Corp., 10131 National Blvd., Los Angeles 34, Calif. Bulletin DDMP-1 illustrates and describes the company’s dynamic disk memory processor, a system nucleus product applicable to many data handling and control computing applications. Circle 236 on Reader Service Card.


Magnetic Tape Tester. General Kinetics Inc., 555 23rd St., South Arlington 2, Va., has available a bulletin describing a new digital computer accessory, the model U-1 automatic magnetic tape tester. Circle 238 on Reader Service Card.

FACILITIES


PLANTS AND PEOPLE

Erecting Microwave Plant

Construction has begun on a new 40,000 sq ft, one-story plant in Clifton, N. J., for the John Gombos Co., Inc., manufacturer of microwave equipment and mechanical and electromechanical assemblies.

Located on a four-acre plot which allows for additional expansion, the plant will almost double manufacturing and assembly space, and will include very modern aluminum dip-brazing facilities, according to John Gombos, president. The plant will be within one-half mile of several major New Jersey highways and 15 minutes from midtown New York.

Gombos says the company plans to substantially expand its engineering department. Company has already purchased many new machine tools which will be moved to the new plant. Gold, silver, chrome, nickel and copper plating facilities will be included.

New building is scheduled for completion in near future and will accommodate approximately 300 employees on a one-shift basis. The company now has about 150 employees in its Irvington, N. J., plant. All operations will be moved to Clifton when the new plant is ready.

Galbraith Takes New Post

Executive vice-president Vess Chigas of Microwave Associates, Inc., Burlington, Mass., appoints James S. Galbraith as manager of semiconductor operations. In this capacity, Galbraith will report directly to Chigas.

Galbraith will be responsible for the coordination of all semiconductor operations at Microwave Associates, including research and development, engineering, and production. He was formerly sales manager for semiconductor products at Microwave.

For seven years prior to his affiliation with Microwave in 1958, Galbraith was with Sprague Electric Co. in North Adams, Mass.

Establish New Company

Formation of Edal Industries, Inc., New Haven, Conn., is announced. Company will manufacture a stabilized instrument rectifier, copper oxide and selenium diodes, selenium rectifiers, diode modulators, demodulators, phase comparators and varistors.

Galbraith Takes New Post

IBM Promotes A. G. Anderson

With the IBM Watson Research Laboratory, San Jose, Calif., since 1953, Arthur G. Anderson was recently appointed acting manager of basic science there. He will be responsible for fundamental research which becomes the basis for new technology which ultimately results in significant new computer concepts.

Yarbrough Joins Gabriel Division

Appointment of Stanton L. Yarbrough as vice president of the electronics division of The Gabriel Co. is announced. Located in Needham Heights, Mass., this division produces antennas, microwave sys-
J&L Comparators are ideally suited for inspection of printed circuits — because they provide coordinate measuring facilities corresponding to the method by which circuits are dimensioned.

In mating the printed circuit with other components, it is necessary that the terminal points be located accurately. Also — to assure a uniform flow of current through the connectors, the drilled holes at the terminals must be centralized within the circuitry.

A Comparator, equipped with a surface illuminator, projects a reflected image to a chart having radii and lines. By comparing the image of the drilled holes to the radii on the chart the size and location of the holes may be determined.

True precision like this never comes cheap!

Of all the possible areas in which to economize, quality inspection is the least promising. Why?

Simply because the kind of intensive research, painstaking engineering and top-quality manufacture it takes to produce precision inspection equipment like the J&L Comparator just CAN’T be offered at bargain-basement prices. On the other hand, cheap equipment doesn’t belong in the same league with a J&L Comparator when it comes to accuracy, speed, versatility and all-round dependability. When it comes to true precision of inspection, a cheap comparator can prove to be terribly expensive.

J&L Comparators come in 11 models, both bench and pedestal type.

---

"The originator of machine tool standards in optical inspection"

JONES & LAMSON

JONES & LAMSON MACHINE COMPANY, Dept. 710. 539 Clinton Street, Springfield, Vt., U.S.A.

Please send me Comparator Catalog 5700, which describes the complete line of J&L Optical Comparators.

name title

company

street

city zone state

ELECTRONICS — February 27, 1959
when only the best is good enough

NOW AVAILABLE

the NEW Superior Catalog
Free At Your Request

Contains up-to-date information on a wide range of quality gun mounts for use with a great variety of cathode ray tubes. Send for your copy NOW.

Depend on the world's leading electron gun mount manufacturers, Superior Electronics Corporation, for uniform product performance, dependable service and fair prices.

Superior Electronics Corporation
208 Piaget Avenue, Clifton, New Jersey • GRegory 2-2500

Wolf Takes New Stavid Post

B. H WOLF has been appointed Air Force Contract Manager for Stavid Engineering, Inc., Plainfield, N. J. He was formerly manager of the airborne electronics department. In his new assignment he will be responsible for pre-contract planning in connection with Stavid's Air Force programs.

Since joining Stavid in 1949, Wolf has directed various development programs including airborne bombing radars, beacons, search-track equipment and radar fire control systems.

News of Reps

The Richard CapeII Co. is named sales rep for southern California and Arizona by Hi-Spec Electronics, North Hollywood, Calif., manufacturer of miniature sensitive relays.

Five new manufacturer sales reps are appointed to handle the products of the Staver Co., Inc., Bay
Shore, L. I., N. Y. New reps and the territories they cover are:

J. H. Paterson of Akron, Ohio, for the state of Ohio; Herb Mandle of Revere, Mass., for Connecticut, Maine, Rhode Island, New Hampshire, Vermont and Massachusetts; Leemark Associates of Kansas City and St. Louis, Mo., for Kansas, Nebraska, Missouri, Colorado, southern Iowa and E. St. Louis, Illinois; Jack Geartner of Miami Beach, Fla., for the state of Florida; Murphy & Cota of Atlanta, Ga., and Charlotte, N. C., for North and South Carolina, Alabama, Mississippi and Tennessee.

Scientific Sales Engineering Co., with offices in Atlanta, Ga., and St. Petersburg, Fla., has opened a new Winston-Salem branch office. Firm represents several electronic instrument and component manufacturers in the southeastern states and specializes in precision components and application and engineering services.

Penta Laboratories, Inc., Santa Barbara, Calif., appoints J. L. Peirce Co., of Detroit, as representative in the state of Michigan.

Ferroran Electronics Co., Inc., New York, N. Y., appoints Featherstone & Salisbury Co. of San Francisco, Calif., as manufacturer's rep for northern California and northern Nevada to handle the sale of its line of transistor equipment and components, miniature rectifiers and audio transformers, and miniature semiconductor power supplies.

Schaevitz Engineering, Peninsauken, N. J., manufacturer of electronic components, announces three new sales reps: Tesco of Seattle, Wash., will represent it in Washington, Oregon, Idaho and Montana. Ensco (Engineering Service Co.) of Kansas City, Mo., will handle the Missouri, Kansas, Iowa and Nebraska area. Southwest Electronic Industries of Dallas, Texas, will cover Texas, except El Paso, as well as Oklahoma, Arkansas and Louisiana.
**New EDIN B-SERIES**

Oscillograph Amplifiers

EDIN has met these specs — ARE THEY YOURS?

- **GAIN:** to 100,000
- **STABILITY:** Down to 10 μV equivalent input drift
- **FREQUENCY RESPONSE:** DC to 1500 cps 1%
- **INPUT IMPEDANCE:** 2 megohms, for use with wide variety of transducers
- **REJECTION RATIOS:** Better than 20,000 to 1
- **CALIBRATION:** Internal
- **PACKAGING:** Standard 19" rack-panel or portable case

A DIVISION OF EPSCO, INCORPORATED  568 Commonwealth Avenue, Boston 15, Mass.

CIRCLE 91 READERS SERVICE CARD

**COMMENT**

No Johnny-Come-Lately

That was a nice roundup on digital computers striking oil ("Digital Computers Strike Oil," p 20, Jan. 23). I'm sorry to mention, however, that there's an error you might consider correcting in whatever way you think appropriate.

The caption (on the lead illustration) says our IBM704 was "installed last month." Actually it was in November and December of 1957.

The only trouble with this otherwise understandable slip is that it makes the company look like a Johnny-come-lately instead of a pioneer in the field.

R. L. DUNNE

ESSO RESEARCH & ENGINEERING CO.
NEW YORK

Tolerance

(Re: "Thin Parts Produced by Etching," p 74, Jan. 30: "A tolerance of ± 0.002 inch is not difficult to hold on material of 0.001 to 0.005 inch thickness..." This is a good trick if you can do it. Or is it a new form of the old-fashioned "puttenon" tool?)

W. L. WRIGHT

WRIGHT RADIO CO.
SCITUATE HARBOR, MASS.

We've been away from New England long enough to have forgotten what a puttenon tool is, but we can vouch for the reasonableness of the tolerance figure. The tolerances are those which can be held in length, width or diameter of the parts; there is no reduction in thickness of the metal sheet, since the resist protects its surface from the etchant.

Of course, once the etchant has removed the top surface of the metal, it can work sideways under the resist. The thicker the metal sheet, the greater the amount of undercutting that can occur.

Of Praise and Glory

(Re: Comment, p 103, Feb. 6, letter captioned "Kudo")...
singer is kudos from the Greek meaning praise, honor . . .

WILLIAM J. TEMPLE
BROOKLYN COLLEGE
BROOKLYN, N. Y.

Reader Temple—who is professor of speech at Brooklyn College—catches us in an error for which we can offer only this rationalization: that we've always been entranced by the idea of a singular kudo. The Greek word, incidentally, means "glory."

And we guess that if we're to be called on this, we must henceforward use the Greek plural "kudoi."

Theodolites

We were very pleased to see the prominent attention you gave to the azimuth alignment theodolites ("Theodolite References Jupiter Guidance," p 62, Feb. 6), and to their important role in helping ensure the accuracy of long-range missiles.

There is one additional point that deserves mention. The particular theodolites we produce for the Jupiter were developed jointly with the Army Ballistic Missile Agency at Redstone Arsenal. The group there, under Walter Haussermann, Fritz Mueller and Henry Rothe, were responsible for, and deserve credit for, the overall alignment system development. Our responsibility was to develop and produce instruments to meet the highly precise requirements of that system.

Unfortunately there was an oversight in noting this among the several credits when we originally prepared the material and had it cleared through the appropriate agencies.

CARLTON W. MILLER
PERKIN-ELMER CORP.
NORWALK, CONN.

Always happy to give credit where due.

SAC Electronics

The series of articles on Strategic Air Command's electronic system is fine. Give us more like them . . .

H. N. STOVER
CHICAGO

ELECTRONICS—February 27, 1959
NEW CONCEPTS IN COMBAT SURVEILLANCE OFFER YOU A MORE PROMISING CAREER

Over $25 Million in New R&D Contracts for SWALLOW Awarded Missile Systems Division of Republic Aviation

It has been the dream of every combat commander to possess accurate information concerning tactical disposition of enemy troops and material, before, during and after the battle. One of the telling answers to this vital problem is the Swallow SD-4. Engineers joining this program will find challenge in:

...new sensing techniques (infrared, optical, radar and other)
...sophisticated, split second guidance
...optimum aerodynamic solutions for high velocity, ground-controlled vehicles

The Swallow SD-4, and the SD-3 are two of many expanding programs—ECM, anti-ICBM and missile guidance—that offer unusual openings in the following areas:

MICROWAVE ENGINEERS Design of microwave antennas and components for airborne navigation systems

COMPUTER ENGINEERS Digital data transmission, digital and pulse circuitry, and digital computer logic and storage

FLIGHT CONTROL ENGINEERS Automatic flight control systems, inertial guidance and stable platforms

Send resume in complete confidence to:
Mr. Paul Hartman, Engineering Employment
MISSILE SYSTEMS DIVISION
Republic Aviation
223 Jericho Turnpike, Mineola, Long Island, New York

ELECTRICAL ENGINEERS

Challenging positions open for high calibre Electrical Engineers with 2 to 5 years experience to work in interesting research and development programs in instrumentation and circuitry. We offer you an opportunity to use your initiative and creative ability.

Excellent employee benefits including liberal vacation policy. Please send resume to:

E. P. Bloch
ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 West 35th Street
Chicago 16, Illinois

TWO INSTRUCTORS for instrumentation courses in training school

Conducted by long-established major instrument-manufacturer. Previous teaching experience desirable. Duties include organizing and conducting one-week to three-month courses, required several times yearly, for field-representatives and company and eventually other instrument-teachers. Subject matter covers operating principles, construction, installation, and maintenance of indicators, recorders, controllers, pirometers, thermocouples, thermometers, equipment, etc.; self-balancing potentiometers and bridles, pneumatic and electronic controls, etc. These are now jobs created because of steadily increasing demand for company's products in industry. Salary is open and will be made definitely attractive to the right men.

Write C. F. Johnson, Manager Education
THE BRISTOL COMPANY
Waterbury 20, Connecticut

DISENCHANTED ENGINEERS

If your present employer has failed to utilize your full potential, why not permit us to explore the parameters for your personal qualifications with the many dynamic young companies in aviation, electronics, missiles and rockets. We now have in excess of 1,000 openings in the $8,000 to $10,000 bracket, all of which are fee paid. Why wait? Send resume in duplicate at once to:

FIDELITY PERSONNEL
1218 Chestnut Street, Philadelphia 7, Pa.

RATES

"Employment Opportunities"

Displayed—The advertising inch is $28.67 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured 7/8" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

Undisplayed—$2.40 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions. Not subject to Agency Commission.

Send NEW ADS to ELECTRONICS, Class Adv. Div., P. O. Box 12, New York 36, N. Y.
Unusual Career Openings
in RAPIDLY growing company for
PROJECT ENGINEERS
SR. ENGINEERS & ENGR'S.
BS-EE or PHYSICS

Several years or more experience in cir-
cuity and equipment design or applicable
background—to work on UHF and VHF sys-
tems. Wide band knowledge desirable for
calling assignments on electronic counter-
measures systems for military application and
electronic instruments for commercial use.
Excellent salary range at all levels. Close
association with acknowledged leaders who
will aid your professional growth and de-
velop your engineering abilities.

Profit Sharing Retirement Plan. Many other Benefits.

INSTRUMENTS FOR INDUSTRY, INC.
101 New South Rd. Hicksville, L. I.

ADDRESS BOX NO. REPLIES TO: Box No.
Chesterfield Adver. Dir. at this publication,
Send in after issued one.
NEW YORK: 60 FIFTH AVE., BOX 17.
CHICAGO 11: 210 N. Michigan Ave.
SIX FRANCISCO 5: 48 Polk St.

POSITION VACANT

Instrument Engineer for expanding Middle
Atlantic Military Electronics. Electrical back-
ground desirable, minimum three years' indus-
trial experience and college degree required.
Excellent opportunity for top-flight engineer.
Resumes will be treated confidentially, P-9987,
Electronics.

POSITION WANTED

Wanted—Concern needing top-quality en-
gineering—BS-EE and MSEE—10 years
experience in industrial, military, and miss-
eile fields. Prefer mid-West location. PW-
6526, Electronics.

Your Inquiry will have
Special value...

If you mention this magazine, when writing advertisers. Natur-
ally, the publisher will appreciate it...but, more important, it will
identify you as one of the men the advertisers wants to reach with this
message...and help to make possible enlarged future service to
you as a reader.
Ideas are the life-blood of an operation devoted exclusively to diversified electronics research, development and production. So it’s logical, we think, for the project engineer to see his idea to completion... from design through construction through field testing (and sometimes, alas, back to the drawing board). The effectiveness of this project approach is illustrated by our achievements in military and industrial electronics. If you generate sound ideas and would like the opportunity to follow through on them... and if you like the idea of living beneath bright, sunny skies the year around... write to Mr. Kel Rowan, Department A-3.

MOTOROLA Western Military Electronics Center 8201 E. McDowell Rd., Phoenix, Arizona

Electronic Engineers, Mechanical Engineers, Physicists—SYSTEM ANALYSIS, DESIGN AND TEST—Radars, Missile Guidance, Navigation, Combat Surveillance, Communications, Field Engineering, Data Processing and Display—CIRCUIT DESIGN, DEVELOPMENT AND PACKAGING—Microwave, Pulse and Video Antenna, Transistor, R/F and I/F Servos, Digital and Analog, TECHNICAL WRITERS AND ILLUSTRATORS, QUALITY CONTROL ENGINEERS, RELIABILITY ENGINEERS

Motorola also offers opportunities at Riverside, California and Chicago, Illinois.

For additional information about classified advertising contact

专业服务

测量

研究 & 制造工程师

Harry W. Buck

Phenix

电子设计专家

移动信号发射器，色差输入，镜像，调制，频谱分析器，和相关装置。

J. H. Puglin, Chairman, 4th of Eng.

29 Rancor Dr., Analytivlle, L. L., N. Y.

雅丁实验室

"电子计算机的先驱"—

"为电能的电子制造者"—

24-35 Lenox Street

New York 15, N. Y. * T. M.

For additional

information

about classified advertising

Contact


ATLANTA, 3—1301 Rhodes-Hawley Bldg.

M. H. MILLER

BOSTON, 16—350 Park Square

D. J. CASSIDY

CHICAGO, 11—520 N. Michigan Ave.

W. J. HIGGENS—D. C. JACKMAN

CLEVELAND, 13—1712 Commerce St., Vaughn Bldg.

B. B. SULLIVAN—T. H. HUNTER

DALLAS, 1—1164 Illuminating Bldg.

GORDON JONES—F. K. HOLLAND

DETROIT, 26—856 Penobscot Bldg.

GORDON JONES—F. K. HOLLAND

NEW YORK, 63—500 Fifth Ave.

H. T. BUCHANG—R. P. LAWLESS

PHILADELPHIA, 3—36-1125 W. 6 St.

T. W. McCLURE—H. W. BOZARTH

ST. LOUIS, 8—36-1125 Olive St.

SAN FRANCISCO, 4—68 Post St.

FOR ADDITIONAL INFORMATION About Classified Advertising

Contact The McGraw-Hill Office Nearest You.

ATLANTA, 3—1301 Rhodes-Hawley Bldg.

M. H. MILLER

BOSTON, 16—350 Park Square

D. J. CASSIDY

CHICAGO, 11—520 N. Michigan Ave.

W. J. HIGGENS—D. C. JACKMAN

CLEVELAND, 13—1164 Illuminating Bldg.

B. B. SULLIVAN—T. H. HUNTER

DALLAS, 1—1172 Commerce St., Vaughn Bldg.

GORDON JONES—F. K. HOLLAND

DETROIT, 26—856 Penobscot Bldg.

GORDON JONES—F. K. HOLLAND

NEW YORK, 63—500 Fifth Ave.

H. T. BUCHANG—R. P. LAWLESS

PHILADELPHIA, 3—36-1125 W. 6 St.

T. W. McCLURE—H. W. BOZARTH

ST. LOUIS, 8—36-1125 Olive St.

SAN FRANCISCO, 4—68 Post St.

FOR ADDITIONAL INFORMATION About Classified Advertising

Contact The McGraw-Hill Office Nearest You.

ATLANTA, 3—1301 Rhodes-Hawley Bldg.

M. H. MILLER

BOSTON, 16—350 Park Square

D. J. CASSIDY

CHICAGO, 11—520 N. Michigan Ave.

W. J. HIGGENS—D. C. JACKMAN

CLEVELAND, 13—1164 Illuminating Bldg.

B. B. SULLIVAN—T. H. HUNTER

DALLAS, 1—1712 Commerce St., Vaughn Bldg.

GORDON JONES—F. K. HOLLAND

DETROIT, 26—856 Penobscot Bldg.

GORDON JONES—F. K. HOLLAND

NEW YORK, 63—500 Fifth Ave.

H. T. BUCHANG—R. P. LAWLESS

PHILADELPHIA, 3—36-1125 W. 6 St.
SEARCHLIGHT Equipment Spotting Service

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components not currently advertised. This service is for USER-BUYERS only. No charge or obligation.

How to use: Check the dealer ads to see if what you want is currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

SEARCHLIGHT EQUIPMENT SPOTTING SERVICE
C/O ELECTRONICS—Classified Advertising P. O. Box 12, New York 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

NO CHARGE • NO OBLIGATION

SEARCHLIGHT EQUIPMENT SPOTTING SERVICE, C/O ELECTRONICS— Classified Advertising P. O. Box 12, New York 36, N. Y.

Please help us to locate the following used equipment:

NAME
TITLE
COMPANY
STREET
CITY
ZONE STATE 227 59

CONTACTS
FOR THE FIELD OF ELECTRONICS

MAGNETS FOR ALL INDUSTRIES

We manufacture all sizes of magnets to any specifications.

Send inquiries to: M-9911
Classified Adv. Div. of ELECTRONICS—P. O. Box 12, New York 36, N. Y.

SEARCHLIGHT SECTION
(Classified Advertising)

BUSINESS OPPORTUNITIES EQUIPMENT—USED or RESALE

400 CYCLE GENERATOR—1 PHASE POWER

For Rent

Brand New
U. S. Navy

400 Cycles—1 Phase—100 Kw.

NOW ONLY $18950
F. O. B. Chicago

LINCOLN 750 AMP 28.5 V.D.C

POWER SOURCE

Designed for continuous duty for testing service, ground power units, battery charging, aircraft starting. Bolt Treating Conversion

1400 RPM 27th Flt. Shaft. 5 Goose V. Bell Pulses.

Value $26500
NOW ONLY $26500
F. O. B. Chicago

GROBAN SUPPLY CO., Dpt. EM-2
1139 S. Wabash Ave Chicago 5, Ill.

FREE! New Catalog, Sensational Values! Electronic & New Equipment Write Today.

WESTINGHOUSE Motors
1/40 HP

(removed from business machines)

$3.75

$3.00 each in lots of 10.

WESTON self generating cell
list price $22.00 our price... $4.50

$60.00 timing unit...

$9.50

motor alone costs $32.00

TRANSFORMER 110/220v to 32/16v

60 amp., 2 KVA. Shipping Wt 12 lbs.

$30.00

We are distributors for

Purchasing Agents
Engineers—Experimenter—Designers

Please turn to your back. We have the largest selection of Electronics for any ads that have not been charged for years.

BARRY ELECTRONICS CORP.
512 Broadway WA 5-7000 New York 12, N. Y.

R A D A R

From Stock Delivery

Skywave Antenna Pedestal, SCR-341 & 761

Search-Talk Radars, MPM-IB RCA, APS-10,

APS-31, APS-33, APS-32

NAVY WEATHER-EYE RADAR

NAVY WEATHER-EYE RADAR

RADAR RESEARCH INSTRUMENT CO.
350 Fifth Avenue, N. Y. 36, N. Y.

— RATES —

DISPLAYED

The advertising rate is $12.50 per line for all advertising except Employment.

Employment Opportunities  $12.50 per line subject to Agency Commission.

UNDISPLAYED

$12.50 per line, minimum 2 lines. To figure advertising cost come 5 average words as a line.

Purchases over 100 words are half of above rate. Discount of 10% if full payment is made in advance for 12 consecutive insertions.

PURCHASING AGENTS

We have practically all types of Relays in large quantities, ready to deliver. We are distributors for

POTTER & BRUMFIELD, Inc.

We have practically all types of Relays in large quantities, ready to deliver. We are distributors for

BLAN

INC.

121
INDEX TO ADVERTISERS

- A C Electronics Division ........................................... 31
- Accurate Instrument Co ........................................... 111
- Ace Electronics Associates, Inc ................................. 101
- Ad-Vu Electronics Lab., Inc ........................................ 122
- Aircraft Armaments, Inc .......................................... 112
- Airpax Electronics, Inc ............................................ 51
- Alamar Co., Inc ...................................................... 96
- All-Weather Co ....................................................... 80
- American Lavu Corporation ....................................... 29
- Ampex Corporation .................................................. 74
- Halco-Amnic, Inc ...................................................... 105
- Bell Telephone Laboratories ...................................... 99
- Bendix Aviation Corp ............................................... 90
- Borden Pioner Division ............................................. 91
- Red Bank Division ................................................... 42
- Redner-Pacific ........................................................ 98
- Berkeley, a division of Beckman Instruments, Inc ......... 11
- Bird Electronics ....................................................... 46
- Bonnell & Co, Inc .................................................... 3
- Cambridge-Thermionic Corporation ............................. 105
- CBS-Hytex .............................................................. 27
- Clifford Precision Products Co., Inc ........................... 81
- Consair, A Division of General Dynamics Corporation .... 77
- Curfiss-Wright Corporation ....................................... 100
- Davis Co., The ........................................................ 33
- Diemco-Gray Co ...................................................... 109
- Don Corning Corporation ........................................... 12
- Eagle Signal Corporation .......................................... 115
- Eide Corporation ..................................................... 108
- Eldeman Corporation ................................................. 97
- Electric Regulator Corporation .................................. 98
- Electronic Instrument Co. EICO ................................. 108
- Electronics ............................................................. 80
- Eppen, Incorporated ................................................ 116
- Essex Wire Corporation, Magnet Wire Division ............. 36
- General Electric Company Tube Dept .......................... 162
- General Products Dept ............................................. 33
- General Instrument Corp ........................................... 82
- Grant Pulley and Hardware Corp ................................. 14
- Hillsboro Electronics Company ................................. 104
- Mihay Wireless Division, Division of General Time Corp 71
- Heath Company ...................................................... 87
- Hewlett-Packard Company ....................................... 9
- Hughes Aircraft Company .......................................... 48
- T T Laboratories ...................................................... 78
- International Telephone and Telegraph Corp ............. 108
- Johnson Co., E. F ................................................... 43
- Jones & Lamson Machine Company .............................. 113
- Ireland Inc., G. H .................................................... 116
- Litton Industries ..................................................... 97
- Lockheed Aircraft Corp ............................................ 71
- Los Alamos Scientific Laboratories ............................ 97
- Louis Levin & Son ................................................... 107
- Merriam Instruments ................................................. 39
- Malby Co., Inc ....................................................... 10
- Marshall Electrical Instrument Co. ............................. 106
- Metro-Hill Book Co .................................................. 189
- Microwave Associates, Inc ....................................... 93
- Mullan Overseas Ltd ................................................ 7
- Nort American Electronics, Inc .................................. 114
- Offner Electronics, Inc ............................................. 45
- O'Malley Mfg. Co .................................................... 7
- Parker Seal Company ................................................. 17
- Philco Corporation ................................................... 52
- Potter & Brumfield, Inc ........................................... 83
- Pyle-National Company ........................................... 49
- Raycor Corporation of America .................................. 10
- Raytheon Mfg. Co .................................................... 37
- Raytheon Instruments ................................................. 7
- Rubbermaid Corporation ........................................... 38
- Texas Instruments Incorporated .................................. 15
- Texas Research Associates Corporation ....................... 5
- Transradio Ltd ........................................................ 71
- Tite Laboratories, Inc ............................................. 31
- Tung-Sol Electric, Inc ............................................. 73
- U. M. C ................................................................. 116
- United Transformer Corporation, 2nd Cover ............... 120
- Vaclin Associates ..................................................... 51
- Veeders-Roent ....................................................... 6
- Westchester Company ............................................... 115
- Westinghouse Electric Corporation ............................. 41, 42, 83
- Whitney Metal Tool Co ........................................... 117
- Professional Services ............................................... 120

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.
EMPLOYMENT OPPORTUNITIES 118-120
EQUIPMENT (Used or Surplus New) For Sale ........................... 121

ADVERTISERS INDEX
Armour Research Foundation of Illinois ................................ 118
Barry Electronics Company ........................................... 121
Bendix Aviation Corp ................................................ 119
Blair ................................................................. 121
Brisol Company ....................................................... 118
Fidelity Personnel Service ........................................... 118
Grobman Supply Company ........................................... 121
Instruments for Industry ............................................. 119
Motorola Inc. Western Military Electronics Center ........ 120
Racio Research Instrument Company ................................ 121
Republic Aviation (MISSILE SYSTEMS DIV.) ................. 118

* See advertisement in the June, 1958 Mid-Month ELECTRONICS BUYERS' GUIDE for complete line of products or services.

This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.