Maser Probes Outer Space
NEW RAYTHEON HEATERLESS AMPLITRONS EXCEED 1,000 HOURS AT RATED POWER OUTPUT

Two new 3-megawatt, S-band Amplitrons have demonstrated an operating life of more than 1,000 hours at rated power output. The QK-622 covers the 2,900 to 3,100 Mc band; the QK-783, the 2,700 to 2,900 Mc band. Both tubes supply full power with low phase pushing characteristics over their entire operating bands at efficiencies greater than 70%—making them unquestionably the most highly efficient microwave tubes thus far developed.

Tubes may be operated at reduced peak power levels to serve as driver stages. High efficiencies are retained at peak power of 600 Kw and gain of 10 db.

Exceptionally long tube life is made possible by the fact that no cathode warmup is required. Starting takes place whenever RF input is present prior to application of modulating pulse. Heater supplies may be omitted entirely from the equipment.

Applications include power-amplifier stages for long-range radars. The tube has been used successfully as an RF power source for linear accelerators.

---

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts.
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1
Ten different ways to actuate this small, dependable switch

Here are ten "SM" subminiature switches equipped with ten different integral and auxiliary actuators that contribute to the great versatility of these dependable, small switches. For ten years MICRO SWITCH subminiature switches have been the choice of designers who require switches of high electrical capacity which can be mounted in small space.

For complete information on the MICRO SWITCH lines of subminiature and sub-subminiature switches, we invite you to contact your nearby MICRO SWITCH branch office, or send for Catalog 63.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario
Lambda Power Supplies specified for newest radar installation

Meet MIL-E 4158 environmental test requirements

Sperry Gyroscope Co., operating under the technical guidance of the Rome (N.Y.) Air Development Center, is producing the new SAGE radar equipment (AN/FPS-35). The power supplies employed to power transmitters and receivers must be able to pass stringent tests.

Sperry's choice: Lambda's COM-PAK®, already widely used as a component in many rocket and missile programs.

All Lambda stock industrial power supplies are made to MIL quality and guaranteed for five years. They are pictured and described in our 32-page catalog. Write for your copy.
SHOPTALK . . . editorial

FOREIGN COMPETITION. Increasing competition for leadership in electronics, from beyond the borders of the U.S., is a fact of our engineering and business life today.

- Japanese transistor imports are still under fire, but this week the fire is being returned. Rising-Sun trade associations have filed a sharp rebuttal to claims that the import level is endangering U.S. national defense. Washington sources indicate the unlikelihood of additional import curbs at this time.

- Canadian broadcasters are showing a keen interest in stereophonic radio. Without benefit of complex committees, a Montreal station will soon be on the air with a-m/a-m stereo for about two hours a day. Plans are afoot to make a-m stereo receivers available in the near future. Meanwhile, listeners will most likely use two separate sets placed six or eight feet apart.

- European missilemakers may become prime suppliers of short-range antitank wire-guided missiles for the U.S. Army and Marines. This would represent a high-production business amounting to tens of millions of dollars a year. We are currently buying a few French and German antitank missiles for evaluation.

Growing concern of U.S. manufacturers regarding foreign competition can be healthy. Keys to the future include improvement in product quality, reduction of engineering costs and elegant simplicity rather than complexity of design.

W. W. Mac Donald
EDITOR

Coming In Our January 22 Issue

CRYOGENICS. Research into the behavior of materials at low temperatures is gathering momentum as more and more uses for cryogenic devices arise. One area is the application to computers. Devices such as the superconducting cryotron (ELECTRONICS, p 39, April 17, 1959) give promise of increased speed and diminished size for digital computers.

Properties of materials near absolute zero pose special problems in circuit testing. Measurement of the critical current in superconducting contacts requires test equipment with fast response because of the short periods such currents can be maintained. In our next issue, J. I. Pankove and R. Drake of RCA Laboratories in Princeton, N. J. describe a system with the necessary response time for measuring currents at 4.2 K.

The tester was developed for a program of basic and applied research in cryogenics, with which Pankove and Drake have been associated during the past year. Pankove is responsible for several new cryogenic device concepts, Drake has an extensive background in test equipment design. Prior to working in cryogenics, Pankove was active in solid-state electronics, for which he received two research awards. He holds 25 issued patents.

RADIATION MONITOR. Nuclear-powered ships require special monitoring equipment to protect their personnel from radioactive dust. Next week, H. E. Debolt of Fairchild Camera and Instruments in Syosset, N. Y. describes a transistorized monitor that sounds an alarm when alpha and beta radiation reach a preset level. Monitor consists of a scintillation counter which feeds pulses to a computer indicator. Computer determines the pulse rate, which is directly proportional to radioactivity.
SPRAGUE® RELIABILITY
in these two dependable wirewound resistors

MINIATURE
Blue Jacket®
VITREOUS-ENAMEL POWER RESISTORS
Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.
A look at the small actual sizes illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.
Get complete data on these dependable minified resistors, write for Engineering Bulletin 7410.

TAB-TYPE BLUE JACKETS: For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. For complete data, send for Engineering Bulletin 7400A.

NEW SMALLER SIZE
KOOLOHM®
INSULATED-SHELL POWER RESISTORS
New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—aged-on-load to stabilize resistance value.
You can depend upon them to carry maximum rated load for any given physical size.
Send for Engineering Bulletin 7300 for complete technical data.

SPRAGUE ELECTRIC COMPANY
35 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS
INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

SPRAGUE®
THE MARK OF RELIABILITY
Here is the first successful application of transistors to high frequency counting and timing. Transistors perform all the functions in CMC's 700 series that required 63 tubes in old style counting equipment. *These are the most reliable counters ever made.* This claim is not made lightly. CMC offers each instrument with an unprecedented:

**2-year service free warranty**
and you can expect little or no maintenance for 5 years.

**True Digital Logic Circuitry**
By answering an obvious need for a completely new, up-to-date approach to counting and timing instrumentation, CMC has produced solid state instruments with greatly simplified circuitry. The digital computer designer has furnished the soundest solution of using solid state devices in high speed switching circuits. He uses logic "and" and "or" gates. And so does CMC.

**Light and Small, Lower Power Drain**
Each 700 series instrument weighs only 27 pounds, measures 7 inches high, 17 inches wide, and 14 inches deep. Light enough for airborne operation and small enough for standard explosion-proof housing. Power consumption is a meager 35 watts, 1/10 the amount for vacuum tube models. Components no longer suffer from the deleterious effects of heat. All components are derated.

**Do All These Jobs**
Measure frequency from dc to 10 mc, time interval from 0.1 sec to 1 mc and unlimited multiple period selection. Frequency converters available for higher frequencies. The counter also generates time interval marker pulses from 1 sec to 1 second. Data can be presented on standard decades or inline Nixie tubes. The 700 series will operate digital recording equipment, punches, inline readouts, and other data handling gear.

**Unique High Frequency Switching**
Gate selection and switching of control functions is accomplished by simply applying -12 v dc signal into control input. High frequencies are not cabled to switches. Control functions can be performed remotely without special regard to cable length or type, impedance matching, etc. All control functions are brought to rear panel plug. Similar diode and transistor gating techniques are used for high speed switching of input amplifiers and decade counters.

**These Features, Too**
Decade count-down time base—frequency divider circuits never need adjustment. Accuracy, ±1 count ± oscillator stability. Sensitivity, 0.25 v rms; input impedance, 25 k ohms/volt.

**And The Price**
Higher than vacuum tube models. But you can save the difference on down time in the first year. Model 727A Universal Counter-Timer, $3,500; Model 707A Frequency Period-Meter, $2,700; Model 757A Time Interval Meter, $2,500. Rack mount optional at no extra cost. All prices f.o.b. Sylmar, California.
2-YEAR GUARANTEE

COMPUTER MEASUREMENTS COMPANY
MODEL 727A UNIVERSAL COUNTER-TIMER

More Information Available
Your nearby CMC engineering representative will be happy to arrange a demonstration and provide you with complete technical information. Or you may write Department 181

COMPUTER - MEASUREMENTS COMPANY
12970 BRADLEY AVENUE • SYLMAR, CALIFORNIA
Phone: EMpire 7-2161
E PLURIBUS UNUM (one unit composed of many parts) aptly describes Raytheon Circuit-Pak.
new word for designers and producers...

CIRCUIT-PAK

for the designer

1. **Space** — compact, encapsulated subassemblies assure maximum space utilization.

2. **Insulation** — better *internal* electrical insulation between circuit elements; better *external* insulation. Corona is minimized.

3. **Matching** — components may be electrically matched, then assembled or replaced as a single unit.

4. **Stability** — temperature stability in critical circuits is improved.

5. **Environment** — greater mechanical stability, resistance to shock, vibration, and resonance.

for the producer

1. **Maintenance** — input and output are quickly checked; circuits may be readily replaced.

2. **Inventory** — one item to buy and stock instead of multiple items.

3. **Assembly** — just plug it in and put it to work; many Circuit-Paks are available from stock.

4. **Design** — save time with Circuit-Paks that meet your specifications; they are ideal for applications such as comparators, bridges, choppers, flip-flops.

5. **Testing** — Raytheon Circuit-Paks are factory pre-tested — your test requirements minimized.
Marvelous new “eyes” for our defense...through

Some dark night, America's defense may well rest upon our ability to “see” what our enemies are up to. This is the urgent mission of Electronic Reconnaissance—uncanny “eyes” with which we can detect enemy electronic signals, and determine exactly the location, type and capability of the signal source.

Since 1952 Hallicrafters, through its Quick Reaction Capability Program, has been instrumental in the rapid development and continuous improvement of Electronic Reconnaissance systems.

Today Hallicrafters QRC is being applied effectively to an increasingly broad area of military electronics, including airborne ECM, communications, SAGE and missile systems.

Put this dynamic design and production force to work now. From single circuit to complete system... for land, sea, air or space application... you’ll get reliable answers quickly and efficiently.

ENGINEERS: Join our rapidly expanding QRC team now. For complete information address inquiries to: William F. Frankart, Director of Engineering.
BUSINESS THIS WEEK

ELECTRONICS NEWSLETTER

THERMOPLASTIC RECORDING development at GE has progressed beyond the implications of a technical article written more than a year ago and published in December by the Journal of Applied Physics. The article described a permanent recording device giving black-and-white and simultaneous color. Last week ELECTRONICS learned that a new tube has been developed for the system. The tube can be used interchangeably for permanent recording of black-and-white and simultaneous color. Instead of using a gun with a splitter grid to produce the phase diffraction gratings on the thermoplastic surface, inventor W. E. Glenn discloses that the new tube produces the gratings by velocity modulation of the horizontal sweep with low-amplitude r-f carriers. Glenn also reports that, in terms of information storage capacity, the GE thermoplastic tape is "several hundred times denser than the best available magnetic tape," is also "comparable to highest resolution photographic film." For more on thermoplastic recording, see p 46.

New Amperex magnetron which operates at 25 kw peak power at 35-kmc and provides a 0.02 millisecond pulse width is now operating in a Philips airport surface detection radar set. The radar can distinguish between objects four yards apart at a distance of 1,000 yards.

FEDERAL COMMUNICATIONS COMMISSION, in yearend statement marking its 25th year of operation, reported 570,000 radio station licenses using more than 1.7 million transmitters. F-m authorizations climbed from 690 to 825, with some 665 stations on the air compared with 570 a year ago. A-m gained about 100 authorizations and 150 operating stations during the year, bringing the 1959 figures to about 3,500 and 3,450 respectively. TV station figures did not change materially—672 hold authorizations and more than 500 in operation (including 76 uhf).

SOLID-STATE COMBUSTION CONTROL system will be installed on a 2-zone slab heating furnace at the plant of an eastern steel producer in mid-1960. The system, to be supplied by Hagan Chemicals & Controls, Inc., Pittsburgh, will use magnetic amplifiers, and includes controls for zone temperature, zone fuel/air ratio, furnace pressure, recuperator temperature balance and air pressure, along with panels and recording instruments.

All-weather radiometric sextant, miniaturized for submarine installation and some five times as accurate as many marine compasses now in use, will be designed by AC Spark Plug under a Navy BuShips contract.

RADIOPHONOGRAPH which weighs 2.8 lb. and operates as a 540 to 1,600-kc radio set with its lid on, and as a phonograph with its lid off, has just been introduced in Japan by Standard Wireless Industry. The company expects to produce 10,000 units per month by April for export. Japanese yen price is equivalent to $42. The unit uses four dry batteries, seven transistors, two diodes and a thermistor.

Antisubmarine warfare (ASW) program demands more and more electronic gear. A $4 million Navy contract was recently awarded to Hazeltine for 32,000 sonobuoys and repair kits. Company is currently producing 12,000 of the cylindrical air-launched packages that detect and transmit sub noises.

AIRBORNE EARLY WARNING blimps just delivered to the Navy by Goodyear Aircraft will carry what the company describes as "the largest complex of modern radar and electronic equipment to be operational in a single aircraft." The 400-ft. 11 million cu ft non-rigid airships designated the ZPG-3W will perform patrol duty as part of the North American Air Defense Command. Two blimps have been delivered; two others are being built. Goodyear says a transistorized intercommunications system with pushbuttons and flashing call lights aids crew teamwork. System includes an ECM radio control unit and a loudspeaker radio monitor control unit, which permits the selection of any one of 13 audio outputs to be monitored over the local loudspeaker.

SOVIET AUTOMATIC CONTROL SYSTEM checks the dimensions of mass-produced parts by using a cathode-ray-tube to scan the contours of the part under test and of a mask fixing the allowable tolerances. A coarse scanning pattern is traced out on the c't screen using a horizontal deflection frequency of 1 cycle and a vertical deflection frequency of 50 cycles. Two thin lines on a transparent mask attached to the screen represent the upper and lower limits of the parts being checked. The production control device is described in the Soviet journal "Priboroostroenie," No. 7, 1959.

Japanese yearend to set buyers so swamped the market that manufacturers couldn't get enough glass tube envelopes as 1959 ended. Six set makers are now turning out 500,000 sets a month. December demand was estimated at 430,000 sets; 300,000 were sold in November. Buying rush is attributed to extension of the government te net work to many outlying areas.

BRITISH TELEVISION and radio manufacturers had a bumper year in 1959, and all sales records have been smashed, according to estimates of the authoritative Financial Times. TV receiver output was estimated at 2.8 million, 800,000 above 1958, with retail sales totaling some $462 million. More than 1.6 million radios were estimated to have been produced and sold in '59. Growing interest was noted in stereo equipment.
NOW—simple, accurate, direct

PEAK POWER

PEAK POWER may now be measured directly—with speed and simplicity—using integrated Microline® equipment from Sperry. Unlike other power measurement techniques which require a wattmeter bridge or calorimetric load, plus an oscilloscope and synchroscope—just four additional components are necessary when using the Microline Model 630: a crossguide coupler, a termination, a barretter mount, and a barretter.

DIRECT READING—Pulsed microwave energy is coupled from the system under test into the crossguide directional coupler, and a high power termination connected to the coupler's primary output. The suitably attenuated energy is fed from the secondary arm directly into a waveguide barretter mount. The output from the barretter and barretter mount is fed coaxially to the input of the Microline Model 630, and peak power is read directly from the scale. The measurement is simple, positive and precise.

THE BARRETER, in a suitable mount, is subjected to pulses of microwave energy from the system under test. The barretter is operated in a constant current circuit and its resistance change is a function of temperature, which is determined by total power. The voltage waveform out of the barretter mount will be sawtooth with an essentially linear rise when a pulse is applied and an exponential decay as a resistance of the barretter returns toward normal after the pulse has decayed. The slope of the waveform is a function of peak power. The sawtooth waveform out of the barretter mount is fed into the differentiator, the output of which is a video pulse. This pulse is an accurate replica of the envelope of the microwave pulse impinging on the barretter. The amplitude of the video pulse is proportional to microwave peak power.

DIFFERENTIATOR OUTPUT is amplified in the video amplifier to provide sufficient signal amplitude to properly operate a peak reading voltmeter circuit. A portion of the output of the video amplifier is brought out to a front panel jack to provide a connection for viewing the video pulse with an external oscilloscope, if desired.

THE PEAK READING VOLTMETER utilizes a novel amplifier feedback circuit which provides a stable and accurate means of measuring the peak voltage of a video pulse over a considerable range of pulse width and repetition rates. The output of the peak voltmeter circuit is a front panel meter which has been calibrated in milliwatts.

Address inquiries to Manufacturers’ Representatives: Gerald B. Miller Co., P.O. Box 1471, Hollywood 28, California; Louis A. Garten & Associates, 645 Eagle Rock Ave., West Orange, New Jersey; Technical Instruments, Inc., 90 Main St., Reading, Mass.
## BARRETERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Nominal Resistance (ohms)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>655</td>
<td>200 for Peak Power Measurements</td>
<td>$14.00</td>
</tr>
<tr>
<td>833</td>
<td>200 for Peak Power Measurements</td>
<td>$14.00</td>
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## ATTENUATORS

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Frequency Range-kmc</th>
<th>Attenuation-dB</th>
<th>Waveguide Type</th>
<th>Fittings</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>134</td>
<td>Calibrated ±.5db</td>
<td>2.4-4.0</td>
<td>8.5-9.6</td>
<td>1&quot;½&quot; Waveguide</td>
<td>UG-29/U</td>
<td>$220.00</td>
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<tr>
<td>152A</td>
<td>Variable</td>
<td>0.5-7.0</td>
<td>8.1-12.4</td>
<td>1&quot;½&quot; Waveguide</td>
<td>UG-29/U</td>
<td>75.00</td>
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<tr>
<td>375A</td>
<td>Variable</td>
<td>12.4-15.0</td>
<td>0.115</td>
<td>0.705&quot;x0.391&quot;</td>
<td>UG-419/U</td>
<td>75.00</td>
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<tr>
<td>374A</td>
<td>Variable</td>
<td>25.5-90</td>
<td>1.20</td>
<td>0.360&quot;x0.220&quot;</td>
<td>UG-599/U</td>
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## DIRECTIONAL COUPLERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Frequency Range-kmc</th>
<th>Attenuation-dB</th>
<th>Waveguide Type</th>
<th>Fittings</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>517</td>
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<td>2.4-4.0</td>
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<td>24</td>
<td>UG-49/U</td>
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<tr>
<td>546</td>
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<td>7.1-10</td>
<td>30</td>
<td>UG-51/U</td>
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<tr>
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<td>30</td>
<td>UG-51/U</td>
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<td></td>
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<tr>
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<td>1½&quot;x1½&quot; Waveguide</td>
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<td>30</td>
<td>UG-51/U</td>
<td>65.00</td>
<td></td>
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<tr>
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<td>1½&quot; Waveguide</td>
<td>8.1-12.4</td>
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<td>20</td>
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<td>429A</td>
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<td>20.5-36.0</td>
<td>20</td>
<td>UG-39/U</td>
<td>65.00</td>
<td></td>
</tr>
</tbody>
</table>

*Input fitting, Main line output UG-45/U, Secondary line output UG-46/U. Adapters (Models 352A and 217) convert these units to Type N.

## BARRETER MOUNTS

<table>
<thead>
<tr>
<th>Bartter Mount Type</th>
<th>Range-kmc</th>
<th>VSWR</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>554</td>
<td>3½&quot; Coax</td>
<td>0.2-2.0</td>
<td>1/1.5</td>
</tr>
<tr>
<td>545</td>
<td>2½&quot; Coax</td>
<td>0.2-2.0</td>
<td>1/1.5</td>
</tr>
<tr>
<td>545</td>
<td>3½&quot; Coax</td>
<td>0.2-2.0</td>
<td>1/1.5</td>
</tr>
<tr>
<td>150</td>
<td>½&quot; Coax</td>
<td>0.2-2.0</td>
<td>1/1.5</td>
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<tr>
<td>152A</td>
<td>½&quot; Coax</td>
<td>0.2-2.0</td>
<td>1/1.5</td>
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<tr>
<td>215C</td>
<td>½&quot; Coax</td>
<td>0.2-2.0</td>
<td>1/1.5</td>
</tr>
</tbody>
</table>

*B-Barretter, T-Thermistor

## HIGH-POWER WAVEGUIDE TERMINATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range-kmc</th>
<th>Power Capacity</th>
<th>Max. Output</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>564</td>
<td>3½&quot; Waveguide</td>
<td>2200</td>
<td>2200</td>
<td>UG-599/U</td>
</tr>
<tr>
<td>565</td>
<td>4½&quot; Waveguide</td>
<td>1500</td>
<td>1500</td>
<td>UG-599/U</td>
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<tr>
<td>566</td>
<td>5½&quot; Waveguide</td>
<td>1000</td>
<td>1000</td>
<td>UG-599/U</td>
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<tr>
<td>567</td>
<td>6½&quot; Waveguide</td>
<td>700</td>
<td>700</td>
<td>UG-599/U</td>
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</table>

## LOW-POWER WAVEGUIDE TERMINATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range-kmc</th>
<th>Power Capacity</th>
<th>Max. Output</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>3½&quot; Waveguide</td>
<td>2.5-4.0</td>
<td>2.0</td>
<td>UG-214/U</td>
</tr>
<tr>
<td>370</td>
<td>3½&quot; Waveguide</td>
<td>2.5-4.0</td>
<td>2.0</td>
<td>UG-214/U</td>
</tr>
<tr>
<td>418A</td>
<td>3½&quot; Waveguide</td>
<td>2.5-4.0</td>
<td>2.0</td>
<td>UG-214/U</td>
</tr>
<tr>
<td>419A</td>
<td>3½&quot; Waveguide</td>
<td>2.5-4.0</td>
<td>2.0</td>
<td>UG-214/U</td>
</tr>
<tr>
<td>309A</td>
<td>3½&quot; Waveguide</td>
<td>2.5-4.0</td>
<td>2.0</td>
<td>UG-214/U</td>
</tr>
<tr>
<td>310A</td>
<td>3½&quot; Waveguide</td>
<td>2.5-4.0</td>
<td>2.0</td>
<td>UG-214/U</td>
</tr>
<tr>
<td>311A</td>
<td>3½&quot; Waveguide</td>
<td>2.5-4.0</td>
<td>2.0</td>
<td>UG-214/U</td>
</tr>
</tbody>
</table>

*Input fitting, Main line output UG-45/U, Secondary line output UG-46/U. Adapters (Models 352A and 217) convert these units to Type N.
WASHINGTON OUTLOOK

Two electronics contractors for NASA have reported patentable inventions on agency projects: Northrop Corp.'s Nortronics div., Hawthorne, Cal., which has developed a new hypersonic flow direction sensor, and Aero-Geo-Astro Corp., Alexandria, Va., a radar tracking beacon.

In recent months, NASA's patent policies have become the center of a new Congressional ruckus. The Nortronics case demonstrates the difference between NASA and Defense Dept. patent policies and plays up what's at issue in the controversy.

Under military R&D contracts, the contractor keeps title to any invention developed and has the right to royalties on commercial production. The military contracting agency gets only a royalty-free, non-exclusive license to use the invention.

NASA's policy falls between the Pentagon's liberal system and AEC's restrictive patent scheme, under which the agency acquires rights and interests in all inventions of its contractors. NASA is required to take title to the invention or waive all rights.

In the Aero-Geo-Astro case, NASA has taken title to the invention and the contractor has not petitioned for a waiver.

Nortronics, however, is fighting for its own patent rights on the hypersonic flow direction sensor. The company has challenged NASA's right to the invention on the grounds that the invention was made on a project which began under a Defense Dept. contract. So far, no decision has been made on the company's claim.

- Over the past six years the split between federal government and private industry sharing of the nation's research and development expenditures has shifted from 60 percent industry—40 percent government to a ratio of 60 percent government—40 percent industry.

The shift in R&D spending shows up in a new National Science Foundation analysis of research and development expenditures.

NSF reports that total U.S. spending on R&D has burgeoned from an annual total of $5.1 billion in 1953-54 to a total of at least $12 billion in 1959-60. During the period, the federal government has almost tripled its R&D budget—from $2.7 billion to $7.7 billion. Industry, meanwhile, has doubled the amount of its own money it spends to sponsor R&D efforts—from $2.2 billion to $4.4 billion.

However, the government is turning more and more to industry for the actual performance of the research and development work. In the past six years, the rate of R&D spending in industry facilities has zoomed by almost 160 percent—from $3.6 billion in 1953-54 to an estimated $9.4 billion in 1950-60.

Although the NSF report fails to detail how these expenditures are being allocated by industry, government experts say the electronics industry is taking on a dominant role in the performance of both industry-sponsored and government-supported R&D.

- The big news about Defense Dept. efforts in computer application has usually been the use of special-purpose machines geared to weapon systems and supporting apparatus. But in the more mundane business of supply management, the military services are also becoming an ever-increasing market for commercial-type computers.

Latest figures show the services using 170 business-type computers for supply management functions. The Pentagon's rental bill will run to $111 million this year, compared to $82 million in fiscal 1959, and the outlook is for continuing increases.
CLEVITE'S NEW
SPACESAVER
TRANSISTOR

Compared with present power transistors of similar ratings, the new Clevite Spacesaver gives you important new advantages.

**Better Switching** — Its low base resistance gives lower input impedance for the same power gain and lower saturation resistance, resulting in lower "switched on" voltage drop. Its lower cut off current means better temperature stability in direct coupled circuits (such as regulated power supplies) and a higher "switched off" impedance.

**Better Amplifying** — Improved frequency response leads to higher audio fidelity, faster switching and improved performance in regulated power supply applications.

**Better Mounting** — The Spacesaver's simple rectangular configuration and low silhouette make it adaptable to a wide variety of mounting requirements where space is at a premium. In aircraft and missile applications, its low mass (half present type) improves shock and vibration resistance of lightweight assemblies.

### THREE AMPERE SWITCHING TYPES

<table>
<thead>
<tr>
<th>TEST</th>
<th>CTP 1728</th>
<th>CTP 1735</th>
<th>CTP 1729</th>
<th>CTP 1730</th>
<th>CTP 1731</th>
<th>CTP 1736</th>
<th>CTP 1737</th>
<th>CTP 1732</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min BVceo @ 2 ma (volts)</td>
<td>40</td>
<td>60</td>
<td>80</td>
<td>100</td>
<td>40</td>
<td>60</td>
<td>80</td>
<td>100</td>
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<tr>
<td>Min BVces @ 500 ma (volts)</td>
<td>25</td>
<td>40</td>
<td>55</td>
<td>65</td>
<td>25</td>
<td>40</td>
<td>55</td>
<td>65</td>
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<tr>
<td>Min BVces @ 300 ma (volts)</td>
<td>35</td>
<td>50</td>
<td>65</td>
<td>75</td>
<td>35</td>
<td>50</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>Max Icbo @ 50°C @ Max Vcb (ma)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Max Icbo @ 2 V (μA)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
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<tr>
<td>D.C. Current Gain @ 0.5A</td>
<td>30-75</td>
<td>30-75</td>
<td>30-75</td>
<td>30-75</td>
<td>60-150</td>
<td>60-150</td>
<td>60-150</td>
<td>60-150</td>
</tr>
<tr>
<td>Max Vebo (A) (volts)</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Max Vce(sat) @ 3.0A, 300 ma (volts)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Min fse @ 3.0 A (kc)</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Max Thermal Resistance (°c/w)</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Phone for data and prices.

CLEVITE TRANSISTOR
254 Crescent Street  Waltham 54, Mass. Tel: TWinbrook 4-9330

ELECTRONICS • JANUARY 15, 1960

CIRCLE 15 ON READER SERVICE CARD 15
How CDF Di-Clad* can solve your printed-circuit problems

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

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

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

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

*Du Pont trademark for its tetrafluoroethylene resin.

CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE "Budd" COMPANY • NEWARK 16, DEL.
In Canada: 46 Hollinger Road, Toronto 16, Ont.

TYPICAL Di-Clad PROPERTY VALUES

<table>
<thead>
<tr>
<th></th>
<th>Di-Clad 2350</th>
<th>Di-Clad 26 (NEMA XXXP)</th>
<th>Di-Clad 28 (NEMA XXXP)</th>
<th>Di-Clad 28E (NEMA G-10)</th>
<th>Di-Clad 112T Teflon*</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOND STRENGTH—0.0014&quot; foil (lbs. reed. to separate 1&quot; width of foil from laminate)</td>
<td>6 to 10</td>
<td>6 to 10</td>
<td>6 to 10</td>
<td>8 to 12</td>
<td>4 to 8</td>
</tr>
<tr>
<td>MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16&quot; thickness)</td>
<td>800</td>
<td>900</td>
<td>850</td>
<td>650</td>
<td>700</td>
</tr>
<tr>
<td>INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C &amp; 90% RH (ASTM D257, Fig. 3)</td>
<td>500</td>
<td>150,000</td>
<td>600,000</td>
<td>100,000</td>
<td>75,000</td>
</tr>
<tr>
<td>DIELECTRIC CONSTANT 10° Cycles</td>
<td>4.5</td>
<td>4.0</td>
<td>3.6</td>
<td>4.9</td>
<td>2.6</td>
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<tr>
<td>DISSIPATION FACTOR 10° Cycles</td>
<td>0.040</td>
<td>0.026</td>
<td>0.027</td>
<td>0.019</td>
<td>0.0015</td>
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<tr>
<td>ARC-RESISTANCE (Seconds)</td>
<td>5</td>
<td>10</td>
<td>10</td>
<td>130</td>
<td>180</td>
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<tr>
<td>TENSILE STRENGTH (psi.)</td>
<td>18,000</td>
<td>16,000</td>
<td>12,000</td>
<td>48,000</td>
<td>23,000</td>
</tr>
<tr>
<td>FLEXURAL STRENGTH (psi.)</td>
<td>27,000</td>
<td>21,000</td>
<td>18,000</td>
<td>70,000</td>
<td>13,000</td>
</tr>
<tr>
<td>IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)</td>
<td>0.80</td>
<td>0.45</td>
<td>0.42</td>
<td>12.0</td>
<td>6.0</td>
</tr>
<tr>
<td>COMPRESSIVE STRENGTH flatwise (psi.)</td>
<td>32,000</td>
<td>28,000</td>
<td>25,000</td>
<td>62,000</td>
<td>20,000</td>
</tr>
<tr>
<td>BASE MATERIAL OR LAMINATE</td>
<td>Paper</td>
<td>Paper</td>
<td>Paper</td>
<td>Medium-weave, medium-weight glass cloth</td>
<td>Fine-weave, medium-weight glass cloth</td>
</tr>
<tr>
<td>COLOR OF UNCLAD LAMINATE</td>
<td>Natural</td>
<td>Natural</td>
<td>Natural</td>
<td>Natural</td>
<td>Natural</td>
</tr>
</tbody>
</table>

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark
Make Possible a Two-Tube Circuit in conjunction with a Driver and an Output Transistor.
12FX8 and 12FR8 provide new economies in the design of automobile radios

Now designers of automobile radios and other hybrid mobile electronic equipment can sharply slice their component requirements to two tubes and two transistors, where previously four tubes and two transistors were needed. That's because Tung-Sol's multi-purpose 12FX8 and 12FR8 combination provides all the functions of the original four tube complement with utmost reliability.

In addition to simplification of circuitry and obvious manufacturing economies, the possibilities for space-saving and heat reduction are indicated.

Early Engineering Assistance

Consult Tung-Sol's applications engineers while your equipment is in the preliminary layout stage. Contact any of the Tung-Sol Sales Engineering Offices listed opposite.

---

**TYPE 12FX8**

- **Coated Unipotential Cathodes**
- **Outline drawing**
- **Tung-Sol**
- **Base**
- **Jedec E9-1**
- **Miniature button 9 pin**
- **Maximum diameter**
- **2 1/16 inches**
- **Maximum overall length**
- **2 3/16 inches**
- **Base pin connections**
- **Pin 1—Heptode grid No. 2 and grid No. 4**
- **Pin 2—Heptode grid No. 1 (oscillator grid)**
- **Pin 3—Heptode plate**
- **Pin 4—Heater**
- **Pin 5—Heater, triode cathode**
- **Heater characteristics**
- **Heater voltage**
- **12.6 Volts**
- **Heater current**
- **300 Amps.**
- **Ratings—Interpreted according to design center system**
- **Maximum heater—cathode voltage**
- **+16 Volts**
- **Maximum heptode plate voltage**
- **16 Volts**
- **Maximum triode plate voltage**
- **16 Volts**
- **Maximum grids No. 2 and No. 4 voltage**
- **16 Volts**
- **Maximum grids No. 2 and No. 4 supply voltage**
- **16 Volts**
- **Maximum negative DC grid No. 3 voltage**
- **16 Volts**
- **Maximum positive grid No. 3 voltage**
- **0 Volts**
- **Maximum grid No. 5 circuit resistance**
- **10 Megohms**
- **Maximum triode grid circuit resistance**
- **10 Megohms**

---

**TYPE 12FR8**

- **Coated Unipotential Cathodes**
- **Outline drawing**
- **Tung-Sol**
- **Base**
- **Jedec E7-1**
- **Miniature button 9 pin**
- **Maximum Diameter**
- **2 1/16 inches**
- **Maximum overall length**
- **2 3/16 inches**
- **Base pin connections**
- **Pin 1—Triode grid**
- **Pin 2—Triode and diode cathode**
- **Pin 3—Pentode grid No. 1**
- **Pin 4—Heater**
- **Mounting position**
- **Any**
- **Heater characteristics**
- **Heater voltage**
- **12.6 Volts**
- **Heater current**
- **0.32 Amps.**
- **Ratings—Interpreted according to design center system**
- **Maximum heater—cathode voltage**
- **+16 Volts**
- **Maximum plate voltage**
- **16 Volts**
- **Maximum grids #2 & #4 voltage**
- **16 Volts**
- **Maximum grids #2 & #4 supply voltage**
- **16 Volts**
- **Maximum pentode grid circuit resistance**
- **10 Megohms**
- **Maximum triode grid circuit resistance**
- **10 Megohms**
- **Maximum plate current**
- **5 Ma.**

---

These tubes are intended to be used in automotive service from a nominal 12 volt battery source. The heater is therefore designed to operate over the 10.0 to 15.9 voltage range encountered in this service. The maximum ratings of the tube provide for an adequate safety factor such that the tube will withstand the wide variation in supply voltages.

---

JANUARY 1960
SHIP WITHOUT AN OCEAN

How do you lay a cable on the ocean floor—a cable that is connected to scores of large, heavy amplifiers? How do you "overboard" such a system in a continuous operation, without once halting the cable ship?

Bell Telephone Laboratories engineers must answer these questions in order to lay a new deep-sea telephone system designed to carry many more simultaneous conversations. They're experimenting on dry land because it is easier and more economical than on a ship. Ideas that couldn't even be attempted at sea are safely tested and evaluated.

In one experiment, they use a mock-up of the storage tank area of a cable ship (above). Here, they learn how amplifiers (see photo right), too rigid and heavy to be stored with the cable coils below decks, must be positioned on deck for trouble-free handling and overboarding.

Elsewhere in the Laboratories, engineers learn how best to grip the cable and control its speed, what happens as the cable with its amplifiers falls through the sea, and how fast it must be payed out to snugly fit the ocean floor. Oceanographic studies reveal the hills and valleys which will be encountered. Studies with naval architects show how the findings can be best put to work in actual cable ships.

This work is typical of the research and development effort that goes on at Bell Laboratories to bring you more and better communications services.
How to put wings on a warehouse

Giving overseas air bases what amounts to local warehouse service on important parts is an Air Force objective. Its present system has slashed delivery schedules up to 20 times... saved taxpayers several billion dollars over the past decade. To improve it further, Douglas has been selected to develop specifications for a comprehensive Material Handling Support System involving better communications, control, cargo handling and loading, packaging and air terminal design. Douglas is well qualified for this program by its more than 20 years in all phases of cargo transport. Air logistics is only one area of extensive Douglas operations in aircraft, missile and space fields in which outstanding openings exist for qualified scientists and engineers. Some are listed on the facing page.

Schuyler Kleinhans and Charles Glasgow, Chief Engineers of the Santa Monica and Long Beach Divisions, go over air transport needs relating to advanced cargo loading techniques with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • CARGO TRANSPORTS • AIRCOMB • GROUND SUPPORT EQUIPMENT

JANUARY 15, 1960 • ELECTRONICS
Two Firms in Overseas Mergers

Two mergers involving overseas companies are in the financial news this week. Countries involved are England and Italy.

- Acquisition of Adrema Ltd., a leading United Kingdom manufacturer of business machines has been announced by Farrington Manufacturing Co., Needham Heights, Mass. The acquisition is a cash transaction for an undisclosed sum. The move is expected to strengthen Farrington's position in the data processing field by expanding its range of business machines. Farrington manufactures scanners used to feed information into computers and data processing systems. Adrema has sales operations in 55 countries and operates subsidiaries in Canada and India. This is Farrington's fourth acquisition since March 1959.

- Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn., reports completion of negotiations leading to the purchase of a 50 percent interest in Microtekina, Turin, Italy. Financial terms of the agreement were not disclosed. The Italian firm has been in existence since 1928. Its main products today are marine and aviation navigation instruments and servomechanisms. It is expected that Hamilton Standard will make use of its acquisition by using Microtekina facilities for manufacturing items for jet aircraft under license.

- Telecomputing Corp., Los Angeles, has acquired the assets and interests of Phoenix Engineering & Manufacturing Co., Phoenix, Ariz. The transaction did not include the issuance or exchange of TC stock. Sales volume of Phoenix is at an annual rate of $1 million, with expectations that the $1 million mark may be reached in the year ahead. The firm makes precision missile, aircraft and electronic parts. The firm will be operated as a wholly owned subsidiary with no changes in personnel now contemplated.

- Eitel-McCullough, Inc., San Carlos, Calif., has reached an agreement with National Electronics and Industrial Tubes Inc., both of Geneva, Ill., that will make both firms wholly-owned subsidiaries of the California company. The two companies have a combined sales volume of almost $3,000,000. Both companies, which have J. W. Hutchings as president, will turn over all their stock in return for 175,450 shares of Eimac securities, (about 9 percent of total stock outstanding). No cash will be involved in the acquisition.
2N1440 series PNP silicon alloy transistor news

Surpassing all existing industry standards for PNP Silicon Alloy Transistors (JEDEC 30), the 2N1440 series extend transistor performance to new, unequalled operating levels. Maximum storage and operating temperatures of 200°C are now a reality. Over the entire temperature range these transistors attain the highest device dissipation—over 170 mw at 125°C in free air. Specifically designed for low level amplification, small signal and medium power applications, and direct coupled linear circuits, the 2N1440 series operate with guaranteed hfe and Icbo at 150°C. Because of inherent low noise and guaranteed β at low collector currents, they are ideally suited for front end usage.

For complete specifications and delivery dates write, wire or phone:

National SEMICONDUCTOR CORPORATION • DANBURY, CONN. • PIONEER 3-7624 WESTERN REGION OFFICE: 690 N. SEPULVEDA BLVD., EL SEGUNDO, CALIF. • OREGON 8-4161 Distributor: Milgray Electronics Inc. • 136 Liberty St., N. Y., N. Y. • REctor 2-4400
All magnetic tape recorders consume magnetic tape. Most have a prodigious appetite. It is because they have to run very fast to capture a broad frequency range. Running tape fast is the easy way to get wide bandwidth. But you pay for that bandwidth again and again with every data run in every month of every year you use the machine. You pay in high tape consumption and high tape costs. The Ampex FR-600 achieves the same bandwidths at half the tape speed you now need. At half the tape cost therefore. At 60 ips the FR-600 has a 250 kc bandwidth. At 30 it has 125 kc and so on. No matter what the bandwidth you can now record it at half the speed, on half the tape, at half the cost on an FR-600. The savings in just a short time can be astonishing. If you use 30 14-inch reels of 1-inch, 1-mil tape each week your weekly tape bill is $5100--minimum. An FR-600 can save half of that each week and literally buy itself in 15 weeks. In your particular case it might take more time—or less—but it’s a fascinating reason for getting the full FR-600 story.

AMPEX DATA PRODUCTS CO., 934 Charter St., Redwood City, Calif.

This instrumentation recorder can buy itself in 15 weeks
DESTINY...
and the ticking seconds

"Thinking" projects, surely. But also "doing" projects. And the time is short, always, to continually equip our military with electronic weapons that defend us successfully.

Electronic Defense Laboratories, Reconnaissance Systems Laboratory, Special Tube Operations—these are some of the elite, sophisticated, compact groups that form Sylvania MVO.

Mountain View Operations—40 minutes south of San Francisco, in the Berkeley-Stanford scientific complex—professional atmosphere for you, fortunate living for yours.

If your specialty appears below, Mr. Wayne Pearson would welcome your confidential resume or telephone call. Address him at Sylvania MVO, (Dept. A1) Box 188, Mountain View, Calif.

Evaluation, Concept, Design of Systems, Circuits, Receivers, Transmitters... Product and Mechanical Engineering...Digital Data Handling...Theoretical, Experimental and Solid State Physics...Microwave Tube R&D, Production... Sales Engineering...Engineering Writing

SYLVANIA MOUNTAIN VIEW OPERATIONS
on the San Francisco Peninsula

ELECTRONIC SYSTEMS DIVISION
SYLVANIA Subsidiary of GENERAL TELEPHONE & ELECTRONICS
MARKET RESEARCH

Instrument Sales Rise Fast

SALES of electronic test instruments to both industry and the armed forces, which are growing at the rate of 15-20 percent per year, will increase to at least $350 million in 1960, predicts Albert T. Craig, president of Technical Information Corp. TIC is a New York consulting group which prepares analyses of available electronic test equipment.

Reflecting the continued growth in use of transistors, one fifth of the test instrument industry’s 1960 sales gain will be in the area of power supplies, Craig says. The power supply market should increase from $60 million in 1959 to at least $70 million in 1960.

The introduction of high-speed oscilloscopes was last year’s outstanding single development in the instrument field, claims Craig. Rapid growth in sales of these oscilloscopes can be expected in 1960.

Manufacturers of pulse generators have the opportunity in 1960 to make significant new developments in their product, according to Craig. Pulse generators require faster rise times for designing and testing new computer circuits, he explains.

• Sales of electronic test, recording and measuring instruments to industry alone may reach $275 million, according to Glen Andrews, industrial specialist with Arthur D. Little, Inc., engineering and management consultants. His forecast is up 10 percent from estimated sales in 1959.

In addition to estimating total industrial test instrument sales for these two years, Andrews has made the following estimates of individual test instrument sales, all in millions of dollars.

<table>
<thead>
<tr>
<th>Instrument Type</th>
<th>1959</th>
<th>1960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscopes</td>
<td>$10</td>
<td>$11</td>
</tr>
<tr>
<td>Oscillographs</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Volt-ohmmeters</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>R,CL measuring equipment</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Analyzers for engine testing</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Tube testers</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Microwave test equipment</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Signal generators</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Transmitter test equipment</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>R-f measuring equipment</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Indicating instruments</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Recording instruments</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Other test equipment</td>
<td>88</td>
<td>102</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$250</strong></td>
<td><strong>$275</strong></td>
</tr>
</tbody>
</table>

• Manufacturers of electrical wire and cable look forward to a 10 percent sales increase in 1960 over the past year with sales moving up from $1.504 billion in 1959 to $1.654 this year, National Electrical Manufacturers Association predicts. In the past the electronics industry has taken about 17 percent of total production of electrical wire and cable.

NEMA also anticipates 1960 output of $6.333 billion worth of electronics and communications equipment at factory-door price, a gain of eight percent over 1959. However the association includes telephone equipment and signaling apparatus along with a wide variety of electronics in this estimate.

• Philco Corporation and CBS-Electronics, a division of Columbia Broadcasting System, jointly announce the signing of a cross-licensing agreement covering the manufacture and sale of semiconductors.
Compact, lightweight servo amplifier employing CBS 2N1434 10-watt push-pull output stage.

For Airborne Equipment

MORE POWER
LESS WEIGHT
LESS SPACE

with new
CBS PNP Power Transistors

In a typical servo amplifier, a pair of these CBS PNP germanium power transistors delivers 10 watts output. Yet each transistor weighs less than 5 grams... and requires only ½ square inch of chassis space. Put the compact CBS 2N1433, 2N1434, 2N1435 to work in your military or industrial equipment — airborne, mobile or portable. Check advantages and basic data. Write for complete technical bulletin E-370. Order from your Manufacturers Warehousing Distributor.

NOTE THE ADVANTAGES

These improved versions of the 2N538, 2N539A and 2N540 offer:

- Single, sturdy 10-32 mounting stud
- Compact male-industrial TO-10 welded package
- High dissipation with minimum size
- High collector-to-base voltage
- High collector-emitter breakdown voltage
- Wide range of operating and storage temperatures

More reliable products through Advanced Engineering

<table>
<thead>
<tr>
<th>Type</th>
<th>Max. W</th>
<th>Max. $V_{CEO}$</th>
<th>Min. $V_{CEO}$</th>
<th>$I_{C}=2A$, $V_{CE}=-2V$ Max.</th>
<th>$I_{C}=2A$, $V_{CE}=-2V$ Min.</th>
<th>Max. $Thermal$ Res. °C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N1433</td>
<td>35</td>
<td>-80</td>
<td>-50</td>
<td>20</td>
<td>50</td>
<td>3.3</td>
</tr>
<tr>
<td>2N1434</td>
<td>35</td>
<td>-80</td>
<td>-50</td>
<td>45</td>
<td>115</td>
<td>1.8</td>
</tr>
<tr>
<td>2N1435</td>
<td>35</td>
<td>-80</td>
<td>-50</td>
<td>30</td>
<td>75</td>
<td>1.0</td>
</tr>
</tbody>
</table>

All types have: Max. collector current, 3.5 amps; junction temperature, -55 to +95°C; max. saturation voltage, 0.6 volts ($I_{C}=2A$, $I_{E}=200 mA$). Minimum alpha cutoff frequency is 200 KC ($I_{C}=100 mA$, $V_{CE}=-4$ volts). +5°C base mounting temperature.

CBS ELECTRONICS, Semiconductor Operations • A Division of Columbia Broadcasting System, Inc.

Sales Offices: Lowell, Mass., 900 Chelmsford St., Glenside 4-0446 • Newark, N. J., 32 Green St., Market 3-5832 • Melrose Park, Ill., 1990 N. Mannheim Rd., Elstonbrook 9-2100 • Los Angeles, Calif., 2120 So. Garfield Ave., Raymond 3-9081

ELECTRONICS • JANUARY 15, 1960

CIRCLE 27 ON READER SERVICE CARD 27
Hughes now offers you immediate delivery on five medium power fused silicon glass diodes—types 1N645, 1N646, 1N647, 1N648, and 1N649.

These Hughes diodes feature a Dumet-stud heat sink for small size and the popular Hughes glass package for proven reliability. Widely used in power supplies, magnetic amplifiers and similar circuits, these Hughes diodes are specially designed to meet the severe environmental requirements of such military equipment as missile telemetering links, airborne radar, and communication gear.

For immediate delivery of these Hughes diodes write, wire or phone the Hughes distributor or Semiconductor Division Sales Office nearest you...or write Hughes Semiconductor Division, Marketing Dept., Newport Beach, California.

Specifications

<table>
<thead>
<tr>
<th>Type</th>
<th>Max. Working Voltage</th>
<th>Min. Forward Current @ specified voltage</th>
<th>Max. Reverse Current @ working voltage</th>
<th>DC Current to (μA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N645</td>
<td>225V</td>
<td>400 mA @ 1.0V</td>
<td>.2</td>
<td>400</td>
</tr>
<tr>
<td>1N646</td>
<td>300V</td>
<td>400 mA @ 1.0V</td>
<td>.2</td>
<td>400</td>
</tr>
<tr>
<td>1N647</td>
<td>400V</td>
<td>400 mA @ 1.0V</td>
<td>.2</td>
<td>400</td>
</tr>
<tr>
<td>1N648</td>
<td>500V</td>
<td>400 mA @ 1.0V</td>
<td>.2</td>
<td>400</td>
</tr>
<tr>
<td>1N649</td>
<td>600V</td>
<td>400 mA @ 1.0V</td>
<td>.2</td>
<td>400</td>
</tr>
</tbody>
</table>

* @ 25°C
Where EECO timing equipment counts

From the Atlantic to the Pacific whenever a missile leaves the launching pad odds are better than 5 to 1 that its instrumentation is being coordinated by timing signal systems made by Electronic Engineering Company of California. In the 10 short years since it first launched a basic study of timing, EECO has become the leading supplier of this type of equipment in the United States. This background of experience enables EECO to produce rapidly and economically the instrumentation timing systems and components so vitally needed for the space age.

Electronic Engineering Company of California
1601 East Chestnut Avenue, Santa Ana, California
new improved
"Memo-Scope"
oscilloscope

Still using "old-fashioned" methods for measuring non-recurring transients? If so, now is the time to investigate the easy way to solve your most difficult transient measurement problems with the latest model Hughes "Memo-Scope" oscilloscope.

Why? Because new features, new advanced circuitry, new panel layout and new mechanical design now assure maximum accuracy in all your transient measurements—plus higher performance, greater dependability and easier operation!

The Hughes "Memo-Scope" oscilloscope (Model 104E) stores nonrepetitive events for an indefinite period—hours, or days—keeping them available for thorough study until intentionally erased.

new improved features

- Simplified panel layout, redesigned trigger circuit...assure easier operation.
- Advanced mechanical design gives:
  - Better cooling for longer component life,
  - Far greater accessibility for maintenance,
  - Increased ruggedness; resistance to vibration,
- Built-in single-sweep circuit ("1-shot" trigger) at no extra cost,
- Available for either 110 v. or 220 v. operation.

applications

- Data reduction equipment troubleshooting
- Physical testing: shock, stress, strain
- Ultrasonic flaw detection
- Semiconductor testing
- Ballistics and explosives research
...and many others.

For complete information on the new improved Hughes "Memo-Scope" oscilloscope (Model 104E), detailed data sheets and application analysis of your transient measurement problems, write or wire: HUGHES PRODUCTS Industrial Systems Division, International Airport Station, Los Angeles 45, California.

HUGHES PRODUCTS

©1960, HUGHES AIRCRAFT COMPANY

INDUSTRIAL SYSTEMS DIVISION

JANUARY 15, 1960 • ELECTRONICS
Experience — the added alloy in A-L Electrical Steels

Higher permeability values now guaranteed for Allegheny Ludlum's Moly Permalloy

Means new, consistent and predictable magnetic core performance

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum, with higher guaranteed permeability values than former typical values. For the buyer, this new high quality means greater uniformity . . . more consistent and predictable magnetic core performance.

This higher permeability is the result of Allegheny Ludlum's intensive research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. A-L continues its research on silicon steels, including Silectron, well-known grain-oriented silicon steel, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available from Allegheny Ludlum. In addition, you can be assured of close gage tolerance, uniformity of gage throughout the coil, and minimum spread of gage across the coil-width.

If you have a problem relating to electrical steels, laminations or magnetic materials, call A-L. Prompt technical assistance will be yours. And write for more information on Moly Permalloy. Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.
Address Dept. E-25.

Allegheny Ludlum
Steelmakers to the Electrical Industry

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17
Export distribution, Laminations: AD. AURIEMA, NYC 4

Electronics - January 15, 1960
Choose your High Temperature from the

15 Types of Mallory Tantalum Capacitors to Choose From

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Capacity Range</th>
<th>W. Volts DC</th>
<th>Temp. Range</th>
<th>Case Style</th>
<th>Body Length</th>
<th>Body Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2</td>
<td>Pellet Anode—Liquid Electrolyte</td>
<td>11-140 mfd.</td>
<td>90-6V.</td>
<td>-55 to +150°C</td>
<td>Metal Case-Axial Leads</td>
<td>.500&quot;</td>
<td>.287&quot; (Body) .484&quot; (Flange)</td>
</tr>
<tr>
<td>XTK</td>
<td>Pellet Anode—Liquid Electrolyte</td>
<td>2-70 mfd.</td>
<td>340-8V.</td>
<td>-55 to +175°C</td>
<td>Metal Case-Axial Leads or Terminal</td>
<td>.438&quot; to .151&quot;</td>
<td>.623&quot;</td>
</tr>
<tr>
<td>XTM</td>
<td>Pellet Anode—Liquid Electrolyte</td>
<td>4-140 mfd.</td>
<td>340-8V.</td>
<td>-55 to +175°C</td>
<td>Metal Case-Axial Leads or Terminal</td>
<td>.566&quot; to .143&quot;</td>
<td>.623&quot;</td>
</tr>
<tr>
<td>XTL</td>
<td>Pellet Anode—Liquid Electrolyte</td>
<td>3.5-120 mfd.</td>
<td>630-18V.</td>
<td>-55 to +200°C</td>
<td>Metal Case-Axial Terminal</td>
<td>.500&quot; to .168&quot;</td>
<td>.875&quot;</td>
</tr>
<tr>
<td>XTH</td>
<td>Pellet Anode—Liquid Electrolyte</td>
<td>7-240 mfd.</td>
<td>630-18V.</td>
<td>-55 to +200°C</td>
<td>Metal Case-Axial Terminal</td>
<td>.688&quot; to .143&quot;</td>
<td>.875&quot;</td>
</tr>
<tr>
<td>XTV</td>
<td>Pellet Anode—Liquid Electrolyte</td>
<td>18-1300 mfd.</td>
<td>630-30V.</td>
<td>-55 to +175°C</td>
<td>Metal Case-Axial Terminal</td>
<td>.563&quot; to .168&quot;</td>
<td>1.125&quot;</td>
</tr>
<tr>
<td>XTO</td>
<td>Pellet Anode—Liquid Electrolyte</td>
<td>7-240 mfd.</td>
<td>630-18V.</td>
<td>-55 to +200°C</td>
<td>Metal Case-Axial Terminal</td>
<td>.563&quot; to .168&quot;</td>
<td>1.125&quot;</td>
</tr>
</tbody>
</table>

...And Eight Other Types

HAT: microminiature, 1-10 mfd., -20 to +85°C, metal case
TAS: miniature, solid type, 33-330 mfd., -80 to +85°C, metal case
TAM: microminiature, solid type, 6.8-56 mfd., -55 to +85°C, encapsulated
TAF: foil type, 22-440 mfd., -55 to +85°C, metal case
STNT: subminiature, 2-40 mfd., -55 to +85°C, metal case
TNT: miniature, 4-80 mfd., -55 to +85°C, metal case
TAP: miniature, 2-30 mfd., -55 to +100°C, metal case
TAP2: miniature, 11-140 mfd., -55 to +85°C, metal case

Immediate Delivery on All 15 Types
Tantalum Capacitor Company
Indianapolis 6, Indiana

a division of

Order Tantalum Capacitors
FROM STOCK
at these
MALLORY
Industrial Distributors

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D & H Distributing Co.

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DeMambro Radio Supply Co.

Buffalo, N. Y.
Wehle Electric
Sunset Electronics Div.

Camden, N. J.
General Radio Supply Co.

Chicago, Ill.
Allied Radio Corp.
Newark Electric Co.

Dallas, Texas
Engineering Supply Co.

Dayton, Ohio
Allied Supply Co.

Denver, Colo.
Denver Electronics

Glendale, Calif.
R. V. Weatherford Co.

Houston, Texas
Harrison Equipment Co., Inc.
Lenert Company

Los Angeles, Calif.
Kierulf Electronics, Inc.

Minneapolis, Minn.
Northwest Radio &
Electronic Supply Co.

Mountainside, N. J.
Federated Purchaser, Inc.

New York, N. Y.
Harrison Radio Corp.

Harvey Radio Co., Inc.
Hudson Radio & TV Corp.

Lafayette Radio Corp.
Terminal Radio Corp.

Oakland, Calif.
Elmar Electronics, Inc.

Palo Alto, Calif.
Zack Radio Supply Co.

Pasadena, Calif.
Electronic Supply Corp.

Pittsburgh, Pa.
Radio Parts Co.

Tampa, Florida
Thurow Distributors, Inc.

Tulsa, Okla.
Engineering Supply Co.

Washington, D. C.
Electronic Wholesalers

When you need tantalum capacitors for high temperature service, look first to the wide Mallory line. You're sure to find a Mallory model right for your requirements—right in reliability... and right in rating, size, mounting.

Pioneer in extreme temperature ratings, Mallory gives you a broad choice: 200°C Types XTL, XTH and XTO and 175°C Type XTV—3.5 to 1300 microfarads; smaller 175°C Types XTM and XTK—2 to 140 microfarads; and miniature 150°C Type M2—11 to 140 microfarads. In a variety of hermetically-sealed, corrosion-resistant case styles... mounting and terminal arrangements for ordinary or high-shock service.

Choose from 15 types of Mallory tantalums—microminiature to high capacitance, foil or pellet anode, solid or liquid electrolyte, encapsulated or metal case, medium or high temperature. Their reliability is proved by 18,000-hour tests, by over a decade of trouble-free service— with unequalled stability of capacitance, equivalent series resistance and low leakage values.

Write today for technical data... and for expert consultation on your circuit requirements, see a Mallory capacitor specialist.

See Mallory Capacitor Company for a complete line of aluminum electrolytics, tantalum capacitors and motor capacitors

P. R. MALLORY & CO., Inc.
**ANALOG-TO-DIGITAL CONVERTERS**

Kearfott's rugged shaft position-to-digital converters are resistant to high shock and vibration and high and low temperature environments. Ideally suited for missile applications, these converters are available for many uses, including latitude, longitude, azimuth or conventional angular shaft displacement conversion and decimal count conversion. Exclusive drum design provides large conversion capacity in smallest size. Combination counter converter assemblies for both visual and electrical readout also available.

**TYPICAL CHARACTERISTICS**

Kearfott Unit No. P1241-11A  
Code Cyclic Binary  
Range ±35,768 (2¹⁶)  
Bits per Revolution 16  
Revolutions for Total Range 2,048  
Volts D.C. 10.5  
Current (ma.) 20  
Inertia (gm. cm.²) 20  
Unit Diameter (in.) 1.5  
Unit Length (in.) 3  
Life 10⁶ Revolutions or 10⁸ hours  
Static Torque (in.-oz.) 2 (break)  
Weight (oz.) 5  
Maximum Speed (RPM) 600  

Write for complete data.

**20 SECOND SYNCHRO**

This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance, matches up to 64 resolver control transformers can also operate from one resolver transmitter.

**TYPICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Control</th>
<th>Type Resolver</th>
<th>Transmitter Transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
<td>25161-001 25151-003</td>
<td></td>
</tr>
<tr>
<td>Excit. Volts (Max.)</td>
<td>115 90</td>
<td></td>
</tr>
<tr>
<td>Frequency (cps)</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Primary Imped.</td>
<td>400/80° 8500/80°</td>
<td></td>
</tr>
<tr>
<td>Secondary Imped.</td>
<td>200/80° 14000/80°</td>
<td></td>
</tr>
<tr>
<td>Transf. Ratio</td>
<td>.788</td>
<td></td>
</tr>
<tr>
<td>Max. Error fr. E.Z.</td>
<td>20 seconds 20 seconds</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>Rotor</td>
<td></td>
</tr>
<tr>
<td>Stator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Write for complete data.

**INTEGRATING TACHOMETERS**

Kearfott integrating tachometers, special types of rate generators, are almost invariably provided integrally coupled to a motor. They feature tachometer generators of high output-to-null ratio and are temperature stabilized or compensated for highest accuracy integration and rate computation. Linearity of these compact, lightweight tachometers ranges as low as .01% and is usually better than ± .1%.

**TYPICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Control</th>
<th>Size 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitation Voltage (400 cps)</td>
<td>115</td>
</tr>
<tr>
<td>Volts at 0 rpm (RMS)</td>
<td>.020</td>
</tr>
<tr>
<td>Volts at 1000 rpm (RMS)</td>
<td>2.75</td>
</tr>
<tr>
<td>Phase shift at 3600 rpm</td>
<td>0°</td>
</tr>
<tr>
<td>Linearity at 0-3600 rpm</td>
<td>.07</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-54° +125°</td>
</tr>
</tbody>
</table>

Write for complete data.
WHEN WINDINGS MUST RUN HOT—GET MORE HP PER POUND WITH 155°C ANATHERM MAGNET WIRE

ANATHERM—a polyester film-coated wire enables you to build a smaller motor without reducing horsepower output—enables your customers to operate motors at higher temperatures without loss of horsepower. In fact, wherever magnetic windings must run hot, Anatherm offers similar advantages.

But this is only part of the reason why Anaconda Anatherm has found such wide acceptance. Its greater thermal stability—plus excellent abrasion resistance, chemical stability and dielectric strength—help make Anatherm ideal for a wide variety of applications.

Anatherm—the first film-coated magnet wire to qualify for the AIEE Class F (155°C) rating has been field-tested and proved. Our broad application experience with Anatherm allows us to offer this wire in Sizes 8 to 46 in standard film thicknesses, and in a full range of round, square and rectangular sizes.

For more information, see the Man from Anaconda. Look up “Anaconda” in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

ASK THE MAN FROM ANACONDA®
ABOUT ANATHERM MAGNET WIRE

For you, Anatherm can mean smaller electrical equipment . . . higher operating temperatures. See details on reverse side.
IMPORTANT FACTS FOR YOUR WORK...

...about Anatherm 155°C (AIEE Class F) Magnet Wire

When proper advantage is taken of Anadora Anatherm's higher 155°C characteristics, electrical equipment can be improved in these ways:

RAISES LIMITING OPERATING TEMPERATURES. Anatherm raises limiting operating temperatures to 155°C. This high heat resistance means extra protection... longer equipment life... wider range of applications.

REDUCES FRAME SIZE. Anatherm gives more horsepower from the same space or the same horsepower from a smaller motor. Costs are cut for you, and your customers benefit from smaller over-all components.

INCREASES HORSEPOWER RATINGS. Anatherm is the best of the polyesters. Its high heat resistance means higher permissible operating temperatures, greater horsepower rating.

UPGRADING. Anatherm helps upgrade standard equipment. Gives added heat insurance through thermal stability. Particularly suited for overloads.

COMPATIBILITY. With polyesters, importance must be placed upon a completely compatible system. Varnish manufacturers have recently developed polyester varnishes which allow a compatible polyester magnet wire system. A number of varnishes other than polyester are compatible with Anatherm, but consultation with varnish suppliers before use is recommended.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Anatherm has unusually high abrasion-resistance. This characteristic allows it to be wound on both conventional and automatic winding equipment. Anatherm offers excellent flexibility and adherence properties. It meets NEMA snap test requirements and exhibits excellent adherence to the conductor.

ELECTRICAL PROPERTIES

Anatherm maintains its dielectric strength under prolonged heating at high temperatures. It consistently exceeds dielectric strength requirements for NEMA dielectric twist test.

CHEMICAL PROPERTIES

Anatherm will resist toluol, VM & P Naphtha, Ethyl Alcohol and 5% Sulphuric Acid. Anatherm is a polyester and exhibits the best characteristics of this class of chemical compound. However, all polyesters must be used with certain precautions where moisture and/or enclosed systems are concerned. Similar precautions must be taken where chloride-base supporting insulations, such as neoprene and polyvinyl chloride, are present. Polyesters should not be used in applications subject to exposure to concentrated alkalies.

THERMAL PROPERTIES

Anatherm is offered as a 155°C (AIEE Class F) magnet wire based on AIEE #57 and #510 test methods. These tests, performed by Anadora engineers, show Anatherm as being capable of a 30,000-hour life at 157°C in an unvarnished state and the same life at 175°C when treated with a silicone or polyester type varnish. Thus Anatherm, when suitably varnished, has reserve stability even above the 155°C rating at which it is being offered. The thermoplastic flow temperature for Anatherm, based on MIL-W-583A, is very high (250°C). Anatherm also shows outstanding retention of flexibility after aging. Wire can be heated 168 hours at 175°C and then wound on three times its own diameter without cracking. Its heat-shock characteristics are exceptionally good for a polyester wire: Anatherm will withstand a 1x mandrel wrap at 155°C for one hour.

Anadora Wire & Cable Company
25 Broadway, New York 4, New York

Please send me a copy of your Anatherm Magnet Wire Booklet.

NAME & TITLE

COMPANY

ADDRESS

CITY.......................... ZONE...... STATE

Valuable Anatherm Magnet Wire Handbook—yours for the asking!

Latest information... full technical data.
NEED PRODUCT INFO? LOOK IN THE NEW

electronics BUYERS' GUIDE

You'll find detailed facts about the products of almost 700 different advertisers — that's 42% more than you'll find in any other electronics directory.

There's also 64 pages of reference data about markets, materials and design — vital information for all working in electronics. Also local sales offices of manufacturers... the names, addresses and phone numbers of representatives... complete lists of manufacturers... registered trade names... and also, of course, the most complete listing of all electronic and related products. Tells what you want to know... when you're ready to buy.
**Why U.S. Buys Missiles Abroad**

Our first wire-guided missile designs will come from Europe, but there is big production and new design business left for U.S. firms

**Though European missilemakers** have been quick to achieve a bench-head in the U.S. market for antitank wire-guided missiles, the market has actually just opened.

If the French and West German missiles now being evaluated by the U.S. Army (French SS-10, 11) and Marines (West German Cobra) are accepted, U.S. firms still have a chance to bid for manufacturing rights for the foreign birds. Also, the missiles being tested represent only two of four categories of such weapons needed by the ground forces today.

Why did European firms get the jump on the U.S. in this field? Two reasons: They planned ahead and they didn't have much money.

**Anticipated Demand**

NATO's military strategists foresaw the need for a transportable, accurate, nonjamming antitank missile while the U.S. Army clung to the 106 recoilless rifle.

European firms with limited defense funds began experimenting with bazooka-type weapons with aerodynamic stability.

Before long cheap, unsophisticated and easy-to-operate wire-guided missiles had been produced by Great Britain (Vickers' Vigilant, for which Clevite has a U.S. agreement), France (Nord Aviation's SS-10, 11, and the French Army Laboratory's two versions of Entoc), Switzerland (Oerlikon's Mosquito), Sweden (Bofors' Bantam), and Germany (Boelkow Entwicklungen's Cobra).

**What the Troops Need**

Although the Army needed three, or possibly four, categories of short-range missiles, Army put all its effort in the Dart. This fact, plus an adequate budget, resulted in too-frequent specification changes. Dart ended up heavy, sophisticated, expensive. Chalking the project up to experience, Army cancelled the program.

The categories the Army needs are: a Light Assault Weapon (LAW) transportable by a man and weighing about 30 lb; Medium Assault Weapon (MAW) transportable by jeep and weighing from 50 to 100 lb; Heavy Assault Weapon (HAW) launched from a tank-killer vehicle, possibly an armored jeep; and a tank missile. The last two categories cannot be wire-guided.

West German missilemakers with long experience with this technique (X-4 air-to-air missile was developed during World War II) say the maximum practical range for wire is from three to four miles.

Although Army may decide to combine categories one and two, LAW and MAW, into a single weapon, both categories are currently being evaluated: the French SS-10 as a LAW (14-mi range) and the SS-11 (21-mi range) as a MAW.

**Waiting for Results**

The Marine Corps has tested both French missiles and is now waiting for results to be evaluated. Meanwhile, the Corps has bought 100 Cobras from West Germany—where the missile is already operational with the Bundeswehr—for testing at Camp Pendleton, Calif. this month. Produced by Boelkow Entwicklungen of Munich, the Cobra will be produced in the U.S. and sold here and in Canada by Daystrom.

A candidate for the third category, HAW, may not appear for some time. The U. S.-designed Lacrosse radio-command missile is the closest solution. It is believed, however, that the Army will want a lighter and more transportable missile in addition to Lacrosse.

**Tank Destroyers**

Category four, a tank missile called the Shillelagh, is expected to be operational at midyear. It's now under development by Aeronutronics Systems, subsidiary of
Ford Motor, with Raytheon as subcontractor for fire control. The contract amounts to $23 million.

**Feelers Sent Out**

While evaluating the French missiles, Army sent out feelers to American industry for proposals for antitank missiles. And although more than two dozen firms have sent in company-financed proposals, Army has not yet made a choice. Probable reasons: Army wants to study existing foreign weapons before jumping into another U. S. development project; Army may decide to combine categories one and two; and, Army's budget may have been strained by the $23-million Shillelagh award.

Going into its test phase this month, the Cobra is 30.7 in. long and 3.9 in. in diameter. It weighs 20 lb, carries 5.5 lb of explosives or chemicals. High explosives reportedly would penetrate 21.5 in. of armor plate. Nerve gas could kill, almost instantly, hundreds of enemy troops.

Powered by solid fuel, the Cobra travels at a top speed of 191 mph and has a range up to 14 mi. It can be fired from the ground, an aircraft or a vehicle. Its four fins, cruciform in shape, are constructed at angles of 90 degrees to the body. The two lower fins support the weapon on the ground and serve as a launching platform.

The Cobra is controllable from the moment it leaves the launching site. The gunner guides the flight of the missile by wire from a hidden position through a 4.4-lb control box so constructed that the gunner can carry it in a pocket sewn to his trouser leg, or by a belt around his body.

**How Cobra Works**

One guidance control unit can launch and control as many as eight Cobras. Launching is accomplished by a selector switch on the control box.

The operator guides the bird to its target by manipulating a control stick up or down, to the right or left.

The control stick operates from a series of pick-offs which provide the corresponding voltage changes to the missile during its flight.

Both control box and missile are transistorized. The German-made receiver in the missile uses hand-soldered circuitry.

Daystrom is working on a modular type receiver that will be incorporated in the U. S.-manufactured missiles.

On the exterior top of the body is the battery that provides the electrical impulses to ignite both rockets and a tracking flare and to amplify flight direction signals from the control unit to the spoilers to guide the weapon in flight. On the underside is the booster rocket, so canted that it starts the missile on its flight at a 22-degree takeoff angle.

Inside the body and wrapped around the sustainer rocket is a reel of guidance wire that spins out through a hole at the rear. The sustainer rocket keeps the missile at constant speed until the target is reached.

**Versatility Is Factor**

The U. S. and Canadian market for wire-guided missiles will be big. How big depends on the weapons’ versatility. Potential tactical applications go beyond defense against enemy tanks. A wire-guided missile carrying an atomic warhead (although to date atomic warheads don’t come this small) could erase an underground command post, building or a concentration of troops. The rocket could spread nerve gas, psychochemicals or even tear gas. Such a variety of uses would create requirements for the missile in a number of units beyond those with antitank missions.
This small, lightweight, 1000 to 1800 watt 400 cycle motor alternator uses no brushes, no springs, no moving coils...is practically maintenance free!

Here's a compact, low priced, nominal 400 cycle motor alternator set by American Electronics that is an ideal high frequency power supply for shops and laboratories, for permanent or portable installation. With outputs up to 1000 watts single phase or to 1800 watts three phase, Model 275 saves space, can be utilized as an individual power source for training aids, flight simulators, radar installations and computers.

Produced by the Precision Power Division of American Electronics, Inc., Model 275 Inductor Alternator, illustrated above, operating from 60 cycles AC, meets power supply requirements of MIL-E-7894. Total harmonic content is under 5%. Output voltages are automatically regulated to within ±1% and are manually adjustable to ±10% from nominal. Specific models for specific requirements are listed in the table.

Other standard alternators in sizes from 500 watts to 120 KVA, with fixed or variable output frequencies ranging from 250 to 10,000 cycles, are in production. Please write for our new brochure which gives complete details on Model 275 and American Electronics' line of rotary power supply units. A new brochure is also available covering AMSTAT Static Power Devices produced by the Precision Power Division of American Electronics.

<table>
<thead>
<tr>
<th>REQUIREMENT</th>
<th>INPUT</th>
<th>OUTPUT</th>
<th>MODEL NO.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>VOLTAGE</td>
<td>HP</td>
<td>WATTS @ 1.0 P.F.</td>
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<tr>
<td>3-PHASE</td>
<td>220/440</td>
<td>1</td>
<td>500</td>
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<td>2</td>
<td>1000</td>
</tr>
<tr>
<td>3-PHASE</td>
<td>220/440</td>
<td>3</td>
<td>1800</td>
</tr>
<tr>
<td>OUTPUT</td>
<td>550</td>
<td>3</td>
<td>1800</td>
</tr>
<tr>
<td>220</td>
<td>3</td>
<td>1800</td>
<td>115/200-115</td>
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<tr>
<td>208</td>
<td>3</td>
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<tr>
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<td>100</td>
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<tr>
<td>1-PHASE</td>
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<td>2</td>
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<tr>
<td>INPUT &amp;</td>
<td>115/230</td>
<td>2</td>
<td>1000</td>
</tr>
<tr>
<td>3-PHASE</td>
<td>115/230</td>
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<td>3</td>
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<tr>
<td>1-PHASE</td>
<td>115/230</td>
<td>3</td>
<td>1800</td>
</tr>
</tbody>
</table>

- Weight: 125 to 140 lbs.
- Output Frequency: 400 CPS nominal
- Maximum Total Harmonic Distortion: 5%
- Voltage Regulation: ±1%
- Voltage Adjustment: ±10% from nominal
- Size: with 3-phase motor 20" L x 12" W x 9½" H
  with single-phase motor 21½" L x 12" W x 11" H

American Electronics, Inc.
Precision Power Division
9705 Klingerman Street, El Monte, California
In these rooms the most infinitesimal air-borne contaminants are scientifically whisked from the air, away from superprecision miniature ball bearing parts. New Departure introduced the White Room nearly twenty years ago. And today, New Departure's concept is a pace-setting standard in miniaturization industries. At N/D, miniature ball bearings are completely assembled in properly humidified, temperature controlled atmospheres that approach fantastic levels of cleanliness. The most advanced air filter systems available are employed. In addition, pressurized access air locks and individual counter-top pressurized chambers are used by N/D's skilled technicians during final assembly and statistical inspections. Air-borne particles rarely ever touch bearing surfaces.

All N/D White Room equipment is of the most recent development and design—incorporating the highest order of today's technological know-how and reliability methods. These are just a few reasons why more and more major missile contractors rely on New Departure Miniature and Instrument ball bearings. If you are working on a new miniature ball bearing application where reliability is critical, include an N/D Sales Engineer in your design discussions. Call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.
Import Curb Plea Under Fire

Counterattacks to petition for import curbs on Japanese semiconductors are registered in Washington. Possible deadlock seen

Importers of semiconductors—transistors, diodes, and rectifiers—are marshaling forces for what promises to be a long and bitter fight in Washington against curbs on foreign sales asked by Electronic Industries Association at Office of Civil and Defense Mobilization.

Electronic Industries Association filed its protest primarily against imports of transistors from Japan, and based its plea for new restrictions on the grounds that recent spurs in the importation of these products threatens domestic manufacturers whose productive capacity is vital to the national defense (ELECTRONICS, p 32, Nov. 6, 1959).

EIA, supported by a companion petition filed by Texas Instruments Inc. and affidavits from several other member companies, is seeking relief under section No. 8 of the Reciprocal Trade Agreements Act, whose so-called “national security” clause provides the procedure by which Office of Civil and Defense Mobilization can recommend import quotas or other restrictions.

According to EIA’s petition, imports of Japanese transistors (and other foreign semiconductors) threaten:
• To impair the efforts of U.S. producers to provide the capacity to meet existing and potential national security requirements;
• To create instability in industry employment;
• To deprive the domestic industry of profits from entertainment transistor profits which go into expensive research and development of military-use products; and
• To deplete domestic production capacity to the point where the U.S. is dependent on foreign sources for defense needs of these products.

Rebuttal Filed

In mid-December, Japanese importers filed a sharp rebuttal to EIA’s plea. The Electronics Industries Association of Japan, the Japan Electronics Export Promotion Association, and the Japan Machinery Exporters Association were later joined by the British Chamber of Commerce and a U.S. importer of German products, Robert Bosch.

The Japanese contentions are:
• That imports of entertainment transistors and transistor radios compete with domestic output of entertainment equipment only, and do not threaten the productive capacity of U.S. firms producing military-use items;
• That the bulk of Japan’s exports of these items to the U.S. are shipped under patent licensing agreements with U.S. firms such as Radio Corp. of America, Transitor, Inc., and Raytheon Co.;
• That domestic leaders in the production of military-use semiconductors do not rely on profits from sales of entertainment items to finance their defense research.
• That the Dept. of Defense has advised OCDM that domestic productive capacity of semiconductor items currently is in excess of defense needs.
What has EIA disturbed is that, according to Commerce Dept.'s latest figures, imports of Japanese transistors multiplied from $7,000 in 1958 to $521,000 in the first six months of 1959 alone.

U. S. imports of other semiconductor devices from Japan totaled $42,000 in the first half of 1959.

Nevertheless, EIA contends that, despite a 15 percent tariff, Japanese transistor imports have burgeoned in the last two years from a negligible volume to "about 25 percent" of total U. S. unit production.

The Japanese counter that their shipments are so concentrated in the nonmilitary, entertainment-item field that their U. S. sales of higher priced military items totaled a mere 2.7 percent of the domestic semiconductor dollar volume output in 1958, and an estimated 3.5 percent in 1959.

Rumors Abound

Behind the feud, the trade is rife with rumors that some U. S. producers of military-use semiconductors depend on Japanese imports of entertainment items to the point where they will refuse to support EIA, though they are members.

OCDM staffers say they want to stay out of any intraindustry wrangle. They point out that only one section No. 8 case has resulted in new curbs on imports—that one involving the mandatory quotas on petroleum. Over a dozen other similar cases have been rejected at OCDM—not because the agency has refused to accept petitioners' contentions that they are "defense-essential," but on the grounds that imports are not constituting a threat to domestic productive capacity needed for defense.

The semiconductor case may take several months to complete. But to date, the strongest indication of the rough road EIA faces is contained in the Defense Department's recent survey cited by the Japanese.

The Pentagon's Electronic Production Resources Agency reported to OCDM several months ago on the request of the National Security Council. Its finding: There is adequate U. S. capacity for production of transistors and other semiconductors to meet both current and long-range military needs.

Look what happened when A. W. Haydon designed a new LABORATORY STOP CLOCK

You just won't find these features in any other stop clock. This versatile timer-of-all-work was designed by engineers who understand timers and timing...and who needed a precise time reference in their own work. Timed outlet—energized whenever clock runs, supplies 115V, 60 CPS, 3 amp to time and control external loads simultaneously...manually or automatically. External Run Socket—for remote running, using a control cable...manually or automatically (when wired into a system). Clutchless timing mechanism—needs no warm-up, make-ready or pre-start. Synchronous motor starts and drives instantly. No power consumed except during timing and reset. Independent RUN and RESET buttons for manual, local control. Schematic diagram and control circuitry silk-screened on bottom of housing for ready reference. Bench type precision stop clocks are available with optional remote control for manual or automatic running and/or resetting. Clocks operate on commercial 115V, 60 CPS power, accuracy is ± 25 milliseconds.

Low power drain: only 2 watts, timing. Sweep second scale calibrated in 10 millisecond increments; totalizer scale calibrated in seconds, up to 1 min. Sturdy instrument case requires only 4¾" square bench space. For complete specifications, write for Bulletin ET-702. Ask also about panel-mounting versions.

AWHAYDON COMPANY
235 North Elm Street, Waterbury 20, Connecticut
Low Cost Miniature Trimmer Pot, Series 110. 3/4" dia. preset wirewound 1/2-5,000 ohms range variable resistor. Exceptional reliability due to several unique design features.

Compact Vernier Variable Resistor, Type VA-45. 12-1/2 to 1 reduction. For fine tuning applications, Ball bearing rotation.

Higher Reliability Micro-Miniature Composition Control, Series M250. 9/32" dia. For miniature transistor hearing aids, miniature radios, telephone equipment and industrial applications requiring tiny size and exceptional reliability.

Compact Motor Driven Control, Type MD 45. For remote control functions.

67% Smaller Side-By-Side Printed Circuit Ceramic Base Control, Type X153. Compact space-saving self-supporting snap-in 2 or 3-section variable and fixed resistor network 1/3 the size of previous units designed for printed circuit applications.

Separately Mounted Simple Design Pull-Push and Push-Push Switches, Types SK-1 and SJ. 13/16" dia. In separable mounted styles for home appliances and other electrical and electronic applications.

Highly Uniform Rugged Rotary Switches, TROLEX Series. Exceptionally high uniform reliability is achieved by an entirely new manufacturing concept. For military and commercial applications.


CTS Specialists are willing to help solve your variable resistor and switch problems. Contact your nearest CTS office today.
Canadian Station Airs Stereo

Regular broadcasting of a-m stereo starts soon in Montreal as government network and other stations show growing interest.

STEREOPHONIC BROADCASTING is well on its way to becoming a reality for Canada's most populated region.

Shakedown of equipment already installed at station CJAD, Montreal, is now taking place. Scheduled broadcasting is slated to start in the near future.

The system is an a-m/a-m installation which transmits stereo to listeners with two a-m receivers. To hear the stereo effect the listener must tune receivers slightly off frequency. Listeners with one radio can hear the same programs with no noticeable loss of quality.

Present plans call for broadcasts of a half-hour during the day and 1½ hours in the evening. Approval for the stereocasting has been granted by Canada's Department of Transport, whose responsibilities include communications. The license for stereocasting has been issued on an experimental basis to the Columbia Broadcasting System affiliate station. There are indications that other commercial stations in Canada as well as the government-operated Canadian Broadcasting Corp. are also interested in stereo broadcasting.

Interest Is High

Owner and president of the station, J. Arthur Dupont, told ELECTRONICS that interest seems high in stereo among Montreal listeners. The station has been keeping a close watch on sales of stereo records and stereophonic high-fidelity equipment. Based on these observations, success of the venture is anticipated.

Kahn Research Laboratories, Inc., Freeport, L. I., supplier of CJAD's stereo gear, reports that interest in stereo is not confined to Canada and the U. S. alone. The company has installed equipment in Mexico City for station XEW, which plans regular stereocasts in the near future, and in Venezuela at both of that country's two radio stations. The Venezuelan stations completed preliminary tests in the fall of last year and have since ordered more equipment.

Expectations are that stereocasting in Canada will move forward at a faster pace than in Latin America. As in the case of television broadcasting, the Latin American stations are operating in an environment where per capita ownership of radio sets is low by U. S. standards. Mexican manufacturers are producing conventional a-m receivers that sell for as low as $11, but doubt that there is as high a proportion of two-set homes in their country as there is north of the border.

It is unlikely, however, that this factor will slow down XEW's efforts to any great extent, observers believe. They note that the station owners have a reputation for positive action.

In the early days of television, the Mexican station stimulated receiver purchases by establishing well-equipped studios, presenting a mixed fare of bullfights, baseball games and variety programs and even installing a complete pint-sized auditorium for children's shows from which parents are banished behind glass partitions.

Supporters of stereophonic broadcasting in Latin America are also relying on the love of music shown by most of the people in their countries.

Leonard R. Kahn, president of KRL, says an expansion of the receiver market will follow the rise in stereo broadcasting in any country. His company has designated a two-channel a-m receiver requiring only an auxiliary speaker. "The cost and complexity of these home receivers must be minimized to assure widespread public acceptance," he said.

Nike-Zeus Antimissile Missile

R&D costs for Army's antimissile missile, Nike-Zeus, have passed $½ million. Congress will decide if the weapon will go into production. Prime contractor Western Electric is responsible for the radio command guidance system.
Recorded Events, only when referred to Time... have significance!

...and with today's accelerating technology, the need for the most accurate time reference available becomes more acute. It is available and free; the standard time and frequency transmissions of the National Bureau of Standards radio stations WWV and WWVH are accurate to better than 1 part in 50 million and are placed at the disposal of anyone having a receiver capable of tuning to one or more of the transmitting frequencies.

The new Model WWVT receiver, designed especially for remote operations under extreme environmental conditions, is a highly-sensitive crystal-control instrument capable of utilizing WWV and WWVH transmission.

**Thermoplastic Recording** of television signals and its effect on users of magnetic tape continues to monopolize a good many conversations this week for both business men and engineers.

Of interest to the engineer is the way in which the tape operates and the equipment it will require. The businessman asks how it will affect the value of the tape equipment he now owns.

Technically, the "thermotape" process may be defined as a system for storing information at high density on a film containing a plastic coating which melts at low temperatures.

Information is placed on the tape with an electron beam in such a way as to permit electronic playback of tv images in black-and-white or NTSC simultaneous color, or of computer input data. In a system described by General Electric this week in New York, the feasibility of producing direct optical images from the thermotape was discussed.

Action of the electron beam lays down a negative charge pattern on the plastic film. Attraction of a positive back plate for the negative charges causes depressions when plastic is heated. The pattern is fixed for storage by subsequent cooling.

For storage of color images, deformation ridges are impressed as phase diffraction gratings whose spacing and amplitude determine the color features. The gratings are produced through velocity modulation of the horizontal sweep of the electron beam by two low amplitude r-f carriers. These carriers are fed to the beam producing gun from an external modulating circuit. Two carriers are applied to the horizontal deflection plates of the gun. Another carrier is applied to the modulator electrodes. This carrier modulates the vertical deflection. Gratings spaced 10 microns center-to-center have been obtained.

Video readout is accomplished by a special optical system in combination with a conventional flying spot scanner or camera tube. Direct optical readout is possible with another type of specialized optical system.

To erase, the charge pattern is removed by raising the temperature of the film high enough above its
Tape Users

Tape Users

melting point to increase conductivity as well as soften the film.

George I. Long, president of Ampex Corp., says his company has also been conducting research in this field for some time. A bulletin on the thermotape method as well as other storage techniques was published by Ampex in September of last year. Company spokesmen told ELECTRONICS there is no great worry over competition from thermotape. They see it as a future adjunct rather than a competitor to their product.

One indication that there will be no great upset in present tv tape usage lies in the fact that there are presently some 700 magnetic tv tape recorders operating in this country. These units range in cost from $52,000 to $71,000. Talks by ELECTRONICS with tv stations, and tv advertising tape producers show a reluctance to start thinking about replacement of their equipment in the foreseeable future. Comment from one major network was "Our people are just getting settled to the existing system and aren't going to start looking for something new for quite a while."

Industrial users are showing a "Wait and see" attitude. Questions have been raised over the reliability of the reused thermotape in view of the fact that it must be deformed during recording.

A company engaged in manufacture of airborne equipment expresses doubt that there will be much application at this time for thermotape in satellite and missile programs.

Manufacturers of magnetic tape do not seem to be overly worried about potential competition arising from the new tape. Minnesota Mining & Manufacturing, for example, is prepared to pick up the ball and run if the play goes in that direction, but reminds that its highly diversified line is not likely to be hurt by any innovations.

Reeves Soundcraft, which launched a new division to produce commercial video tape this month feels confident that its predictions for a $10-million market will not be impaired by thermotape.

over 95% of all popular rectifier tube types can be replaced with Tarzian tube replacement silicon rectifiers

ultimate reliability, small size—with excellent efficiency—are some of the many Tarzian plus values

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Better Environmental Design

Where environmental conditions are extreme, or fluctuate from one extreme to another, specify resilient Silastic® to protect sensitive components. Silastic, the Dow Corning silicone rubber, is not affected by temperatures from —90 to 250°C (—130 to 500°F), nor by rapid thermal cycling. It retains its excellent dielectric and physical properties . . . resists the effects of ozone, storage, moisture, corona.

For these reasons, Silastic was selected by engineers of the Emerson Electric Manufacturing Company, St. Louis, for several parts of the electronics package shown. Part of the fire control system on Convair B-58 Mach 2 bombers, this unit must function at —65°F . . . continue to function dependably despite vibration and operating temperatures up to 350°F around the miniature tubes. A molding of heat resistant Silastic holds the tubes gently but firmly to protect them from vibration and shock. Silastic grommets, feed-throughs, and connector insulation are also part of the package. In any climate and under any environments, Silastic gives required protection to Emerson's assemblies.

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

Wire That STRETCHES
Like a stretch-to-fit sock, this snappy new product extends itself to meet your needs. Available with insulation of Silastic, it is called Stretch Wire, and is manufactured by the Stretch Wire Corporation.

Stretch Wire elongates to 165% of its original length . . . then springs back. It has already proven itself in missile and ordnance electronics, withstanding launchings at speeds of 1000 fps and inertia loads of 800 G's. Because of the properties of Silastic, the insulating sheath remains elastic under the temperature extemes encountered.
...silicones provide lasting protection

Laminate Parries Lightning Thrust

Long range HF communication systems employing probe-type antennas are now safe from lightning strikes with the new Aircraft Lightning Arrester made by Joslyn Manufacturing and Supply Company, Chicago.

Key component: a 0.0625 inch thick slotted silicone-glass laminate part that serves as retainer and insulator for 15 phosphor bronze spring elements. Made of Dow Corning silicone resins and glass cloth, this part enables the arrester to safely discharge lightning strokes with a peak current of 100,000 amperes and 200 coulombs charge. The silicone laminate is strong, resists moisture, vibration and fungus growth, and is inexpensive to fabricate. Electric strength is . . . obviously . . . excellent.

CIRCLE 253 ON READER SERVICE CARD

997 Varnish Ups Power, Cuts Weight

When designing transformers to operate at high temperatures in standby control power supplies for submarine nuclear reactors, Milro Controls Co. faced three major musts: maximum power output for minimum weight; great resistance to moisture; ample overload protection.

Impregnating with Dow Corning 997 Varnish, and using silicone insulating components, proved to be the right answer on all three counts. This silicone varnish withstands operating temperatures up to 250°C . . . provides superior protection against all the well-known enemies of electronic and electrical equipment. Each of the new Milro power supplies contains three compact, light-weight transformers, impregnated with 997.

CIRCLE 255 ON READER SERVICE CARD

New Gel Gives "View-Through" Protection

Poured as a liquid, transparent Dow Corning Dielectric Gel fills all voids, then sets up to form a heat stable gel. Dielectric strength is excellent; stress on components almost nil. Potted components and circuitry remain clearly visible . . . can be checked by eye. Probes can be inserted for instrument checks . . . the gel re-seals itself when probes are removed. Individual components can be removed and replaced.

Dielectric Gel enabled CBS Laboratories to meet stringent reliability requirements on its Photoscan power supplies. Despite high temperatures, high voltages, and high vibration levels in this remarkably small unit, Dielectric Gel prevents arcing. Components are spaced less than 1/4" apart, yet output voltages run from 1,000 to 25,000 volts!

CIRCLE 254 ON READER SERVICE CARD
SYLVANIA D-1820 is the forerunner of an outstanding family of diodes, designed, produced and controlled specifically for logic circuitry. The cost of this new SYLVANIA diode is low enough to make it especially attractive for use in quantity-produced electronic computers. SYLVANIA D-1820, and the circuits designed around this diode, feature:

**High-Speed Operation** — with recommended circuits, all units are guaranteed to provide a maximum recovery time of 4 millimicroseconds. However, recovery times of 2.5 millimicroseconds are typical.

**Long-Life Performance** — proved in 1000-hours operating and 7000-hours storage life tests.

**High Reliability** — basic point-contact structure has been field-proved for more than a decade. Withstands environmental conditions of shock and vibration.

**Exceptional Uniformity** of electrical characteristics — assures complete interchangeability within the type — result of modern automated-production techniques employed in the manufacture of SYLVANIA D-1820.

**Economy** — SYLVANIA pioneered the field of germanium point-contact diode manufacture, has "know-how" of superior-quality, large-quantity economical production. SYLVANIA is able to pass these savings on to you.

**Simplicity** — diode-logic circuitry is relatively uncomplicated, requires few components. It reduces computer construction costs. It adds to equipment reliability.

**Compactness** — SYLVANIA D-1820 "package" is miniature all-glass.

**Availability** — units can be supplied immediately through your local Sylvania Semiconductor Distributor or through your local Sylvania Field Office.

Complete sales information on quantity prices, delivery and sampling for your own evaluation is available from your local Sylvania Semiconductor Distributor or Field Office. For engineering data sheets on the new Sylvania D-1820 High-Speed Switching Diode or on any Sylvania Semiconductor Device, write Sylvania Semiconductor Division, Dept. 22-1, Woburn, Mass.

### ELECTRICAL CHARACTERISTICS — SYLVANIA D-1820

<table>
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<tr>
<th>Absolute Maximum Ratings*</th>
<th>Typical Operating Conditions*</th>
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<tr>
<td>Fwd. Volt .................. 1.3 V</td>
<td>Fwd. Volt .................. 0.9 V</td>
</tr>
<tr>
<td>Fwd. Cur. .................. 50 mA</td>
<td>Fwd. Cur. .................. 2.0 μA</td>
</tr>
<tr>
<td>Back Volt .................. 20 V</td>
<td>Rev. Recovery ................ 2.5 μs</td>
</tr>
<tr>
<td>Pwr. Diss. .................. 80 mW</td>
<td></td>
</tr>
</tbody>
</table>

\*at 10 mA \*at 20°C.
Soviets Spur TV Set Output

USSR plans to triple production to 3 1/2 million sets a year by 1965. New standards decreed.

Despite emphasis on consumer goods, the USSR seven-year economic plan will make little dent in the U.S. production and design lead in home television sets.

The Soviets plan to triple TV receiver production from the present rate of 1,200,000 sets a year to about 3 1/2 million in 1965 when the plan ends. By then, an estimated 18 million TV sets will be in operation.

Information comes from B. A. Berlin, of the USSR state committee on radio-electronics, who recently presented a paper before the British Institute of Radio Engineers' convention on TV engineering.

Soviet TV set production falls largely into three categories: 21-in. high-quality sets, 17-in. medium quality sets and cheaper sets up to 14 in. The first two have f-m sound. Luxury models are produced only in limited numbers.

Better quality Soviet sets have automatic frequency control and stabilization circuits. Principal new design trends in production models are: (1) introduction of automatic frequency control for tuners and (2) replacement of 70-degree picture tube designs by 110-degree tubes.

The design standards, which follow by years the U.S. and Western European lead in this field, have been recently specified by Communist Party decree along with other goals of the seven-year plan (Electronics, p 34, Nov. 29, '59).

In addition, the party has called for the establishment of special design offices at major plants producing consumer articles. Observers in Moscow generally believe that this is at least partly the result of Khrushchev's U.S. visit and the impact of the American exhibition in Moscow last summer.

New Look in Sets

The party decree deplores heavy, uneconomic design of household goods. It calls for use of plastic cases instead of wood for transistorized radio sets, phonographs, TV sets and tape recorders. It also appears that long-standing complaints of Soviet citizens about the lack of repair facilities for TV sets are being answered with a party order for the "organization" of TV repair shops.

Report on television broadcasting was given the Supreme Soviet by communications minister Nikolay Psurtsev. He said 84 TV centers are now operating. Thirteen of them were commissioned just before the end of 1959, thus extending broadcasts to all capitals of union republics and other cities with a total population of 75 million.

The minister reported that 60 TV stations out of 100 envisaged in the seven-year plan are under construction. He indicated that programs would be exchanged with other Communist countries by the end of the plan. He was non-committal on color TV, stating only that "much attention is being paid" to its development and that trial transmissions have begun in Moscow.

Identifying Wires

Portable current-path verifier, built by Boeing for aircraft applications, identifies individual wires in seconds in the complex wiring of B-52G bomber. Two small batteries supply power to 5-lb unit in use at firm's Wichita division.

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Industro is proud of its contribution to the success of this vital military project. Whether your transistor requirements are military or commercial you can depend on Industro. We invite your inquiries.
A COMPLETE RANGE OF RANDOM NOISE SOURCES and NOISE GENERATORS, 1 KC–26,500 MC

Measurement of Receiver Gain,
Indirect Calibration of Standard Signal Sources,
Measurement of Noise Figure

Your specific needs for noise figure measurement can be met by one or more instruments from the Kay Electric Company's comprehensive range of six instruments and 17 Microwave Assemblies.

<table>
<thead>
<tr>
<th>Instrument &amp; Cat. No.</th>
<th>Frequency Range (mc)</th>
<th>Noise Figure Range (dB)</th>
<th>Output Impedance (ohms)</th>
<th>Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mega-Node 240-B</td>
<td>5-220</td>
<td>0-16 at 50 ohms</td>
<td>unbal.–50, 75, 150, 300, 600, 1000, 1500, 3000, 6000, 10000</td>
<td>$365.00</td>
</tr>
<tr>
<td>Mega-Node 175-A</td>
<td>50-500</td>
<td>0-19</td>
<td>balanced–300</td>
<td>$365.00</td>
</tr>
<tr>
<td>Mega-Node 403-A</td>
<td>3-500</td>
<td>0-19</td>
<td>unbalanced–50</td>
<td>$365.00</td>
</tr>
<tr>
<td>Mega-Node 3000</td>
<td>10-3000</td>
<td>0-20</td>
<td>unbalanced–50</td>
<td>$790.00</td>
</tr>
<tr>
<td>Radio-Node 600-A</td>
<td>10-3000</td>
<td>0-20</td>
<td>balanced as specified</td>
<td>$1495.00</td>
</tr>
<tr>
<td>Thermo-Node</td>
<td>Head A 2-1000 mc</td>
<td>10</td>
<td>unbalanced, 500</td>
<td>$1965.00</td>
</tr>
<tr>
<td></td>
<td>Head B 1 kc - 400 mc</td>
<td>50</td>
<td>balanced, 50</td>
<td>$495.00</td>
</tr>
<tr>
<td></td>
<td>Head C 25 - 400 mc</td>
<td>Selectable 50, 100, 200</td>
<td>balanced, 500</td>
<td>$125.00</td>
</tr>
</tbody>
</table>

With Microwave Mega-Node as Accessory — prices below

Microwave Mega-Node — argon, neon and fluorescent gas discharge tubes. Noise output of 15.8 ± 0.25 db for fluorescent tubes; 15.25 ± 0.1 db for argon. Fluorescent tubes equipped with thermometer for correction factor of —0.05 db per degree above 32° C.

No correction required for argon tubes. Supplied with power cables and fittings. Power Supply for any waveguide size: $95.00.

<table>
<thead>
<tr>
<th>Waveguide Type AN</th>
<th>Flange AN</th>
<th>Frequency mc.</th>
<th>Catalog No. Argon</th>
<th>Catalog No. Fluor.</th>
<th>Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-59/U</td>
<td>UC-417/U</td>
<td>1120-1700</td>
<td>312-A</td>
<td>310-A</td>
<td>$395.00</td>
</tr>
<tr>
<td>RG-65/U</td>
<td>UC-417/U</td>
<td>1200-1400</td>
<td>312-A</td>
<td>310-A</td>
<td>$395.00</td>
</tr>
<tr>
<td>RG-70/U</td>
<td>UC-345/U</td>
<td>1700-2600</td>
<td>312-A</td>
<td>310-A</td>
<td>$495.00</td>
</tr>
<tr>
<td>RG-112/U</td>
<td>UC-345/U</td>
<td>2200-3390</td>
<td>312-A</td>
<td>310-A</td>
<td>$695.00</td>
</tr>
<tr>
<td>RG-424/U</td>
<td>UC-214/U</td>
<td>2600-3900</td>
<td>271-A</td>
<td>270-A</td>
<td>$175.00T</td>
</tr>
<tr>
<td>RG-44/U</td>
<td>UC-145/U</td>
<td>3600-5850</td>
<td>271-A</td>
<td>270-A</td>
<td>$175.00T</td>
</tr>
<tr>
<td>RG-50/U</td>
<td>UC-344/U</td>
<td>5800-8500</td>
<td>271-A</td>
<td>270-A</td>
<td>$175.00T</td>
</tr>
<tr>
<td>RG-51/U</td>
<td>UC-371/U</td>
<td>7050-10,000</td>
<td>291-A</td>
<td>290-A</td>
<td>$175.00T</td>
</tr>
<tr>
<td>RG-52/U</td>
<td>UC-369/U</td>
<td>8200-12,400</td>
<td>301-A</td>
<td>300-A</td>
<td>$250.00</td>
</tr>
<tr>
<td>RG-53/U</td>
<td>UC-419/U</td>
<td>12,400-18,000</td>
<td>531-A</td>
<td>530-A</td>
<td>$290.00</td>
</tr>
<tr>
<td>RG-55/U</td>
<td>UC-425/U</td>
<td>18,000-25,500</td>
<td>531-A</td>
<td>530-A</td>
<td>$290.00</td>
</tr>
</tbody>
</table>

1† Any three plus power supply: $855.00. Any in excess of three: $167.00 ea.
2** None available.

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RARE COMBINATION OF RELAY SPECS

SIGMA SERIES 32 — POLARIZED, DPDT MAGNETIC LATCHING RELAY

50 mw. sensitivity
current operated
30 g to 5000 cps
vibration immunity
100 g shock immunity

That artistic square wave is here to suggest but one of the application virtues of Series 32 relays: operation on nothing more than the meager energy of a single, short pulse. And with magnetic latching, the need for standby power and return springs is eliminated. The "32" is also a true current-sensitive relay, designed and built to operate cleanly when a slowly increasing current reaches the operate value. Contact closure is fast, positive and synchronous. And in common with most polarized relays, the dual-coil version of the "32" operates on the algebraic sum of the currents in its windings — making it ideally suited to comparing a variable signal current to a reference current.

The specs published here all include safety margins and understate the "32's" actual capabilities. And better than the printed word, they hold true in customers' circuits. Further data will be sent in answer to letterhead requests.

(See reverse side for major specifications)
**Major Specifications**

Sigma Series 32 Subminiature Relay
(See reverse side for basic design & application characteristics)

**Operation**
Double-pole double-throw, either-side stable, polarized magnetic latching (Sigma Form Z). Depending on the polarity of coil signal, the armature latches magnetically in either of two fixed positions. There is no center-off position. The coil signal may be ONE current flowing in one coil, two coils in series or two coils in parallel; or the operating coil signal may be the algebraic sum of the currents in each coil.

**Sensitivity**
Operate 50 mw., single-coil, 100 mw. each coil of dual-coil version.

**Vibration**
30 g to 5,000 cycles per second with no contact opening (with relay energized or de-energized).

**Shock and Constant Acceleration**
100 g will not cause damage and there will be no contact opening (with relay energized or de-energized).

**Thermal Stability**
Relay remains within specification over an operating temperature range of -65°C to +125°C. See curve, Fig. 1.

**Contact Rating**
2 amperes at 28VDC/120VAC, resistive load, for a minimum of 100,000 operations at +125°C maximum, based on silver contact material. Gold alloy contacts recommended for dry circuit applications.

**Contact Resistance**
50 milliohms, max. before use; 100 milliohms, max. after 100,000 operations at rated load.

**Timing Characteristics**
Relay operate time depends largely on the nature of the energizing circuit, mainly in terms of effective source voltage and final steady state coil current. Operate time varies inversely with both current and voltage overdrive. See timing curves, Fig. 2.

**Mechanical Data**

- **Enclosure**
  Hermetically sealed.

- **Size**
  .800" x .400" x .900" high (0.288 cu. in.)

- **Weight**
  18 grams (0.63 oz.)

- **Mounting Styles and Connections**
  All pins spaced on 0.100" grid. Dimensions are the same for single- or dual-coil versions; only the pin configurations differ.

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Here's an end to circuit unreliability caused by "leaking" printed circuitry. Unique bonding methods, developed by Shamban, bond insulator to copper without compromising the electrical properties of either. Even in extreme environments, there is no breakdown of strengths.

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New Shamban KOP-R-KLAD laminate presents several distinct advantages to the users of printed circuitry. KOP-R-KLAD offers a complete line, the right constructions for every application; optimum electrical properties through proper bonding, best volume, surface and insulation resistivity, highest dielectric strength; highest peel strength, for sharp bends, rugged environments; continuous lengths, for convenience of user, for wider application. KOP-R-KLAD is available in twelve different types, including copper to Teflon, to Teflon-glass, to Kel-F, and to FEP-fluorocarbon. Each type has specific advantages, all types have the advantage of absolute dependability and predictability within the limitations of the materials specified. KOP-R-KLAD is immediately available, dependent upon type, in widths up to 36", in lengths from 2" to continuous rolls. Write or wire factory for complete data.

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Locating Undersea Oil Lines

Six-foot, 200-lb detector finds buried flowlines, avoids damage during new drilling

Off-shore oil operations involving a network of 350 buried undersea flowlines led to the development of a new six-foot, 200-lb electronic metal locator by the Shell Development Co., Houston, Tex.

The company found that the maze of undersea lines, which carry oil from producing wells to production platforms, presented a constant danger of breakage in the placing of a well jacket on a new off-shore drilling site. The firm designed the locator to find areas clear of such lines.

Generates Field

The instrument generates an electromagnetic field which is disturbed when a pipeline or other metal object is within range. Aboard the ship, from which the "fish" is launched, a recorder makes a permanent record of ferrous metal objects detected. Gear is calibrated to permit operators to determine depth of buried objects.

Three-inch pipelines have been spotted at six feet under silt, says the company, but most underwater lines are less than six feet below the ocean floor.

The oil company believes the locator may also be useful in some types of marine salvage work. Shell has contracted with F. H. Maloney Co., Houston, to manufacture and distribute the locators.

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For scintillation counters, spectrophotometry, flying spot scanning. The range of phototubes made by E.M.I. is one of the largest in the world. It includes end-window types of 1" to 15" diameter, with S10, S11, S13 and S30 cathodes, with 10 to 14 dynodes of venetian blind type or of box and grid or focused construction. Tubes for C" and H' scintillation counting, also very low dark-current types, are an E.M.I. speciality. Tubes can also be produced to special order.

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AiResearch leadership in the development and production of electromechanical equipment for aircraft, ground handling, ordnance and missile systems of all types also includes such recent examples as spoiler servo control systems, magnetron and Klystron tuning devices, and safe-arm mechanisms for missile igniting. We invite you to submit a problem statement of your electromechanical requirements.

U.S. Army Signal Corps ground portable radar unit operated with two AiResearch electromechanical actuation systems.

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**SPECIFICATIONS**
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- **Output Voltage:** 100 volts maximum
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- **Output Polarity:** Floating or negative grounded
- **Voltage Regulation:** 0.01% or 0.1uA, whichever is greater, for 10% line voltage change
- **Current Regulation:** 0.01% or 0.1uA, whichever is greater, for load change from zero to maximum
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We will gladly mail you literature giving full details of Marconi multi-channel link test equipment—please ask for leaflets B144.

MEETINGS AHEAD

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, Statler Hilton Hotel, New York City.


Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.


Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 16-18: Nondestructive Testing of Aircraft and Missile Components, Southwest Research Institute, Hilton Hotel, San Antonio, Tex.


Apr. 3-8: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 11-14: Weather Radar Conference, American Meteorological Society and Stanford Research Institute, San Francisco.

Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland.


Aug. 23-26: Western Electronic Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

There’s more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 112.
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LOW COST: Up to 12 positions; staked or strut screw construction.
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MINIATURE: 8, 10, and 12 positions; up to 18 contacts per wafer.
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Series MF, 50, 53

SIMPLE SWITCHING: Up to 5 positions combined with AC switch.
Series 52, 54

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CONCENTRIC SHAFTS: Dual and triple shafts with many wafer types.

FOR PRINTED CIRCUITS: Special lug designs for direct insertions.

SOLENOID SWITCH: Oak wafers with G. H. Leland type of Rotary Solenoid.

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Series 160

1-3/8"  1-7/8"  1-3/8"  1-3/8"  1-7/8"  1-7/8"  1-7/8"  1-7/8"  1-1/8"

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5 digit accuracy with 3 digits!

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Speeds testing – Using three digits, instead of five, and elimination of time consuming range changing, reduce the average reading time by 40%. Average balance time is one second.

0.01% accuracy – The instrument reads ±5% of the total resistance to an absolute accuracy of 0.01%. The chosen ±5% range is measured to a full, three-digit accuracy. Essentially, reading accuracy is limited only by the absolute accuracy of the nominal value.

The new instrument is particularly suited for automatic measurement of temperature coefficients. Contact closures are available for go/no go and tolerance sorting operations.

Values can be referenced to a single resistor of known value or set with the optional precision resistance decade unit (shown above).

If you are testing resistors in quantity, you will want complete information on this extremely versatile instrument. Get in touch with your nearest EI field engineer today.

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Display:
3 digits, over range indication.

Resistance range:
10 ohms to 10 megohms.

Accuracy:
The instrument reads ±5% of the total resistance to an absolute accuracy of 0.01%.

Speed:
1 second, average.

Electro Instruments, Inc.

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What's Going On In Advanced Research

New high-power microwave tube is among developments revealed at Northeast Electronics Research and Engineering Meeting

By THOMAS MAGUIRE, New England Editor, and SY VOGEL, Associate Editor

THEME OF THE 1959 Northeast Electronics Research and Engineering Meeting (NEREM) was advanced research-and-development. Among the technical papers were reports on: an impending breakthrough in microwave-tube power, a new crossed-field microwave amplifier, a fresh approach to the problem of stabilizing maser gain, a new semiconductor switch, developments in electron-beam technology, and thermoelectric cooling of transistors.

MICROWAVE SUPER POWER—A new concept in microwave-tube design foreshadows a breakthrough in economic generation of large quantities of microwave power in the S-band region. Pulsed tubes may have an average r-f power output of 200 kw, and eventually, 400 kw. The new design makes possible a 10-fold increase in the heat removed from an anode, thus permitting a 10-fold increase in tube input and output power levels without a large increase in physical size or cost. This increase in heat-dissipation density, combined with high efficiency, produces 10-kw output for each sq cm of anode area; 20 kw/sq cm may be possible, eventually.

These large anode-dissipation densities have been experimentally confirmed in an X-band Amplitron, a cross section of which is shown in Fig. 1. The slow wave structure is constructed of very small tubing having an inside diameter of 0.018 in., through which water is circulated. Wall thickness is only 0.006 in., so the heat generated by electron bombardment of
the slow wave structure is easily conducted to the water coolant. Water flow through the tubing is in parallel flow. Due to the short distances involved, a difference of only 100 psi between input and output water connectors causes water to flow through the tubing with high velocity. In this small Amplitron, which has a total projected anode area of only slightly more than one cm², it has been possible to dissipate 8 kW in the anode under conditions of close to 50 percent operating efficiency. Projected anode area is the product of vane diam, the length over which the vanes collect anode current and the number of vanes.

Higher heat-dissipation densities than those already achieved could result by using a higher water pressure, with a resultant increase in flow velocity of the coolant. A value of 3 kW/sq cm is a conservative figure for future designs.

In a device limited by anode dissipation, the combined effect of large dissipation density and higher efficiency produces a sharp increase in useful r-f output power, as shown in Fig. 2. Combining a dissipation density of 3 kW/sq cm with 80 percent efficiency, 12 kW of useful r-f power may be obtained for each sq cm of anode area. Thus, in a modified S-band Amplitron with an anode area of 22 sq cm a useful r-f output of 264-kw-average power could be predicted.

Within a few years there will be tubes which cost $10 to $20/kw of output power, assuming a reason-
At intervals during observation, gain is set back manually to the middle of the automatic gain stabilization (ags) range.

The ags loop gain of about 30 reduces gain drifts, which might otherwise amount to several percent during an observation, to the order of 0.1 percent. Such small drifts are not troublesome if they are linear.

Success of the ags scheme depends on the gain of stages following the maser remaining constant. If the gain of these stages should vary while at the same time the overall gain is held constant, the contribution of these stages to the input-noise temperature will change. Such a change would be equivalent to a spurious input signal. Fortunately, it is possible to maintain gain stability in the post-maser stages to better than one part in a thousand by careful regulation of supply voltages and ambient temperatures.

It is possible to record output in two ways. The total second-detector output is differenced against a battery in the record 1 channel. The mean second-detector output is differenced against the amplitude of the noise step in the record 2 channel. The second channel has the advantage that residual gain fluctuations affect both its inputs in the same ratio and should therefore not appear in its output. However, fluctuations are enhanced in this channel since two noise voltages are compared.

The system has employed a 20-db coupler and a 100-K noise-step tube to record with minimum added noise in the first channel. It is possible that a coupling factor between 10 and 20 db would be better.

CONTROLLED-RECTIFIER SWITCH — A new semiconductor component, the Transwitch', is designed for computer applications. It can be turned off by a relatively small negative pulse, compared to the negative pulse required to turn off a conventional silicon controlled rectifier. Physical configuration is shown in Fig. 6A; Fig. 6B shows the equivalent transistor circuit.

The component operates at relatively low currents (50 ma) and low voltages (30 v). Beta decreases with increasing load current; thus turn-off current must be increased as load current is increased. Compared to the silicon controlled rectifier, whose approximate turn-off beta is 2, turn-off beta of the Transwitch is between 5 and 10. Turn-on time is inversely proportional to input-pulse height and width. Pulse height must be sufficiently positive or negative to turn the switch on or off. The higher the temperature, the higher is the required switch-off current.

Although the switch can be turned off by any pulse below a minimum level, the turn-off transient will not be clean unless the turn-off pulse is appreciably more negative than this level.

Counters have successfully performed with these switches up to 20 kc. Switching at 1 usec should eventually be feasible.
ELECTRON BEAM TECHNIQUES — Development work has started on an electron-beam device for accurate machining of small holes in evaporation masks, one of the pressing problems in micro-module programs. The holes must be accurate in dimension, positioned accurately, and have good registration between the masks in each set. The new device works on the same pulsed-energy principle as used in Zeiss electron-beam techniques, but it drills out all holes simultaneously without motion of the work piece. The setup is shown in Fig. 7. A stencil mask of a convenient size is illuminated by a collimated beam of electrons. The large stencil is imaged at a good-size reduction on the work piece and all the holes are drilled at once by pulsing the illuminating beam.

In another aspect of metallurgy for electronics, space requirements have created vast need for refractory metals with improved physical and electrical characteristics—and most of the improvements have come about through ultra purification. A basic limitation on ultra-purification research is the extreme difficulty of measuring low-level impurities. One technique is to measure the resistivity of the material at room temperature and then in liquid helium. The ratio of the two resistivities can then be used as an index of purification. This measurement is reasonably sensitive, but it does not give an absolute quantity, nor does it identify the impurities and define their state chemically.

Instrumentation at the level of primary-standards labs is required by the sensitivity of this measurement. Many labs use a Rubicon six-dial potentiometer, which is capable of resolving increments of 10⁻⁴ v d-c. Bell Labs reports an apparatus using two such Rubicon potentiometers which will resolve increments of 10⁻⁸ v d-c and is sensitive enough to measure 10⁻¹⁰ v absolute to an accuracy of 10 percent. Estimated cost of the apparatus is $200,000. Large problems remain to be solved in this area, since many labs working with Hall effect and Zener voltages will soon have to make measurements of this magnitude.

Electron-beam techniques have become increasingly important in production of semi-conductor devices. Electron beams are used for three general categories of work: cutting, joining, and film deposition. Material can be deposited either by the masking technique or by using electrostatic or electromagnetic fields to focus the ionized vapor and direct it onto the desired areas of the work piece. Advantages include high efficiency of energy transfer with few side effects, ability to deliver high power density to very localized areas, ease of control, high dynamic response, and freedom from contamination.

High cost is the most important disadvantage. Electron-beam processing takes place in a vacuum, with the degree of vacuum determined principally by experimentation. Generally, pressures are between 10⁻⁷ and 10⁻⁸ mm Hg; an ultra-high vacuum of 10⁻¹⁰ mm is advisable in semiconductor fabrication. Typical values for electron-beam power in semiconductor and micro-circuit work are between 1,000 and 5,000 w. Accelerating voltages for the beam vary from a few to several kv.

THERMOELECTRIC TRANSISTOR COOLER — Wide-range temperature control of dissipative electronic components with semi-conductor Peltier cooling is within the existing state of the art. Peltier junctions perform heat pumping at the dissipation levels met in typical electronic circuits. Use of the technique to extend a transistor's dissipation limit is a practical illustration.

A transistor cooler assembly is shown in Fig. 8. Active part of the unit consists of two bismuth-telluride thermocouples comprising two p-type and two n-type legs. Thermocouples are connected electrically in series and thermally in parallel. The cold junctions are soldered to the platform supporting the transistor. Heat-sink ends of the thermocouples are soldered to nickel-plated copper blocks, and these
blocks are mounted on a nickel-plated copper platform. A thin sheet of mica electrically isolates the thermoelectric structure from the outer case. A 15-w transistor with a 1-deg-C/W thermal resistance in its case is mounted on the cooled platform. Ten glass-to-metal seals are soldered into the base of the assembly to provide lead-throughs for the transistor, the thermocouples, and a thermistor.

Performance of the cooler was tested at ambient temperatures of 5 C and 102 C. Device performance was practically constant over this range, not because of the constancy of semiconductor properties, but because the deteriorating effect of heat was prevented. In a typical test, with the collector dissipating 4 w, a power input of 7 w was required to cool the collector to 80 C.

The geometry of the cooling device determines the heat-pumping capabilities. The requirement of short thermoelements for large heat-pumping capability is compatible with the requirement of fast transient response for good control characteristics. Other materials under development, such as solid solutions of Bi,Te, with Bi,Se, or Sb,Te, with Sb,Se, look promising.

OPTICAL-ELECTRONIC SYSTEMS — These systems may be used in such jobs as communication, navigation, and acquisition and tracking. Optical-electronic systems may be active or passive. The general type of system to be analyzed below is the active, which contains a transmitter of optical energy.

The basic system contains a modulated light source which transmits energy through a medium such as the atmosphere to a detection system. In the transmitter, the modulator determines the frequency spectrum of the light-signal modulation. Thus the modulated signal is described by the center frequency f, and the bandwidth A f.

The spectral power of the transmitted beam is P, = a, W, where W is the spectral radiant emittance of the source in w/cm — micron, γ is the light-gathering ratio of the transmitter optics and a is the light-source area.

The spectral irradiance of the beam arriving at the input of the detection system is

\[ H_\lambda = P_\lambda \Gamma_\lambda / \lambda R \]

where \( \Gamma_\lambda \) is the transmission of the medium at wavelength \( \lambda \), \( \theta \) is the solid angle of the beam, and \( R \) is the range.

Passing through the detector system, the irradiance is attenuated so that the signal power reaching the detector within the spectral interval d\( \lambda \) is dP = H, A(T(\lambda)d\( \lambda \)) where A is the effective detector-aperture area and (\( \Gamma(\lambda) \)) is the transmission of the detector-system optics.

The quantum efficiency \( q(\lambda) \) of the detector is the ratio of the number of electrons generated by the detector to the number of photons striking it. Using the energy relation \( E = h\nu/\lambda \), the number of electrons generated per second is

\[ n = (A/h\nu) \int H_\lambda \Gamma(\lambda) q(\lambda) d\lambda \]

Thus the input current to the detector amplifier is

\[ i_i = e n = A \int H_\lambda \Gamma(\lambda) q(\lambda) d\lambda \]

where e is the electron charge and \( q(\lambda) = (\nu/\hbar) q(\lambda) \)

Detector-amplifier center frequency and bandwidth should match the modulation characteristic of the light source. Assuming a constant gain, \( G \), the output signal is

\[ S = \frac{e n A G}{\gamma} \int H_\lambda \Gamma(\lambda) q(\lambda) d\lambda \]

Radiation noise \( N_\lambda \) is usually the dominant noise component. Where \( H \) is the angle of view of the detector-system optics, the detector noise current is

\[ i_n = A H \int H_\lambda \Gamma(\lambda) q(\lambda) d\lambda \]

Thus the power S/N ratio of the system is

\[ (S/N)^2 = \left( \frac{A n H \Gamma(\lambda) q(\lambda)}{\gamma} \right)^2 \int H_\lambda \Gamma(\lambda) q(\lambda) d\lambda \]

where

\[ I(\lambda) = \int H_\lambda \Gamma(\lambda) q(\lambda) d\lambda \]

REFERENCES

All of the following were presented at the 1960 NEREM in Boston:


One-Tube Oscillator Mixers

Balanced bridges and semiconductor diodes limit frequency pulling and radiation into the antenna. Frame-grid pentode promises considerable gain improvements. Advantages of new circuit show up in comparison of conventional and modified tuners.

By E. H. HUGENHOLTZ*, Consultant to Amperex Electronics Co., Hicksville, N. Y.

EARLY OSCILLATOR MIXER circuits were based on single tube circuits that combined the functions of oscillator, mixer, and i-f amplifier. Having no buffer between the oscillator section and the r-f stage, these circuits were prone to frequency pulling and radiation into the antenna. Although the drawbacks have been overcome by using circuits with double triodes and triode pentodes, such circuits are complex.

This article describes two groups of circuits that are relatively simple, and whose improved performance offers a promising future. The first group uses a single tube as in the original autodyne circuit, but with the addition of tuned circuits to cancel unwanted coupling. The second group is similar to the first, but uses semiconductor diodes for mixing. Departing from convention, a frame-grid pentode is used in one of the second group of circuits, and its considerable gain promises smaller and more economical i-f amplifiers.

Circuit Operation

Figure 1 shows the basic circuit of the first group of oscillator mixers in a version suitable for tv tuners. Tube V1 is the oscillator mixer, while V2 is a conventional r-f amplifier. Coils L1 and L2 are the primary and secondary r-f coils; L6 is the oscillator coil, and the i-f output circuit is formed by L and L5.

Oscillator coil L1 is connected between the grid and plate of the oscillator mixer, V1, through series capacitor C0. First i-f coil L is a choke for the oscillator signal, which is returned to ground through capacitor C0.

Coil L is shunted by capacitors C3 and C4. The values of C3 and C4 are chosen so that their junction is a null, or at least a minimum, for the oscillator signal. The second r-f coil L6 is connected to this junction and so a minimum signal is fed into it from the oscillator. Thus with a minimum oscillator signal developed across L6, the radiation into the antenna is reduced.

The bridge diagram of Fig. 2 illustrates the cancellation of the coupling between oscillator circuit L1 and r-f circuit L6. No component of the oscillator signal across L6 will appear across L1 as long as the relationship C3/C2 = C6/C6 = C6/C2 exists.

The bridge diagram of Fig. 3 shows the cancellation of i-f coupling between the plate and grid of V2, which is necessary to prevent undesirable feedback effects. Figure 3 shows that no i-f feedback can cause a signal between cathode and grid if the branch-impedance relationship Z3/Z4 = Z2/Z3 is obtained. The oscillator inductance is not shown in this diagram since its effect at intermediate-frequency is negligible; it would otherwise appear in branch Z3. The branch Z3

*Now with Rogers Electronic Tubes And Components, Toronto, Canada

FIG. 1—Single-tube oscillator mixer uses balanced bridges to cancel harmful coupling and feedback

FIG. 2—Bridge prevents oscillator signal from being developed across r-f coil L6

FIG. 3—Bridge prevents i-f signal feedback in V2

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For Tv and F-M Tuners

Measuring r-f output of modified turret-type tuner

does contain the r-f coil $L_x$ however, since the inductance of this coil increases with frequency, thus preventing its omission.

To achieve stability, the bridge is balanced at the lowest frequency at which it will be used. If this were not done, the increase in inductance of $L_x$ at lower frequencies could result in positive feedback capable of causing unwanted (parasitic) oscillations. This means that operation on the higher channel frequencies brings about some negative feedback and consequent loss of gain. Despite this effect, an experimental tuner of this type showed gain figures comparable to those for a conventional tuner.

Although the circuits described are simple in concept, they suffer in efficiency by having to perform the combined functions of oscillator, mixer and i-f amplifier. Another problem (in tv tuners) is the necessity of maintaining the balance over all channels. This can be accomplished without too much difficulty in turret-type tuners, but for incremental, or switch-type tuners, the balancing presents serious problems.

Furthermore, the capacitive division between $C_x$ and $C$ causes some loss of gain, while, as in the earlier autodyne circuits, this circuit is susceptible to overloading. Nevertheless, as these unfavorable conditions seldom occur in their extreme form, these circuits still present a simple solution for some applications.

**Mixing by Semiconductor Diodes**

The second group of circuits was developed to overcome the disadvantages of the circuits based on a single tube, and uses a semiconductor diode for mixing. Thus the functions of oscillator, mixer and i-f amplifier are separated to some extent, permitting greater freedom of design.

Oscillation can be sustained by either plate-to-grid or cathode-to-grid feedback. As plate-to-grid feedback would cause feedback of
the i-f signal, this method is not used; instead, cathode-to-grid feedback has been chosen. The circuit is given in Fig. 4.

The circuit of Fig. 4 operates in the following way: Tube $V_1$ is connected as a Colpitts oscillator employing oscillator coil $L_1$ in series with $C_r$. Feedback is provided by grid-to-cathode capacitance $C_n$, in parallel with $C_1$, plus the cathode-to-ground capacitance of $C_1$ and $C_a$ in series.

The oscillator signal is fed through $C_2$ to the mixer diode, $D_1$. The opposite end of the diode is connected to the top of r-f coil $L_a$. The i-f signal is developed across $L_a$, which is tuned to the i-f frequency by the capacitances of the grid circuit. These capacitances include $C_a$ which prevents a shorting of the i-f signal by the oscillator coil $L_a$. Feedback, and consequent damping of oscillation, is prevented by connecting the return-point of the i-f coil $L_a$ to the junction of $C_1$ and $C_a$. The values of $C_1$ and $C_a$ are chosen to give a cancellation of feedback effects. Resistor $R$, is the detector resistor for the mixer diode, and is selected to give the best compromise for matching to the r-f coil $L_a$, on one hand, and to the i-f grid impedance on the other.

To cancel i-f feedback effects through $C_r$, between plate coil $L_1$ and the grid coil $L_a$, a neutralizing capacitor $C_t$ is introduced, which feeds a signal component from the plate to the lower end of $L_1$. The operation of the two feedback canceling bridges can be seen from Fig. 5. This diagram shows that no direct feedback from the tube to $L_a$ will occur if $(C_1 + C_{na})/C_a = C_t/C_a$. Furthermore, no i-f feedback from plate to grid occurs if $C_{ps}/C_a = C_t/C_a$.

Diode $D_1$ is a conventional video diode, type 1N87 or 1N87A. These types have proven to be satisfactory for mixer efficiency and damping, up to 250 mc.

The damping of the circuit is determined mainly by the diode resistor, thus it is approximately constant over the tv range of frequencies. Furthermore, the mixing efficiency of the diode decreases only slightly at the highest frequencies. The i-f coil is matched to the grid of $V_1$, which presents a higher impedance at i-f frequencies than at r-f frequencies.

The i-f gain of the tube depends upon the amplitude of oscillation, since for small grid signals the effective $g_m$ of the tube increases and ultimately approaches the $g_m$ of a nonoscillating tube. In general, the amplitude of oscillation will decrease at higher frequencies, thus the i-f gain and the resultant conversion gain will be proportionately raised. This is contrary to conventional mixer circuits, since they usually show a decrease in gain at higher channel frequencies, because of reduced mixer efficiency resulting from too low an oscillator signal.

This increase in conversion gain at the higher channel frequencies is an advantage. At lower frequencies a high gain value is usually less important because of higher input noise level and the generally higher r-f amplifier gain. Usually, it is the mixer gain at higher channel frequencies that sets the level of receiver performance.

Another advantage of the circuit of Fig. 4 is that the diode acts as an isolator between the oscillator and the second r-f coil, reducing the oscillator signal on this coil to some 10 db lower than in conventional mixers. The choice of the damping on i-f coil $L_a$ determines the contribution of this coil to the i-f selectivity; in particular, for tv tuners (with their substantial bandwidth) $L_a$ is relatively heavily damped and so the feedback cancellation by the junction of $C_1$ and $C_a$ is noncritical.

For the frame grid tube 6ER5, with its relatively small plate-to-grid capacitance of 0.36 µf, the neutralizing capacitor will also be small. The tube has close characteristic tolerances, permitting fixed rather than adjustable neutralizing capacitors to be used. Such capacitors could be precut from molded dual-conductor plastic wire, or from miniature coaxial cable.

The output circuit consists of tuned coils $L_1$ and $L_a$. The plate resistance of triode $V_1$ imposes some damping on the circuit of $L_1$; this must be compensated by a reduction in the damping on the coil $L_a$, which feeds the grid of the next stage of the amplifier.

To investigate the practical possibilities of this second type of circuit, a number of different tuners were modified by replacing the existing triode-pentode mixer with the circuit described. Tuners investigated included turret-type tuners as well as the incremental or switch-type tuners. In every case two tuners were compared, one in the original condition (the control) and one with the modified circuit.

It has to be emphasized that in converting the tuners, the characteristics of the new circuits are not demonstrated in the most favorable way. For example: in most tuner design a substantial coupling exists between the oscillator circuit and the second r-f circuit. In the original circuit this coupling is not objectionable, being an addition to the regular coupling between these two circuits. However, in the new circuits, such a coupling reduces the
Table I—Comparison of Performance of Original and Modified Tuners

<table>
<thead>
<tr>
<th>Tuner</th>
<th>Channel</th>
<th>Antenna signal in mv</th>
<th>Total gain</th>
<th>Conversion gain</th>
<th>Total gain improvement</th>
<th>Oscillator signal on r-f coil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>original</td>
<td>modified a</td>
<td>original</td>
<td>modified c</td>
</tr>
<tr>
<td>A</td>
<td>2</td>
<td>7.75</td>
<td>6.25</td>
<td>130</td>
<td>160</td>
<td>3.5</td>
</tr>
<tr>
<td>Incremental tuner</td>
<td>6</td>
<td>12.5</td>
<td>8.0</td>
<td>80</td>
<td>125</td>
<td>3.65</td>
</tr>
<tr>
<td>using triode</td>
<td>7</td>
<td>12.5</td>
<td>9.0</td>
<td>80</td>
<td>110</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>11.0</td>
<td>4.5</td>
<td>72</td>
<td>222</td>
<td>3.25</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>15.0</td>
<td>8.7</td>
<td>66</td>
<td>115</td>
<td>3.75</td>
</tr>
<tr>
<td>turret tuner</td>
<td>6</td>
<td>14.0</td>
<td>8.75</td>
<td>70</td>
<td>115</td>
<td>4.1</td>
</tr>
<tr>
<td>using triode</td>
<td>7</td>
<td>27.0</td>
<td>13.0</td>
<td>36.5</td>
<td>77</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>30.0</td>
<td>14.0</td>
<td>33</td>
<td>72</td>
<td>3.5</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>20</td>
<td>5.0</td>
<td>50.0</td>
<td>200</td>
<td>6.5</td>
</tr>
<tr>
<td>turret tuner</td>
<td>6</td>
<td>20</td>
<td>7.5</td>
<td>50.0</td>
<td>134</td>
<td>6.3</td>
</tr>
<tr>
<td>using triode</td>
<td>7</td>
<td>18</td>
<td>3.8</td>
<td>55.5</td>
<td>220</td>
<td>6.6</td>
</tr>
<tr>
<td>pentode</td>
<td>12</td>
<td>15</td>
<td>3.1</td>
<td>65.0</td>
<td>310</td>
<td>6.5</td>
</tr>
</tbody>
</table>

* R-f input fed directly to grid of r-f stage in Tuner C to avoid gain variations due to neutralization. * Total gain figures for Tuner A show tendency to feedback in r-f stage caused by reduced coil damping. * Conversion gain results for Tuner A shown in brackets are measured direct, those unbracketed are calculated from total gain figures.

isolation between the oscillator and the r-f sections—and this isolation is fundamental to the new circuits.

Another limitation is imposed by the attempt to use existing coils without greatly altering their inductance; consequently, their values will not always be the optimum ones for matching the r-f circuit as well as for best mixer performance.

Notwithstanding the above difficulties, two types of tuner were modified with reasonable success. In each case an increased overall gain was recorded, particularly for the higher channel frequencies. This indicates the possible versatility of the new circuits.

In the modified tuners, the value of the unwanted oscillator signal developed across the second r-f coil, $L_a$, was 0.5 volt or less; this is on the order of 10 db lower than in the original tuners. Thus, a reduction in antenna radiation is to be expected. A more detailed comparison of the characteristics is given in Table 1 where results of tests on representative tuners (tuner A and tuner B) are shown.

Use of Balanced Diodes

A further improvement that may be introduced into the last group of circuits is a pair of diodes connected in a balanced arrangement. This would reduce antenna radiation and, in addition, suppress second harmonics and, hence, spurious response. A circuit using two mixer diodes is given in Fig. 6. It should be remarked that although such an arrangement would be desirable, it would probably be uneconomical for commercial television receivers.

This arrangement could be made responsive to the oscillator second and higher even-harmonics, thereby presenting some advantages when used in uhf-type tuners.

Pentode as Mixer Oscillator

At the present time, work is in progress on the use of a pentode in circuits similar to those shown in Fig. 4 but having an i-f by-pass trap in the cathode. Tentative results using a frame-grid 6EJ7 pentode with a $g_m$ of 15,000 indicate a conversion gain of 10 to 15 over the operating range, with the gain for individual channels as high as 20. This represents an increase in gain of some 2.5 to 3 times the gain of the original mixer using a 6CG8A tube.

Improvements of this sort open the possibility of using a tuner of the type described with a two-stage i-f amplifier employing similar pentodes. Such a combination could be expected to give as much gain as a conventional tuner when followed by a three-stage i-f amplifier using 6BZ7 pentodes. The tentative results from this experiment are given in Table I (tuner C), which compares the performance of modified and unmodified tuners.
Six Ways to Use Magnetic Shift Register Elements

By JOHN PORTER, Portronics, Inc., Tarzana, California

Magnetic shift registers are used not only in digital computers but in a wide variety of pulse-type data handling situations. Their small size, negligible average-power consumption, low cost, ruggedness and reliability offset the disadvantage that output of most types is a narrow, triangular voltage pulse rather than a level.

Typically, a shift-register element consists of a toroid-shaped core with square-loop flux-magnetizing force characteristics, either of ferrite or thin metallic tape, on which are assembled two or more windings, together with one or more diodes, capacitors and a storage or delay inductor or resistor. The core has two stable states, $-B$, and $+B$, in either of which it can remain indefinitely. When switched from one stable state to the other by a polarized pulse to one winding, an output voltage is induced in the other windings. This is called a destructive readout; the amplitude of the output voltage indicates the state of the core before being switched.

The operation of a typical core-diode element such as that shown in circuit I-A, will be explained. A positive-going output pulse first charges the capacitor through the diode; the storage network delays the capacitor discharge until the shift pulse subsides; if the next core is in the $-B$ state, the pulse from the capacitor switches the core to the $+B$ state. Because the switching takes a relatively long time, the voltages induced in the windings of the second element are smaller than the original output pulse.

If the core is already in the $+B$ state when the shift pulse is applied, the output will be even smaller. For the $-B$ state representing a zero, and the $+B$, a one, the one-to-zero output ratio is often used as a figure of merit. Core-diode units have ratios of about 7 to 1, and core-transistor elements have ratios of about 15 to 1 or more. The maximum operating frequency is set by the core and the storage network.

Generally, the elements are packaged into small rectangular blocks, with the components assembled on a base plate and the whole unit potted for hermetic sealing. Pin connections on the base plate are arranged for either etched wiring boards or miniature tube sockets. Volume of some high-frequency units may be as low as 1½ cu. in., while small-quantity costs range from $5.50 to $16.00 per element, depending on circuit and highest operating frequency.

Advances in the design of sophisticated, yet simpler, shift register elements can be expected from increased understanding and application of the devices. The twistor and a special magnetized glass rod, where digital data are shifted along the length of the device, are expected to contribute to the art.

Characteristics of some commercially available shift registers are given in Table I.

A brief description of each of the element types shown on p 81 follows; the typical element itself is shown enclosed in dashed lines.

CIRCUIT I-A—The core-diode configuration has been covered in the discussions above. The diode may be internal or external and may be associated with either the serial-input or serial-output winding.

CIRCUIT I-B—The core-transistor technique has the advantages of lowered shift-current require-

---

Table I—Tabulation of Typical Magnetic Shift Register Elements

<table>
<thead>
<tr>
<th>Type of Element</th>
<th>Shift Current Ma</th>
<th>Shift Width μSec</th>
<th>Power Watts</th>
<th>Signal Noise Ratio</th>
<th>Freq Range ke</th>
<th>Output Voltage</th>
<th>Min Load Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core-Diode, Current Operated</td>
<td>220</td>
<td>1.2</td>
<td>1.4</td>
<td>8:1</td>
<td>0-200</td>
<td>15</td>
<td>10K</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>3.5</td>
<td>0.07</td>
<td>8:1</td>
<td>0-50</td>
<td>8</td>
<td>5K</td>
</tr>
<tr>
<td>Core-transistor, Blocking Osc</td>
<td>100</td>
<td>0.5</td>
<td>0.2</td>
<td>15:1</td>
<td>0-250</td>
<td>$V_{cc}$</td>
<td>2K</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>1.3</td>
<td>0.2</td>
<td>10:1</td>
<td>0-50</td>
<td>$V_{cc}$</td>
<td>2K</td>
</tr>
<tr>
<td>Core-transistor, Pulse Ampl.</td>
<td>75</td>
<td>1.0 Min</td>
<td>0.15</td>
<td>—</td>
<td>0-250</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>Core-Diode, Voltage Controlled</td>
<td>25</td>
<td>1.5 Min</td>
<td>0.2</td>
<td>10:1</td>
<td>0-200</td>
<td>0.3</td>
<td>47K</td>
</tr>
<tr>
<td>Core-Diode, Wide Width</td>
<td>100</td>
<td>8</td>
<td>1.7</td>
<td>10:1</td>
<td>0-25</td>
<td>6</td>
<td>5K</td>
</tr>
<tr>
<td>Two Core per Bit</td>
<td>100</td>
<td>10</td>
<td>0.45</td>
<td>—</td>
<td>0-33</td>
<td>12-24</td>
<td>30K</td>
</tr>
</tbody>
</table>

(a) Upper limit determined by operating shift rep rate

(b) Output voltage determined by supply voltage
ments and improved ONE/ZERO ratio. The transistor is arranged as a triggered blocking oscillator so that a minimum shift pulse produces one cycle of regeneration, yielding a parallel output pulse equal in amplitude to the supply voltage. If the core is in the zero state when the shift pulse arrives, regeneration does not take place. Since large amplification is possible, this circuit is sometimes used with ferrite cores to augment their normally low voltage output.

CIRCUIT I-C—Occasionally a transistor is used to amplify the delayed output pulse from the temporary storage network, thus improving the ONE/ZERO ratio. The transistor is biased to a threshold slightly beyond the ZERO level so that only one's are transferred.

CIRCUIT II-A—The voltage-controlled element is one of a new family of devices intended to facilitate the design of shift-register drivers and readout devices. Shift pulses from a constant voltage source, such as an emitter-follower, are applied to all elements in parallel. A reverse-biased diode to each element normally keeps the shift-pulse line at a high impedance and the shift pulse must be large enough to overcome this bias. The diode in the element output line is thereby gated so that all energy accumulated on the capacitor is available for shifting data. The core switches during the first microsecond or so of the shift pulse and is effectively disconnected for the rest of the pulse. Thus the minimum width of the shift pulse is that of the switching time of the core; the maximum width is limited by the shifting rate.

CIRCUIT II-B—The wide-width element is another technique developed for transistor drivers. Shift pulses from a constant voltage source are applied to all cores in parallel. During the pulse the voltage on the capacitor, which is charged through diode D, bucks the voltage across the resistor in the coupling circuit. Therefore the parallel output pulse is essentially as wide as the shift pulse, and the only requirement on shift-pulse width is that it be off long enough to allow the capacitor to discharge through D, and hence condition the succeeding core.

CIRCUIT III—The two-core-per-bit elements have a simple interelement coupling network but need a two-phase driver. In essence, core 2 acts as temporary storage for a one being shifted from core 1 by shift pulse A. Shift pulse B restores core 2 and causes it to condition core 3. A pulse on A and then on B is required to shift a zero from core 1 to core 3, and the diode effectively isolates a given core from the preceding core.

BIBLIOGRAPHY


Data Conversion Circuits
For Earth Satellite Telemetry

Transistorized pulse height-to-time converters can be included in satellite payload. Output width is proportional to input height.

By D. N. CARSON, Bell Telephone Laboratories, Murray Hill, N. J.
and S. K. DHAWAN, Dept. of Electrical Engineering, Columbia University, N. Y.

At present, earth satellite experiments measuring radiation require that the amplitude distribution of pulses from radiation detectors be determined by tedious manual reduction of telemetered data. This time consuming work can be eliminated by including a complete pulse height analyzer as part of the satellite payload. Thus, the telemetered data would directly contain the amplitude distribution of detected radiation over a given period of time. Poor signal-to-noise and other problems preclude the use of an analyzer on the ground.

Key portion of the analyzer is a circuit which converts pulse heights to widths or time. The time pulse controls an oscillator, which gives a number of cycles of output directly proportional to the height of the input pulse. Output information may then be stored in some type of memory so that the number of pulses of each amplitude occurring in a given period of time may be determined. Such an analyzer (using vacuum tubes and mechanical registers) was first described by D. H. Wilkinson in 1950.

Linearity of the analyzer depends upon the linearity of height-to-time conversion and the oscillator stability. The oscillator can be easily stabilized. However, linear conversion of height-to-time over a reasonable range of input pulse amplitude is not easily accomplished. Furthermore, when using semiconductor devices, as dictated by satellite requirements, the leakage current is particularly troublesome in the height-to-time portion of the analyzer. Two simple circuits which provide linear conversion are discussed.

The schematic diagram of what will be referred to as the constant current charge circuit (CCC circuit) is shown in Fig. 1. This circuit accepts negative input pulses of up to 40 v in amplitude. Transistor Q is used to charge capacitor C, at constant current. Transistor Q, and associated diodes make up the comparator.

It should be noted that the voltage comparison is made only at the instant C, is recharged, thus reducing leakage current problems. Transistor Q, is merely an emitter follower output, which may be eliminated if a low output impedance is not required. Thus, the circuit performs the required function with just two transistors, Q, and Q,.

Direct connection between stages greatly simplifies the biasing and eliminates components.

CCC Operation

Under quiescent conditions, the approximately 200 µamp of current available from Q, is used to supply the base current of Q,. The collector load resistance of Q, is selected so that the collector is saturated under these conditions. Upon application of a negative input pulse, C, is charged to the peak value of the pulse through diode D,. In order for C, to charge faithfully, the rise time of the input pulses must be longer than the charging time constant of D, and C,. As soon as C, has been discharged (charged negatively) by the input pulse, diode D, is reverse biased, cutting off the base current to Q,. After the input pulse has disappeared, the 200 µamp of current begins to recharge C,. Diode D, isolates C, from the pulse source during the ramp generation.

Since the base current of Q, is reduced to zero by the reverse bias on D, the collector current of Q, cuts off and the collector rises to the full supply voltage of +25 v. When the ramp amplitude reaches...
the point where $D_1$ is once more conducting, the collector of $Q_2$ is again saturated.

A large amplitude (25 v p-p) rectangular pulse appears on the collector of $Q_2$. The width of this pulse is linearly related to the input pulse amplitude.

Zener diode $D_2$ is used to clip the output pulse to about 8 v p-p. In many applications it might be desirable to differentiate the output pulse for triggering purposes; in this case, $D_1$ can probably be eliminated. Diode $D_3$ may also be eliminated since its only function is to make it easier to adjust the nominal -4 v supply to the optimum value for biasing $D_1$.

**Linearity**

The linearity of the circuit is shown in Fig. 2. A straight line has been drawn between the end points to show the departure from exact linearity over the complete range of input pulse amplitudes. Maximum departure from linearity is 3.2 percent. If the input pulse amplitude range is restricted to 1-30 v, the linearity improves to about 1 percent. Obtaining input amplitudes this large with transistors presents problems. Unfortunately, the linearity below 1-v input could not be measured accurately. Improved methods of measuring the linearity, particularly at small input pulse amplitudes, are required.

Temperature stabilization of the CCC circuit was accomplished by using silicon diodes and transistors. In addition, a Sensistor is used in the emitter of $Q_2$. (Fig. 1). With these simple expedients, theupper limit of operation was between 100 C and 120 C, while the lower limit was between -30 C and -40 C.

Effect of temperature on linearity was not investigated because it was felt that as long as the output pulse width was stable for a fixed-amplitude input pulse, the linearity probably was not affected. Attempts at stabilization by control of $R$, were not examined.

**Pulse Stretcher**

Another approach to the problem of providing linear conversion of height-to-time is shown in Fig. 3 and 4. In this circuit, which accepts positive pulses up to 7 v in amplitude, $D_1, D_2$, and $C$, stretch the input pulse for a fixed period of time while preserving the amplitude. Transistors $Q_1$ and $Q_2$ form a monostable multivibrator which is used for delay and triggering. Diode $D_4$ is used as a voltage comparator, the stretched input pulse being compared to the ramp from the bootstrap ramp generator. $Q_2$ Comparison is made only when the magnitude of the ramp reaches the stretched pulse amplitude. Transistor $Q_3$, an operational differentiator, provides a rectangular output pulse, the width of which is directly proportional to input pulse amplitude.

**Stretcher Operation**

The positive input pulse triggers the monostable multivibrator ($Q_3$ and $Q_4$), which gives a positive-going pulse of 20 v at the collector of $Q_3$ and a negative-going pulse of 4 v at the collector of $Q_4$. Time duration of these pulses (68 µsec) is several µsec greater than the widest output pulse required. The extra delay gives better comparator output pulse shape. The input pulse also charges storage capacitor $C$, through $D_3$, to its full voltage, minus the 0.3 volt drop across $D_3$. During the stretching period of 68 µsec, $D_1, D_2$, and $D_3$ are reverse biased.

The 20-v positive pulse from the collector of $Q_3$ is differentiated by $C_1, C_2, R_1$, and $R_2$. A low impedance path is provided for positive pulses by $D_1$, and the negative pulse discharges $C_2$ after the 68-µsec delay.

The ramp generator is gated by the 4-v negative pulse from the collector of $Q_4$. Normally, $Q_3$ and $Q_4$ are conducting; grounding $C$. When the negative pulse is applied to its
base, Q, cuts off. Capacitor C, starts charging at constant current because of the bootstrap action. The ramp is applied to the anode of D, while the stretched pulse is applied to its cathode. When the amplitude of the ramp is 0.3 v greater than the stretched pulse, D, conducts, thus bypassing most of the charging current of C.

The comparator waveform is differentiated in the emitter follower differentiator Q., Because of the emitter follower arrangement, the emitter follows the base. Because of C, the current that flows in the emitter of Q, (hence in the collector of Q,) is the derivative of the base voltage. The negative output pulse appears at the collector of Q, and may be differentiated for triggering purposes.

**Linearity and Stability**

Silicon transistors and diodes are employed in the pulse stretcher circuit. Preliminary measurements indicated that the linearity of height-to-time conversion is of the order of 0.1 percent over a temperature range of \(-40\) C to \(+50\) C.

Nonlinearity introduced at elevated temperatures is caused by the ramp generator and diodes D, D, and D,. Diodes D, and D, do not affect the stretcher voltage waveform up to \(+75\) C, but the comparator works over a more limited range of \(-40\) C to \(+50\) C. It is not necessary to compensate the ramp generator since temperature-dependent changes in the current through R, are balanced by opposite changes in the leakage current. Thus, the charging current of C, is kept constant over the temperature range mentioned.

Amplitude sag in the stretcher itself (because of a finite leakage time constant) does not seriously affect the operation of this circuit. Voltage across C, is a linear function of time during the stretching period, and, therefore, does not affect the linearity of the height-to-time conversion.³

**Applications**

Both circuits are designed to provide linear conversion of pulse height to time within the limitations of their specifications. Specifications are shown in Tables I and II. These circuits were designed to accept input pulses with rise times of 1 to 2 \(\mu\)sec. For other rise times the charging time constant for the storage capacitors (C, in Fig. 1 and 4) have to be changed.

Possible applications include pulse width modulation systems, as well as pulse height analyzers as considered here.

Since the height-to-time converter is normally synchronized so that the oscillator controls the start of the digital output, the leading edge of the time pulse is not important in this application.

In the CCC circuit (Fig. 1) the collector-to-emitter voltage rating of the 2N496 is exceeded when large amplitude pulses are applied. The short duty cycle apparently protects this transistor from damage, but use of another type transistor is desirable for critical applications.

In general, the circuit shown in Fig. 1 would be most useful where the higher amplitudes required would not present a problem. It offers simplicity, good linearity, and good temperature stabilization. The pulse stretcher circuit of Fig. 4 would prove useful where lower amplitude pulses must be converted to time information. This circuit offers somewhat increased complexity, but provides very good linearity and reasonable temperature stability.

In both circuits, particularly the CCC circuit, improved methods of linearity and jitter measurements are desirable.

This work, performed in the Cosmic Ray Laboratory of the State University of Iowa, Department of Physics, was supported in part by the Office of Naval Research. The authors gratefully acknowledge this aid and that of the staff members of the Physics and Electrical Engineering Departments.

**Table II—Specifications For Pulse Stretcher Circuit**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output pulse amplitude:</td>
<td>about 25 v.</td>
</tr>
<tr>
<td>Output pulse rise time:</td>
<td>2 (\mu)sec.</td>
</tr>
<tr>
<td>Output pulse fall time:</td>
<td>1 (\mu)sec.</td>
</tr>
<tr>
<td>Output pulse width:</td>
<td>64 (\mu)sec with 7 v input pulse.</td>
</tr>
<tr>
<td>Linearity:</td>
<td>0.1 percent for input pulse amplitudes up to 7 v.</td>
</tr>
<tr>
<td>Temperature stability:</td>
<td>stabilized from (-40) C to (+50) C.</td>
</tr>
<tr>
<td>Voltage supply:</td>
<td>(\pm30) v.</td>
</tr>
</tbody>
</table>

**References**

2. R. N. Copson, Transientized Pulse Height-to-Time Conversion Circuits for Use in Multichannel Pulse Height Analyzers Employing Digital Techniques, State University of Iowa, Physics Dept., No. 50-19, Iowa City, Iowa, August 1950.
3. S. N. Dhawan, A Transientized Analog to Digital Converter Circuit for Use in Multichannel Pulse Height Analyzers Employing Digital Techniques, State University of Iowa, Physics Dept., No. 50-20, Iowa City, Iowa, August 1950.
Microwave Switching With Computer Diodes

Biasing techniques permit electronic switching of microwaves with small-area junction diodes. Series of spdt switches are formed by mounting germanium diodes in waveguides or transmission lines


Microwave switches that utilize the high-frequency characteristics of small-area junction germanium diodes are described. Since no mechanical drives or contacts are required the switch will operate at high speeds with long life expectancy.

Switches for 1 to 10 kmc have been designed. X-band switches covering 7 to 10 kmc are fabricated in rectangular waveguide; all others in a type of coaxial transmission line (slabline).

Spdt and spst switches have been made. The spdt type is useful for low-level duplexing, time sharing or to switch r-f at high speeds.

Crystal switches offer smaller size, lower weight, faster switching and lower drive power requirements than mechanical or ferrite elements. Many crystal diodes were studied to determine their r-f characteristics and switching ratios. As a result, it is possible to choose them with only a knowledge of their r-f impedance.

Earlier Switches

Past designs include; an X-band switch using a 1N263 microwave germanium diode; an S-band coaxial switch using 1N91 germanium diodes; and a switch in which a microwave crystal detunes a resonant circuit. Some work has also been done by Uhlir on the use of diodes at high frequencies. While all these switches are compact and require low drive power, they are not capable of double-throw operation over greater than octave bandwidths.

Crystals Tested

Silicon and germanium crystals of both microwave and computer types were tested for r-f impedance, insertion loss and switching action. Rectifiers and large area junction diodes were excluded because of their relatively long switching time.

Result indicated that certain computer-type germanium diodes with high front-to-back ratios and low forward resistances would attain high r-f switching action. Since most of the previous work had apparently concentrated on microwave crystals exclusively, this result was not discovered. The 1N419 was selected for X-band and the 1N118 for all lower frequencies.

Because these computer crystals have larger current-handling capability and higher reverse breakdown voltage than microwave diodes, it is possible to switch at higher r-f power levels. Tests conducted on the X-band waveguide switch at power levels up to 4 watts c-w showed no significant degradation of switching or insertion loss characteristics. (See Fig. 1.) A coaxial switch has also been tested at 1 watt c-w with compar-
able results. (See Fig. 2.) It is expected that these crystal switches will operate at even higher powers, but this property has not been investigated and verified experimentally.

**Switch Theory**

From the impedance data of the 1N118 crystal shown in Fig. 3, it can be seen that in the reverse-biased condition the crystal appears as a large capacitive reactance which decreases with increasing frequency. This impedance approximates that of a capacitive gap in the center conductor of a coaxial line. In the forward-biased condition, the crystal impedance can be approximated by a short length of 100-ohm coaxial line inserted in a 50-ohm coaxial line. Generally, the r-f impedance of the crystal in the forward-biased condition is dependent on the ground plane separation of the slabline. To achieve the 100-ohm impedance, it is necessary to construct the slabline with small ground plane spacing—in this case 0.110 in. Diameter of the center conductor is chosen accordingly.

When the crystal is inserted in series with the center conductor of a coaxial line and biased in the forward direction, it exhibits a small insertion loss; when biased in the reverse direction, a large insertion loss is obtained as shown in Fig. 4. The insertion loss in both cases results mainly from reflective losses with very little r-f power being absorbed by the crystal.

Insertion loss in the forward-biased condition increases slightly with frequency and insertion loss in the reverse-biased condition decreases with frequency. (See Fig. 4.) Insertion loss and switching of a given crystal can be calculated from the r-f impedance of the crystal; also, the frequency dependence of insertion loss and switching loss can be predicted. Switching loss is difference between reverse-biased and forward-biased insertion loss.

Operation and equivalent circuit of a crystal mounted across a waveguide through the broad face has been treated in other articles. Basically, the crystal is considered as a series R-L-C circuit as in Fig. 5.

When the crystal is biased in the forward direction, barrier resistance R is small and effectively shunts the capacitance. The crystal then appears as a high impedance because of the series R-L circuit shunting the waveguide. This condition results in a small mismatch and a small insertion loss.

When biased in the reverse direction, R is very large, but it is shunted by the capacitive reactance. The equivalent circuit of the crystal then becomes a series R-L-C circuit with a small value of R. At resonance, the crystal is a very low r-f impedance shunting the waveguide similar to a short circuit. A large mismatch and insertion loss result as shown in Fig. 6.

Resistance makes the crystal a low-Q circuit. The switch operates favorably over about 500 mc centered at a resonant frequency determined by the crystal parameters.

**FIG. 1—Switching as function of power for untuned waveguide switch using single 1N419 crystal. Insertion loss remains constant.**

**FIG. 2—Switching as function of power for coaxial Tee switch using two 1N118 crystals per arm.**

**FIG. 3—Impedance of single 1N118 crystal mounted in 50-ohm slabline. Impedance is referred to center of crystal.**

**FIG. 4—Switching and insertion losses as a function of frequency in a series switch.**

Single 1N118 crystal is in series with center conductor of slabline.
To switch at other frequencies, it is necessary to use a different crystal or tune the existing crystal.

A short-circuited coaxial line in series with the crystal adds reactance. Varying this reactance changes resonant frequency as in Fig. 7. To decrease frequency, inductive reactance is added; to increase frequency, capacitive reactance is added. Both slightly increase pass-power insertion loss. Switching and insertion loss can also be predicted from crystal impedance. (See Fig. 8.)

**SPDT Slabline Switch**

A single crystal placed in the center conductor of a coaxial line will switch r-f power; however, in doing so a large vswr is encountered in the stop-power condition. By placing one crystal in each arm of a slabline Tee it is possible to switch r-f power alternately between two loads.

In addition, if the crystals are placed at the junction of the Tee, or an integral number of half wavelengths away, the input vswr will be that of a single crystal biased in the forward direction. This impedance is seen in either condition of the switch. Slabline is used for simplicity of constructing d-c returns and ease of fabrication.

**SPDT Wideband Switch**

The two crystals are connected in series with a voltage applied at the connection. The outside ends are grounded by d-c returns.

When a positive voltage is applied to the crystals, one crystal is biased in the forward direction and the other in the reverse direction. The crystal biased in the reverse direction approximates a short length of 100-ohm line.

R-f power is transmitted through the forward-biased crystal with a small insertion loss while very little power will be transmitted through the other crystal. If the applied voltage is reversed, biasing of each crystal is reversed and r-f power is switched to the other output.

With the crystals mounted at the junction of the Tee, reliable operation is obtained over octave bandwidths with approximately the same changes in insertion loss and switching as with a single crystal.

At higher frequencies, where gap reactance has decreased considerably, it is necessary to replace each single crystal by two crystals in series to preserve the high switching characteristics. (See Fig. 9.)

**SPDT Waveguide Switch**

As frequency increases, crystal length becomes an appreciable portion of a wavelength. When forward biased, insertion loss increases because of length of the high-impedance line; when reverse biased, gap reactance and switching decrease. A switch in waveguide has similar characteristics to a slabline switch except that it has smaller bandwidth (about 5 percent).

A waveguide Tee switch can use an H or E-plane Tee. Crystals are mounted in the broad face of the guide in the plane of the continuation of the walls at the junction or an integral number of half wavelengths away.

Operation is similar to the slabline switch although two separate bias supplies are required. The crystal biased in the reverse direction approximates a short circuit across one arm of the Tee and a high insertion loss results, while the other crystal transmits r-f with small insertion loss. Bandwidth is limited because of the crystal tuning requirement and the necessity of placing crystals at a half wavelength from the junction.

**Other Switch Devices**

Other switches were made by inserting a diode in series with the center conductor of a coaxial line. L, Tee and π configurations were made with crystals in series with each arm, as in Fig. 10.

These switches are basically single-pole single-throw types that are capable of larger switching values than a single crystal. The crystals in the shunt arms are biased in the reverse direction and the series crystals are biased in the forward direction.

Another switch was designed using a zero-db coupler and placing crystals in series with the center conductors of two arms. It resulted in narrow-band switching.

Crystal switches also operate as pulse modulators with rise time of 0.05 μsec or less, electronically variable attenuators, power dividers, duplexers—wherever high-speed variation of low-level r-f is required. It should be possible to extend power-handling ability and frequency range.

**REFERENCES**


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Low-Pass Filter for

Low-pass filter uses three transistors and solid tantalum capacitors for a flat frequency response from d-c to the 1 cps cutoff frequency, attenuation slope of 15 db per octave, near zero insertion loss and good temperature stability

By R. C. ONSTAD, Senior Electronics Engineer, Convair-Astronautics, San Diego, Calif.

Due to the limited number of higher response channels available on a missileborne telemeter it is often necessary to commutate signals that have frequency components greater than one-half the sampling rate. According to sampling theory, in order that the multiplexer shall not superimpose interfering sidebands on the signal, it is necessary to insert a low-pass filter between the signal source and the multiplexer.¹

Assume the signal requiring the filter is sampled at a 5-cps rate and has useful frequency components up to 1 cps and undesirable responses at 4.5 cps and higher. Because of the frequency characteristics of the signal, primary design objectives for the filter are for a 1 cps corner frequency and sufficient steepness of attenuation slope in the stop band so that the attenuation is 26 db or greater at 4.5 cps. Other criteria are for a flatness in pass band within 1 db, a d-c insertion loss not greater than 1 db and output impedance not greater than 10,000 ohms. The input signal voltage range is zero to 5 volts and signal source impedance is 4,000 ohms.

The required filter characteristics as defined by the above requirements are such that the filter should have a maximally flat frequency characteristic. Space and power supply limitations rate out a filter containing inductances or vacuum tubes. A passive RC filter would be unsatisfactory because of the insertion loss, output impedance and frequency characteristic requirement. The development of an active RC filter incorporating a highly stable simple transistor feedback amplifier and RC networks was the solution to the problem.

Amplifier Design

An active filter based on Fig. 3 (within the panel) has been developed for vacuum tubes using a gain stage and a cathode follower² A similar approach using a transistor in an emitter-follower configuration might be used. A d-c coupled emitter follower produces zero offset and introduces considerable drift with temperature. The amplifier incorporated in the filter has the desired characteristics of stable gain, zero d-c offset, low-temperature drift, high input impedance and low output impedance. The basic circuit diagram of this amplifier is shown in Fig. 4. In this circuit, drift is minimized by using a balanced input to transistors Q₁ and Q₂. The signal is direct coupled from Q₁ to Q₂ through the direct-connected emitters. The amplified signal on the collector of Q₁ is coupled to the output through emitter follower Q₃. Unity closed-loop gain and feedback ratio results from connecting the output directly to the base of Q₂. The input impedance of the amplifier is the input impedance of the common-collector input transistor and approaches as a limit the collector resistance of Q₁. The output impedance of this amplifier is essentially the output impedance of an emitter follower that has as its input a zero impedance generator. Due to the tight negative feedback loop the base of Q₁ sees essentially a zero impedance and the amplifier output impedance is less than 100 ohms.

There are three principle sources of zero drift due to temperature. Zero drift can result from variations in the d-c supply voltages. Maximum drift occurs when the plus and minus supply voltage are both changing in the positive direction or vice versa. Under this condition a change of 1 percent in each power supply causes a zero drift of 14 millivolts at the output.

Another source of zero drift is due to a shift in the emitter voltage — collector current transfer characteristics of transistors Q₁ and Q₂. This shift in parameters of Q₁ results in a zero drift that is cancelled by a corresponding shift in the parameters of Q₂ due to the rejection of common-mode signals that is characteristic of the differential circuit incorporated in this amplifier. The drift due to this source can be minimized if required, by using transistors that are matched with respect to temperature characteristics and are connected by a good thermal conductive path.

A third source of temperature drift is the variation with temperature of the input current of Q₁. This produces a zero drift at the input to the amplifier that is directly proportional to the source resistance of the input signal. If signal source resistance is of a value such that zero drift introduces significant error, compensation must be employed. If base current of Q₁ (Fig. 4) is plotted as a function of temperature it is found that a fairly linear plot is obtained over the temperature range of 0 to 100 C. The magnitude of current at a given temperature will vary for different transistors but the slope of the plot

¹ The development of a passive RC filter was limited by the problems of inserting a filter with insertion loss too high and output impedance too low. This problem was solved by using a low-pass filter with a gain of 1 entering the multiplexer.
² The use of a cathode follower has no advantage over the use of an emitter follower in this application.

References

Subaudio Frequencies

ACTIVE NETWORK THEORY

The filter network used is essentially a cascaded RC filter with feedback. Consider a two-section RC filter to give an attenuation slope of 12 db per octave. The two-section RC filter in cascade shown in Fig. 1 has a transfer function which equals

\[
\frac{S}{(R_1C_1 + R_2C_2)S^2 + (R_1C_1 + R_2C_2 + R_1C_2)S + 1}
\]

This transfer function is modified by the insertion of a two-section RC filter as shown in Fig. 3 so that

\[
\frac{K}{1 + (\beta + 1)K} \cdot \frac{1}{F(S)} - \beta K
\]

where \( K \) is the transfer function of the two-section RC filter. Substituting equation (1) for \( F(S) \),

\[
G(S) = \frac{1}{\beta + 1} \cdot \frac{1}{K} = \frac{1}{F(S)} - \beta K
\]

The new values of \( \omega_0 \) and \( \xi \) are

\[
\sqrt{\frac{R_1C_1 + R_2C_2}{R_1C_1R_2C_2}} \quad \text{and} \quad \frac{1 + \beta K}{R_1C_1 + R_2C_2 + R_1C_2} \cdot \frac{1}{\sqrt{1 + \beta K}}
\]

Assuming \( R_1C_1 = R_2C_2 = RC \),

\[
\xi = \frac{2RC + R_1C_2}{2RC \sqrt{1 + \beta K}} = \frac{1 + \beta K}{\sqrt{1 + \beta K}}
\]

There is now means of adjusting \( \xi \) to any value from 1 + \( |R_1C_2/2RC| \) corresponding to \( \beta = 0 \), see equation (5), to

\[
\frac{1 + \beta K}{\sqrt{1 + \beta K}}
\]

to obtain any set of curves within the limits of \( \beta \) and \( K \).

for various transistors will agree quite closely. Compensation in the form of a resistance and thermistor network between the positive voltage source and the base of the transistor to be compensated provides a current of equal but negative slope to reduce the zero drift at the amplifier input from 1.6 millivols/degree C to 0.4 millivolt/degree C over the range of -25 to +80 degrees C.

Active Filter Design

The 12 db per octave filter of Fig. 4 incorporates a two-section RC network and a temperature compensated amplifier. This feedback filter can be designed to have a response that very closely approximates the maximally flat frequency characteristic. The frequency characteristic is determined by the amount of feedback voltage as selected by the ratio of \( R \), to \( R \), and by the ratio of \( R_1C_1 \), to \( R_2C_2 \). A close approximation of corner frequency is \( R_1C_1 = |R_2C_2| 1/2 \). The values of \( R \), and \( R_1 \), should be made as small as possible to limit temperature.
drift. The temperature compensation network is made up of resistors \( R_1, R_2, \) and \( R_3 \), along with the thermistor \( R_t \). This network can be designed after the values of \( R_t, R_4, \) and \( R_{pr} \) are known. The filter is designed to accommodate an input signal that varies from 0 to +5 v. Limiting occurs with negative signals that are greater than -1.5 v. Potentiometer \( R_6 \) is an adjustment for d-c zero set. This adjustment is set for zero d-c at the output with the input grounded.

The ultimate filter design which meets the particular requirements for a filter to precede a 5-rps commutator consists of an active filter cascaded with a passive RC network. Although the passive network may be placed either ahead of or after the active filter, it follows the active filter because input conditions are unchanged and output impedance remains sufficiently low. This design maintains the simplicity of the one active stage, requiring only the addition of a resistor and a capacitor, yet provides sufficient attenuation slope.

The active section of this filter shown in Fig. 5 is designed to have a frequency characteristic such that when its response is combined with the response of a passive section, \( R_3 \), and \( C_3 \), the resultant frequency characteristic closely resembles that desired. In order to achieve this type of frequency response in the active section of the filter, the factor \( \beta K \) must be greater than for an active filter without a passive section. The ratio of resistors \( R_3 \) and \( R_4 \), of Fig. 5 determines the gain \( K \) of the amplifier.

The ratio of \( R_3 \) to \( R_4 \) determines the magnitude of \( \beta \). The product \( \beta K \) greatly controls the shape of the frequency curve. Proper choice of the two resistance ratios can provide an optimum overall frequency characteristic and zero overall d-c insertion loss. Figure 6 shows the nominal overall frequency characteristic of the cascaded active and passive filter. This final design of the filter has a corner frequency of not less than one cps (3 db point); insertion loss, adjustable to zero if desired, less than one db with no adjustment; flat passband, within ±1 db from d-c to 0.7 cps; attenuation slope of 15 db per octave; input signal voltage range of 1.5 to +7.5 v peak; zero drift of less than 0.4 millivolt per degree C; d-c input impedance of 0.5 megohm; and an output impedance of 2.5 kilohms.

The filter is packaged in a modular plug-in subassembly. Silicon transistors are used because of their superior temperature characteristics. Supply voltages are regulated to minimize zero drift.

In order to maintain the same degree of flatness in the pass band, a closer tolerance on capacitance is required for a cascaded active and passive filter than for a filter consisting of only active stages since a fall off in the pass band of the passive filter stage must be compensated by a corresponding peaking in the active stage to produce a maximally flat response. For this condition a given change in the capacitance of \( C \) in Fig. 4 results in a greater change in the amplitude of the overshoot than when the frequency characteristic of the active stage is flat in the pass band. Using capacitors with a tolerance of ±20 percent, it was found impractical to combine the active filter stage with a passive stage of more than one section, and still maintain a flatness of ±1 db as necessitated by design requirements unless an additional adjustable resistance network were inserted in the feedback loop of the filter to vary \( \beta \). The frequency characteristics of the filter might be maintained precisely within the limits imposed by the temperature coefficient of the capacitors by trimming the filter networks to keep constant the RC products of each section. In assembling the filter the capacitors can be measured and values of resistance selected to provide the required RC product.

**REFERENCES**

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INSERT ARRANGEMENTS—5 (plus coaxials)

NUMBER OF CONTACTS—9, 15, 25, 37, 50

INSULATION MATERIAL—D- Zytel 101, DH- Glass, C7- Diall (Type MDG Mil. M-14), C13- Melamine (Type MME Mil. M-14), C25- Glass Diall (Type GDI-30 Mil. M-19833), F114- Diall solder pot side, Nylon pin engaging side.

POLARIZATION—keystone cornered shell

COUPLING MEANS—friction-locking accessory

WIRE ACCOMMODATION—#20 AWG, B&S stranded

Sweep Generator Design: How To Keep It Simple

Thoughtful selection of components takes care of both high and low temperature operation of four-transistor circuit. Precision multiple-range sweep generator is used in an airborne radar system.

By H. P. BROCKMAN*, Air Arm Division, Westinghouse Electric Corp., Baltimore, Md.

This simple multiple-range sweep generator, designed for use in an airborne radar system, contains only four active elements and provides a constant amplitude output sawtooth for all ranges, plus a fast rising gate-pulse (or pedestal) equal to the duration of the sawtooth.

How It Works

The circuit diagram, Fig. 1, consists of a conventional flip-flop, Q, and Q; a transistor switch, Q; an R-C timing network; an emitter follower, Q; and a diode feedback circuit composed of R, R, and D. Initially, Q, is cut off and Q, is in saturation, so that switch Q, is held in saturation by base current supplied through R. A positive trigger on the base of Q, drives Q, to saturation and opens switch Q, at this time, the potential on the collector of Q, rises exponentially from zero toward +300 volts at a rate determined by the time constant R, C, assuming switch S, is in the position shown.

The sawtooth is coupled through emitter follower Q, and a portion is fed back to the base of Q, through D, so that at some predetermined bias-level the flip-flop is reset with Q, in saturation and Q, cut-off. Switch Q, is driven quickly into saturation by a positive pulse through C, to the base of Q, thereby providing fast recovery for timing capacitor C.

Range switch S, provides a range sweep of 15, 50, and 200 miles by selecting a single timing capacitor for each range. The output sawtooth is obtained from the emitter of Q,; a positive gate-pulse is obtained from the collector of Q,. Precision timing of the sawtooth is obtained without adjustments by using precision parts in the R-C timing network and by making the input impedance to emitter follower Q, high compared to the value of R. so that the timing of the waveform is independent of the active elements of the circuit. The linearity of the sawtooth is held within one percent without the use of a bootstrap circuit by using a +300-v supply for the charging potential and by restricting the amplitude of the sawtooth to about 15 v.

Constant Amplitude

The amplitude of the sawtooth is determined by the bias level at the junction of R, and R, and by the energy required to trigger Q,. Constant amplitude regardless of range selection is maintained by choosing the proper value of C. The trigger amplitude required for a slow rising sawtooth is less than for a fast rising sawtooth because the time duration, and thus the energy, of the former is greater. The value of C, is such that the feedback is increased for a fast rising sawtooth but it has very little affect on the feedback of a slow rising sawtooth. The circuit is designed to operate over a temperature range of −55 to +85 degrees C. This required care in component selection.

* Now a member of the Electronic Development and Design Group, Missile and Surface Radar Division, Defense Electronic Products, Radio Corporation of America, Moorestown, N. J.

FIG. 1—Simple circuit provides constant amplitude for three ranges. Linearity is kept within one percent without use of a bootstrap circuit.
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800-Lb Film to Record Cosmic Rays

Cosmic ray research program will be executed by the University of Chicago and the U. S. Navy. The program has entered the final months of preparation. The expedition to the West Indies area is called Skyhook 60 and is sponsored by the National Science Foundation and the Office of Naval Research. (See ELECTRONICS, p 11, Jan. 1, 1960.)

Objective of the experiment is to keep a large amount of film at the edge of the atmosphere in Skyhook balloons for as long as possible. The film will record cosmic rays at very high energy levels.

D. M. Haskin, Chicago University research aide to M. Schein, director of the project, will pick up 2,800 pounds of special film in England. The $100,000 worth of film will be flown back to Chicago to be put in capsules.

**Balloon Capsules**

The Atlantic fleet will aid in recovery of the 2,500-pound capsules to be released by the balloons. The balloons are expected to reach an altitude of 100,000 to 120,000 ft (18 to 22 miles) and to remain aloft for about 48 hours.

The balloons will be launched from the flight deck of the USS Valley Forge. Each balloon capsule will contain an 800-pound block of emulsion sheets somewhat like photographic film.

**Emulsion Blocks**

The emulsion blocks are designed to record primary cosmic rays or nuclear particles that reach energies as high as 10^15 electron volts as they fall toward earth. Chicago University officials say that research at these high energy levels has heretofore been almost nonexistent.

The complete scientific program is named Project ICEF (International Cooperative Emulsion Flight) with 25 universities and research institutes taking part. All scientific work is under Schein's direction. He has been working in the area of cosmic ray research for several years using high altitude balloons. Funds totaling $625,000, were provided by the National Science Foundation to support the effort.

Haskin explained that at very high energy, cosmic rays penetrate the photographic emulsions at high altitudes, colliding with nuclei of the emulsion to cause showers of other fast particles. The collisions produce a series of nuclear interactions recorded in the photographic blocks. From the returned plates, the physicists hope to learn details of physical laws ranging from the nature and behavior of the smallest elementary particles to creation of cosmic radiation on a galactic scale.

**Possible Results**

Present theories explain interactions of nuclear particles at low energy levels. However, there is no complete explanation of particle activity at very high energies, more than 100 times that of the 25^8 electron volts produced by the Cern accelerator at Geneva. Formation of a more complete relativistic theory of very high energy phenomena may result from the cosmic research project.

The unusually large block of emulsion sent to high altitudes for long periods increases the number of high energy primary particles detected. Nuclear events can be traced in three dimensions by the stacked sheets. Depth of the emulsion block allows detection of many complete events, such as the entire chain of secondary interactions that were started by each primary particle.

High altitude is a prerequisite because primary particles will be captured before they have collided with particles in the atmosphere and become secondary particles of lower energy. Earth satellites could not be used because they would pass through the Van Allen radiation belts, fogging the emulsion.

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Winzen Research, Inc., developed the balloons, and the emulsion blocks were manufactured in England by the Ilford Company. After recovery, the blocks will be shipped to Chicago University for processing for a two-month period. They will then be sorted and dispatched to cosmic ray groups in the U.S. and overseas. Chicago University scientists say these groups will take about two years to analyze the data completely.

Higher Accuracy For Paraboloids

DEVELOPMENT work on plastic parabolic radio mirrors may provide antenna surface accuracies presently not practical. The technique was announced by D. S. Kennedy & Co., Cohasset, Mass.

Spincasting

The parabolic reflectors are produced by a process called spincasting. It is based on a natural law hitherto little recognized and little used except in optics. The method is based on the fact that the surface of a liquid curves into the shape of a paraboloid when the

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4. Vacuum capacitors in the output tuned circuit.

This 100 kw transmitter is used to test and establish ratings on Jennings high voltage vacuum components. The testing program may require rapid frequency changes to 2, 4, 8, 16 and 32 mc. Each band is tuned by motor driven vacuum capacitors. Single dial panel switching between bands is accomplished with vacuum relays.

Fixed inductances were desired in the tank circuit in order to avoid problems of maintenance and reseatability associated with transmitters that use tap switches and sliding contacts. This was made possible by taking advantage of the low minimum capacitances, small size, and low inductance of vacuum variable capacitors. This circuitry would be particularly useful in any r-f transmitter design demanding daily repetitive frequency changes.

Space reduction and efficiency were further improved by using Jennings vacuum relays with their high voltage and current carrying capabilities. The sealed contacts are clean and remain clean because they are free of all oxides and contaminants. In addition vacuum relays never need maintenance.

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containers in which the liquid is held is rotated about an axis at constant speed.

Advantage claimed for spincasting applied to antennas is that surface accuracies more than a thousand times greater are achieved than by most known methods. Except for machining, which is prohibitively expensive on large dishes, present tolerances are seldom better than 1/4 inch.

The liquid used is one of the new synthetic resins. The liquid resin is put into the container at the beginning of the spin. The spinning table on which the container is fastened is rotated, and the liquid moves out to assume the characteristic shape. The liquid synthetic resin hardens into a cast within a few hours.

The pan that contains the plastic liquid is actually a conventional antenna reflector with its normal surface irregularities. The liquid resin coating the paraboloidal reflector surface imparts an almost glass-like smoothness to the surface if desired.

The surface is then metallized so that it acts as a radio frequency reflector.

Benefits

Expected benefits of the new process are greater efficiencies in r-f power transmission and reception at much higher frequencies than are now practical. Advances in satellite tracking, space communications and radio astronomy are expected as a result of the new development in producing accurate antenna surfaces.

The company has developed a 4-ft pilot model and is working on a 10-ft design. Spincast antennas up to 60 ft in diameter are planned for early development. Theoretically there seems to be no size limit for this production method except for the size limitation of a stable spinning table.

Work on spun plastic optical mirrors has been done by P. B. Archibald of the University of California Radiation Laboratory under auspices of the Atomic Energy Commission. Optical paraboloids of this type up to 3 ft in diameter have been produced for the purpose of light gathering.
General Motors pledges

AC QUESTMANSHIP

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GUIDANCE/NAVIGATION/CONTROL/DETECTION/AC SPARK PLUG

The Electronics Division of General Motors

ELECTRONICS • JANUARY 15, 1960
Bending Ceramic and Ionic Crystals

By Sheldon Weinig, President, Materials Research Corporation, Yonkers, New York

Designating a ceramic material as useful for a specific application severely limits its scope. Under the impetus of space and rocket requirements as well as cryogenic and elevated temperature needs, ceramic materials are now used in areas never before considered.

This article discusses four basic ceramic research programs and some very general areas of application. These programs are presently being performed at the laboratories of the Materials Research Corporation in Yonkers, New York, under contract to the Office of Naval Research, Atomic Energy Commission and the Office of Scientific Research, U. S. Air Force, respectively.

Ductile or Brittle

Undoubtedly the most important physical property of a metal is its formability. In contrast, one serious difficulty in utilizing ceramic materials is their inability to be plastically deformed. It was recently found that a single crystal of magnesia (MgO) could be bent immediately after cleaving, that is after a clean surface was exposed. This led to the conjecture that the embrittled state was not the natural state of the material, but that ductility was lost because of surface contamination.

Using this concept it has been possible to bend “clean” crystals of ceramic and ionic materials as illustrated in Fig. 1. This apparent ductility is certainly of interest in the laboratory but lacks the adaptability required for practical application. What is required is a mode of ductilization that doesn’t necessitate cleaving or dissolving the material immediately prior to deformation.

A technique has been developed which will ductilize ionic crystals through the application of a high voltage d-c source across the material during the actual deformation. Crystals of NaCl were bent into a horseshoe shape, reversed, and bent in the opposite direction. Although the technique has not been extended to MgO or other ceramic materials, applications for the ionic are immediately apparent: Crystal detectors requiring special shapes, or perhaps a more important application is for crystal transducers.

Grain Boundary Phenomena

The poor thermal shock resistance of ceramics is due to the inability of the ceramic to equalize its heat content sufficiently rapidly, i.e. low thermal conductivity. If impurity atoms of a metallic nature were preferentially segregated to the grain boundaries then short
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Available in capacitance tolerance values of $\pm 20\%$, $\pm 10\%$, $\pm 5\%$, $\pm 2\%$, $\pm 1\%$ (or $\pm 1$ mmfd, whichever is greater).

The insulation resistance of these capacitors will exceed 3,000 megohms at $125^\circ C$.

Insulation resistance shall be greater than 1000 megohms as measured in accordance with paragraph 2.6.2 of EIA specification RS-186-A, Method 2. Paragraphs 2.4 and 2.6.1 do not apply. The test shall continue for 10 cycles, as described in paragraph 2.5.

Insulation resistance shall be greater than 3000 megohms after being subjected to temperature cycling between $-55^\circ C$ and $+125^\circ C$, as outlined in Method 102-A, Test Condition D, and followed by Method 104-A, Test Condition A, of MIL-STD 202A.

Write for Bulletin TSC-118C

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<tr>
<th>TYPE</th>
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Circuit thermal diffusion paths could be developed which will result in a marked increase in thermal shock resistance.

One method of measuring the ability of an atom to segregate at the boundary is to measure the shear resistance of the grain boundary. This study is performed with bi-crystals of MgO. The program also investigates the mechanism of elevated temperature deformation of the ceramic material.

Bi-crystals of NaCl and MgO have been sheared under varying conditions of time, temperature and applied load. Typical specimens are shown in Fig. 2. The originally straight fiducial markings have been displaced across the boundary. Present experiments are designed to selectively segregate metallic impurities at the boundaries.

Ceramic-Metal Fibers

One of the most interesting areas of materials technology has been the attempt to combine different types of substances and thereby utilize the excellent properties of each: in particular, making composite metal-glass fiber and metal-ceramic fiber compacts. This concept is similar to reinforced concrete where the metal rods are replaced with glass or ceramic fibers and the metal substituted for the concrete.

In this way the inherent strength of the fibers due to both material and geometry is obtained while still retaining the excellent properties of the metal. The high surface-to-volume ratio of the fiber reduces the thermal shock propensity of the ceramic material.

Materials

Compacting is especially advantageous in that it is in no way restricted to any specific fiber or metal combination. Successful compacts have been made between materials that are not normally compatible by utilizing intermediary coating agents for the fibers.

Typical results are shown in Fig. 3. More dramatic results have been obtained with high melting point metals and ceramic fibers but can not be shown at this time.

As a corollary to the above work, a proprietary technique was de-
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Fast Switching Diodes For Half Amp Pulses

VOLUME PRODUCTION of 0.3 µsec, ± 1 ampere devices that have a peak power dissipation of 800 milliwatts now make these very fast high-current silicon switching diodes readily available for computers.

The new diodes are said to approach a universal, all-purpose diode, excellent for general high-conduction applications as well as for the more exacting computer uses. Available in four voltages, these devices are designed for operation up to 175 C and feature high forward conductance (500 ma at one volt maximum drop) and low leakage (50 pamp max at 150 C).

The units feature a maximum recovery time of 0.3 microseconds to return to 10 k ohms when switched from a forward current 2 microsec pulse of 500 ma to a reverse voltage of −50 v, with a loop impedance of 1 k ohm. Faster switching speeds are obtained at lower currents.

These devices have been used in the Univac Lark computer, Remington Rand, which operates at very high speeds and in more than a dozen other high-speed computer prototypes.

The diodes are now in production at Sperry Semiconductor Division of Sperry Rand Corp., South Norwalk, Conn., and will be used for computer switching, pulse clamping, gating, blocking and diode logic circuits.

Spray-On Insulator

A NEW COMPOUND, sprayed like paint, dissipates heat and controls temperature by a process similar to the vaporizing of dry ice directly from solid to gas without passing through a liquid stage.

Called Thermo-lag, and developed by Emerson Electric Manufacturing Co., St. Louis, Mo., the material has been sprayed on the outside of space capsules. Protection afforded is well within ranges for performance of internal electronic devices.

Spray-On Insulator
Encapsulate First—Machine Later

Normal assembly procedures are reversed in the production of miniature slip rings by Electro Tec Corp., S. Hackensack, N. J. Encapsulation is one of the first steps, machining and metal deposition follow.

Among production advantages cited by the firm are: fixtureing is simplified, lead-to-ring connections are strain free, better dimensional control promotes miniaturization, and the number of rings can be increased without a corresponding increase in production costs.

Ring styles vary widely. Cross sections of a typical miniature type is shown in Fig. 1. This type has a body molded over the bundled leads. The body is machined and the rings formed in the machined grooves.

Leads are first bundled around a notched and varnished center wire. The ends of the center wire are clipped off at the notches (scores) as a finishing operation. Lead wires are prepared by winding wire on a cam whose circumference equals the length desired. The coil is slit into individual leads.

** Bundling Leads **

The wires are aligned in parallel holes running lengthwise in a cylindrical jig. The holes correspond to wire positions in the body. The jig is slid up the wires while being rotated, forming a twisted bundle. Outer ends of the bundle are later soldered to maintain position. Ends which will be inside the body are laid parallel on the center wire by withdrawing the jig in a straight motion. As the inner ends are exposed, they are wrapped with soft nickel-plated copper wire turns spaced about 1/4 inch.

The wrapped ends are dipped in an encapsulating primer of epoxy or polyester resin, depending on the body material. After the primer is dried, securing the bundle, the wrapping wire is removed. Collars are placed on the bundles and the...
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bundes are encapsulated in 20-cavity molds. This forms a slug of plastic around the bundle.

After curing, the slug is removed from the mold and machined into the body. Four series of cuts are made on jewelers’ lathes. The flange, front shaft, backshaft and pin grooves are machined in that order. The bottoms of the grooves are left thick enough to maintain adequate insulation between the rings and the leads.

**Keys Formed**

The grooves are prepared to receive the rings. The front shaft is laid in a fixture under a microscope. The operator uses a dental burr to rout out a key hole in the bottom of each groove and in the insulation of the lead corresponding to each groove. A portion of the lead wire metal is also routed out so that the ring will be keyed to both the body and the lead. The routed apots, or picks, form a spiral from groove to groove up the length of the shaft.

**Groove bottoms are painted with conductive paint**

**Cup catches gold dust during finish machining**

Bottoms of the grooves are coated with conductive paint, generally a fine silver or gold suspension. The painter applies the tip of a small brush to the groove bottom as the body rotates in a lathe. A pick is then used to reexpose the lead wire metal and to remove any paint on the groove walls.

Rings are deposited as previously reported (ELECTRONICS, p 128, Dec.
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<tr>
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<td>10.5 to 16 KMC</td>
<td>30 DB (min.) 10 DBM (min.)</td>
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<tr>
<td>12 to 18 KMC</td>
<td>20 DB (min.) 10 DBM (min.)</td>
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4, 1959). The deposit is allowed to build up over the top of the grooves. Overdeposition permits the rings to be machined and polished back to final size with a more regular surface.

Finishing Steps

Center wires are removed at the scores and ground flush with shaft ends. Finish machining is done with a diamond tool on a jewelers' lathe. Vacuum pipes at the tool re-capture gold or silver chips and dust. Very light cuts are taken. The ring surface is buffed with rouge to a finish of 2 microinches. Higher finishes can be obtained with diamond tools, but buffing assures sur-

Bodies are handled with plastic bags during insulation test

Radiating leads are placed in clips to test lead-ring continuity

face regularity. After buffing, the assembly is ultrasonically cleaned to removed rouge. Silver rings may be given a finish plating of buffable gold.

Other finishing operations include clipping off the soldered ends of the lead bundle, visual and electrical inspection, and packaging. Inspections are also made after each production step and by roving inspectors. After final buffing or plating, the cleaned assemblies are handled by the wire bundle. Shafts are put in small plastic bags, which are also used as holders. Production is scheduled in batches, since many of the rings are custom-built.
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G. H. LELAND, INC., 123 Webster St., Dayton 2, Ohio. The Lexel BD2E subminiature assembly circuit selector weighs less than 3 oz and measures only 1.5 in. long and 1.375 in. in diameter. It can be used for stepping, counting, programming, circuit selecting and homing. The switch can hold up to four 12-position circuit wafers, with 2-, 3-, 4-, 6- or 12-electrical position selective control. Wire sizes are available to accommodate 3 to 300 v d-c, 1,000 v rms Hi-pot.

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five stock sizes

MUCON CORP., 9 St. Francis St., Newark, N. J. The Narrow-Caps series of ceramic capacitors are especially designed for 1/8 in. modular spacing in printed circuitry; and other tight packages. Because of their size (0.095 width and 0.025 length), they have an average component density of approximately 1,500,000 units to the cu ft or approximately 900 to the cu in. Capacitance values in five stock sizes are 100 μf, 250 μf, 500 μf, 750 μf and 1,000 μf. Tolerance is ±20 percent, and body length of the first four sizes is 0.250 in. maximum, while the length of the 1,000 μf unit is 0.300 in. maximum. Temperature range is -60 C to +125 C.

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Converter
binary to decimal

HERMES ELECTRONICS Co., 75 Cambridge Parkway, Cambridge 42, Mass. Model 260 solid state binary to decimal converter is designed as companion equipment for computers which require decimal display readout for any number of four bit code inputs. Unit activates a cold-cathode decimal display equivalent to a Nixie tube. Filamentary projected readout equivalent to IEE alphanumeric unit is available on special order. Model 260 is available as a single plug-in module complete with illuminated display or as an assembly of a number of modules which are packaged for convenient mounting in a standard RETMA rack.

CIRCLE 304 ON READER SERVICE CARD

CIRCLE 305 ON READER SERVICE CARD

(Continued on p 114)
are you silicon wait-bait?

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- MEDIUM SPEED LINEAR AMPLIFIER

PNP: 2N1219 2N1220 2N1221 2N1222 2N1223

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Ico .1 μA max. .1 μA max. .1 μA max. .1 μA max.
Hre 18 min. 9 min. ——— ———
ToL (inc.) 5 min. 2 min. 5 min. 2 min. 2 typ.
Nbe ——— ——— 18 min. 9 min. 6 min.

For immediate delivery from stock, contact your nearest authorized General Transistor Distributor or General Transistor Distributing Corp. 91-27 Jamaica Blvd, Jamaica 1, New York. For export, General Transistor International Corp. 91-77 Jamaica Blvd, Jamaica 35, New York.

PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP. 610 VENICE BLVD, LOS ANGELES, CALIF.
even in toughest environments,

CEC’s 4-123 transducer

DETECTS

VIBRATION

IMMEDIATELY

A hint of vibration in a jet engine or in engine test cells is detected instantly by CEC’s omnidirectional 4-123 vibration transducer. This rugged pickup assures a frequency response of 45 to 2000 cps ... provides constant damping over an operating temperature range of —65°F. to +500°F.

Hermetically sealed against sand and dust, the 4-123 functions perfectly in oily, corrosive and humid atmospheres. It weighs only 4.25 oz., including connector, and is 2 1/8" high.

Wherever unbalance is present— in engines, machinery, motors or generators—CEC’s line of vibration transducers ensures fast detection, quickly helps solve your vibration problems.

For complete information, call your nearest CEC sales and service office or write today for Bulletin CEC 1596-X13.

Transducer Division

CONSOLIDATED ELECTRODYNAMICS / pasadena, california
readily detectable. Pen speed with standard servo is 2 ips. Speeds up to 20 ips and electronic subassemblies to operate from low level d-c inputs are available on special order. Domestic price is $3,200.

CIRCLE 307 ON READER SERVICE CARD

Unit Indicator for T-PAC modules

COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass., announces model UI-10 unit indicator for use with its line of T-PAC modules. Each UI-10 displays the output of a logical element package (model LE-10) or a static flip-flop (model FS-10), and contains provision for driving an external indicator. Power requirements:—50 v, 1 ma minimum to 2.3 ma maximum. Input requirements: accepts +0.6 v, at 0.1 ma from the LE-10; or —12 v, at 0.2 ma from the FS-10; or 1 mc pulses, 2.5 v minimum amplitude.

CIRCLE 308 ON READER SERVICE CARD

Transducer displacement type

PHOTOCON RESEARCH PRODUCTS, 421 N. Altadena Drive, Pasadena, Calif. Model PT5 proximity transducer was developed to measure small mechanical displacements from 0 to 20,000 cps with the Photocon Dynarage measuring system. It can be calibrated under dynamic

if you think this looks like CEC'S 5-752...

YOU'RE ONLY HALF RIGHT

The picture shown here is of a new, improved version of the famous 5-752 Recorder/Reproducer. We call it Model 5-752A, and it represents the culmination of years of engineering time and practical experience.

Never before such versatility.

Pick a mode...any mode: Analog, FM, PDM, CM, Digital. CEC's new 5-752A can handle any or all of them, with interchangeable Plug-In Amplifiers for five modes of recording or playback.

Monitoring versatility too.

The 5-752A features optional monitoring, either local or remote, of Signal Input/Output. True head-current monitoring also.

New features.

The cabinet is tougher than ever...it's all-steel, all-welded...all-rigid, too, for such rough environments as mobile or marine installations. And a new, metal-framed, transparent cover closes dust-tight on a gasket seal...gives protection where it counts, over the tape and heads.

Specially designed CEC Current Amplifiers slide right into place...boost reproduce amplifier signal output...give galvanometers, chart recorders, and other allied instrumentation the whole story, loud and clear.

For complete information on this most versatile of instrumentation recorders, call the CEC sales and service office nearest you, or write for Bulletin CEC 1576-X41.

DataTape Division

CONSOLIDATED ELECTRODYNAMICS / pasadena, california
...Where only a Precision Wirewound is **Precise** Enough!

**Shallcross**

"P" type RESISTORS

- Exclusive tapered lugs for wrap-around or feed-through connection
- Lug flexing will not destroy hermetic seal
- Windings of pre-tested wire to meet specific operating needs
- Unique contour provides long leakage paths
- Mineral-filled epoxy resin bobbins & encapsulating coating

RADIAL LUG, AXIAL LEAD, and PRINTED CIRCUIT RESISTORS

**PRECISION RESISTOR NETWORKS** using specially stabilized resistors which may be matched to an accuracy of 0.005% with a tracking temperature coefficient of 3 ppm per °C—far superior to linear type resistors in many applications.

As specialists in precision wirewound resistors and resistor assemblies for over 30 years, Shallcross offers unmatched experience in meeting the most exacting matched resistor requirements. Encapsulated “P” Types illustrated are available in over 25 basic types—many to critical MIL-R-93A, MIL-R-93B, and MIL-R-9444 Specifications. Detailed performance comparisons to applicable MIL specs are available for all types.

operating conditions. A micrometer head on the transducer is calibrated directly in 0.0001 in. Output of the Dynagage should be displayed on a direct coupled c-r oscillograph. By rotating the micrometer head on the transducer, any point on the oscilloscope trace can be measured in reference to any other point, by displacing the oscillograph trace until the first point is displaced to correspond with the location of the second point.

**CIRCLE 309 ON READER SERVICE CARD**

**Telephone Relay** highly reliable

**PHILLIPS CONTROL** CORP., 59-T W. Washington, Joliet, Ill. Type 8 is an extremely flexible telephone type relay. During rugged life comparison tests it was still going after 200,000,000 operations made at a pace of 10 pps. Rugged, cup mounted glass Teflon spring and armature bushings are incorporated with new design techniques. Unit provides fast make and break for maximum number of circuits. The long coil construction permits the use of high resistance coils and it is engineered to operate on as little as 2 ma. Relay is ideal for communication and military applications, as well as for a wide variety of data processing and other electronic equipment.

**CIRCLE 310 ON READER SERVICE CARD**

**Computer Diodes**

**low capacitance**

**PACIFIC SEMICONDUCTORS,** INC., 10451 W. Jefferson Blvd., Culver City, Calif. Series 1N925 through 1N928 are extremely low capacitance, very fast recovery silicon computer diodes. Maximum inverse
NEW INDICATING 3AG FUSE POSTS

EXAMINE THESE FEATURES

1. New patented knob design to assure high degree of illumination for instant blown fuse indication.
2. Positive finger grip for knob extraction.
3. Quick service bayonet lock.
4. Constant tension beryllium copper coil & leaf spring for positive contact & lower millivolt drop.
5. Optional—at extra cost—neoprene "O" ring to assure splash-proof feature.
6. New high degree vacuum neon lamp for greater brilliance & visibility.
7. Impact black phenolic material in accordance with MIL-M-14E type CFG.
8. One piece brass hot tin dipped non-turning bottom terminal.
9. Double flats on body to permit mounting versatility.

SPECIFICATIONS:

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<th>PART #</th>
<th>VOLTAGE RANGE</th>
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<tr>
<td>344006</td>
<td>25/8—7 volts</td>
</tr>
<tr>
<td>344012</td>
<td>7—16 volts</td>
</tr>
<tr>
<td>344024</td>
<td>16—32 volts</td>
</tr>
<tr>
<td>344125</td>
<td>90—125 volts</td>
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<tr>
<td>344230</td>
<td>200—250 volts</td>
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</table>

Maximum current rating 20 amps.

PHYSICAL CHARACTERISTICS—Overall length 25/8" with fuse inserted • Front of panel length 11/16" • Back of panel length 13/16" • Panel area front 11/16" dia. • Panel area back 13/16" dia. • Mounting hole size (D hole) 5/8" dia. flat on one side.

TERMINAL—Side—one piece, 0.25 brass electro-tin plated • Bottom—one piece, lead free brass, hot tin dipped.

KNOB—High temperature styrene (amber with incandescent bulbs—2½ thru 32 volts—and clear with high degree vacuum neon bulbs—90 thru 250 volts) • Extractor Method—Bayonet, spring grip in cap.

HARDWARE—Hexagon nut—steel, zinc cronak or zinc iridite finish • Interlock lock washer—steel, cadmium plated • Oil resistant rubber washer.

MILITARY SPECIFICATIONS—MIL-M-14E type CFG. Fungus treatment available upon request per Jan-T-152 & Jan-C-173.

TORQUE—Unit will withstand 15 inch lbs. mounting torque.

...IT GLOWS when the FUSE BLOWS!

LITTELFUSE

DES PLAINES, ILLINOIS

CIRCLE 205 ON READER SERVICE CARD

ELECTRONICS • JANUARY 15, 1960

undersea or in outer space...

Gremar Connectronics™ guarantees reliability

*BECAUSE GREMAR CONNECTRONICS™ concentrates engineering, production and quality control on RF Connectors only... guarantees 100% conformance to your most exacting specs.

BECAUSE GREMAR DELIVERS... by stocking America's most complete line of RF Connectors and Fittings... by maintaining a shelf stock of more than 500,000 assembled units... of over 2,000 types... and 4,000,000 component parts ready for fast assembly!

SPECIFY GREMAR for top-level reliability and performance in RF Connectors. Write for literature on any series of standard RF Connectors... or send us your specs on special requirements.

GENERAL DYNAMICS' Electric Boat Division specifies Gremar hull antenna fittings for our latest atomic powered, POLARIS—armed, missile subs: George Washington and Patrick Henry. Why Gremar?

Helium mass spectrometer leak test performed on critical hermetic seal problems can detect a leak that would pass only 1 oz. of fluid in 500 years! Just one of 142 separate quality checks performed to make Gremar RF Connectors specified for use in all major missile programs.
Waters has a watertight case!

Waters APW, Sealed Potentiometer is so watertight and so heat resistant that it operates reliably even in boiling water! The APW1/2 is completely unaffected by humidity and water vapor, the two common causes of potentiometer failures in aircraft and missiles, where pressure and altitude changes allow equipment "to breathe". Naturally, the watertight construction of the APW1/2 also seals out dust and other minute particles which might cause failure. Meets MIL-E-5272A immersion specifications by means of a double "O" ring shaft seal. The glass-to-metal terminal board is solder-sealed to the case. Available with 125°C or 150°C construction, mechanical rotation stops, special winding angles, values to 100K and tighter linearity tolerances. Can be supplied with optional split bushings and various shaft lengths. (Waters WPW1/2 Sealed Potentiometer features the same construction as the APW1/2, but with a servo face.) Write for Bulletin APW-359.

Low Noise VHF and UHF Amplifiers and Preamplifiers

For application as receiver preamplifiers or wide band i. f. amplifiers . . . in scatter communications systems, laboratory, or nuclear research. Eight standard models cover VHF and UHF to 900 mc. High gain, low noise. Special pass bands available.

Advanced techniques permit modification of standard units at minimum cost.

Write for complete details:

COMMUNITY ENGINEERING CORPORATION
P. O. BOX 824
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JANUARY 15, 1960 - ELECTRONICS
MUCON perfections a new family of

SUBminiature

CERAMIC CAPACITORS

NARROW-CAPS to fit

"NARROW-CAPS" subminiature ceramic capacitors and 1/10 inch modular spacing of printed circuitry form the newest "hand-in-glove" team to speed the still smaller assemblies required today.

5 CAPACITANCE VALUES IN STOCK
100 mmf. = 20% ... 250 mmf. = 20%
500 mmf. = 20% ... 750 mmf. = 20%
1000 mmf. = 20% with ambient temperature range -60°C to 125°C and a voltage rating of 50VDC.

MUCON CORPORATION
NINE SAINT FRANCIS STREET
NEWARK 5, NEW JERSEY

CIRCLE 208 ON READER SERVICE CARD

AVON GEAR GEARS

"Specific" for electronic equipment, control components, small tools, motors, and UNCOMMENDABLE SPECS.

- Exacting tolerances held from commercial grade to ultra precision.
- Generated in wide range of steels, non-ferrous metals, and non-metallic materials.
- Capacity range: 12 to 200 d.p., and maximum O.D. of 7½".

Make AVON Your "Gear Department"

AVON is completely tooled to follow your specifications precisely, and to produce the very best precision or commercial grade Fine Pitch gears for your specific needs. At AVON you can get one gear or a million of ALL types, ALL classes, from ALL materials. AVON has a modern complement of the finest inspection equipment procurable. Truly a setup tuned to the exacting tempo of the "Space Age." Your gear formula is followed with the utmost care. Result: Accurate assembly of your most critical units! AVON's fifty years aggregate gear engineering experience guarantees an end product exactly as specified. We will be glad to work with you on any development project requiring Fine Pitch gearing ... for either commercial or precision applications. You can depend on AVON. Send drawings or descriptions for free estimates.

PRODUCTION • EXPERIMENTAL • CONSULTING

AVON GEAR AND ENGINEERING CO.

2009 RICE STREET • MELORE PARK (Chicago Suburb), ILLINOIS

CIRCLE 221 ON READER SERVICE CARD

Waters has an airtight case!

Waters APH₃½ hermetically sealed precision potentiometer, in addition to maintaining the hermetic seal behind the panel, is itself tightly sealed against outside atmosphere and salt spray by means of a double "O" ring shaft seal. The entire potentiometer passes Liquid Immersion Tests per MIL-E-5272A, par. 4.12.1. and, excluding the shaft, passes the Mass Spectrometer Test with leak rate less than 10⁻⁷ CC/sec. N.T.P. Pre-tinned, it can be easily soldered into the panel. Its terminal lugs are installed with a glass to metal seal, and are positioned for easy wiring. The brass case is plated in conformance with military requirements. Waters APH₃½ HT Potentiometer also has high temperature operating characteristics. It derates to zero watts at 150°C; ½ watts may be safely dissipated at 125°C. Available with mechanical rotation stops, special winding angles, resistance values to 100K ohms and tighter linearity tolerances. Write for Bulletin APH.

Waters MANUFACTURING, INC.
WAYLAND, MASS.

CIRCLE 119 ON READER SERVICE CARD
capacitance is 4.0 µF at zero voltage and typical inverse capacitance, 1.1 µF at -10 V. Maximum recovery time is 20 K at 0.15 µsec switching from 5 ma to -10 V. The diodes are furnished in the new smaller diameter (0.125 max.) PSI package.

CIRCLE 311 ON READER SERVICE CARD

Peak Accelerometer accurate unit

FERRANTI ELECTRIC INC., 95 Madison, Hempstead, L.I., N.Y. This instrument was developed for accurate measurement of true peak "g" in shock and vibration tests. A barium titanate transducer is connected to a specially designed amplifier and indicator unit which retains the peak reading for 15 sec for shock measurements or follows the peak acceleration reading when the instrument is set to make vibration measurements. Four ranges are provided for accelerations up to 1,000 "g" which are indicated on a 8½ in. meter with a mirror scale and a knife-edge pointer.

CIRCLE 312 ON READER SERVICE CARD

Quartz Crystal subminiature

THE KEYSION ELECTRONICS CO., 65 Seventh Ave., Newark 4, N.J. Type KC-43A quartz crystal is available in subminiature HC-18/U military-type holders. It has a frequency range of 4 mc through 150 mc, with a frequency shift of less

THE WORLD'S MOST VERSATILE OSCILLOSCOPES!

with Plug-ins for All Needed Ranges . . .
All Needed Features . . . No Obsolescence.

Here is true multi-channel oscillography with features, performance, and prices "tailored" to your exact needs. Versatile plug-in pre-amplifiers, sweeps, and marker-calibrator circuits need be purchased only as you need them . . . when you need them. No worries of having "too much" scope now . . . not enough scope flexibility a few years later.

From simple one-channel monitoring jobs to difficult medical, biophysical and low-level strain gauge recording involving two, three or four channels, you'll find no jobs too small or few too large for these versatile ETC instruments.

Write for detailed specifications and prices.
than \( \pm 0.0025 \) percent over a temperature range of \(-55\) C to \(+105\) C. In type Sm-43, the quartz crystals are available for high shock, vibration and other extreme environmental conditions. Physical dimensions of the KC-43A are: pin diameter, 0.017; pin spacing, 0.192; body height, 0.530; body width, 0.402; body thickness, 0.150. On the plug-in unit, pin diameter is 0.040.

Transformers
toroidal type
BARNER & WILLIAMSON, INC., Bristol, Pa. Toroidal transformers suitable for transistorized power supplies are encapsulated to meet all requirements of sealed construction and are designed to perform satisfactorily within a temperature range of \(-55\) to \(130\) C. Line includes transformers of 25, 60 and 120 w ratings and a 25 w inverter which generates 26 and 115 v 400 cycles. The transformers operate on 12 to 14 v d-c input. Prices range from \$8.10 to \$15.25.

Silicon Rectifiers
two series
DELCO RADIO Div., General Motors Corp., Kokomo, Ind., offers silicon rectifiers consisting of four models each in two series—rated at 40 and 22 amperes for continuous duty up to ambient temperatures of 150 C. Both series offer a low maximum reverse current of 5.0 ma at maximum rated temperature and peak inverse voltage. The 22 ampere series has four models—1N1191A through 1N1193A—in 50 v steps from 50 v
WHAT
THIS UNUSUAL
AC-DC "PLUG-IN"
TRANSISTORIZED
POWER SUPPLY
DESIGN
GIVES YOU...

One piece finned aluminum extrusion, achieving high heat dissipation. Most units need no external heat sink to 55°C ambient. All units have adjustable output. Platform mounted standardized subassemblies and components enable quick delivery of a wide range of voltages and currents.

Specifications:
- Input: 105 to 125V AC, 45 to 420 cps, single phase
- Regulation: 0.1% (line or load)
- Stability: Better than 0.25% for 8 hours
- Ripple: 0.02% rms
- Response time: less than 100 microseconds
- Low dynamic impedance

Designed primarily as a component power supply, units are widely used in computers, electronic instrumentation, production test equipment, and quality control check out systems. Best of all, the unique design makes these units available at the lowest possible cost to you.

(Units pictured above. Model no. 18 90-1. 85-95 V., 0.100 ma. Price $145.00) Prices on other units range from $100 to $200.

All solid state - zener diode reference, transistor amplifiers and regulator
- Output Voltages: from 2.0 to 300V DC
- Output Power to 30 Watts
- Reliable short circuit protection
- All components readily accessible

CERTIFIED AVIONICS CORPORATION
A SUBSIDIARY OF CONSOLIDATED DIESEL ELECTRIC CORPORATION
800 Shames Drive • Westbury, L. I. • EDgewood 4-8400

piw to 200 v for the 1193A model. The 40 ampere series (1N1183A through 1N1186A) also run from 50 v through 200 v. Maximum forward drop for the 22 series is 1.2 v while only 1.1 v for the 40 series.

CIRCLE 315 ON READER SERVICE CARD

Rectifier Test Set
20-ampere unit

WALLSOn ASSOCIATES, INC., 912 Westfield Ave., Elizabeth, N. J.
Model 141A is a completely self-contained dynamic rectifier test set for incoming inspection, on-line testing and laboratory use. Forward current and reverse voltage controls are independently adjustable. Forward current range is 0-1, 10, 20 amperes d-c average, with a reverse voltage peak of 0,1,000. It measures a forward drop range of 0-0.5 v and a reverse current range of 0, 0.05, 0.5, 5, 50 ma average. Permanent provisions are made for monitoring all four parameters with an external oscilloscope.

CIRCLE 316 ON READER SERVICE CARD

Dual Pots
low torque

ME-MAR ELECTRONICS CORP., 2716 E. Huntington Dr., Duarte, Calif. Precision single turn dual element pots feature: 1/4 in. to 3 in. diameter, 1/4 in. thick, various shaft and
NOW YOU CAN SPECIFY SPERRY FOR 2N327A 2N328A 2N329A 2N330A

SILICON PNP TRANSISTORS IN PRODUCTION QUANTITIES

Newly-added to the world's widest line of general-purpose PNP silicon transistors, these popular types are available immediately for your audio, switching and control applications.

More than an additional production source for these devices, you will find Sperry Semiconductor to be the source, with new standards of quality and reliability.

Like all other Sperry transistors, these units feature new low levels of Ic0 and are baked at 200°C for 200 hours for utmost stability. For immediate delivery on the 2N327A series, contact the nearest Sperry sales office as listed below.

And don't forget these other recently-announced types for which you can now SPECIFY SPERRY:

2N1034 2N1219
2N1035 2N1220
2N1036 2N1221
2N1037 2N1222
2N1275 2N1223
Look beyond the obvious...

...as you consider your future in the electronics industry. First, what is the obvious? It's obvious that you're in demand. You don't have to worry about getting your material wants satisfied.

But, when you look beyond the obvious, you realize that you want something more than simple "want satisfaction" out of your career. You want pride—pride in the importance of your personal, individual contribution.

At Melpar, where we are now working on 120 advanced defense and space exploration projects, we have significant opportunities for the professional engineer or scientist who wants to be proud of his contribution to advancing the state of electronic art.

Senior-level positions are available in the following areas at this time:

- Reconnaissance Systems
- Airborne Equipment
- Ground Data Handling Equipment
- Simulation & Training Systems
- Communication & Navigation Systems
- Ground Support Equipment
- Detection & Identification Systems
- Antenna & Radiation Systems
- Physical Sciences Laboratory
- Production Engineering
- Quality Control
- Field Service Engineering

Interviews arranged in your locale.

For details wire collect or write to:
Professional Employment Supervisor

Melpar, Inc.
A Subsidiary of Westinghouse Air Brake Company
3323 Arlington Boulevard, Falls Church, Virginia
In Historic Fairfax County
10 miles from Washington, D. C.

mount combinations, all metal exterior, external phasing with precision clamp bands, gold anodize finish and screw-in terminals. Resistance is to 200 K ohms, linearity to 0.05 percent, high temperature 150°C, and life exceeds 2 million operations. Pots are gangable to 30 units.

CIRCLE 317 ON READER SERVICE CARD

Subminiature Jack guided-entry

SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y. Type SKT-50 Press-Fit jack takes the inserted probe almost blindly. The guided-entry feature is an improved version of the SKT-5BC test jack with the advantages of elimination of binding, more rigid holding of probe after insertion, and greater electrical insulating properties. The jack accepts a 0.080 in. diameter probe with maximum length of 0.310 in.

CIRCLE 318 ON READER SERVICE CARD

Zener Diode high power

U. S. SEMICONDUCTOR PRODUCTS, 3540 W. Osborn Road, Phoenix, Ariz., has developed a high power Zener diode with standard tolerance of 5 percent in single units. No matched pairs are needed to achieve this tolerance. Space and weight are saved, while power dissipation up to 35 w is easily attained in a single Zener with proper heat sink. Zener voltages range from 8.2 to 100 v at 500 to 50 ma. Zener or dynamic impedance is low, and
breakdown is abrupt over the whole Zener voltage range.

**CIRCLE 319 ON READER SERVICE CARD**

---

**Converter**

true rms to d-c

EPSCO, INC., 275 Massachusetts Ave., Cambridge, Mass. Model MCV-910 true rms to d-c converter is designed exclusively for optimum performance at those frequencies most commonly encountered in precision gyro testing. It generates a d-c output voltage that is directly proportional to the true rms value of an a-c input signal. The dynamic range is 10 mv d-c to 10 v d-c. The all solid-state converter is built to meet the rugged environmental requirements of MIL-E-4168B.

*CIRCLE 320 ON READER SERVICE CARD*

---

**Power Supply**

solid state unit

POWER SOURCES, INC., Burlington, Mass. Model PS4023 power supply has excellent regulation characteristics and low thermal drift. Operating at an input voltage of 105-125 v at 57-63 or 380-420 cps, it puts out 100 to 200 v at up to 400 ma load current. The output voltage is selectable by a six-step range switch, while a vernier pot is provided for exact adjustment of output voltage. There is less than 0.03 percent change in the set output voltage for any combination of input voltage or load current conditions. Thermal drift is held to a

---

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**electronics**

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The Lapp porcelain rod insulator shown at the top of the illustration develops 12,000 lb. strength, and is suitable for the most severe electrical and mechanical duty. It is available with rain shield and/or corona rings. All hardware is silicon aluminum alloy. Smaller insulators, in porcelain or steatite, are suited to lighter duty for strain or spreader use. Lapp engineering and production facilities are always ready for design and manufacture of units to almost any performance specification. Write for Bulletin 301, with complete description and specification data. Lapp Insulator Co., Inc., Radio Specialties Division, 159 Sumner Street, LeRoy, N. Y.

**Transformer chopper input type**

**Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif., announces a chopper input transformer for use with frequencies of 60 to 500 cps and with an impedance ratio of 40,000 ohms CT to 40,000 ohms CT. Model G-24 exceeds MIL-T-27A standards and has**

**Miniature Switch lever-actuated**

**Electro-Switch Corp., 167 King Ave., Weymouth 88, Mass. The MA-12-L provides multcircuit control, panel-mounting, and lever operation in a compact unit suitable for low-power and electronic circuits. The assembly can be furnished with either one or two sections, giving up to 12-pole switching. Switch is designed to meet MIL-S-3786. Electrical ratings: 3 amperes continuous current at 115 v a-c; interrupting rating, 1 ampere at 115 v a-c; voltage breakdown 1,000 v rms.**
a MIL designation of TF3R09YY. The primary and secondary of the unit is 100 percent reversible. Each winding employs the new "Box" shielding method to reduce capacitive coupling to less than 0.05 μf.

CIRCLE 323 ON READER SERVICE CARD

Power Supply automatic switchover

MATTHEW LABORATORIES, 3344 Fort Independence St., New York 63, N.Y. Model HCVS-250-20 constant-current and constant voltage automatic switchover regulated power supply is used primarily for tantalum capacitor production, precision electroplating, and battery charging. The application of constant current and Faraday's Law in this unit results in quantitative coulomb or electric charge transfer for the controlled formation of oxide-films or material deposition or removal. When on constant current operation at a desired current, the supply will automatically switch to constant voltage operation upon reaching a predetermined voltage due to load resistance buildup. Unit is adjustable to a maximum output of 250 v and 20 amperes.

CIRCLE 324 ON READER SERVICE CARD

Coaxial Diode tripolar

MICROWAVE ASSOCIATES, INC., Burlington, Mass. The 1N630 broadband tripolar coaxial diode is rated for use over the temperature range -40 C to +150 C. It is a direct replacement for the 1N358 tripolar diode in microwave video receivers used in video detection applications.

CIRCLE 325 ON READER SERVICE CARD

GO MIDDLE WEST... for a prime opportunity in missiles!

Go Midwest for outstanding career opportunities with Bendix Missiles, prime contractor for the U.S. Navy Talos—first line anti-aircraft weapon aboard missile-age cruisers. Take advantage of the wide range of engineering opportunities Bendix Missiles offers you right in America's heartland!...

The established success of Talos by Bendix Missiles, its prime contractor, not only assures permanence of the present program but has opened the door to other advanced missile projects that offer new and challenging job opportunities in design, development, testing, and manufacturing.

Bendix Missiles, in addition to its direct responsibility for Talos and other advanced missile projects, is a key division of Bendix Aviation Corporation. The corporation-wide activities of Bendix cover practically every phase of advanced technology with particular emphasis on systems design and development. Participation in this highly diversified corporation effort is your further assurance of a more secure future.

Enjoy living in the Midwest and find unmatched job opportunities with Bendix Missiles. Grow professionally as well as financially. Take the first step today. Mail the coupon for your copy of the interesting booklet "Opportunities Abound at Bendix Missiles."

Bendix PRODUCTS DIVISION Missiles

PRIME CONTRACTOR FOR THE TALOS MISSILE

CIRCLE 328 ON READER SERVICE CARD

Bendix Products Division—Missiles
402 F St., Beiber St., Mishawaka, Ind.

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When you have extraneous common mode signals and want to measure 0.1 to 100 millivolts full scale, and then amplify.

Choose the new Honeywell D-C Amplifier

AccuData II
wide-band differential all-transistor D-C Amplifier for strain gages and thermocouples

- Full Scale Input: Unbalanced: ±100 µV to ±100 mv
  Differential: ±3 mv to ±100 mv
  Open Loop: Below drift level
- Full Scale Output: ±2v at 50 ma, dc to 10 kc
- Frequency Response: to 20 kc
- Output Impedance: Less than 0.5 ohm at dc on all ranges
- Input Impedance: Unbalanced 3 to 100 mv ranges; greater than 20 megohms in parallel with 350 micromicrofarads.
  Differential: Greater than ±2 megohms
- Equivalent D-C Input Drift: Less than 2 µV/°F ambient temp. change on 0.1 to 30 mv input ranges
- Equivalent Input Noise: 4 µv peak-to-peak on 100 µV to 300 µV range (10-10 cps). 8µv rms on 10 to 30 mV ranges (0 to 100 kc)
- Common Mode Rejection: 200,000 at 60 cps on 3 to 30 mv ranges

The new Honeywell AccuData II is a completely transistorized D-C Amplifier designed for use in high accuracy data handling systems as a wide-band pre-amplifier for strain gages and thermocouples. Its output can be led to electronic or electromechanical analog-to-digital converters and simultaneously recorded on galvanometer oscillographs or magnetic tape. Either differential or single-ended input modes can be selected by an eleven position range switch. This switch changes the gain in three-to-one steps. Intermediate gains with high resolution are provided by a ten-turn potentiometer. Write for AccuData II Bulletin to Minneapolis-Honeywell, Dept. E-1, Boston Division, 40 Life Street, Boston 35, Mass.

Data Converter
all-transistor

ELECTRONICS ENGINEERING Co. OF CALIFORNIA, 1601 E. Chestnut Ave., Santa Ana, Calif. The ZA-25159 data converter will convert a 27-bit time code, one 20-bit data signal, and two 17-bit data signals into an IBM 704 magnetic tape. Unit will also supply signal outputs to seven central locations also in the IBM 704 coding but without gaps between the blocks. The sampling rate of the input data may be selected at 10, 20, 40, 80, or 100 pps. The data converter was designed for the multiplexing and the recording of range, azimuth, and elevation data from digital radar outputs together with a timing signal.

Crystal Oven
accurate unit

FEDERATED ELECTRONICS, INC., 189-14 Jamaica Ave., Jamaica 35, N. Y. The EM200 quartz crystal oven holds either one or two HC-6/U crystals. It is warranted to main-
tain even temperature to ±1 deg over a 100 C ambient temperature range. Contacts are of platinum iridium.

CIRCLE 327 ON READER SERVICE CARD

D-C Power Supply
variable output

DEL ELECTRONICS CORP., 521 Home-
stead Ave., Mt. Vernon, N. Y. D-C
power supply is rated 40 kv at 1 ma
and 5 ma at 55 kv. Unit employs se-
lenium rectifiers immersed in high
grade insulating oil. Output voltage
can be varied over the full range by
varying the input voltage. Ripple
is 0.5 percent per ma. Dimensions
are 10 in. by 12 in. by 11 in. high.
The unit, filled with insulating oil,
weighs 70 lb.

CIRCLE 328 ON READER SERVICE CARD

Shift Register
four-stage

HARVEY-WELLS ELECTRONICS, INC.,
East Natick Industrial Park,
Natick, Mass. A new low cost, high-
speed, four-stage shift register,
featuring three inputs and eight
outputs, may be cascaded to form a
multistage shift register. It has
the same electrical characteristics

CIRCLE 329 ON READER SERVICE CARD

MICROWAVE
FREQUENCY
MULTIPLIER

-model FM-4A

measures 100 to 30,000mc
 generates 500 to 30,000mc
 with high accuracy and stability

This phase-locked oscillator transfers the accuracy and stability of
a VHF driver into the microwave region, giving continuous coverage.
You can drive the unit with Gertsch frequency meters FM-3, FM-6,
or FM-7. Fundamental frequency range is 500 to 1000 Mcs, with
harmonic output to at least 30,000 Mcs.
Ideal for calibration of cavity wavemeters…for precise measure-
ments, or as an ultra-stable frequency source. Unitized construction.
Adaptable for rack mounting.

Complete data
in Bulletin FM-4A.

CIRCLE 209 ON READER SERVICE CARD

Here are the Cinema Resistors used
in the nation's finest instruments.

CINEMA

Precision wire-wound
MICRO-MINIATURE
RESISTORS
for applications where space is
at a premium.
• axial and printed circuit types
• temperature coefficient of
  resistance ±20 PPM.
• for −65° to +150° C operation
• epoxy encapsulation
• accuracies 1% to .01%.
Write for Bulletin LC1066

CINEMA ENGINEERING
1100 Chestnut • Burbank, Calif.
DIVISION AEROVOX CORPORATION
as other units in the Data Bloc and Data Pac lines. Model 1801 replaces four standard flip flop B units for shift register applications.

CIRCLE 329 ON READER SERVICE CARD

\[ \text{SPECTRUM ANALYZER} \]

MORE USEABLE SENSITIVITY BAND RF SENSITIVITY*

- 10 to 420 MC \[-95 to -105 dbm\]
- 500 to 1500 MC \[-90 to -100 dbm\]
- 910 to 2200 MC \[-90 to -100 dbm\]
- 1960 to 4500 MC \[-80 to -95 dbm\]
- 4.5 to 10.88 MC \[-80 to -95 dbm\]
- 10.88 to 18.0 MC \[-70 to -90 dbm\]
- 18.0 to 26.4 MC \[-60 to -85 dbm\]
- 26.4 to 44.0 MC \[-55 to -85 dbm\]

\*Measured with signal and noise equal \( \pm 2 \) noise

Using one tuning head which contains one triode and two klystron oscillators, Model SPA-4 offers more exclusive advantages for applications demanding extreme sensitivity, stability, versatility, accuracy.

- Three precisely calibrated amplitude scales—40 dB log, 20 db linear, 10 db power.
- Two independent frequency dispersion ranges—continuously adjustable 0.7 to 0.7 db over the entire frequency range.
- Variable I.F. bandwidth from 1 kc to 50 kc.
- Push-button frequency selector.
- Synchronoscope output with 40 dB gain.
- Accurate measurement of small frequency differences. A self-contained marker oscillator, modulated by a calibrated external generator, provides accurate differential marker output as close as 10 kc.

Tremendous flexibility and many unique advantages of Panoramic's compact SPA-4 make it unsurpassed for Visually analyzing FM, AM and pulsed signal systems; instabilities of oscillators; noise spectra; detection of parasitics; studies of harmonic outputs; radar systems and other signal sources.

Write, wire or phone today for detailed SPA-4 bulletin.

CIRCLE 330 ON READER SERVICE CARD

D-C Amplifier

broad-band

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Model 603 is a broad-band d-c amplifier with 10 ohms input impedance, high voltage and current gain, and a remote differential input. Its separate input head may be operated up to 24 ft from the amplifier or plugged directly onto the panel. Other features include 9 ranges from 2.5 to 1,000 mv, with precise gains up to 4,000 and a 10-v output at 10 ma for full scale meter deflections. Bandwidth is d-c to 10 kc on the 25 mv range, rising to 50 kc on the 1,000 mv range. Calibration and gain accuracy are assured by over 40 db of negative feedback.

CIRCLE 330 ON READER SERVICE CARD

Nixie Driver
digital module

COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass. The NX-101 Nixie driver is a BCD to decimal converter that accepts the 8-4-2-1 binary decoder from a BD-101, or equivalent decimal counter, and applies appropriate drive signals to the corresponding cathode of a Nixie tube. Each

CIRCLE 210 ON READER SERVICE CARD

WHY ELECTRONIC CIRCUITS PERFORM BETTER WITH BENDIX SPARK GAPS

Two big jobs are performed by Bendix Red Bank Spark Gaps in electronic circuits. The first is protection against high voltage surges that might damage circuit components, as in the case of radar equipment.

The second is acting as a "triggering switch," as on the ignition systems of jet engines. Here Bendix* Spark Gaps pass high currents with relatively low voltage drop in small space.

Due to inherent design characteristics, Bendix Spark Gaps can be made insensitive to ambient temperature variations and are not normally affected by pressure, altitude, or humidity changes.

Our broad line of Spark Gaps—ranging from 750V to 50KV—should contain a type to fit your needs. If not, we can design one to perform your particular job with the efficiency you require.

Call or write for complete information.


SPECIAL-PURPOSE TUBES DEPARTMENT

ELECTRONICS DIVISION

EATONTOWN, NEW JERSEY

West Coast Sales & Service: 117 E. Providence Ave., Bountiful, Calif.; Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.; Canadian Distributor: Computing Devices of Canada Ltd., P.O. Box 505, Ottawa 4, Ontario.

CIRCLE 210 ON READER SERVICE CARD
of the 10 stages consists of an n-p-n transistor and a resistor decoder. The NX-101 will satisfactorily decode signals from any flip-flop capable of sustaining an additional 3 ma of current in the ON transistor and whose OFF collector potential is at a minimum of + 17 v. Power requirements: + 195 v ± 2 percent at 5.5 ma, + 20 v ± 5 percent at 9.5 ma. Input: + 18 v ± 10 percent, – 5 percent at 3 ma. Output: + 20 v at 2 ma.

CIRCLE 331 ON READER SERVICE CARD

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**Chart-Pak Tapes for Printed Circuits . . . now in NEW TAPE-SAVER DISPENSER**

(at no extra cost)

**ONLY CHART-PAK HAS IT!**

Keeps tape edges clean
No waste . . . use every inch
Easy spindle storing
Protected from damage

Make conductor patterns and terminal pads for printed circuit layouts in minutes! Chart-Pak tapes and symbols are precision slit to .002". High dimensional stability, non-reflective, opaque black surface. Adhesive backing holds firmly, will not melt under heat of reproduction; yet can be easily lifted and re-applied for corrections. Available in tape widths of 1/32" and up, and in die-cut lands, fillets, corners, tear drops, etc. Ideal for use on any surface, especially Chart-Pak precision grids.

Write for full details or consult your Yellow Pages under "Charts-Business"

**CHART-PAK, INC.**

*ORIZINATOR OF THE TAPE METHOD OF DRAFTING*

1510 River Road, Leeds, Mass.

CIRCLE 211 ON READER SERVICE CARD

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**Power Transistor military type**

BENDIX AVIATION CORP., Semiconductor Products, Long Branch, N. J. The 2N1011 germanium p-n-p power transistor is designed to meet MIL-T-19500/67 (Sig. C). It has a 5 amperes maximum current rating, a current gain range of 30-75 at I. = 3 amperes d-c, and a maximum collector-base voltage rating of 80 v. It will readily dissipate 35 w at 25 C mounting base temperature. Ideally suited to power switching and power control circuits, the 2N1011 is particularly useful in such military equipment as aircraft power supplies, missiles, and communications power supplies. Other applications are high current switching and audio amplification.

CIRCLE 332 ON READER SERVICE CARD

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**Milliwattmeter**

**Ku-band**

WAYNE KERR CORP., 1633 Race St., Philadelphia 3, Pa. Type U-381 Ku-band milliwattmeter is an ex-

ELECTRONICS - JANUARY 15, 1960
...now wind 19,000 times!

If you're dedicated to the cause of high resolution, you could wind your own pots and be sure. Allow yourself plenty of time, though — because the secret's in the number of turns per inch, and the spacing between 'em. Pack those turns right in there closely and accurately, and you might have a pot you'll be proud of!

But if you want to eliminate all bother, but not the high resolution, call on Ace! We've designed and built our own special winding equipment; we use premium, close tolerance resistance wire — and really leave no winding unturned to produce pots with the highest resolution in the industry. All AIA sizes, all mounting styles, specials and standards. So get your resolution the easy way — get Acepots! See your ACErep at once!

Here's highest resolution in a standard sub-miniature pot: The 500 Acepot® ⅛" size, ±0.5% independent linearity. Special prototype section insures prompt delivery on the Acepot® — ⅛" to 6″ AIA sizes.

Temperature Sensors
two models

ADVANCED TECHNOLOGY LABORATORIES, 360 Whisman Road, Mountain View, Calif. Designed to indicate rapidly changing surface temperatures of steel structures over a wide range of pressures and temperatures, the Delta-Couples are offered with nickel-steel thermocouple junctions at either 0.0002 in. below the surface of interest for maximum response or at 0.002 in. below the surface where abrasion is a consideration. Type S1 was developed to withstand extremely high pressures, such as those experienced in gun chambers, while the threaded body of the model S2 facilitates simple installation. The sensors have successfully experienced repeated transient pressures of 100,000 psi and transient temperatures in excess of 2,100 °F.

Solid State Control
for industrial use

TEXAS ELECTRONIC CONTROL SYSTEMS, Houston, Texas. A completely solid state control of supervisory systems is designed for industrial applications such as automation, microwave communication fault alarm systems, and oil and gas...
## Multi-Product Advertisements

Fill in the "For Subscriptions" area on your card if you desire to subscribe to or renew your present subscriptions. Circle the number of the Reader Service post card at the right that corresponds to the product or the Literature of the week, request literature on specific items in multiple product advertisements noted area marked by asterisk (*) in the "For Subscription", address on the Reader Service post card.

### All Foreign Inquiries That Cannot Reach Electronics Before the Expiration Date

Note on the Reader Service post card at the right that corresponds to the product number at the bottom of the advertisement. New products advertised for more detailed information on product(s) M'td include:

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2. **Renewal**

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**Canada**

1. **1 year-$10.00**

**Foreign**

1. **1 year-$20.00**

Product(s) M'td include:

- **Searchlight**
- **MIN**
- **MN**
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- **HD**
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- **FIL**
- **ASS**
- **LD**
- **JAN.**
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- **MAR.**
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**Canada**

1. **1 year-$10.00**

**Foreign**

1. **1 year-$20.00**

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- **Searchlight**
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Use these handy prepaid Post Card Numbers for more detailed information on products advertised.
THE ELECTRONICS MAN... A SPECIAL BREED

In most industries the management man went to business school and doesn't concern himself with design problems.

In most industries the design engineer doesn't concern himself with management problems.

The electronics man is different. He is many things. He is in Research-Design-Production-Management. His interests are in any or all of the four areas.

No matter where you find the electronics man his engineering background enables him to influence the purchase of electronic components and equipment. Your advertising must reach him if you are to sell electronic goods.

This is the strength of electronics, the one magazine published weekly and edited to reach this engineering oriented electronics man, wherever he is.

THE ELECTRONICS MAN "BUYS" WHAT HE READS IN...

electronics

and in the electronics BUYERS' GUIDE

A McGRAW-HILL PUBLICATION

330 West 42nd St., N.Y. 36, N.Y.
transmission line control and supervision. The solid state principle of construction has no mechanical parts to wear out.

CIRCLE 335 ON READER SERVICE CARD

Time Delay Relay
precision device

WHEATON ENGINEERING CORP., 920 Manchester Road, Wheaton, Ill. The E404 time delay relay weighs only 1/2 oz and is of crystal can size. Unit is potted in polyurethane foam, which contains CO₂, and is hermetically sealed. It can be mounted in any position. A technical data sheet is available.

CIRCLE 336 ON READER SERVICE CARD

Aluminum Spheres
for semiconductors

SEMI-ALLOYS INC., 550 S. Fulton Ave., Mt. Vernon, N. Y. A new process in the manufacture of tiny aluminum and alloy spheres eliminates contamination inherent in punching and rolling operations by producing virtually perfect spheres with diameters from 0.001 to 0.125 in., within critical tolerances of one ten-thousandth of an inch. The 99.999 percent purity is further maintained by hermetically sealing a single day’s production of these spheres in capsules with controlled inert atmosphere offering complete protection against oxidation and an indefinite shelf life. Provision for rescaling after partial use further extends product durability.

CIRCLE 337 ON READER SERVICE CARD

Laboratory Power Supply

MODEL 150 features
VARIABLE FREQUENCY OUTPUT
380-2400 cps.

With front panel control of feedback for improved load matching, the Model 150 provides 150 volt-amperes for 1.0 to 0.7 leading or lagging power factors. Consuming about 450 watts from a nominal 115-volt 50/60 cycle line source, its output voltage is adjustable from 105 to 125 volts (0-130 volts as a power amplifier). Output voltage regulation is ±2% for load or line as an oscillator (as a power amplifier, regulation is dependent on feedback control setting and power factor of the load).

Total output distortion at full load is about 1.5% at 400 cps. At 50 watts, distortion is less than 1% from 100-500 cps.

Output frequency variation due to rated line and resistive load changes is less than 0.1% ±2 cycles. Frequency variation due to a change of 100 VA of reactive load is about 0.5%.

Cabinet is 21-1/2" wide x 13" high x 15" deep and is equipped with ventilating fan. Front panel is 19" wide x 10-1/2" high and can be mounted on standard relay rack. Net price $575.

For Owners of the
RFL Model 829 AC-DC
Instrument Calibration Standard

By combining the Model 150 with the Model 829 and the Model 10 Test Equipment Cart, a complete meter calibration facility can be achieved in a small space.

The cart is made of heavy gauge sheet steel and is equipped with free rolling, swivel casters. Usable inside space is 33" wide x 16-1/2" deep x 26" high. One side accommodates standard 19" wide panels to meet RETMA rack standards; the other side has 24" wide opening for equipment mounted in cabinets, such as the Model 150. Interior shelf is adjustable in any position from top to bottom. Accessory, drop-leaf work counter, attachable to either side of the cart, is also available.

Performance is rigidly guaranteed. Price is net, f.o.b. Boonton, N.J. and subject to change without notice.

For additional information, including application data, write or phone DE 4-3700. Demonstrations available by local representatives.

CIRCLE 135 ON READER SERVICE CARD
PREVENT THERMAL RUNAWAY

Prevent excessive heat from causing "thermal runaway" in power diodes by maintaining collector junction temperatures at or below levels recommended by manufacturers, through the use of new Birtcher Diode Radiators. Cooling by conduction, convection and radiation, Birtcher Diode Radiators are inexpensive and easy to install in new or existing equipment. To fit all popularly used power diodes.

FOR CATALOG and test data write:

THE BIRTCHER CORPORATION
industrial division
1371 Valley Blvd., Los Angeles 32, California
Sales engineering representatives in principal cities.

CIRCLE 212 ON READER SERVICE CARD

Electrical Coil Windings

For 43 years . . . specializing in all types of coils to customers' specifications. Design or engineering assistance available on request.

COTO-COIL CO., INC.
SINCE 1917
65 Pavilion Avenue Providence 5, Rhode Island

CIRCLE 214 ON READER SERVICE CARD

ELECTROMECHANICAL SWITCHES FOR TELEMETERING SYSTEMS!

Specifications, performances, applications for typical electromechanical commutators for long-range sampling, programming. Quick comparisons let you know what's going on . . . see October 2nd, 1959 issue (did you miss it?). Another reason to subscribe to electronics (or renew your subscription). Fill in Reader Service Card box. Easy to use. Postage free.

CIRCUIT 216 ON READER SERVICE CARD

Literature of

TRANSISTORIZED POWER SUPPLIES. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J. New two-page bulletin describes complete line of transistorized power supplies featuring more than 60 off-the-shelf models including dual output types.

CIRCLE 375 ON READER SERVICE CARD

DIGITAL DATA RECORDING SYSTEM. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin No. 350-8 describes a digital data recording system designed for the automatic testing of vacuum tubes on a mass-production basis.

CIRCLE 376 ON READER SERVICE CARD

VIBRATION METER. Southwestern Industrial Electronics Co., 10201 Westheimer, Houston 27, Texas. Model T-1A vibration meter, designed for accurate measurement of the velocity, displacement amplitude and acceleration of vibration, is described and illustrated in a recent bulletin.

CIRCLE 377 ON READER SERVICE CARD

GENERAL PLATE PRODUCTS. Metals & Controls Division of Texas Instruments Inc., 34 Forest St., Attleboro, Mass. A revised brochure describes the scope of the manufacturer's line including solid and clad base metals, solid and clad precious metals, thermostat metals, electrical contacts, and the company's "industrial" metals.

CIRCLE 378 ON READER SERVICE CARD

COAX TRANSMISSION LINES. Prodelin, Inc., 307 Bergen Ave., Kearney, N. J., has available catalog No. 595 showing its entire series 800 rigid copper and rigid aluminum coaxial transmission lines and accessories.

CIRCLE 379 ON READER SERVICE CARD

SUBMINIATURE SERVOMECHANISM. Servo Development Corp., 567 Main St., Westbury, L. I., N. Y. A 16-page brochure describes a kit of precision parts designed to construct model 20-200 subminiature servomechanisms for use in lab-
the Week

oratory, prototype or limited production applications.
CIRCLE 380 ON READER SERVICE CARD

ULTRAMICROWAVE EQUIPMENT. Demornay-Bonardi, 780 S. Arroyo Parkway, Pasadena, Calif. A 12-page brochure illustrates and describes instruments and components for the W size—90 to 140 kmc.
CIRCLE 381 ON READER SERVICE CARD

SILICON TRANSISTORS. Transistor Electronic Corp., 168-182 Albion St., Wakefield, Mass. A two-page reference piece lists descriptions, important data and useful applications of five new silicon transistor developments.
CIRCLE 382 ON READER SERVICE CARD

STRAIN GAGES. N. V. Philips' Gloeilampen-fabrieken, Eindhoven, Nederland. A 49-page brochure gives an extensive description of the technique and applications of strain gages and strain measuring equipment.
CIRCLE 383 ON READER SERVICE CARD

FERRITE ISOLATORS. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. A recent bulletin describes PRD 1203-1209 ferrite isolators which are specially designed to offer maximum isolation and minimum insertion loss over a frequency range of 3.95 to 26.5 kmc.
CIRCLE 384 ON READER SERVICE CARD

COAXIAL CONNECTORS. Gre-mar Mfg. Co., Inc., 7 North Wakefield Ave., Wakefield, Mass., has compiled a cross-reference manual to simplify specifying and ordering of r-f coaxial cable connectors and expedite their delivery. For a free copy write on company letterhead.

TIME DELAY RELAYS. Tempo Instrument Inc., P. O. Box 338, Hicksville, N. Y. Bulletin 5903 is an 8-page illustrated catalog containing technical data on a line of time delay relays incorporating the company's no-moving-parts transistor timing module.
CIRCLE 385 ON READER SERVICE CARD

PESCO STATIC INVERTERS

A high degree of efficiency and reliability is assured by the new PESCO Static Inverter developed by BORG-WARNER research.
Utilizing controlled rectifiers and no transistors, the new unit offers exceptional performance under space flight conditions.
Fewer components increase reliability. Operation at ambient temperatures of −55°C up to +135°C is possible without fans or coolers. Built-in short circuit protection, automatic or manual (local or remote) reset, is accomplished without fuses or circuit breakers. Other outstanding characteristics include:
Voltage Regulation to ±1%; Frequency Regulation to ±.005%; Inherent sine wave output.

PESCO PRODUCTS DIVISION
Borg-Warner Corporation
3310 Vanowen Street • Burbank, California
24700 No. Miles Road • Bedford, Ohio

Electronic Week • January 15, 1960

CIRCLE 137 ON READER SERVICE CARD

137
CGS Labs In New Quarters

CGS LABORATORIES, INC., manufacturer of communications, computing and countermeasures equipment, has moved into newly-constructed quarters in Wilton, Conn., consolidating facilities formerly situated in Stamford and Ridgefield.

The new $500,000 building contains 35,000 sq ft, enough space for the firm to expand to three times its 1959 sales volume. A modern brick, steel and glass structure, the building features recessed fluorescent lighting, year-round air-conditioning, and a floor-to-ceiling glass wall entrance. Sufficient land is available at this site to expand the building to 100,000 sq ft.

Immediate plans call for the development of commercial and consumer items to supplement present government and military business. CGSL is best known in the electronics industry for its TRAK line of advanced communications equipment, including a high-performance antenna multicoupler for the 2-32 mc range and the Increductor controllable inductor, a high-frequency saturable reactor. The firm also manufactures miniature S-band oscillator cavities.

plant manager at Astron Corp., East Newark, N. J.

The post coordinates the many manufacturing functions that have developed from increased sales and facility expansions, according to Irving Black, Astron's executive vice president.

Scott to Head Plant Management

FRED SCOTT, formerly of Kearfott Mfg. Co., has been appointed to the newly created position of general

Analab Adds To Staff

APPOINTMENT of Theodore Lasar, Philip G. Schifflin, and Edwin J. Sommers as senior engineers at Analab Instrument Corp., Cedar Grove, N. J., was recently announced by Clee O. Marsh, vice president and chief engineer for the company.

Lasar was formerly a senior engineer with Allen B. DuMont Labo-

ratories. Prior to that he was with the Weston Electrical Corp. and the Bendix Aviation Co.

Schifflin brings to Analab 21 years of experience in the administrative and technical direction of design, fabrication and assembly of a-m and f-m receivers, military and electronic developmental models, telephone test equipment and tv receiver engineering models. His most recent position was with DuMont Laboratories as a research administration coordinator.

Sommers is responsible for the mechanical design engineering at Analab, and most recently was with the Emerson Radio and Phonograph Co. as a senior engineer. Previous experience included four years with the Western Electric Co. and ten years with DuMont Laboratories.

Fairchild Takes Important Post

To HEAD UP Dynamics Corp. of America's first overseas operation—a newly-created Latin America, Far East division—the company's board has elected John A. Fairchild as corporate vice president in charge of commercial and governmental operations in South and Central America and the Orient.

Former director of U. S. naval aid to Latin America (1953-1955) and IT&T executive (1955-1958), Fairchild for the past two years was area manager for Latin America for the Raytheon Co.

The new international division
NEW RAYTHEON "WORKHORSE" RECTIFIER FOR TV AND HI-FI

HANDEL LOAD OUTPUT TO 425ma

- Improves regulation
- Cuts transformer costs
- Eliminates one socket

In applications requiring up to 300 dc volts
One tube does the work of two
Replaces 5U4GB and 5Y3GT

FIRST FULL-WAVE CATHODE TYPE RECTIFIER

Raytheon's new 5CU4 "workhorse" rectifier tube will handle a load output of up to 425 ma. This first full-wave cathode type current rectifier is ideal for TV and hi-fi applications requiring up to 300 dc volts. Very low tube drop gives improved regulation and lower transformer costs are possible. Transformer secondary voltage may be reduced approximately 25 volts per plate as compared with conventional rectifiers.

For more information on the 5CU4 rectifier, call your local Raytheon Distributor or write to the Raytheon Company, Receiving Tube Division, Quincy, Massachusetts.
A Pneumatic Attachment on The Green Model D2 Pantograph Engraver rapidly drills holes in printed circuits by tracing templates.

- Drill as many as 100 holes per minute, Foot switch actuates air powered operation.
- Drill speeds and feeds have independent adjustments. Feed regulated by air pressure.
- Spindle speeds up to 26,000 rpm. Permits use of carbide drills when required.
- D2-201 air attachment includes spindle air cylinder, regulating valve and pressure gauge, foot switch, filter and oiler, ready to operate when connected to compressor.

The Model D2 Heavy Duty Pantograph Engraver features ratios of 2 to 1 to infinity. Unobstructed on three sides to handle large work. Micrometer adjustment for depth of cut. Vertical range 10" adjusting copy table automatically with pantograph.

GREEN INSTRUMENT COMPANY, INC.
363 Putnam Ave. • Cambridge 39, Mass.

FOR FULL DETAILS, WRITE, WIRE OR CALL
CIRCLE 213 ON READER SERVICE CARD

Deluxe makes more coils for America's Industries than anyone else in the world

From dimensional stability of components for hi-fi to the rugged environmental requirements of the space age, Luxolene coils, encapsulated in epoxy resin, provide the needed reliability.

For specific information on what Deluxe Coils' Luxolene production capacity can mean to you—and how it can speed your orders—write to Deluxe Coils, Inc., Wabash, Indiana, or Phone Wabash - 1720.

Sperry Names Plant Engineer

SAM J. KARG was recently named department head of plant and industrial engineering at Sperry Semiconductor, So. Norwalk, Conn. This division of Sperry Rand Corp. manufactures silicon diodes and transistors.

For 8 years prior to joining Sperry, Karg was a plant engineer for General Electric Co.

Set Up New Company

As part of its expanded program of producing special components for the electronic industry, Accurate Specialties Co., Inc., Woodside, N. Y., has formed a controlled subsidiary called Metalizing Industries, Inc., situated in a 5,000 sq ft facility in Hackensack, N. J.

Metalizing Industries, Inc., will
produce a complete line of metalized ceramic components including metalized solder seal terminals, micro-module wafers, printed circuits, metalized ceramic housings for hermetically sealed resistors, capacitors, transformers, diodes and rectifiers.

News of Reps

Appointment of Southwest Electronic Industries, Inc., Dallas, Texas, and Zak-Cowen Associates, Inc., St. Louis, Mo., as sales reps is announced by Telemeter Magnetics, Inc., Los Angeles, Calif. Southwest Electronic Industries will represent TMII in Texas and New Mexico. Zak-Cowen will carry the company's components lines to southern Illinois, southern Indiana, western Wisconsin, and the states of Iowa, Kansas, Missouri, and Oklahoma.


Pacific northwest sales representation for Cal Chassis will now be Don Kohler of Seattle, Wash., according to sales manager H. P. Balderson, of California Chassis Co., Lynwood, Calif. Area will include Oregon, Washington and Idaho.

Digitronics Corp., Albertson, N. Y., announces the appointment of Components Sales Corp. of Hartsdale, N. Y., as its rep for the sale of the Dykor high speed perforated tape reader. Territory covered is New York State and the northern half of New Jersey.

S.B.M. Associates, of Rochester and Albany, N. Y., has been appointed sales rep for Shockley Transistor Corp., Palo Alto, Calif., for all of New York State except New York City, Westchester County and Long Island.
COMMENT

Microminiaturization

In regard to the article "Three Approaches to Microminiaturization," p. 49, Dec. 11 '59:
The author's description of type C, under which he identifies Texas Instruments' Semiconductor Solid Circuits, states the components are mounted on one surface of a single wafer. In this approach no discrete nor nondiscrete components are mounted; Semiconductor Solid Circuits are fabricated from a single wafer. By using only a single wafer of semiconductor material, the bonds between dissimilar materials that are encountered in other approaches and conventional components are mainly eliminated. This is a significant feature of Semiconductor Solid Circuits and it is one of the reasons for the potentially improved reliability of these devices.

The primary disadvantage to the type C approach from the author's viewpoint is the temperature and voltage coefficients of semiconductors. Because of these effects, the conclusion is made that linear components cannot be made, limiting these devices to logic type functions. Semiconductor Solid Circuits have the potential to perform many linear circuit functions. It is not inevitable that linear functions cannot be made. The initial development effort was focused on nonlinear functions and, with the successful development of a number of these devices, such as multivibrators, gates, and other logic elements, an intensive investigation of linear functions has begun. This development effort has been most encouraging.

Early in the article, extreme component densities are attributed to semiconductor functional devices, so further emphasis on decreased size would appear to evoke increased interest in this approach. It was puzzling to read the author's "conclusion" that further emphasis on size reduction together with temperature and voltage coefficients of semiconductor material will tend to limit the applications of this approach. One of the particularly strong features of Semiconductor Solid Circuits is that its fabrication has

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been closely allied to the diffusion process. This highly controllable process has been proven in the past few years by Texas Instruments and other semiconductor manufacturers. Therefore, with the successful design of digital functioning devices accomplished, TI has the experience and background to place them into a proven production process in the near future.

In describing the type B thin-film approach, it is stated that, with the exception of crystals, batteries and chokes, it is now possible to deposit virtually all major components in thin-film form. To the best of our knowledge, semiconductor devices have not been successfully deposited by thin-film techniques.

The reference to transistors being lithographed in this film form on a substrate is inaccurate. Conventional diffused transistor wafers are placed in recesses in the ceramic substrates and only the emitter and base ohmic contacts are made by lithographic techniques. In fact, this statement describes a main deficiency in the type B approach. The semiconductor wafer is not compatible with processes required for the formation of the other components, and an unmounted wafer must be handled separately. In so doing, the proper handling and protection of these wafers is a step that requires more caution and knowledge than is often appreciated.

Charles H. Phipps
Texas Instruments
Dallas

From France

... Thank you for making your magazine so interesting and useful. Your articles keep one informed of the frontiers of progress, as do also your advertisements, without ever becoming over-expansive at the cost of a busy reader's time. Of your features perhaps the ones I appreciate most are the closely related series of articles covering a whole field, such as instrumentation. Please do even more of these.

Abraham Schwartz
Emerson Radio
U. S. Army General Depot
Saumur, France

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ELECTRONICS • JANUARY 15, 1960

CIRCLE 143 ON READER SERVICE CARD 143
IBM’s explorations in the semiconductor field include theoretical and experimental studies in basic semiconductor science as well as development of advanced devices and technologies. In one current research project, for example, a better physical understanding of the origin of the negative resistance characteristic of the Esaki diode is being sought. At the same time, development engineers are exploring applications of this device and have already produced a new solid state oscillator of exceptional simplicity in the 3,000 megacycle range. To date, this represents the deepest incursion into the microwave region via semiconductor electronics. In another project, an NPN double-diffused high-speed drift transistor has been developed that will greatly accelerate logical switching and high-power core driving. Both exploratory investigation and development of these and related electronic devices are expanding at a rapid pace at IBM. To further these programs, well-qualified specialists are required for all areas of device exploration.

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Take other areas of special interest to Stromberg-Carlson engineers: Instrumentation and safety systems for nuclear reactors and ground testing equipment for missile systems. Here interchange of information with General Atomics, Electric Boat and Convair Divisions adds a new dimension to Stromberg-Carlson's electronics capability.

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J. PATTER

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R. YOCOM

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OXford 5-5959
H. T. BUCHANAN—R. P. LAWLESS
T. W. BENEDER

PHILADELPHIA, 3
Six Penn Center Plaza

LOcust 8-4330
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JEfferson 5-4867

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DOuglass 2-4600
S. HUBBARD

January 15, 1960 • Electronics
Introduction to Matrix Analysis

Three basic fields in analysis of matrices are clearly covered in this book—symmetric matrices and quadratic forms, matrices and differential equations, and positive matrices and their use in probability theory and mathematical economics. Also presented is a part of the theoretical treatment of the use of matrices in the computational solution of ordinary and partial differential equations by means of digital computers. Included are discussions of the mathematical, physical, engineering, and economic backgrounds of matrix theory. By Richard Bellman, Mathematics, The RAND Corp., 331 pp., 6 x 9, $10.00.

Resistance and Resistors

This practical reference thoroughly treats the most frequently used component in electronic circuits—the resistor. It analyzes the basic objects of resistors and describes each type of resistor and the material used in making the resistors associated with each type, and also provides electronic tables and manufacturers' data on a given type or material used. A decision or component engineer can tell at a glance exactly what is available. By Charles L. Weillard, Technical Director, Systems Division, Clifton Precision Products Co., 264 pp., 6 x 9, 82 Ills., $8.50.

The Theory of Optimum Noise Immunity

This important reference book presents an elementary analysis of the effect of noise on circuit or system performance in an arbitrary communication system—determines what the ideal theoretical performance might be and how to approximate it. The subject was developed from a communication systems approach. The treatment is concise and should be of special value to the practical engineer, the student in his instructional work to follow, and he succeeds in establishing the behavior of communication circuits and systems on a theoretical, reasonable level. By Vladimir A. Kotelnikov, Institute of Mathematical Sciences, N.Y.U., 152 pages, $7.50.

Electrical and Electronic Drawing

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OLD SIZE*
Molded Deposited Carbon Resistor

NEW IRC SIZE
Molded Deposited Carbon Resistor

*MIL NOMINALS

These SIZE REDUCTIONS also result in nearly corresponding weight reductions.

<table>
<thead>
<tr>
<th>IRC Type</th>
<th>Length Nominal</th>
<th>Diam. Nominal</th>
<th>Min. Ohms</th>
<th>Max. Ohms</th>
<th>Max. Volts Continuous</th>
<th>Wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td>RN60</td>
<td>.406</td>
<td>.130</td>
<td>10</td>
<td>5M</td>
<td>300</td>
<td>1/4</td>
</tr>
<tr>
<td>RN65</td>
<td>.594</td>
<td>.203</td>
<td>10</td>
<td>5M</td>
<td>350</td>
<td>1/4</td>
</tr>
<tr>
<td>RN70</td>
<td>.719</td>
<td>.261</td>
<td>5</td>
<td>25M</td>
<td>500</td>
<td>1/4</td>
</tr>
</tbody>
</table>

IRC HAS GREATER LOAD LIFE RESERVE
IRC Molded Deposited Carbon Resistors exhibit excellent heat dissipating characteristics. Size for size, IRC Resistors will run cooler under any load condition and take sudden overloads with very low permanent change. Load life is superior to that of hermetically sealed resistors which cost three times as much!

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RCA now offers a comprehensive group of industrial drift field transistors specifically designed for industrial and military high-frequency communications, instrumentation, controls, navigation and mobile equipment.

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Call your RCA Field Representative now and ask him about RCA Industrial Drift Field Transistors with performance specifications tailored to your specific needs. For additional technical data, write RCA Commercial Engineering, Section A-19-2N3, Somerville, N. J.

<table>
<thead>
<tr>
<th>Frequency Range (Mc)</th>
<th>RCA Type Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>2N1023, 2N1066, 2N1397</td>
</tr>
<tr>
<td>12.5</td>
<td>2N231, 2N232, 2N235</td>
</tr>
<tr>
<td>30</td>
<td>2N1396</td>
</tr>
<tr>
<td>50</td>
<td>2N1395</td>
</tr>
</tbody>
</table>

**HIGH FREQUENCY AMPLIFIER PERFORMANCE**

<table>
<thead>
<tr>
<th>Common Emitter Circuit</th>
<th>Power Gain (db)</th>
<th>Input Resistance (ohms)</th>
<th>Output Resistance (ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 to 7.0 (JEDEC 10-44)</td>
<td>18</td>
<td>2</td>
<td>8000</td>
</tr>
<tr>
<td>2.0 to 7.0 (JEDEC 10-33)</td>
<td>18</td>
<td>2</td>
<td>5000</td>
</tr>
<tr>
<td>5.0 to 12 (JEDEC 10-33)</td>
<td>15</td>
<td>3</td>
<td>5000</td>
</tr>
<tr>
<td>10.0 to 20 (JEDEC 10-33)</td>
<td>10</td>
<td>4</td>
<td>5000</td>
</tr>
<tr>
<td>20.0 to 25 (JEDEC 10-33)</td>
<td>10</td>
<td>4</td>
<td>5000</td>
</tr>
<tr>
<td>30.0 to 40 (JEDEC 10-33)</td>
<td>10</td>
<td>4</td>
<td>5000</td>
</tr>
<tr>
<td>50.0 to 80 (JEDEC 10-33)</td>
<td>10</td>
<td>4</td>
<td>5000</td>
</tr>
</tbody>
</table>

RCA Drift Field Transistors can be supplied to meet MIL-S-19000B specifications.

**PERFORMANCE CHARACTERISTICS**

- Common-Collector Circuit, Base Input
- Ambient Temperature = 25°C
- DC Collector-to-Emitter Voltage = ±12
- DC Emitter Milliamperes = 1.5

![Graph showing performance characteristics](image-url)