IF YOU DON'T MIND THE SCORE*

VITREOUS ENAMEL POWER RESISTORS MAY DO

The Temperature Coefficient of power wire wound resistors is a lot like golf. The higher the "score" the worse the performance. Even on special order, vitreous enamel coated PWW's are not guaranteed for a temperature coefficient of less than ±80 p.p.m. (and they often run up duffer scores) whereas IRC Resisteg Coated Power Wire Resistors consistently average ±25 p.p.m.

The reason is simple. Vitreous enamel units are cured at temperatures of 1200°F or over. At this temperature the turns of wire tend to loosen, shift and even short. Finer wire is therefore used to achieve wider spacing and turns are tension wound. The end result is a high temperature coefficient, and a substantial resistance change for any change in temperature.

On the other hand, IRC Resisteg Coated Resistors are cured at only 205°F or less, can be wound with a larger diameter wire, more closely spaced, and without extra tension. The Temperature Coefficient is about ±25 p.p.m. after the cure or only slightly higher than that of the original wire. So why work with the high handicap resistor coating? Insist on IRC Resisteg Coated PWW's.

Vitreous Enamel Power Resistors best guaranteed score is at least ±80 p.p.m. for Temperature Coefficient and then only on special order. But the par for IRC Resisteg Coated Resistors is only ±25 p.p.m.

Write for new Power Wire Wound Resistor Bulletin C-1C.

INTERNATIONAL RESISTANCE COMPANY, Dept. 3313, 401 N. Broad Street, Philadelphia 8, Pa.
CIRCLE 1 ON READER-SERVICE CARD

Ceramic-covered rods—new capacitor element (cover). 30
Smaller ceramic capacitors are achieved through a new manufacturing process. An extremely thin ceramic film is formed on a rod which serves as one of the capacitor's electrodes. The rods may be bundled together in a honeycomb structure to get various capacity values.

Engineering Passes in Review ................................ 5
A busy year for the electronics industry draws to a close. Miniaturization and reliability were engineered into missiles and satellites. Almost "revolutionary" developments emerged in communications, particularly in radar and its antennas. There were no "breakthroughs", but significant advances were made in instrumentation, data processing, components, microwave amplifiers, and production processes and materials.

Index of Articles, July 9 through December 24 . . . 74
The reader of ELECTRONIC DESIGN can use this handy reference guide to quickly locate all articles which appeared in the magazine over the last six months.

Next Issue
Design '59—A Challenge
What the design engineer should be working on in 1959 is the subject of a special report in the January 7 issue of ELECTRONIC DESIGN.
Kennedy Introduces
a new low-band duplexer for 755-985 mc range

This new Kennedy Model 803 duplexer is an isolation filter which allows the same antenna to be used for transmission and reception simultaneously without any interaction. It is particularly useful for scatter propagation.

For the most efficient operation of your antenna, let Kennedy engineers design the complete feed system.
**NEW RAYTHEON®**

1N1763 and 1N1764 DIFFUSED JUNCTION

SILICON RECTIFIERS

PRICED FOR COMMERCIAL AND INDUSTRIAL POWER SUPPLY APPLICATIONS

**FEATURES:**

**Economical** — now, silicon rectifiers at entertainment field prices.

**Uniform** — the Raytheon Solid State Diffusion Process permits flat junctions and assures uniform characteristics and uniformly high quality.

**Hermetically Sealed — Welded**

**Reliable**

**SPECIFICATIONS:**

<table>
<thead>
<tr>
<th>PARAMETER (25°C)</th>
<th>TYPE</th>
<th>1N1763</th>
<th>1N1764</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIV</td>
<td></td>
<td>400</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>RMS Voltage</td>
<td></td>
<td>140</td>
<td>175</td>
<td>V</td>
</tr>
<tr>
<td>DC Load Current</td>
<td></td>
<td>500</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>Surge Current</td>
<td>for 0.1 sec</td>
<td>15</td>
<td>15</td>
<td>A</td>
</tr>
<tr>
<td>Max. Reverse Current at PIV</td>
<td></td>
<td>100</td>
<td>100</td>
<td>μA</td>
</tr>
</tbody>
</table>

*for operation direct from power line

*for operation from step-up transformer

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**ELECTRONIC DESIGN • December 24, 19**
Another year ends, one for the history books. Sputnik demonstrated Soviet scientists' superiority in propulsion techniques; Explorers' microminiaturization testified to sophistication of U.S. design concepts. Long strides were taken in radar, mobile communications, automatic testing and other fields. This review of the year's news replaces the regular Design Behind the News section.

**Engineering Passes in Review**

_by Ben Patrusky_

**Satellite and Missile Electronics**

The Russians hurled a ton-and-a-half satellite into orbit this year, while America's heaviest weighed less than 30 pounds. Russia thus demonstrated its superiority in propulsion techniques, but it seemed likely that highly sophisticated U.S. design concepts eclipsed many the Soviets had developed. For lacking advanced propulsion capabilities, American engineers had been obliged to microminiaturize—to get as close as possible to designing instrumentation which occupies no space and is weightless.

Explorer I measured 80 in. and weighed 29.87 lbs. This is what it contained:

- A Geiger-Mueller cosmic ray counting tube and associated circuitry to count primary cosmic radiation. The apparatus was designed and built by the State University of Iowa. It also designed the miniature tape recorder which collected radiation information and played it back.
- Two micrometeorite detectors developed at the Air Force Cambridge Research Center. One was a set of 12 grids mounted as a parallel resistance network on the aft end of the fourth stage rocket motor. Variations in electrical resistance denoted micrometeorite collisions. The second was a microphone to record impacts of micrometeorites upon the exterior.

(Continued on following page)

Army Nike-Hercules is in production (top). Here it goes through final assembly at Douglas Aircraft Co. (Right) Convair's Atlas test fired at Cape Canaveral by Air Force.
Where abnormal conditions of vibration (25 to 2000 cps at 10G) are encountered, such as in advanced airborne applications, this pulsed-type X-band (9245 ± 40 Mc) air-cooled RK967A/QX366A magnetron oscillator maintains exceptional frequency stability and operational reliability. Optimum performance is assured by a double-ended supported cathode and aluminum-clad integral magnets. Nominal peak power output is 100 kw at typical pulse conditions of 0.5 μ sec (.001 duty cycle). The tube operates at a peak anode voltage and current of 15 kv and 13.5 amp. respectively.

Integrated gyro feed-throughs provide take-off points from gas-filled gimbal housings. These high-alumina, vacuum-tight, R-95 ceramic assemblies can be soldered to housings at temperatures up to 1000C. They also assure positive electrical insulation with leakage less than one microampere per 500 volts dc.

COMPACT STANDARDS. These miniature gyro feed-throughs provide take-off points from gas-filled gimbal housings. They assure positive electrical insulation and are available to all ceramic tube manufacturers.

CIRCLE 110 Reader Service Card

A Leader in Creative Microwave Technology

Radiation hardened 110C. Bases can be directly mounted to chassis or cold plates. Stems are available to all semiconductor manufacturers.

CIRCLE 111 Reader Service Card

Compiled as a Raytheon service to the field, new consolidated data booklet contains comprehensive information about principal unclassified magnetrons, klystrons, backward wave oscillators and special purpose tubes manufactured by Raytheon. Characteristics presented include maximum ratings, typical operating values, band or frequency ranges and other essential data of microwave engineers and purchasing departments.

CIRCLE 114 Reader Service Card

Described for voltage tunable CW or pulsed operation over the Government X-band (8500 to 9600 Mc), the QX-684 integral magnet backward wave oscillator delivers 10 to 50 mw over delay-line voltages ranging from 215 to 325 vdc. Regulation of a special control grid facilitates pulsed or amplitude modulation to meet power and frequency requirements. Models available for coupling to standard, type "N" connectors.

CIRCLE 113 Reader Service Card

Four temperature gages, to read temperature at three different locations on the outer shell and the interior. These were designed by 

Propulsion Laboratory.

Two radio beacons, to transmit data back to ground receiving stations. Two silicon-transistor transmitters used mercury battery power supplies. The higher power transmitter radiated 60 mw continuously at 108.03 mc for about two weeks. It weighed 2 lbs with four telemetering oscillators.

The lower-power phase-modulated transmitter radiated 10 mw at 108.00 mc. This unit telemetered continuously much the same information as did the high-power unit. It transmitted for two months. The frequency-determining quartz crystal was mounted on a spin axis. The transistors next, and power supply batteries were symmetrically arranged outside. The entire package was potted in plastic and tested to withstand 100-g steady acceleration and 15-g rms vibration acceleration.

Explorer II, which did not orbit, also contained the miniature tape recorder. The 1/2 lb 2.25 in.-diam. La Cima memory device was designed to monitor cosmic particle impacts from all directions in space. Each second of recording time, a ratchet-stripped gear advances the 0.16 in.-wide oxide magnetic tape about 0.005. As the 36-in.-long bronze tape is advanced, the return spring is wound. Playback is completed in 5 sec, the tape speed being damped by an eddy current brake. The recorder then resets itself.
Transducers installed in Explorer III carried out the experiments intended for Explorer II. However, in the transmitting system, the turnstile antenna wires were eliminated. Instead, the stainless steel instrument case and motor case were wired and tuned to the higher-power transmitter. Thus they served as a dipole radiating antenna.

Similarly the nose cone and instrument case served as dipole radiators for the lower-power transmitter. Telemetered data included satellite internal and external temperatures, micrometeorite impacts, and cosmic ray counts, much the same as its predecessor had been designed to do.

Explorer IV contains 18.26 lbs of instrumentation, all devoted to radiation studies.

The security lid is shut tighter than ever on this biggest and costliest earth satellite project to date. Lockheed Aircraft is the prime contractor for this project, the "Pied Piper."

Vanguard II's launching was "scratched" for 1958. But when the program is resumed, the Navy satellite will contain a two-way radio about the size of a loaf of bread. Known as DOVAP (Doppler, Velocity and Position), it was proposed by International Telephone and Telegraph Corp. The 10 lb radio will send back data on the trajectory and velocity of the first and second stages of the Vanguard missiles.

Pioneer I, the first lunar probe, fell short of its goal by 66 per cent because of a 3.5 deg error in the gyroscope. Scientifically, however, the rocket was a huge success. The radiation detectors and telemeters worked well. The communications link seemed to work well. The 400 mw transmitter appeared to be unaffected by distance, shock environment.

The activity in missiles has been confusing, and it is not always clear which service and which contractor is doing what. Here is a brief account of the number of missiles now under development or in production.

Air-to-Air missiles--7

Air-to-Surface missiles--7

Anti-Submarine--5

Surface-to-Surface--18

To obtain more information on Hughes products, please write Hughes Aircraft Company, International Airport Station, Los Angeles 45, Calif.

Hughes Products now offers high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unattainable.

With center frequencies of 30 kc to 30 mc and fractional bandwidths of 0.01% to 6%, these crystal filters have seven distinct advantages:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
7. Excellent shock and vibration stability

For further information please write HUGHES PRODUCTS, Crystal Filters, International Airport Station, Los Angeles 45, Calif.
PERKIN
FOR THE FIRST TIME... 28V AT 100 AMPERE
transistorized, virtually transient-free
DC POWER SUPPLY

A MAJOR BREAK THROUGH IN DC POWER!!
Realizing a definite need for dynamically regulated D.C. Power in high current capacities, Perkin Engineering has pioneered the development of a line of units headed by 100 ampere, completely transistorized, power supply, with excellent transient regulation which is a “must” when powering voltage sensitive equipment such as transistorized inverters, converters, etc. This unit suppresses line and load transients to a very low level virtually eliminating voltage “overshoot” and “undershoot” common with more conventional supplies.

UNIQUE FEATURES
OF MODEL MTR28-100
• COMPLETELY TRANSISTORIZED
• EXCELLENT DYNAMIC (TRANSIENT) REGULATION
• LOW RIPPLE
• SHORT CIRCUIT PROOF
• AUTOMATIC CURRENT LIMITING
• SILICON POWER RECTIFIERS
• FAST RESPONSE TIME
• REMOTE SENSING
• SILICON ZENER DIODE REFERENCE ELEMENT

SPECIFICATIONS ON MTR28-100
AC INPUT: 208/230 OR 460 V, ±10% 3 PHASE, 60 CPS
D.C. OUTPUT: 24-32 V @ 100 A
REGULATION: STATIC: ±0.1% LINE, ±0.1% LOAD
DYNAMIC: ±0.5% LINE, ±2% LOAD
RIPPLE: 20 MV RMS MAX.
DYNAMIC IMPEDANCE: 0.025 OHMS MAX.
RESPONSE TIME: 1 MILLISECOND MAX.

OTHER UNITS AVAILABLE
WITH COMPARABLE SPECIFICATIONS

<table>
<thead>
<tr>
<th>MODEL NO.</th>
<th>D.C. OUTPUT</th>
<th>AMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTR060-1</td>
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<tr>
<td>MTR060-5</td>
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<td>MTR28-10</td>
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</tr>
<tr>
<td>MTR28-30</td>
<td>24-32</td>
<td>30</td>
</tr>
</tbody>
</table>

PERKIN ENGINEERING CORPORATION
345 KANSAS STREET, EL SEGUNDO, CALIFORNIA • OREGON 8-7215
For additional information contact factory or:
New England Area Office: 46 Amesbury, Lawrence, Massachusetts • Malden 2-3232
Sales offices in principal cities throughout the country.

Engineering Passes in Review

Communications

NARY a week went by during '58 that some "revolutionary" development in communications didn't break into print. It was an exciting year with significant progress made in radio, mobile communications, and broadcasting.

Radar
Perhaps one of the most interesting announcements was Hughes Aircraft's "3-D" radar. Dubbed Frescanar, the radar simultaneously computes distance, bearing and altitude of airborne targets. Scanning is done electronically. The antenna rotates but does not move vertically. By supplying a succession of frequencies to the antenna, Frescanar achieves what is a three-effect, vertical scan.

All available energy is concentrated in sharp pencil beams of energy, flashing on and off fan-shaped array to pinpoint targets with extreme accuracy. Data are transmitted electronically to missile battery processing centers to direct missiles to targets more rapidly. The Army states the new radar has 25-50 per cent better range than radars with similar missions. The Navy installed similar radars on test ships.

Early in the year, a highly classified pulse radar system was announced which permits extremely fast scanning and faster pulse repetition rates. Resolution and range losses are minimized. Developed by W. L. Maxson Corp., details remain secret. FASTAR also scans electronically in elevation or azimuth, or both.

By applying the technique of space or frequency diversity—common in communication
**MAXIMUM TELEMETERED RESPONSE THROUGH FLAT AMPLITUDE AND CONSTANT DELAY**

In keeping with its reputation as a pioneer in the field of toroids, filters and related networks, Burnell & Co. now offers a complete line of low pass and band pass constant delay filters for standard RDB telemetering channels. These Burnell constant delay filters combine accurate amplitude and phase with effective limit intelligence distortion and false transients to a minimum. Telemetered signals from off course missiles or those in distant or terminal flight are no longer blocked by attenuation and noise.

**Amplitude and Phase Necessary**

For maximum performance of telemetering systems, it is recognized that filtering of sampled data requires both linear phase and flat amplitude in the pass band. However, until recently a combination of the two in one unit had not been available.

**Combination Achieved**

Existing sub carrier discriminators afford no better than a choice of flat amplitude pass band with non-linear phase in one filter or a constant time delay filter with distorted amplitude. In contrast, Burnell constant delay filters combine both—are flat within 3 db over the pass band—1½ db for the low pass filters—and possess a time delay constant within 5%.


**TECHNICAL DATA**

1. **FOR ± 7½ % PASS BAND**
   - Flat within 3 db over pass band
   - 3 db at ± 15% of center freq.
   - 4 db at ± 22% of center freq.
   - Time delay over the pass band constant to ± 7½%.

2. **FOR ± 15% PASS BAND**
   - Flat to 3 db over pass band
   - 3 db at ± 30% of center freq.
   - 4 db at ± 44% of center freq.
   - Time delay over pass band constant to ± 7½%.

Input impedance — 500 ohms
*Output impedance — 500 ohms and high impedance for operation to a grid.*

*optional impedance available on special order.

**PIONEERS IN TORODS, FILTERS AND RELATED NETWORKS**

**Burnell & Co., Inc.**
Six rugged new capacitor types designed SPECIFICALLY to SAVE SPACE in compact, transistorized assemblies. Two temperature ranges to choose from. All types rated for 500-hours accelerated life testing.

**Full Rated to 85°C**

**Types** 626G - 627G (Extended foil)
Types 628C - 629G (Inserted tab)

**Temperature Range**—Full rating at 85°C — to 125°C with 50% derating.

**Life Test**—500 hours at 85°C and 125% of rated voltage.

**Capacity Tolerance**—All tolerances to ±1%.

**Insulation Resistance**—40,000 meg. x mfd. at 25°C but need not exceed 70,000 megohms.

**Case Styles**—Available in all case style variations in MIL-C-25A.

**50-VOLT DIMENSIONS**

<table>
<thead>
<tr>
<th>Capacitance in mfd.</th>
<th>626G</th>
<th>627G</th>
<th>628C</th>
<th>629G</th>
<th>616G*</th>
<th>617G*</th>
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<td>47</td>
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<td>133</td>
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<td>133</td>
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</tr>
<tr>
<td>1.0</td>
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<td>133</td>
<td>133</td>
<td>133</td>
<td>133</td>
<td>133</td>
</tr>
</tbody>
</table>

*These types have one lead grounded to the case. Others have both leads grounded.

Also available in 300V, 400V, and 600V versions.

Write for literature on these new types.

---

**Communications (continued)**

One significant application of radar systems, as demonstrated by Airborne Instrumentation, Inc., is the so-called Airport Surface Detection Equipment system. This system makes it possible to control ground traffic in foggy weather. Clear images of all vehicles on the airport show up on a scope. Idled dead (New York) has installed the system.

Microwave radiation is being converted to visible light. The Eyatron, as Diamond Antenna & Microwave Corp. calls the conversion device, produces on a screen scenes which are illuminated by or contain sources of microwave energy. A microwave collector separates incoming rays according to their angle of arrival. These are channeled into a precise location corresponding to the direction from which they came, forming an image corresponding to the appearance of a scene to the human eye appears on the screen.

**Broadcasting**

A compatible TV set which would enable two different programs to be broadcast simultaneously on the same channel was shown last November by Blonder-Tongue. Standard receivers equipped with special decoding circuitry could pick up both signals. The FCC has yet to license multiple TV.

RCA's experimental transistorized portablename color TV uses less power than the sealed beam headlights of an auto. It can be operated from batteries or a fixed power supply. The laboratory system comprises a 20 lb camera using the 1/2 in. Vidicon pickups, and a 45 lb control monitor unit. The system weighs 65 lbs. It is designed for closed-circuit applications. Over 300 transistors were used. Only the camera tube and a black-and-white viewing tube for monitoring are vacuum tubes.

Way back in January Motorola exhibited all-transistorized battery-powered black-and-white TV receiver. Thirty-one transistors were used. Two rechargeable batteries provide 100 hours of continuous operation away from commercial power sources. Motorola has no making plans until 1960.

A unique TV antenna was designed by RCA. The traveling-wave antenna permits transmission of TV signals to travel the length of the section of antenna as complete waves. This characteristic proves for ideal shaping of vertical patterns and simpler mechanical constructions. Cones from eight to 18 times are available.

Stereophony got big play this year. One stimulating development was announced just last month. It's RCA's experimental system which provides full stereophonic sound in a single...
Itron, «¡tributi! terns, sistors black section ions. Mark stioming he wave lalent tick rick? by i

In the same RCA demonstration, a high speed, equipment was unveiled. The Megacoder permits coding of any one of more than a million radio receivers from a common transmitter. Idled in a system consists of a microminiature array of capsuleats that can be set positively or negatively to form a code. The device, only one cu in. in the, acts as a gate barring receipt of any but single correct signal. The system can operate at speeds of 5000 or more codes per min.

Activity in single side band has been dynamic, with the Army announcing that at least half of communications setup will go to SSB in five years. The Marine Corps has also started its study of SSB. Collins Radio Co., Western Electric and Federal Electric have supplied equipments for the Army tests being held at a strategic communications center in Puerto Rico. Aaco Mfg. Co. finalized designs on a fully transistorized one-man portable radio with several hundred watts output for the Marines. The Navy has also awarded contracts to Collins, RCA and Westinghouse for SSB equipment.

Motorola developed and successfully tested a type SSB radio for the Army. Called AN/PRC-66 communications central system, it presented the Army commander with mobile “wire-ratated” telephone service to include switching and labor-saving calling to distances of 10 miles with the help of battery-operated sets. The system is used for control and channel compared to the 100 kc per channel in standard mobile communications. The system operates in the 132-165 kc or more frequencies.

At early this year announced a multi-channel SSB radio system which operates in the 900 hertz to 3 mc region. Although designed primarily for line-of-sight and transmissions, the SSB equipment is suitable for use as a transceiver over-the-horizon microwave radio and as an experimental antenna for larger from larger amplifiers. Development plans will push to make operating frequency to 2000 or more mc. The SSB accommodates up to 120 telephone channels within a 500 kc bandwidth, allotting about 50 kc per channel. Total power required to operate 100 channels transmitter and receiver is about 65 watts. The

<table>
<thead>
<tr>
<th>Power requirements:</th>
<th>103 to 227 volts ac</th>
<th>380 watts power consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution bandwidth</td>
<td>25 kc at all frequencies</td>
<td></td>
</tr>
<tr>
<td>Frequency dispersions</td>
<td>500 kc to 25 mc; adjustable</td>
<td></td>
</tr>
<tr>
<td>Spectrum calibrator</td>
<td>160 mc center frequency with a tuning range of</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>± 12.5 mc</td>
<td></td>
</tr>
<tr>
<td>R-F attenuation</td>
<td>100 db, uncalibrated, continuously variable</td>
<td></td>
</tr>
<tr>
<td>I-F attenuation</td>
<td>0 - 60 db, step-variable in 6 db increments</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>0°C (32°F) to 55°C (131°F)</td>
<td></td>
</tr>
</tbody>
</table>

**NEW! MULTI-BAND MICROEVE ANALYZER**

Complete frequency coverage 10 mc to 40,880 mc all in one unit

Extremely broad frequency range in a single unit makes Polarad Model SA-94 Spectrum Analyzer a general-purpose instrument for visual microwave analysis. It displays pulse modulation components, small frequency differences, polarization and bandwidth characteristics, r-f energy leakage, radiation and interference signals, and VSWR information.

**FEATURES:**
- 10 mc to 40,880 mc frequency range in a single tuning unit.
- Unique band selector shows only the band in operation, eliminating operator error.
- Expanded direct reading slide rule dial.
- Internal r-f attenuation from 10 mc to 12,400 mc.
- Direct waveguide inputs in addition to Type N.
- Stable r-f attenuator covering more than one octave reduce required number of frequency bands.
- Expanded frequency marker with graduations every 200 kc permits measurements of very small frequency differences.
- Provisions for multi-pulse spectrum decoder.
- Rugged construction meets government equipment specifications, including shock, environment, vibration and interference.

**SPECIFICATIONS:**

<table>
<thead>
<tr>
<th>Frequency Range: 10 mc to 40,880 mc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band 1</td>
</tr>
<tr>
<td>Band 2</td>
</tr>
<tr>
<td>Band 3</td>
</tr>
<tr>
<td>Band 4</td>
</tr>
</tbody>
</table>

Polarad Electronics Corporation
43-30 34 Street, Long Island City, N. Y.
Representatives in principal cities. See your Yellow Pages.
Instrumentation

Perhaps the most pronounced progress in instrumentation came in the way of automatic test equipment. Equipment has been built or is being built for virtually every operation from missile guidance (at audio and ultrasonic ranges) to navigation-doppler radar (at K band). Missile and aircraft checkout equipment was the most publicized. But there was also a wide array of odds-and-ends equipment built covering a multitude of applications.

Sperry Runs RACE

Sperry Microwave Electronics concentrated on RACE (Rapid Automatic Checkout Equipment) for complete checkout of weapon systems. Currently several kinds of RACE systems are under development or in production for a number of weapon systems and associated component systems. Many of the modular components in RACE are being standardized so as to be applicable to several types of weapon systems.

Sperry recently earned praise from Conair for a RACE system to check out the B-58 Hustler navigation and guidance bombing systems. Thirty minutes are required to check out these systems. All testing and fault location is directed by punched tape. Output is of “go, no-go” variety.

Taylor Packages SPAM

All-around checkout of any aircraft or missile package is possible with SPAM (Selective Programmed Automatic Maintenance), Taylor Engineering Co., Baltimore, Md., built it. This too is punch tape controlled. The tape tells voltage check points, and what voltages should be. Lights indicate whether the voltage levels are right, too low or too high. SPAM also includes a 5-in. scope for display. A filmed image of the correct voltage waveforms is superimposed on the scope for pictorial comparison.

Bell Rings with ASCAT

Electrical, hydraulic and pneumatic systems of guided missiles and airplanes can be checked with Bell Aircraft’s ASCAT (Analog Self-Checking, Automatic Tester). Only two minutes are required by a single technician to check out a number of operations which previously required 10 men for more than an hour. ASCAT is a voltage of “go, no-go” measuring unit.

Missile-laneous

Nike missile-men and other anti-aircraft crew are being trained in enemy interception and destruction, through electronic simulation of an actual attack. IT&T developed the simulator.

Under the direction of a control officer, various combat problems are simulated with the device exactly as they might occur in actual attack— including the first identification of an enemy plane, “jamming” of signals by the enemy, tracking of the aircraft, “firing” of a missile and “destruction” of the enemy plane. The device can inject six synthetic aircraft targets into the control radars, with each of the simulated targets having the characteristics of extremely fast, maneuverable planes. Target speeds of up to 2300 mph with a maximum target range of more than 100 miles can be simulated. It can also simulate target altitudes up to 80,000 ft.; maneuvers, including climb rates up to 40,000 fpm and dive rates up to 80,000 fpm.

Several atomic clocks hit the scene. IT&T said its clock could be used to guide space travelers. It is not a wall fixture. It is small and light weight. Tests indicate the clock varies one second in 100 years. This error factor is expected to improve as the project continues.

The gas cell device uses optical pumping and optical detection. Atoms in vapor form—cesium and sodium—are acted on in a chamber by light and radio energy. The light comes from a vapor lamp using the same atoms as those in the chamber.

A Time Signal Generator is being used by Army Electronic Proving Ground personnel at Fort Huachuca, Ariz., to provide timing signals with an accuracy of 6-thousandths of a second per day. Timing signals record the time of day on magnetic tape, to provide event markers on special strip chart recorders. Coded time-of-day signals operate neon lamp drivers in remotely located instrumentation equipment. The generator was built by Electronics Engineering Co., Santa Ana, Calif.

A Look Across the Board

Here’s a brief across-the-board look at some other developments.

An ultrasonic light modulator has overcome the shortcomings of crt displays—limited resolution and low dynamic range. Operation is based on the diffraction of light at ultrasonic wavefronts. Fairchild Camera and Instruments made it. Though applications remain classified some were suggested. The modulator may be used to obtain extremely high resolution and dynamic range in radar and video recording. It may also...
used as a high speed shutter. Here it would be a speed of about 1/10 μsec. It might also serve as a correlator or analyzer in computer systems.

Westinghouse designed a "light chopper" to mechanically chop light beams into "pieces" only billionths of a second in length. The chopper can be useful in studying "on-off" phenomena. Under investigation is its use in picture scanning and in high-speed photography.

A new machine is automatically testing transistors to a degree of accuracy previously unknown. The Stromberg-Carlson equipment processes any type of transistor through seven successive steps, at rates up to 430 transistors per min. Transistors which fail any one of the tests are rejected at the station which they fail. Thus the machine sorts rejected transistors according to their defects. Accuracy is said to be within 2 per cent of the range.

Assistance to production line inspection of transistors is being offered by a traveling waveilloscope made by Edgerton, Germeshausen Grier, Inc. Boston, Mass. Waveforms of a high speed switching transistor (2N501) made by Sandale Tube Co. are being examined over a closed-circuit TV system with the aid of the scope.

Magnetic forces originating inside the earth and in outer space may now be measured far more precisely than was before possible. The Department of Commerce technique uses light reception. A beam of light is sent through a cell containing a small quantity of vaporized lithium. The manner in which the light is absorbed indicates the strength of magnetic fields.

According to Commerce Dept. officials, the instruments embodying the principle will be simply, lightly miniaturized and capable of measuring very small magnetic fields—perhaps one billionth of the force developed by the motor which runs an apartment elevator.

A unique development in digital voltmeters is a six-digit device developed by Non-Linear Systems, Inc. Voltages from 0.0001 v to 100 v can be measured automatically at approximately 1 readings per min. Numerical readout is on the front panel. The voltmeter was built for the National Bureau of Standards and is not slated for production.

During this busy year now ending, Tenney Engineering and Westinghouse were just two of many manufacturers who came up with a large tray of environmental test chambers.

RC developed a noteworthy testing device. The Compressed Air Loudspeaker generates the world's loudest controlled noise to test sensitive electronic gear. Noise levels of 160 db can be produced in the plywood box measuring 5 x 5 x

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IT WOULD take a pretty active computer to process information on developments in data processing this year. There are computers everywhere doing just about everything—and more. A complete machine tool line has been automated. A computer corrects its errors. There's even a machine that thinks.

Perception is the thinker. The Office of Naval Research unveiled plans for this machine, which perceives, recognizes and identifies its surroundings without human control or training. It has demonstrated its ability to perform what no machine previously has done—conceive an original idea. Perceptron generates a spontaneous concept based on its observations of visual forms and attaches meaningful symbols to things which it senses. A pilot model is now being built. The original demonstration used the IBM 704 to simulate the Perceptron concept. The first model will probably use a TV-like device to “see” with. Perceptron was developed at Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y. No practical applications are expected in “the immediate future.” However, applications of Perceptron as automatic landing systems, missile and space vehicle guidance systems, library research, and scientific data gathering seem clearly indicated.

The first Semi-Automatic Ground Environment (SAGE) center went into operation at McGuire Air Force Base, N.J. More than 30 SAGE sites will be made operational within the next few years. SAGE will be a vast, interconnected network of air defense direction centers which will receive information from many sources, process the information rapidly on high-speed digital computers, and generate battle orders to jet interceptors and other weapons in an air defense system.

Hughes Aircraft revealed its completely automatic punch tape control of a machine tool line. It's the first. Machines can work on a series of successive operations and make a variety of parts at the same time with the Digitape system. Changes in operations may be introduced or production may be started on new parts by changing tapes without stopping the machines. The system makes available mass-production techniques for small-lot production.

The Datamatic Div. of Minneapolis-Honeywell well built a system which automatically corrects errors being entered into its computer tape file. Orthotropic Control re-creates source data of the computer speeds the instant it is read into film for the computer. The system works with the Datamatic 1000 computer. It uses the 32nd channel on a 3-in. magnetic tape used in the computer memory system. Thirty-one channels store data.

Special adding circuitry check the tape twice. A binary zero is written in the 32nd channel if the sum of the other 31 bits is an even number. A binary one is written in the 32nd channel if there is an odd number. It takes two checks to detect a single error.
numbers. A one signifies the sum is odd. A weighted binary check count is inserted in each channel after every 48-bit word. If the machine detects an error in a channel, a comparison with the 32nd channel shows which bits are wrong. Where an error is detected, the system inverts the parity digit. Further verification assures that the corrections are authentic.

Handwritten numbers can be read by a device developed at Bell Labs. Numbers are recognized as being written and the device indicates the numeral by lighting up the correct light on a numbered panel. With some modification, the equipment could be used to read handwritten letters. The size of a typewriter, the device works off a flashlight battery.

TAI developed an aerial automatic caption system. The Digital Data Recording Device records, in code, the speed, location, altitude and other pertinent data directly on the photographic film as the camera plane speeds over its target. It was made to "meet the demands of jet-age photography." The device continuously takes information from the plane's instruments and displays it on a one-in. c.r.t in the camera's field of view.

A lot of work is being done in speech and signal research using computers as simulators. Bell Labs and the National Bureau of Standards are actively engaged in this area. General-purpose digital computers are being used. The object is to understand the nature of visual and speech information to make transmission of information more efficient.

From the University of Texas came news of a new computer which provides automatic determination of network characteristics. It measures impedances, admittances, and transmission functions of networks rapidly. The computer contains an oscillator which provides the driving function, automatically sweeping through the desired frequency range. The devised information obtained on a complex plane plot.

The British Broadcasting Corp. announced a tape recorder which is said to be considerably cheaper to operate than comparable American units. Designated VERA (Vision Electronic Recording Apparatus), it uses a standard 1/2-in. nine-track tape. The comparable American make, put out by Ampex, uses 2-in. tape.

VERA records along the length of the tape as normal sound recording. The reproducing head permits pictures to be monitored while recording is taking place, a facility which is not permitted to exist in other equipment. Visual pictures are separated into two bands. Each image is recorded on different tracks. Sound is put on a third. The machine accommodates tape 3/16 to 1/2 in. diam. for 15 min. recording. The recording speed is 200 in. per sec.

The Human Eye, Nature's inspiration for the camera, can convert wavelengths of blue-green light measuring as little as 400 microns into visual perceptions that are truly life-size. Yet this entire human mechanism occupies space less than 1" in diameter.

Tiny New Potentiometer, shown actual size, is designed to add space-saving precision to missile and aircraft servo mechanisms. Two MPB bearings in it assure accurate, low-torque shaft rotation — a vitally important benefit in subminiature components.

Man With Miracles. This is Maurice Hebert, one of MPB's Sales Engineers. He'll personally help you choose the correct MPB bearing to reduce friction and increase the precision of your instruments — while keeping your operating costs low with trouble-free service.

Miracles in Miniaturization

The Smaller The Better is often completely true. Engineers now know that miniaturization is the surest method of developing new or improved components for many of the latest developments in modern industry. But, as components become smaller, the problems of maintaining high precision and long service life become larger — and the call for MPB bearings constantly increases. MPB answers with the most experienced engineers in the miniature bearing industry, and advanced research facilities . . . producing over 500 types and sizes of bearings from 1/4" O.D. down, with specials as required. We welcome your request for engineering advice, our catalog, or both.

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If FAST SWITCHING is your need and available germanium types won't meet temperature and reliability requirements...

A definite break-through of the inherent temperature limitations of germanium is provided by these outstanding new Silicon Diffusion Computer Diodes. They switch as fast as the best germanium types...and at temperatures to 150°C!

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These three related military types can replace all germanium diodes in computers of advanced design where high reliability performance at high temperatures must be sustained without compromise.

Look at these outstanding specifications!

![EIA Type and Specifications](image)

Write for full information on the entire line of PIF silicon and germanium diodes, silicon rectifiers and PSI voltage-variable capacitors (VARICAP). Production quantity delivery on all types.

**Components**

**Electronic components manufacturers broke new ground in the past year, working generally in four major areas. They improved existing components. They came up with brand new components. They reduced the size of components. And they designed components for higher operating temperatures.**

To list all the companies, and their work, is impossible. The field is too big. Those mention here have been arbitrarily selected.

**Hot Stuff**

There are very few components available for 200 C operation and even fewer for 500 C operation. Pressed by military needs, however, research for components to operate at higher and higher temperatures goes on.

A thermistor which could operate continually at about 650 C was announced by Tenwal Electronics, Inc. About 300 C was the limit for previous thermistors.

General Electric developed a vacuum tube not much larger than a shirt button which operates at ambient temperatures in the 600 C range.

An interesting feature was that the cathode heating was supplied by the high ambient temperature. There was no filament in the tube. The tube is not commercially available at this time.

Using gallium arsenide, the Radio Corporation of America developed a microwave diode that will operate effectively above 572 F. The laboratory unit beats silicon rectifiers which operated a maximum of about 392 F.

The key to high temperature components development is the use of new and advanced materials which can stand high heat. 

And research is essentially a slow process.

**It's Little Things That Count**

Everyone and his competitors, it seems, is trying to make components tinier—and better.

Miniaturization sometimes has confusing results. A tiny silicon rectifier is smaller than its germanium predecessor. But the heat sink required for the silicon unit eats up the space saved.
Nevertheless, a big need for small components remains.

The Radio Corporation of America is developing micro-modules. These electronic units, designed for avionic equipment, are expected to provide a 90 per cent reduction in the size and weight of components. Modules consist of 3 in. sub-modules. Each sub-module is made from ceramic plate and mounts one or more components with flat shapes.

Lumped constant delay lines suitable for transistor and printed circuit applications are available in 1 in. x 0.4 in. cases, manufactured by Color Instruments, Inc., Gardena, Calif.

A tantalum capacitor which measures less than 0.16 in. in diameter and a little longer than 1/8 in. in length is produced by P. R. Mallory & Co., Indianapolis, Ind. They are available in ratings of 1 to 10 mf and 1 to 10 v.

National Cash Register developed a pin-sized memory device, a glass rod with magnetic coating, which serves as both switching and data storage element and promises to increase “thinking” speeds of future computers 10 to 20 times. Research models had switching speeds of 4 nanoseconds. The rod lends itself to cheap mass production techniques, both in fabrication and testing.

And so the story goes. If something is small it is miniaturized. If it’s miniature it’s made peanut size. And if it’s peanut size, it’s made pea size.

**Something New, Something Old**

Thousands of new products were announced during the year. In general, it was a big year for solid state devices. Here are a few products that made people sit up and take notice.

The maser oscillator was put on the market by the Polytechnic Research and Development Co., Brooklyn, N.Y., for the first time. For about $7000

**Now PNP SWITCHING TRANSISTORS from Sylvania**

**designed to give you this same reliability you’ve come to expect from Sylvania’s full line of NPN types**

**Here is an important line of PNP switching transistors to complement Sylvania’s line of NPN types. Manufacturing techniques developed for producing high-temperature stability in NPN types have been incorporated in these new PNP switching transistors. For designers this means the high reliability and stability synchronous with Sylvania NPN types, and permits circuit designs which take full advantage of the complementary aspects of NPN and PNP.**

These transistors feature a new hermetically sealed inverted base TO-5 package which offers better heat dissipation to easily provide up to 150 mw at 25°C.

Electrical, mechanical, and environmental tests applied to these PNP transistors are in accordance with MIL-T-19500A.

**SYLVANIA**

**LIGHTING - TELEVISION - RADIO - ELECTRONICS - PHOTOGRAPHY - ATOMIC ENERGY - CHEMISTRY-METALLURGY**

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you could generate a signal at 23.8701924 km/c ±0.0000005 km/c. Stability of the unit was better than one part in a billion.

Then there was the silicon controlled rectifier by General Electric. Sample models created a stir in the industry but they weren't available beyond sample lots until now. The solid state device acts like a thyatron and can handle up to about 60 amp.

A four-layer switch, ten times faster than most switching transistors, was made available by the General Transistor Research Laboratory. It had a switching time of from 0.03 to 0.05 usec. and was designed for driving memory cores.

Ohio Semiconductor, Inc. and Westinghouse experimented with an 80-year-old principle: The Hall effect. Both companies came out with devices that took advantage of this principle. The devices generated a voltage as a function of the current and a magnetic field passing through the unit. Ohio Semiconductor called theirs the Halltron, and Westinghouse called theirs the Hall Generator. Same thing.

Ohio Semiconductor went one step further. Using the Hall effect, they developed the Magnetoresistor. This unit changes its resistance as a function of the field passing through it.

Westinghouse also developed what they called the silicon Trinistor triode, which is a high power switch. Still in the laboratory stage in the early part of the year, these units are capable of blocking up to 200 vac and carrying up to 10 amp. From the on to off time, the unit is ten times faster than that of a comparable transistor.

Another component still in the laboratory stage was the constant-current varistor. Work on it is being done by Bell Telephone Laboratories. This two-terminal passive semiconductor is applicable as a current regulator where load or supply varies from 20 to 120 vac. It can be used as a coupling choke or ac switch.

The Wamoscope, developed by Sylvania, has

Components (continued)

Components...
Since its recent introduction, the miniature silicon controlled rectifier has opened up many new circuit possibilities, a few of which are shown at the left.

Neither a transistor nor a rectifier, this remarkable device combines features of both. In the reverse direction it acts like a standard rectifier. But it also blocks forward current until either a critical breakover voltage is exceeded or a signal is applied to the third lead. Then it switches to a conducting state and performs exactly like a forward-biased silicon rectifier.

The controlled rectifier offers the circuit designer current ratings comparable to thyatrons, blocking voltages useful in industrial circuits, complete control of current turn-on without complicated circuitry, and switching speeds in microseconds.

While in many ways similar to the gas thyatron, the controlled rectifier provides faster firing and recovery times, very low forward voltage drop, higher efficiency, absence of filament with attendant warm-up delay and power consumption, and higher-temperature operation.

Check the sample ratings and suggested applications at left. Application data and specifications will be sent on request.

For fast delivery, lower prices, see your local G-E distributor!

A recent check shows that General Electric transistors and rectifiers are being sold by local tube distributors for within pennies of the factory price on quantities less than one hundred—with the important difference that transportation charges are prepaid when you buy from your local G-E distributor.

Increased stocking of semiconductors by local G-E distributors means you now have one source for all your electronic needs. General Electric distributors can also furnish you with a wide variety of technical information, application data and spec sheets.

General Electric Company, Semiconductor Products Department, Section S23128, Electronics Park, Syracuse, N. Y.

For more information, contact your G-E semiconductor representative for information on low-current silicon rectifiers.
THE LOW NOISE solid-state microwave amplifier field has been one of the most exciting news hatcheries this year. It is estimated that anywhere from 100 to 150 facilities are seriously engaged in R & D activity. And a booming dollar business is expected in three years—perhaps $70 million dollars worth.

Applications, however, remain classified generally but certainly their use in radars, radio astronomy, telemetering, scatter and satellite communication are logical speculations.

Basically, there are two kinds of solid-state amplifiers—masers and parametric amplifiers (mavars).

Masers are low power devices operating under cryogenic conditions at a 1 db or better noise level. Parametric amplifiers require no cooling. They offer noise levels on the order of 3 db.

To many engineers these microwave devices are still sources of confusion. Some of their general characteristics:

Masers: Masers depend on electron energy within individual atoms or molecules. When these electrons interact with a microwave field they can exist only at a discrete number of energy levels. At various frequencies electrons can absorb energy or emit energy by jumping to higher or lower energy levels. The trick is to put more energy out than is absorbed.

Until recently masers were operating with gases to achieve the molecular energy exchange. A short time ago, Professor N. Bloemgarden of Harvard proposed an effective technique whereby solid-state materials could be used in maser work. These solid-state masers provide much larger gain for a given bandwidth than the gas type. Another useful property is the tunability obtained by using paramagnetic salts as the active material.

The frequency of these salts can be changed by varying the magnetic field strength. The salt is placed in a high Q cavity. Electrons within the structure assume various energy levels depending upon the salt used. With an increase in energy levels, the electron population of each level decreases. Most cavity-type research is with three-level devices. Westinghouse, Stanford University and the University of California are working on two-level devices. There is also activity in four-level masers by Varian and Ewen Knight.

Here's how a three-level maser works: A pumping signal with a frequency corresponding to the energy difference between the lowest and highest energy level is supplied by an external oscillator (a klystron is often used.) Electrons then jump from the lowest to the highest energy level. Electrons in the highest level jump to the intermediate level because of impurities in the crystal. This middle level then becomes over-populated compared to the lowest level. Application of an input signal corresponding to the energy level between these levels results in amplification.

In a four-level device pumping frequencies correspond to the energy differences between levels one and three and two and four. The output is the difference between levels two and three.

Work with cavity-type masers has been abandoned at Bell Telephone Labs because of development of a traveling wave maser. This slow-wave structure produces wide-amplifying bandwidth by variation of the pumping frequency and the magnetic field. The device also offers gains which are much higher than cavity-type offerings. BTL scientists report that the TWM can be tuned over a 350 mc range centered at 5.9 km.

Here's a capsule review of some present maser activity:
Columbia University—Developing an infrared laser to produce oscillations in infrared range. Presently, one of their solid state lasers was installed in the Naval Research Labs' 50-ft telescope. This represents one of the first practical uses of these devices that have been put to.

ARPA—Trying to develop new crystals with the aid of chemists under a Signal Corps contract. Building a solid-state maser with K-band pump and X-band amplification.

Finn—Working under Government sponsorship. Projects include: three-level solid-state maser for 8-keV operation; exploring titanate crystals for maser use.

University of California—Engaged in developing and testing two-level solid-state devices using magnesium oxide; further along is a three-level ruby laser (X-band).

University of Michigan—Operated three-level maser in the S-band. Working on four-level masers using three-level ruby maser (K-band pump, X-band output) in noise studies on their radio telescope.

Cornell—Working on two-level and three-level masers in C and X band under a Wright Development Center contract.

General Electric—Recently built three-level deuterium maser for an S-band operation. A high power maser was constructed.

Parametric Amplifiers: These devices operate reliably at room temperature and do not require the liquid helium coolant temperatures necessary for maser operation. Determined by molecular or atomic energy interchange, the mavar depends on energy stored in a circuit element, such as a capacitor ferrite, or inductor. Perhaps the best explanation can be achieved with the aid of a schematic of a parametric amplifier, which is shown here.

In the circuit currents from the pumping source \( F_s \) and from the signal \( F_s \) flow in the linear reactance \( X \). The two currents mix to produce sideband currents \( F_s \) and \( F_s \). Meshed to the lower sideband, \( F_s - F_s \) only this component of current can flow in the \( X \). It adds to the current already present in the mesh. In turn this current \( F_s \) mixes with the source current and has a lower side band at \( F_s - F_s \). For positive feedback it has been found that a current in both meshes builds up to a level determined by circuit losses and source power.

The critical source power necessary to overcome circuit amplification is obtained.

Some of the representative developments in paramagnetic amplifiers are depicted in the accompanying picture spread.

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If you have a problem that slip rings can solve, put it in the hands of our specialists.

Write for detailed literature.
A SLEW of new production processes and materials took prominence in the industry during the year.

Three of the newest developments in production processes have come from Bell Telephone Laboratories.

One, a floating zone method for growing single crystals of binary semiconductors, looks superior to other crystal-growing techniques. Basic experimental work was done on gallium arsenide. But the method should be applicable to a variety of compounds which are thermally unstable at their melting points. The compound, however, must have a high enough thermal conductivity to allow heating by rf induction. Also, surface tension and density of the molten material must be such as to support a molten zone during the process.

In the basic floating zone refining technique, a rod is supported vertically. A heat source (an induction coil operated at radio frequencies) is moved relative to the rod. It melts a liquid zone as it moves. Surface tension supports this zone.

Also From Bell

In Bell's second development, downtime of equipment such as that used in the manufacture of printed circuits is eliminated by a process for continuously regenerating copper etching solutions. The process does away with the dangers inherent in changing corrosive spent etchants. It also makes it possible to salvage the etched copper.

For its third contribution, Bell conducted research which indicates that cathode metal sputtering may be useful in producing precision printed circuits. Entire circuits, including resistors, capacitors and leads, may be laid down. In this technique ionized gas molecules bombard a cathode, dislodging atoms of metal which then redeposit on nearby surfaces.

Earlier in the year, a machine which winds coils on toroidal cores almost invisible to the naked eye was designed at Stanford Research Institute. The wire forming the coil is made to pull itself through the hole or holes through which the coil is wound.

A process for electroplating copper on aluminum strips and wire was developed at Sylvania. The technique permits plating of strips in widths up to 10 in. and thicknesses of 0.008 to 0.050 in. Thickness of the copper plating ranges from flash coating of 0.002 in. per side.

An ultrasonic continuous seam welder—reportedly the first fully automated—joins any two similar or dissimilar metals. Gulton Industries was the designer. Welding is the result of a plastic flow at the interfaces of the two metals below the melting point of either. There are eight welding heads which can weld at a rate of 200 in. per min.

New Materials, New Products

Development of new materials is important for two broad reasons. First, new materials often lead to unique new products. Second, new materials are needed to meet the severe environmental stresses in military applications.

Indium antimonide is an example of a new material which is used in a unique new product—new at least in terms of the development of a suitable indium antimonide. Using this material, Westinghouse and Ohio Semiconductor, Inc., developed a solid state component based on the Hall effect. This effect, though known for 50 years, could not be turned into a commercial product until suitable materials were developed. The device manufactured by the two companies produces a voltage as a function of the current and magnetic field passing through it.

Employing gallium arsenide, a new suitable material, RCA Laboratories developed high-temperature semiconductor devices. The material is used in transistors and experimental microwave diodes and power rectifiers.

For use as a light weight free flowing filler, hollow silicate glass microspheres were produced. They look like ground sand and are manufactured by Emerson & Cuming, Inc. Dissipation factors as low as 0.008 are achieved when the microspheres are used in low-loss material. This material has a low density and low conductivity.

For molding and extrusion purposes, Teflon 100X fills the bill. It is a polyflorocarbon resin. Operability temperature limit of Teflon 100X is approximately 450 °F. However, when used in injection or transfer-type molds, it may be preheated at 750 °F and cooled at 400 °F. It has low-loss properties and can be combined with inorganic fillers to provide rigidity and dimensional control.

Penton, manufactured by Hercules, is not affected by moisture pickup and may be used as a coating material. It is a high molecular weight chlorinated polyethylene thermaplastic. Penton has a strong resistance to abrasion, excellent dimensional stability and may be easily fabricated.

In high-humidity electrical applications, Orlon filled diallyl phthalate (DAP) is an important new material. Two manufacturers are the Food Machinery and Chemical Corp. and Mesa Plastics. Among the material’s features are its arc resistance, low loss and dimensional stability.

Insulating Under Stress

A silicone resin rubber tape has several good properties for insulation purposes. It can stand ozone, vibration, shock and moisture well enough to be used in big motors and generators. The tape is a product of Moxness Products, Inc.

As brought out at the recent first National Conference on the Application of Electrical Insulation, the greatest advances in recent years have been the development of the silicones and fluorocarbon materials. To meet today’s ultrahigh temperature requirements these substances, along with the newer plastics, are being combined successfully with the traditional insulating materials.
EDITORIAL

Peace on Earth, Good Will To All Men — A Proposal

The marvels of electronics described in preceding columns have been largely designed with the aim of saving Western mankind. If Western man is kept safe, if the deterrent effects of his weapons capability staves off Armageddon, there will be "peace on earth."

History unfortunately records that most weapons developed by man have been called upon to kill. The end objective of weapons — that of maintaining the peace — never has been fully realized.

We can only hope that our arsenals will not lead to destruction, that they will remain a deterrent to all-out war. With the advent of electronic controls, the difference between a deterrent and destruction is the flick of a switch.

The precarious balance can be swung to peace if "good will to all men" becomes operative, if it becomes more than a seasonal ideal. A great amount of good will could be given the world — given both our enemies and our friends — if we were to share those electronic marvels now saving men here, electronics for medicine.

The limited exchange of scientists and engineers between East and West already has done much to generate understanding and feelings of good will. Where "security" was at stake, however, both sides have held back. In the area of medical electronics, "security" is not a factor and there can be full giving on our part.

Nor need we concern ourselves about receiving as much or more in return. Our good will need not be confined to a few guarded overtures made from time to time by a State Department official. It can be a genuine effort, made with no thought of repayment — an effort to make the marvels of electronics available to all mankind.

International cooperation in the field of medical electronics got a start this year through the efforts of Dr. Vladimir K. Zworykin of the Rockefeller Institute’s Medical Electronics Center. But there are vast problems to be surmounted before the program can go into full swing — problems of money, of labor, and, importantly, of planning. National and international committees of doctors and electronic experts, in equal partnerships, must be set up.

The engineer can participate, for example, by joining the IRE Professional Group on Medical Electronics. And to the engineer engaged in weapons development who may be pondering the meaning of his work, an avocation in medical electronics possibly could add the dimensions he seeks.

To the individuals who already have given much of their time to this work, we can appreciatively pay tribute at this season for their acts of good will to all men.

By Joe E. Hoffman
Different types of microwave instruments were described in the first part. It included a complete list of manufacturers of microwave instruments. In this second part, signal generators are taken up. They are classified into different types and discussed both as a source of signal power and as an accessory to supply a calibrated signal for comparison purposes.

In all measurements on passive sections of a microwave system, a signal generator is required as a source of signal power for the measurement. A signal generator is normally needed when making measurements of units which produce microwave signals such as oscillators, or in making noise level measurements. But, it is often used as an accessory to supply an accurately calibrated signal as a reference for comparison purposes.

Measurements which require the use of a signal generator include: receiver sensitivity; selection or rejection, signal/noise ratio; gain-bandwidth characteristics, conversion gain; antenna gain; transmission line characteristics, filter network characteristics; for driving bridges; and interference line measurements.

A signal generator is designed to give a signal output of known frequency and power, within a wide range of power and as wide a range of frequency as possible. Up to frequencies of a few hundred megacycles, signal generators are relatively easy to build; frequency ranges are very wide (2:1 or more), power measurements can be made by the use of diodes as power voltmeters, and variable power output is possible by use of resistive ladder-type attenuators up to about 100 mc, while above 100 mc the power is used with loop or probe coupling. Microwave signal generators are more difficult to make and there are a large number of excellent commercially available. In all measurements, the final measurement of power is by bolometer or thermistor. But a power monitor is often included to avoid the necessity of frequent calibration measurement. Tables 1 through 4 list manufacturers of K, X, S, L band signal generators.
Types of Signal Generators

Signal generators may be divided into a number of different types. The block diagram of a complete signal generator containing all the different sections that may be included in commercial units is shown in Fig. 1. It may include all of the sections shown, or in its simplest form it may consist merely of an oscillator and a frequency meter. Another class of signal generators, shown in one form in Fig. 2, includes an oscillator and a power meter, which may be used for measurements of frequency and power independently of the signal generator itself. This type of unit is generally called a frequency and power meter.

Low Frequency Measurements

Oscillators for use at the lower microwave frequencies generally consist of an oscillator tube, a frequency meter, and a power meter. The oscillator is either a grounded-grid oscillator circuit or a coaxial line. A typical grounded-grid oscillator is a grounded-grid oscillator circuit which uses two independently tunable concentric coaxial lines as the resonant circuit elements. These lines are tuned to one-quarter or three-quarter wavelengths of a wavelength depending upon the frequency range under measurement. Feedback from plate to grid is obtained through small loops or capacitive probes which couple energy between the two cavities, and the power output is taken from a loop or capacitive probe coupled into the plate cavity. This type of oscillator can produce appreciable power, ranging from 30 watts or more at 1000 mc to 3 watts or more at 2500 mc.

High Frequency Measurements

At higher frequencies the signal generator usually uses a reflex klystron oscillator, with either an external or an internal cavity. The klystron is used because it can be easily tuned over a relatively wide frequency range and can be readily frequency or amplitude modulated.

In a reflex klystron oscillator with an external tuned cavity, the cavity is connected to the klystron resonator grids, and is tuned to the other end by changing its length by a noncontacting movable short-circuit. A coaxial cavity is preferred for broadband oscillators because it is inherently more narrowband than the external cavity oscillator. Output power is coupled by means of a loop extending into the cavity. In many units, the oscillator repeller voltage is

Fig. 1. Block diagram of a complete microwave signal generator showing all of the sections that may be included.

Fig. 2. Block diagram of a signal generator which contains a frequency meter and power meter that can also be used with external generated signals.

Bristol miniature pressure switch features ultra-reliable precision pressure element. Exclusive design provides outstanding resistance to shock, vibration, acceleration and overpressures.

These Bristol miniature, widely proved in modern aircraft, are designed for switching electrical circuits in response to pressure changes in air, fuels, lubricants, hydraulic fluids, other gases and liquids.

Bristol's specially designed Ni-Span element is silver brazed to the stainless steel base assuring greater reliability than ordinary soft-soldered construction. Result: accurate, reliable, repeatable performance in any position, at temperatures from -65°F to +250°F, and under Mil Spec environmental requirements.

Write for Bulletin AV2010 on Bristol Miniature Gage and Absolute, Adjustable and Differential Switches. The Bristol Company, Aircraft Components Division, 151 Bristol Road, Waterbury 20, Conn.
made to track frequency changes automatically, thus avoiding the necessity of voltage adjustments during operation.

When extremely good frequency accuracy is required, the output frequency may be compared with the reading of a wavemeter for final settings. Some units may have built-in automatic frequency control, in which the output signal is compared with the frequency of a reference cavity, and automatically tuned by a feedback loop which causes a drift in the klystron frequency to be opposed by a feedback voltage applied to the klystron repeller to correct the frequency.

In such a unit, the klystron output is applied to a tunable reference cavity which has dual mode responses—one just below center frequency, the other just above center frequency. The outputs of these two cavities are connected through a stabilizing amplifier to the klystron repeller in such a manner that drift in the operating frequency will cause a feedback voltage which opposes the change in frequency. The discriminator cavity is made to resonate through a band of frequencies by moving a plunger within it. Tuning of the oscillator is accomplished by tuning the cavity to the desired frequency, and then adjusting the klystron frequency until it automatically follows the cavity resonant frequency.

### Modulation

Modulation in microwave signal generators can be accomplished in a number of different ways. Triode oscillators used at the lower microwave frequencies can be modulated by applying the modulation voltage in series with the plate voltage supply to the tube; since considerable power is required, power amplifier is necessary for modulation, and there is a certain amount of incidental frequency modulation. Another method, which can be used for square-wave modulation, is to insert a resistor in the grid circuit to make the oscillator unstable, and it can be triggered in and out of oscillation with relatively low power in the grid circuit.

Amplitude modulation of reflex klystrons may be accomplished by applying the modulating voltage to either the reflector electrode or the control grid. Oscillations will cease if the reflector voltage is driven out of the mode; thus, a square wave or pulse applied to the reflector will alternately turn the oscillations on and off. With control grid modulation, the electron stream is turned off and on. Klystrons may be frequency-modulated by taking advantage of their voltage tuning characteristics, by superimposing a modulation voltage on the reflector and causing the frequency to change; however, this modulating voltage must not drive the reflector from one mode to another. Depending upon the elaborateness of their circuit, microwave signal generators may include modulation generators and amplifiers, or may simply have taps for the application of external modulating voltages.

### Other Arrangements

Several different arrangements may be used in the output section of the signal generator. The simplest is to couple the output of the oscillator directly to the load. More elaborate units may include an attenuator (either calibrated or uncalibrated) between the oscillator and the load, to permit setting the output level as desired. Other units include a power monitor as well as a calibrated attenuator, and some include wavemeters for most accurate settings of frequency. Specific types of attenuators, power monitor, and wavemeters will be described in later articles dealing specifically with these devices.

---

**Table 1 — K band signal generators**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model No.</th>
<th>Frequency Range</th>
<th>Output</th>
<th>Accuracy of Frequency Calibration</th>
<th>Frequency Drift</th>
<th>Modulation</th>
<th>Price</th>
<th>General Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hewlett-Packard</td>
<td>626A</td>
<td>10,000-15,500 mc</td>
<td>+10 to −90 dbm</td>
<td>±1%</td>
<td>−</td>
<td>Int or Ext. Pulse, fm, square wave</td>
<td>$3000</td>
<td>Output power continuously variable, monitored and indicated to accuracy of ±1 db</td>
</tr>
<tr>
<td></td>
<td>628 A</td>
<td>15,000-21,000 mc</td>
<td>+10 to −90 dbm</td>
<td>±1%</td>
<td>−</td>
<td>Int or Ext. Pulse, fm, square wave</td>
<td>$3000</td>
<td>Output power continuously variable, monitored and indicated to accuracy of ±1 db</td>
</tr>
<tr>
<td>Polarad Electronics Corp.</td>
<td>EH F</td>
<td>18,000-39,700 mc</td>
<td>−10 to −90 dbm</td>
<td>±0.1%</td>
<td>−</td>
<td>Int: 1000 cps square wave Ext: pulse 100-10,000 pps; fm 50-10,000 cps</td>
<td>−</td>
<td>Output power continuously variable, monitored and indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td></td>
<td>SS-1218</td>
<td>12,400-17,500 mc</td>
<td>15 mw</td>
<td>±0.1%</td>
<td>−</td>
<td>Int: 1000 cps square wave Ext: Pulse, fm</td>
<td>−</td>
<td>Output power continuously variable, not monitored</td>
</tr>
<tr>
<td></td>
<td>EHF</td>
<td>18,000-50,000 mc</td>
<td>3 mw to 10 mw</td>
<td>±0.1%</td>
<td>−</td>
<td>Int: 1000 cps square wave Ext: Pulse, fm</td>
<td>−</td>
<td>Output power continuously variable, not monitored</td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics, Inc.</td>
<td>814-K-1 to 814-K-21</td>
<td>12,000-13,800 to 15,500-17,500 mc (6 separate instruments)</td>
<td>20 mw to 100 m</td>
<td>1 mc per division and vernier</td>
<td>1 part in 10^6</td>
<td>Int: 1000 cps am, fm Ext: am, fm</td>
<td>$3800 to $3950</td>
<td>Ultra stable microwave oscillator, frequency stabilized by comparison with reference cavity and feedback control</td>
</tr>
<tr>
<td>Polarad Electronics Corp.</td>
<td>PMK</td>
<td>10,000-21,000 mc</td>
<td>+10 to −90 dbm</td>
<td>±1%</td>
<td>−</td>
<td>Int: Pulse, square wave, fm Ext: Pulse, square wave, fm</td>
<td>$5220 (complete)</td>
<td>Power unit and each tuning unit may be purchased separately; output power continuously variable and indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Model No.</td>
<td>Frequency Range</td>
<td>Power Output</td>
<td>Accuracy of Frequency Calibration</td>
<td>Modulation</td>
<td>Price</td>
<td></td>
<td></td>
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<tr>
<td>----------------------------------------</td>
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<td></td>
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</tr>
<tr>
<td>General Radio Corp.</td>
<td>1220-A5</td>
<td>80-100 mc</td>
<td>10 mw</td>
<td>0%</td>
<td>T</td>
<td>$175</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holland-Rayland</td>
<td>620-A</td>
<td>10 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMX Inc.</td>
<td>818-B</td>
<td>10 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F.R. Machine Works, Inc.</td>
<td>10 X</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microwave Research Corp.</td>
<td>MSG-34</td>
<td>10 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polaronic Electronics Corp.</td>
<td>SSX-A</td>
<td>10 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory for Electronics</td>
<td>X8500-6000 mc</td>
<td>0 to -127 db</td>
<td>0%</td>
<td>1%</td>
<td>T</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2** - X band signal generators

*Continued on following page*
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model No.</th>
<th>Frequency Range</th>
<th>Output</th>
<th>Accuracy of Frequency Calibration</th>
<th>Frequency Drift</th>
<th>Modulation</th>
<th>Price</th>
<th>General Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amerac, Inc.</td>
<td>192A</td>
<td>400 mc tuning range</td>
<td>200 w peak (pulsed) 10 mw (cw)</td>
<td>(counter for frequency calibration)</td>
<td>—</td>
<td>cw or pulse models (extreme modulation)</td>
<td>$475</td>
<td>Complete series of oscillators available for frequencies in 1000-40,000 mc range</td>
</tr>
<tr>
<td>B J Electronics</td>
<td>80</td>
<td>2700 - 3000 mc</td>
<td>10 w peak (pulsed, 1.25% max. duty cycle)</td>
<td>±0.03%</td>
<td>—</td>
<td>Pulsed: 200-2500 pps; 0.5-5.0 microsec pw</td>
<td>$3675</td>
<td>Signal generator to supply high-level pulsed signals in 10 cm band</td>
</tr>
<tr>
<td>F-R Machine Works, Inc.</td>
<td>82</td>
<td>2700 - 3000 mc</td>
<td>2.3 µv to 22.5 v</td>
<td>±0.1%</td>
<td>—</td>
<td>Pulsed: 1000 pps; 2.3 microsec; max duty cycle 0.23%</td>
<td>—</td>
<td>Uses Model 83 r-f oscillator; continuously variable output from -60 to +40 dbm</td>
</tr>
<tr>
<td>General Radio Co.</td>
<td>1220-A1 to 1220-A4</td>
<td>2700-4460 mc</td>
<td>75-100 mw</td>
<td>Uncalibrated</td>
<td>—</td>
<td>Int: 1 kc square wave Ext: sine wave, square wave, pulse or fm</td>
<td>$254.65 to $312.15</td>
<td>Frequency range depends upon klystron tube used; four klystrons required to cover range; see also x-band listing</td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>616A</td>
<td>1800-4000 mc</td>
<td>0 to -127 dbm</td>
<td>±1%</td>
<td>0.01%</td>
<td>Int: Pulse, fm Ex: Pulse, square wave</td>
<td>$1950</td>
<td>Output power continuously variable; monitored and indicated to accuracy ±1.5 db</td>
</tr>
<tr>
<td>Loral Electronics Corp.</td>
<td>MSS-2</td>
<td>2140-4440 mc</td>
<td>5 to 15 mw max; 100 db attenuator</td>
<td>0.3%</td>
<td>—</td>
<td>Int: 1 kc square wave Ext: 40-4000 pps</td>
<td>—</td>
<td>Output power continuously variable to ±1 db accuracy</td>
</tr>
<tr>
<td>New London Instrument Co.</td>
<td>TS-155c/ve</td>
<td>2700-3400 mc</td>
<td>0 to -100 dbm calibrated</td>
<td>±1%</td>
<td>—</td>
<td>Int: 80-2600 pps</td>
<td>—</td>
<td>Also contains power meter for measurement of average power up to 200 mw; frequency band covered in three ranges</td>
</tr>
<tr>
<td>Polarad Electronics Corp.</td>
<td>MSG-2</td>
<td>2150-4600 mc</td>
<td>0 to -127 dbm</td>
<td>±1%</td>
<td>—</td>
<td>Int: Square wave, pulse, FM, 40-4000 cps Ex: Pulse 40-4000 pps</td>
<td>—</td>
<td>Output power monitored and continuously variable</td>
</tr>
<tr>
<td>Model B (Band 2)</td>
<td>2150-4600 mc (For other frequency bands see other tables)</td>
<td>0 to -127 dbm</td>
<td>±1%</td>
<td>±0.25%</td>
<td>—</td>
<td>Int: Pulse, square wave, FM, etc. (5 independent pulse channels)</td>
<td>—</td>
<td>Adjustable coupling probe may be used as uncalibrated attenuator; requires external power supply</td>
</tr>
<tr>
<td>Sivers Lab</td>
<td>SL-5640</td>
<td>2500-4000 mc</td>
<td>50 mw</td>
<td>±1% (using internal wavemeter)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Requires external power supply</td>
</tr>
<tr>
<td>Transitron, Inc.</td>
<td>SG-153</td>
<td>1800-4000 mc</td>
<td>0 to -120 dbm</td>
<td>±1%</td>
<td>—</td>
<td>Int: Pulse, fm Ex: Pulse</td>
<td>—</td>
<td>Output power continuously variable; monitored and indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td>Laboratory for Electronics, Inc.</td>
<td>814-S-1</td>
<td>2500-3050 mc</td>
<td>75 mw</td>
<td>1 mc per division and vernier</td>
<td>1 part in 10 to 100 min.</td>
<td>Int: 1000 cps am, fm Ex: am, fm</td>
<td>$3600</td>
<td>Ultra-stable microwave oscillator; frequency stabilized by comparison with reference cavity and feedback control</td>
</tr>
<tr>
<td>Marconi Instruments</td>
<td>1058</td>
<td>1700-4000 mc</td>
<td>-30 to -165 dbm to 50 mw uncalibrated</td>
<td>±1% and vernier 0.001%</td>
<td>—</td>
<td>Int: 1 kc square wave Ex: Pulse</td>
<td>—</td>
<td>Output power continuously variable; indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Model No.</td>
<td>Frequency Range</td>
<td>Output</td>
<td>Accuracy of Frequency Calibration</td>
<td>Frequency Drift</td>
<td>Modulation</td>
<td>Price</td>
<td>General Comments</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Airborne Instruments Lab.</td>
<td>124B</td>
<td>200 - 2500 mc</td>
<td>2.5 - 20 watts (varies with frequency)</td>
<td>(Indicated by 4-digit counter)</td>
<td>0.005%</td>
<td>Int: 400 and 1000 cps sine waves</td>
<td>$2285</td>
<td>Frequency coverage in three ranges; power output varies with frequency; useful for applications requiring appreciable power, such as antenna design, etc.</td>
</tr>
<tr>
<td>Amerac, Inc.</td>
<td>192 ab and 192 b series</td>
<td>300 - 500 mc range (950 - 2000 mc in 4 models)</td>
<td>500 - 1000 mw</td>
<td>(Indicated by counter)</td>
<td>—</td>
<td>External</td>
<td>$475</td>
<td>Coaxial line cavity using 2C 36 uhf planar triode; requires external power supply</td>
</tr>
<tr>
<td>B-J Electronics</td>
<td>82</td>
<td>1050 - 1350 mc</td>
<td>2.3 mv to 22.5 mv</td>
<td>—</td>
<td>Pulsed: 1000 pps: 2.2 µsec; max duty cycle 0.23%</td>
<td>—</td>
<td>$910</td>
<td>Output continuously variable; indicated by meter with ±20% or better accuracy</td>
</tr>
<tr>
<td>F-R Machine Works, Inc.</td>
<td>L771B</td>
<td>950 - 2000 mc</td>
<td>50 mw (average)</td>
<td>—</td>
<td>Int: pulse or square wave 350 to 2000 cps; cw Ext: Pulse or fm</td>
<td>—</td>
<td>$465</td>
<td>Requires external power supply; modulator must be able to carry plate current of oscillator</td>
</tr>
<tr>
<td>General Radio Co.</td>
<td>1021-AW</td>
<td>900 - 2000 mc</td>
<td>0.7 v max</td>
<td>—</td>
<td>Ext: Square wave 100 to 5000 cps</td>
<td>$2325</td>
<td>Output power continuously variable, monitored and indicated to accuracy of ±1 db</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1213-A</td>
<td>900 - 2000 mc</td>
<td>200 mw</td>
<td>±1%</td>
<td>Ext: Sine wave, square wave, pulse, or fm</td>
<td>$910</td>
<td>Output power continuously variable; monitored and indicated to accuracy of ±2 db</td>
<td></td>
</tr>
<tr>
<td>Hewlett-Packard</td>
<td>614A</td>
<td>800 - 2100 mc</td>
<td>0 to −127 dbm</td>
<td>±1%</td>
<td>Int: Pulse, fm Ext: Pulse, square wave</td>
<td>$2285</td>
<td>Frequency coverage in three ranges; power output varies with frequency; useful for applications requiring appreciable power, such as antenna design, etc.</td>
<td></td>
</tr>
<tr>
<td>Maxson Instruments</td>
<td>Power Oscillator</td>
<td>200 - 2500 mc</td>
<td>2.5 to 20 watts (varies with frequency)</td>
<td>(Indicated by 4-digit counter)</td>
<td>0.005%</td>
<td>Int: 400 or 1000 cps sine wave or square wave Ext: Sine wave or square wave</td>
<td>—</td>
<td>Output power continuously variable; monitored and indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td>NE 12-20-SC</td>
<td>NE 12-20-SC</td>
<td>900 - 2100 mc</td>
<td>0 to 120 dbm</td>
<td>±1%</td>
<td>Int: 40 to 4000 pps Ext: Pulse</td>
<td>—</td>
<td>Output power continuously variable; monitored and indicated to accuracy of ±2 db</td>
<td></td>
</tr>
<tr>
<td>Polrad Electronics Corp.</td>
<td>MSG-1</td>
<td>950 - 2400 mc</td>
<td>0 to 127 dbm</td>
<td>±1%</td>
<td>—</td>
<td>Int: Square wave, pulse, fm 40 - 4000 cps Ext: Pulse 40 - 4000 pps</td>
<td>—</td>
<td>Output power continuously variable; monitored and indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td>Model B (Band I)</td>
<td>950 - 2400 mc</td>
<td>0 to −127 dbm</td>
<td>±1%</td>
<td>—</td>
<td>Int: Pulse, square wave PM, etc. (has 5 independent pulse channels)</td>
<td>—</td>
<td>—</td>
<td>Output power continuously variable; monitored and indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td>NE 12-20-SC</td>
<td>650 - 1300 mc 1050 - 2250 mc</td>
<td>—</td>
<td>±1%</td>
<td>—</td>
<td>Ext: Square wave, fm</td>
<td>—</td>
<td>Adjustable coupling probe may be used as uncalibrated attenuator; requires external power supply</td>
<td></td>
</tr>
<tr>
<td>Transistor, Inc.</td>
<td>SG-161</td>
<td>900 - 2100 mc</td>
<td>0 to −120 dbm</td>
<td>±1%</td>
<td>—</td>
<td>Int: Square wave, pulse, fm 40 - 4000 cps Ext: Pulse 40 - 4000 pps</td>
<td>—</td>
<td>Output power continuously variable; monitored and indicated to accuracy of ±2 db</td>
</tr>
<tr>
<td>Winschel Engineering</td>
<td>MS-3</td>
<td>900 - 2000 mc</td>
<td>50 mw</td>
<td>±1%</td>
<td>Int: 1000 cps square wave Ext: Sine or square wave</td>
<td>$2550</td>
<td>—</td>
<td>When used with directional coupler and power monitor, feedback regulator amplitude stability is ±0.05 db 1 hr; without regulator ±0.1 db 1 hr</td>
</tr>
</tbody>
</table>
CERAMIC CAPACITORS

Made

SMALLER

THESE CERAMIC capacitors are smaller than those previously available. Their miniaturization was achieved through a new manufacturing process which also makes their cost reasonable. Called Cerafil, the new ceramic capacitor is compared to a paper unit in Fig. 1.

Cerafil capacitors—manufactured by Aerovox Corp., Hi-Q Div., Myrtle Beach, S.C.—were designed primarily for transistor and other subminiature applications. They range in size from 0.09 in. in diameter by 0.320 in. long for the 0.001 μF unit to 0.310 in. in diameter by 0.750 in. long for the 0.1 μF unit. These are maximum dimensions. In some cases diameters are 20 to 25 per cent smaller than guaranteed maximums.

These units are rated at 100 V dc. a maximum power factor of 2.5 per cent at 1000 cps. Capacity varies with temperature by approximately +10%/-15% over the range of -55 to +85 C based on 25 C as the reference temperature. They are available in capacities from 10 pf to 100,000 μF.

These capacitors will meet or surpass all requirements of MIL-C-11015A. Extended temperature tests are being performed on these capacitors. They are subjected to 200 V dc in an ambient temperature of 200 C. After 3000 hours no failures were reported.

Fig. 1. A paper capacitor (top) vs a Cerafil capacitor (bottom).
The Good and Bad of Ceramics

Ceramic dielectrics are good because they have a high dielectric constant. Unfortunately, ceramics have a brittle nature. This imposes limitations on processing thin sheets of ceramic dielectrics in the conventional manner.

New Manufacturing Techniques

Aerovox Corp. circumvented the problems of handling ceramic sheets by employing new manufacturing techniques. The main principle consists of forming the thin film of dielectric on a substrate. The substrate is used as one of the electrodes and serves as a support for the fragile film. With this support, extremely thin films can be procured conveniently and resulting high capacities obtained. Naturally, the voltage rating is determined by the thickness of the film employed.

The Cerafil construction consists of a single capacitor element, or a multiple of this capacitor element, depending on the capacity required. A capacitor element is a rod of approximately 1/32 in. in diameter. Length of the rod is determined by the length of the unit desired. The bundled rods form a cylindrically shaped honeycomb structure. Surface to volume ratio increases with diminishing rod diameter.

This design and construction offers several advantages. Parallel connection to obtain the high capacities is a simple operation. Also, an element with a positive temperature coefficient may be paralleled with one of a negative temperature coefficient to give a flat curve.

Ten thousand partially finished Cerafil capacitors, three finished Cerafil capacitors and a paper clip (for comparison) are shown in Fig. 2.

For more information of these miniature ceramic capacitors, turn to the Readers-Service card and circle number 109.

Tung-Sol/Chatham power triode family covers every series regulator need!

Now designers can specify a premium quality Tung-Sol/Chatham tube for all series regulator sockets. Tung-Sol/Chatham's family of power triodes—the first designed and produced specially for series regulator service—meets all design requirements and assures maximum reliability and life at all times.

Types include the new 100 Watters, 7241 and 7242, medium mu or low mu-high current. 12 or 26 Volt heater versions available on most types. All embody sturdy construction features that contribute to overall ruggedness and long hours of heavy-duty operation.

Compare the ratings below against your particular application! If you desire complete data sheets...or you have a specific design problem, contact us today! We'll be glad to give whatever assistance we can. Just write: Tung-Sol Electric Inc., Newark 4, N. J., Commercial Engineering Offices: Bloomfield and Livingston, N. J., Culver City, Calif., Melrose Park, Ill.

<table>
<thead>
<tr>
<th>TYPICAL VALUES</th>
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<tbody>
<tr>
<td>Total Plate Current</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>200 ma</td>
</tr>
<tr>
<td>400</td>
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<tr>
<th>PERTINENT CHARACTERISTICS PER TUBE</th>
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<tr>
<td>Max. Plate Current</td>
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<tr>
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<td>280</td>
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<tr>
<td>600</td>
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<table>
<thead>
<tr>
<th>TUBE TYPES BY PLATE DISSIPATION RATINGS</th>
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<tr>
<td>Total Plate Dissipation</td>
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<tr>
<td>64STQ, 6082</td>
</tr>
<tr>
<td>6394B</td>
</tr>
<tr>
<td>6598</td>
</tr>
</tbody>
</table>

CIRCLE 21 ON READER-SERVICE CARD
new and unique!

**SPEED DESIGN OF TRANSISTOR CIRCUITS**

**With the SPRAGUE TRANSIMULATOR**

Bring transistor circuits to life in a matter of minutes with the Sprague LF-1 Transimulator. This new instrument lets you simulate any amplifier stage, a-c or direct-coupled, short of high power audio output; also multivibrator, switching, phasing, push-pull, Class A and B, and many others using cross-coupled Transimitors... whether the circuit is common or grounded emitter, base, or collector... whether the transistors are PNP, NPN, or Surface Barrier. You can simulate circuits stage-by-stage for cascade operation... or use a separate Transimulator for each stage to get simultaneous multi-stage operation.

**Bring Circuit Diagrams To Life In Minutes**

Everything you need for RC amplifier circuits is built right into the LF-1, including coupling capacitors... bias and load resistors... battery voltage supplies... Base Collector—Voltage Divider stabilization circuits... 5-way binding posts for transformer coupling and metering.

Whether you're designing audio circuits or switching circuits, you'll get a true picture of operating parameters minutes after you've drawn the circuit diagram... without wasting valuable time with breadboard and soldering gun.

**Pays For Itself In A Matter Of Weeks**

An ideal laboratory instrument, Transimators are inexpensive enough to justify several on every bench. You can even use the LF-1 to test transistors in the circuit... the only real proof of design parameters. And a complete step-by-step instruction manual makes operation fast, simple, and easy.

**FEATURES OF THE LF-1 TRANSIMULATOR**

- **TRANSISTORS**—PNP and NPN Junction, and Surface Barrier.
- **CIRCUITS**—Common or Grounded Emitter, Base, Collector.
- **RANGE**—Audio, up to 100 kc.
- **TRANSISTOR POWER**—Through medium power audio output.
- **BATTERY SUPPLY**—Separate bias and load. 1.5, 3, 4.5, 6 volts d-c. Polarity Reversing Switch.
- **COUPLING**—2 µ and 20 µ Direct, and Ext. C. posts, on both input and output.
- **BIAS RESISTANCE**—Up to 555,000 ohms continuously variable.
- **LOAD RESISTANCE**—Up to 277,500 ohms continuously variable.
- **EMITTER RESISTANCE**—Up to 2,500 ohms variable. Series resistor and bypass capacitor can be added.
- **BASE COLLECTOR STABILITY**—Up to 250,000 ohms variable. Series resistor and bypass capacitor can be added.
- **VOLTAGE DIVIDER STABILITY**—Up to 50,000 ohms variable.
- **5-WAY BINDING POSTS**—For meters, transformer coupling, external supply voltage, degeneration, bypass, coupling, signal input and output, almost any connection required.

**only $79.50**

**SPRAGUE PRODUCTS COMPANY, NORTH ADAMS, MASSACHUSETTS**

**EIGHTY-TWO** per cent smaller, seventy per cent lighter, and much cheaper. This achievement for an airborne power supply was a real achievement for an airborne power supply. Without sacrificing required performance, Westinghouse substituted one chassis for three and maintained reliability and ease of maintenance.

To do this, modern miniaturization techniques were put to work by M. L. Feistman and R. Lieske of Westinghouse Electric's Air Arm Division in Baltimore, Md. Here are some of the techniques they used.

"Cold plate" transformers are used to size and weight. With their better means of conducting heat away from the core, and with better core materials, they can chop volume about one per cent without affecting electrical characteristics.

For high voltage rectification, a bridge of silicon diodes replaces a two-thyratron full-wave rectifier. This reduces size further and obvious...
Subminiature tubes, silicon diodes, and the "cold plate" transformer in the rear helped shrunk this airborne power supply.

More cheaper Too

A generous filament supply. As a bonus, the silicon diodes take vibration and shock better than the thyratrons.

A 6336A series regulator tube replaces two older ones.

Further shrinkage results from the use of subminiature tubes and potentiometers and printed circuitry. The diodes and subminiature components lend themselves well to mounting on printed circuit cards. The cards, identical for positive and negative supplies, help trouble shooting.

Perhaps most significant is the introduction of the zener diode as a precision regulator. A small, simple zener circuit with a few components replaces older circuitry with many components.

Simpler circuitry and fewer components throughout enhance the reliability of the power supply.

Airborne power supply on the right is 82 per cent smaller, 75 per cent lighter than earlier three-chassis model.

Avoid Radiation Interference for VHF and UHF Receivers

Their unique discoidal design eliminates all parallel resonance effects which are normally encountered with tubular type capacitors in the VHF and UHF frequency ranges. With this complete absence of self-resonance, as shown in the graph at left, you can use far greater nominal capacitance values to obtain lower coupling impedances... and superior filtering.

The rugged construction of Allen-Bradley discoidal capacitors minimizes breakage during assembly or from thermal shock incurred during soldering. And, these capacitors have gold plated terminals to insure faultless soldering every time even after long periods in storage.

Both feed-thru and stand-off capacitors are available in standard nominal capacitance values from 5 mmf to 1,000 mmf.

For suppression of stray radiation at frequencies to 1,000 megacycles, you cannot equal Allen-Bradley discoidal capacitors. Send for Technical Bulletin 5409.


CIRCLE 23 ON READER-SERVICE CARD
NEW PRODUCTS

MODULAR UNITS
Small units which plug into a system, or are connected easily, have grown in popularity. They've become popular because they can be easily taken out of a system and quickly replaced if defective. Here are some modular units which have just hit the market.

LOGIC CIRCUITS
These transistorized plug-in modules for digital equipment are based primarily upon the NOR logic. The module is designed to fit a standard 7 pin inline subminiature tube socket. Up to 144 units mount on a 3-1/2 x 19 in. rack panel. Module measurements are 0.75 x 0.857 x 0.297 in. The standard unit contains four inputs.
Erie Resistor Corp., Dept. ED, Erie, Pa.
CIRCLE 24 ON READER-SERVICE CARD

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

TRANSISTOR AMPLIFIER
Model 2620 transistor amplifier amplifies and converts charge to voltage. This design eliminates high input impedances normally required for low frequency response. Transducer and amplifier may be separated by 300 ft without signal loss. Two continuously variable gain ranges are provided: 0.8 to 12, and 4 to 15 (based on a 500 µf source). Having a relatively low input impedance, the unit is sealed against dust and humidity. Temperature range is -65 to +185 F.
Endevco Corp., Dept. ED, 161 E. California St., Pasadena, Calif.
CIRCLE 25 ON READER-SERVICE CARD

TELEMETRY KEYER
Having an input impedance of 5 megohms shunted by 68 µf, this keyer was designed for use in missile or other telemetry systems. It converts an amplitude modulated pulse sequence to a pulse series of constant amplitude and variable width. Output is suited for modulating a subcarrier oscillator or rf transmitter. Linearity error is less than 1%. Output amplitude is 5 v peak-to-peak max.
Rotary Devices Corp., Dept. ED, 30 Jay St., Englewood, N.J.
CIRCLE 26 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 24, 1958
RESISTORS

Engineered to handle 1/10 w, the DCH-1/10 resistors measure 7/64 x 1/4 in. They are hermetically sealed deposited carbon resistors housed in a ceramic shell and come in a resistance range of 100 ohms to 100 K. Their tolerance is ±1%. Operating temperature range is -55 to +150 C. The 1/10 w rating is at 70 C, and they must be rated to 0 w at 150 C.

Dale Products, Inc., Dept. ED, Box 136, Columbus, Nebr.

CIRCLE 27 ON READER-SERVICE CARD

ELECTRONIC INDICATOR TUBES

These Nixie all-electronic indicator tubes have had their life characteristics extended. The regular miniature Type 7009 (BD-200-S) requires a minimum of 170 v and has an average dynamic life of from 3000 to 5000 hr. Type B-4032 has an average dynamic life of more than 10,000 hr and requires a minimum of 170 v. Type B-4021 (BD-214) is designed for transistor operation and requires a 120 v supply. It has provisions for preheating for 45 v operation. All tubes operate with less than 1 ma on approximately 1/8 w of power. Visible up to 20 ft.

Burroughs Corp., Electronic Tube Div., Dept. ED, Plainfield, N.J.

CIRCLE 28 ON READER-SERVICE CARD

NEW FROM JFD Electronics
DECEL LINES
An outstanding new component series in the JFD tradition of uncompromising quality.

Now... after extensive laboratory research — JFD distributed constant Delay Lines to meet today's challenging reliability demands!

Designed for applications calling for short delay intervals, the new lines offer a high ratio of delay to pulse rise time, in minimum space. Available for printed circuit assembly or for conventional mounting, JFD Delay Lines meet all military requirements. They can also be modified or custom-designed to meet your most rigid specifications.

Call or write today for Bulletin 213 providing complete electrical and mechanical data. Better yet, tell us your delay network problem — distributed or lumped constant. Our engineering staff will promptly recommend the solution with detailed specifications for your particular application.

Characteristics:
- Precise pulse fidelity
- Operating temperature range of -55°C to +125°C
- Excellent temperature stability
- Rugged encapsulated construction resists environmental moisture, humidity, shock and vibration
- Linear phase shift
- 0.1 inch grid spacing for printed board types
- Attenuation of approximately 1 db per m sec.

PHONE DEWEY 1-1000
JFD Electronics Corporation
1462 62nd Street, Brooklyn, New York

CIRCLE 29 ON READER-SERVICE CARD
radar relay switch noise problem

solved by
ASTRON
custom engineered
26
r. f. filter networks

The filters pictured were specifically developed to suppress radiated and conducted noise pulses generated from a coaxial relay switch. In this particular case Astron found it necessary to filter each contact of the switching network individually. The result was a single compact unit housing 26 different filters. A twelve-terminal line filter was also required to absorb residual noise. Both filters were hermetically sealed and compliance with all applicable military and environmental requirements was achieved.

These particular filters are one example of many custom built by Astron . . . We bring them to your attention not to demonstrate an unusual filter problem, but rather to demonstrate a very usual result of Astron’s engineering skill.

Regardless of the complexity of your filter applications ... the severity of the existing environmental conditions ... Astron will design and produce RF noise suppression filters to your exact requirements.

IF YOU HAVE A FILTER PROBLEM — WRITE TODAY FOR ASTRON’s “FILTER SPECIFICATION CHECK LIST”

NEW PRODUCTS

Oscilloscope Kit
0 to 4.5 mc vertical response

Professional oscilloscope kit OP-1 has a dc coupled amplifiers and a dc coupled crt unit. The triggered sweep circuit operates on internal or external signals and may be ac coupled. The polarity of the triggering signal may be selected, and a triggering level control can start the sweep at any point on the waveform. The sweep frequencies are provided by a switch-selected base rates of 2 and 0.2 msec per cm and 20, 2, and 1 usec per cm in conjunction with the continuously variable 10 to 1 ms sweep time multiplier. Sweep frequencies are calibrated to within 10% at all control settings. Vertical frequency response is within 1 db from dc to 2.2 mc, and within 6 db from dc to 4.5 mc. Rise time under 0.1 usec. Horizontal frequency response is within 1 db from dc to 450 kc, and within 6 db from dc to 900 kc.

Heath Co., Dept. ED, Benton Harbor, MI
CIRCLE 31 ON READER-SERVICE CARD

Solderless Terminals
For high voltage

Rated 12, 25, and 35 kv at 5 amp, type UO3D solderless terminals are designed for high temperature, high altitude use. The leads, made from silicone rubber insulated wire, come in a length which is a multiple of 3 in. The terminals are epoxy and glass fibre or ceramic.

CIRCLE 32 ON READER-SERVICE CARD
Resistance Welder
Uses stored energy

A precision resistance welder, model DC 80A has a stored energy panel of 80 w-sec capacity. It welds copper, silver, tungsten, molybdenum, and other difficult materials without discoloration or metallurgical change. It also joins dissimilar metals of widely different thickness.
Federal Tool Engineering Co., Dept. ED, Cedar Grove, N.J.
CIRCLE 33 ON READER-SERVICE CARD

Multichannel Sampling Switch
For amplifier drift stabilization

Model 108A is a high-speed sampling switch which stabilizes the sequential drift of 83 high gain dc amplifiers. It has two poles, each with 70 contacts or 85 nonshorting channels. The plug-in unit is 10 x 10.38 x 6.31 in.
General Devices, Inc., Dept. ED, P.O. Box 83, Princeton, N.J.
CIRCLE 34 ON READER-SERVICE CARD

Vacuum Pumping System
For silicon and germanium deposition

A 3 in. vacuum pumping system, model 50-40V was designed primarily for vacuum metallizing and silicon and germanium deposition. It provides an ultimate pressure of 5 x 10^-5 mm Hg and operates during reloading. The chamber is 12.5 in. in diameter and 12 in. high.
Bo-De Electronic Labs, Inc., Dept. ED, Danvers, Mass.
CIRCLE 35 ON READER-SERVICE CARD

OAK can engineer
and manufacture your
special SUBASSEMBLIES

one responsibility for the design and production
of your electromechanical requirements...

In the servo-selector, shown above, Oak engineers solved three different design problems. They developed (1) an ingenious jig-assembly for fastening the clips to the switch sections, giving exceptional accuracy in placement and retention; (2) lower speed operation through special reduction coupling and gears; and (3) special solenoids for positive clutching.
Oak then produced the assembly...stamping the aluminum chassis...manufacturing screw machine parts...making the complicated cable harnesses, switches, and solenoids...assembling all...then running vibration, cold (-55°C), humidity, and life tests.
Why not contact Oak engineers about your own requirements? But, do it early in the design stage...take full advantage of Oak's 25 years of experience in solving electromechanical problems.

Phone or Write Our Mr. Howard Olson, Today,
on Any Aspect of Your Subassembly Projects

CAPACITOR SWITCH
built for Radio Corporation of America

1260 Clybourn Ave., Dept. D, Chicago, Illinois
Phone: MOhawk 4-2222

SWITCHES • ROTARY SOLENOIDS • CHOPPERS • SPECIAL ASSEMBLIES • VIBRATORS • TUNERS
CIRCLE 36 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 24, 1958
Transistorized Choppers
Handle signals from 0 to 100 kc

Shock and vibration resistant, these 1 gram transistorized choppers handle 0 to 100 kc signals. They may be driven by a sine or square wave with 1 to 18 v peak to peak amplitude. Type 6000 operates from —40 to +60 C and handles input signals from less than 1 mv to 5 v. For type 6010, the upper limits are extended to 85 C and 10 v.

Airpax Products Co., Cambridge Div., Dept. ED, Jacktown Rd., Cambridge, Md.
CIRCLE 38 ON READER-SERVICE CARD

Elapsed Time Indicator
2 inches long

Recording up to 10,000 hr, the WT-1 elapsed time indicator keeps track of the time electrically powered equipment is in use. It is 1 in. in diameter, 2 in. long, and weighs 3 oz. Designed to operate from 115 v, 60 or 400 cps, it attains synchronous speed almost as soon as power is applied. In a variety of mountings, the unit is hermetically sealed and meets MIL-E-5272A specifications.

Waltham Precision Instrument Co., Dept. ED, Waltham, Mass.
CIRCLE 39 ON READER-SERVICE CARD

How to cure by liquid cooling...

Monsanto Coolanol* 45 coolant-dielectric for electronic equipment...—65° to 400° F

For reliable operation of electronic equipment, Monsanto Coolanol 45 maintains desired temperature control within the range of—65° to 400° F. Pumped through jacketed components, it efficiently dissipates heat through liquid-phase heat transfer. Coolanol 45 is an excellent fluid for the "package concept" of liquid cooling systems, such as UAP's, because it can also function as a hydraulic fluid. This makes possible a one-fluid, packaged coolant and hydraulic system.

Coolanol 45 has extremely high purity, good dielectric qualities, excellent lubricity, low foam tendency, and good viscosity properties over its wide temperature range. The fluid is compatible with common materials and its non-toxicity simplifies handling methods. For complete technical data, write today for Technical Bulletin AV-3 on Coolanol 45. Address:

Monsanto Chemical Company
Aviation Fluids Department AV-6
Lindbergh and Olive Street Road
St. Louis 24, Missouri

*Coolanol: Monsanto Trademark.
The electronic and Heat requirements.

Typical weapon systems consist of heat exchanger, fan and motor, pump and motor, expansion reservoir, and safety controls to protect the system and customer’s equipment. The entire package is contained in an envelope of strict space and weight requirements.

U-518078-3, shown above, is 9 x 5.9 x 4.4 inches and weighs 6.75 lbs. exclusive of coolant fluid. Heat load of 275 watts is transferred from the electronic equipment to Monsanto COOLANOL 45. The pump circulates 1/4 to 3/4 gpm through the cooling system. Forced air through the heat exchanger maintains fluid outlet temperatures that vary between the extreme design points of 192°F. at sea level (air-in temperature 160°F.) and 220°F. at 70,000 ft. altitude (air-in temperature 36.5°F.).

Get complete information on UAP electronic cooling systems . . . or submit your application problem today for UAP design study! Call the nearest UAP Contractual Engineering Office: Burbank, California VI-9-4236; New York, N. Y. MU-7-1283; Dayton, Ohio BA-4-3841; Montreal, Canada ME-1-4396.

UNITED AIRCRAFT PRODUCTS, INC.
1116 Bolander Avenue, Dayton, Ohio

Dry Batteries
High voltage

Dynox dry batteries come in four sizes: 0.14, 1.15, 1.57, and 2.87 cu in. Respectively, the units have 95, 190, 580, and 930 v potential.

Universal Winding Co., Patterson, Moos Div., Dept. ED, 90-28 Van Wyck Expressway, Jamaica, N.Y.

CIRCLE 41 ON READER-SERVICE CARD

Terminal Blocks
Time saving design

RH terminal blocks are delivered open and ready for wire insertion. To save searching time for dropped or lost screws, each terminal has a spring clip to retain backed out screws. Rated at 750 v, 50 amp, the blocks have 1 to 20 terminals. They accept 8 to 18 AWG wire.


CIRCLE 42 ON READER-SERVICE CARD

Missing Ace

Change-Quick potentiometers, announced on p 85 of ELECTRONIC DESIGN, Nov. 12, are made by Ace Electronics Associates, Inc. Inadvertently, we dropped the Ace and credited them to Electronics Associates, Inc.

CIRCLE 40 ON READER-SERVICE CARD
If you have this problem, investigate

GRIP-EZE®
—an example of Phelps Dodge’s realistic approach to Magnet Wire research

THE PROBLEM: To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.

THE SOLUTION: Phelps Dodge Grip-eze—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.

EXAMPLE: Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

NEW PRODUCTS

Digital Logic Packages
For data handling equipment

These solid state digital logic packages can be combined to build registers, counters, computers, and other data handling equipment. They include flip-flops, inverters, gates, drivers, clock generators, and so forth. Low cost plug-in modules, they are easily replaced and can be built into systems of any size. High reliability is achieved through the elimination of both eyelets and printed circuit connectors. Shown are modules in an input buffering system.

Packard-Bell Computer Corp., Dept. ED, 100 S. Armacost Ave., Los Angeles 25, Calif.

CIRCLE 45 ON READER-SERVICE CARD

Plastic Rods and Sheets
10⁶ ohm-cm resistance

In rods and sheets of various shapes and sizes, Eccostock HT 0003 is a thermosetting plastic that withstands 500 F and exhibits almost no cold flow. From 10⁴ to 10⁶ cps, dielectric constant is 2.2 and dissipation factor is below 0.0003. Insulation resistance is 10⁶ ohm-cm. The material can be used for coaxial insulation, antenna windows, and sundry dielectric machine parts.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 46 ON READER-SERVICE CARD
Manufacturers of electromagnetic equipment can reduce material and production costs now—by switching to Alcoa® Aluminum strip windings. Equipment designed with Alcoa strip is more compact, lighter in weight, and better able to dissipate heat than conventional wire. For information about recent Alcoa developments in this field and how they benefit you—please turn the page.
NEW DESIGN CONCEPTS WITH ALUMINUM STRIP

by Robert R. Cope, Aluminum Company of America, Pittsburgh, Pa.

Light weight, better space factor, better heat dissipation, low voltage between turns, less point-to-point contact . . . these characteristics of aluminum strip have long intrigued designers of electrical windings. Today, this aluminum application is a practical reality.

Intensive research and testing by ALCOA have contributed to important technical breakthroughs. New techniques are solving problems relating to edge effect, joining and insulation.

Recently, ALCOA purchased the transformer division of Automation Instruments, Inc., to perfect winding techniques and to produce prototype coils for customers' evaluation. With this added facility, the electrical windings division of ALCOA Research Laboratories is equipped to wind coils from small solenoids up to distribution transformer sizes for testing by manufacturers—an important, new service for the electrical industry.

ALUMINUM'S NATURAL ADVANTAGES

Aluminum weighs less. In general, an aluminum strip winding weighs only half as much as an equivalent winding of copper. Based on equal current-carrying capacity, 0.48 pounds of aluminum replaces one pound of copper. (Figures are for 61.0 per cent conductivity aluminum, 97 per cent conductivity hard-drawn copper.) ALCOA No. 3 EC alloy has been developed expressly for electrical windings. Space factor of aluminum strip can be 90 per cent and higher; for copper wire, 55 per cent to 65 per cent is typical. Thus, although an aluminum strip requires more conductor volume than a conventional wire winding, the total space occupied by each is about the same. Variations in space factor will depend on the strip-to-insulation thickness ratio.

Aluminum strip windings permit higher current densities because each turn has an outside radiating edge that provides effective heat dissipation. Layer-to-layer temperatures are constant; hot spots are virtually eliminated. The inner turns of a wire-wound coil cannot radiate heat as efficiently as the outer turns.

In most cases, aluminum strip windings can be manufactured at lower cost than equivalent wire windings. Aluminum strip lends itself to automation; new high-speed winding techniques have reduced fabrication costs by eliminating much of the hand labor necessary with wire.

Conventional wire windings require heavier insulations to withstand (1) abrasion during winding, (2) abrasion from point-to-point contact between turns, (3) layer-to-layer voltage, which may be many times the turn-to-turn voltage. Aluminum strip insulation needs to withstand only turn-to-turn voltage because a single turn occupies the entire width of the coil. Thus, thinner and less abrasion-resistant insulations can be used, such as interleaved sheets of Mylar or Kraft paper . . . coatings of varnish, lacquer or epoxy . . . anodized films or vitreous enamel.

ALCOA has tested every known method of joining aluminum. Some techniques proved impractical or costly. But successful joining has been accomplished with ultrasonic welding, high temperature soldering, shielded inert arc welding, cold pressure welding, resistance welding and mechanical joining. Cold pressure welding is quite practical; joints have high strength and conductivity. Ultrasonic welding requires no heat, precleaning or flux; joints are made quickly between parts of different thicknesses, or of multiple thicknesses—and the weld can be made through many types of insulation.

Where is the best application for aluminum strip windings? In power devices or electronic equipment, the economics of aluminum strip windings are indicated when customary wire sizes are 24 gage or larger. However, in many aircraft and missile applications, where weight is a critical factor, aluminum strip is a natural application regardless of size.

Here, at a glance, are the main areas of comparison:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>HARD-DRAWN COPPER WIRE</th>
<th>ALUMINUM STRIP No. 3 EC</th>
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<tbody>
<tr>
<td>Weight (lb/ct in.)</td>
<td>0.321</td>
<td>0.098</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>8.89</td>
<td>2.70</td>
</tr>
<tr>
<td>Coefficient of linear expansion (°/°C)</td>
<td>0.000017</td>
<td>0.000023</td>
</tr>
<tr>
<td>Thermal conductivity at 20°C (watts/sq in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.7</td>
<td>6.0</td>
</tr>
<tr>
<td>Electical conductivity at 20°C per cent IACS</td>
<td>97</td>
<td>61.0</td>
</tr>
<tr>
<td>Electrical resistance at 20°C (microhms/sq in./ft)</td>
<td>8.40</td>
<td>13.14</td>
</tr>
<tr>
<td>Temperature coefficient of electrical resistance at 20°C (°C)</td>
<td>0.00381</td>
<td>0.00409</td>
</tr>
<tr>
<td>Modulus of elasticity</td>
<td>17 x 10⁶</td>
<td>10 x 10⁶</td>
</tr>
</tbody>
</table>

ALCOA Aluminum Electrical Windings will reduce your costs and improve your product. We'd like to prove it. Send your specifications to us and we will wind sample coils. Then make your own test.

ALUMINUM COMPANY OF AMERICA, 2263-M Alcoa Building, Pittsburgh 19, Pennsylvania.

Interleaving sheet-type insulation with aluminum strip.
Specially designed equipment for winding smaller coils.
Preliminary testing of foil-wound transformer.

Send for Alcoa's new Conductor Selector Chart, a convenient slide rule for converting standard wire sizes to equivalent strip conductor.

ALCOA ALUMINUM COMPANY OF AMERICA

DIAMETER PRODUCTION: 20 lbs.
Lengths up to 1,000 feet.

Model: 2010,
conductivity: 61.0 per cent.
Weight: 24 lbs. per 1000.

Four sizes:
4 x 1 x 50 ft.
6 x 2 x 50 ft.
10 x 1 x 50 ft.
16 x 2 x 50 ft.

All Alcoa aluminum ribbon meet or exceed MIL-R-8577 standards.

ALCOA CIRCLE 225

Production Coil Tester

Checks for shorts, opens, and grounds at a rate of 600 an hour, this coil tester or check for armature windings for shorts, opens, and grounds. It automatically ejects acceptable parts to a support cradle. Rejected parts light a red lamp and stay clamped to the machine until a button is pushed to release them.


Circle 48 on Reader-Service Card

Permanent Magnet Motors

Miniature

Diameters of these permanent magnet dc motors are 1-1/8 in. for BD and 1-1/4 in. for BL. They are respectively 1/2 and 1-1/4 in. long and 1/16 and 1/2 in. long. They are 26,000 rpm continuous duty at 10,000 rpm.

Dobe Industries, Inc., Dept. ED, 4401 Stanley Ave., Dayton 4, Ohio.

Circle 49 on Reader-Service Card

Transient Protector

Transistorized

Model N210 transistorized transient protector is for use on a 28 v r. e. 1 c. It passes up to 30 amp with input to output voltage drop of 1 v. The clipping level of the input voltage is 35 v. The unit is 1-1/2 x 3-1/2 x 1-1/2 in.

Alto Scientific Co., Dept. ED, 871 Commercial St., Palo Alto, Calif.

Circle 50 on Reader-Service Card

Circle 51 on Reader-Service Card

NEW Electro-Snap modular mounting

Simplified push-button panel switch

Simplifies Control Panels; Saves Space, Cuts Cost.

May be used singly or in "stacked" arrangement.

This new Electro-Snap push-button panel switch efficiently combines a name plate, pilot light assembly and a switching unit in one compact modular assembly. The trim, streamlined design permits easy "stacking" on control panels or consoles. It eliminates congestion by replacing three individual units (nameplate, pilot light assembly and switch unit). You can achieve greater operating efficiency and quality appearance while making substantial savings in space and cost.

A wide variety of configurations is available in:

- circuit arrangements of switch and pilot lights
- colored buttons for color coding
- colored lights for color monitoring
- Snap-in button permits easy lamp replacement from front of panel
- Barrier can be color-anodized to your specification

The lighted push-button switch assembly is also available without the switch unit for use where only pilot light duty is required.

Variety of Circuit Arrangements Permits Wide Range of Indicating and Switching Combinations

Switching Circuits to Meet Your Needs

The double-pole, double-throw switching unit may be used normally-open or normally-closed.

A standard Electro-Snap Unit

- Compact
- Space Saver
- Precision-Engineered
- Low Cost
New G-E grid-spaced relay

Lab test reports now confirm the outstanding performance capabilities of General Electric's new Type GS micro-miniature relay. Here are data on two tests:

7,000,000 operations plus—Type GS relays switched 360 ma at 30 v DC in an ambient of +125°C. Maximum contact resistance reading was .024 ohms during and after test.

3,000,000 operations plus—Here, relays switched dry-circuit loads of 1 micro-amp at 300 mv in an ambient continuously cycled from -65°C to +125°C. A 1000 ohm contact resistance failure point was set. No failures occurred.

New G-E grid-spaced relay terminals match standard spacing for printed circuits. The relay excels in missile and aircraft applications. Quality control tests assure that relay will meet applicable portions of MIL-R-5757C and MIL-R-25018 specifications.

Specifications include:

- Shock: 50G's per MIL-R-5757C and MIL-R-25018.
- Operating Time: 4.5 ms nominal.
- Release Time: 3.5 ms nominal.


NEW PRODUCTS

Miniature Relay

Has heavy-duty socket

For industrial and instrument use, this sealed electromagnetic relay has a 14 terminal header mated with a heavy-duty socket. The 4ph unit has a minimum creepage of 1/4 in. At reduced contact loads, it survives up to 100 million operations. In ratings to 5 amp at 28 v dc or 120 v ac, it measures 1.5 x 1.6 x 2 in.

General Electric Co., Specialty Control Dept., Dept. ED, Schenectady 5, N.Y.

CIRCLE 53 ON READER-SERVICE CARD

Magnetic Core Memory System

Modular

Made from transistorized plug-in packages, the 3C-Memory magnetic core memory system is designed to handle core matrix driving and sensing circuits. Its modular construction permits random access memories with capacities to 4096 words and 40-bit word lengths.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 54 ON READER-SERVICE CARD

DC Power Supply

Two continuously adjustable outputs

Type D-10-10-100KS4 power supply has two continuously variable outputs: 6 to 10 v, 50 amp and 6 to 100 v, 10 amp.

CIRCLE 52 ON READER-SERVICE CARD
Preamplifiers

Low noise

These miniature broadband preamplifiers give low noise and cover the 50 to 500 mc range. A typical unit accepts everything from 50 to 500 mc and has a noise figure of 5 to 8 db and a dynamic range of 60 db.


CIRCLE 56 ON READER-SERVICE CARD

Strip Chart Recorder

Offers continuous integration

This strip chart recorder measures, records, and continuously totals any linear variable with respect to time. Quantitative integration is read on a 6 digit counter at speeds to 1000 counts per minute. Analog equivalent is recorded on a chart by a dual pipping pen at rates to 500 strokes per minute. The unit is ±1% accurate.


CIRCLE 57 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD

Special aptitude test for metals

This man is vaporizing a test sample from an incoming metals shipment in a spectrograph to determine its composition. And spectral readings, accurate to .001%, will show whether or not it meets Varian's high quality standards. Copper for components, nickel alloy for cathodes, glass sealing alloys, all are critically checked and controlled before and during manufacture to guarantee that the completed Varian Tubes will perform as specified.

This is the kind of quality control that has made Varian Tubes "Standard" for all microwave installations. Over 100 of these tubes are described and pictured in our latest catalog. Write for your copy today.

VARIAN associates
PALO ALTO III CALIFORNIA

Representatives throughout the world

KEYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R.F. SPECTROMETERS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES
NEW PRODUCTS

Miniature Relays
Control one to six circuits
In 1 to 6 pdt arrangements, series DC miniature relays have snap-action, heavy duty contacts rated at 2 or 5 amp. They have 400 cps ac coils or high resistance coils for plate circuit operation. Available in various mounting brackets, the units are provided with potted leads of any specified size or length.
CIRCLE 59 ON READER-SERVICE CARD

Electro-magnetic Brake
40 oz-in. torque

Industrial Miniature-B-125 brake has a minimum torque of 40 oz-in. and weighs 6 oz. Unit's backlash is 0 deg, and power consumption is 5 w. Designed for operation on 28 v dc, its response is 50 msec.
Autotronics Inc., Dept. ED, Box 208, Florissant, Mo.
CIRCLE 60 ON READER-SERVICE CARD

Power Supply
For strain gage excitation
Designed for strain gage excitation, model SR-1000 solid-state dc power supply provides a floating output. Voltage is adjustable from 5 to 30 v; maximum output current is 1 amp; and ripple is under 1 mv. Line regulation from 95 to 135 v is 0.1%.
Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.
CIRCLE 61 ON READER-SERVICE CARD

Transitron announces

5 NEW TYPES
OF SILICON
TRANSISTORS

LOW NOISE type... lowest noise figure yet achieved
in the critical range from one cycle per second to audio frequencies. The ST1050 offers improved equipment stability down to a fraction of a cycle per second. Use it for all low level amplification problems having an input source impedance of 50 Kohms or less... strain gages, thermocouples, accelerometers.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Equivalent Input Noise Voltage (0.8 to 50 cps)</th>
<th>DC Beta @ Ic = 20mA</th>
<th>Collector Cutoff Current (100°C, -3V)</th>
<th>Collector Cutoff Current (100°C, -3V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1050</td>
<td>1.5 uV RMS</td>
<td>20</td>
<td>0.002</td>
<td>0.2 µA</td>
</tr>
</tbody>
</table>

Complete data in bulletin TE-1353

LOW LEVEL INPUT type... extremely low drift
over the recommended operating range of 2-200 µa collector current. With typical drift of only 1.0 milli-microamps per degree C and 5 milli-microamps per day, ST1026 may be used in circuits with high impedance sources... phototubes, G-M tubes, infra red tubes and ionization gages. Many new low current applications are opened up by the high beta and extremely low Ico.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Minimum DC Beta @ 3 µA</th>
<th>Maximum Collector Cutoff Current (25°C, -3V)</th>
<th>Typical Collector Cutoff Current (100°C, -3V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1026</td>
<td>15</td>
<td>0.005 µA</td>
<td>0.2 µA</td>
</tr>
</tbody>
</table>

Complete data in bulletin TE-1353
HIGH BETA types... current gain of 60 minimum

the highest level yet achieved in the industry. A useful end-of-life beta is maintained at temperatures down to -65°C, even at reduced collector current levels. The high gain of these transistors reduces the number of stages required in amplifier applications. A greater degree of degenerative feedback may be used to obtain much greater gain stability and uniformity, resulting in reliable amplifier operation.

<table>
<thead>
<tr>
<th>TYPES</th>
<th>2N543</th>
<th>2N542</th>
<th>2N541</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Common Emitter Current Gain @ 1 kc</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Typical Common Emitter Current Gain @ 1 Mc</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Maximum Collector Voltage</td>
<td>45</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Maximum Collector Cut-Off Current (25°C @ Vc Max.)</td>
<td>.5</td>
<td>.3</td>
<td>.3</td>
</tr>
</tbody>
</table>

Complete data in bulletin TE-1363

HIGH Veb/SMALL SIGNAL types
... Veb of 5 Volts minimum

eliminates the need for series diodes in many applications and protects against transients in pulse and digital circuits. This improvement in emitter-base voltage is available in Transistor's entire line of small signal transistors, at no sacrifice of other characteristics.

<table>
<thead>
<tr>
<th>TYPES</th>
<th>2N543A</th>
<th>2N408A</th>
<th>2N475A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Emitter-to-Base Voltage</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Maximum Collector Voltage</td>
<td>45</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Minimum Common Emitter Current Gain</td>
<td>80</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Maximum Collector Cut-Off Current (at Veb = 45 Volts)</td>
<td>.5</td>
<td>.3</td>
<td></td>
</tr>
</tbody>
</table>

Complete data in bulletin TE-1353

HIGH BETA/MEDIUM POWER types
... current gain of 40 minimum

at 500 milliamps. Typical power gain of 1000 into a 100 ohm load significantly reduces drive power requirements. When used in conjunction with small signal high gain types, these transistors reduce the number of components needed in a system and hence, the overall weight and volume. It is measured at maximum rated collector voltage at 150°C.

<table>
<thead>
<tr>
<th>TYPES</th>
<th>ST404A</th>
<th>ST404B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum DC Beta = 40 at Ic</td>
<td>500</td>
<td>200</td>
</tr>
<tr>
<td>Maximum Collector Voltage</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Power Dissipation (100°C, free air)</td>
<td>6</td>
<td>.6</td>
</tr>
<tr>
<td>Power Dissipation (100°C, solder heat sink mounting) (at specified current)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Typical Collector Saturation Voltage</td>
<td>3</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Complete data in bulletin TE-1355

HEAT SINK MOUNTINGS... higher power ratings

for medium power transistors in Transistor's TO-5 Outline package. These factory-fitted heat sink mountings make possible a realistic 5 watt rating at 100°C case temperature for the first time. The stud type offers the convenience of single-hole mounting, the same as for our JAN rectifiers in the 1/4" hex package. No clip is needed... insulation and mounting hardware are supplied. Complete data in bulletin TE-1355.

Proximity Pickups

Waterproof

Designed for complete water and oil resistance, these proximity pick-ups have a 10 ft cable that is potted in place. In model 4913-WPN, the cable ends with a 3-pin connector; in the 4913-WPL, with terminal lugs. The units can detect ferrous and nonferrous metal parts with diameters of less than 0.1 in., and they can be excited by gear teeth of 10 diametral pitch. When connected to a proximity control unit, they can detect moving metal pieces passing at a rate of 60,000 per min. Operating clearances for metal pieces over 3/8 in. in diameter are up to 1/4 in. The units have a 5/16 in. diameter sensing face and are 1-21/32 in. long. They operate from extremely low temperatures to 200 F.

Electro Products Labs, Dept. ED, 4500 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 62 ON READER-SERVICE CARD

Counting-Dividing Units

Speed of 100,000 counts per sec

For scaling, computing, and control, Incremag counting and dividing units have a maximum count rate of 100,000 per sec. They accept random or uniform pulses. From a 1 kc input, one form can deliver four outputs from 1 to 1000 cps.

General Time Corp., Dept. ED, 109 Lafayette St., New York 13, N.Y.

CIRCLE 63 ON READER-SERVICE CARD

TRANSISTRON

Electrical Corporation - Wakefield, Massachusetts

Transistors Diodes Regulators Rectifiers

CIRCLE 64 ON READER-SERVICE CARD
NEW PRODUCTS

Solid Tantalum Capacitors
Operate to 125 C

Maximum capacitances of type 150D solid-electrolyte tantalum capacitors now range up to 330 μF at 6 V, 220 μF at 10 V, 150 μF at 15 V, 100 μF at 20 V, and 47 μF at 35 V. The units may be operated at 125 C with appropriate voltage derating. They withstand severe shock and high frequency vibration.

CIRCLE 65 ON READER-SERVICE CARD

Broadband Load Isolators
Low power

Handling 10 w in the forward direction and 2 w in the reverse, these broadband ferrite load isolators have 1 db maximum insertion loss. Input vswr into a flat load is 1.15 maximum. Models X-12.29 and X-12.25 cover 8.2 to 12.4 kmc with 30 and 40 db minimum isolation, respectively. With the same respective isolations, models XL-12.10 and XL-12.7 cover 7 to 10 kmc, and models J-12.70 and J-12.65 cover 5.85 to 8.2 kmc.

Cascade Research, Div. of Monogram Precision Industries, Inc., Dept. ED, Los Gatos, Calif.
CIRCLE 66 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 24, 19
This plastic balloon, resting on a mobile trailer bed like a golf ball on a tee, protects the new Hughes three-dimensional radar antenna.

Frescanar, the exclusive system combining high-speed data processors and a frequency scan radar antenna, has been developed by Hughes engineers in Fullerton, California.

Sensitive to the inadequacies of conventional radar, these Hughes Fullerton engineers have devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This frequency sensitivity results in the radar beam being radiated from the antenna at different angles, depending on the frequency of the energy supplied. With the supply of a succession of frequencies, the antenna beam can be moved through a succession of positions. Utilizing this advanced technique, range, bearing and altitude can be detected...on a single antenna.

This Hughes-developed radar system has been combined with compact, high-speed Hughes data processors to provide a completely self-sufficient, mobile defense system.

Other Hughes projects provide similarly stimulating outlets for creative engineering talents. Current areas of Research and Development include Advanced Airborne Electronics Systems, Space Vehicles, Nuclear Electronics, Subsurface Electronics, Ballistic Missiles and many more. Hughes Products, the commercial activity of Hughes, has assignments for imaginative engineers for research in semiconductor materials and microwave tubes.

The diversity and advanced nature of Hughes projects provides an ideal environment for the engineer or physicist interested in advancing his professional status.

**Conductive Cement**

For printed circuit repair

Hysol 6250 is a conductive cement based on epoxy resins. Its volume resistivity is 0.01 ohm-cm at 25 C. For repairing printed circuits or bonding electrical components, it cures in 24 hours at room temperature, or in two hours at 140 F.

Houghton Labs, Inc., Dept. ED, Olean, N.Y.
CIRCLE 67 ON READER-SERVICE CARD

**Silicon Transistor Chopper**

Operates from -55 to +130°C

Encapsulated in epoxy resin, model 70 silicon transistor chopper withstands 500 g shock for 11 msec, 30 g vibration from 0 to 2000 cps, and 700 g acceleration. Operating from -55 to +130 C, it has a chopping frequency of dc to 100 kc. The driving voltage is square wave, 5 to 10 v peak to peak. Both driving source and input resistances are 600 ohms. Input voltage can range from less than 1 mv to over 10 v, and output voltage equals chopped input voltage. The unit may be used as a modulator or demodulator and is suited for low level voltage measurements, dc amplifier stabilization, high speed servomechanisms, thermocouple instrumentation, and low level switching. It is 5/16 in. in diameter and 1-1/8 in. long.

CIRCLE 68 ON READER-SERVICE CARD
NEW PRODUCTS

DC to DC Converter
300 v dc output

Solid state model PP 12300 converter has an output of 300 v dc at 100 ma for a 12 v dc input. In a commercial case or hermetically sealed, it can serve as a plate supply for all types of communication and telemetering equipment.
Polytron Engineering Inc., Dept. ED, 32 W. Biddle St., Baltimore 1, Md.
CIRCLE 69 ON READER-SERVICE CARD

Power Supply
Has continuously variable output
Transistorized type PS-T-LV12 power supply provides 6 to 18 v at 2 amp, continuously variable. Load regulation is 0.3% no load to full load, and line regulation is 1% for a 105 to 130 v input.
The Reflectone Corp., Dept. ED, Stamford, Conn.
CIRCLE 70 ON READER-SERVICE CARD

Time Sequence Control
Operates on 3 channels

Fully automatic, this time sequence control operates on three channels and handles any time up to 130 sec on the selected channels. Of sturdy construction, the unit is suited for production as well as laboratory testing.
Mid-Eastern Electronics, Inc., Dept. ED, 32G Commerce St., Springfield, N.J.
CIRCLE 71 ON READER-SERVICE CARD

FOR BETTER WIRE TERMINATING

AMP PATCHBOARD TECHNIQUE

A-MP PATCHCord PROGRAMMING SYSTEMS AND PANELS offer tremendous versatility and flexibility. Exclusive feature of A-MP Systems is wiping action of pins against springs for clean contacts. A-MP Universal Patchcord Programming Systems and Panels are excellent for digital computers, data processing equipment and automatic test equipment. A-MP Shielded Patchcord Programming Systems and Panels are excellent for analog computers, telemetering equipment, test equipment and other low level applications where reliable shielding is required. Patchcords are made in a complete series for all programming requirements.

A-MP "240" SYSTEMS ... offer complete reprogramming in seconds in airborne applications. The compact "240" System weighs 31/4 pounds and features 240 patchcord receptacles for maximum program combinations. It, too, features the exclusive wiping action to assure optimum electrical contact at all times.
Bulletin Number 58

CIRCLE 103 ON READER-SERVICE CARD

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

CIRCLE 104 ON READER-SERVICE CARD

AMP Incorporated
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

ELECTRONIC DESIGN • December 24, 1959
Temperature Control

Noncontacting

A noncontacting monitor and control, the Pyrotrol, senses the temperature of objects 6 inches or many feet distant. Insensitive to flame, it reacts only to infrared radiation. Operating range is 950 to 2000 F, and repeat accuracy is within 0.5% of scale.

Mason Instrument Co., Dept. ED, 29 Elm Ave., Mt. Vernon, N.Y.

CIRCLE 72 ON READER-SERVICE CARD

Terminal Block

Snaps together

The Modulok terminal block consists of modules that snap together and fit into a steel track where they are held in place by end locks. Holding up to 30 modules per foot, the tracks come in lengths to 32 in. The modules have either two or four tier spring-loaded plated sockets which may be set for quick-disconnect or made into permanent connections with a screwdriver. The block accommodates wire sizes 22 through 12.

Burndy Corp., Omatic Div., Dept. ED, Norwalk, Conn.

CIRCLE 73 ON READER-SERVICE CARD

Motor Alternators

Provide 420 cps current

PA-40 and SA-40 motor alternators will operate computers, synchros, servo mechanisms, and other control equipment. They can be provided with outputs of 115 or 230 v, single, two, or three phase, at 420 cps. Inputs may be supplied at 230 or 460 v, 50 cps, three phase; 220 or 440 v, 60 cps, three phase; or 220 v, 60 cps, single phase.

Electric Motors and Specialties, Inc., Dept. ED, King and Hamsher Sts., Garrett, Ind.

CIRCLE 74 ON READER-SERVICE CARD

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

CIRCLE 105 ON READER-SERVICE CARD

CIRCLE 106 ON READER-SERVICE CARD

CIRCLE 107 ON READER-SERVICE CARD
Chicago Aerial Industries has developed a camera control system that allows one jet pilot to do the job of ten expert aerial photographers...automatically.

Heart of this new unit is the CAX-12 servo power unit. It accurately synchronizes film speed with speed of the jet—changes lens openings in response to electronic signals—regulates shutter speed and controls driving motor on cameras.

Because this power unit is vital to the camera control system component reliability is a must. That's why CAI relies on Edison Thermal Time Relays exclusively for CAX-12.

Edison's line of miniature time delay relays are available for a wide range of electronic applications. They are light, small, rugged and offer these advantages:
- Designed to withstand vibration frequencies to 500 CPS
- Exceptionally high rate of contact closure
- Permanent calibration and hermetic seal
- Extremely rigid mechanical structure using high-strength, high-expansion alloys.

NEW PRODUCTS

Servo Motor
Velocity damped

Servo motor model 8 VM 420 damped by the magnetic couple of a low inertia drag cup to a fixed field of two parallel magnets. The field intensity can be varied to provide added damping up to dyne-cm-sec per radian. The velocity-damped motor has an undersized rotor with 0.24 gm-in inertia. Stall torque is 0.25 m-N and acceleration at stall is 76 rad/sec. The unit is 1.395 in. long.

Beckman Instruments, Inc., Electronic Instrument Div., Dept. ED, Fullerton, Calif.

Circle 76 on Reader-Service Card

Microwave Relay System
For 120 to 240 channel operation

Operating in the 5925 to 8500 kc band, model MCR-1000 microwave relay system accommodates 120 to 240 channels. It has linear base-band response and 1 watt output.


Circle 77 on Reader-Service Card

Emitter Follower
Designed for missiles

For use in aircraft and missile programs, this emitter follower model 5000 generates from -65 to +185 F high noise and shock conditions. It permits measurements from 1 cps to 100 kc and handles signals of less than 1 microvolt and pulse amplitudes up to 20 volts. Each stage is 10 times stable at power supply variations, less than 0.1%.

Perkin-Elmer Corp.

Circle 78 on Reader-Service Card

The FBU-1P Crusader recently set new coast-to-coast speed record. CAI camera control system with Edison Time Delay Relay was used to automatically provide sharp, clear aerial photographs of the entire flight.
Primary Phase Standard

\[ \pm 0.01 \text{ degree accuracy} \]

Self-calibrating type 7000-B audio primary phase standard has an ultimate accuracy of \( \pm 0.01 \) degree. It supplies two sinusoidal voltage signals whose phase relationship, continuously variable from 0 to 360 deg, is known to \( \pm 0.05 \) deg. The two signals have the same frequency set at one selection from 30 cps to 20 kc.

Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

CIRCLE 79 ON READER-SERVICE CARD

Differential Transformer

Has large bore

Model 1000XS-N variable differential transformer has a large bore which suits it for flow meter and other applications where a tube must separate core and transformer. With a linear range of 1 in. either way from null, the unit provides a stepless output with less than 1% deviation from a straight line.

Schaevitz Engineering, Dept. ED, Route 130 and Schaevitz Blvd., Penasauken, N.J.

CIRCLE 80 ON READER-SERVICE CARD

CIRCLE 81 ON READER-SERVICE CARD

ESC WIDE BAND VIDEO TRANSFORMERS have been engineered and developed to offer... subminiature units of unusually wide bandwidth (10 CPS to 8.0 MC). They are used to replace bulkier and more costly components, thereby creating greater economy, and increasing equipment efficiency. There are 14 catalog units available from stock, cased or uncased.

ESC ELECTRONIC COMPONENTS DIVISION specializes in the design and development of Wide Band Video Transformers to meet your particular applications. Each transformer prototype is accompanied by a comprehensive laboratory report, which includes submitted electrical requirements, photo-oscillograms (which indicate input and output pulse shape and output rise-time), the test equipment used, and evaluation of the electrical characteristics of the prototype.
Just published—bobbin core guaranteed performance limits!

We have just published new data which will light the way to ease, sureness and accuracy for the designer who works with tape wound bobbin cores.

First—and this is a "first"—we have published guaranteed maximum and minimum performance limits for all of our bobbin cores. Computer-type designers who would like open-circuit characteristics, guaranteed core flux and guaranteed squareness will find them all here.

Second—and this too is a "first"—we have published the first fundamental data on characteristics of bobbin cores for circuit designers. Need core total flux characteristics as related to core material? Want switching time vs drive levels? How about typical spreads of core characteristics? It's all yours.

Third—and this too is a "first"—we automatically give you test data for prototype orders. With your prototype cores come open-circuit outputs, total flux, and squareness data. You get a basic understanding of the core's characteristics under specific test conditions. More important, when you re-order production quantities, you will be able to duplicate the core around which you designed your circuit.

Last—but still a "first"—to show that we manufacture as well as publish, we have designed the first bobbin core protective cap which will permit normal potting procedures for all sizes of steel and ceramic bobbins. Our "Poly Caps" have virtually no effect on dimensions—and will not soften or deform under manufacturing or operational temperatures. We'd like to show you samples.

At what stage do you want to start? Whether it's design data, prototype data and cores, or production quantities of our "Performance-Guaranteed" bobbin cores—you can get what you need by writing Magnetics, Inc., Department ED-48, Butler, Pennsylvania.

MAGNETICS inc.

New Products

RF Signal Generators
Permit remote tuning

For the S through K bands, these tunable magnetron rf supplies consist of a modulator and an rf source, and an optional remote control unit. Pulse rates of 1000 pps and pulse widths of 0.5 to 5000 μsec are standard. Typical rf sources are the 2J51, tuneable from 8500 to 9600 mc with 35 db peak power, and the 2J66, tuneable from 28 to 2905 mc with 15 kw peak power.


Low Pass Filters
Sharp cutoff

Compact type 4 low pass filters have sharp cutoff characteristics. They cover a frequency range from 100 to 2000 mc and are supplied with TNC, BNC, and N connectors. Insertion loss is 0.4 to 0.8 db ripple in the pass band. VSWR is 1.5 maximum in the pass band. Rejection slope is 40 db minimum at 1.25 x f0 second harmonic is 60 db minimum; and spurious responses are 40 db minimum greater than 2 x f0. Nominal impedance is 50 ohms and power handling is 15 or 50 w cw. The units weigh between 0.19 and 0.58 lb.

Grid Dip Meter
400 kc to 250 mc range

Supplied complete or as a kit, the 710 grid dip meter covers 400 kc to 250 mc in seven overlapping ranges. Its meter movement is 500 μa. The unit may be used to align traps and filters, as a signal or marker generator. It comes with wound plug-in coils calibrated to ±0.5% accuracy.

Electronic Instrument Co., Inc., Dept. ED, 91-27 Northern Blvd., Long Island City, 1, N.Y.
CIRCLE 85 ON READER-SERVICE CARD

Contact Meter and Controller
Work together or apart

The C'trol combination contact meter and controller continuously limits or controls any electrical variable. The self-contained transistorized unit uses no locking coils or magnetic contacts. Set is automatic. The modular panel-mounted meter and chassis-mounted controller may be used together or separately.

CIRCLE 86 ON READER-SERVICE CARD

Regulated Power Supply
Has two outputs

With 0.01% regulation and stability, model C-31 transistorized power supply delivers two independent outputs of 0 to 32 v, 0 to 1.5 amp. Ripple is under 1 mv rms; recovery time, 1 usec; output impedance, 0.01 ohm.

Kepco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Jamaica, N.Y.
CIRCLE 87 ON READER-SERVICE CARD

GENERAL TRANSISTOR IS NOW MAKING GERMANIUM SUBMINIATURE GOLD BONDED DIODES

You may be assured that this new product line has the same high quality and reliability that has made General Transistor the Fastest Growing Name in Transistors. Experienced design engineers, quality materials, proven production techniques, and strictly enforced quality controls are your guarantees.

These diodes have been designed for computer, industrial and military applications where high reliability is of prime importance. They are hermetically sealed in a glass case with tinned leads. Their rugged construction makes them resistant to humidity, shock and vibration, and impervious to extreme environmental conditions.

Write today for Bulletin GD-10 showing complete specifications, diagrams and other engineering data.
BARDEN engineers work with you creatively from design to application

To achieve system isoelectricity and minimize moment errors, gyro rotors need bearings that provide rotational accuracy, exact positioning and controlled axial and radial yield rates.

All standard Barden Precision bearings have the extreme accuracy required for precise radial and axial positioning. In addition, the special purpose Z148 has these important features:

- Closely controlled contact angles—essential for bearing or system isoelectricity
- Inner ring raceways ground in shaft—to simplify rotor design . . . reduce mating part errors . . . improve bearing alignment
- Ball bearing yield and system isoelectricity

Write for the Barden booklet, “Ball Bearing Yield and System Isoelasticity.” An aid to application of precision instrument bearings, it offers background data on axial and radial play, axial take-up, preloading, iselastic bearings and achievement of system isoelectricity.

One of hundreds of Barden “specials,” the Z148 is an example of the results that stem from working creatively with Barden engineers from the earliest design stage.

Like all Barden Precision bearings, standard or special purpose, the Z148 is planned for performance from research and design, through quality controlled production, functional testing and application engineering.

Your product needs Barden Precision if it has critical requirements for accuracy, low torque or low vibration . . . if it operates at extreme temperatures or high speed.

THE BARDEN CORPORATION

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

NEW PRODUCTS

Piezoelectric Accelerometers

Ungrounded

Series AXT ungrounded piezoelectric accelerometers may be directional or tridirectional. They operate from -100 to +525 Fe. ±5% accuracy and ±1% line Standard housings are titanium, aluminum can be provided.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.
CIRCLE 90 ON READER-SERVICE CARD

Filter Set

Octave band

Model 530P filter set, when attached to the company’s GR151 sound level meter, permits measurements in octave bands between 30 cps and 10 kc. The unit has built-in transistorized amplifier, measuring noise to 36 db below overall noise level. A switch selects the filter in and out so that the set need not be disconnected from the sound level meter at any time.

Allison Labs, Dept. ED, 14 Skyline Dr., La Puente, Calif.
CIRCLE 91 ON READER-SERVICE CARD

Transistorized Power Supply

±5 mv long term stability

Output of this transistor power supply is 0 to 30 v at

CIRCLE 89 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 24, 1965
**LECTROFILM®-B CAPACITORS**

For Computer Applications, General Electric Announces...

**New Lectrofilm®-B Capacitors**

With a Design Life of 44,000 Hrs.

Over 3,000,000 unit-hours of life test data in accordance with G-E Specification MTC-3 indicate a probability of survival in excess of 0.99 for 44,000 hour life, under rated voltage at 85°C. At 125°C, indicated probability of survival is in excess of 0.98...and low unit cost means the highest order of reliability per dollar invested.

**LOW FAILURE RATE AND LONG LIFE** of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls...units are precision wound with high-purity aluminum foil and capacitor-grade Mylar® film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

**SMALL, LIGHTWEIGHT ENCLOSURE** consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

TO MEET YOUR APPLICATION REQUIREMENTS, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volt. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.


* Trade-mark of General Electric Co.

† Registered trade-mark of DuPont Co.

**Progress Is Our Most Important Product**

**GENERAL ELECTRIC**

**LECTROFILM**

**-B CAPACITORS**

**CIRCLE 92 ON READER-SERVICE CARD**

**CIRCLE 93 ON READER-SERVICE CARD**

**CIRCLE 94 ON READER-SERVICE CARD**

**CIRCLE 95 ON READER-SERVICE CARD**

**CIRCLE 96 ON READER-SERVICE CARD**
NEW PRODUCTS

Electronic Delay Timer
Plug-in

Complete in a 2 x 2-1/4 x 3-1/8 in. can, this delay timer employs a unique circuit to control the breakdown of gas tubes and provide 0.001 to 300 sec delays. Unaffected by line voltage variations, the timer needs no warmup and consumes under 2 w. It has an octal radio type plug and can be provided with an spdt or 3pdt relay. It can also be supplied to operate an external relay. The unit recycles instantly. Any number of these timers can be connected to provide a sequence of controlled intervals.


CIRCLE 98 ON READER-SERVICE CARD

Volt-Ohm-Milliammeter
Highly sensitive

Volt-ohm-milliammeter model 980 is an analyzer with 20 K per v dc and 1 K per v ac sensitivity. Its accuracy is 2% full scale dc, 3% ac. The unit has seven dc ranges to 4000 v, six ac ranges to 1600 v, six db ranges from -15 to +54 db, and six dc ranges to 8 amp.

Weston Instruments, Div. of Daystrom, Inc., Dept. ED, Newark 12, N.J.

CIRCLE 99 ON READER-SERVICE CARD

Rotary adjustable—available individually unmounted or in combinations on rack mounted panels—every production unit completely tested for insertion loss and voltage standing wave ratio—guaranteed for two years.

Read these specs!

<table>
<thead>
<tr>
<th>Type</th>
<th>V6</th>
<th>V7</th>
<th>V8</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Steps</td>
<td>5</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>DB/Step</td>
<td>10</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Specification</td>
<td>0 - 50 db</td>
<td>0 - 11 db</td>
<td>0 - 11 db</td>
</tr>
<tr>
<td>Freq. Range</td>
<td>0 - 500 MC</td>
<td>0 - 500 MC</td>
<td>0 - 500 MC</td>
</tr>
<tr>
<td>Overall Accuracy</td>
<td>.5 db at 500 MC</td>
<td>.25 db at 500 MC</td>
<td>.1 db at 500 MC</td>
</tr>
<tr>
<td>Impedance*</td>
<td>50 ohm</td>
<td>50 ohm</td>
<td>50 ohm</td>
</tr>
<tr>
<td>SWR - 100 MC</td>
<td>1.02</td>
<td>1.02</td>
<td>1.02</td>
</tr>
<tr>
<td>SWR - 500 MC</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Max. Insertion Loss DC</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Max. Insertion Loss 100 MC</td>
<td>&lt;.1 db</td>
<td>&lt;.1 db</td>
<td>&lt;.1 db</td>
</tr>
<tr>
<td>Power Dissipation**</td>
<td>1/2 watt</td>
<td>1/2 watt</td>
<td>1/2 watt</td>
</tr>
</tbody>
</table>

*Note: power rating means actual power dissipated in the attenuator and varies with power input and attenuation setting.

**Note: 75 ohm units also available.

Write for complete information.

Ortho Filter Corp.

196 Albion Avenue
Paterson 2, New Jersey
Mulberry 4-5858
Transistorized Power Supply

2 amp output

This power supply has a 2 amp output over a voltage range of 0.5 to 36 v dc. Designed model 62-124, it operates continuously in temperatures up to 50 C. Regulation is 0.05% for the voltage change from 105 to 125 v, and 0.05% from no load to full load. Unit is short circuit proof and free from line transients in its output. Dressen-Barnes Corp., Dept. ED, 250 N. Vineo Ave, Pasadena, Calif.

CIRCLE 115 ON READER-SERVICE CARD

Power Converter

Output of 200 amp, 28 v

From a three phase, 400 cps, 115 or 200 v source, the W-1328 transistorized converter delivers 200 amp of 28 v rectified power. It weighs 7 lb, has a 50,000 hr life expectancy, and meets MIL-E-5272A specifications.

Electrosolids Corp., Dept. ED, 13745 Saticoy St, Panorama City, Calif.

CIRCLE 116 ON READER-SERVICE CARD

Multitester

Pocket size

Furnished semi-assembled, the TK-10 pocket size multitester has six dc and five ac voltage ranges from 0 to 1000; three resistance ranges from 10 K to 1 meg; three dc current ranges from 15 to 250 ma; and two db ranges. Sensitivity is 20 K per v on dc and 10 K per v on ac. Lafayette Radio, Dept. ED, 165-08 Liberty Ave., Jamaica 33, N.Y.

CIRCLE 117 ON READER-SERVICE CARD

number 1 source for the finest semiconductors made today!

General Instrument Corporation

for all your RECTIFIER and DIODE needs

General Instrument for Silicon

AUTOMATIC SILICON POWER RECTIFIERS  RR  RADIO RECEPTOR SILICON DIODES

General Instrument for Germanium

RR  RADIO RECEPTOR GERMANIUM DIODES

General Instrument for Selenium

RR  RADIO RECEPTOR HIGH CURRENT DENSITY SELENIUM RECTIFIERS

Complete reliability, long life—along with dependable delivery and competitive prices! The General Instrument trademark assures you that these claims are valid. Whether your requirements are for silicon power rectifiers, germanium or silicon signal diodes or selenium rectifiers, General Instrument is the only supplier that can meet all of your needs from a single source. Because of this, General Instrument can afford to be objective in making recommendations and you can be certain that your application will be reviewed in an unbiased manner—And that the device best suited for your needs will be offered.

The General Instrument team of semiconductor experts and its many years of production know-how assure you of superior products at competitive prices with on-time deliveries.

All General Instrument semiconductor products, sold under the AUTOMATIC and RADIO RECEPTOR trademarks, are available at strategically located distributor organizations—in many cases no further away from you than a local telephone call.

We solicit your inquiries and requests for technical data sheets pertaining to standard types.
NEW PRODUCTS

Photoheads
For electronic counters
These photoheads permit Count-Pak electronic counters to operate up to 30 in. away from a light source. They can be assembled so that jarring will not knock them out of focus.
Veeder-Root Inc., Dept. ED, 70 Sargeant St., Hartford 2, Conn.
CIRCLE 119 ON READER-SERVICE CARD

Transistorized Power Supplies
±0.25% regulation
This transistorized power supply line includes plug-in units for ac to dc power supplies, dc to dc converters, dc to ac inverters, and rack-mounted and bench top dc supplies. Standard regulation is up to ±0.25% with a 0.05% ripple content.
Consolidated Avionics Corp., Dept. ED, Westbury, N.Y.
CIRCLE 120 ON READER-SERVICE CARD

Potentiometers
In 25 to 500 K values
Internal redesign has raised the rating of model 3 Radiohm variable resistors from 1/4 to 1/2 w. The miniature units come in values from 25 to 500 K and meet MIL-R-94B requirements.
CIRCLE 121 ON READER-SERVICE CARD

Input Transformers
Plug-in
Designed to match the impedance of a microphone, pickup, or line to a high impedance amplifier, these input transformers have a frequency response of 20 cps to 20 kc ±2 db. The plug-in units have double mu metal shielding.
Microtran Co., Inc., Dept. ED, 45 E. Mineola Ave., Valley Stream, N.Y.
CIRCLE 122 ON READER-SERVICE CARD

READY FOR TOMORROW’S CIRCUITS-

Only tubes can perform many difficult jobs of tomorrow’s advanced systems and still give the performance, flexibility, and reliability you require. The significance of these tube advantages is increasing through General Electric’s program to improve constantly such 5-Star qualities as known, predictable reliability.
ElectroniC tubes are, and will remain, superior in these areas of performance:

- Proved reliability.
- VHF and UHF capability, and flexibility at these frequencies.
- One third the number of devices.
- Economy.
- Stable under ambient-temperature variations. Tolerate high temperatures.
- Low noise in wide-band RF circuits.
- High-voltage capability.
- Uniform product, with predictable performance to ratings.

This margin of superiority grows as General Electric's active program of improvement makes 5-Star Tubes still more efficient and reliable. Design; manufacture; test; application—every product stage from development to final use in circuits shows progress in materials, methods, or both, as illustrated and described below.

14,000 tubes, using various cathodes and cathode coatings, make up one of many tests by General Electric to help determine the specifications for future 5-Star Tubes having even better performance. Equipment designers can be sure that General Electric leadership in high-reliability tubes is being maintained and strengthened; that 5-Star types will continue to meet the challenges of advanced electronic circuitry.

Beam Power Tubes

250 w plate dissipation

Capable of dissipating 250 w in the plate, these small beam power tubes are forced air cooled and designed with ceramic-metal seals. They can be operated with full ratings to 500 mc. Model 7203/4CX250B has a 6 v, 2.6 amp heater; model 7204/4X250F has a 26.5 v, 0.58 amp heater.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 470 ON READER-SERVICE CARD

Power Supplies

Provide B+, B-, bias voltages

Operating from a 400 cps power line, these miniature power supplies provide various B+, B- or bias voltages. They are sealed in an octal plug-in base.

Magnetico, Inc., Dept. ED, 6 Richter Court, East Northport, N.Y.

CIRCLE 124 ON READER-SERVICE CARD

Impact Switch

Works in 90 μsec

For missile and kindred speed measurement requirements, this single action impact switch has a controllable time limit range of 90 to 200 μsec. It may be supplied in 95% nonmetallic materials. Vibration and shock resistant, it operates from -80 to +185 F.


CIRCLE 125 ON READER-SERVICE CARD
VICTOR DIGIT-MATIC PRINTERS

Proved by over 16,000,000 printings without repairing, adjusting or cleaning!

The adding machine in the Digit-Matic has been tested with over 16,000,000 continuous printings, with no failure, no service other than periodic oiling. Forty years of experience in producing 1,500,000 adding machines—as well as precision instruments such as the Norden Bombsight—has given Victor Adding Machine Co. outstanding qualifications for producing rugged and reliable digital printers.

CHECK THESE 4 VICTOR ADVANTAGES

Reliability: Examine the rugged construction of a Victor machine. Each part is conservatively designed to provide extended life and reliability. Wearing surfaces heat treated, cadmium hardened to stand up under constant use. All steel parts cadmium plated to prevent rusting.

Immediate Service: Factory-trained servicemen (and parts) are on call in more than 725 cities coast to coast.

Flexibility: At least 500,000 different combinations available, with speeds up to 33 characters per second. With Victor Digit-Matics you have your choice of listsers, accumulators, or calculators plus an almost infinite number of other variations ranging from electrical noise filters to upside-down printing.

Fast Delivery, Low Price: Because of Victor’s continuous high volume of adding machine production, we can ship almost any quantity of Digit-Matics—built specifically to your order—within 30 days. Victor Digit-Matics, from only $2.50, are the value buy in the digital printer field.

VICTOR SERIAL ENTRY DIGIT-MATIC PRINTER

10 Digit solenoids. Digits are entered in sequence with most significant digit first. Accepts digits at a rate up to 20 per second. Print cycle: listsers 0.27 seconds; accumulators 0.35 seconds. Available in up to 11 column entry capacity.

COIL DATA

<table>
<thead>
<tr>
<th>Voltage</th>
<th>25-28VDC</th>
<th>45-54VDC</th>
<th>125-160VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance, ohms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit solenoid</td>
<td>25.5</td>
<td>75.0</td>
<td>400.0</td>
</tr>
<tr>
<td>→ or → Print solenoid</td>
<td>25.5</td>
<td>75.0</td>
<td>400.0</td>
</tr>
<tr>
<td>Minimum on time, seconds</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>Maximum on time, seconds</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
</tr>
<tr>
<td>Minimum off time between digits—all serial entry machines</td>
<td>.025 seconds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VICTOR PARALLEL ENTRY DIGIT-MATIC PRINTER

All digits 1 through 9 of each column equipped with solenoids. Digit and print command solenoids may be simultaneously energized. Print cycle: listsers 0.30 seconds; accumulators 0.35 seconds. Available in up to 10 column entry capacity.

COIL DATA

<table>
<thead>
<tr>
<th>Voltage</th>
<th>20-28VDC</th>
<th>31-56VDC</th>
<th>125-160VDC</th>
<th>105-250VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance, ohms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit solenoid</td>
<td>17.6</td>
<td>53.0</td>
<td>700.0</td>
<td>125.0</td>
</tr>
<tr>
<td>→ Print solenoid</td>
<td>17.6</td>
<td>89.0</td>
<td>375.0</td>
<td>125.0</td>
</tr>
<tr>
<td>Minimum on time, seconds</td>
<td>.020</td>
<td>.020</td>
<td>.015</td>
<td>.025</td>
</tr>
<tr>
<td>Maximum on time, seconds (continuous printing)</td>
<td>.050</td>
<td>.050</td>
<td>.035</td>
<td>.050</td>
</tr>
</tbody>
</table>

A few popular model variations:—columnar spacing; right side of machine accumulating and left side listing data identification; Non-Add printing; Non-printing adding; MIL-I-17623 Electrical Motor Noise elimination; Induction Motors; Manual Keys over the solenoids; “digit key depressed” switch (serial entry Digit-Matics); tag and label printing; and all kinds of alphabetic and special types.

NEW PRODUCTS

Stacked-Foil Capacitors

Standard ratings to 260 C

Stacked-foil Fabrika capacitors can be used in jet ignition systems, missile controls, in reactors, and high voltage dc power supplies. A dielectric of silicone bonded mica paper limits them to function effectively at high temperatures. Standard units have ranges from -100 to +125, +160, +200, or +260 C. Special units can operate at 310 C. Radiation resistant, these capacitors are available uncased, uncased and clamped, in cast epoxy housings, or in metal cases.


CIRCLE 127 ON READER-SERVICE CARD

Reference Resistors

Accurate within 1%

Certified accurate within 1% at a given temperature and humidity, these improved reference resistors are available in values of 100, 1,000, 10,000, 1,100,000, 1,100,000, 1 million, and 10 million ohms. Designed to plug directly into any of the company’s megohmmeters, the instruments are supplied in a Faraday box, utilizing Teflon insulating rings which are encompassed by grounded guarding rings. Surface leakage is virtually eliminated by silicone treatment.

Mid-Eastern Electronics, Inc., Dept. ED, 301 Commerce St., Springfield, N.J.

CIRCLE 128 ON READER-SERVICE CARD
Size 8 Servo Motor

Velocity Damped

Designed to replace motor generators in servo loops, model 8 VM 460 is a size 8 velocity-damped servo motor for 115 V operation. It permits damping up to 85 dynes-cm-sec per radian. 0.34 gm cm² rotor inertia and 0.53 oz-in. torque produce an acceleration of 68,000 per sec². The unit has a no load speed of 700 rpm and a 3.3 W power input. It passes E-5272A tests and stands 100 g shock and vibration at 2000 cps in all major axes. Its speed range is -55° to +190°.

Eckman Instruments, Inc., Helipot Div., Dept. Fullerton, Calif.

CIRCLE 129 ON READER-SERVICE CARD

Snap Action Switch

Has safety lock

This snap action switch has a safeguard to prevent it from being moved by accident. It will move from neutral unless the toggle handle is raised or pulled out. Particularly suited for high instrument panels, the dpdt unit comes in four switching combinations: momentary, latch, maintained; maintained, neutral, momentary; momentary, neutral, momentary; or maintained, neutral, maintained. Any or all parts of these combinations can be supplied with the switch feature.

Field Switch Corp., Dept. ED, Frankfort, Ind.

CIRCLE 130 ON READER-SERVICE CARD

Power Supply

Protected against spikes

Model 6073 transistorized power supply has protection against spikes and transients. Communication and navigation applications, 8.5 in. in diameter and 8.25 in. long. It provides 100 and 100 V from 27 V dc input and from -40 to +80°C with 87% efficiency.

Universal Transistor Products Corp., Dept. B-11 Brooklyn Ave., Westbury, N.Y.

CIRCLE 131 ON READER-SERVICE CARD

The E-315 capacitor offers proven stability of operation over the temperature range of -55° to +315°C with no voltage derating and low capacitance variation. Of rugged hermetically sealed construction and nonstrategic materials, this capacitor is built for high altitude and severe environmental operation.

This nonpolarized capacitor is available in a variety of sizes in a capacity range of from 0.05 to 4.0 microfarads at 600 VDC. It is also available in higher voltage ratings. Performance data and operating characteristics are given in Technical Bulletin SL-61 which is supplied upon request.

*Confirmed by qualification test of 100 hours at 100% rated voltage over ambient temperature range of -55° to +315°C.

CIRCLE 132 ON READER-SERVICE CARD

Scintilla Division

Sidney, New York

CIRCLE 133 ON READER-SERVICE CARD

New ESNA CLINCH NUT HANDBOOK

Here's a brand new design manual giving full information on ESNA's line of self-locking clinch type Elastic Stop® nuts. The manual covers such points as:

Applications

Design Features

New Flush mounting Types:

Insertion methods

Correct part selection

Plus: Materials, finishes and complete dimensional data

SEND TODAY for your copy.

Write Dept. 9-V-7 Elastic Stop Nut Corporation of America,

2330 Vauxhall Road, Union, New Jersey.

This new flush mounting miniature ESNA Clinch nut is easily installed by a simple flaring operation—becomes a permanent fastener.

CIRCLE 134 ON READER-SERVICE CARD
**NEW PRODUCTS**

**ROTARY DIAZO PRINTERS.**—Blu-Ray 1959 models have improved paper feed. Cases can be quickly removed with snap fasteners.

Reproduction Engineering Corp., Dept. ED, Ivoryton, Conn.

**CIRCLE 136 ON READER-SERVICE CARD**

**UNIVERSAL TRANSISTOR TESTER.**—Model TT-1 tests npn and pnp low, medium, and high power types. Has both socket and external leads. Needs no external power connection.

The Reflectone Corp., Dept. ED, Post Rd. and Myano Lane, Stamford, Conn.

**CIRCLE 137 ON READER-SERVICE CARD**

**WIRING DUCT CORNER STRIP.**—In 5 ft lengths easily cut to any height. Makes corners for any of the company's plastic ducts.

Panduit Corp., Dept. ED, 14461 Waverly Ave., Midlothian, Ill.

**CIRCLE 138 ON READER-SERVICE CARD**

**TELEMETERING PRESSURE GAGE.**—Single coil variable inductance gages 7/8 in. diam. and 1.3 or 1.6 in. long. Absolute, gage, and differential units in ranges from 5 to 5000 psi for use from 1.3 to 70 kc and -85 to +250 F.

Travis Instruments, Inc., Dept. ED, 1901 E. Walnut St., Pasadena, Calif.

**CIRCLE 139 ON READER-SERVICE CARD**

**INDUSTRIAL SERVO MOTOR.**—Model A Selsyn transmitter-receiver features rugged, waterproof construction. Operates from 115 v, 50 to 60 cps. Maximum torque is 2.75 oz-in.; maximum speed, 500 rpm.

Rotron Controls Corp., Dept. ED, Woodstock, N.Y.

**CIRCLE 140 ON READER-SERVICE CARD**

**HEAVY-DUTY INDUSTRIAL THERMOCOUPLE.**—PermaKouple consists of heavy protecting tube with two no. 8 B & S gage wires completely embedded in solid ceramic. Remains rigid indefinitely in temperatures to 2200 F. In standard pipe diameters of 1/2, 3/4, and 1 in.


**CIRCLE 141 ON READER-SERVICE CARD**

12 INCH CATHODE RAY TUBE.—Type SC-2558 uses electrostatic deflection, post deflection acceleration, and an aluminized P7 screen. For medical, radar, and other oscilloscope equipment.

Sylvania Electric Products Inc., Dept. ED, Seneca Falls, N.Y.

**CIRCLE 142 ON READER-SERVICE CARD**

**RIGID VINYL WIRING DUCT.**—Type O has slots instead of holes to speed installation of large lugged wires on control panels. Eliminates harness lacing or lug attachment after assembly. Snap-on cover holds all wires in place.


**CIRCLE 143 ON READER-SERVICE CARD**

---

**EVERYTHING UNDER CONTROL WITH THE GUARDIAN ON-OFF LATCHING RELAY**

Design Engineers are highly enthusiastic about the positive impulse control performance of this ON-OFF Latching Relay by Guardian. It is ideally suited to positioning devices, T-V remote controls, appliances, lighting controls and applications requiring positive ON-OFF impulse control. Special armature toggle spring reverses position of cam actuator either to open, close, or transfer the snap-action switch. Unit utilizes power only on impulse or coil energization. Replaces costlier ratchet relays, conserves power, saves space, cuts costs, increases the salability of your product.

**Thousands of Variations in Guardian's Complete Stepper Line**

**WRITE** for details on Guardian's ON-OFF Relay and for Stepper Bulletin P-84

**GUARDIAN ELECTRIC**

1622-P W. WALNUT STREET CHICAGO 12, ILLINOIS

**CIRCLE 135 ON READER-SERVICE CARD**

---

**NEW FROM SYSTRON!**

**RMS to DC CONVERTER**

**NOW, for the first time, laboratory standard accuracy readings of AC voltages (from 20 millivolts to 300 volts) are achieved without sluggishness, excessive loading, and non-linear scales. Model 1240 provides a precision DC output directly proportional to the **TRUE RMS** of an applied AC voltage regardless of the waveform of the input. Linear DC output has low importance for meter, analog recorder, data processing system. Combined with DC digital voltmeter operates as precision AC digital voltmeter.

Price $1,150.00
F.O.B. Concord

**SYSTRON CORPORATION**

950 GALINDO STREET CONCORD, CALIFORNIA

**REPRESENTATIVES IN PRINCIPAL CITIES**

**CIRCLE 144 ON READER-SERVICE CARD**

**HOW MUCH AIR?**

**WHAT PRESSURE LOSS?**

**WHAT TYPE OF FILTER?**

**WHAT SIZE FILTER?**

**HOW MANY FILTERS?**

**How Are You Going To Solve Your Electronic Equipment Ventilation Problems?**

More Important, Farr Engineers who are among the country's leading authorities on air filtration, offer you expert assistance in your ventilation design problems.

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**FARR**

**Electronics Design** • December 24, 1959
ELECTRICAL CONTACTS.—Type 710, cold-headed directly from sintered silver-cadmium oxide wire. Conductivity of the material is 84 to 88% IACS, 6 to 12% above that of oxidized type and 15% above that of pressed and sintered type.


CIRCLE 147 ON READER-SERVICE CARD

DUAL VOICE COIL WOOFER.—Model C-12SW, a 12 in. unit for monophonic or stereophonic use, has 1.5 lb Alnico 5 Gold Dot magnet and built-in response limiter adjustable for 700, 2500, and 5000 cps cutoff. Response: 40 to 6000 cps.

University Loudspeakers, Inc., Dept. ED, 80 S. Kensico Ave., White Plains, N.Y.

CIRCLE 148 ON READER-SERVICE CARD

AIR DRYER AND RECEIVER.—Purifies and dries air to zero dewpoint quality, then stores and delivers it. Prevents fouling, corroding, and freezing of instruments. Capacities to 8000 scfm and 6000 psig.


CIRCLE 149 ON READER-SERVICE CARD

REFRIGERATED BLOWERS.—Model BR-6 holds cabinet temperature at 70°F or any preset value between 60 and 100°F. Panel-mounted unit fits standard 19 in. rack. Capacity of 6000 BTU.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood, Calif.

CIRCLE 150 ON READER-SERVICE CARD

SEALED METERS.—Ruggedized, 1.5 in. square metal-cased units for electronic and aircraft equipment.

WacLine, Inc., Dept. ED, 35 S. Clair St., Dayton 2, Ohio.

CIRCLE 151 ON READER-SERVICE CARD

AUTOMATIC BATTERY CHARGERS.—Check batteries every hour; charge those that need it, disconnecting them when fully charged. For inputs to 600 v, 60 cps and 6 to 32 v batteries. Charging rate of 6 amp.

Automatic Switch Co., Dept. ED, Florham Park, N.J.

CIRCLE 152 ON READER-SERVICE CARD

POTENTIOMETER TESTER.—Model FC-15 uses 10-turn master potentiometer to check 1, 3, 10, and 15-turn units with respective accuracies of 0.01, 0.005, 0.002, and 0.003%. It

Analog Controls, Inc., Dept. ED, 39 Roselle St., Mineola, N.Y.

CIRCLE 153 ON READER-SERVICE CARD

BROADBAND VHF ANTENNA.—CV-3 system has eight vertically polarized corner reflector elements placed two wide and four high. Uses tropo scatter propagation; covers 90 to 160 mc range without adjustment. Gain of 19 to 21 db.

All Products Co., Dept. ED, Box 110, Mineral Wells, Tex.

CIRCLE 154 ON READER-SERVICE CARD
For years we have been meeting the requirements of U.S. government agencies for both defense and peacetime needs, as well as supplying major aircraft, missile, electronic controls, computer manufacturers and the communication field.

These vital industries rely on Synkote to supply sure-performing, long-lasting, high quality wire and cable of every type and description and meeting the most rigid specifications. Our varied coaxial constructions are an indication of our versatility.

Our engineers are always available to discuss your special requirements.

Send for our latest catalog.

PLASTOILD Corporation

42-61 24th Street, Long Island City 1, N. Y.
Plant: HAMBURG, N. J.

NEW PRODUCTS

INERTIA DAMPED SERVO MOTO -- Series 8 IM 460 permits use of a rotor with an 0.34 gm cm^2 inertia. Flywheel damping is 52 dynes-cm-sec/rad. Power input: 3.3 watts. No load speed: 6000 rpm.

Beckman Instruments, Inc., Helipot Div., ED, Fullerton, Calif.

CIRCLE 157 ON READER-SERVICE CARD

POTENTIOMETER -- Improved model 215 Resistor Transpot is rated 0.25 w at 70 C, stands 1000 volts and meets MIL-STD-202 specifications. Meets 1/4 x 5/16 x 1-1/4 in.

Bourns Labs, Inc., Dept. ED, P.O. Box 23, Riverside, Calif.

CIRCLE 158 ON READER-SERVICE CARD

TV I-F PENTODES -- Sharp cut-off units with umbo transconductance. Types 3DK6 and 4DK6. 3 and 4 v versions heater warmup controlled series-string operation. Type 6DK6 is for parallel operation.


CIRCLE 159 ON READER-SERVICE CARD

INDUSTRIAL HANDLES -- Round wire type adaptable to any electronic chassis, relay rack, or cabinet. Series 600 have female thread and bushings; 700 have male thread.

Grant Pulley & Hardware Corp., Dept. ED, 31-10 46th St., West Nyack, N.Y.

CIRCLE 160 ON READER-SERVICE CARD

PLUG AND JACK -- Combination 2317 allows patch panel backing of patch work panels and additional plugging to mates with company’s 2201-2 plug. For terminals from 0.087 to 0.214 in. thick.


CIRCLE 161 ON READER-SERVICE CARD

LIGHT SOURCES AND PHOTOUNITS -- Miniature electric eyes designed for use with company’s IRC-5 control relay.

ESS Instrument Co., Dept. ED, 96 S. Washington Ave., Bergenfield, N.J.

CIRCLE 162 ON READER-SERVICE CARD

TIME DELAY RELAY -- Type TDS provides delay to 0.2 sec. Coil resistance for 26.5 v dc operation is 425 ohms. Dpdt contacts rated 5 amp at 26.5 v or 115 v ac. Weighs 5 oz.

E. V. Naylor Labs, Inc., Dept. ED, 26 Marathon Blvd., Port Washington, N.Y.

CIRCLE 163 ON READER-SERVICE CARD

PRESSURE-SENSITIVE TAPES AND SYMBOLS -- For printed circuit master layouts. Tapes are 1/16 in. thick, to 2 in. wide ±0.002 in. Symbols are precision cut.


CIRCLE 164 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 24, 1965
PRESURE CONTROL.—Model PE-103 for wind tunnel applications. Acts like 30 psig switch: cuts off 300 pounds pressure in one position; connects 30 input outlets to 30 output lines in the other. For any pressure to 125 psig.

Datax Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 165 ON READER-SERVICE CARD

STEPPING SWITCHES.—Plug-in base with removable top cover has been added to type 11 spring driven switches. Bases have three 16 or 36-pin Amphenol type plugs, or two 54-pin Elco plugs.

C. P. Clare & Co., Dept. ED, 3101 Pratt Blvd., Chicago 45, Ill.

CIRCLE 166 ON READER-SERVICE CARD

PRESS-ON NAMEPLATES.—Furnished in any commercial metal from 0.003 to 0.006 in. thick. Suits panel and dial facings. Wide choice of colors, shapes, and designs.

The Dickey-Grabler Co., Dept. ED, 10302 Madison Ave., Cleveland 2, Ohio.

CIRCLE 167 ON READER-SERVICE CARD

RECTANGULAR CATHODE RAY TUBE.—Improved 3 in. type 3XP has 20% more distortion free usable screen area. Available with P1, P2, P5, P7, and P11 phosphors.

Allen B. Du Mont Labs, Inc., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.

CIRCLE 168 ON READER-SERVICE CARD

PHENOLIC INSULATOR.—Impact-resistant type R-1100 has Bakelite insulator body and steel cadmium plated base which may be obtained separately. Meets MIL-241B-Type CFC requirements.


CIRCLE 169 ON READER-SERVICE CARD

PAK.—Model 2515 for tight patch work. Compression spring used with floating key provides permanent gripping power. For plugs with 0.062 in. pin diameter and panels from 1/32 to 3/16 in. Has solder terminal.


CIRCLE 170 ON READER-SERVICE CARD

PULSE DELAY UNIT.—Step variable delays of 5, 10, 15, 25, 50, and 100 nsec. For matched use in pulse systems using RG 6/3 Cable. Characteristic impedance of 125 ohms.

Electrical and Physical Instrument Corp., Dept. ED, 42-19 27th St., Long Island City 1, N.Y.

CIRCLE 171 ON READER-SERVICE CARD

AUTOMATIC IMPEDANCE FLOTTER.—Portable or rack-mounted units present continuous data on unknown rf impedance. Trace 60 points per sec on a Smith chart. Frequency ranges: 2.5 to 250 mc, 30 to 400 mc, 180 to 1100 mc.


CIRCLE 172 ON READER-SERVICE CARD

The K&E "Engineered Surface"

All K&E paper, cloth and film has one extremely individual characteristic. It’s what K&E calls its "engineered surface"... a unique surface designed and applied by K&E, right in its own plant, to every roll of sheet of prepared tracing paper, cloth and film. It means controlled drafting qualities far beyond anything the base material alone can normally provide, with a surface tooth that’s exactly right and uniform.

Whatever’s penciled, inked or typed onto it goes on crisply and sharply... shows up clearly and stays that way. Furthermore, the "engineered surface" lets you erase if you want to, easily and quickly and without any of those leftover ghost lines that drive you crazy when they show up in reproductions. And remember, only with K&E do you get all the advantages of an "engineered surface," no matter which paper, cloth or film you’re interested in.

About HERCULENE

The Newest of Films

Frankly, we think K&E Herculene Drafting Film is a real discovery. It has all the properties of the K&E "engineered surface"... exceptional "take," adhesion and erasability... plus the toughness and durability of its Mylar® base. What’s the latter? It’s a polyester film, developed by DuPont, that’s uncommonly strong and virtually indestructible... waterproof and almost immune to the effects of age, heat, ultraviolet exposure and handling. With our K&E "engineered surface" added, it becomes K&E Herculene Drafting Film... the toughest, most durable drafting medium yet to reach the drafting room. And it will last indefinitely, without flaking off or chipping off.

Some Facts About Cloth

When you want cloth, think first of K&E Phoenix® Tracing Cloth. Besides the K&E "engineered surface" with the superb "take" adhesion and erasability for pencil, ink or typing, K&E Phoenix has all the advantages of a water-resistant, chemically-inert coating that won’t soften even under high heat and won’t discolor, become brittle or flake off the base. You can even clean both sides with a damp cloth, without worrying about moisture stains.

And Some Tips On Erasing

All K&E drafting media give you excellent erasability, but there’s a right way to erase on each one. On cloth and film, harsh, gritty erasers can destroy the surface. You’ll get the best results with plastic erasers, such as the Richard Best "Tud" and the Eberhard Faber "Race Kleen." Moisten them for removing ink and stubborn typing; use them as they are for removing pencil lines. Large areas of ink can be removed completely without damage by using a moist cloth and Bon Ami cleaner. On Alpanene, electric erasing machines are fine if used with a soft eraser.

The Choice is Up to You

When it comes to selecting K&E paper, cloth or film for the job at hand, we want to leave the choice to you. We’re not being indecisive...it’s just that you’re the only one who knows the particular problem you have and which product solves it best. But remember...K&E has a complete line of paper, cloth and film...and only K&E puts a special "engineered surface" on all three media to provide a well-balanced, uniform surface suited to the base material.

...and its Package

And now, all Alpanene paper in rolls is packaged in the new square carton for better protection and easier storage. Your rolls stay neat and clean while in use, and the cartons will do double duty in helping you to store finished tracings. In fact, some companies are rearranging their filing systems by using Alpanene cartons, which hold large numbers of rolled-up drawings and stack simply and neatly.

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

Please send me more information and samples on the following:

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Name & Title:

Company & Address:

CIRCLE 173 ON READER-SERVICE CARD

KEUFFEL & ESSER CO., Dept. ED-12, Hoboken, N.J.

65
NEW... FROM api
THE PANEL METER
WITH THE BUILT-IN

NATURAL READING ANGLE

Here is the newest, freshest meter styling idea in years: The A.P.I. Model 561... the slim, trim panel meter with the longer, larger dial you read like a book. Subtly recessed and correctly sloped at the natural reading angle, this meter gives you 30% more dial area in 15% less panel space. Back-of-panel mounting neatly conceals the meter movement; only the clean, crisp façade of the dial is exposed, a clear picture window.

Installation is easier done than said. The 5" x 2 3/8" case frame is self-trimming, requires a simple panel cutout—no holes to drill, no stud alignment troubles. A window in the meter case provides for dial illumination; you can save a bit of work (and panel space) by using the dial light as a pilot.

For the man who needs a smaller meter, there's the Model 361, an identical but diminutive companion to the Model 561. It measures just 3/1/4" x 2". Both models are molded of satin-finish Bakedlite, and both can be had in ranges of 0-5 microamperes to 0-50 amperes or 0-5 millivolts to 0-500 volts.

MORE INFORMATION? SEND FOR DATA SHEET 10-A

ASSEMBLY PRODUCTS, INC.
Chesterland 16, Ohio

CIRCLE 174 ON READER-SERVICE CARD

NEW PRODUCTS

SPECIALIZED AIR CONDITIONER.—Model BOMO controls temperature and humidity in mobile vans that house electronic systems used to compute aircraft flight paths. Suspends beneath van floor.

Ellis and Watts Products, Inc., Dept. ED, Cincinnati 36, Ohio.

CIRCLE 175 ON READER-SERVICE CARD

PRECISION GEAR HEADS.—Size 11 units for use with standard BuOrd MK 14 Mod. 2 servo motors. Can be provided with adapters for use with other than size 11 motors and systems. Pass MIL-E-5272A tests.

Fae Instrument Corp., Dept. ED, 42-61 Hunter St., Long Island City 1, N.Y.

CIRCLE 176 ON READER-SERVICE CARD

ELECTRIC COUNTER.—Model CE-500 for dc or any standard voltage to 230 v ac, 25, 40, or 60 cps. Available with six digits, knob or key reset. Rated at 1000 counts per minute.

General Controls Co., Dept. ED, McCormick Blvd., Skokie, Ill.

CIRCLE 177 ON READER-SERVICE CARD

FOOT, KNEE, OR ELBOW SWITCH.—Actuates electric counters, production equipment, and other electrically operated mechanisms. Switches 3/4 hp loads at 115 v ac.

General Controls Co., Dept. ED, McCormick Blvd., Skokie, Ill.

CIRCLE 178 ON READER-SERVICE CARD

CERAMIC COIL FORM.—Type 2500, for printed circuitry, has independently tunable primary and secondary windings. Threaded to accept tuning cores supplied for four ranges between 1 and 150 mc.


CIRCLE 179 ON READER-SERVICE CARD

BATTERY CHARGER POWER UNITS.—Provide economical power; can deliver current peaks up to 10 times rated capacity of the batteries. Built-in charger keeps batteries fully charged at all times.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.

CIRCLE 180 ON READER-SERVICE CARD

VARIABLE SPEED DRIVE.—Servotran drive for automatic control systems now has accurately calibrated dial for precision manual speed adjustment. Calibrations may be for 180 deg rotation forward and reverse, or for 360 deg in one direction.

Humphrey, Inc., Humphrey Products Div., Dept. ED, 3794 Rosecrans St., San Diego 10, Calif.

CIRCLE 181 ON READER-SERVICE CARD

NEON PILOT LIGHT.—Extends less than 7/8 in. behind panel, mounts in single 1/2 in. hole. U/L and CSA approved.

Industrial Devices, Inc., Dept. ED, 982 River Rd., Edgewater, N.J.

CIRCLE 182 ON READER-SERVICE CARD

TEST INSTRUMENTS
for LABORATORY/PRODUCTION FIELD TESTING

measure microwave power directly, quickly, accurately

TRANSISTORIZED POWER BRIDGE

The AIL Type 50 R-F Power Bridge applies the most advanced transistor circuitry techniques to power measurements in the 10-40,000 MC range. Full scale ranges of 1.0 and 10 milliwatts plus and minus 10 dbm are provided. Accuracy within 0.5 db.

Compact—battery operated—weighs less than 4 pounds—hand held—ideal for field applications.

Each Type 50 is carefully checked and tested under the rigid AIL quality control system assuring highest reliability for a variety of applications in:

Radar • Communications Navigation • Telemetering Television • Transmission Links Microwave links • R-F leakages

Price $199.00

1345 NEW YORK AVENUE
Huntington Station, L. I., N. Y.
CIRCLE 263 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 24, 1957
NEW 400 cycle DEVR

eliminates distortion
regulates voltage

SIMULTANEOUSLY AVAILABLE

- 1.4 kVA regulation ±1% electronically response 125 microseconds distortion elimination to less than 0.3%
- 4 kVA regulation ±1% electro-mechanically response 20 V/sec

Distortion Eliminating Voltage Regulator responds to transient surges and harmonics, as well as to normal variations caused by line and load changes. The Curtiss-Wright Model 104 DEVR corrects for any deviations of up to 20% from pure sine wave, regardless of their nature, in less than 125 microseconds.

It provides the answer where line fluctuations or distortion cause inaccuracies and loss of engineering and production man-hours in the design and manufacture of electronic systems for aircraft and missiles. In servos and computers, and wherever summing operations are performed, the Model 104 DEVR assures increased accuracy and stability. It is invaluable for standards laboratories and others where accuracy of instrumentation is pushed to extremes; it also increases equipment life by eliminating surges.

Write today for complete information. Price: $1875 f.o.b., Carlstadt, N. J.
The DEVR is also available in 60 cps model.

ELECTRONICS DIVISION
CURTISS-WRIGHT CORPORATION • CARLSTADT, N.J.
CIRCLE 191 ON READER-SERVICE CARD
IDEAS FOR DESIGN

Contour Following Photocoper Rides On Air

This portable photocoper can make direct copies of pages from books or magazines right to the margin—and without harming the binding. It follows the contour of a page in a volume by virtue of its inflatable plastic air cushion. The photocoper, placed face down on a page, makes a copy in 30 seconds.


Good, clean copies can even be made of overlays and paste-up jobs without showing India tape marks.

Transistorized Driver for Medium and High Impedance Crystals

We needed a single oscillator to drive crystals in the 500 to 500 kc range and in the 1000 to 1600 kc range. Crystal characteristics dictate the use of CT or DT cut crystals for the lower frequency operation and AT cut crystals for the higher frequencies. Series-resonance crystals were chosen for the desired high frequency stability. With oven control, our final circuit...
Transistorized crystal driver works with medium high impedance crystals.

Provided a stability of 0.0005 per cent over a deg C temperature variation.

We found the best circuit for the job was a transistorized Butler oscillator. It has a common collector amplifier driving the series-resonance crystals, and a common base amplifier to provide the voltage gain necessary for the unity loop gain required for oscillation.

Since there is no Miller effect in either stage, the circuit can operate in the megacycle region without high frequency transistors. Since the common collector stage has a low output impedance and the common base stage has low input impedance, a constant current drive results, since the crystal impedance is much higher than the common base input impedance.

A resistor in series with the crystal keeps internal heating down and increases stability. Its value is determined experimentally as different crystal impedances are used in the circuit.

The output frequency can be trimmed by changing the value of Cj. In the case of AT cut crystals, a variation of several hundred cycles can be achieved.

Max Liang, Electronics Engineer, Consolidated Electrodynamics Corp., Pasadena, Calif.

Battery Saver

Some people drive to work early in the morning, then leave their lights on in the parking lot. (Not a technical problem, but a very practical one.)

The solution to this problem is a simple one. Put a small warning light in series with a diode between the taillight contact and the ignition wire in such a way that the bulb will light when the lights are on and the key off, but not vice versa. The small current through the bulb does not interfere with normal operation of either circuit. The same circuit without the diode would also warn you to turn lights on at nightfall.

Robert W. Blanchard, Sr. Engineer, Federal Telecommunication Labs., Nutley, N. J.
IDEAS FOR DESIGN

Fig. 1. The neon lamp (or a zener diode) helps bootstrap sweep from zero to 200 v in 3 sec with better than 10 per cent linearity.

Long Linear Sweeps

Here's a way to get very long duration sweeps with good linearity.

A neon lamp, or zener diode, is used in a bootstrap circuit to make the bootstrapping action effective all the way down to dc. The linearity of the sweep depends on the change in grid bias of the cathode follower as the sweep runs from zero to a maximum of 200 volts or more.

Linearities of better than 10 per cent can be achieved with the circuit of Fig. 1. Linearity is defined as per cent change of charging current from the beginning to the end of the sweep.

Another new miniature from Corning...

1 to 8 μf direct traverse trimmer capacitor

Small but still precise, this new Corning direct traverse type trimmer capacitor meets military as well as civilian requirements.

Other features besides its size:

Silver plated hardware takes the noise out of tuning and protects the unit from corrosion even under extreme environments.

Mechanical stops at both ends of capacitance adjustment, with self-contained adjusting shaft.

Linear tuning with fine resolution. About 0.50 μf capacitance change per turn.

No capacitance reversals.

Glass-Invar construction.

Bushing and shaft assembly is coaxial for low inductance, high frequency applications.

Shock, vibration, and thermal shock resistance all excellent.

If you'd like more information, write for our new data sheet.

CORNING GLASS WORKS, Bradford, Pennsylvania
Electronic Components Department

Fig. 2. This bootstrap includes a constant current generator. It sweeps 60 times slower than that in Fig. 1.
Eclipse-Pioneer designs test set for B-58 Hustler autopilot system...

...and Vernistat* is there!

Doesn't Vernistat thinking belong in your system design too?

In this application, Vernistat thinking by Eclipse-Pioneer engineers helped solve a design problem with reduced equipment cost, system complexity, and design time. Cost was only a quarter of that of an alternative method utilizing conventional potentiometer, isolation amplifier, and d.c. power. Use of fewer components reduced system complexity, increased accuracy and reliability, and saved valuable design engineering man-hours.

In servo systems, analog computers, and similar uses, you too can obtain such results with Vernistat a.c. potentiometers. With this new concept in relating shaft position to voltage, you get low output impedance (as low as 45 ohms) with high input impedance (as high as 200,000 ohms), plus high resolution (to 0.004%), low phase shift (as low as 0.2 minutes), and high linearity (to 0.01%).

In addition to precision a.c. potentiometers, Vernistat products include function generators (adjustable nonlinear potentiometers), and variable ratio transformers. Military specifications are met by the wide selection of models available.

Write today for complete details and specifications on Vernistat precision products.

*vernistat® — a new design concept that unites in one compact device the best of both the precision autotransformer and the multiturn potentiometer.
IDEAS FOR DESIGN

A Polarity Sensitive Trigger Circuit

In designing a Schmitt trigger to change states when the input goes through zero, two approaches can be used. These are (1) use of an input stage to change the level of the input signal, (2) use of both positive and negative supply voltages to bring the firing level of the Schmitt to zero volts. Because the firing level and hysteresis are subject to changes with age and supply voltage variations, use of the standard Schmitt circuit dictates that for accurate sensing of polarity, caution be taken to insure stability.

The circuit shown here was developed primarily to detect polarity changes. Because of the balanced design and use of complementary symmetry the circuit is stable with temperature and aging. The transistors are operated at either cutoff or saturation and the loop gain is quite high. As a result, the firing points remain relatively drift free. The amount of hysteresis is varied by changing the common emitter resistor R10 and remains balanced about zero. Typical values of hysteresis are ±0.1 v for R10 set at 100 ohms, to ±0.5 v for R10 equal to 500 ohms.

Circuit constants are selected so the transistors operate in either the cutoff or saturation regions. When the input pnp and output npn units are at cutoff the input npn and output pnp units are in saturation. Because the collector current in the output stage is approximately twice that in the input stage, the polarity of the voltage across R10 is determined by the conducting output transistor. This polarity is opposite the input signal and its magnitude determines the hysteresis of the circuit.

Transition from one state to the other occurs when the input approaches the emitter voltage sufficiently to reduce the collector current in the conducting input transistor. The change in collector voltage resulting from the reduction of collector current is transferred to the conducting...
output transistor. The signal appearing at the output transistor is transferred to the input transistor through the common emitter resistor, reappearing at the collector of the input transistor with the same polarity as the original change.

When the loop gain exceeds unity regeneration takes place, causing the circuit to switch states. The action is identical with the operation of the Schmitt trigger and the relationship between loop gain and hysteresis hold for both circuits. This is discussed more fully in Millman and Taub's "Pulse and Digital Circuits."

The circuit can be used as a Schmitt trigger, a squaring circuit or a flip-flop. It has proven quite useful in detecting the polarity of random pulses. It operates over wide temperature ranges and its stability at high temperature can be improved by shunting R4 and R5 with back biased germanium diodes to supply $I_{co}$ to the output transistors.

As a sine wave phase comparator it can provide 1 degree accuracy with 3 v rms input. It requires no amplification for most input waveforms.

James E. Curry, Tasker Instruments Corp., Hollywood, Calif.

**Simple Test For Temperature Effects On Transistors**

With germanium transistors, the effect of changes in collector cutoff current ($I_{co}$) with temperature is very important. Here is a simple and rapid means of evaluating this effect.

The diagram shows how additional $I_{co}$ is injected into the transistor. The series resistor R must be very large compared with the collector and base circuit impedances. The amount of current used is determined by the proposed rise in $I_{co}$ over the temperature range.

Typical values are 150 v through 1 meg. This simulates an $I_{co}$ change of 150 $\mu$A. Voltage polarity must be reversed for pop transistors.

J. R. Siconolfi, Engineer, I. T. & T. Labs., Fort Wayne, Ind.

Now Bendix offers a broad line of diffused type silicon power rectifiers that can deliver up to 30 amperes of rectified current. Featuring hermetic seal and welded construction, these rugged units can be used where thermionic devices will fail. Actual usage proves them outstanding for applications where high ambient temperatures, small size and high efficiency are of utmost importance. The packages conform with the latest standardization. The rectifiers are ideal for magnetic amplifier and DC blocking circuits as well as applications to power rectification.

Write, wire or phone for complete details, competitive prices or immediate shipment. Our Application Engineering Department is available for your circuitry problems. SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.
Wheeloock SIGNALS CRYSTAL CASE RELAYS resist high temperatures ... up to 125° C and excessive vibrations ... 2000 cps at 20 g

These new Wheeloock Crystal Case relays will solve all your space problems! Wheeloock engineers designed these precision-made relays smaller than small . . . about the size of a quarter . . . lighter than lightweight . . . approximately .35 oz . . . and sensitive enough for mill-second operation, yet so rugged to withstand rigid military environmental specifications.

For consistent reliability, extended life and never-failing performance, specify Wheeloock Crystal Case relays for your electronic applications. Wheeloock will help you solve your relay problems ... they will gladly recommend the relay to suit your needs.

Write for additional details and literature.

**SPEcIFICATIONs**

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<td>1000 VRMS: 750 VRMS across contact gaps</td>
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<tr>
<td>SHOCK</td>
<td>JAN-S-44 Test in excess of 100 g all planes — no opening</td>
</tr>
<tr>
<td>VIBRATION</td>
<td>10-55 g at 50° and 0-2000 cps at 20 g acceleration</td>
</tr>
<tr>
<td>ENCLOSURE</td>
<td>HERMETICALLY SEALED DRY NITROGEN FILLED</td>
</tr>
<tr>
<td>TERMINAL &amp; MOUNTING</td>
<td>MOUNTING ARRANGEMENTS TO YOUR SPEC</td>
</tr>
<tr>
<td>DROP-OUT TIME</td>
<td>1.45 milliseconds approx.</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>.35 oz</td>
</tr>
<tr>
<td>COIL POWER</td>
<td>350 milliwatts</td>
</tr>
<tr>
<td>COIL RESISTANCE</td>
<td>up to 6000 ohms</td>
</tr>
<tr>
<td>SIZE</td>
<td>.359 in. x .797 in. x .875 in.</td>
</tr>
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ELECTRONIC DESIGN • December 24, 1959
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MODEL PT244 $1895.00

WHAT IT IS
. . . a paired trigger generator with fixed and delayed pulses. Combination of counters and digital dial provides direct reading delays to 9,999,999 microseconds. Note that this instrument is a full size module of the TLI Modular Instrumentation System.

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Full specifications and application information available on request in Bulle tin E-82

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Provide an electro-magnetic clutch, spring return mechanism and rotary potentiometer. Assemble these parts into the required package with the resultant difficulties brought about by the mounting and coupling problems with a consequent increase in cost.

THE OPTIMUM SOLUTION:
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Acton, Massachusetts

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ELECTRONIC DESIGN • December 24, 1958

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by MRC

Versatile... Dependable ... Adaptable

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ELECTRONIC DESIGN • December 24, 195X
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5400B, 16400 -- provides data in 2 min, -- requires transponder in drone only -- measures salvo firings -- determines miss on multiple targets. Target equipment (less power supply) under 2 lbs. Accuracy confirmed by field tests.
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Wide Range Transistor Multivibrator...

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**PHASE LOCK**

Now available in the Nems-Clarke line of telemetry receivers is the 400 Series employing phase-lock detection. The receivers are of the double super-heterodyne type with a noise figure of less than 8 db. The primary advantages of phase-lock when used as a wide band receiver demodulator is a lowering of the receiver threshold and an overall improvement in signal-to-noise ratio.

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- Type 1432, 1431: 225 to 260 mc
- Type 1432, 1433: 215 to 260 mc

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**PROVIDES**

Bi-Directional

**PROPORTIONAL SHAFT ROTATION FOR A GIVEN PULSED INPUT**

**MODEL SM-300-1**

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- Stepping rate — up to 15/second.
- Voltage requirement — 28 V. D.C.
- Duty cycle — (on time / off time) 56% max.
- Weight — 8 oz.
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The two rotary solenoids contained in each motor produce the incremental motion of the output shaft in either direction. Energizing either of these solenoids produces a combination of linear and rotational motion which moves a ratchet gear axially into engagement with its mating ratchet gear and thus imports a constant amount of rotation to the output shaft. The detent roller assembly assures constant, reproducible angular shaft rotation increments in either direction and maintains the output-shaft position while the motor is at rest with the power off.

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CIRCLE 228 ON READER-SERVICE CARD

Nonlinear and Phenomena Radio

Part 8
A. A. Kharkevich
(Translated by J. George Adashko)
Chapter 1

Nonlinear Circuits I
Nonlinear Circuit

10. FM and PM Detection
In this section we discuss the general principles of detection, used for modulation other than a-m, particularly frequency modulation (f-m) and certain forms of pulse modulation (p-m).

FM Detection
The usual manner of detecting frequency modulated oscillations consists of first converting the f-m oscillations into a-m oscillations, then detecting them as described in Sec. 9. The a-m signal is converted into a-m with a so-called frequency detector.
Do You Have Critical Filter Problems?

Sangamo Electric Company has been designing and building specialty filters since 1927. These filters have been used in a wide variety of metering, telephone and military equipment produced by Sangamo, and by a limited group of electrical and electronic manufacturers. Sangamo's thirty years of filter design and manufacturing experience is now available to the industry.

Here's a Typical Example: The filter illustrated was required for use in a circuit which was designed to amplify extremely small signals in the range of 25 KC to 26 KC.

BASIC OPERATIONAL AND DESIGN SPECIFICATIONS:
Meet applicable requirements for military apparatus.
Operate in a plate circuit of an amplifier presenting an effective generator impedance of 47,000 ohms and to drive the grid circuit of the following amplifier stage.
Operate at signal level as low as 10 microvolts.
Must be well shielded against external fields.
Passband ripple not to exceed 1 db. from 25 KC to 26 KC.
Minimum rejection shall be 35 db. at 28 KC and 40 db. at 23 KC.
The phase shift, from one production filter to another, shall not vary more than 5° at any point in the 25 KC to 26 KC bandpass.
The phase shift and attenuation characteristics must be reproducible over a long period of years to insure properly functioning spare parts.
Temperature range 0° to 85°C.

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The above requirements were met by using three parallel tuned circuits properly coupled by capacitors. Selection of the L-C ratios, coupling, and circuit Qs were made in order to fulfill the overall response requirements and at the same time present the proper load to the driving amplifier stage. Stability requirements were obtained by using Sangamo silvered mica capacitors. Negative temperature coefficient capacitors were inserted in parallel with the tuned circuits to correct for the positive temperature coefficient of the inductors. A phase shift variation of 2.5° maximum from 25 KC to 26 KC has been consistently maintained during eight years of production on these units. The universal wound coils are enclosed in powdered iron cups with moveable slugs for precise adjustment of the response and the phase shift. These inductors manufactured by Sangamo have uniform distributed capacity and Q. The cup-enclosed inductance coils are in turn housed in a die-cast aluminum enclosure. This housing lends physical rigidity to the coupled structure and assists in minimizing magnetic interaction between the enclosed inductors. The entire filter assembly is enclosed in a hermetically sealed drawn steel case. The terminals are of the extremely rugged compression glass type.

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RUSSIAN TRANSLATIONS

to detect and filter it in the usual manner. A basic circuit for f-m detection is shown in Fig. 34. Modern practice calls for better frequency detectors. The point is that to avoid nonlinearity, the characteristic of the frequency detector must be linear. In other words, the derivative of the characteristic, given by the derivative $dI_m/d\omega$ must be constant within the operating range. For broadband f-m, it is difficult to meet this requirement with a simple circuit; therefore employs symmetrical circuits with more favorable characteristics.

An example of such a circuit is shown in Fig. 34. Here the two tank circuits are usually designed to the extreme values of the frequency, i.e., $\omega_0 + \Delta \omega$ and $\omega_0 - \Delta \omega$. Each of these tank circuits converts f-m into a-m. The a-m oscillations are detected by the respective halves of the detector diode.

The RC combinations serve as filters. The frequency voltages of $U_1$ and $U_2$ across $R_1$ and $R_2$ are proportional to the ordinates of the resonance curves of circuit 1 and 2 respectively. But these voltages across $R_1$ and $R_2$ are opposite in sign (see arrow showing the directions of the currents on the diagram), the output of the circuit is the difference between the voltages $U_1$ and $U_2$.

The characteristic of the frequency detector, i.e., the dependence of the output voltage $V_0$ on the f-m frequency at the input, is obtained by subtracting the two resonance curves, as shown in Fig. 35. Frequency detectors of this type are called discriminators.

PM Detection

Let us turn now to pulse modulation. There are two principal forms of pulse modulation and demodulation of pulses by amplitude—(PAM) modulation, modulation of pulses by repetition frequency (PFM), (3) modulation of pulses by duration (PDM), and (4) modulation of pulses by phase (PPM).

Detection of a PAM signal does not differ substantially from detection of an ordinary amplitude-modulated oscillation. The difference lies only in the contents of the high frequency part of the spectrum, which must be filtered out anyway.

The same pertains to PDM, although it is not so obvious at first glance. It must be taken into account, however, that the low-frequency component, after the usual detection of the PDM modulated signal, is proportional to the area under the pulse. Consequently, it makes no difference what changes in the envelope of the pulse during modulation, the amplitude or the duration of the pulse.
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into PDM one can employ, for example, a circuit containing an electronic relay energized by the in-phase pulses (or vice versa), as shown in Fig. 36.

Topics connected with detection of pulse-code modulation, being more specialized will not be considered here.

11. Modulation

The purpose of modulation is to shift the spectrum of the transmitted (low-frequency) signal into the high-frequency region. This makes the signal suitable for transmission by radio. Such a shift is necessary because effective radiation can be obtained only at high radio frequencies.

Modulation is produced when the signal modifies the high-frequency oscillations yet remains "imprinted" in the variations of one of the parameters. The high frequency, so to speak, carries the signal with it, retaining all the signal properties. The signal can thus be again separated on the receiving end.

Modulation is essentially a linear process realized in a linear system with variable parameters.

We shall first explain the mechanism of amplitude modulation, using as an example an extremely simple circuit, used at one time in low power telephone transmitters. The circuit is shown in Fig. 37. The high-frequency oscillator is coupled inductively to the antenna. Connected in series with the antenna is an ordinary carbon microphone. The sound causes the membrane of the microphone to vibrate and compress the carbon powder contained in the microphone, thus changing its admittance.

Let us assume that the microphone is strictly linear, i.e., that its admittance is a linear function of the sound pressure. We then obtain for the admittance of the antenna circuit

$$ Y = Y_0 + k P $$

Let the sound pressure be sinusoidal

$$ P = P_0 \sin \Omega t $$

We can then write for the admittance

$$ Y = Y_0 + k P_0 \sin \Omega t = Y_0 + Y_1 \sin \Omega t $$

where $m = Y_1 / Y_0$ as the coefficient of modulation of the admittance. Furthermore, let the electromotive force induced by the oscillator in the antenna be

$$ E = E_0 \sin \omega_0 t, $$
where \( \omega_0 \) is the high (carrier) frequency. The antenna current is the product of this emf and the admittance.

\[
I = EY = E_a Y_0 (1 + m \sin \Omega t) \sin \omega_0 t.
\]

We have derived the usual expression for an oscillation, amplitude modulated sinusoidally at a frequency \( \Omega \).

This is a linear circuit with variable parameter. The variable parameter is the admittance.

Returning to the expression for the amplitude-modulated oscillation, let us rewrite it in a more general form.

\[
I = I_m [1 + m f(t)] \sin \omega_0 t.
\]

where \( f(t) \) is an arbitrary transmitted signal and it is assumed here that \( |f(t)| < 1 \).

We see that the modulation process consists of multiplying two functions of time, \( 1 + mf(t) \) and \( I_m \sin \omega_0 t \). Consequently, the modulator should act in principle as a multiplying device, i.e., a device with two inputs and one output.

If the inputs are, say \( x(t) \) and \( X_d(t) \), the output is

\[
y(t) = x(t) X_d(t)
\]

Multiplication by a given function \( X_d(t) \) is a linear operation, as can be seen from the following relationship

\[
y(t) = [x_1(t) + x_2(t)] X_d(t)
\]

\[
= x_1(t) X_d(t) + x_2(t) X_d(t) = y_1(t) + y_2(t)
\]

Devices that multiply two functions of time

are used for modulation and frequency conversion are usually called mixers. This is a poor term, for it does not describe the nature of the process. We shall call a device that multiplies two functions a multiplier.

Thus, to obtain ordinary amplitude modulation it is necessary to take a multiplier with inputs \( x(t) = 1 + m f(t) \) and \( X_d(t) = I_m \sin \omega_0 t \). The multiplication will yield the modulated oscillation.

(Continued on following page)
RUSSIAN TRANSLATIONS

Fig. 37. A simple modulation scheme, once used in low power telephone transmitters.

Let us note that this expression can be written

$$I = I_a \sin \omega_d t + m \, I_a f(t) \sin \omega_d t.$$  

The first term is the carrier-frequency current. Expansion of the second terms gives the sideband frequencies of the modulation spectrum. Along with ordinary a-m, one also employs transmission without the carrier frequency, obtained with the aid of so-called balanced modulation.

To obtain amplitude modulation without a carrier frequency, using a multiplier, it is merely necessary to eliminate the dc component of the modulating function, i.e., use only \( x(t) = f(t). \) This results in a multiplier output

$$y(t) = x(t) X_a(t) = I_a f(t) \sin \omega_d t.$$  

The spectrum of this oscillation does not contain the carrier frequency; the spectrum consists of only the two sideband frequencies.

Any two-port network with adjustable transfer function can be used as a linear multiplier. Thus, if we have, in general,

$$y(t) = k \cdot x(t)$$  

and if we can vary the transfer function \( k \) in accordance with an arbitrary law \( k = k(t), \) we indeed obtain a multiplier, whose operation is described by

$$y(t) = k(t) \cdot x(t)$$  

By way of an example, let us examine how a multigrid tube (specifically, a heptode) operates as a multiplier. In such a tube, as is known, the transconductance with respect to the third (so-called "signal") grid depends on the voltage on the first ("heterodyne") grid. In the ideal case, the dependence of the transconductance on the
Fig. 38. This balanced multiplier gives $U$, the product of $U_1$ and $U_2$.

potential of the first grid would be linear, i.e.,

$$S_2 = b_a + b_1 U_1.$$  

Applying the two multiplicand voltages $U_1(t)$ and $U_2(t)$ to the first and third grids, we would obtain in the plate circuit the following current

$$I_3 = U_1 U_3 = U_2 (b_a + b_1 U_1) = b_a U_3 + b_1 U_1 U_3.$$  

We see that we would not obtain pure multiplication, owing to the presence of a dc component in the transconductance as given by

$$S_3 = b_a + b_1 U_1.$$  

But the effect of this component can be eliminated by using a symmetrical (balanced) circuit with two tubes, as shown in Fig. 38 (for simplicity the connections to the auxiliary grids are not shown). The voltage $U_2$ is applied to the third grids of both tubes with like polarity (i.e., in phase), while the voltage $U_1$ is applied to the first grids with opposite polarity (i.e., out of phase). The output voltage $U_3$ by virtue of the bucking connection of the coils in the plate circuits, is proportional to the difference in the plate currents, i.e., to the quantity

$$(b_a U_3 + b_1 U_1 U_3) - (b_a U_3 - b_1 U_1 U_3) = 2b_1 U_1 U_3.$$  

Thus, if the transconductance varies linearly with the voltage, the circuit of Fig. 38 operates as an ideal linear multiplier. Actually, the expression $S_3 = b_a + b_1 U_1$, is satisfied only approximately, and over a small voltage range at that. Nevertheless, under these conditions, the balanced circuit of Fig. 38 gives a better result than the simpler (one-tube) circuit.

(To be continued)

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Generator for Triangular Video Pulses by Yu. N. Prozorovskiy. RE, 8/58, pp 47-49.

Triangular video pulses are generated with the aid of a shaping two-terminal network, such as line segment, having a signal time delay that is shorter than the duration of the front of the voltage that is current applied to the generator. See Figs. 2 and 3.

TELEMETRY


In most telemetering systems, the measurement error depends on the stability of the transfer functions of the system as a whole and of its individual elements. This is why precision of the various converters and transducers used (modulators, demodulators, etc.) in such systems is of primary importance.

This article shows that the use of new type high-stability time-pulse and width-pulse converters or transducers (which the authors call "exponential") makes the telemetering system less sensitive to changes in such external influences as ambient temperature or line voltage. See Figs. 4, 5 and 6.

---

Fig. 3. Pulse produced along with a 1 x 10 second time marker.

Fig. 4. Prototype of exponential pulse-width converter.

Fig. 5. Two exponential converters modified to accommodate pickups with low resistance.

Fig. 6. Telemetering system with exponential converter. 1—indicator; 2—electronic relay; 3—radio generator. The electronic relay operates at the instant $t_e$ and turns on the audio generator until the primary pulse is complete. The receiver is tuned to the audio frequency. The amplified signal causes the relay to operate at the instant $t_e$. The transmitter and receiver RC cells have equal time constants, thus ensuring a linear relation between the measured parameters and the reading of the output meter. The error is less than 1 per cent for ambient variation from $-50 \text{ to } +50^\circ$ and for supply line variations of $\pm 15$ per cent.
**RUSSIAN TRANSLATIONS**

**TELEVISION**


Lists all the television sets produced in the USSR and gives some statistical data on operating failures and repairs necessitated in three most popular sets, as well as the causes of these failures.

**ANTENNA**

Disk and Cone Antenna by V. Botayev. R, 8/58, pp 34, 4 figs.

Description of an umbrella type antenna for 144-146 Mc, having a circular pattern in the horizontal plane and a vertical pattern. The disk is made of 1.5 mm duraluminum 370 mm in diameter. Eight ribs are used, each made of aluminum tubing 8 mm in diameter and 74 cm long. A coaxial cable (II) is used to feed the antenna.

**PROPAGATION**

General Formulas for the Field Produced by a Dipole with Arbitrary Orientation, Located over Plane Homogeneous Earth by L. S. Tartakovskiy. RE 4/58, pp 36-44, 1 fig.

The author gives and analyzes general field formulas in the radiation zone produced by the vertical and horizontal electrical dipoles located over a plane homogeneous earth. The features of the propagation of radio waves over a region with a surface deposit of iron ore are indicated.

Stability of the Field Intensity over Sections of Radio Relay Lines by A. I. Kalinin. RE 1/58, pp 22-28, 8 figs.

The author plots curves for the stability of the field intensity on sections of radio relay lines. He uses the known dependence between the attenuation factor on the vertical gradient of the dielectric constant of air and on the statistical
distribution of the values of this gradient in the region where the given section of the line is located. Equations are derived for the curves of optimum stability of field intensity. Numerical results are given for the climatic conditions of the middle zone of European portion of the USSR.


The diffraction produced by a disc is analyzed with account of the interaction of the edge currents. Expressions are obtained for the fields scattered by the disc in the form of spherical waves from two points on the rim of the disc. The way each wave is diffracted on the disc is examined.


The method proposed in the preceding article in the same issue is used to find a closed-form solution for the components of the field vectors and current density on the phases of an ideally-conducting wedge excited by a Hertz dipole located on the edge of the wedge. It is shown that if the wedge has a sharp angle, an "edge wave" propagates along the edge of the wedge. This wave is pronounced most clearly in the case of a half plane.


Formulas are derived for the calculation of the equivalent resistance and inductance of the earth as the return lead for an axially-symmetric system for the transmission of electromagnetic signals, with allowance for the surface effect. The irregularities of the ground are taken into account conditionally by assuming it to contain two inhomogeneous coaxial layers. The calculation formulas are simplified for the cases of low and high frequencies.

Contribution to the Theory of a Double Block of Slot Resonators by M. F. Stel'makh. RE, 8/58, pp 30-36, 4 figs.

The propagation of waves in a double block of slot resonators was treated by Pierce "Traveling Wave Tubes" and Brillouin's "Waveguides for Slow Waves." (Journal of Applied Physics, Vol. 19, No. 4, 1948). It was found that both symmetric and anti-symmetric waves can propagate in such a system. In the former case the frequency band in which slow waves exist is
RUSSIAN TRANSLATIONS

broader than in the latter case, but the longitudinal electric field vanishes in the space between the blocks of a symmetrically placed waveguide, while for the harmonics of the anti-symmetric waves this field is nonvanishing.

A longitudinal shift of one block relative to the other produces a field structure that is more suitable for the odd harmonics of the anti-symmetric waves, from the point of view of interaction with the electron beam. The results can be used for the design of traveling wave tubes and backward wave tubes in which the interaction between the electric electron beam and the odd-harmonic field is used.


The author derives approximate formulas for the total losses of magneto-dielectric materials when these losses are small, using the results of only one short-circuit measurement (or only one open-circuit measurement). This makes it possible to select a specimen thickness to insure sufficient accurate measurement of the SWVR in the slotted line.

MISCELLANEOUS


Extensive survey of the literature, published mostly in 1956-1957, on magnetic materials, design of nonlinear magnetic circuits, magnetic amplifiers, magnetic contactless elements, and descriptions of commercial devices.


This all-transistor radio is designed for electrified rural communities and apparently no portability or miniaturization was intended. It measures 222 x 282 x 158 mm and weighs 3.5 kg. It is supplied by four 1 1/2-volt dry batteries.

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**KEY**

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

- **AJ** Acoustic Journal (Akusticheskiy Zhurnal)
- **AT** Automation and Telemechanics (Avtomatika i Telemekhanika)
- **CJ** Communications Journal (Vestnik Syvazi)
- **EC** Electrical Communications (Elektrosvyz)
- **IET** Instruments and Experimental Techniques (Pribori i Tekhnika Eksperimenta)
- **JTP** Journal of Technical Physics (Zhurnal Tekhnicheskoy Fiziki)
- **ME** Measurement Engineering (Izmeritel'naya Teknika)
- **RE** Radio
- **REE** Radio Engineering and Electronics (Radioelectrnika)
MEETINGS

Calendar of Events

December
26-31 Annual Meeting American Assoc. for Advancement of Science, Washington, D.C.

January
12-14 5th National Symposium on Reliability and Quality Control, Philadelphia, Pa.*
26-29 27th Annual Meeting Institute of Aeronautical Sciences, New York, N.Y.
27-30 15th Annual Technical Conference (SPE), New York N.Y.
28-29 1st International Symposium on Nuclear Fuel Elements, New York, N.Y.
29-30 Long Distance Transmission by Waveguides (IRE), London

February
1-6 AIEE Winter General Meeting, New York, N.Y.
2-6 ASTM Committee Week, Pittsburgh, Pa.
3-5 14th Annual Technical and Management Conference, Chicago, Ill.
8-14 National Electrical Week, New York, N.Y.
17-20 6th Annual Western Convention, Audio Engineering Society, Los Angeles, Calif.

March
3-4 Western Joint Computer Conference, San Francisco, Calif.
5-6 Flight Propulsion Meeting, Cleveland, Ohio.
5-7 Second Western Space Age Conference and Exhibit, Los Angeles, Calif.
16-20 National Meeting American Inst. Chemical Engineers, Atlantic City, N.J.
17-21 8th Electrical Engineers' Exhibition, London
23-26 IRE National Convention, New York, N.Y.
26 15th Annual Quality Control Clinic, Rochester, N.Y.
30-
April 1 Electrical Industry Show, Chicago, Ill.
31-
April 2 21st American Power Conference, Chicago, Ill.
31-
April 2 Symposium on Millimeter Waves, New York, N.Y.

April
5-10 5th Nuclear Congress, Cleveland, Ohio
6-8 3rd Annual Astronautics Symposium, Washington, D.C.
6-9 16th Annual British Radio and Electronic Component Show, London
8-10 AIEE Southern District Meeting, Atlanta, Ga.
16-18 Southwestern IRE Regional Conference and Electronics Show, Dallas, Tex.

*Indicates meetings herewith described.
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CIRCLE 259 ON READER-SERVICE CARD

5th National Symposium on Reliability and Quality Control, Jan. 12-14
The program this year attempts to show the transition of experience in the reliability art. Highlighted are new design techniques and the greater use of transistors; cost considerations, and management's part in a reliability program; quality control techniques, measurement of reliability; quantitative treatment with progress in the mathematical theory of reliability; and field reliability and maintainability. The program is listed here.

Mon. a.m., Jan. 12
Reliability of Transistorized Equipment
Transac S-2000—A Case History
R. J. Segal, Philco Corporation
Reliability Evaluation of Silicon Transistors
K. W. Davidson, Texas Instruments, Incorporated
An Approach to Transistorized Equipment Design
O. Golubjatinikov, General Electric Company

Cost of Reliability
Support Costs vs Reliability and Maintainability
H. D. Voigten, RCA Service Company
A Reliability-Cost Optimization Procedure
P. R. Gyllenhaal, Radio Corporation of America
Experiments to Expose Marginal Reliability Designs
W. R. Kuzmin, Minneapolis-Honeywell Regulator Co.

Mon. p.m., Jan. 12
Military/Industry Reports
Putting the R & D Reliability Dollar to Work
G. N. Beaton, Hughes Aircraft Company
Minuteman Missile Reliability Requirements
S. C. Morrison, Ramo-Wooldridge Corporation
Reliability Program for an Analog Computer
H. M. Davis, Sperry Gyroscope Company
AN/ARC-58 Reliability Program Case History
R. L. Vander Hamm, Collins Radio Company

Mathematical Theory
Methods for Evaluating Reliability Growth
M. H. Saltz, Hughes Aircraft Company
Reliability Starts with the Design
Dr. I. R. Whitman, General Analysis Corporation
Significance Tests of Effects of Wearout Failures
Dr. J. H. Smith, Vitro Laboratories
Acceptance Sampling with New Life Test Objectives
Dr. M. Sobel, Bell Telephone Laboratories
(Continued on following page)
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- Pulse circuit design
- IF strip design
- Device using klystron, traveling wave tube and backward wave oscillator
- Display and storage devices

CIVILIAN POSITIONS OPEN
2-WAY RADIO COMMUNICATIONS
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- Power supply
- Systems Engineering
- Selective Signaling
- Transistor Applications
- Crystal Engineering
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MEETINGS

Reliability Definitions Panel
C. M. Ryerson, Radio Corporation of America, Moderator

Tues. a.m., Jan. 13
Reliability Training and Education
System Operational Effectiveness
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G. A. Henderson, Army Rocket & Guided Missile Agency
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Reliability Design Tools for Engineers
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C. J. Brzezinsky, Ofc. Ass’t, Sec. of Def., (S & L)
Determining AQL by Linear Programming
G. H. Sandler, Raytheon Manufacturing Company
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L. H. Chapin, Minneapolis-Honeywell Regulator Company
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Tues. p.m., Jan. 13
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H. L. Dwyer, Bendix Aviation Corporation
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Field Reliability and Maintainability
Predicting Electronic Equipment Availability
J. W. Thomas, Vitro Laboratories
Cost, Reliability, and Replacement Analysis
Dr. E. L. Welker, ARINC Research Corporation
Selection of Spare Parts Using Part Failure Data
Dr. G. Black, Sylvania Electric Products Inc.
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R. C. Horne, Jr., ARINC Research Corporation
Symposium Reception
Capt. David R. Hull (USN, Ret.)
"Is Your Customer Satisfied?"

Wed. a.m., Jan. 14
Reliability Tests & Measurements
Accelerated Life Test for Composition Resistors
B. C. Spradlin, Battelle Memorial Institute
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L. Knight, British Tabulating Machine Co., Ltd.
Designing Combined Environmental Tests-to-Failure
V. L. Grose, Boeing Airplane Company
Prediction, Test, & Field vs Lab Reliability
R. G. Stokes, Vitro Laboratories

Reliability Management
Bulkup Reliability & The Project Team Concept
G. R. Eagle, The Martin Company
Organizing Dynamically for Reliability
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Measurements Engineering—A Key Reliability Tool
J. A. Connor, Hughes Aircraft Co.
Time Phasing of a Reliability Program
G. Ashendorf, Radio Corporation of America

Mon. p.m., Jan. 12
Tutorial Session on the Fundamentals of Reliability
Basic Reliability Considerations
M. P. Feyerherm, Radio Corporation of America
Statistics for Prediction and Analysis
Dr. G. R. Herd, Booz Allen Applied Research, Inc.
Effective Reliability Management
M. M. Tall, Radio Corporation of America
Data Collection and Evaluation
D. W. Sharp, ARINC Research Corporation
Panel Discussion—A review of the session by the Moderator and Speakers, with audience participation.

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