Highlights of This Issue

Don't fail to follow through on the following series that continue in this issue: Part 2 of a three-part series dealing with radar modulator circuits; Paul Wradic's articles describing the industrial designer's novel approach to human factor engineering in industry.

Super accurate cryogenic gyroscopes may result from two projects underway at General Electric Co. and Jet Propulsion Laboratory. Some people feel that mechanical gyroscopes for inertial guidance have been pushed to the absolute limit. That's why at least two companies are now developing cryo gyroscopes to meet the stringent requirements of space. See what advantages—as well as problems—are involved in the design of these radical gyroscopes.

The load-line approach to transistor amplifier design offers many advantages over conventional methods, according to Alan Phillips of Sperry Gyroscope Co. He feels that this method provides a rapid way to find low-frequency gain and input impedance. Read this article in which he shows how easy it is to use the load line in amplifier analysis.

Applications of tunnel diodes in conventional circuits are presented on page 10. The four circuits shown represent some typical uses for Esaki diodes not in the near future—but now. Read these interesting uses that General Electric application engineers have suggested for these solid-state devices.

Speaking of solid-state devices, the recent Solid State Conference held in Philadelphia attracted experts from all over the world. ELECTRONIC DESIGN's News Staff was, as usual, right there to cover the proceedings, and interview the people you want to hear from. The entire story will be presented in detail in the next issue, but see the preliminary notes on the conference in this issue.

At Victor's Electric-Car Division...

where precision is a must

RED/LINE

timing relays "Pay Off"!

The design engineers at Victor's Electric-Car Division sought a way of making their Dyna-Powered Maintenance Truck accelerate automatically and smoothly through the three forward speeds. The answer: Two G-V Red/Line Thermal Relays, each providing a two-second delay between steps. This assures smooth, even acceleration every time. A third Red/Line Relay shuts off the dynamic brake after a fixed time interval, conserving battery power. So, at Victor, G-V Red/Line Timing Relays are "paying off".

More and more companies are finding the reliable performance of G-V Red/Line Timing Relays makes them best for their products. G-V Red/Line Relays will "pay off" in your product, too. Your customers appreciate the importance of high quality, reliable components. G-V Red/Line Timing Relays are specially designed for industrial applications. They have the precision, reliability and long life needed to "pay off" in industrial use.

Your G-V distributor has them in stock now. Call him or write for Bulletin 131 today.

G-V CONTROLS INC.
Livingston, New Jersey
Collins Radio Achieves Production Goals with Weldmatic Welding

A new, exceptionally reliable mechanical filter—key component in the Collins version of the highly strategic Single Sideband Radio—is now in production using an all-welded construction provided by Weldmatic equipment. This advanced filter makes possible improved selectivity characteristics and better utilization of the radio spectrum. Unvarying uniformity of the weld nugget and absolutely no displacement of the positioned parts are required specifications. Electrical characteristics are extremely critical... each of 33 connections must be identical in production quantities! After extensive evaluation, Collins selected Weldmatic's 1032 Miniature Welding Head and Model 1026 Power Supply... the combination that has enabled Collins to meet its production goals. They're a real team for precision welding: the miniature head with perfect vertical electrode motion and accurate repeatable pressure—the power supply with ultra-short current flow (0.001 second) over a continuously variable heat range. Why not consider Weldmatic for your metal-joining problems? WRITE for our free 20-page brochure describing techniques, applications, and Weldmatic's sample welding service.

Weldmatic pressure gage reads firing force...calibrated from 0 to 50 lbs., insures exact weld pressures from job to job. (Right) Welded filter cartridge and completed miniaturized Collins filter.

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In The Next Issue

- More than 200 IRE products and where to find them at the IRE show will appear as part of a huge 335-page special issue.

- Using the resonance equation, anyone can find the bandwidth, impedance, voltage, phase, and Q of resonant circuits. In an important article, Dr. Phil Amlinger will show how to solve the resonance equation much faster using graphical methods.

- Close temperature control in miniature ovens challenges the ingenuity of many designers. A down-to-earth article shows how to meet the challenge without “hit or miss.”
Report No. 4
AXC 620 Miniature True Airspeed Computer (Minitas)

Exceptional accuracy and small size are key features of SMI's new Miniature True Airspeed Computer. Any one of three true air speed operating ranges and accuracies can be supplied to meet the requirements of high-performance aircraft, patrol planes, helicopters, artillery-directing aircraft, and missiles. The MINITAS consists of an extremely sensitive and accurate force balance Mach transducer, a passive resistance network, and a follow-up servo. The transducer is made up of a pressure ratio sensor—which is the heart of the system—a servo, and an electrical function generator. All servo amplifiers use silicon transistors for uniform reliability in severe environments. The MINITAS is capable of operation in a 125°F environment and requires only 20 watts of 115 vac, 400 cps power. Without shockmounts, the computer measures 5" dia. x 8 1/4" and weighs 6.5 lbs. The MINITAS conforms to MIL-E-5400 and MIL-E-5272.

Typical Performance Specifications

<table>
<thead>
<tr>
<th>TYPE NO.</th>
<th>TRUE AIRSPEED RANGE (KNOTS)</th>
<th>ALTITUDE (FT.)</th>
<th>ACCURACY (KNOTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AXC 620</td>
<td>70 - 450</td>
<td>0 - 20,000</td>
<td>± 1/2%</td>
</tr>
<tr>
<td></td>
<td>70 - 125</td>
<td>0 - 12,000</td>
<td>± 1/4%</td>
</tr>
<tr>
<td></td>
<td>125 - 450</td>
<td>12,000 - 20,000</td>
<td>± 2/4%</td>
</tr>
<tr>
<td>AXC 620-1</td>
<td>100 - 200</td>
<td>0 - 10,000</td>
<td>± 3/4%</td>
</tr>
<tr>
<td>AXC 620-2</td>
<td>300 - 1500</td>
<td>0 - 80,000</td>
<td>± 12</td>
</tr>
</tbody>
</table>

NOTE: These are standard accuracies. Increased accuracies are available over restricted ranges upon request, and special ranges and output forms are also available. AXC 620 and AXC 620-1 are capable of operation up to 40,000 ft. with reduced accuracies.

For more information and complete operating specifications, write or wire SMI today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.
Designers Tackle Tough Problem: Cryogenic Gyros With Super Accuracy

FOR MISSILES traveling ultra-precise trajectories into unexplored space; for atomic submarines cruising murky seas for months without resurfacing, and for many other present and foreseeable applications, the precision gyroscope of today is fast becoming obsolete. Needed are revolutionary instruments—gyros so refined that drift rate is all but eliminated. A long stride toward this goal is envisioned in two design projects under way at General Electric Co. and Jet Propulsion Laboratory. The projects: cryogenic gyroscopes.

The drive to build the first practical cryogenic gyro may produce instruments with less than one-hundredth the drift rate of conventional types. Both GE and JPL are designing gyro's that would operate at cryogenic temperatures and in the superconductive state. Frictional and electrical losses would be cut to insignificant amounts. Success is being pursued in the face of the knowledge that the company that did the original design research on cryogenic gyros, Arthur D. Little, Inc., abandoned the project when the magnitude of the problems became apparent.

GE is developing a rate gyro for the Army Ballistic Missile Agency that may achieve a random drift rate as low as 0.0001 deg hr.

JPL is designing a free gyro for the National Aeronautics and Space Agency that would not use servos. Both the GE and the JPL designs represent additional support for the so-called "West Coast" approach to gyro design, which favors two-degree-of-freedom devices over those able to move in only one plane.

Two Advantages in Cryogenics

In the cryogenic gyro's under development, the gyro bearing would be supported by a magnetic force field. This field would be induced by superconductive coils acting on a superconductive bearing surface. To achieve superconductivity, both components would be cooled to temperatures near absolute zero.

Two features of this type of design are:

1. Extremely low frictional losses, because the bearing spins in a vacuum and is supported by a magnetic force field; and
2. Elimination of gyro power supply once the bearing is spinning properly. With no resistance in either the superconductive bearing coils or surface, an electrical current, once started, continues as long as superconductivity is maintained, thereby maintaining the magnetic field.

Applying Superconductivity to Gyros

The most important characteristic of superconductors for gyro applications is their ability to exclude magnetic fields from their interiors. This is the Meissner effect, which can produce a diamagnetic body that is repelled by, rather than attracted to, regions of relatively high magnetic field density.

The magnetic field excluded from the interior of a superconductor forms in lines of magnetic flux on the conductor's surface. Because the lines form parallel to the surface, the force they exert is perpendicular to the surface. In a sphere, such as a gyro bearing, the forces can be made to act through the center of the mass, which results in translational but not torquing forces. The JPL gyro will exploit this absence of torque; the GE gyro will not.

GE Gyro to Use Niobium

GE plans to use niobium as the basic superconductive material of its gyro. This hard-to-machine metal becomes superconductive at the highest temperature—18 K—of all materials considered by the company. But it exhibits a relatively poor Meissner effect and one that can be destroyed completely by welding and soldering.

The gyro bearing would be about 1.5-in. in diameter and would rotate at about 20,000 rpm.

GE reports that the smoothness of the bearing surface is not critical, because the rotating speed can be adjusted to compensate for irregularities. (JPL considers bearing smoothness one of the most difficult problems to be overcome.)

Because niobium is hard to work, GE designers are using in their experiments a hollow titanium ball covered by a thin sphere of spun niobium. Clearance between the stator of the gyro and the bearing would be 0.3 mm.
Sharper Definition... Improved Gray Scale... with

RAYTHEON "KILOLINE"

RECORDING STORAGE TUBES

A Raytheon-designed tetrode gun insures higher resolution — 1,000 TV lines at 50% modulation — and improved control over beam cut-off in Raytheon's new CK7571/QK685 and CK7575/QK787 recording storage tubes. A new multiple collimating lens improves back-ground uniformity and results in a signal-to-shading ratio of ten.

These advanced design features, plus low noise and stable operating characteristics, make Raytheon recording storage tubes ideal for frequency and scan conversion. Among the applications where these tubes play an important role are:

- Scan conversion for bright display and target trails.
- Slow-down video for transmission of still pictures over telephone lines.
- Stop motion to permit analysis of production machinery or to stop action in a sporting event.
- Signal-to-noise improvement of radar or other still pictures by integration.
- Conversion of television pictures from one transmission standard to another.
- Indication of moving targets by electrical comparison of pictures taken at different times.

For scan conversion applications, both r.f. read-out and video cancellation techniques have proved equally effective with Raytheon single- and dual-gun storage tubes.

Raytheon's single-gun CK7571/QK685 and dual-gun CK7575/QK787 recording storage tubes are available from stock in sample quantities. Detailed technical data bulletins are yours for the asking — write direct to Dept. 2527.

TYPICAL OPERATING CHARACTERISTICS
CK7571/QK685 and CK7575/QK787

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode Voltage</td>
<td>4,000 Vdc</td>
</tr>
<tr>
<td>Magnetic Focus Resolution</td>
<td>1,000 Lines (nominal)</td>
</tr>
<tr>
<td>Electrostatic Resolution</td>
<td>700 Lines (nominal)</td>
</tr>
<tr>
<td>Output capacitance:</td>
<td></td>
</tr>
<tr>
<td>CK7571/QK685</td>
<td>12 µF (nominal)</td>
</tr>
<tr>
<td>CK7575/QK787</td>
<td>27 µF (nominal)</td>
</tr>
<tr>
<td>Maximum Deflection Angle</td>
<td>30 Degrees</td>
</tr>
</tbody>
</table>

Typical Resolution Curve

RESOLUTION (NUMBER OF TV LINES)

Hollow sphere of spun niobium would cover a titanium ball and form a rotor bearing of GE's cryogenic gyro. Bearing would spin with 0.3-mm clearance.

The stator contains a conventional motor winding to start the bearing spinning and to accelerate it to speed, and bearing coils of niobium to induce the supportive magnetic field. In the bearing are torque coils to keep the spin on one axis and to compensate for unevenness of surface or of homogeneity.

Readout would be optical, using either the known position of the torquers or a special mark on the sphere.

To maintain the low temperatures to make niobium superconductive, GE is using liquid helium at 4 K. The company has developed an insulator, P-Zero, that it calls "better than a Dewar flash" for conserving the cooling agent.

The gyro will operate in a vacuum of about \(10^{-4}\) or \(10^{-7}\) mm of mercury. The company has already achieved this vacuum.

JPL Gyro Is Gimbal-less

In contrast to the GE gyro, which can be considered a step in the advance of the rate-gyro art through the harnessing of superconductivity, JPL's gyro is planned as a long leap forward. It would be a free, or gimbal-less, gyro that would make use of the absence of torque and would have no servos or servos.

For the bearing, JPL is planning to use a sapphire sphere about 0.5-in. diameter, coated with a vacuum-deposited layer of pure lead. Lead shows a better Meissner effect than niobium, but it requires a lower temperature to become superconductive.
Measure 10cps to 110Mc with one compact meter

Comprehensive range for only $1895. Never before has so broad a range been offered for so low a price—a combination made possible by closely integrating a simple heterodyne converter with a top-notch 10Mc counter. Frequencies up to 10Mc are measured by direct counting. To measure frequencies above 10Mc, the operator simply rotates reference frequency selector until panel meter shows strong deflection, then reads counter indication. Measurements take less than a minute to make. Accuracy far exceeds FCC requirements over communications range. Possible error is .00004% or less from 1Mc to 110Mc.

Write for technical bulletin on Model 7175.

Beckman
Berkeley Division
Richmond, California

---

**NEWS**

conductive and a higher field strength to return to its normal state.

JPL, like GE, will use an ac-induced field to accelerate the rotor to speed. But the JPL gyro will not be cooled and made superconductive until it is at speed. When the rotor is spinning properly, the ac supportive field will be switched to dc.

The rotor of the JPL gyro would be supported while at non-cryogenic temperature by ac levitation. It would then be spun by the rotating magnetic field of an induction motor. While it spun to speed, it would be supported by high-frequency eddy currents. At speed, the bearing would be cooled and made superconductive, and dc would replace ac to induce the supporting field.

**Progress Thus Far**

GE is scheduled to show an engineering model of its gyro to the Army missile agency by the end of this year. A cylindrical superconductive rotor has been spun at 21,000 rpm in a 10⁻⁶-mm vacuum at cryogenic temperatures; and the problems of thermal and electrical shielding have been solved. But the company is hoping to find a better material than niobium, and it has yet to put together a working model of its gyro.

---

**How Magnetic Field Supports Cryogenic Gyro Bearing**

Magnetic field generated by a superconductive coil induces a counter-magnetic field in a superconductive sphere. The counter-field forms on the surface of the sphere, where its lines lie parallel to the surface, as shown by the faint aurora at the surface edge of the sphere. The two fields repel each other, indicated by the flattening of the coil's field lines, and support the sphere. Lines of force will act through the center of a homogeneous, sufficiently spherical spinning body to give torqueless support with no important friction loss.
Lead-coated ping-pong ball under test at Jet Propulsion Laboratory has been supported, while superconductive, in a magnetic field as part of a cryogenic gyro project.

JPL has computed the fields, forces and coil geometry of its design on a computer and has actually lifted a lead-coated ping-pong ball at 4.2K. The laboratory expects that its design will be adequate to support a 0.5-in. lead-coated sapphire sphere against 2 g in all directions. As at GE, readout would be optical.

Great Problems Remain

Both GE and JPL have enormous problems to overcome. JPL's calculations indicate that "sphericity of the bearing must be on the order of 100 times better than anything devised by man," says Dr. J. T. Harding, head of the laboratory's cryogenic gyro project. This requirement represents a sphericity tolerance of about one atom in diameter. Such sphericity is believed necessary to reduce torques in a free superconducting gyro bearing to below the value that would impair accuracy.

Although bearing-surface unevennesses not parallel to the axis of spin tend to even out, those parallel to the spin axis do not. This means great surface smoothness is necessary.

Keeping the gyro bearing suspended in high-g environments is another major problem. As the g's increase, the magnetic force field supporting the bearing must be strengthened. But as the field gets stronger, the temperature has to be dropped to prevent superconductivity from being destroyed. JPL is now researching requirements for a 0.5-in. diam bearing in a 4-g environment. The eventual goal is a bearing the size of an "orange or grapefruit," says Dr. Harding.

GE is leaning heavily on trial-and-error design, which is being complicated by the difficulties of working with niobium. At this time the company cannot predict the configuration of the engineering model that it is preparing for the Army.
FIRST Navy Militarized SSB Transmitter
Generates Cleaner Signal Using
HERMES CRYSTAL FILTERS

MODULATORS formed of a thin film of single-domain permalloy were described at the 1960 Winter Convention of the IRE Professional Group on Military Electronics.

R. L. Samuels and A. A. Reed of Iowa State University told the meeting in Los Angeles that experimental, completely balanced circuits incorporating thin-film modulators to modulate a 4-mc carrier provided carrier feedthrough of 2.5 mv peak for no modulation.

Among other developments described at the convention were:

- Design of transistorized telemetry equipment for the Mercury and Centaur satellite programs.
- The Signal Corps dual-channel infrared reconnaissance system.

Thin-Film Modulators Handle Vlf to Uhf

The thin-film modulators described by the Iowa State researchers are built by winding two mutually perpendicular wires around the film, which is less than 1 micron thick. The carrier winding axis is parallel to the film magnetization rest direction; the output winding at right angles to it. A modulation winding can be parallel to the output, or the output winding itself can be used for modulation, the researchers said.

A modulation signal rotates the magnetization to provide coupling between the carrier and the output windings proportional to signal amplitude, giving suppressed-carrier amplitude modulation. Carrier frequencies from 5 through the lower uhf region are possible, as are dc through video modulation frequencies.

Mr. Reed gave the results of an experimental, completely passive balanced modulator circuit designed at the university. Sinusoidal frequencies from 20 cps to 20 kc and square-wave frequencies up to 100 kc were used to modulate a 4-mc carrier. Carrier feedthrough of 2.5-mv peak for no modulation was measured. Mr. Samuels and Mr. Reed did not have equipment to measure feedthrough with modulation, but they believe it could be kept very low. With the use of sandwich construction and potting techniques, a balanced modulator could be made almost completely immune to the effects of a wide range of mechanical and thermal environments, Mr. Reed reported. He added that the modulator would be very small as well. This work...
A thin-film inductor of sandwich construction could be constructed as shown. After potting, it would tolerate vibration and temperature over wide ranges.

was partially supported by the National Science Foundation.

Transistorized Telemetry

State-of-the-art achievements in transistorized telemetry design were described by J. H. Smith of Texas Instruments’ apparatus division. Specifically discussed in his paper, “Recent Advances in Transistorized Telemetry,” were a highly flexible and reliable eight-bit pcm system with low-level capabilities, high- and low-level solid-state multiplexers, transistorized transmitters, and subcarrier oscillators designed to the rigid needs of the Mercury, Centaur and Vega missile programs.

Mr. Smith described some of the design problems of getting higher bit rates for pcm telemetry, including the transistor types involved, and of obtaining increased power output from transmitters at high frequencies. He discussed, also, recent work on Varactor multipliers and offset and drift problems with low-level commutators.

IR Recon System Has Two Channels

An unusual dual-channel infrared reconnaissance system, AN/AAS-5, was described in a classified technical session by W. B. Birtley and D. D. Chaffee Jr. of HRB-Singer, Inc., State College, Pa. This airborne system, developed for the Signal Corps, uses two detectors simultaneously, with interchangeable detector preamplifier assemblies. Several sensors are also used.

CIRCLE 9 ON READER-SERVICE CARD >
from this...

with Tuf-Plate

Miniaturization of electronic components put the pressure on circuitry to keep pace. Photocircuits took up the challenge and turned an idea into the space and weight saving reality of Tuf-Plate plated thru holes — reliably interconnecting conductor patterns on both sides of the circuit board.

Where even greater component density is required — up to 50% — Photocircuits now offers printed circuit boards with miniaturized conductor patterns using landless Tuf-Plate — another first by P/C.

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CIRCLE 10 ON READER-SERVICE CARD

THE ELECTRONIC DESIGN MAGAZINE

NEWS

Tunnel Diode's Future Use Stirs Speculation at Solid-State Parley

The tunnel diode has the experts temporarily stumped.

Semiconductor specialists at the 1960 Solid-State Conference in Philadelphia, beseiged for details on circuit-design limitations and applications of the new solid-state device, had a stock reply: "We don't really know." A panel at one session compared the uncertainty today over the future use of the diode to that accompanying the introduction of the transistor in 1949.

Research physicists, one panelist noted, are still studying how to build and reproduce the tunnel diode, and application engineers are only scratching the surface of possible circuit configurations.

Other observations made at the conference included:

Transistor and tube users, familiar with devices having separate input and output takeoffs, are trying to uncover new techniques needed for a bilateral, two-terminal device. They are not alone in their effort. Computer designers are applying three-phase supply principles to overcome this difficulty, and others are experimenting with hybrid-T connections.

At present communication engineers are convinced that the tunnel diode is the answer to high-speed computers, and computer designers are equally certain that the device is a natural for high-gain, low-noise amplifiers. Granted sufficient time for laboratory and developmental work, both groups may be right.

A full report on the conference, attended by more than 3,100 engineers, will appear in the March 16, 1960 issue of ELECTRONIC DESIGN.

Basic Tunnel-Diode Circuits Designed for Immediate Use

Four basic tunnel-diode circuits for detecting, switching, clipping and delay have been designed by applications engineers of General Electric. The company released the circuits concurrently with
the announcement of reductions in the prices of its germanium tunnel diodes, which are in limited production. The diodes, previously sold to designers at $60 and $75 each, now cost $10 and $12.50 each.

**Micro-Alloy Transistors** from SPRAGUE*

### 2N393

**High-Speed, High-Gain Micro-Alloy Transistors** for modern digital computer circuitry

**Type 2N393** Micro-Alloy Transistors combine high gain with excellent high frequency response to meet the demands of high-speed computer switching applications in the megacycle range. Low saturation resistance, low hole storage, and exceptionally good life characteristics make these transistors top performers in computer circuits as well as in general high-frequency applications.

D-C β is remarkably linear up to 50 milliamperes collector current. The design of the 2N393 is particularly well adapted to direct-coupled logic circuitry. The polarities of the emitter and collector voltages are similar to those of PNP junction-type transistors.

Made by electrochemical manufacturing techniques, Sprague Micro-Alloy Transistors are uniformly reliable and very reasonably priced.


* Sprague Type 2N393 micro-alloy transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable. You have two sources of supply when you use micro-alloy transistors!
The New Rutherford Pulse Generator

B-7

Built for HIGH PERFORMANCE
WIDE VERSATILITY
LOW COST

Today's basic research demands the finest. The Rutherford B-7 Pulse Generator is precisely engineered to meet the rigid standards of research and development—from biological research at low repetition rates, to transistors, transistor circuits, and magnetic core research at high repetition rates.

The one unit Rutherford B-7's rack-mountable dimensions are compact: 19¾" wide, 8¾" high, and 12" deep. Amplitude is 50 volts delivered into a 50 Ohm load. Delay with respect to Sync. Out: 0-10,000 μs. Width: 0.5 μs-10,000 μs. Repetition rate: 20 c to 2 mc. Cost: A budget-conscious $720.

Your "space-age" research and development grows steadily more important, your equipment more strategic. On the results of research performed with Rutherford equipment rest many of America's scientific achievements. If you play a part in those still to come, put Rutherford on your scientific team. Write for complete information.

Rutherford Electronics Co.
8944 Lindblade Street, Culver City, California

Microcircuit Production Problems Cited

The microcircuitry discussion indicated that engineers now face the practical problems of getting such devices into production.

Several companies have already developed devices using microcircuit techniques (ED, Dec. 23, 1959, p 3). But production is generally limited to the laboratory.

An exception was reported by Dr. Richard Lee, department manager for solid circuits of Texas Instruments, Inc., who said TI was prepared to quote on 500 units a day now in production.

Major production problems, panelists agreed, are in the areas of materials and process control. The consensus was that the role of the electronics circuit designer was becoming less important, with the physicist and chemist assuming more importance. Reproducibility is a problem that some felt would not be solved for several years.

During the discussion after the papers, Harry Owens of Texas Instruments chided some of the people working in microcircuitry for shrouding their activities. He implied that the concept of a block that could not be characterized as a circuit composed of resistors and capacitors was ridiculous.

In discussing reliability, some panelists, noting that transistors were expected virtually to "last forever," suggested that new orders of reliability would be achieved by solid circuitry. Others disagreed, citing the problems of unknown surface factors, interconnections between surfaces, and the complexity of solid circuits in contrast with a single component such as a transistor.

Because of the need for understanding surface phenomena, research is being directed to this area, it was observed. Mr. Owens said progress was also needed in the related area of interconnection between surfaces. Better understanding of surface phenomena should contribute to the solution of this secondary problem, he added.

I. A. Lesk of General Electric argued that interconnections could be made very reliable. In response to a question by Nick DeWolf of Transistor, however, he implied that because of the number of com-
Magnet-Gapped Inductors Described

Miniaturized inductors using counter-biased barium ferrite permanent magnets rather than air gaps can now be designed instead of developed by hit-or-miss methods, according to J. T. Ludwig of Minneapolis-Honeywell's aeronautical division. His paper gave mathematical procedures for constructing design charts directly from the characteristics of the magnetic material.

Digital data blocks, each filling one of six main data-handling functions, were recommended as components in a solid circuit, reliability would be a long time coming. Mr. Owens disagreed, saying that if the number of components were kept below ten, the circuits could be made very reliable.

H. W. Henkels of Westinghouse counterbalanced these views with an example of a silicon transistor whose yield rate did not change despite great increases in complexity during production.

Speakers then turned to the testing problem, suggesting that testing would probably be performed during process with new test procedures. Because of the specific application of the finished “lumps” as these solid circuits are sometime called—they will probably need fewer final tests than a conventional component. A transistor, for example, might require tests of 16 parameters.

And there's still another. For a nominal additional charge any specific electrical design characteristic will be 100% guaranteed not to exceed its distribution limits. These guarantees add up to a marked upgrade in circuit design accuracy...high reliability in operation...and consistent repeat performance. In specifying the Tung-Sol 2N1313 high speed switching transistor, you're selecting a transistor which features an ideal balance of the most wanted characteristics as revealed by a survey of computer designers. You're also choosing a transistor which offers improved performance at lower cost over most of today's popular computer types.

The 2N1313 is designed to meet rigorous military environmental standards. It features “Thermal Bond” construction, exclusive with Tung-Sol. The transistor junction tab is securely joined to the base of the transistor. The bonding material provides high heat dissipation while maintaining complete base-to-case electrical isolation.
A new transistor RISE, STORAGE AND FALL TIME METER for fast, millimicrosecond-accurate measurements you read directly

Here is a great new advance in metering—an instrument which makes possible quick, simple measurements to millimicrosecond accuracy. Three independent channels of time measurement are provided. Each has individual adjustable voltage discriminators, permitting measurements of any three times of interest over the delay, rise storage or fall of the switching transient characteristic. E-H Model 140 is designed primarily for fast measurement of rise, storage and fall time parameters of transistors in saturated mode operation. It is also useful for transient response measurement of diodes, cables, pulse transformers, delay lines, amplifiers and similar high speed devices. Like all E-H instruments, the 140 is conservatively designed for trouble-free performance. Top quality components are used throughout.

For more information on the 140, write or wire E-H today.

**SPECIFICATIONS:**
- **TIME DIFFERENCE Channels (Three)**
  - **Ranges:** 10 millimicroseconds full scale to 10 microseconds full scale—four ranges.
  - **Readout:** 1 volt full scale at BNC connector and panel meter for each channel.
  - **Readout Time:** Less than 100 milliseconds.
  - **Accuracy:** ±7% ± 5 millimicroseconds.
  - **Power Supply:** (for transistor collector)
    1. Voltage: 3 to 20 volts, continuously variable.
    2. CURRENT: up to 0.1 ampere available.
  - **Mercury Pulsar (base drive)**
  - **Rise and Fall Time:** less than 2 millimicroseconds.
  - **Repetition Rate:** 60 cps.
  - **Amplitude:** 3 to 20 volts, continuously variable.
  - **Preampifiers:** Separate preamplifiers are available for testing either PNP transistors, NPN transistors, or diodes. The preamplifiers may be remotely located at the test fixture.
    - Model 141-PPN (for PNP transistors)
    - Model 141-NPN (for NPN transistors)
    - Model 141-01 (for Diodes)
  - The Model 140 comes equipped with any one preamplifier—additional preamplifiers are priced at $600.00 each.

**NEWS**

the proper direction for digital equipment design by Helmut Schwab, Consolidated Electrodynamics Corp. The six submodule types in Mr. Schwab's "combi-system" are: position selection, value comparison, data-flow switching, memory, systems control and character translation. Combinations of these units can be used to form the data-handling system required for a specific application.

A panel on the adaptability of principles of the human nervous system to equipment design pointed out that sensory data were handled in parallel rather than serially. The brain computes the most probable values for the sensory data and cross-compare these with the actual received values. This cross-comparison at various levels achieves a high degree of reliability and permits rejection of inaccurate sensory data.

**Educational TV Needs Noted**

Newly designed TV equipment, providing maximum possible transmission power and minimum receiver noise, will probably be necessary for a nation-wide airborne educational system, according to Martin T. Decker of the National Bureau of Standards. Current uhf TV equipment will probably not be adequate for these requirements, he said. The National Bureau of Standards is studying the problem under the sponsorship of the Ford Foundation Fund for the Advancement of Education. Mr. Decker reported that further theoretical work would be carried out to estimate the number of aircraft and portion of the frequency spectrum required for efficient coverage of the United States.

Automatic data-logging systems are now being used by broadcasting stations to monitor transmitting equipment, and the National Association of Broadcasters is attempting to have logging charts accepted as the official log of a station, according to Gustave Ehrenberg of Minneapolis-Honeywell. He said that current measuring and telemetering systems were being built with provision for later addition of automatic control systems at the transmitting site.

**New Pnpn Diode Developed**

A triple-diffused silicon pnpn diode with turn-on and off times of about 10 microseconds was reported by A. N. Baker, J. M. Goldie, and I. M. Mackintosh of Bell Telephone Laboratories. The diode, which is said to be capable of switching several watts of power, is triple-diffused, starting with an n-type layer. The wafer is etched to form a mesa-like construction, producing a unit with a capacity of about 5 microfarads. High speed is attributed to the thin layers and
duction in the lifetime of the charge carriers. The latter is accomplished either by irradiation with high-energy electrons or by diffusing in small amounts of gold.

At a session devoted to a comparison of digital differential analyzers, DDA, and general purpose computers, GPC, in control applications, the "feud" between engineers in the two groups turned out to be no feud at all.

The consensus at the session was strongly--"each has its place." Despite attempts by the session chairman to evoke definitive support for one or the other type of computer, each speaker held closely to the idea that in some applications the GPC is best, and in others the DDA, or incremental computer as it is called, is preferable.

In general, where large, rather unpredictable changes take place in a process, a general purpose machine is called for, while processes involving slower, continuous changes are well suited to control by the DDA. It appears, speakers commented, that in actual applications general purpose machines are taking the lead.

Slow sweeping is probably the chief limitation of the incremental computer, said. Sweeping time is the time required for the computer to provide an initial solution to a new problem.

The DDA starts with an initial set of values for process variables, and then works toward a solution using incremental changes. If the complete process set-up changes radically, the DDA might require 300 sec to reach a new solution. The general purpose computer, on the other hand, starts each new problem afresh with a new set of values so that large changes are as easy to handle as small ones.

With slow changing problems the DDA shows an advantage because it might produce 200 solutions per sec while the conventional computer gives only 10 to 20 solutions per sec. This is a distinct advantage in real-time problems, speakers pointed out.

Some of the other factors in favor of the GPC include: ease of reprogramming; ability to do general information processing; and relatively predictable behavior in dynamic situations.

Other factors favoring the DDA include: use of fewer components—for some uses it may be one-fourth the size and weight of a GPC with consequent cost savings; better reliability with respect to failures because of fewer parts; and accuracy equal to conventional machines.

According to a paper by S. M. Shackell, deceased, and J. G. Tryon, University of Alaska, the DDA makes more efficient use of circuitry, which allows the use of fewer parts but makes troubleshooting more difficult. It is also difficult to design the DDA because it is not easy to predict its behavior in highly dynamic situations, Mr. Tryon commented.

FORD VIBRATION INSTRUMENTATION: The Ford Motor Company entered the experimental gas turbine engine field in 1956. The Ford Turbo Machines Department is now engaged in research and development of a turbine engine and a working model has been tested in a tilt-cab truck. An obsolete engine, the 702, has developed 160 horsepower at shaft speeds up to 36,000 rpm. A new supercharged 300 horsepower turbine engine was recently announced by Ford Engineers. Known as the "704," the engine weighs 650 pounds installed, compared to 2,700 pounds for a truck diesel engine of comparable horse-

ENDEVCO TRANSDUCERS SOLVE VIBRATION ANALYSIS PROBLEM

power. The engine has two stages of compression, each operating at a 4:1 pressure ratio. Two burners are used for driving the dual compressors, the low speed wheel turning at 46,500 rpm and the high speed wheel at 91,500 rpm.

THE PROBLEM: The Ford Test program requires a wide variety of instruments to measure, control, and record performance data of component parts. Measurement of vibration, for example, is a critical factor in this program. Vibrations that may cause metal fatigue, oil film breakdown, overheating, etc., are discovered during tests on individual engine "stands."

THE SOLUTION: Ford engineers use a total of six Endevco Series 2200 Accelerometers providing frequency responses up to 6,500 cycles per second. The accelerometers are connected to bearing test rigs, for example, (see photo). The accelerometers relay measurements of acceleration movements in turbine shafts from three coordinates (radial, vertical, radial horizontal and axial). Temperatures of the metal housings to which the standard Endevco transducers are attached average up to +150°F. Temperatures at which the water-cooled, heat-resistant models are used range up to +1000°F or more. The large self-generated output of the Endevco accelerometers eliminates the need for additional stabilization of a power supply.

THE RESULTS: The Endevco transducers are attached with a single-plate threaded bolt. The signal is fed through an Endevco amplifier to an oscilloscope or panoramic analyzer. The analyzer concentrates on a small section of the total signal and may present from 4 to 10 harmonic vibrations of different frequencies being fed from the unit at one time. This analyzer separates the frequency bands into individual bands, which it then sweeps from 20 to 40,000 cycles every second, measuring the frequency and amplitude in millivolts. Ford Technicians convert these vibration records by mathematically integrating acceleration with respect to time to obtain the displacement or housing vibration. Thus, they locate the sources of objectionable resonance and take steps to eliminate or reduce vibration in the overall design. Other transducers have also served as pick-up for determining spring rate and damping characteristics of rubber bonded bearings. • ENDEVCO CORPORATION • 161 EAST CALIFORNIA BOULEVARD PASADENA, CALIFORNIA • PHONE SYCAMEO 5-0271

Close-up shows two Endevco Accelerometers on bearing test rig in Ford Instrumentation Section, Dearborn, Michigan. Cable passes to Endevco Amplifier (not shown on right).
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Motorola, Inc., protects its radio tube filament properties. For the low cost leader models, a simple, inexpensive way. A GLOBAR silicon carbide thermistor is used in series with the tube filament string. Its negative temperature coefficient is utilized to limit the initial voltage surge during warm-up. Motorola expects tube life to be prolonged up to ten times.

GLOBAR thermistors find many other applications where surge protection, time-delay operation, or temperature sensing and control are required. There is a wide range of sizes and ratings. Write: Globar Plant, Refractories Div., Dept. EDT-30, The Carborundum Co., Niagara Falls, N. Y.

Vacuum-Tight High Voltage Connector poses ceramic-to-metal sealing problem

The connector shown above is designed to meet severe space limitations which necessitate maximum voltage protection with a minimum of ceramic insulation.

The 1552 alumina insulator has a metallized coating for corona protection. The housing is heavy stainless steel.

Making the insulator to the required close dimensional tolerances, accurately centering the electrode in the housing, and then providing a vacuum-tight seal, were some of the problems Carborundum had to solve. To add to the difficulties, the center electrode had to be a special high conductivity material to provide sufficient current capacity.

Ingenious methods had to be worked out to seal this high expansion material to the ceramic. The complete assembly is hydrostatically tested for vacuum tightness, and withstands an electrical test of 30,000 volts. For help on your sealing problems, write Latrobe Plant, Refractories Div., Dept. EDS-30, Carborundum Co., Latrobe, Pa.

NEWS BRIEFS...

... ELECTRIC POWER CONSUMPTION in the nation will rise to 1.5 trillion kw-hr by 1970, Don G. Mitchell, President of General Telephone and Electronics Corp., has predicted. In 1959, about 700 billion kw-hr were consumed.

... THE TITAN ICBM has successfully completed its first guided test flight. It was the first time that the second-stage engine had been fired.

... AN EXCHANGE AGREEMENT between the Raytheon Co., Waltham, Mass. and the Compagnie Générale de TSF, Paris, France, has been signed. The companies will exchange information about microwave tubes.

... THREE-DIMENSIONAL TELEVISION has been developed by E.M.I. Electronics, Ltd., Middlesex, England, for use in plants where dangerous materials must be manipulated remotely. Images from two cameras are superimposed on polarized glass to form a single image. The viewer must use polarized spectacles.

... RADAR SIGNALS have been bounced off the sun's corona by Stanford University scientists. The signals were received 16 and a half minutes after their transmission. Stanford Provost Frederck E. Terman said this was "by far the greatest distance man has ever sent anything and been able to get part of it back."

... A NEW INERTIAL GUIDANCE SYSTEM has been developed for long-range missiles, satellites and space vehicles by the Avionics Division of Bell Aircraft Corp., Buffalo, N. Y. Bell engineers describe the classified system, developed by Dr. Helmut Schlitt, as "the most successful and reliable of any new instrumentation concepts so far tested."

... A DIGITAL VELOCITY METER utilizing a miniature accelerometer of extremely stable mechanical configuration has been developed by engineers of the Bell Aircraft Corp., Buffalo, N. Y. The device is designed to operate over a wide range of accelerations, temperatures and vibratory forces.

... WESCON (Western Electronic Show and Convention) has mailed exhibit-space applications for the 1960 show to more than 4000 electronics companies. A priority system, based on a company's previous exhibits in WESCON and promptness in replying to the mailing, will be used in allocating space.
A SATELLITE WITH BRITISH EQUIPMENT may be put into orbit by a United States 4-stage Scout rocket by the end of 1961, Prof. H. S. W. Massey, Chairman of the British National Committee in Space Research, reports. He said other satellites may be orbited at yearly intervals. They will be designed to last at least six months at altitudes between 200 and 600 mi.

MISSILE-GUIDANCE AND TRACKING RADAR manufactured by the Sperry Gyroscope Co., Great Neck, New York, will be installed in the Navy's first nuclear-powered cruiser, the USS Long Beach.

TRANSLATING LANGUAGES BY MACHINE is an area in which the United States appears to be lagging the Soviet Union according to Dr. Kenneth E. Harper of the University of California at Los Angeles. He said the Russians had 450 machine-translating experts, compared with 120 in the United States.

CHANGES IN PRICES AND AVAILABILITY

UNIVERSAL BRIDGE, Type B-221 has been reduced 10 per cent in price by Wayne Kerr Corp. The transformer ratio-arm bridge has been reduced from $990 to $880, fob Philadelphia.

LOW-CURRENT SILICON RECTIFIERS have been reduced 28 to 61 per cent in price by General Electric Co. The new prices affect nine types of military silicon rectifiers.

TEFLOm TUBING, including standard and thin-wall spaghetti tubing, flexible and millimeter tubing has been reduced in price by Pennsylvania Fluorocarbon Co.

MICRO-MIN glass-encapsulated microwave diodes have been reduced in price from 10 to 30 per cent by Sylvania Electric Products, Inc.

SINGLE-SUPPLIERS silicon transistors have been reduced 25 per cent in price by Fairchild Semiconductor Corp. Types 2N696 and 2N697 npn units have been reduced from $28.50 each in lots of less than 100, to $22.70. The 2N1131 pnp, formerly $37.50 is now $28.80.

SILASTIC LS fluorosilicone rubber has been reduced 25 per cent in price by Dow Corning Corp. The price has dropped from $22 per lb to $18 per lb.

With 20% bandwidth and over 20 db isolation, the new Hughes "Y" and "T" Circulators are ideally suited for microwave reception and transmission applications. They also give you small size and weight...without sacrifice in performance. C- and X-Band models are available today!

For information on the new 20-20 Circulators, or other advanced microwave components, please write Microwave Products Department, Advanced Program Development, Hughes Aircraft Company, Culver City 7, California. Or, phone UPton 0-7111, Ext. 6919.
WASHINGTON REPORT

Ephraim Kahn

... R&D PRIORITIES have been juggled by the Air Force. As a result, some projects formerly in Importance Category 1 have slipped back to Categories 2, 3, or 4. The new first priority class calls for R&D spending "as necessary" to insure that "an operational or technical capability" will be attained by a specified date. Items in this class comprise vital operational systems (both present and planned) and their supporting projects. Second priority goes to systems considered an "essential element" of military strength, to operational support items needed to "eliminate major deficiencies," and to projects needed to avert a "critical degradation of a future operational capability." Budgetary limitations will govern the extent to which funds are applied to R&D in this category. Less urgent items are relegated to Categories 3 and 4, where stringent funds limits will apply.

... PARTIAL FINANCING of defense contracts by private firms has been scored by the General Accounting Office. Commenting on three Air Force contracts, it notes that the policy of forcing contractors to finance 20% of costs incurred before delivery had sharply increased the government's final cost of production. Reason is that the private firm had to pay about 5% for money when the government was getting funds for 3%. Both the contractor and the Accounting Office agreed that this financing arrangement—intended to furnish an incentive to reduce costs—probably was not effective.

... COMPULSORY QUESTIONNAIRE on R&D spending has been proposed by the Census Bureau. The National Science Foundation is sending a 3-page questionnaire to about 8,000 firms. Firms that do not answer this inquiry would be sent a brief, two question, query by Census. It would be compulsory to answer and return it. Questions to be asked are (1) cost of R&D in the physical and life sciences during 1959, and (2) the portion financed by the government.

... SUBCONTRACTOR PRICES are being checked carefully by the Defense Department. The General Accounting Office has complained
to Congress that some "unreasonably high prices" have been accepted by prime contractors when offered by suppliers. It cited profits ranging from 24% to 41% made by some subcontractors and attributed them to price acceptance by the prime contractor "without requiring the suppliers to furnish information on costs incurred in producing similar items under earlier purchase orders or explanation for any increases in estimated costs over prior cost experience." Laxity in price negotiation, according to the agency, is "attributable in part at least to the fact that in most cases the prices negotiated with the suppliers are passed on to the government and consequently the contractor has little financial self-interest in close subcontract pricing."

... MASS PRODUCTION of tiny, precise, and reliable electronic parts for the Nike-Zeus anti-missile system is feasible, according to the Army's Chief of Research and Development, Lt. Gen. Arthur G. Trudeau. Pilot lines to make items now hand-made were set up in two companies (and probably paid for with funds allocated to industrial readiness). Gen. Trudeau says that "these operations indicate that the miniature devices can be produced on a mass basis with a high degree of equipment reliability."

... ELECTRONICS INDUSTRY study is planned by the Commerce Department, provided Congress grants sufficient funds. Data to be compiled include the industry's basic structure, products made, end uses, value and volume, employment, capital invested and similar items. Also to be looked at are the kinds of raw materials and components required, their sources, the problems of sources, and the degree of dependence on imported raw materials. Also to be studied would be growth trends and characteristics, competitive effects of new things that substitute for existing products; industry capacity and its utilization; factors that influence new investment, and the effect of government policies and programs of industry. Expansion prospects, both short- and long-term and technological developments as they affect expansion would also be looked at, as would the impact on the industry of imports, exports, and U.S. investment overseas.

... MISSILE INSTALLATIONS account for about half of the military construction money asked for fiscal 1961. Installations for both long- and shorter-range missiles would be covered by the approximately $650 million to be spent. Also included are substantial (but classified) sums to pay for electronic facilities that are a part of the Pacific Missile Range, DEW Line, Pine Tree Line, SAGE, expansion of Loran, and improvements to radar used in connection with Nike Hercules.

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These Are Times...

These are times that try engineers' thinking.

Success was once a "planned" affair (after an initial lucky break). An enterprising engineer might stumble on an idea that appeared good. He might scrape up a few dollars, get started, and if luck was with him, the idea caught on and he was in business.

Then, to ensure long-range success for his idea, he tried several well-known techniques: He improved his product; he cut costs; he expanded his sales effort; he trained his personnel; he watched the market and his competition...and so on.

Consider the present situation. Tube manufacturers have been improving tubes for years—and along comes the transistor. Transistor manufacturers have been improving transistors—and along comes the tunnel diode. Component designers have been improving capacitors, resistors, coils, and the like for years—and now the solid-circuit era seems to be at hand.

Whole technical areas are being "leapfrogged" like an army leapfrogging islands to its objective on the mainland.

There is every possibility that while we worry about making a component more reliable, the component may soon become unnecessary. Knowing this, we must continue to try to make the component more reliable until new devices are available.

In many ways it is a frightening time to live in—but a stimulating one too. The engineer who is afraid to think imaginatively while keeping his feet on the ground is going to be left behind.

Today's technical world calls for bold, original thinking, for an intense awareness of what is being done in many technical disciplines, and for a deeper understanding of basic principles underlying the electronic art.

Truly these are times that try engineers' thinking.

Edward S. Grayson

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**EDITORIAL**

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- simple in-line readout.
- Large enough for laboratory accuracy; small enough for convenient portability. Model 250-DA, a self-contained, line-operated portable unit for accurate measurements of impedance elements at dc and audio frequencies. $355. Model 250-C1, battery-operated. $375 (ac detector $200 additional).

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- simple in-line readout.

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CIRCLE 22 ON READER-SERVICE CARD
Alan Phillips feels that the load line approach to transistor amplifier design offers many advantages over conventional methods which assume that the actual current gain is equal to the short-circuit current gain. In this article he shows how easy it is to use the load line in amplifier analysis.

**Load Lines Simplify Transistor Amplifier Analysis**

Alan H. Phillips  
Sperry Gyroscope Co.  
Great Neck, N. Y.

Without resorting to conventional approximations, the load-line method of transistor-amplifier design provides a rapid way to find low-frequency gain and input impedance. When used with manufacturers' "typical" curves, the method provides accuracy adequate for most applications.

The advantages of the load-line method over others are:
- It helps the designer visualize what is going on in the circuit.
- It directly provides a current-gain term \( B \) (not to be confused with short-circuit current gain \( \beta \)) which simplifies the expressions for gain and input impedance. These expressions use no approximations.
- It locates the dc operating point of a transistor amplifier more accurately than do the customary equations using a dc beta.

**Input Impedance**

Fig. 1 shows the basic circuit of a transistor amplifier. To find the input impedance \( R_{in} \) of the amplifier stage, it is necessary to find the current gain which can be designated \( B \).

Assume that the load line is as shown in Fig. 2 and the quiescent operating point is point 1. If the input current swings 25 \( \mu A \) peak-to-peak, the operating point swings from 4 to 5. The output current changes 2.4 mA peak-to-peak. Hence:

\[
B = \frac{2400}{25} = 96
\]

The transistor input impedance \( r_{in} \) is the slope of the base-input characteristic curve of Fig. 3 at the operating point. Then,

\[
i_e = B i_t
\]

\[
i_e = i_v + i_t = (B + 1) i_t
\]

\[
i_t = \frac{v_t}{r_{in} + R_b}
\]

\[
i_t = \frac{v_t}{r_{in} + (B + 1) R_b}
\]

\[
R_{in} = \frac{v_t}{i_t} = R_b + r_{in} + (B + 1) R_b
\]

As far as the base circuit is concerned the emitter resistance \( R_e \) looks as if it has been multiplied by \( B + 1 \).
Amplifier Gain

We know that

\[ v_{out} = i_t R_L = B_i R_i \]

But

\[ i_t = \frac{v_i}{R_i} \]

Hence

\[ v_{out} = B R_i \frac{v_i}{R_\text{i}} \]

Gain = \[ \frac{v_{out}}{v_i} = \frac{B R_i}{R_b + R_i + (B + 1) R_e} \]

The Emitter Follower

The input-impedance expression for the emitter follower is the same as for a conventional amplifier.

\[ R_{\text{in}} = R_b + R_i + (B + 1) R_e \]

The output voltage appears across \( R_b \) and is called \( v_e \) in Fig. 1.

As before:

\[ i_1 = \frac{v_i}{R_b + R_i + (B + 1) R_e} \]

\[ v_2 = \frac{R_b + R_i + (B + 1) R_e}{B + 1} \]

Gain = \[ \frac{v_2}{v_i} = \frac{R_b + R_i + (B + 1) R_e}{B + 1} \]

The output impedance is derived as follows:

It was shown previously that \( R_b \) appeared to be multiplied by \( (B + 1) \) when transferred into the base circuit. In like manner \( R_b \) appears to be divided by \( (B + 1) \) when transferred into the emitter. Hence:

\[ R_{\text{out}} = \frac{R_b + R_i + (B + 1) R_e}{B + 1} \]

Since \( R_{\text{out}} \) is in parallel with \( R_b \), the output impedance as seen by the next stage is

\[ \frac{R_{\text{out}} R_b}{R_{\text{out}} + R_b} \]

Cascaded Amplifiers

In the case of cascaded amplifiers, \( R_i \) is the input impedance of the following stage in parallel with the collector load resistance. The gain of an \( n \)-stage amplifier is obtained by solving for the gain and input impedance of each stage in turn, starting from the last stage.

Effect of Increased \( I_c \)

At high temperatures \( I_c \) increases. The effect of increased \( I_c \) may be found by carrying out the

---

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- High dissipation with minimum size
- High collector-to-base voltage
- High collector-emitter breakdown voltage
- Wide range of operating and storage temperatures

CHECK THE CHARACTERISTICS

<table>
<thead>
<tr>
<th>Type</th>
<th>Max. W (Vdc)</th>
<th>Max. Vce</th>
<th>Min.</th>
<th>Max.</th>
<th>( h_{fe} ) (( I_c = 2A, V_c = -2V ))</th>
<th>Max.</th>
<th>Max.</th>
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<tr>
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<td>50</td>
<td>2.5</td>
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</tbody>
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All types have: Max. collector current, 3.5 ma; junction temperature, -65 to 150°C; max. saturation voltage, 0.6 volts (\( I_c = 2A, I_a = 100 \) ma). Minimum alpha cutoff frequency is 200 KHz (\( I_c = 100 \) ma, \( V_c = -4 \) volts).

25°C base mounting temperature.

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<table>
<thead>
<tr>
<th>L-T Transistor-Regulated Series</th>
<th>0-1 and 0-2 AMP, 0-32 VDC</th>
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</thead>
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<tr>
<td>Com-Pak Tube Regulated Series</td>
<td>200-400-800-1500 MA</td>
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<tr>
<td>0-200, 125-325, 325-525 VDC</td>
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</tbody>
</table>

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Fig. 4. A typical transistor-amplifier stage.

analysis using a new set of characteristic curves which are the same as the old ones except that the base current corresponding to a given curve is changed. For example, if $I_β$ is increased by 30 $\mu A$ with temperature, then in Fig. 2, the 50 $\mu A$ curve now corresponds to 20 $\mu A$ base current.

**Variations**

To clarify the effects of varying $\beta$, halve each of the base current numbers in Fig. 2 and repeat the analysis.

**Sample Computation**

To illustrate the load-line method, the circuit of Fig. 4 will be analyzed. The dc equivalent circuit reduces to Fig. 5 the Thévenin's theorem. The ac Thévenin equivalent circuit is given in Fig. 6. The line 2-3 in Fig. 2 represents the collector voltage for various assumed base currents. Its intersection with the load line at point $I$ is the quiescent operating point. Its equation is

$$V_I = V_{OC} - (V_1 - I_b R_e - V_{BE}) \left(1 + \frac{R_L}{R_e}\right) + I_b R_e$$

Fig. 5. Dc Thévenin equivalent for the circuit of Fig. 4.
Fig. 5 defines the symbols in this equation. $V_{be}$ is the dc drop between base and emitter. Fig. 3 is actually a plot of $V_{be}$ vs collector current for a type 2N167 transistor.

\[
\text{Gain} = \frac{B R_L}{R_b + r_{re} + (B + 1) R_e}
\]

From Fig. 6:

- $R_b = 4.0 \text{ K}$
- $R_e = 200 \text{ ohms}$
- $R_L = 6.8 \text{ K}$

From Fig. 3:

- $r_{re} = \frac{d V_{be}}{d I_b} = 4.4 \text{ K}$

As before:

- $B = 96$
- $\text{Gain} = \frac{(96) (6.8)}{4.0 + 4.9 + 97 (0.2)} = 23.5$

Since $v_1 = 0.4 v_{re}$

\[
\frac{v_{out}}{v_{re}} = 9.4
\]

**Load-Line Construction**

The equation for load line with the entire load in the collector circuit is

\[
E_e = E_{cc} - I_c R_L
\]

where $E_{cc}$ is the collector supply voltage. When part of the load is in the emitter circuit this becomes:

\[
E_e = E_{cc} - I_c (R_L + R_e) - I_b R_e
\]

This can readily be plotted on the transistor characteristic curves. However, the change in load line is usually small.

Fig. 6. Anven equivalent for the circuit of Fig. 4.

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How To Design Symmetrical

“T” “Pi” Attenuators Rapidly

Glyn Bostick
Chief Engineer
Radar Design Corp.
Syracuse, N. Y.

Ohmic values and power ratings of resistors used in symmetrical “T” and “Pi” type attenuators can be quickly determined by using the accompanying nomogram that combines the design procedures for the two types.

Attenuator parameters that are most commonly specified are:
- Characteristic impedance
- Input power
- Attenuation value

The characteristic impedance of this symmetrical network is defined as that value of impedance

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MULTIPLY BY 100 TO GET "%" OF INPUT POWER RATING FOR R_{T(1)} AND R_{T(1)}

MULTIPLY BY 1000 TO GET "%" OF INPUT POWER RATING FOR R_{T(1)} AND R_{T(1)}

ATTENUATION (dB)
which, when connected as the output impedance, reproduces itself at the input of the network.

**Example**

Assume the values for the above parameters are 100 ohms (characteristic impedance), 10 w (input power) and 10 db (attenuation value). Given these values, find the ohmic value and power rating for both the "T" and "Pi" type attenuators.

In this example the 10-db rating is used for both types for convenience of illustration only. To keep errors at a minimum, due to frequency sensitivity of resistors, use the following rule:

Below 6 db, use the "Pi" type
Above 6 db, use the "T" type

**Step 1.** Draw a vertical line from 10 db and intersect all three curves.

**Step 2.** Intersection of the vertical line with the lower curve occurs at an ordinate of 0.033. Thus $R_s$ for either type, must handle 0.033 $\times$ 1000 per cent = 33 per cent of the input power, or 3.3 w.

**Step 3.** Intersection of the vertical line with the middle curve occurs at an ordinate of 0.52. Thus $R_s$ for either type, must handle 0.52 $\times$ 100 per cent = 52 per cent of the input power, or 5.2 w.

Also:

$$R_1(\tau)/Z_o = R_1(\tau)/100 = 0.52$$

$$R_1(\tau) = 52 \text{ ohms}$$

$$Z_o/R_1(\tau) = 100/R_1(\tau) = 0.52$$

$$R_1(\tau) = 100/0.52 = 192.5 \text{ ohms}$$

**Step 4.** Intersection of the vertical line with the upper curve occurs at an ordinate of 1.4. Thus:

$$R_2(\tau)/Z_o = R_2(\tau)/100 = 1.4$$

$$R_2(\tau) = 140 \text{ ohms}$$

$$Z_o/R_2(\tau) = 100/R_2(\tau) = 1.4$$

$$R_2(\tau) = 100/1.4 = 71.5 \text{ ohms}$$

**Impedance Check.** If the above computations are correct, then, with an output impedance of 100 ohms and $Z_o$ connected, the input impedance should also be 100 ohms. For the "T" type, the input impedance equals:

$$R_2(\tau + Z_o) + R_1 = 71.5 (52 + 100) + 52$$

$$= 100.8 \text{ ohms}$$

For the "Pi" type, the input impedance equals:

$$R_2 = \frac{100 \times 192.5}{100 + 192.5} = 99.3 \text{ ohms}$$

Therefore, the nomogram errors are less than 1 per cent.

---

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CIRCLE 27 ON READER-SERVICE CARD
How to Design a Line-Type Modulator

Part II—Charging Circuit

By determining the discharging-circuit components in Part I, we now have gained enough information to compute the values of the charging-circuit components. This, in turn, will permit us to specify the characteristics of the power supply needed for this modulator.

Quantities and Relationships Used

Three important parameters are used in the charging-circuit design. They are the pulse repetition rate \( ppr \), the pulse width \( t_p \), of the output pulse (both given), and the pulse forming network (PFN) impedance \( Z_y \), determined in Part I. The relation between the PFN parameters \( C_y \) (total PFN capacity, \( Z_y \), and the pulse width \( t_p \), is:

\[
t_p = 2C_NZ_N
\]

(1)

The formula for the charging circuit, Fig. 1, is:

\[
ppr = \frac{1}{\pi \sqrt{L_yC_N}}
\]

Using Frequency-Reactance Charts

Note that \( C_y \) is common to both expressions, and that the expressions themselves can be represented by modified reactance-frequency charts. This allows the complete representation of the charging-PFN circuits to be arranged as shown in Fig. 2. The portion of this chart representing the PFN (lower right) is after C. A. Epp.1 The portion of the chart representing the charging circuit (upper left) is the normal reactance-frequency chart, except for the frequency scale, which has been modified to follow

\[
ppr = 2f_r
\]

(3)

where \( f_r \) is the resonant frequency of the \( L_yC_N \) charging circuit.

Starting from the PFN section (lower right), the chart is entered from the bottom for the pulse width \( t_p \), and from the right side for the PFN impedance \( Z_y \). The intersection of these two lines will give a value of total PFN capacitance \( C_y \). The latter will be on a line parallel to the diagonal lines connecting the two sections of the chart, and need not be recorded.† The intersection of the total PFN capacitance line, with the vertical pulse-repetition frequency line, located in the charging-circuit section (upper left), will give the required value of charging-choke inductance \( L_y \), necessary for resonant charging.

An Example—Continued

To illustrate the use of Fig. 2, the example

†If it is desired to construct a PFN, this value is needed. The total PFN inductance \( L_y \), also necessary, may be taken from the chart given in Reference 1.

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**Fig. 1.** Basic functional diagram and waveforms of the charging circuit.

- **a) CHARGING CIRCUIT-FUNCTIONAL DIAGRAM**
- **b) VOLTAGE WAVEFORM ACROSS C_N**
- **c) CHARGING CURRENT WAVEFORM**

**Fig. 2.** Use these modified reactance-frequency charts to determine the value of charging choke reactance. The example needed may be continued in Fig. 3. In that example, the given value of $t_p$ was 1.75 usec while the given prr was 1000 cps. It was also found (assuming a 10-per-cent mismatch between the magnetron-pulse transformer combination and PFN) that the value of $Z_N$ necessary for proper operation of the hydrogen thyatron, was 55 ohms.

Entering Fig. 3 at 1.75 usec and 55 ohms, a value of 0.016 μf is found for the total PFN capacitance $C_X$. Continuing along the diagonal line corresponding to this value of $C_X$, to the vertical line representing 1000 pps in the charging circuit section, the required value of charging-choke input...
ductance $L_s$ for resonant charging is found to be 6H.

**Resonant Charging**

When resonant charging is being used, it is possible to specify the power supply parameters almost immediately. From the relation:

$$E_{bb} = \frac{1}{2} e_{pp},$$  \hspace{1cm} (4)

and the relations:

$$\frac{I_{rms}}{I_b} = 1.11, \text{ (resonant charging)}$$  \hspace{1cm} (5)

$$\frac{i_{\text{max}}}{I_b} = 1.57, \text{ (resonant charging)}$$  \hspace{1cm} (6)

the power-supply voltage $E_{bb}$, power-supply rms current $I_{\text{rms}}$, and the power-supply peak current $i_{\text{max}}$, may be computed from the values of $e_{pp}$ and $I_b$, found in Part I.

For example, it was found in Part I that our modulator had a peak forward voltage $e_{pp}$ of 2.8 kV, while the average current $I_b$ was 47 mA. If operated under conditions of resonant charging, the power supply ratings are:

$$E_{bb} = 1.4 \text{ kV},$$

$$I_{\text{rms}} = 52 \text{ mA},$$

$$i_{\text{max}} = 74 \text{ mA}.$$  \hspace{1cm} (4)

**This relation is valid for charging chokes having $Q$'s larger than 10, and assumes that a clipper diode is used to remove any inverse voltage left across the network. It is not valid for linear charging ($prp > 2f_b$), but may be used for subresonant charging ($prp < 2f_b$), but may be diode is included in the charging path.**

**Designing For Variable Prp**

If the modulator is to operate over a range of pulse-repetition frequencies, the charging circuit should be designed so that resonant charging conditions exist at the highest pulse-repetition frequency used. At the lower pulse-repetition frequencies, a hold-off diode should be employed to prevent the discharge of the PFN through the power supply.

Eq. 4 is still valid for finding the power-supply voltage $E_{bb}$. Fig. 4 will give the current demanded from the power supply for conditions other than resonant charging. Since the average current $I_b$ will naturally change with pulse-repetition rate, it must be recomputed, using Fig. 6 of Part I.

Our modulator is already designed for resonant charging at a $prp$ of 1000 pps. Assuming that 1000 pps will be the highest frequency of operation and...
230 pps the lowest frequency of operation, the duty cycle for this lowest frequency will be:

\[ d_u = 1.75 \times 10^{-4} \times 230 = 0.000403 \]

The average current for a peak current \( i_b \) of 27 amp, will be (Fig. 2):

\[ I_b = 11 \text{ ma}; \]

(Fig. 4):

\[ \frac{I_{rms}}{I_b} = 2.3; \quad I_{rms} = 25 \text{ ma}; \]
\[ \frac{i_{max}}{I_b} = 6.8; \quad i_{max} = 74 \text{ ma} \]

The preceding computation illustrates the wisdom of finding the values \( I_{rms} \) and \( i_{max} \), particularly for low duty cycle operation. The average current is usually employed to set the modulator power level, since the ordinary d’Arsonval movement measures the average current passing through it. At low duty cycles, however, the peak and rms currents are well in excess of the average current meter reading, and will cause overloading of the power supply if it has been designed for a given average current. The peak charging current \( i_{max} \), does not change in the resonant-subresonant charging range, if a hold-off diode is employed.

**Specifying Diode and Choke**

From the information derived so far, it is now possible to specify the type of hold-off diode to be used. From the circuit and waveform of Fig. 1, it may be seen that this diode must withstand an inverse voltage of \( E_{th} \), as well as the peak current of \( i_{max} \) and an rms current of \( I_{rms} \). As a possible candidate, the liquid-cooled 545 diode may be used as a hold-off diode in this modulator.

The manufacturers ratings for rectifier operation are:

- Max. Inverse Voltage 5 kv,
- Max. Peak Current 180 ma,
- Max. Average Current 50 ma.

The calculated rms current is 92 ma for this tube. It is therefore applicable to this modulator design, whose operating conditions are well within the maximum ratings of the tube.

The charging choke specifications may also be taken from the data derived. The currents will be the same as for the hold-off diode. The voltage excursion will be 0 to \( e_{pp} \) on the thyratron side, and the power supply terminal voltage will remain constant at \( E_{th} \).

The modulator design is now almost complete. Only the clipper diode and trigger source remain to be considered. These will be treated in the third and final article of this series.

---

**Reference**

An Industrial Designer Discusses ...

PANELS

Paul Wrablica
President
Paul Wrablica Associates
New York, N. Y.

By considering the human operator during equipment design, efficiency can be increased together with a reduction in operator fatigue and errors. Panels which are confusing and cluttered can be redesigned to achieve the above goals. (Knobs were discussed in the February 17th issue of ED, p 56.)

COMPLEX test equipment, hampered by a disorganized grouping of dials, jacks, and meters, can be responsible for excessive operator fatigue, poor technician efficiency and errors in measurements.

Frequency Meter Redesign

Typical of an industrial designer's assignment was the challenge to organize an existing panel for a frequency meter. The instrument, developed and produced by Lavoie Laboratories, Inc., Morganville, N.J., had been adjudged insufficiently confusion-proof in the hands of semitechnical operators.

In addition to creating a sense of visual organization to the panel, it was felt that the average semitechnical operator would sense more confidence in a unit that looked as though the various components were clearly related and placed with specific intention to perform a recognized function.

Original Panel Confusing

Although the meter in question, shown in Fig. 1, performed its function perfectly, it was a typical example of visually confused design. In effect, little attention had been given to the human being who became a "component" of the "instrument-in-operation." Engineers had designed it for performance; this accomplished, the chassis was enclosed with sides and a front panel. As a result, the instrument was an unrelated group of windows, dials, gages, crank knobs, check points, inputs and outputs. Groups of components meant to be operated or in use simultaneously bore no visible relationship. Other information gathering areas were obstructed during operation.

Initial Considerations

The immediate problem facing the designer was to organize and create a panel with an immediate sense of visual organization, allowing the operator maximum orientation when facing the instrument and a direction and pattern from which to read and gather information correctly and efficiently.

To compound the situation, a basic requirement was that organization be carried out with minimum changes in the circuitry. All elements on the facing had, therefore, to remain in their original relative positions.

Initial problems included:

- Three radial dial windows, which provided simultaneous digital information, needed an obvious relationship.
- Gages supplying simultaneous or comparative data were spread apart whereas their optimum...
Although far from unsightly, the panel consists of an unrelated group of dials, jacks and meters.

A study revealed that pie-cut openings placed in a horizontal plane reduced time and errors.

An alternate redesign proposal emphasizes vertical separation of functions by means of color areas.

The accepted design, similar to the approach of Fig. 4, uses a rectangular plate rather than a trapezoid to reduce production costs.

A delicate touch and a tiny hand are required to vary the frequency due to poor dial drive placement.

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location should allow them to be sighted simultaneously.

- Crank knobs operated in conjunction with dials and check points bore poor relationships to each other and their functions.
- Dial check points were spotted so awkwardly that the operator was forced to block the windows during testing.

Design Steps

Organization began with an over-all look at the facing and a decision to relate entire areas in terms of their importance. Most important were the three large dials. In this application, where highest accuracy in reading was essential, design principles were applied with particular care. Since the operator was required to read initial, intermediate and final settings from left to right, windows were placed in a single horizontal line. Such placement also reduced time and errors. Though the mental process in operating the meter is relatively simple, the operator should easily read these facings while performing the series of manual operations required to obtain them.

Several Solutions offered

Typical of such assignments, the industrial designer submitted more than one possible solution to the organizing of the meter facing. Such a procedure has many values. One solution rarely solves all the problems, some of which are based on the client’s requirements and facilities. Alternate solutions to common problems allow the industrial designer to comprehend the entire scope of solutions. Based on the client’s appraisal of his product, the designer can recommend the best solution in keeping with these appraisals. In addition, such a method of alternative solutions has proven to be the least expensive, inasmuch as problems not clear in one design become markedly so in another.

In one suggested version, Fig. 2, clear pie-cut shapes were emphasized, focusing attention to the important areas. Strong horizontal emphasis was added to the instrument facing which could be manufactured as a one piece stamping. In addition to strong linear emphasis, the dimension added a rich appearance and a look of quality.

Gages were located vertically rather than horizontally since data was to be read simultaneously. Dial surfaces were designed with light calibrations and markings on dark backgrounds for focal contrast and ease of reading.

Another concept, Fig. 3, emphasized vertical separation of the components by means of color areas. Oval windows were employed, the frames of which complimented the shape of the round dials.

Note that in these two concepts, input jacks,
connectors, fuses, switches, and pilot lights were placed in a single line across the bottom. Common inputs and outputs were color-coded. Jacks providing similar functions could be seen at a glance. Additional jacks were added to provide greater capacity and located to permit neat and rapid hook-up. Knobs were restyled to introduce consistent and homogenous appearance; they were found judged easier to grip and less likely to be used in error.

A third concept, Fig. 4, was submitted as a suggestion for departure from the original version by the utilization of a flat overlay panel of aluminum on which all three windows are cutout and color-coded with crank and check knobs that control them. Here the proposed design theme is the framing of the windows with a trapezoid; additional emphasis is achieved by an applied molding. The horizontal meters were pulled together to minimize waste motion in comparative reading. The design makes use of tapered handles which tend to relate compatibly with the tapered theme around the windows. The handles also tend to visually combine the two-tone combination of colors selected.

Fig. 5 uses the same abstract approach for visual organization of the windows and controls. In this version, accepted as the final design, the use of a flat rectangular overlay plate minimizes cost and production problems. The straight vertical handles serve the same function of combining the two-tone effect and utilize existing hardware. The rectangular theme was carried out for grouping three areas with their appropriate jacks. The meters in this application are round due to an imposed subsequent requirement that they be ruggedized for military application. Meters are physically as close as possible for quick reading of data.

Colors, selected for their compatibility with other laboratory equipment, were a neutral warm grey of satin aluminum and off-black.

Audio Generator Redesign

Another example illustrating a dramatic "before and after" comparison is shown in Fig. 6. In Fig. 6a, the dial control is located in an awkward position for operator handling (especially a right-handed technician).

As shown in Fig. 6b, the redesigned version of the Kay Electric Co. "KC Audiolator" is vertical, with the face tilted back slightly, for greater ease in use and reading. The dial control has been labeled, to avoid confusion to newly-assigned operators, and is placed in a convenient spot. The jacks have been moved to the side of the unit for improved accessibility.

By making the panel in one piece, with silk screen areas, unsightly screw heads are eliminated while assembly time and cost are reduced.
**E** = \( \frac{mc^2}{2} \)

\[ \text{Ampex Reveals the IPS Corollary} \]

**W**hat a joy it is to sow a seed and see it flower.

The ink was hardly dry on our revelation of the new physical law discovered in our laboratory, when the post brought us a singularly fat letter from a certain T. J. Ips. Mr. Ips, it seems, had read our paper and done some pondering of his own in regard to \( E = mc^2 \). He presented at some length a proposition which we have come to refer to as the Ips Corollary. We won't reproduce the entire letter here because of the exhaustiveness of Mr. Ips' thinking and the complexity of his mathematical proofs. His conclusion however is this, "There is a possibility that it might be probable to assume therefore, (what admirable caution—a true scientist) that if the rate of consumption of a material is cut in half, a given amount of material will last twice as long."

Now it is truly amazing that Mr. Ips was arriving at this conclusion independently, miles away, while we were doing experimental work along the same line with our new machine the FR-600 analog recorder—our practical application of \( E = mc^2 \) Our work proves in a practical way the Ips Corollary. Since our FR-600 machine records the same amount of data at half the usual speed, a given amount of tape lasts twice as long. (Engineering readers of our first paper will remember that bandwidth is 125 kc at 30 ips.** for example.)

The marketing people were very reluctant to allow us to publish these facts. They pointed out that by recording 125 kc data at 30 ips a 14-inch reel of tape would last a full 48 minutes. Enough for most complete missile tests including pre-launch time. This would eliminate the need for a stand-by machine or a second transport to take up where the first left off. Sales might be cut in half. But altruism finally won out. We decided to go ahead and publish it even if our competitor's sales were cut in half.

We are sorry we cannot publish the answer to our last trial problem at this time. Our mathematician was taken ill after a strenuous bout with the mathematical proof of the Ips Corollary. As soon as he recovers we will have the answer for you. Meanwhile we invite our readers to try their hand at it. The marketing people respectfully submit that since the FR-600 does the work of two machines, half an FR-600 is better than none.

---

*For those who may have missed the first paper explaining \( E = mc^2 \), we have a limited supply of free copies on hand.

**A standard unit of measure for tape speed named in honor of T. J. Ips. (One-twelfth of a foot per second.)

---

\[ \text{25-Kilowatt Magnetron Brings Millimetric Radar Down To Earth} \]

**U**sing a new magnetron that generates 25 kw of 8-mm power, radar designers can now take advantage of the high resolution and small size of millimetric waves for sea-level applications. A pulse length of only 0.02 usec, combined with a typical beam width of about 4.5 mil in an antenna of reasonable size, yields a square resolution of 4.5 yd at 1000 yd.

Designed by Philips Research Laboratories of N. V. Philips' Gloeilampenfabrieken of Eindhoven, the Netherlands, the new magnetron type 7093 is being distributed by Ampex Electronics Corp. of 230 Duffy Ave., Hicksville, L. I., N. Y. The 4.2-lb tube is tightly designed to yield the optimum power-weight-pulse length compromise for short-range, lightweight, high resolution systems.

Since magnet size varies exponentially with frequency, careful selection of total output power, in view of probable applications, was necessary. Because 8-mm waves are attenuated in normal atmosphere at almost 0.2 db per mile, a fairly high power level is necessary.

Rapid emission build-up, needed for the short pulses, is achieved by the use of a dispenser-type cathode. This is a sintered tungsten cathode impregnated with barium oxide emitting material. The design results in a rugged, yet "fertile" oxide.

The anode block, only 25/32 in. in diameter, contains 18 resonators in a sunburst pattern. Heat generated in the block is carried off by conventional air-cooling.

---

**On map-like PPI presentation of airport, people walking show up plainly, dead time at close range almost disappears.**
Tiny anode block, only 25/32 inch in diameter, employs sunburst cavity structure.

When operating with a 0.02-μsec pulse length, duty cycle is 0.0001, peak anode voltage is 13.5-15 kv, and the peak power of 25 kw becomes 2.5 average. Rate of rise is 600 kv per μsec. The extremely short pulse length enhances ranging performance in two ways.

The map-like presentation, illustrated in the photo of the PPI presentation, has a resolution of 13 ft or less. A jeep can be seen on the runway in the upper left hand portion of the PPI as a series of dots, one for each sweep. The speed of the vehicle can be calculated from the dot-spacing, knowing the prf of the Radar. In this case, after taking the corner a low speed, the jeep travelled up the runway at 55 mph. Even more impressive are the tracks of people walking on the apron near the center of the PPI.

The second enhancement gained from the short pulse length is the ability to range on objects very close to the radar antenna. A dead-space of less than 15 yd has been achieved. Since 1 μsec corresponds to a distance of 1 ft, the pulse length occupies about 20 ft during radiation, or 10-ft round-trip range.

To take advantage of the close-in ranging capability, special design must be employed in the accompanying circuitry. Among the more important is the use of two antennas rather than a duplexer. Thus far, no switch tube deionizes fast enough to permit reception soon enough after the transmitted pulse has ended.

For further information on the 25-kw magnetron, turn to the Reader-Service card and circle 101.
TOP TEAM IN WAVE TUBES

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Silicon-Carbide Rectifiers Operate in High-Heat and Radiation Environments

The first commercially-available silicon-carbide rectifiers, Types TCS10 and TCS5, are claimed to withstand temperatures of 500°C and are ten times more resistant to radiation damage than silicon units. During an equivalent bombardment of $2.3 \times 10^{16}$ nvt ($e > 1$ kev), the forward voltage increased by less than 5 per cent, it was reported.

Made by Transitron Electronic Corp., 168 Albion St., Wakefield, Mass., the rectifiers will be exhibited at the IRE Show in March.

Transitron expects that the rectifier will be employed in many applications where silicon rectifiers are marginal. The present upper temperature limit of silicon units is about 200°C. The silicon-carbide rectifiers will be the first of a series providing “good performance” above 200°C, said Dr. David Bakalar, Transitron’s president.

Typical reverse currents are less than 100 μA at 50 v, at 400°C. At 500°C, the maximum average forward current ($I_0$) is 100 ma for both units. The maximum peak inverse voltage, at 500°C, is 100 v for the TCS10 and 50 v for the TCS5.

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<th>Rectifier Specifications</th>
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<td>TCS10</td>
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<td>TCS5</td>
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<td>TCS5</td>
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Said the engineer, "The problem of growing junctions. Because silicon-carbide will not melt under normally-attainable pressures, it became necessary to design a furnace for vapor-phase crystal growing that would operate at 2500 C. The silicon-carbide is grown out of the vapor phase by depositing it on a seed at 2200 C. While the seed is growing, dope is added to the protective gas and a junction made.

Pilot line production is now underway and prototype orders are being taken for the rectifier.

For more information on these units, turn to the Reader-Service Card and circle number 100.

A Sunday punch in a velvet-covered gauntlet — this is the state of America's offensive muscle.

Missiles "at ready" in concrete silos buried deep in the earth. Swift submarines roaming the depths with missiles tucked away inside. Pentomic airborne divisions able to move anywhere on earth in a matter of hours. Far-reaching carrier groups controlling the seas. Space stations, atomic aircraft — the list is lengthy.

Some of this offensive might is now operational, some is being built, some exists only as germs of ideas in an engineer's mind. The engineer is the pivotal point around which revolves the development of well-rounded, imaginative offensive capabilities geared to today and tomorrow. This is the work of creative specialists.

Because of RCA's tremendous West Coast expansion program, we have need for electronic and mechanical project engineers, and development and design engineers to work on information handling and data processing systems, electronic countermeasures and missile launch control and checkout systems for the operational ATLAS missile. We also have openings for systems engineers to study future military needs and synthesize systems to meet these requirements. You'll work in the pleasant surroundings of our new, modern electronic center in the San Fernando Valley and you'll work on a number of high priority projects that mean added strength for our country's offense.

If you'd like to grow with RCA on the West Coast, we'd like very much to hear from you, in all confidence of course.
NEW PRODUCTS

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

Computer Circuit Synchronizes Random Input Signals

Model SY-101 Synchronizer is a double M-Pac designed either to synchronize random inputs to a clock, or to receive random parallel inputs and to deliver these serially to a counter. Each SY-101 package contains two identical synchronizer circuits. Up to six packages may be grouped to allow accumulation of signals from 12 asynchronous sources for delivery to a single counter. Maximum synchronizing rate for an individual circuit is 30 kc; for a group of n circuits, 30 kc/n.


Price & Availability: Price is $77; available from stock.

Modular Construction Gives Electronic Counter Flexibility

Designed to indicate any physical variable that can be converted to a proportional frequency, the model 720 electronic counter uses modular construction for flexibility. Frequency range is 0 to 120,000 pulses per sec or 1 to 120,000 cps. It is available with 3, 4, 5 or 6 decades. Other options include: four time-base modules, a remote readout indicator operable at distances to 100 ft, and a high sensitivity preamplifier providing 10 mv sensitivity. The unit weighs 21 lb and measures 19 x 5.25 x 10 in.


Price: Price for 4, 5, and 6-decade units is, respectively, $525, $595, $665, fob Hawthorne, Calif.

Thin Panel Meter Has Printed Circuit Movement

Series S35, 3.5-in. Parker panel-meter has four coils printed on a disc. This, a nylon pointer, and a thin ring magnet assembly make up the complete movement. The entire meter is contained in the scale housing and nothing projects from the rear except the terminals, which also serve as mounting screws. The four standard models available are: Group A, B, C, and D. They measure current from 1 ma to 1 amp, and voltage from 1 v to 500 v. Accuracy is better than 1.5% of full scale value at 70 F, and 0.5% accuracy is available on order.

Interlab Inc., Dept. ED, 437 Fifth Ave., New York 16, N. Y.

Price & Availability: Sample quantities shipped on short notice, but a lead time of 30 days is necessary for production orders. Prices range from $14 to $12.50, depending on model; discounts available.
VHF Silicon Mesa Transistors 643 Deliver 1 W at 70 Mc

These vhf silicon mesa power transistors deliver 1 W of power output at 70 mc with a 28-v collector voltage. Type 2N1505, operating as an oscillator at 70 mc with a power output in excess of 1 W, has an efficiency of 45%. Type 2N1506 has a typical power gain of 12 db at 70 mc with a useful power output of 1 W. At 200 mc, it has a power output of 300 mw. Both units are characterized by a 3-w collector dissipation, 40-v collector-to-emitter rating, and low collector-capacitance.


Price & Availability: The 2N1505 is priced at $39.50 up to 99 pieces and $29.60 up to 1000 pieces. The 2N1506 is $49.50 and $37, respectively. Delivery is now being made on both types.

**Price and Availability**

Price and Availability data is now being added, whenever possible, to the New Product descriptions that appear in ELECTRONIC DESIGN. This data will help you to:

- Evaluate the products more intelligently.
- Decide which products to buy now and which to wait for.
- Schedule your orders wisely.
- Get an insight into prices and savings for similar products.

Most manufacturers have been very cooperative in providing us with Price and Availability data. Since some of the data arrived after our deadlines, it was impossible to add it to all of the products. The data represents the latest information at the time of publication.
NEW PRODUCTS

PNPN Silicon Rectifiers
Rated at 1 amp from 50 to 400 v

Types 110 through 114 pnpn diffused silicon controlled rectifiers are rated at 1 amp from 50 to 400 v. Packaged in a JEDEC TO-5 case, the units are suited for printed circuitry, high-temperature switching, military airborne systems, and other uses. The average rectified forward current is 300 ma at 125 C case temperature. The maximum gate current required to turn on the device is 20 ma with maximum holding current of 25 ma and maximum leakage current at pivot of 1 ma.

Texas Instruments, Inc., Dept. ED, P.O. Box 312, Dallas, Tex.
Price & Availability: Price is between $20 and $65 ea for quantities of 1 to 99 and between $12.50 and $58.50 for quantities of 100 to 999. Units are available from stock.

Plug-in Circuit
Provides two flip-flops

Model S-84001-FD transistorized, plug-in circuit provides two identical RST flip-flops. It can be used in circuits with noise levels as high as 2.5 v. In addition to reset, set, and trigger (or binary) operation, provision is made for a manual reset. Pulse repetition rates to 150 kc with a 4-µsec resolution are standard. This circuit can be used with other plug-in circuits and mounting hardware to fabricate all types of medium speed digital or hybrid systems.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville, Tenn.
Availability: Delivered 3 weeks after order received.

VIBRATION RESISTANT RELAYS

The heart of every Hi-G RELAY is the ROTARY BALANCED ARMATURE, effectively designed to provide superior resistance to smashing shock and severe vibration. Permanent magnet stabilization allows full contact pressure, eliminating chatter and eventual relay failure. Standard vibration immunity of 20G to 2000 CPS. Special units to 50G or more. For constant dependability under extreme operating conditions — see Hi-G. Write for new catalog No. 259 for complete information and specifications.

See Hi-G at the IRE Show Booth No. 2227

BRADLEY FIELD, WINDSOR LOCKS, CONN.
Model P-31 command modulator pulser contains four separate phase-shift oscillators covering the frequency range of 50 to 1000 cps. Any two oscillators are selected by front-panel push buttons. The unit contains a PRF generator with a range of 200 to 2000 groups per sec. The generator delivers a complex three-pulse output train; one pulse can be varied from 10 to 100 µsec. One of the pulses is delay-modulated between 0 and +10 µsec from the nominal value by the added frequency output of two selected phase-shift oscillators.

Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.

A total of 47 different models, in each of three optional styles providing sensitivities from 2.5 to 1000 ma full scale, make up this line of vacuum thermocouple junctions. Both contact and insulated-heater types are included. The exact value of open-circuit voltage and junction resistance are individually calibrated to ±0.5% and marked on the unit case. For high precision uses, all units are available with an integral thermally-controlled heater.

The Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N.J.

Price & Availability: Delivered 15 days after order received. Prices range from $35 to $65, depending on type. Quantity discounts available.

Designing a low-power switch can sometimes turn into a real tussle. Before this happens, call in Oak specialists. From a vast store of past designs and experience they are able, many times, to offer a ready-made solution—whether it be for a standard unit, something unusual, or a complete package of circuitry. The result is the exact switch you need, representing top engineering and optimum economy.
NEW PRODUCTS

Metallized-Paper Capacitors 619
Plastic-cased

Type P8292ZN metallized-paper capacitors have Polycap plastic cases construction and a high temperature solid impregnant. They offer excellent humidity resistance and improved insulation resistance characteristics. A wide range of sizes, voltages and capacitances are available.


Portable Amplifier 635
For recording galvanometers

Model ASA-200 dual-channel amplifier system, designed to accept any two of the firm's preamplifiers, consists of two transistorized driver amplifiers housed in a portable cabinet. The system provides a power source for driving recording galvanometers. The input is ±0.05 to ±200 v for ±10 mm deflection, the input impedance is 5 meg single ended and 10 meg differential, and the output is 600 ma max into a 20-ohm load. Drift is less than 2 mv equivalent input per hr at maximum gain.

Cohu Electronics, Inc., Massa Div., Dept. ED, 5 Fottler Road, Hingham, Mass.

Core Mountings 622
Have one-piece construction

These core mountings accommodate 1600 different U and E core sizes. Having one-piece construction, they are made from steel or aluminum. Several adjustable lengths and 42 different strip widths are offered. More than one core can be mounted on a single strip.

Coremount, Dept. ED, 704 W. Slauson Ave., Los Angeles 44, Calif.

...and now for a spot of welding!

Still at it? Trying to improve potentiometer reliability by building 'em yourself? Well, you're on the right track about one thing — welding's a sure way to eliminate a lot of operational headaches — like gassing contamination of contact metals at high temperature, from organic solder flux. No chance of "cold joints", either, to increase circuit resistance. No soldered connections to come loose under vibration and shock. Welding is the way to reliability!

But why set the wife's drapes afire to get a reliable, all-welded pot? Utilizing welding techniques, Ace produces reliable potentiometers operable at temperatures exceeding 150°F, and able to withstand 50 G's at 2000 cycles. All this, plus extremely low contact resistance and longer rated life. All taps, end connections, resistance elements, contact assemblies and terminal leads are specially prepared beforehand — then welded with pure nickel or palladium silver. So, for built-in reliability through sounder construction techniques, see your ACErep!

This 2" AIA Accep® (shown ½-scale) incorporates all these exclusive welding construction features, for superior reliability.

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville, Mass.

Accep®, Acacimp®, Accel®, Acacym®, *Reg. Appl. for CIRCLE 40 ON READER-SERVICE CARD
Frequency Standards

Stability is 1 part in 100,000,000 per day

Available in frequencies of 1, 1.8, 2.5, 3, and 5 mc, the JKTO-P1P frequency standards offer a stability of 1 part in 100,000,000 per day under normal conditions. These compact, precision, plug-in signal sources use stable glass-sealed crystals, matched-design silicon-transistor oscillator circuitry, and proportional control oven performance. Other frequencies can be supplied on special order. Standard units have an output of 1 v into 500 ohms, operating from 24 to 28 v dc. Dimensions are 2 x 1.84 x 2.875 in. Weight is 10 oz.

The James Knights Co., Dept. ED, Sandwich, Ill.

Magnetic Force Welding Machine

For full area percussion welds

Model APPAMPF-1-100-12 magnetic force welding machine makes full area percussion welds. Specifically designed for welding silver alloy relay contacts in motor starters, it can be adapted to other operations requiring the joining of non-ferrous metals. The unit is composed of a 100-kva magnetic force projection and spot welding machine with a dc holding coil delayed forge, diaphragm safety head, and selective micro-switch firing features.


Frequency Converter

Has magnetic-core components

This magnetic-core frequency converter is designed to convert three-phase power to either single-phase or three-phase power at a frequency which is seven times the supply frequency. Units are available in 2.5, 5, 10, and 20 kw sizes for converting 60 cps power to 420 cps.

Cambridge Products Corp., Dept. ED, 141 Main St., Cambridge 42, Mass.

You get an extra measure of design freedom with

... POWDERED PERMALLOY FILTOROID® CORES*

The high permeability and low core loss of powdered permalloy Filtoroid cores can remove design roadblocks for you. You can build extra frequency stability into filter networks with these cores. Their permeability remains stable with changes in time and flux levels. Distortion factors are held to a bare minimum. Temperature coefficient of inductance is tightly controlled.

There's extra design flexibility for you, too, in

the broad range of Filtoroid cores available. They're made in three standard permeabilities—150, 125 and 60—in sizes up to 1.570" O.D., all carried in stock for immediate shipment.

Our engineers are ready right now to help you select the proper Filtoroid core for your filter circuits. Write or call for a discussion of your needs, or send for Bulletin G-1.

*Made under a license agreement with Western Electric Company

MAGNETIC METALS

transformer laminations • motor laminations • tape-wound cores powdered molybdenum permalloy cores • electromagnetic shields

Magnetic Metals Company • Hayes Avenue at 21st Street, Camden, N. J.

CIRCLE 42 ON READER-SERVICE CARD
NEW PRODUCTS

Power Amplifier

Operates in telemetry band

Designed to amplify a 2-w signal to as high as 100 w, model PA-15 power amplifier operates in the 225 to 260 mc telemetry band. A self contained 400 cps blower is provided to give sufficient cooling air for conditions of maximum rf output. The unit withstands vibration of 10 g from 20 to 2000 cps, and shock and acceleration of 100 g each. Its operating temperature range is from −67 to +176 °F.

United Electrodynamics, Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

Analog-to-Digital Converter

Has servo type mounting

Type 18-1077 analog-to-digital converter with servo type mounting is for use in a military aircraft program, but variations of the unit are applicable in both military and industrial computer-controlled systems of automation, processing, programming and other servo devices. The maximum rated input speed is 400 rpm and life of the unit is 1,000,000 revolutions or 1000 hr of normal operation. Angular bit length is 15 deg, 100 revolutions of the input shaft are required to complete the code from 0 to 999 or from −0 to −000, and accuracy is within 1/3 of any bit in the entire range.

Memcor, Courter Products Div., Dept. ED, Boyne City, Mich.

FOR LONG LIFE—The "Angler" Fathometers is a portable, transistorized depth finder made by Raytheon Company for fishing and boating enthusiasts. It aids in navigation and finding fishing holes by means of ultrasonic sound beams, powered by Mallory mercury batteries. Their longer life eliminates inconvenience of frequent battery changes.
sales appeal from

MALLORY
MERCURY
BATTERIES

Look to the amazing capabilities of Mallory mercury batteries for extra performance values, new sales appeal in your battery-powered electronic equipment... both in new designs and in product improvements. Pioneered and perfected by Mallory, mercury batteries give you features far superior to other commercial dry cells.

SMALLER SIZE—Mallory mercury batteries have a high energy-to-volume ratio, are miniaturized without performance loss.

HIGH STABILITY—Output remains so constant that they can be used as reference voltage standards. Constant voltage discharge is ideal for transistor circuitry.

EXTRA DEPENDABILITY—Mallory mercury batteries give at least four times longer service life than conventional types. Tests prove they can be stored as long as six years without appreciable loss of capacity. They operate over wide temperature ranges.

EXTRA CONVENIENCE—Longer life reduces frequency of battery changes.

The examples shown here are but a few of the many new electronic products now utilizing the outstanding characteristics of Mallory mercury batteries. Our application engineers will welcome the chance to discuss how you can apply these extra values to your products. We have a wide line of standard single and multiple voltage cells available... and we can develop customized power packs to your specifications. Write today for a consultation, and for our latest mercury battery engineering data.

MALLORY BATTERY COMPANY
Cleveland, Ohio
a division of

MALLORY & CO Inc

In Canada, Mallory Battery Company of Canada Limited, Toronto 4, Ontario

CIRCLE 43 ON READER-SERVICE CARD

Radar Beacon
Measures 1-1/4 x 2-7/8 x 5-3/4 in.

Model SRT-3081 radar beacon measures 1-1/4 x 2-7/8 x 5-3/4 in. and weighs 1-1/4 lb. For the receiver and transmitter, the frequency range is 3750 to 2950 mc and stability is ±2 mc. The following environmental conditions are met: temperature range, -54 to +125 C; vibration, 10 to 100 cpm at 25 g; acceleration, 50 g; shock, 15 g; and altitude, 60,000 ft.

Telerad Manufacturing Corp., Dept. ED, 1440 Broadway, New York 18, N.Y.

Semiconductor Materials 632

Include gold, silver, and platinum

Gold, silver, platinum, and other precious metals are provided in the pure state or alloyed with other materials. Fine diameter wire, ribbon, sheets, rings, and preforms are offered for semiconductor use.

Western Gold and Platinum Co., Dept. ED, 525 Harbor Blvd., Belmont, Calif.

Tape Loop Magazine
Handles 120 ft of tape

This tape loop magazine contains easily threaded rollers for handling 1/4, 1/2, or 1-in. tape up to 120 ft in length. All standard tape speeds from 1-7/8 in. per sec can be selected. This unit allows the firm's PS-200 recorder to be used for delay applications and spectrum analysis of up to 14 channels of data. The magazine is compact in size.

Precision Instrument Co., Dept. ED, San Carlos, Calif.
Solving switch problems fast...

your job... and Centralab's

Your switch problems can be solved quickly and efficiently at CENTRALAB. No matter how unusual or difficult the switch, you can get samples fast, quotations fast, and production fast! This is a result of years of specialized experience and superior facilities for designing and manufacturing a wide variety of switch types.

Typical of the extensive range of units available to you are the four CENTRALAB ceramic section switches shown here. These switches, and many others, are also available with phenolic sections, for economy applications, or where a larger number of positions is required.

DESIGN AIDS FOR ENGINEERS

CENTRALAB's unique Switch Visualizer, which simulates actual switch operation, will help you simplify and speed up switch design. Used in conjunction with our detailed layout sheets (available for all CENTRALAB switch types), they greatly facilitate your job in switch design (and ours, too). Write for them today—along with a copy of CENTRALAB Switch Catalog 42-405.

NEW PRODUCTS

Miniature Servo Indicators

Have modular construction

The modular construction of these miniature servo indicators utilizes standard stock parts and is suitable for prototype and limited production applications. The basic module is the gear-box in which up to seven shafts measuring 0.0937 in. in diameter are mounted in ABEC-7 ball bearings. Gear ratios up to 65,000:1 can be obtained using precision 2-stock gears. The component module uses standard plates for mounting size 8 or 10 rotating components. Indicators have these possible configurations: integrally lighted, vernier pointer and dial presentation, and high input impedance transistorized indicators. The cases conform to MS-33639. Silicon transistors, diodes, and tantalum capacitors used meet MIL-E-5272 environmental requirements.

Servo Development Corp., Dept. ED, 567 Main St., Westbury, N.Y.

Subcarrier Oscillators

Supplied for MIL-STD-442 bands

Both models of these transistorized subcarrier oscillators are supplied for MIL-STD-442 bands; the VC-14 for channels 7 through 18, and the VC-15 for channels A through E. The units come with a bandpass filter which prevents interchannel interference, and have a cascadable emitter-follower input to achieve high input impedance. The oscillators measure less than 3 cu in., and weigh 5 oz. They are completely sealed in an aluminum case and meet the requirements of MIL-E-5272B for vibration, shock, and acceleration.

United Electrodynamics, Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

CIRCLE 200 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960
Model 1300-A wide-range beat-frequency video generator is suitable for point-to-point, transient, and sweep testing. It can also be used as a source for acoustic and ultrasonic tests as well as testing of video systems, amplifiers, discriminators, networks, and video filters. Ranges are: 20 cps to 20 kc, sine or square wave for audio and 20 kc to 12 mc, sine, and 20 kc to 2 mc, square wave, for video signal and sweep. All signals are monitored by an output voltmeter and are available from an output attenuator. Output levels are 10 v for both sine and square wave. The unit mounts in a 19-in. relay rack.

Price & Availability: Price is $1950 per unit. It will be available from stock in May, 1960.

Environmental Chambers

For wire testing

These environmental chambers are designed for testing wire and insulation breakdown in accordance with military specifications. They are constructed so that a mandrel can be installed in the upper part of the chamber. By means of outside control, the wire is wound on the mandrel without disturbing the test temperature. The cabinet measures 84 x 20 x 42 in. and the test chamber is 8 x 12 x 72 in. Units operate on 230 v and offer a temperature range of -10 to -80 F.

Cincinnati Sub Zero Products, Dept. ED, 3932 Edgewood Road, Cincinnati 29, Ohio.
Another breakthrough in amplifier noise reduction...

3 low-noise amplifier characteristics

RECONCILED

Tolerance of high source – impedance without undue increase of noise voltage.

High input impedance (better than 1 meg-ohm).

Low noise-voltage, referred to shorted input.

The three amplifier characteristics illustrated (A, B and C) are often considered contradictory, even irreconcilable. True, there are amplifiers which exhibit low-noise voltage, referred to the shorted input terminals. Fact is, our VS-64A still holds the record in this field – less than 0.5 μV RMS over a 60 kc pass band. Also, there are many high input impedance amplifiers. But never before have low-noise voltage characteristics and high input impedance been combined with a highly incompatible third stipulation: tolerance of high source impedance, without spoilage of premium shorted-input noise performance, by insertion of a comparatively large source impedance.

Two new Millivac low-noise amplifiers – the VS-66A and VS-68A – combine all 3 of these most desirable characteristics to meet the demands of the Space Age for extended communications and control ranges.

NEW PRODUCTS

Metallized Mylar Capacitors

These metallized Mylar capacitors are available in type AB bath-tub and type AM metal tubular designs. They have a temperature range for operation and storage of -90 to +125 C. Capacitance tolerances are 1%, 2%, 5%, 10%, and 20%. Dielectric absorption is low. Made to meet Mil specs, they have applications in computer circuits, audio coupling, tuned filters, oscillator circuits, power supply filters, and other devices.

Plastic Capacitors, Inc., Dept. ED, 2620 N. Clybourn Ave., Chicago 14, III.

Price & Availability: Price varies from $0.54 to $8 for units when ordered in quantities of 1000. Some are available from stock. Delivery time is a maximum of 30 days.

Power Supplies

For original equipment and laboratory uses

For original equipment, ground support systems, computers, and laboratory use, these power supplies provide from 6 to 50 v with currents to 1 amp, and up to 2000 v at 1 ma. Outputs can be fixed or adjustable, as specified by the user. Both ac-de and de-de types are offered. Type 320, shown, operates from 115 v at 60 cps and supplies 18 to 24 v de, adjustable. It has a regulation of 0.5% from no load to 250 ma. At full load, regulation is 0.2% for a ±10% change in input voltage. Maximum peak-to-peak ripple is 0.005 v.

Transistor Specialties, Components Div., Dept. ED, Terminal Drive, Plainview, N.Y.

Price & Availability: Price is $69.50 ea. Delivery time is 10 days.

MILLIVAC

A DIVISION OF

COHU

ELECTRONICS, INC.

Schenectady, New York

CIRCLE 46 ON READER-SERVICE CARD
Acceleration Switch

Repeatability is within 0.1 g

Model 200 multi-level, uni-directional acceleration switch consists of a gas-damped seismic system with a range of 1 to 10 g, an accuracy of ±0.1 g, repeatability within 0.1 g, and a damping ratio of 0.8:1. A single-axis switch, it successively closes four independent electric circuits with a common point, in response to preset acceleration levels. The unit operates over the temperature range of −60 to +250°C. It is normally open single-pole, four steps, with contact ratings of 100 mA each. Hermetically sealed, it weighs 20 oz and measures 3.25 x 1.75 in. Requirements of MIL-A-22145 are met.

W. L. Maxson Corp., Instruments Div., Dept. ED, 475 Tenth Ave., New York 18, N.Y.

Price & Availability: Units are made on order and are furnished in sample quantities only. They can be delivered 45 days after receipt of order. Price is $250 ea for quantities of 2 to 10.

VHF Admittance Bridge

Accuracy is 2% to 300 mc

Model 978 vhf admittance bridge, using a miniature thermistor element in a servo feedback system as a conductance, has an accuracy of 2%. Range of the instrument is 30 to 300 mc. The capacitance range is ±40 μf and the conductance range is 0 to 50 mmhos. Two terminal measurements can be made on rf components, semiconductor components, and transmission lines. The test voltage is rarely more than 50 mv. Bridge sources and detectors can be supplied for operating the bridge, although any signal generator and receiver covering the frequency range can be used.

Think of the measuring convenience, time saved and accuracy gained when you don’t have to break into a circuit, solder on a connection, or worry about probe loading.

With the @ 428A Milliammeter and its new probe, you literally “clamp around” and read! You get maximum accuracy because there is no effective circuit loading from the 428A’s dc probe. The instrument easily measures dc currents in the presence of ac. And insulation is more than adequate to insure safe measurements at all normal voltage levels.

For extremely low current level measurement, sensitivity can be increased by looping the conductor through the “jaws” of the 428A probe two or more times.

Brief specifications are given here; for complete details and demonstration on your bench, call your @ representative or write direct.

HEWLETT-PACKARD COMPANY
1000 E. Page Mill Road • Palo Alto, California, U.S.A.
HEWLETT-EASTON S.A., 101 VIEUX BILLARD NO. 1,
GENEVA, SWITZERLAND
HEAD OFFICE—101 W. 32nd ST., NEW YORK 1, N.Y.

HEWLETT-PACKARD CANADA LTD.
HEWLETT-PACKARD AUSTRALIA LTD.
HEWLETT-PACKARD LTD.

Test the new hp 405A DC Digital Voltmeter

CIRCLE 47 ON READER-SERVICE CARD
Your answer to low-cost stereophonic or monophonic phonographs with high power-output capability is the new RCA-50FE5—the amazing beam power tube with big-league sound. Only 3 tubes—two RCA-50FE5's and one RCA-12AX7 and you have a complete, compact stereo amplifier.

At B+ voltage of only 145 volts, this 3-tube stereo amplifier can deliver up to 4.3 watts of audio output per channel with cathode bias, and up to 5.6 watts per channel with fixed bias. In a monophonic system with the same low B+ voltage and cathode bias, two RCA-50FE5 tubes in a push-pull circuit can deliver up to 8.5 watts of audio power.

So, if it's high power output at low cost you're after, design your stereophonic and monophonic circuits with the RCA-50FE5. There's a 6-volt heater type (RCA-6FE5) available too! Ask your RCA Field Representative for all the facts. For technical data, write RCA Commercial Engineering, Section C-18-DE1, Harrison, N.J.

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

REPEAT CYCLE TIMER

Provides a 1-min on-off output

Model WC-605 repeat cycle timer provides a repetitive 1-min on-off output. Using an RC method of measuring the time interval, the circuit has an over-all accuracy of ±2 sec. The dual gate output is arranged so that when one gate is closed, the other is open. The device operates from 25 v dc.

Webcor, Inc., Dept. ED, 816 N. Kedzie Ave., Chicago 51, Ill.

POWER SUPPLIES

Many dc types available

These modular dc power supplies are available in ten models. Models 21-101A through 21-103 unregulated supplies provide 28 v at 2 to 10 amp; each operates from an input of 0 to 125 v ac at 50 to 400 cps. Model 22-101A magnetic-amplifier supply provides 28 v at 5 amp and requires 105 to 125 v ac at 50 cps. Models 22-102A through 22-109A vacuum-tube types have outputs from 150 to 500 v at 0.07 to 0.3 amp. They require 105 to 125 v ac at 50 to 400 cps.

Dressen Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

Price & Availability: Units will be available from stock after March 1, 1960. Price varies from $45.50 to $169.50.

ADHESIVE FOR TEFCON

Supplied in kit form

Type 74B adhesive is supplied in kit form for laboratory and production use. Each kit includes a treating agent to prepare the Teflon surface and a bonding agent that cures in a few hours. It can be used with any grade of Teflon or other fluorocarbon plastic.


Price & Availability: The kit is available from stock at a price of $8. It is shipped two days after receipt of order.

NEW PRODUCTS
Potentiometer 540

Has size 9 front end mounting

The series 4 Vernistat potentiometer now comes with a size 9 front end mounting. The unit employs the standard 1-1/16 in. diam housing of the ac potentiometer, but the shaft end of the enclosure has been machined to suit BuOrd size 9 requirements. This permits retrofit application of the unit in systems designed to use conventional size 9 potentiometers.

Perkin-Elmer Corp., Vernistat Div., Dept. ED, Norwalk, Conn.

Price & Availability: Made on order only and delivered 8 to 10 weeks after order received. Price is $625 per unit, special fabricating charges included. When ordered in quantities of 100 and up, price is $325 per unit.

Printed Circuit Transformer 546

With relay bobbin

This printed circuit transformer, with a relay bobbin, is designed to prevent wire breakage. Lugs are embedded in nylon for permanent location. Special bobbins can be made to customer specifications.

American Molded Products Co., Engineering Dept., Dept. ED, 2727 W. Chicago Ave., Chicago 22, III.

Receiver-Decoder 538

Frequency is crystal controlled

Model BCR-39 receiver-decoder has crystal controlled frequency coverage over the range of 400 to 550 mc. The 5 volt transistor unit is specifically designed for missile command, destruct use. An input of 5 mV or less will command destruct.

Dimensions of the unit are 2-1/2 x 4-1/4 x 5-1/2 in. and weight is 2 lb.

Babcock Radio Engineering, Inc., Dept. ED, 1840 Monrovia Ave., Box 344, Costa Mesa, Calif.

Price & Availability: Delivery is 120 days after receipt of order. Price on request.

CIRCLE 49 ON READER-SERVICE CARD
NEW PRODUCTS

Differential Amplifier 678

Provides 10^8 to 1 common-mode rejection

Providing common-mode rejection of 10^8 to 1, type 1-102 transistorized differential dc amplifier has a true floating input and stability of 0.05%. Gain is variable in steps of 10, 20, 30, 50, 100, 200, 300, and 500. The unit operates with both input and output isolated from each other and from ground. This design eliminates the chance of accidental voltage drops.

Neff Instrument Corp., Dept. ED, 2211 E. Foothill Blvd., Pasadena, Calif.

Photoconductive Cell 529

For infrared use

Type 63TV photoconductive cell is designed for use in the infrared regions. Using cooled lead telluride, it has a spectral response range of 0.6 to 6 microns with a peak response of 4.2 microns. The sensitivity is 1300 v rms per w, peak-to-peak, and the signal to noise ratio is 500:1. These measurements are from a black body at 200 C; sensitivity of the cell increases rapidly with the radiation source temperature. The sensitive area is 0.1 sq cm and the minimum detectable power at 4 microns is 1.1 x 10^-16 w.

International Electronics Corp., Dept. ED, 81 Spring St., New York 12, N.Y.

Price & Availability: Sample quantities are now available from stock.

Voltage Regulator 674

Has 30 v max output

Voltage regulator model 1807-0300 has a maximum output of 30 v and a voltage drop of 1.6 v dc at 350 ma. It is suited as a surge limiter to protect transistor amplifiers against the 80-v transient peaks encountered in the 28-v dc aircraft power supply. The unit measures 1-1/8 x 1-1/8 x 1-1/4 in. and weighs 3 oz. It meets environmental requirements of MIL-E-5400 and power requirements of MIL-E-7894.

M. Ten Bosch Inc., Dept. ED, Pleasantville, N.Y.

ELECTRONIC DESIGN • March 2, 1960
Faster switching speeds combined with low saturation resistance make Motorola 2N627-30 power transistors ideal for industrial power-switching applications. Their low power loss results in greater circuit efficiency especially for applications operating above 400 cps. In addition, these 10 amp power transistors offer: high voltage breakdown... flat gain vs current curve... and low lene. Their high reliability is proven in more than 20 million hours of life-test data.

Motorola 2N627-30 power transistors are IMMEDIATELY AVAILABLE, in engineering quantities, from your nearest Motorola Semiconductor Distributor, who also carries a full line of Motorola mounting hardware. Call him, today!

FOR MILITARY APPLICATIONS... Motorola offers the 2N1120, a 10 amp power transistor designed to meet MIL-T-19500A/68 (Sig. Corps) specifications. These units are available, in quantity, through your Motorola Semiconductor district office.

FOR MORE EFFICIENT SWITCHING
Less power loss... improved circuit performance

HIGHER FREQUENCY POWER LOSS

\[ P = \frac{1}{\tau} \times \frac{1}{2} \times \left( V_c + 3V_i \right) \times \left( t_h + t_c \right) \]

HOW TO DETERMINE AVERAGE POWER LOSS

\[ P = \frac{1}{\tau} \times \frac{1}{2} \times \left( V_c + 3V_i \right) \times \left( t_h + t_c \right) \]

Where:
- \( V_c \) = maximum collector current.
- \( V_i \) = maximum collector/emitter voltage.
- \( t_h \) = collector fall time.
- \( t_c \) = collector rise time.
- \( t_{on} \) = period of square wave.

FOR COMPLETE TECHNICAL INFORMATION, APPLIATION ASSISTANCE AND PRICE INFORMATION contact your Motorola Semiconductor district office.

DESIGN CHARACTERISTICS at 25±3°C

<table>
<thead>
<tr>
<th>2N627</th>
<th>2N630</th>
<th>2N632</th>
<th>2N633</th>
<th>2N1120</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BV ( \text{CEO} ) max</td>
<td>40</td>
<td>60</td>
<td>80</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>BV ( \text{CEO} ) max</td>
<td>50</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>( L ) max</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>( T_{ce} ) max</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>°C</td>
</tr>
<tr>
<td>( V_{CEO} ) (max) ( \text{max} )</td>
<td>1.1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>( I_f ) (typical)</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

SWITCHING TIME based upon average of a typical production lot @ 10A

<table>
<thead>
<tr>
<th>( t_1 )</th>
<th>( t_2 )</th>
<th>( t_{fall} )</th>
<th>( t_{rise} )</th>
<th>( t_{storage} )</th>
<th>Total switching time</th>
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</thead>
<tbody>
<tr>
<td>4.1 sec</td>
<td>1.3 sec</td>
<td>3.2 sec</td>
<td>2.5 sec</td>
<td>19.8 sec</td>
<td></td>
</tr>
</tbody>
</table>
NEW PRODUCTS

Telemetry Transmitter
Range is 215 to 260 mc

Designed for aircraft and missile applications, model TRPT-250 crystal-controlled transmitter operates over the frequency range of 215 to 260 mc. Other characteristics are: output impedance, 50 ohms; frequency tune-up tolerance: ±0.005%; modulation frequency range, 100 cps to 200 kc; and power output 0.25 w. The unit measures 2.6 in. in diameter and is 1.5 in. thick; it weighs about 9 oz.

Vector Manufacturing Co., Inc., Dept. ED, Keystone Road, Southampton, Pa.

DC Power Supply
Provides 200 to 250 v dc

Model PS4017 power supply delivers 200 to 250 v dc. It is designed for a nominal input of 105 to 125 v ac; input may vary ±10 v. Regulation provides a change of less than 0.2 v in the output for load variations from 0 to 1.5 amp with the line voltage held constant. Under no-load conditions, the supply continues to operate at the preset output voltage.

Power Sources, Inc., Dept. ED, Burlington, Mass.

PNP Transistors
Intermediate-power types

Types 2N1183, 2N1183-A, 2N1183-B, 2N1184, 2N1184-A, and 2N1184-B npn germanium alloy- junction transistors use the JEDEC TO-8 pack-
 Rotary Potentiometers

Are 7/8 to 3 in. in diam

These precision rotary potentiometers, called Turnquate, range in size from 7/8 to 3 in. in diam. Featured in this line are: humidity sealed units, stainless steel units for operation to 200 C, high resolution, and self-phasing without loosening screws or clamp bands. Smaller units have dual outputs or two circuits. Units measuring 2-7/8 in. in length have 10 or 20 output circuits. Subminiature Instruments Corp., Dept. ED, 705 Sunnyside Drive, Riverside, Calif.

Price & Availability: Most units are available from stock or will be by March 15. Price ranges from $15 to $70 for orders of less than 10. Quantity discounts are furnished.

Battery

For use in missiles

Designed for use in missiles, model P63A battery weighs 4.2 lb and measures 2.75 x 5.5 x 5 in. The 19-cell battery provides 8 amp, with a maximum current of 15 amp. Discharge time is 10 min., and activation time is 0.2 sec. The silver-zinc battery withstands vibration to 8 g, acceleration to 30 g, and shock to 30 g, in all three major axes.

Cook Batteries, Dept. ED, 3850 Olive St., Denver 7, Colo.

Now being manufactured entirely in the U.S.A., not only in its original West German design previously sold in this country by Allied Control Company, Inc. under an agreement with Siemens & Halske Company A.G., Germany but with variations to meet American requirements as well.

Performance Characteristics

Contact Arrangement
Up to 12 springs maximum form A, B or C

Contact Rating
2 amperes resistive or 1 ampere inductive at 29 volts d-c or 115 volts a-c
Low level or 5 ampere contacts available on request

Standard Coil Voltages
Suitable coil resistances can be supplied for operation at any voltage within the range of 0.5 to 130 volts d-c

Coil Power
Nominal: 700 milliwatts
Minimum Operate Power: 125 to 300 milliwatts depending on application, contact arrangement and coil resistance.

Timing at Nominal Voltage
Operate time: 15 milliseconds maximum
Release time: 5.0 milliseconds maximum

Vibration
10-55 cps at .062 inch double amplitude
55-500 cps at a constant 10g

Shock: 25 g operational

Enclosure
Open, dust cover or hermetically sealed

Weight
Open type 1.0 ounce maximum
Sealed type 2.0 ounces maximum
NEW CERAMIC TRANSUDER ELEMENTS

U. S. SONICS
new transducer elements
US600, US500, and US100
are characterized by their:

- High activity over wide temperature ranges (US500, US600)
- High coupling coefficient (US500, US600)
- Stability over wide temperature ranges (US500, US600)
- Demonstrates excellent activity at temperatures to -300F.
- Advanced production techniques assure reproducibility.

For applications requiring average energy levels, model 160 ultrasonic cleaner has a 13-gal tank made of stainless steel and measuring 20 x 16 x 10 in. Corners of the tank are rounded and 30% of the tank bottom is covered with crystals. Actual radiating surface is 96 sq in. The 115 v ac, single-phase, 60 cps generator delivers 500 w avg and 2000 w peak.

National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington 11, N.J.
Price & Availability: Available from stock, the unit is priced at $1375.

Signal Generator
Drift is less than 0.001%

Type TD-1101 signal generator has a frequency drift, after warm-up, of less than 0.001% over a 10-min period. Incidental fm is less than 300 cps at any rm and modulation frequency. The unit may be internally or externally sine-wave-modulated up to 50%. Amplitude modulation is maintained within 5% over the frequency range. The generator may be externally pulse-modulated with a rise-time of better than 1 usec from 6 to 120 mc, and better than 0.5 usec from 120 to 410 mc. Frequency calibration of six bands is within 0.5% and resettability is under 0.05%. The rf output is both continuously variable, and variable in discrete steps.

Trad Electronics Corp., Asbury Park, N.J.

NEW PRODUCTS

Ultrasonic Cleaner
Average energy level type

For further information write or call:

U. S. SONICS CORPORATION
625 McGrath Highway • SOMERVILLE 45 • MASSACHUSETTS
Monument 6-5100
CIRCLE 55 ON READER-SERVICE CARD

NEW
direct-current
TACHOMETER GENERATOR
permanent-magnet

APPLICATIONS
- SERVOS The highly linear output and wide speed range are ideal for velocity or integrating servos. Low driving torque permits its use as a damping or rate signal in all types of servos.
- INDICATING TACHOMETER Matching indicating meters available from stock in various speed ranges.
- SPEED TRANSUCER Ideal for use as a speed transducer in connection with fast-response direct-writing oscillographs.

FEATURES
- SIZE Miniature. Approx. Dia. 1 1/4".
- OUTPUT Various models with outputs as high as 24 v/1000 rpm.
- LINEARITY Linearity from 0 to 12,000 rpm is better than 1/10 of 1% of voltage output at 3600 rpm.
- BRUSH LIFE Better than 100,000 hours (10 years) of continuous operation at 3600 rpm.
- BIDIRECTIONAL OPERATION Output in either direction is held to 1/8 of 1% tolerance.
- RIPPLE The rms value will not exceed 3% of the d-c value at any speed in excess of 100 rpm.
- CONSTRUCTION Aluminum housings with protective treatment; stainless steel shafts; fully shielded ball bearings; Mylar insulation.

SEND FOR COMPLETE DATA
SINGLE UNITS FROM $22.50
quantity discounts

Servo-Tek
PRODUCTS CO
Main Office
1086 Goffle Road, Hawthorne, N. J.
Western Office
14736 Arminta Street, Van Nuys, Cal.
CIRCLE 56 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960
Transitron

announces a NEW computer element
for: Greater Reliability - Circuit Simplicity

The TRANSITCH is a new bistable silicon device that can be
TURNED ON with gate current.

This NPN latching device “remembers” its last gate
signal. High current gain, both turn-on and turn-off, leads to
greater circuit simplicity and inherent reliability. Excellent
linearity of electrical parameters over a wide current
range fulfills both low logic level and medium power needs.

Here is a unique device that replaces two transistors plus
resistors in most bistable circuits and permits increased
component density.

Furthermore, the TRANSITCH is fast...requiring only
.3 microseconds to turn ON or OFF!

The TRANSITCH is now available from TRANSITION in
the popular JEDEC TO-5 package, ready to solve your
switch-on-switch-off requirements.

For further information, write for Bulletin TE-1357A

The TRANSITCH is a new bistable silicon device that can be
turned ON with gate current.

This NPN latching device “remembers” its last gate
signal. High current gain, both turn-on and turn-off, leads to
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Here is a unique device that replaces two transistors plus
resistors in most bistable circuits and permits increased
component density.

Furthermore, the TRANSITCH is fast...requiring only 0.3 microseconds to turn ON or OFF!

The TRANSITCH is now available from TRANSITION in
the popular JEDEC TO-5 package, ready to solve your
switch-on-switch-off requirements.

For further information, write for Bulletin TE-1357A
New Trigger/Timer/Gap Tube
Switches 1000 Ampere Pulses

The KP-130 is one of a family of subminiature, cold cathode, arc-discharge pulse tubes (Krytron) for high-voltage, high-current switching applications. The KP-130 can control pulse discharges at voltages as high as 2500V, with currents up to 1100 amperes. The anode delay time equals 0.2 usec. average, with "jitter" (variation in delay) averaging less than 0.05 usec. The low, combined with the high hold-off voltages and short delay, make the KP-130 ideal for timing, triggering, and other pulse circuit uses. Unlike spark gaps, the KP-130 requires low trigger grid power, thereby eliminating large transformers. The KP-130 operates in light or total darkness and has exceptional environmental capabilities. The KP-130 has found application in pulse circuits, protective devices, precision-timed high energy switching circuits, overload devices, etc. The KP-130 eliminates circuit components and reduces input power requirements, thereby contributing to improved equipment reliability. A similar tube is available for lower power circuits, and many of these tubes are supplied to military requirements. For details, data, etc., write:

KIP ELECTRONICS CORP.
Dept. 68, P. O. Box 562, Stamford, Connecticut
CIRCLE 58 ON READER-SERVICE CARD

New Products

Microvolt Potentiometers

Resolution is 0.01 µV

These single and double six-dial thermofree potentiometers are for emf measurements in the microvolt range with a resolution of 0.01 µV. Both models have double inputs with ranges of 0 to 111.11 µV in steps of 0.1 µV and 0 to 1111.11 µV in steps of 0.1 µV. On the double model, duplicate sets of dials permit measuring the two inputs independently. For both models the high range limit of error is 0.01% of reading +0.1 µV, while the low range is 0.01% of reading +0.01 µV.

Price & Availability: Price is $5200. Delivery requires 16 to 20 weeks.

Ratiometer

Provides direct reading

Designed to provide a direct reading through a dual-pointer geared head, type 3100 servo ratiometer has 0.1% linearity and resolution. The basic range is 10 mV for full scale reading. Sensitivity is 10 µV and full-scale response time is 5 sec. The unit measures 6 in. in length and 3-1/4 in. OD.
M. Ten Bosch Inc., Dept. ED, Pleasantville, N.Y.

Pilot Light

Is mounted from front of panel

The Omni-Glow pilot light, for mounting from the front of a panel, uses four molded-in nylon ribs. It pushes through a 0.5-in. hole and snaps

Spectrol Precision Potentiometers

Two valid reasons why Spectrol delivers better non-linear pots faster!

Reason 1

Computer Designed

Spectrol uses an IBM 610 computer to turn out complex non-linear precision pots in record time, both single-turn and multi-turn. This in itself saves weeks of time, assures more accurate performance. Spectrol alone maintains a computer on the premises for this purpose.

How It Works. Design information in the form of X and Y coordinates or mathematical equations describing the particular parameters of a given non-linear function is entered in the computer. Previously programmed general equations automatically compute from these data points manufacturing directions in terms of winding equipment settings, cam angle and radii. An electric typewriter prints out winding machine set-up information on a form which is sent to production. Simultaneously, a punched tape is made to store data for repeat requirements.
Control coil impedance is 200 ohms. For maximum phase shift, 100 ma is required. The unit is rated at 2 kw peak, 2 w avg.
Rantec Corp., Dept. ED, Calabasas, Calif.

Coaxial Attenuator
Insertion loss is less than 0.5 db

Model PX 105 X-band temperature compensated ferrite phase shifter produces ±90 deg of phase shift and maintains an absolute phase stability of within ±15 deg from -10 to +100 C. The input vswr is less than 1.15:1 for all control coil current ranges over the temperature range.

Operating over the frequency range of 4 to 7 kmc, model AE-6 coaxial attenuator has an insertion loss of less than 0.5 db. The attenuation variation vs frequency is less than ±5%. The unit provides up to 40 db attenuation; it has a power handling capacity of 4 w avg, and a vswr of 1.5 v max.
Merrimac Research and Development, Inc., Dept. ED, 517 Lyons Ave., Irvington 11, N.J.

Price & Availability: Price is $285; units are available from stock.
Our experienced Design Engineers specialize in cable and cable assemblies utilizing Teflon® insulated hook-up wire (large and small), solid core and air dielectric coaxial cable, shielded and jacketed multi-conductors—or any combination of these.

Many leading aircraft and electronic manufacturers are taking advantage of Tensolite's cable design and production facilities. Let us work with you in translating your requirements into highly reliable jumbo cables and cable assemblies.

**ENAMELED PRODUCTS**

High temperature magnet wire—and other enameled wire products—must be produced under exacting dust-free conditions. To assure this, Tensolite recently set up its Mechtron Division in a separate and specially designed plant. Tensolite is the only manufacturer to provide this assurance of reliability and high quality.

**FREE**

Valuable New Catalogs! Just clip this to your calling card or letterhead!

- Wire, cable, cable assembly catalog.
- Magnet wire catalog.
- For Reference Only.
- Have Representative Contact Me.

See us at Booth 4330 at the I.R.E. Show CIRCLE 63 ON READER-SERVICE CARD

**NEW PRODUCTS**

**Pressure Transducer**

Repeatability is ±0.1%

Model 1000A potentiometer pressure transducer is available in ranges from between 0 and 15 to between 0 and 350 psig and in resistances up to 10 K. Linearity is to ±0.5%, repeatability is held to ±0.1% max, hysteresis is 0.2% max, and temperature sensitivity is ±0.01% per deg C. The unit has virtually infinite resolution. It operates over the temperature range of −55 to +85 C. Acceleration of 20 g along any axis will cause less than 1% change in output.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L.I., N.Y.

**Perforated Tape Spooler**

Take up is 300 ft

Model 4533 spooler provides a take-up reel for a minimum of 300 ft of punched paper or Mylar tape. Having a 6-in. diam, the unit can be used with photoelectric readers with operating speeds to 300 characters per sec. It mounts on a standard 19-in. relay rack and requires 9-3/4 in. of panel space.

Digitronics Corp., Dept. ED, Albertson, L.I., N.Y.

Price & Availability: One unit is priced at $495; for an order of 10, the price is $450. Delivery time for four weeks.

ELECTRONIC DESIGN • March 2, 1960
General Instrument semiconductor engineering has made possible these silicon diodes with a range of characteristics never before available to the industry.

The types listed here are just a small sampling of the complete line which can be supplied in volume quantities for prompt delivery. General Instrument also makes a complete line of medium and high power silicon rectifiers. Write today for full information.

General Instrument semiconductor diodes

high speed • high conductance • high temperature
high voltage • high back resistance
complete reliability

Including the industry's most versatile diode with uniform excellence in all parameters.

1N658

General Instrument semiconductor diodes are available in a range of characteristics suitable for various applications. They are ideal for use in high-speed circuits, such as digital systems, where rapid switching is required. These diodes offer high conductance and temperature stability, making them suitable for high-temperature environments. Additionally, they are capable of withstanding high voltages and providing high back resistance, ensuring reliability in demanding applications.

With a variety of types available, General Instrument semiconductor diodes cater to different needs. The chart provided includes general purpose diodes, fast recovery diodes, and high conductance diodes, each with specific characteristics. Prices range from $4.95 to $65, depending on the type and quantity required. Customers can choose from a wide range of diodes, with delivery times ranging from 2 to 15 days, ensuring prompt availability.

For immediate delivery, contact your authorized stocking distributor. To request a catalogue or more information, please use the reader-service card provided.
NEW PRODUCTS

Time Analyzer
Has 32 consecutively gated channels

Designed to count and store digital data in 32 consecutively gated channels, the system 0900 time analyzer comes complete with timer, delay provisions, count and cycle totalizers, and internal calibration program. Each of the 32 channels has electronic counting units and a 4-digit mechanical register to provide storage of 106 digits. Channel widths are variable from 1 µsec to 0.08 sec.

Eldorado Electronics, Dept. ED, 2821 Tenth St., Berkeley 10, Calif.

Price & Availability: Can be delivered 90 days after order received. Price depends on options. Quote on request.

Signal Generator
Has outputs up to 400 mw

Model DY-5381 signal generator delivers a minimum power output of 250 mw from 8500 to 10,000 mc with outputs up to 400 mw in the area of 9500 mc. Types of modulation provided internally are pulse and fm, separately or simultaneously, and square wave. The pulse length is variable from 0.5 to 25 µsec; the repetition rate is adjustable from 35 to 3500 pps. Provision is made for external pulse.

Hewlett-Packard Co., Dymec Div., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.

Price & Availability: Delivery is 90 days after order received. Price is $4835 fob, Palo Alto, Calif.
Coaxial Attenuators
Range is dc to 2000 mc

Designed to meet requirements for high strength and low mass, model RDA-2 coaxial attenuator has a sensitivity of 0.05 db per db max from dc to 2000 mc. Available in values of 3, 6, 10, and 20 db, they have a maximum vswr of 1.1.

Radar Design Corp., Dept. ED, 1001 Pickard Drive, Syracuse 11, N.Y.
Price & Availability: Price is $30 ea, prices for quantity order is quoted on request. Delivery is from stock to four weeks.

Epoxy Header
Replaces glass-to-metal hermetic seals

This all-epoxy header, for use with epoxy shells or conventional metal cases, replaces glass-to-metal hermetic seals in a variety of electronic applications. Since the header leads are embedded in cured, molded epoxy, there is no danger of cracked glass, no broken seals, and no coefficient of expansion during the soldering operation. In addition to conventional straight-through leads, headers are available where the leads take a bend while passing through the body of the header. Headers fit a standard 7-pin miniature socket. Epoxy formulations for use with copper, brass, silver, and gold-plated metals are offered.

Epoxy Products, Inc., Dept. ED, 13 Coit St., Irvington, N.J.
Price & Availability: Types having 3/4-in. diam are available from stock in 3, 7, 8, and 9-pin sizes. Price of 3-pin type is $0.21 ea for up to 250 units. Prices quoted on request. Various other sizes are made on order and are delivered in 30 to 45 days.
The Many Sides of Solid State Power

There are many examples of Western Design solid state power supplies...regulated multiple-outlet units with a maximum of 3% distortion, less than 1° phase shift and regulation as tight as ±.5V at 130V, 400 cps...economy-priced single-outlet units regulated to .3%, with extremely low heat-generation and 100 microsecond response. Features such as these are typical of Western Design's power conversion capability in airborne, ground support and industrial applications. Backed by long, complementary experience in the electro-mechanical field...strong corporate financial back-up...excellent field service...no one offers quite so reliable a package of solid state power as Western Design. For detailed information, contact your Western Design representative or write us for Data File ED-1020-1.

Western Design
DIVISION OF U.S. INDUSTRIES, INC.
SANTA BARBARA AIRPORT, GOLETA, CALIFORNIA

NEW PRODUCTS

Insulation Tape 612

Has controlled low shrinkage

Specified to show no more than 2% change in any dimension when heated free at 730 F for 15 min, this Teflon tape has controlled, low shrinkage. It comes in thicknesses from 1 mil up, and widths from 1/4 to 12 in. Tensile strength for the 1-mil tape is 3000 psi; dielectric strength is 3800 v per mil. At 5 mil, tensile strength is 4000 psi, and dielectric strength is 2200 v per mil.

Dixon Corp., Dept. ED, Bristol, R.I.

Price & Availability: Made on order only and delivered 1 week to 10 days after order is received. Standard teflon tape price.

Thermistor 613

Used in liquid nitrogen range

Engineered to operate in liquid nitrogen temperature ranges, type 05A8 bead thermistor has a resistance of 100,000 ohms at -195.8°C and is hermetically sealed in a glass probe. Its time constant in liquid nitrogen is less than one second. The thermistor measures 4 in. in length, and can withstand pressures greater than 10,000 psi.

Victory Engineering Corp., Dept. ED, 519 Springfield Road, Union, N.J.

Price & Availability: Available from stock. Price is $17.50.

Brake Clutches 614

Multiple disc and toothed types

This line of electro-magnetic clutches includes a multiple disc type and a toothed type. Disc type clutches range from 4 to 21 in. in diameter, weigh from 4 to 660 lb, and have torque capacities from 10 to 12,000 ft-lb. The toothed clutches come in diameters from 3 to 9 in., weigh from 1-5/8 to 53 lb, and have torque capacities from 40 to 4000 ft-lb. Both types can operate dry or in oil.

Bendix Aviation Corp., Eclipse Machine Div., Dept. ED, Elmira, N.Y.
Temperature Probe 616

Is a thermistor bead on an aluminum disc

Type G312 surface-temperature probe consists of a thermistor bead mounted on an aluminum disc 0.25 in. in diameter by 0.005 in. thick. All units in the line have identical RT curves from 0 to 350 F, and meet the company's EMD-31 curve (4000 ohms at 25 C). They are supplied with a 48 in. Teflon-insulated ribbon wire, and can be cemented, taped, potted, or held on to any surface.

Fenwal Electronics, Inc., Dept. ED, 51 Mellen St., Framingham, Mass.

Price & Availability: Made on order only and delivered in 4 weeks. Price is $45 per unit in quantities of 1 to 19; when ordered in quantities of 20 or more, price is $27.

Solenoids 615

Operate without rectification

Available in two sizes, these solenoids operate without rectification from a 400-cps power source. They have an externally adjustable stroke length and linear action that may be either push or pull. Model 175 weighs 1.3 oz and consumes 13 w; model 375 weighs 5.1 oz and uses 40 w. Both sizes operate continuously at temperatures from -65 to +450 F.


Relays 617

Automatically monitor 3-phase power

Available in three mounting and hook-up configurations, and four frequency and voltage ranges, these phase sequence relays offer automatic monitoring of three-phase power.

Master Specialties Co., Dept. ED, 658 E. 108th St., Los Angeles 59, Calif.

Price & Availability: Delivered 14 to 21 days after order received. Price is $66.32 per unit.
NEW PRODUCTS

Strip Chart Recorder
Response time is 1 sec

This rectilinear strip chart recorder is sensitive to 1 ma full scale and has a response time of 1 sec. The six-channel model provides six independent, non-overlapping and continuous records. It is suitable for recording volts, milliamperes, or other variables available as outputs from electrical systems. The unit is compact, measuring 12-3/4 x 9-13/16 x 8-3/4. Models having two, three, four, and five channels are offered. Chart speeds can be from 1/2 in. per hr to 24 in. per min. Each unit has interchangeable pens for ink or inkless recording.


Variable Delay Line
Provides delays to 0.79 μsec

Model 443B3 variable delay line box provides delays up to 0.79 μsec with an accuracy of 0.8% of the maximum delay by means of binary switching. Rise time is 0.05 μsec for the maximum delay and decreases as lesser delays are used. Impedance is 100 ohms and attenuation is 3.5%. Dimensions are 3 x 3 x 5 in. The unit may be connected into a circuit to determine the specifications of the delay line that will provide optimum circuit characteristics or, as a substitute until a production prototype delay line can be supplied.

Valor Instruments Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.
Price & Availability: Price is $170 per unit. For orders of five or more, price is $160. Units are available from stock.
HIGH SPEED SWITCHING

... with reliable T/I silicon transistors

New improved T1 2N337 and 2N338 specifications provide greater design flexibility for your switching circuits ... nuclear counters ... pre-amplifiers ... RF amplifiers ... 455 KC IF amplifiers ... and many other high frequency applications.

You get high gain at low current levels with T1 diffused silicon transistors. High alpha cutoff ... 10 mc min for 2N337, 20 mc min for 2N338 ... and extremely low collector capacitance assure optimum performance in your switching and high frequency amplifier applications.

Over four years of mass production and successful use in the most advanced military and industrial applications have proved the value of the T1 2N337 series. Consider T1's guaranteed specs when you select devices for your next transistor circuit. These units are immediately available in production quantities or from large stocks at all authorized T1 distributors.

design characteristics at 25°C ambient (except where advanced temperatures are indicated)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2N337</th>
<th>2N338</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;CB&lt;/sub&gt;</td>
<td>min</td>
<td>design center</td>
</tr>
<tr>
<td>V&lt;sub&gt;CB&lt;/sub&gt;</td>
<td>20V</td>
<td>-</td>
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<tr>
<td>I&lt;sub&gt;EB&lt;/sub&gt;</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt;</td>
<td>50µA</td>
<td>-</td>
</tr>
<tr>
<td>I&lt;sub&gt;E&lt;/sub&gt;</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>I&lt;sub&gt;B&lt;/sub&gt;</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>I&lt;sub&gt;x&lt;/sub&gt;</td>
<td>0</td>
<td>0.2</td>
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<tr>
<td>V&lt;sub&gt;ce&lt;/sub&gt;</td>
<td>200</td>
<td>2000</td>
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<tr>
<td>V&lt;sub&gt;ce&lt;/sub&gt;</td>
<td>20V</td>
<td>-</td>
</tr>
<tr>
<td>V&lt;sub&gt;BE&lt;/sub&gt;</td>
<td>0.95</td>
<td>0.985</td>
</tr>
<tr>
<td>V&lt;sub&gt;b&lt;/sub&gt;</td>
<td>DC Beta</td>
<td>35</td>
</tr>
<tr>
<td>V&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Frequency Cutoff</td>
<td>20</td>
</tr>
<tr>
<td>V&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Collector Capacitance</td>
<td>12</td>
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<tr>
<td>R&lt;sub&gt;ce&lt;/sub&gt;</td>
<td>Collector Saturation Resistance</td>
<td>75</td>
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<tr>
<td>R&lt;sub&gt;ce&lt;/sub&gt;</td>
<td>Current Transfer Ratio</td>
<td>14</td>
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<tr>
<td>t&lt;sub&gt;r&lt;/sub&gt;</td>
<td>Rise time</td>
<td>0.05</td>
</tr>
<tr>
<td>t&lt;sub&gt;f&lt;/sub&gt;</td>
<td>Fall time</td>
<td>0.08</td>
</tr>
</tbody>
</table>

* Measured at 1 mc | † Common Emitter | ‡ | 1µA = 1mA for 2N337, 0.5mA for 2N338 | § Includes delay time (t<sub>r</sub>)
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26 ISSUES IN '60
NEW PRODUCTS

Holders and Clamps 564

For short run welding, soldering, and brazing, they are offered in these three types: adjustable holders with clamping faces that can be set to any angle, right angle type, and straight angle type with clamp faces aligned for butt joints.

Wales-Strippit, Inc., Dept. ED, 223 S. Buell Rd., Akron, N.Y.

Price & Availability: The products will be available from stock by March 31, 1960. Price is furnished on request.

Coupling and Slip Clutch 565

Type T14 in-line coupling and slip clutch has spring slip torques of 0.5 to 50 oz-in. Shaft to shaft misalignment is up to 0.01 in, angular misalignment is up to 1 deg, and backlash is 10 min max.

Pic Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L.I., N.Y.

Price & Availability: Price is $24 to $26 ea. Available from stock, units can be delivered in 10 days or less.

Plugs 566

Silent Plugs No. 49 and No. 169 are designed to eliminate amplifier open-circuit noises. Adapter No. 341 has a 2-conductor jack input to a 2-conductor plug outlet.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, I11.

Price & Availability: The plugs are priced at $1.50 and $1.75; price of the adapter is $2.95. All items are immediately available.

Silicon Rubber Tape 567

This guide line tape is permanently resilient, self-adhering, and self-fusing. It is resistant to corona, oils, weathering, and abrasion.


Price & Availability: Complete price information is furnished on request.

Potting Compound 568

For electronic hardware use, type 0308 stands 4500 F for 5000 hr, 5000 F for 1 hr, and 4000 F continuously. Types 0307 and 0306 stand a maximum of 3000 F and 2000 F respectively.


Price & Availability: Available from stock, types 0306, 0307, and 0308 are priced at $11.25, $47.50, $95 per lb. Prices are $8, $32.25, and $62 per lb when quantities of 25 lb or more are ordered.
NEW PRODUCTS

High-Q Rejection Filters

Have hermetically-sealed cases

These high-Q rejection filters are protected from environmental conditions by encapsulation in hermetically-sealed cases; magnetic shielding is provided by a steel case. These networks are available at frequencies as low as 25 cps in MIL-T-27A cases; lower rejection frequencies are available in larger cases. The notch frequencies can be as closely spaced as 2:1 with less than 4 db loss between notches. Harmonic Frequency can be rejected with intermediate frequencies transmitted. The notches offer 50 db attenuation. The units are suited for transistor circuits.

T T Electronics, Inc., Dept. ED, P.O. Box 180, Culver City, Calif.

Price & Availability: Price is about $35. Units are shipped about 7 days after order is received.

Clutches and Brakes

Miniature

Series 6 and series 8 miniature clutches and brakes are for applications in computer, control and servo positioning. They feature no backlash, no end-play, and need no slip rings. Clutching and braking are accomplished without angular displacement or axial motion. They require about 1.2 w at 24 v dc and meet the following requirements: MIL-E-005272, MIL-E-5400, MIL-STD-202, MIL-E-4158, and MIL-E-5189.

Guidance Controls Corp., Dept. ED, 110 Duffy Ave., Hicksville, L.I., N.Y.
Strip-Chart Recorder

Has six chart speeds

Model 80A strip chart recorder provides instant selection of chart speed by front panel push buttons. Speeds of 2, 4, 6, 8, 15, and 60 in. per min are available. The instrument has a full scale sensitivity of 0.05 and a resolution and accuracy of 0.2%. The input range of $5$ mv to $100$ v is covered in 10 steps or by vernier for continuously span voltage control. The input resistance is 200,000 ohms per v through $10$ v, and 2 meg on higher ranges. Pen speeds to 0.25 sec for full scale are provided. Standard 120 ft chart rolls are used.


Price & Availability: Price is $1750 ea. Units can be delivered in 30 days.

Cases for Electronic Components 574

Epoxy-molded

These high temperature epoxy-molded cases come in round, square, and rectangular shapes in a wide range of sizes. Serving as molds during the potting of electronic components, they simplify assembly line operations. They have high dielectric characteristics, low moisture absorption, good mechanical strength, and other characteristics of epoxies. The cases become integral with the encapsulated component.

Pilastronic Engineering Co., Dept. ED, 721 Boston Post Road, Marlborough, Mass.

Price & Availability: Most sizes are available from stock. Maximum delivery time is three weeks. Price quotes are on request.

Preview the products of interest to you—see them in ELECTRONIC DESIGN's March 16th IRE Show issue.

ELECTRONIC DESIGN • March 2, 1960

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SIZE</th>
<th>CAPACITANCE (uuf)</th>
<th>DCV</th>
<th>TC</th>
<th>MAX. CASE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY</td>
<td>CY10</td>
<td>1 to 150</td>
<td>500</td>
<td>300</td>
<td>$\frac{1}{2} x \frac{1}{4} x \frac{1}{4}$</td>
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<tr>
<td></td>
<td>CY15</td>
<td>151 to 240</td>
<td>300</td>
<td>500</td>
<td>$\frac{1}{2} x \frac{1}{4} x \frac{1}{4}$</td>
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<tr>
<td></td>
<td>CY20</td>
<td>511 to 1,200</td>
<td>300</td>
<td>500</td>
<td>$\frac{1}{2} x \frac{1}{4} x \frac{1}{4}$</td>
</tr>
<tr>
<td></td>
<td>CY30</td>
<td>3,301 to 6,200</td>
<td>500</td>
<td>300</td>
<td>$\frac{1}{2} x \frac{1}{4} x \frac{1}{4}$</td>
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<tr>
<td></td>
<td>CY60</td>
<td>Up to 56,000</td>
<td>100</td>
<td>500</td>
<td>$\frac{1}{2} x \frac{1}{4} x \frac{1}{4}$</td>
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<tr>
<td></td>
<td>CY70</td>
<td>Up to 150,000</td>
<td>100</td>
<td>500</td>
<td>$\frac{1}{2} x \frac{1}{4} x \frac{1}{4}$</td>
</tr>
</tbody>
</table>

Why you have to smash these Corning capacitors to affect their reliability

Stack alternating layers of glass ribbon and aluminum foil, fuse the stacks under heat and pressure, and you have a solid, practically indestructible capacitor.

The properties of the capacitor are entirely those of the closely controlled dielectric. They cannot be altered in processing. They stay the same under heat, moisture, and all other environmental conditions.

There's no problem with delivery. We mass produce them all.

If you need capacitors high in reliability, small in size, and light in weight, you should know more about this Corning design. The coupon will bring you complete technical data.

For orders of 1000 or less, please contact our distributor, Erie Resistor Corporation.

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CORNING GLASS WORKS, BRADFORD, PA.

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Company ____________________________

Address ____________________________

City ____________ Zone ______ State

CIRCLE 84 ON READER-SERVICE CARD
Drafting Aids

This 32-page booklet is entitled "Tips-Techniques and Drafting Aids." It is divided into the following headings: Helpful Drawing Techniques, Simplifying Drafting Practices, Protecting Prints and Drawings, Tips for Drawing Lines and Curves, Modifying Equipment for Extended Use, and Getting the Most from Drawing Instruments. Send 50¢ to Alvin & Co., Inc., Dept. ED, 611 Palisado Ave., Windsor, Conn.

Printed Circuit Connectors

Standard card receptacles, terminal strips, contact strips, and miniature series EC coaxial connectors are described in this 36-page catalog. In addition, 12 pages illustrate and give design and engineering data on printed circuit connectors for special applications. General specifications include details of construction and description of materials and terminations. Write on company letterhead to H. H. Buggie Div., Burndy Corp., Dept. ED, Toledo 1, Ohio.

Thermal Testing

Model B210, thermal test unit for use with the Thermion tube, is described in this bulletin, No. 210-10-9, two pages. Photographs, operating characteristics, and applications of the unit are included. Research Council Inc., 1062 Main St., Waltham 54, Mass.

Relay Analyzer

Model 140 relay analyzer is described and illustrated in this two-page data sheet. The instrument evaluates relay operating characteristics under actual contact loading. Specifications and accessory data are included in the bulletin. Schmeling Electronics, 20 First St., Keyport, N.J.

Tape Wound Cores

This 16-page bulletin contains data on the operating characteristics and typical circuit applications of the firm's round and square Hy Mu 80 tape-wound cores. Maximum and minimum gain-limit curves and tables are included in the booklet. Magnetels Inc., Butler, Pa.

What can you do with a remarkable instrument like this?

We knew we had an outstanding instrument in our product line when this readout device was introduced several years ago. It proved to be ahead of its time during those early days, but now this remarkable precision instrument for displaying data is gaining acceptance in many industries. It's about as big as a candy bar, and it will display, store, or transfer up to 64 different numbers, letters, or symbols without using complicated conversion equipment and "black boxes."

This is an entirely new species of readout device so we had to give it a new name, the Readall® readout instrument.

We developed the Readall instrument for data display in flight control equipment. We knew the Readall instrument was fine but didn't know just how valuable it was. But one of our engineers did. He designed a complete new pipeline control system based on the new instrument. The application was a breakthrough in data handling, and the control system is a big success.

 Naturally, we put the Readall instrument on the market so systems engineers could use it to improve their control systems. We announced the Readall instrument as "... an electro-mechanical, D.C. operated readout device for displaying characters in accordance with a pre-determined binary code..." a compact, self-contained device... which can be applied to the output of digital computers, teletype receiving equipment, telemetering systems, or wherever data must be displayed."

Other systems have been developed with separate units for data display, decoding, storing, and electrical readout. These separate units cost more and occupy more room. Market response confirms the need for one, small, inexpensive unit that does all these jobs. The Readall instrument serves the purpose.

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Division of Westinghouse Air Brake Company
Pittsburgh 18, Pennsylvania

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Send more information about the Readall instrument

Name ________________________________ Title ________________________________

Company ________________________________

Address ________________________________

City ____________________________ Zone ______ State ______

See us at Booth #2122-24 at IRE Show—Mar. 21-24

CIRCLE 94 ON READER-SERVICE CARD

GREEN INSTRUMENT COMPANY, INC.
361 Putnam Ave. • Cambridge 39, Mass.
CIRCLE 94 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960
NEW SILICON "PILL" VARACTOR

GREATLY REDUCES THE PACKAGE AS A FACTOR IN CIRCUIT DESIGN

specifically developed for:
- amplifiers at the higher microwave frequencies (1000 mc and above)
- travelling wave parametric amplifiers
- microwave computers as sub-harmonic generators
- amplifiers in which stray susceptance effects must be minimized
- applications of varactors to stripline circuits
- modulators for frequency synthesis

| Experimental quantities are available with these nominal specifications |
|---|---|---|
| **TYPE NUMBER** | **CAPACITANCE TOLERANCE (Zero Bias)** | **TYPICAL Q AT 6 VOLS** |
| MA-4255X | 0.5-1.4 µF | 60-80 |
| MA-4256X | 1.2-2.5 µF | 50 |
| MA-4257X | 2.5-4.0 µF | 30 |

*Package shunt capacitance = 0.2 µF. Series lead inductance <10⁻⁶ henries.

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CIRCLE 105 ON READER-SERVICE CARD

NEW LITERATURE

Slit Insulation

Thicknnesses, widths, tolerances, and coil and core sizes of slit electrical insulation are given in table form in this four-page bulletin, No. 33. Conversion tables are included to enable users to transpose area to lineal foot per pound. Inmanco Div. of Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Magnetic Shielding

Data sheet No. 152 explains how nonshock sensitive nonretentive Netic-Co-Netic magnetic shielding can be used to isolate the fields generated by toroidal devices and how shielding prevents pickup or inter-action between adjacent coils. Magnetic Shield Div. of Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.

Time Delay Relays

Bulletin No. 5905, eight pages, describes the firm's complete line of electronic time delay relays. Units are available with overlapping time delay ranges, each capable of a 20 to 1 adjustment range. Data on circuit design, sizes, specifications, mounting arrangements, and terminal styles are included. Tempo Instrument Corp., Box 338, Hicksville, N.Y.

Vibration Test Systems

Four-page bulletin No. 59-5 describes the series 70 vibration test systems. System performance, components, and accessories are covered. A complete description and dimensions of the 400-lb force shaker are given. Unholtz-Dickie Corp., 2994 Whitney Ave., Hamden 18, Conn.

Resin Color Concentrates

Recommended applications, high temperature test results, and color chips of epoxy resin color concentrates are included in this folder. The user may perform his own coloring, or obtain already colored resin. Resin Formulators, Inc., 9956 National Blvd., Los Angeles 34, Calif.

Components

The firm's complete electronic instrument line is contained in this 54-page catalog. Oscillators covering a range of 0.001 to 520,000 cps, band-pass and rejection filters, power supplies having ultra-high regulation, and low distortion amplifiers are shown. Nomographs and tables for aid in measurements are included. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass.
Clutches and Brakes

Type 125 electro-magnetic clutches and brakes are described in bulletin No. AIM 959, four pages. The units are for control component use with multi-speed devices, direction changers, and machine tool controls. Dimensional data and specifications are included. Autotronics Inc., Dept. 22, Box 208, Florissant, Mo.

Synchro Components

This brochure on size 8 synchro components contains general specifications for torque receivers, torque transmitters, control transformers, resolver transmitters, vector receivers, linear transformers, and control differentials. The design options and mechanical characteristics are also listed. Induction Motors of California, 6058 Walker Ave., Maywood, Calif.

Transistor Stampings

Solder-clad base tab stampings used in making ohmic junctions to germanium or silicon junction transistors are described in bulletin No. Z-102, one page. A photo of typical stampings is included. Accurate Specialties Co., Inc., 37-11 57th St., Woodside 77, N.Y.

Resin Fluxes

Printed circuit resin fluxes that meet the requirements of MIL F-14256 are described in this three-page bulletin. Information on five available grades include solderability value, corrosion potential, and specific gravity. Printed in color, the bulletin can be used as a reference chart for selecting a proper flux. London Chemical Co., Inc., Dept. E1-2, 1535 N. 31st Ave., Melrose Park, Ill.

Metal Crystals

Entitled "Large Single Metal Crystals," this 11-page bulletin, No. 102, describes standard specimens as well as unusual shapes and special crystal orientations. Data on each metal is tabulated individually. Flow Corp., 85 Mystic St., Arlington 74, Mass.

Wafer Capacitors

Glass dielectric wafer capacitors for printed circuit, modular or encapsulated assemblies are described in this four-page data sheet. The capacitors meet the requirements of MIL-C-11272A. Characteristics and performance curves are included in the bulletin, No. CE-102. Write on company letterhead to Corning Electronic Components, Corning Glass Works, Dept. ED, Bradford, Pa.

Check RCA—for your industrial test equipment requirements—whether you're engaged in laboratory and production testing, or research and service. Factory-wired and calibrated RCA Test Equipment can provide the accuracy and dependability required in many industrial electronic applications.

Call your Authorized RCA Test Equipment Distributor for complete technical details and fast delivery!
TWO SIMPLE and easily built circuits were devised for obtaining accurate quadrature outputs from a variable frequency oscillator. The same negative feedback amplifier, Fig. 1, having a large open loop gain and with a tungsten lamp age, was used in each circuit.

The first scheme, Fig. 2, uses two capacitors and two variable resistors to form a modified Wien Bridge selective network. This network provides a positive feedback loop around the circuit of Fig. 1. Two RC sections would provide only zero and -45 deg outputs. Hence a third RC section is used to obtain a +45-deg output. The voltage amplitude and phase at each output point are indicated on the figure. Note that the feedback amplifier is adjusted for a gain of 3. For equal amplitudes, the outputs must be amplified through identical amplifiers, to maintain the exact 90 deg phase difference, with gains in the ratio of 3 to 2.

The second scheme, Fig. 3, uses four resistor-capacitor pairs, but it provides two outputs at angles of +90 deg and -90 deg from a reference signal. The amplifier must now have a gain of 9. Again, for equal amplitudes, the outputs must be amplified through identical amplifiers having the proper gain ratios.

In either scheme, the relative position of the
Fig. 2. A modified Wien Bridge arrangement provides the frequency selection. The third RC section is necessary for the +45 deg output.

Fig. 3. Four RC pairs provide outputs at ±90 deg from a reference, 0 deg, signal.

Capacitors and resistors can be interchanged, if it is convenient. The oscillation frequency will still be

\[ f = \frac{1}{2 \pi RC} \]

For a frequency range of 2.5 kc to 31.8 kc, capacitor C was 1000 μf, ±1%. Variable resistors \( R \) were gauged precision potentiometers varying between 62.4 K and 5.00 K for the frequency extremes.

Sergio Bernstein-Berry, Chief Engineer, Optimized Devices, Thornwood, N.Y.

Credit Risk

The article "High Input Impedance Transistor Monitor" by J. T. Moses (Electronic Design, Jan. 20, 1960, p 116) was actually coauthored by Mr. Moses and by Mr. E. B. Jenkins, Sonar Engineering Unit, General Electric Co., Syracuse, N.Y.

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QUICKLY INSTALLED SOUTHCO CAPTIVE PANEL SCREWS END MISALIGNMENT PROBLEM...

Simplicity of design contributes to clean, distinctive appearance and fast, low-cost installation. Stand-off is slipped into panel hole and secured by flaring. Screw is passed through stand-off and made captive by vinyl o-ring.

"Floating" screw design eliminates costly close tolerance manufacture and permits easy engagement regardless of panel distortion encountered under adverse use conditions.

SPECIFICATIONS

Material: Screw is brass, chrome plated; can be supplied in stainless steel. O-ring is vinyl plastic.

Overall length of screw: \( \frac{7}{8} '' \) Depth of screw head: \( \frac{1}{4} '' \)

Sizes:

<table>
<thead>
<tr>
<th>SCREW HEAD DIAMETER</th>
<th>THREAD SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{3}{8} '' )</td>
<td>( \frac{4}{20} )</td>
</tr>
<tr>
<td>( \frac{7}{16} '' )</td>
<td>( \frac{4}{20}, \frac{12}{24} )</td>
</tr>
<tr>
<td>( \frac{5}{32} '' )</td>
<td>( \frac{10}{24}, \frac{10}{32} )</td>
</tr>
</tbody>
</table>

Length of thread: \( \frac{1}{4} '' \)

Screw head is supplied plain, as shown, or slotted for screw driver.

PRE-ASSEMBLED PAWL ADJUSTS TO DESIRED THICKNESS AND PRESSURE

This neat, compact Southco panel and door fastener is supplied assembled, requires but two rivets or bolts for low cost installation. It is available in three models—large, intermediate and midget.

The unique feature of Southco Pawl Fasteners is the fact that, by merely turning the knob, the pawl is adjusted to a wide range of frame thicknesses. This assures a tight grip without precision setting regardless of variations in frame or door dimensions or changes that are produced by wear or warping of sheets.

Pressure exerted by the pawl on the frame is controlled in the same way, by merely turning the knob. Against gasketed frames, pressure can be easily applied to compress the gasket.

SPECIFICATIONS

Knob: Cadmium or chromium plated steel.

Head Styles: Protruding ribbed or knurled knob; flush screw driver slotted for large size only.

<table>
<thead>
<tr>
<th>Knob diameter</th>
<th>( \frac{1}{4} '' )</th>
<th>( \frac{3}{8} '' )</th>
<th>( \frac{1}{2} '' )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total width</td>
<td>( \frac{2}{6} '' )</td>
<td>( \frac{1}{4} '' )</td>
<td>( \frac{1}{8} '' )</td>
</tr>
<tr>
<td>Total height</td>
<td>( \frac{1}{8} '' )</td>
<td>( \frac{1}{4} '' )</td>
<td>( \frac{3}{4} '' )</td>
</tr>
<tr>
<td>Back of panel</td>
<td>( \frac{1}{4} '' )</td>
<td>( \frac{1}{2} '' )</td>
<td>( \frac{3}{8} '' )</td>
</tr>
<tr>
<td>Knob length</td>
<td>( \frac{1}{8} '' )</td>
<td>( \frac{1}{2} '' )</td>
<td>( \frac{3}{8} '' )</td>
</tr>
</tbody>
</table>

FAST, HAMMER-DRIVEN BLIND RIVETS CUT INSTALLATION TIME

You "hit-the-pin" and the rivet's in. No special tools to limit production or require maintenance, no bucking, no finishing. For blind or open applications, Southco Drive Rivets save time, reduce costs.

Automatic "pull-up" action assures uniform, tight grip.

Southco Rivets are made of aluminum or cadmium plated steel with cadmium plated or stainless steel pins. Diameters are from \( \frac{1}{8} '' \) to \( \frac{3}{8} '' \), grip range is from \( \frac{1}{8} '' \) to \( \frac{3}{8} '' \).

Increased widespread use is due to low installed cost and elimination of down time and maintenance associated with fasteners requiring special tools.

FREE!

Fastener Handbook

Send for your free copy of Handbook No. 9, just released. Gives complete data for designers on these and many other specialty fasteners. 48 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS

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STYLE 1005

MIDGET DC RELAY

Cut your material and direct labor costs with this small, inexpensive, mass-produced relay for use in printed circuitry where the relay is self-supporting. Designed for simple plug-in installation.

The Style 1005 Relay is a single-pole, double-throw relay, light in weight yet capable of withstanding severe operating conditions and rough handling.

TYPICAL APPLICATIONS

Remote TV Tuning, Control circuits for recording instruments, Radiosonde, Auto headlight dimming, etc.

GENERAL CHARACTERISTICS

| STANDARD OPERATING | VOLTAGES       | 3 to 32 VDC |
| CONTACT RESISTANCE  | 13,000 ohms    |
| CONTACT SENSITIVITY | 0.05 watt at standard contact rating; 0.3 watt at maximum contact rating |
| CONTACT RATING      | Standard 1 amp; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC |
| MECHANICAL LIFE     | 10,000,000 operations minimum |
| DIELECTRIC STRENGTH| 500 VRMS minimum |

Also available with solder lugs in open or hermetically sealed styles.

STYLE 1001

For Details, call or write

PRICE ELECTRIC CORPORATION
304 E. Church Street, Frederick, Maryland
Monument 3-3541

IDEAS FOR DESIGN

Camera Lens and Solar Cell Make Pulse Generator

A production test set-up called for a pulse generator with an adjustable pulse width and amplitude. Using readily available equipment, the arrangement shown in the figure was used with great success.

A metal tube, closed at one end and housing a small pilot bulb, was slipped over a camera lens. A solar cell was mounted inside the camera, facing the lens. When the shutter is snapped, light passes through the lens onto the solar cell, generating a pulse whose duration and intensity are determined by the shutter and lens settings.

Joseph Leeb, Project Engineer, Bulova Watch Co., Jackson Heights, N.Y.

A Low Repetition Rate Timer

A timer was required to generate fast rise, low impedance pulses at low repetition rates of from 0.01 to 100 per second. Many schemes, such as blocking oscillators, multivibrators and thyatron-type solid-state components, were tried, but suffered severely in stability, especially at the lower rates, because of dc triggering level jitter.

It was decided to investigate the stability of a simple neon tube RC oscillator using the stabilized Ne76. Firing voltage of this tube is held to close tolerances by including a small quantity of radio-active material in the envelope. The repetition period of the neon oscillator at low frequencies is given closely by $RC \log \left( \frac{V - E_F}{V - E_B} \right)$, in which $RC$ is the resistor and capacitor time constant, $V$ is the supply voltage, $E_F$ and $E_B$ the neon tube firing and extinguishing voltages respectively.

Because of the log function of voltages, pulse rates of such an oscillator are very insensitive to $V$, $E_F$, or $E_B$ changes. Generally, $E_F$ is 72 v, while $E_B$ is 50 v. The circuit shown capacitively couples

Stromberg-Carlson's type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the drawing above shows, universal frame mounting holes and coil terminal spacing allow you to specify these relays — of "telephone quality"— interchangeable with the brands you have been using. Costs are competitive and expanded production means prompt delivery.

Welcome engineering features of the telephone type "E" relay are:

Contact spring assembly: maximum of 20 Form A, 18 B, 10 C per relay.

Coil: single or double wound, with taper tab or solder type terminals at back of relay.

Operating voltage: 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R2. Write to Telecommunication Industrial Sales, 116 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

CIRCLE 127 ON READER-SERVICE CARD

CIRCLE 128 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960
Pulse timer designed to give 0.02-μsec rise-time Pulses at intervals of up to 10 sec. Repetition rate is variable by adjusting RC time constant of neon tube circuit.

the neon timer to a transistorized Schmitt circuit. Silicon 2N240's are used, mainly to conserve space. Negative or positive-going pulses are obtainable by simply inverting the neon tube voltage V and resetting the dc base bias of the input transistor.

The circuit met the following specifications: subminiaturization, ruggedness, low power, simplicity, an output spike of 3 V at 0.02 μsec rise time. It had a repetition accuracy of better than 2 per cent at 10 sec, even after 100,000 flashes at a neon bulb temperature of 150 C, under high radiation intensities.

Patrick F. Houden, Electronics Engineer, Consolidated Systems Corp., Los Angeles, Calif.

Resistors for High Reliability Designs

Carbon resistors are known to be a source of noise in high-gain amplifiers, especially when used as plate resistors. This noise is approximately proportional to the dc voltage drop across the resistor and is usually between 0.1 and 1 μv per v. The normal noise for a good carbon plate resistor is about 50 μv. This may be quite negligible in high-level amplifiers except that this noise figure frequently increases several orders of magnitude after many hours of use.

A noisy resistor is quickly located and replaced, but what is often overlooked is that many not-quit-so-noisy resistors can cause a deterioration of the signal-to-noise level. Such noise may remain undetected for long periods of time. Where high-reliability and good signal-to-noise ratios are required, the carbon resistors should be used only in high-level stages. In high-reliability equipment it is wise to design on the assumption that carbon resistor conduction noise may be as high as 100 μv per volt.

Wirewound and metal-film type resistors are normally free of the conduction noise problem.

Lawrence G. Cowles, Electronic Design Engineer, The Superior Oil Co., Bellaire, Texas.
PATENTS

Cathode Ray Deflection System
(Assigned to Westinghouse Electric Corp.)

In the television flyback scanning system, the cathode-heater insulation of the damper diode is increased by means of a helical electrostatic shield, coated with a ceramic, placed between the cathode and heater. With the shield voltage at one half the pulsed cathode voltage, the heater may be operated at ground potential without internal voltage breakdown.

In the conventional circuit illustrated, the invention lies in the addition of shield 44 between cathode 42 and heater 43. The shield is then conductively joined to tap 47 of flyback transformer 14.

INDUSTRIAL POWER SUPPLY

Fast-action Heinemann circuit breaker safeguards equipment

... and NFB if accidentally shorted or overloaded. Built to give years of maintenance-free service under punishing loads. Ample filtering gives wide range of applications. Versatility of NFB includes servicing of radios and low voltage devices; operates electronic equipment in missiles, aircraft and tanks. Rack mounted NFB available at $235 net.

Continuous Variable Output: 0-32 volts up to 15 amperes,
0-40 volts up to 3 amperes. Ripple: less than 1% at top load. Germanium Rectifiers greatly increase operating efficiency. Internal Z: 0.5 ohms @ 32v.

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Canada: Atlas Radio Corp., Ltd., Toronto, Ontario

BEST PERFORMANCE FOR $210

CIRCLE 132 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 2, 1960
Coupling Arrangement for TWT's

Radio frequency energy is coupled from a waveguide to the TWT helix through a coaxial cable which drives the helix capacitively. At the tube output, the helix connects to a coaxial line which transforms to a waveguide.

Waveguide 9, having height 15 and tuned by plunger 11, is changed to a coaxial line having inner conductor 12 and outer shield 13. Coupling to helix 8 is by means of antenna 7. For wideband matching, the spacing of the coaxial conductors should approximate the height of the waveguide.

COMPACT Modine transistor coolers
keep tight reign on temperature

Same size and weight as a pack of cigarettes . . . dissipate 85 watts with only 5 cubic feet per minute of 25°C air with silicon transistors.

Standard models for forced air flow and natural convection carried in stock, available for immediate shipment with any of five standard transistor mounting hole patterns.

Write for bulletin ID-159

Modine Manufacturing Company
1608 DeKoven Ave., Racine, Wisconsin
CIRCLE 133 ON READER-SERVICE CARD

Large Diameter SILICON for INFRARED Cut Domes and Lenses

Silicon cut domes and lenses to 8" diameter, with IR transmission to 97% (coated), are now available in production and evaluation quantities. Diameters up to 19" will be available in the near future.

These significantly larger diameters can now be grown as a result of recent Knapic research and experimental growing programs. Temperature gradient, pressure, and impurity evaporation controls, as well as unique growing methods, are the result of original Knapic laboratory work.

Germanium lenses and domes are also available

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>SILICON</th>
<th>GERMANIUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>750-2000 (Knoop) Excellent</td>
<td>692 (Knoop) Excellent</td>
</tr>
<tr>
<td>Index of Refraction</td>
<td>3.50 high</td>
<td>4.10 high</td>
</tr>
<tr>
<td>Melting point</td>
<td>1420°C Excellent</td>
<td>958°C Excellent</td>
</tr>
<tr>
<td>Density</td>
<td>2.3 gm/cm³ Excellent—very hard</td>
<td>5.34 gm/cm³ Good</td>
</tr>
<tr>
<td>Ease of finishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission cut-off</td>
<td>About 20 microns Excellent</td>
<td>About 23 microns Excellent</td>
</tr>
<tr>
<td>Reaction to Thermal Shock</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

TYPICAL INFRARED TRANSMISSION CHARACTERISTICS OF UNCOATED KNAPIC-GROWN SILICON AND GERMANIUM

Also manufacturer of Silicon and Germanium crystals for solar cell and semi-conductor devices.

Write for specifications sheet

Knapp Electro-Physics, Inc.
936-938 Industrial Avenue, Palo Alto, Calif. Phone: DAvenport 1-5544
CIRCLE 134 ON READER-SERVICE CARD
THERMO-COUPLE to resistors. This ability is known as the thermoelectric effect. A compact array of diode or insulated junctions, 64 cross-overs per inch, is formed by depositing semiconductive material at selected junctions to internally form electrical diodes. In the example shown, core wire 14, aluminum or nickel, is coated by the semiconductor which is then heated to form a diode with cross-over wire 12. Other cross-overs are conveniently insulated. The assembly is subsequently potted in an insulating material which hermetically houses the matrix in a solid insulating block.

PATENTS

Diode Matrix
A compact array of diode or insulated junctions, 64 cross-overs per inch, is formed by depositing semiconductive material at selected junctions to internally form electrical diodes. In the example shown, core wire 14, aluminum or nickel, is coated by the semiconductor which is then heated to form a diode with cross-over wire 12. Other cross-overs are conveniently insulated. The assembly is subsequently potted in an insulating material which hermetically houses the matrix in a solid insulating block.

Transmitter Linearized by Negative Feedback
Patent No. 2,912,570. H. Holzwarth et al. (Assigned to Siemens and Halske, Germany)
In a single sideband transmitter, a portion of the power output is mixed with the converter oscillator voltage. This oscillator voltage is conveniently phase-shifted in order to produce a signal corresponding in frequency to that applied to the input amplifier. This signal is then fed back to the input stage to linearize the overall transmitter amplification.

The signal-to-input stage 1 beats with the oscillator to develop the modulated signal at aerial 5 which is driven by grounded grid stage 4. Capacitor 6 picks up the high frequency component of the signal, and capacitor 20 stores d.c. energy, which is necessary for the oscillator process.

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MINIATURE LOW FREQUENCY CRYSTAL CONTROLLED OSCILLATOR

Quality-proven, this unit can be procured in either Silicon or Germanium. Created to withstand high vibration and shock requirements, plus other high environmental specifications. Save important space!

Specifications: Frequency range is 3 thru 100 KC, with frequency tolerance of ±0.03%, 2-16KC or ±0.07%, 16-100KC, over ambient range of 10 to 60°F, ±20 – 28 V DC ±5%. Output voltage: 2V P.P. thru 500 Dcns. Better than 7% amplitude stability. Total harmonic distortion is better than 5%. 6 Milliamp. oscillator current drain. Mountings: 9 pin module. Dimensions: 950° dia x 2.25 sealed height. ½” oz. weight. Available down to 1000 cycles.

Have a problem? Wire or phone, TODAY Send for detailed literature:

MONITOR PRODUCTS COMPANY
815 Fremont • South Pasadena, Calif. • MU 2-1174
Twin Pano, Calif. 7616
A portion of the output which mixes in reconverter 7 with the phase shifted oscillator voltage. The proper voltage is then fed back to linearize the amplifier.

Low Noise Electron Gun
(Assigned to Hughes Aircraft Co.)

A 3-dB noise figure electron gun, similar to the velocity jump type, produces a highly non-uniform current density across the cross section of the electron beam. Undesired velocities are discriminated against and shot current is reduced.

Essentially, the structure produces a potential profile which, in combination with an axial magnetic field, causes a voltage jump near the cathode followed by a region in which the voltage increases very slowly.

A low noise gun is illustrated in Fig. 1. Cathode 134, at ground potential, emits electrons in the direction of accelerator 140 set at a positive voltage. Placed about the cathode is a profile shaping electrode, 140. This is tapered as shown and set at a higher positive voltage than the accelerator.

Typical voltages and dimensions for this structure are tabulated.

The relative electron current density versus position across the cathode is shown in Fig. 2. The density is a maximum near the edge of the cathode and a minimum in either direction away from the edge.

In operation, the profile shaping electrode tends to pull electrons radially from the cathode. However, the axial magnetic field causes these electrons to spiral inward to the accelerator. From the electrons see a long, gradient-free drift region which reduces velocity and shot current fluctuations to improve the noise figure. (See Nevins and Curries, letter to editor, Proc. IRE, Nov. 1959, pages 2015-2018.)

Honeywell Motors
... for chart drives, servos, balancing circuits

Stack-Type Motors
These newly designed motors have such maintenance saving features as: sectional housing ... wick-type lubrication ... printed circuits ... ball bearings ... shock absorbers ... alignment keying rings. Any major part replaceable in two minutes.

Oil-Sealed Motors
These field-proven motors feature self-lubrication, have shock absorbers, are totally enclosed and oil sealed.

Military Motors
These are oil-sealed-type motors, modified to comply with MIL-M-17059. Housing is treated as specified in MIL-C-5541, and leads are fungus resistant as per MIL-V-173.

Specifications (applicable to all motors described above)

Two-Phase Induction Motor

<table>
<thead>
<tr>
<th>Nominal No Load R.P.M.*</th>
<th>Gear Ratio</th>
<th>Interim Load (oz.-in.)</th>
<th>Minimum Standig Torque (oz.-in.)</th>
<th>Power (Watts) Loaded</th>
<th>Current (amps) Loaded</th>
<th>Temp. Rise °F</th>
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</thead>
<tbody>
<tr>
<td>330</td>
<td>4.4:1</td>
<td>4</td>
<td>10</td>
<td>11.5</td>
<td>0.11</td>
<td>70</td>
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<tr>
<td>144</td>
<td>10:1</td>
<td>5</td>
<td>23</td>
<td>11.5</td>
<td>0.11</td>
<td>70</td>
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<tr>
<td>48</td>
<td>30:1</td>
<td>15</td>
<td>56</td>
<td>11.5</td>
<td>0.11</td>
<td>70</td>
</tr>
<tr>
<td>23</td>
<td>60:1</td>
<td>30</td>
<td>105</td>
<td>11.5</td>
<td>0.11</td>
<td>70</td>
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</table>

Synchronous

<table>
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<th></th>
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<tbody>
<tr>
<td>180</td>
<td>10:1</td>
<td>12</td>
<td>12</td>
<td>24.0</td>
<td>0.21</td>
<td>100</td>
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<tr>
<td>180</td>
<td>10:1</td>
<td>2</td>
<td>2</td>
<td>11.5</td>
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<td>65</td>
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<tr>
<td>90</td>
<td>30:1</td>
<td>14</td>
<td>12</td>
<td>11.5</td>
<td>0.11</td>
<td>65</td>
</tr>
<tr>
<td>40</td>
<td>60:1</td>
<td>30</td>
<td>36</td>
<td>11.5</td>
<td>0.11</td>
<td>65</td>
</tr>
</tbody>
</table>

*1/4 less at 50 cycles
1/16 less at 50 cycles
1/8 less at 50 cycles
1/16 less at 50 cycles
1/8 less at 50 cycles
1/4 less at 50 cycles
1/2 less at 50 cycles

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Electronics Design • March 2, 1960

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THE CATHODE-RAY TUBE AND ITS APPLICATIONS

The Cathode-Ray Tube and Its Applications

The third edition of this book, first published in 1937, has been completely revised and enlarged to reflect the recent changes made in oscillography. Primarily, the book has been planned as a guide to the operation and use of the cathode-ray tube as "one of the most versatile measuring instruments that has ever been devised." Only superficial treatment is given to the theory and design of the electron gun and tube structure. Instead, emphasis is placed on the circuitry associated with the cathode-ray tube in order to make it function as an indicating and measuring device. Also, considerable space is devoted to the application of the tube in various phases of electrical and mechanical engineering, radio engineering, television measurements, and other fields where it can be of use. Chapter headings include Power Supplies, Amplifiers, Liner Time-bases, Frequency Bases, Photographic Recording Transducers, Mechanical and Electrical Engineering Applications—transmission measurements, waveform display, radio reception, and Applications to General and Nuclear Physics.

The Cathode-Ray Tube And Its Applications


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Electron Physics

Fundamental for the whole subject of electron physics is the study of the properties of the free electron, and that is the subject of this book. Starting with some introductory notes on the history of electron physics, it goes on to discuss the main problems of electron motion, electron optics, electron flow in dense space charges and the statistical fluctuations in low intensity beams. A short discussion of experimental methods for the detection of free electrons concludes the first part of the book.

Part II deals with the fundamental properties of the free electron: its charge, mass, wavelength, spin and magnetic moment. The discovery of these properties and their study by highly precise quantitative methods is described.

Basically, the text is an extension of the lecture courses which the author delivered at the University of London. As such it is a text for undergraduate stu-
dents though, to make it as comprehensive as possible, some graduate level sections have been included.

Exploding Wires

This is a collection of the papers presented at the Conference on the Exploding Wire Phenomenon conducted by the Air Force Cambridge Research Center in Boston, Mass., on April 2 and 3, 1959. The papers are divided into three broad sections. Section one deals with theoretical and experimental studies made on the exploding wire phenomena, section two discusses the shock waves built up while this phenomenon is taking place, and section three relates the practical applications to which the previous studies have led. Among the organizations which presented papers at the conference were the Sandia Corporation, the California Institute of Technology, the Los Alamos Scientific Laboratory, and the Aerojet General Corporation.

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The 440-A's wide range offers more measurement flexibility. Its constant signal-to-noise ratio allows effective use of small signals in low level applications. Its low distortion eliminates troublesome harmonics in precise measurements.

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LITTON INDUSTRIES Electronic Equipments Division
Beverly Hills, California

BOOKS

Computers and People

What modern computers can mean to readers whom these machines are designed to serve—such as businessmen, managers, and other non-technical people—is explained in this newly published book. It gives a practical picture of electronic devices that can lead to new techniques for business operation and control.

A clear discussion of the economics of computers and related equipment is presented in terms designed to be grasped by non-specialists. Compromises that the data processing specialist must make in behalf of the organization he serves are described, as well as the decision-making aspects of computers and the changes that must be made by business to utilize data processing most effectively.

Future equipment and capabilities of computers are predicted, and the role that computer manufacturers should play in maximizing benefits to users is also discussed. The book treats the social problems created by modern data processing equipment and includes an illustrative review of some present and forthcoming computer applications.

Masers

The title is the commonly used form for the devices employed in producing Microwave Amplification and Oscillation by Stimulated Emission of Radiation. A discussion of the stimulated emission process is followed by a brief outline of methods used to obtain the conditions necessary for amplification. The effects of various physical processes upon amplifier efficiency, and upon the effective frequency response of a molecular transition used to amplify, are described. The book goes on to give derivations of the gain,
A review of the experimental work on masers is given, together with a comprehensive bibliography.

**Nuclear Technology For Engineers**

This is a practical text for all engineers and technicians confronted with nuclear problems in their own fields, or who are now working in nuclear energy. The four major areas of nuclear engineering—radioactive technology, radiation, fission energy, and nuclear fusion are covered. Mathematics is used only to illustrate important points, and is not essential to a sound understanding of the subject matter.

Found here is a concise explanation of the structure of the atomic nucleus and the ways in which unstable nuclei disintegrate to produce rays of particles and photons. How modern technology makes use of these rays is discussed, including both radiotracer methods and the irradiation of materials.

The book proceeds from low-level radiation (radioactive work) to high-level radiation, which is of interest in radiation processing and radiation-damage studies. It treats in illustrative detail the effects and uses of radiation as well as radiation dose and its measurement. A section on fission and the chain reaction answers questions on what fission is, how it is used to produce a chain reaction, how a chain reaction is controlled, and many more. A discussion on using fission reactors takes up the engineering problems of building a power reactor, explains reactor components, describes eight modern power-reactor types, and treats other topics such as auxiliary functions and nuclear economics.

A practical introduction to fusion technology is also included in the book, bringing details on the techniques of plasma physics, fusion devices, and the advantages of fusion reactors.
Solid State Reliability
IN A 10 mc Counter

The CMC 700 Series is the only major breakthrough in counting, timing and frequency measuring equipment in the past 10 years. Here is the first successful application of transistors to high frequency counting and timing. Transistors perform all the functions in CMC's 700 series that required 63 tubes in old style counting equipment. These are the most reliable counters ever made.

TRUE DIGITAL LOGIC CIRCUITRY
By answering an obvious need for a completely new, up-to-date approach to counting and timing instrumentation, CMC has produced solid state instruments with greatly simplified circuitry, using logic "and" and "or" gates.

LIGHT AND SMALL, LOWER POWER DRAIN
Each 700 series instrument weighs only 27 pounds, measures 7 inches high, 17 inches wide, and 14 inches deep. Power consumption is a meager 46 watts, 1/10 the amount for vacuum tube models.

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

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And The Price—Higher than vacuum tube models. But you can save the difference on down time in the first year. Model 727A Universal Counter-Timer, $2,750; Model 707A Frequency-Perioed Meter, $2,575; Model 707A Time Interval Meter, $1,975. Rack mount optional at no extra cost. All prices f.o.b. Sylmar, California.

More Information Available—Your nearby CMC engineering representative will be happy to arrange a demonstration and provide you with complete technical information. Or you may write Department 19-3.

GERMAN ABSTRACTS
E. Brenner

Frequency Stability of Cylindrical Cavities

Resonant cavities used as wavemakers or to control the frequency of microwave oscillators must have high-frequency stability. The resonant frequency of a cavity depends on the geometry and the material that fills it. Temperature variations have a direct influence on the cavity geometry. They affect the dielectric constant of air-filled cavities indirectly through pressure and humidity variations.

The effect of geometry on the resonant frequency of a cylindrical cavity, radius R and length L, for the E_{011} mode is given by

\[ \frac{\Delta f}{f} = \left( \frac{a}{R} \right)^2 \frac{\Delta R}{R} + \left( \frac{\pi}{L} \right)^2 \frac{\Delta L}{L} \] (1)

where a is the first zero of the Bessel function of the first kind, zero order, J_{1}(a) = 0. If the entire cavity is made of one material then \( \Delta f/f = \alpha \), the temperature coefficient of the material. For invar, \( \Delta f/f = -2 \times 10^{-4} \) per deg C. In the band 7.1 to 7.75 km/gc this corresponds to a frequency change of \(-14.2 \text{ ke} \) per deg C at the lower frequency limit and \(-15.5 \text{ ke} \) per deg C at the upper frequency limit of the band.

By using different materials for the cavity walls...
and for the plunger, Fig. 1, for example invar and brass respectively, and assuming no fields to the right of reference plane A-A, it can be shown that

\[ \frac{\Delta f}{f} = -\alpha_l + \left( \frac{\alpha_l - \alpha_b}{a} \right)^2 \left( \frac{d}{L} \right)^2 + \left( \frac{\pi^2}{a} \right) \left( \frac{1}{R} \right) \]

(2)

where \( \alpha_l \) and \( \alpha_b \) are the temperature coefficients of invar and brass respectively. It is then possible to compensate completely for the temperature effect at a mean frequency and to choose \( d \) so that equal errors occur at frequency band extremes. For the example cited above, \( \Delta f/f \) equal to \( \pm 0.48 \times 10^{-6} \) per deg C applies at the lower (+ sign) and upper (- sign) limits of the band. Thus the minimum improvement over the band is a factor of four.

Materials in the cavity have an influence independent of geometry. The additional frequency increment is

\[ \frac{\Delta f}{f} = \frac{1}{2} \left( \frac{\Delta \epsilon}{\epsilon} + \frac{\Delta \mu}{\mu} \right) \]

(3)

For air, \( \Delta \mu = 0 \). The influence of air pressure and humidity can only be eliminated by hermetically sealing the cavity after it is filled with dry air. Otherwise, changes in relative dielectric constant of up to 0.2% can, at temperatures above 20 deg C, result in frequency deviations of the order of \( 10^{-6} \) per deg C. Numerical results for various pressures and relative humidity can be calculated with the aid of Fig. 2 using Eq. 3 with \( \Delta \mu = 0 \).

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STANDARDS AND SPECS.

Microfilming Drawings Will Be Required By Military Agencies

In the not too distant future, companies who furnish reproducible copies of engineering data to military agencies will be required to furnish microfilm in an aperture of an EAM tabulating card. In addition, according to R.F. Franciose, in the October-November issue of Standards Engineering, EAM techniques will be used for data retrieval. Mr. Franciose, reporting on the activities of the Department of Defense, stated that with the advent of microfilm, industry in general will need to discipline itself in the preparation of engineering drawings. This is necessary so that the drawings will be suitable for the microfilm requirements under consideration by the proposed DOD unified microfilm spec. For example, the quality of drawings will need to be upgraded. Character heights must be increased to compensate for the highest reduction ratios which will be encountered. Line quality and spacing will need to be given closer attention. Photo-generations of drawings to produce new drawings will need to be kept at a minimum. Preparation of tracings will have to be given closer attention to eliminate retracing by hand when microfilming.

Three sizes of so-called microfilm are being commonly used in industry to record reproductions of engineering drawings: 35mm, 70mm, and 105mm. The military has decided to standardize on 35 and 105mm.

Connectors

Multicontact, molded body, electrical-plug and receptacle connectors are covered by this spec. In this spec the term connector means the connector (plug or receptacle) and its applicable accessories. For airborne applications, connectors covered by this spec are intended for use only for internal connections within the same equipment container. They should not be used for external connection to a container or between containers. A typical type designation for a connector meeting this spec is UMO1R14P92A, MIL-C-38548B, General Specification for Connectors, Plug and Receptacle, Electrical (Molded Body); and Accessories.
Electrical Insulating Materials

This spec covers class L, low dielectric constant (12 or under) ceramic, electrical, insulating materials. The materials covered are intended for use as electrical-insulating elements in components and parts, or as insulators in subassemblies and equipments. This spec establishes minimum requirements for those materials, and grades them according to their performance. MIL-I-10A, Insulating Materials, Electrical, Ceramic, Class L.

National Electric Code

The 1959 edition of the National Electric Code, approved as American Standard CI-1959, includes not only many changes in substance, but also a new numbering system. Because of this new numbering system, an appendix is included providing cross references with the 1958 edition. Sections which have been revised since then are indicated in bold face in this appendix. The code sets up minimum requirements for safety in the use of electricity for light, heat, power, radio signals, etc., primarily in buildings. Copies of the National Electric Code, ASA CI-1959, are available at $1.00 per copy from the American Standards Association, 70 E. 45 St., New York 17, N.Y.

Minimum Performance Standards

A minimum performance standard is that threshold of performance which an electronic equipment must achieve in a prescribed operational environment. A minimum performance standard is limited to threshold performance requirements, not optimum requirements. Threshold requirements are the least restrictive values which will satisfy the operational environment of the equipment. These standards define themselves to performance. They do not include design specs which might limit manufacturers in achieving an end product. Request Paper 149-59/DO-97 and enclose 20 cents per copy for a complete report on Aircraft Electronic Equipment Minimum Performance Standards—Their Purpose and Application. Available from The Radio Technical Commission for Aeronautics, 16th & Constitutional Avenue, N.W., Washington 25, D.C. Also issued by RTCA were three new minimum performance standards. Airborne Weather and Ground Mapping Radar Operating Within the Frequency 5250 to 5440 and 9300 to 9500; price 50 cents. Airborne Doppler Radar Ground Speed and or Drift Angle Measuring Equipment, price 40 cents. Airborne DMET Operating Within Range of 960-1215 MC, price 50 cents.
SCIENTISTS AND ENGINEERS: There are two sides to the STL coin...

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NEW YORK INTERVIEWS FOR MEMBERS OF IRE
For the convenience of those attending the Institute of Radio Engineers meeting, members of STL’s Technical Staff will conduct personal interviews in New York, March 21-24. For an appointment, please telephone Mr. Robert Galbraith at STL’s IRE suite, or send a complete resume to Space Technology Laboratories, Inc., P.O. Box 95004, Los Angeles 45, California

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CIRCLE 900 ON CAREER INQUIRY FORM

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ENGINEER-IMPROVEMENT COURSES AND SEMINARS
Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographic areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

Regional Lectures
Organizing the Engineering Project, AMA, March 9-11, New York

This seminar will be of interest to those who are responsible for initiating projects and evaluating final results. It will focus on: reviewing outside requests for assistance; reviewing alternative courses of action; establishing an order of priority; analyzing the capacity of the engineering department; planning realistic work loads; scheduling the workload; establishing controls; and evaluating performance.

PAPER DEADLINES
Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

March 15: Deadline for 200-400 word abstracts for the 5th Annual Conference on Non-Linear Magnetics and Magnetic Amplifiers scheduled for Oct. 26-28 to be held at the Bellevue-Stratford Hotel, Philadelphia, Pa. Possible topics include: computer magnetics—magnetic memory components, devices and systems; magnetic logic elements and circuits; combined semiconductor and nonlinear magnetic devices; and theory design and application of magnetic amplifiers. Send to: David Katz, Technical Program Chairman, Bell Telephone Laboratories, Whippany, N. J.

March 15: Deadline for 500 word abstracts for the 2nd Annual Bay Areas Reliability Seminar scheduled for May 6-7 in Monterey, Calif. Papers are solicited on the following topics: a theory of error; criteria for selection of policies for reliability; and appraisals of policies for reliability. Send to: L. Fein, 431 Ferne Ave., Palo Alto, Calif.
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Robert DeFloria was a principal engineer at Ford Instrument Division of Sperry Rand Corp. until he became associate editor of ELECTRONIC DESIGN in September 1959. He received his BS in Physics from Fordham in 1949, and has studied engineering at the University of Rochester, Harvard, MIT, and Brooklyn Polytechnic Institute.

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