ELECTRONIC DESIGN

COVER: The modern lines of Los Angeles' New Memorial Sports Arena inspired Art Director Ray Schultz to create this cover design (See photo on p 26). The arena will be the site of WESCON 1960. The four new products, glass ambient diode, p. 98, highly regulated supply, p 102, binistor switch, p 100 and switching meter, p 96, are all described in detail in this issue, and will be on display at WESCON.

Selected Topics in This Issue

Westward, Ho!—To WESCON

Engineers will be making tracks westward to attend WESCON 1960. In this issue, New Products Editor, Leon Tolopko, has given you a bird's-eye view of preview evaluations of new products, that will be on display at the show. A detailed program of technical sessions (See p 28) is given, including a sessions index which will enable you to spot quickly the subject which is of particular interest to you. A detailed coverage of show affairs and events begins on p. 26. As usual we will be on the scene publishing *ELECTRONIC DAILY* and covering each day's happenings at the show. We will be located at Booth 2714-5 and will be glad to discuss your manuscripts or article ideas. If you should miss picking up a copy of *ELECTRONIC DAILY* at your hotel, please drop in and pick up one at the booth. We are looking forward to renewing old acquaintances and making new friends, and will be glad to listen to your comments and criticisms on *ELECTRONIC DESIGN*.

Western Electronics

The electronics industry in the west is expected to reach a total of $2 billion sales this year. "West" in this instance refers to five principal areas: Portland-Seattle, San Francisco-Oakland, Los Angeles-Orange County, San Diego, and Phoenix-Tucson. West Coast Editor, Tom Mount, has covered the industries explosive growth with text, graphs and charts beginning on p 36. The nature of this explosive growth should be of significant interest to those planning to attend WESCON.

RFI

As the number of artificial earth satellites increases, projected plans for exploration beyond the earth's atmosphere may be hampered by natural interference levels encountered. Therefore careful consideration must be given to the problems stemming from radio noise of cosmic origin, the principal source of natural interference to be expected. On p [illegible] James F. Lee presents an interesting article on these problems.

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WESCON 1960

RFI Series

ELECTRONIC DESIGN

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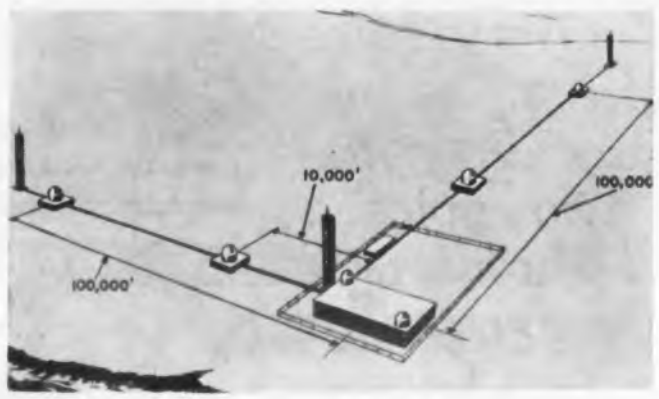
ELECTRONIC DESIGN
NEWS

Plan High Accuracy Trajectory System

Range, Range Difference Measurements To Give Point Missile Positions in Mistram



L-shaped receiving station network planned for missile trajectory measurements over the Atlantic Missile Range. The central station along with either the pair of receiving stations 10,000 feet away or the pair 100,000 feet away provides a point position for a missile. Errors are expected to be small in relation to missile size.

A HIGHLY precise missile trajectory measurement system will be constructed near Cape Canaveral by General Electric Co.'s Defense Systems Dept., Syracuse, N. Y.

An initial $15.5 million Air Force contract has been awarded to GE for design and construction of the system, called Mistram for Missile Trajectory Measurement system. Operational status is scheduled for January, 1962, with total costs estimated by GE at $25 or $26 million.

Measurement errors expected with the new system will be small compared to a missile's size, so that a transponder on the top of the vehicle will be tracked. This order of accuracy exceeds that accomplished by any presently existing or planned trajectory measurement systems, according to GE.

The total system will consist of a central transmitting and receiving station, and four outlying receiving stations arranged in an L-shaped pattern. One pair of receiving stations will be located 10,000 feet from the central station, and the second pair will be 100,000 feet distant.

Mistram is designed to position a missile at the intersection of a hemisphere and two hyperboloids. These surfaces are determined by measurement of transit time of a continuous wave signal between the ground transmitter in the central station and the various receivers. The hemisphere of possible position is provided by the transit time from the central station to the missile and back. The difference in signal transit times between the central station in a pair provide the two hyperboloids of possible position.

The receiving stations located on the 10,000 foot

Interference Key to Space Frequency Controversy

AT&T Requests New Space Frequency Allocations; EIA, Private Users Favor Sharing of 1-10 Kmc Band

Project Echo control panels are handled by W. C. Jakes, Jr., Bell Labs project director, at Holmdel, N. J., site (*ED*, April 13, p. 4), as horn reflector antenna, inset, picks up transmission bounced off an inflated plastic satellite. Active repeater satellites are more likely to be used commercially EIA spokesmen told the FCC during recent hearings. Because of horn reflectors and other techniques to lower noise to the receiver, both ground and space systems might operate compatibly on the same frequencies, the EIA said. AT&T asked that at least 2 kmc be allotted solely for commercial space uses.

FUTURE commercial space system design is bound to be affected by recent requests that the Federal Communications Commission reassign large portions of the 1-10 kmc band for potential space uses (*ED*, June 8, p 4).

American Telephone and Telegraph Corp. asked the FCC at recent hearings to reconsider allocations already made in the 1 to 10 kmc region to include at least four and preferably more 500-mc bands for satellite communications links. The relative costs per channel of satellite versus undersea cable links already are beginning to make space communications attractive, according to AT&T. The techniques for accomplishing these systems are already here or in advanced development.

The Electronic Industries Association and some

(continued on page 10)

Subcontractors for Mistram System

Subcontractor	Subsystem
GE Heavy Military Electronics Div.	Precision Measuring
Lenkurt Electric Co., Inc.	Data Transmission/ Recording
Electronic Associates, Inc.	Analog Computer
GE Communications Products Dept.	Rf Communication Link
Milgo Electronics Corp.	Data Multiplex
GE Light Military Electronics Div.	Airborne Transponders
General Bronze Corp.	Transponder Test Set
	Acquisition and Tracking

baselines will be used initially for missile positioning, with the 100,000 foot baselines used for redundant data. Theoretically the longer baseline receivers should give more precise missile positions, but since baselines of this length have not been attempted before the accuracy that can be attained is not yet firmly established.

This technique provides direct measurement of range, azimuth, and elevation angle. Velocity will be obtained from doppler shift data.

Frequency modulation will be used to determine the number of cycles which occur between transmission of a carrier and return of the missile transponder carrier to the ground receivers. The phase difference between the transmitted and received signals is measured by interferometer techniques to determine a fraction of the last cycle being counted. The ultimate accuracy of the system depends on the precision of this phase measurement.

Two techniques are credited with the accuracy GE expects to get with the new system. One of these is the use of a high modulation frequency. The central station on the ground will continuously transmit two carrier frequencies—one at 8,148 mc and the other at 7,792 mc—so that when they are beat together a 256 mc intermediate frequency is obtained. The 7,792-mc signal is swept down 8 mc to 7,784 mc over a 1.5-sec interval.

The transponder in the missile is synchronized and phase-locked to the ground transmitter. It returns signals continuously offset by 68 mc from the ground transmitter frequencies. Thus the transponder smoothly follows the frequency sweep.

The transit time between the ground station and the missile causes the frequency sweep received from the transponder to be offset—usually by a few milliseconds—from the ground transmitter sweep. Matching of the transmitter and transponder sweeps permits the determination of the number of cycles which have elapsed in the ground transmitter during the signal transit time. An 8 mc sweep back up to the 256 mc if is used so that phase-lock is not lost although no measurement depend on this return sweep.

NEWS

Mistram

(continued from page 5)

Use of a high modulating frequency means that only a small portion of the range measurement is provided by the difficult phase measurement on the last cycle.

The second important feature of the GE system is the development of equipment to provide an electrical baseline for use in making interferometer measurements.

In past systems of this type it has been difficult to get an accurate measurement of transit time differences between two receiving stations. Propagation anomalies in the atmosphere introduce a spurious phase shift into a signal which is sent from one station to another for phase comparison. Since these anomalies vary with temperature, pressure, and other conditions it is difficult to make proper corrections for them. In the past temperature controlled waveguide has been used for this interstation transmission, with precalculated corrections made for propagation anomalies. Small variations in the length of this path, caused by equipment expansion with temperature, shifting of the ground, or other factors sometimes caused serious errors.

In the planned GE system the phase shift error introduced by propagation anomalies will actually be electrically determined at the time of interstation transmission. A phase stabilization technique developed by Dr. Lewis J. Neelands, specialist, systems development engineering in GE's Defense Systems Dept., is credited with making this electrical baseline feasible.

The possibility of such an electrical correction has been known theoretically for some time, according to Dr. Neelands, however it has been difficult to instrument the theory. According to this theory if two signals of different phase, cos $(\omega t + \alpha)$ and cos $(\omega t + \beta)$ for example, are received at separate stations and it is desired to measure the phase difference between them, $\alpha - \beta$, then each of the signals can be transmitted to the opposite station. Since both signals travel over the same path the propagation anomalies introduce a phase shift Δ into each of them. At one of the stations the phase angle difference between cos $(\omega t + \alpha)$ and cos $(\omega t + \beta + \Delta)$ is $(\alpha - \beta - \Delta)$. At the other station the phase difference between cos $(\omega t + \beta)$ and cos $(\omega t + \alpha + \Delta)$ is $(\beta - \alpha - \Delta)$.

Since these measurements give discrete values they can be subtracted and divided by two:

$$(\alpha - \beta - \Delta) - (\beta - \alpha - \Delta)/2 = (\alpha - \beta).$$

A variation on this technique for cancelling the Δ factor will be used in the GE system, according to Dr. Neelands. The signal received at the central station will be sent out to each outlying re-

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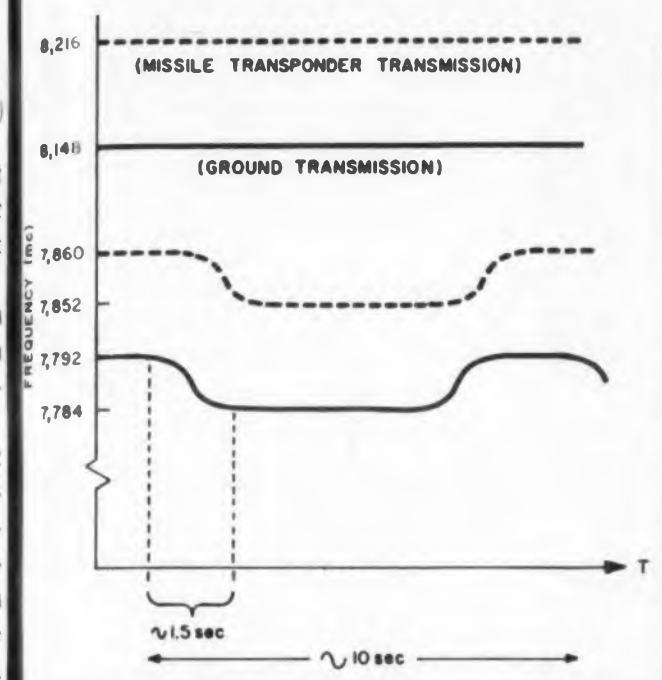


Ground transmitter frequencies are returned by a transponder on the missile with a continuous 68-mc offset. Beating the high and low carriers together gives a 256 mc if which is swept down to 264 mc over a 1.5-sec interval. The sweep returned from the missile is offset in time from the ground transmitter frequency sweep by a few milliseconds—corresponding to the signal transit time. No measurements are made on the 8 mc upsweep, used to maintain phase-lock throughout the system.

ceiving station and back again, with all computation done at the central station. This permits all phase measurements and other calculations required to be performed at the central station, so that only receivers must be located at outlying points. To minimize propagation effects some form of waveguide will still be used for the 10,000 foot baseline, Dr. Neelands explained. An air link is planned for the 100,000 foot baseline.

Since no angular measurements are involved in Mistram high precision tracking antennas will not be required. Standard radar tracking antennas will be sufficient to get accurate range and range difference measurements. An auxiliary tracking antenna will be used to guide the central and outlying stations to the proper position for missile tracking.

The system will be designed to provide coverage for 1,000 miles at velocities of 50,000 ft/sec and accelerations up to 750 ft/sec^2.

Range of the system is essentially limited to missile transponder power, according to Dr. Neelands, so that space tracking uses are feasible with minor additions to the equipment.

Accuracy of positioning of the receiving stations is critical in accuracy of the system. The Coast and Geodetic Survey expects to attain accuracies of 1/4 in. in surveying for the 10,000 foot baseline receivers, according to a GE spokesman. Shift of the ground under receiver locations may prove a source of some error. The inherently greater accuracy of a longer baseline system is expected to minimize this source of error. ■ ■

Photoelectric Oscilloscope Tracer Developed

A PHOTOELECTRIC device to follow a trace on an oscilloscope face, providing signals suitable for operating a recorder, has been developed by Elcon Laboratory, Inc., Cambridge, Mass.

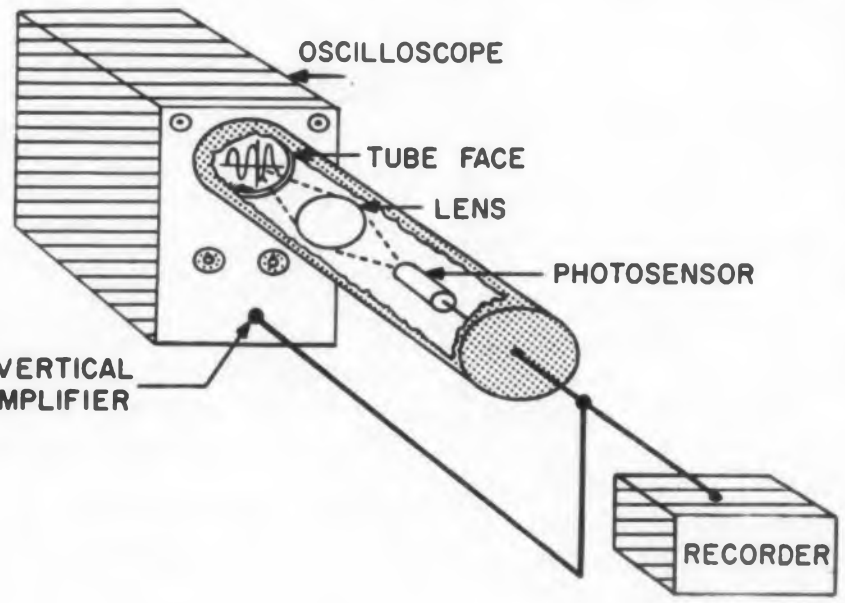
The device, known as a Scopograph, is expected to find applications where photography is now used to record signals at too high a frequency to be traced by a recorder. Since Elcon is a research organization without manufacturing facilities, production of the Scopograph will not begin until licensing or other arrangements have been completed, according to Dr. Edwin Langberg, president.

The Scopograph is a small electronic package which can be fitted over the face of an oscilloscope, sealing out ambient light. A photodetector is directed at the center of the scope face. This detector is designed so that it can sense whether the trace on the CRT face is above or below the center point.

In operation a trace to be recorded is first synchronized on the scope face, and then the Scopograph is fitted over the face and a plug-in connection is made to the oscilloscope.

A small ramp bias voltage is summed with the horizontal sweep voltage, so that the trace moves slowly across the scope face. The speed of motion can be synchronized with paper or tape recorder speed if desired.

A slowly varying dc bias voltage is added to the vertical amplifier to continuously position the trace at the center point of the oscilloscope



Artist's representation of an operating Scopograph shows how error signals generated by the photodetector bids the vertical amplifier of the oscilloscope, continuously moving the trace to the centerpoint of the scope face. The bias signals required, proportional to the amplitude of the trace, drive the recorder. Not shown is a small ramp summed with the sweep voltage so the trace moves slowly across the scope face.

face. This bias voltage is supplied by the photosensor as an error signal with polarity depending on whether the trace starts to move above or below the center point.

The magnitude of the photodetector signal thus provides a continuous measurement of the amplitude of the oscilloscope trace.

When sharp rises in a curve must be measured, the horizontal sweep bias can be reduced to slow up horizontal motion and provide more accurate amplitude measurements.

Electromechanical System for Transients

An electromechanical model of the Scopograph has been designed for use with either repetitive or transient signals.

Storage on the tube face is required for this system. A high persistence crt is sufficient for simple waveforms but complex waves require a storage tube.

The photodetector in this second model is carried by a moving carriage. As the carriage moves horizontally across the face of the tube the photodetector moves vertically to follow the trace.

The carriage can be linked directly to an ink tracer, or potentiometers can generate signals proportional to trace amplitude. Output signals might be fed to a digital encoder to feed magnetic or punched tape or punched cards.

Another system providing direct digital output for use in a computer is also being developed by Elcon, according to Dr. Langberg.

This system will be capable of following photographs or other visual presentations as well as oscilloscope traces, providing a direct digital output. It should be capable of supplying x vs y values for about 100 data points per sec, and should be useful for transients of very short duration.

Similar experiments with short set-up times will probably be the major application for this latter system. Analyzing bubble or cloud chamber data, or nuclear reaction information, are some possible uses, Dr. Langberg feels. ■ ■

CIRCLE 9 ON READER-SERVICE CARD

Space *(continued from page 4)*

private microwave user groups opposed the reallocation request. The present allocations in the 1 to 10 kmc region already give 1.77 kmc to common carrier and operational fixed services, they said. Where is the additional 2 or more kmc now requested by the telephone companies going to come from, queried Samuel G. Lutz, senior staff scientist, Hughes Aircraft Co. Research Laboratories.

The answer, according to Mr. Lutz and several other industry speakers, will have to be sharing of frequency between ground and space users.

Mr. Lutz and others presented many possible engineering considerations which could permit such interference-free sharing to be accomplished. He recommended that stationary active satellites be chosen for communication and TV links.

Possible interference with the satellite receiver by horizontal transmission on the ground would only be a problem around a narrow band of the earth, and if care was taken interference could be avoided. Fewer earth terminals and satellites would be required with this system in comparison to random low-orbit active repeater satellites, and continuous service would be assured.

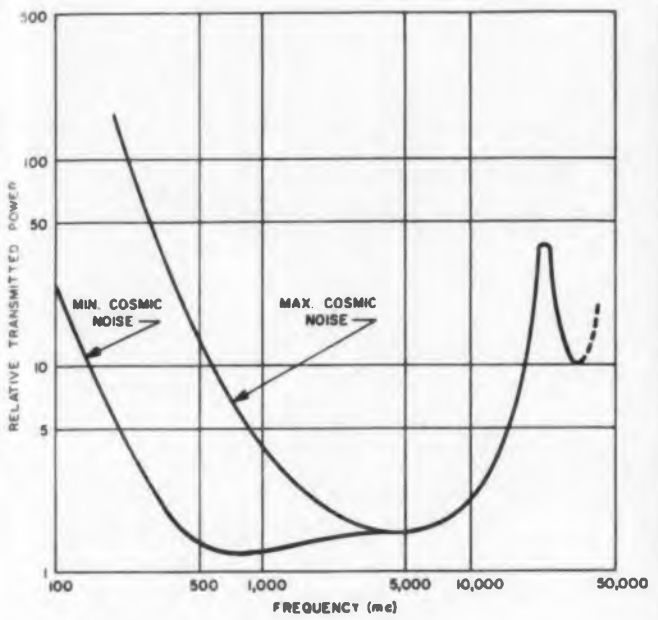
Recommends Isolated Station Sites

Another consideration pointed out by William L. Firestone, director of engineering, Communications Div., Motorola, Inc., is that isolated sites rather than near-city locations would probably be best for non-interference reasons. A passing airplane, for example, might cut off or disturb communications much as TV reception is presently affected by aircraft.

The interference problem which does exist was illustrated by a Project Echo incident related by John R. Pierce, director of research, communications principles for Bell Telephone Laboratories.

Nine receivers of the New Jersey Turnpike Authority operate in the 953-960 mc band, with a receiver at New Brunswick, 15 miles from the Crawford Hill Project Echo site, operating at 959.7 mc with nominal 0.5-mc band. The Echo transmitter operates at 960.05 mc, which theoretically should have been compatible. If more than 3 kw was transmitted in any direction, however, the New Brunswick receiver was knocked out.

To cooperate with the Echo work, the Turnpike operators switched the New Brunswick transmitter and two others in the area down to 953 mc. Then it was found that interference at New Brunswick could be considered negligible.

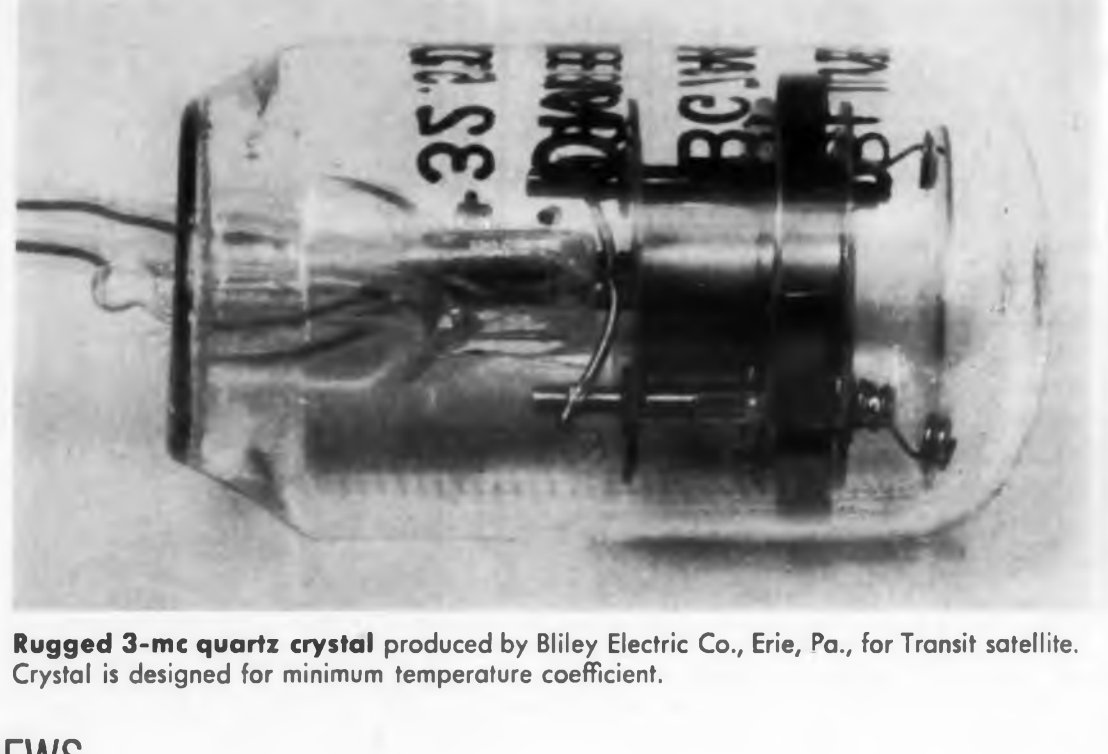


Plot of relative radiated power of a transmitter in space required to produce a received signal having a fixed proportion to thermal ground-receiver noise. A no-noise receiver is assumed with a fixed-area antenna looking 10 deg above the horizon. A window of frequencies between about 500 and 20,000 mc, is apparent. The lower end is limited by cosmic noise, and the higher end by atmospheric attenuation. Power requirements are absolute, so that even new developments can not extend the window very much because of the steep slopes at each end.

The EIA cited this example as an indication of how interference problems could be worked out in the future. Common carrier spokesmen, however, indicated that with the expected growth of overseas use of telephone, TV, data, and other transmission, the interference problems would become too severe.

Even more specific in its demands for new allocations, Radio Corp. of America and RCA Communications, Inc. asked for four 50-mc bands between 1,000-2,300 mc; four 100-mc bands between 2,300-3,500 mc; four 200-mc bands between 3,500-6,575 mc; and four 300-mc bands between 6,575-10,000 mc, just for record communications usage. Other specific channels should be allocated for point-to-point TV transmission, RCA said.

Because of heavy assignments already made to the government and such important services as radio navigational aids in the 1-10 kmc region, the FCC faces thorny problems in attempting reallocation. The technical complications of the filings with the Commission further complicate the decision. Because of the important public considerations, however, a decision will probably be reached soon according to an FCC spokesman. ■ ■



Rugged 3-mc quartz crystal produced by Bliley Electric Co., Erie, Pa., for Transit satellite. Crystal is designed for minimum temperature coefficient.

NEWS

Shipboard Success Speeds Transit Project

PRECISION navigation results currently being obtained from the orbiting Transit II-A satellite aboard a Navy experimental ship are speeding the Transit system toward operational status.

The planned doppler navigation system, set for 1962, will consist of four satellites. Design aim for the system is 1/10-mile accuracy, considered necessary for precision positioning of Polaris-firing submarines. This accuracy will require a full computer system on shipboard, consisting of a dual frequency receiver, a mixer which can apply ionospheric refractive corrections, a digitizer and a computer.

Regular Navy vessels will probably use a simpler version of this system, which takes into account first order errors, but skips corrections for second or higher order errors. The electronics required for this system would be comparable in complexity to a home TV receiver, according to a system designer at Johns Hopkins University's Applied Research Laboratory, Baltimore. ARL is designing the system for the Navy.

This shipboard installation might consist of a dual frequency receiver and a mixer which applies an ionospheric refraction correction, along with some form of readout. Navy sources indicate that the exact configuration of this simpler navigation system is still being debated. The navigator would calculate his position from equipment data using a Weems-type circular calculator or some other manual technique.

A key point in achieving acccuracy with either system is the ionospheric refraction correction. Some estimates of the effect of this error on doppler measurements place navigational inaccuracies at tens of miles. Corrections planned for this effect are based on the assumption that doppler shift ionospheric refraction errors are dependent on the inverse square, and higher powers, of the frequency.

Confirmation of this theory is being provided by the present Transit II-A, which is transmitting at four frequencies – 54, 162, 216, and 324 for doppler measurements. Pulse width modulation telemetry is being provided on a separate 108 mc carrier.

Design of stable oscillator circuits is a major requirement in this experiment,

This Dewar flask is used to maintain a stable temperature for the stable oscillators in the Transit program. The quartz crystal is mounted in the flask, and the oscillator circuitry is mounted on a circular plastic board fitted inside the top of the flask.

as it will be in the operational system. Thermal stability is the key to packaging of the 3-mc AT cut quartz crystals and the oscillator circuitry in double Dewer flakes (*ED*, April 27, p 14).

Requirements set up for the stable oscillator designed for Transit were short term stability of 1 part in 10^8 for any 30-min period during the life of the satellite, and long term stability of 25 parts in 16^6 for three months. Tests indicated that the circuits designed considerably exceeded these goals under the most extreme environments expected.

A Colpitts-type circuit using a transistor has been used. The crystal is operated in a fundamental mode at series resonance in the feedback loop between the emitter and the tank circuit. Low phase slope of the transistor at 3 mc contributes to the frequency stability.

A silicon diode is used across the tank circuit to limit crystal drive level and thereby help stabilize the frequency against power supply fluctations. Base voltage is held constant by a two-stage avalanche diode regulator.

The oscillator is isolated from the following stages by a resistor. A common emitter amplifier following the buffer resistor raises the output voltage to a usable level. Gain control is provided by a variable emitter degeneration resistor. Drive level at the input to frequency multipliers is kept constant by an emitter follower output stage.

Two frequency multipliers apply doublers and tripplers to the 3-mc stable oscillator outputs to provide the proper frequencies to two power amplifiers. Multiplier circuitry is mounted on a plastic board which is potted in plastic foam for vibration resistance. ■ ■

Optical Maser Research Programs Nearing Success

Development Speeded on Crystal, Gas and Semiconductor Types; Hughes Laser Announcement Stirs Industry, Triggers Controversy

Manfred W. Meisels
Assistant Editor

AFTER long and patient laboratory development, optical and infrared masers may soon evolve to the point of useful application in system and equipment design. An indication of things to come is the recent Hughes Laboratories' announcement of a successful ruby laser. Spurred by this news, many organizations are stepping up the pace of their work in this field. Other groups are dusting off old plans and planning an active role in laser and iraser development.

Industry and government planners are meanwhile establishing design requirements for space communications, light radar and weapons systems predicated on the successful development of lasers and irasers. Such applications are suggested by the highly coherent and extremely narrow, intense beams to be radiated by these devices.

Crystalline solids, gases, and semiconductors in almost bewildering variety are being investigated for application in lasers and irasers. Oscillators and amplifiers at power levels ranging from milliwatts to thousands of watts are in the works and each class of material will undoubtedly find its proper niche in this array of devices.

Principal Laser and Iraser Research Programs

Organization	Maser Type	Frequency Generated	Maser Characteristics
Hughes Research Laboratories, Malibu, Calif.	Ruby: Pumped by pulsed mercury arc. Output due to energy decay from R level to ground level.	Red (6,943A)	Inherently high output power. Output band width and coherence require considerable improvement. Interferometer resonator being designed to eliminate unwanted oscillation modes. Traveling-wave type considered feasible. Operates at room temperature, but much narrower band widths possible at liquid nitrogen temperature. CW operation difficult.
*Technical Research Group, Syosset, N.Y.	Ruby: Pumped by continuous mercury arc. Output due to energy decay to satellite level.	Red (7,009A)	Operates at cryogenic temperatures. Considerably lower power output than Hughes laser. CW operation believed possible.
	Krypton-mercury vapor: Pumped by self discharge.	Infrared (6 microns)	Intermediate power output (several watts). CW operation possible.
	Cesium vapor: Pumped by continuous helium arc.	Infrared (7 microns)	Low power output (milliwatts). Alkali vapors attack maser cell. CW operation possible.
Bell Telephone Laboratories, Murray Hill, N.J.	Ruby: Pumped by continuous mercury arc. Output due to energy decay to satellite level.	Red (7,009A)	Operates at cryogenic temperatures. Considerably lower power output than Hughes laser. CW operation believed possible.
	Helium-neon mixture: Pumped by self discharge.	Infrared (1 micron)	Energy transfer from helium to neon by collisions. CW operation possible.
*Columbia University, New York City.	Cesium vapor: Pumped by continuous helium arc.	Infrared (7 microns)	Low power output (milliwatts). Alkali vapors attack maser cell. CW operation possible.
	Potassium vapor: Pumped by continuous mercury arc.	Infrared (3.14 microns)	Characteristics and problems similar to those of cesium vapor iraser.
American Optical Co., Southbridge, Mass.	Helium-neon mixture in hollow glass filaments: Pumped by self discharge.	Infrared (1 micron)	Filaments act as mode selectors to reduce incoherent oscillations. Many filaments can be paralleled to increase power output. Feasibility study now in progress.
	Inert gases in hollow glass filaments: Mercury arc pumping.	Infrared	Above comments on helium-neon filament iraser apply here.
R.C.A. (David Sarnoff Research Center), Princeton, N.J.	Ruby: Output due to energy decay to ground level.	Red (6,943A)	Device would be similar to Hughes laser. Feasibility study now in progress. Development proposal submitted to Air Force.
General Electric Co. (Electronic Laboratories), Syracuse, N.Y.	Ruby: Xenon arc pumping: Output due to energy decay between R levels.	Far Infrared	Operates at cryogenic temperatures. Feasibility study now in progress.
Varian Associates, Palo Alto, Calif.	Ruby: Pumped by pulsed mercury arc. Output due to energy decay from R levels to ground level.	Red (6,943A)	Comments on Hughes loser apply here.
*M.I.T. (Lincoln Laboratories), Lexington, Mass.	Thin germanium sheet sandwiches: Pumped by mercury arc. Output due to energy decay to deep valence level in germanium.	Infrared (10 microns)	Operates at cryogenic temperatures and in intense magnetic field. Coherent operation results from cyclotronic resonance principle. CW operation believed possible. Believed tuneable over two octaves from infrared to millimeter range.
*I.T.T. Laboratories, Nutley, N.J.	Silicon-indium antimonide Junction: Non-optical pumping method employed.	Infrared	Coherent operation results from spin resonance principle. CW operation believed possible.
	Cesium vapor: Pumped by continuous helium arc.	Infrared (7 microns)	Previous comments on cesium vapor irasers apply here.

*Research in lasers and irasers supported by Air Force

Wide Variety of Optical Masers Predicted

"I foresee a complete family of optical and infrared masers, each designed for a particular application, power level and frequency," is the prediction of Dr. Arthur L. Schawlow of the Bell Telephone Laboratories who, together with Dr. Charles H. Townes of Columbia University, first suggested the development of optical masers.

The use of ruby in a laser, proposed by Dr. Schawlow and others has been demonstrated by Dr. Theodore H. Maiman of the Hughes Research Laboratories, Malibu, Calif., but in a manner unlike that envisioned by most scientists. The Schawlow proposal suggested the use of the so-called "satellite" line in ruby. In this approach, chromium ions in the ruby crystal are pumped to a higher energy level by optical excitation. They

Other Maser Types Under Study
Solids other than ruby under study but not disclosed.
Solid chlorides doped with rare earths also being studied.
Lanthanum chloride crystals doped with samarium or europium. Other rare earth chlorides. Other gases, mixtures and vapors.
None reported.
Crystals capable of being grown in micron-size filaments. Ruby not feasible as minimum possible diam. is 200 microns.
Various gases and alkali vapors reportedly under study.
Alkali halide crystals under study. Gases, vapors and mixtures also being investigated.
None reported.
None reported.
None reported.

NEWS

Laser operation is described by Dr. Theodore H. Maiman at the New York announcement of the Hughes Laboratories device. Chart illustrates coherent oscillation of chromium ions in a fluorescent ruby crystal achievable by placing crystal in an interferometer.

then emit 7009 A red light by dropping into a lower energy level normally empty at liquid helium temperatures. Pumping power is reasonably

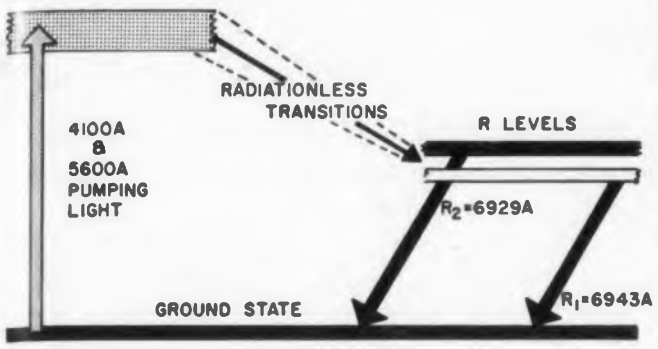
Systems Designers Preparing to Use Lasers in Space Radio and Weapons

Serious consideration is already being given to the design of weapons and communications systems employing optical and infrared masers. When these devices finally emerge from the laboratory, hardware design for their utilization will likely be weil along.

Technical Research Group, for one, is performing in-house and government-supported studies on "High-energy radiation weapons" employing lasers.

According to TRG president Lawrence Goldmuntz, two proposals submitted along these lines have been "well received" by Defense Dept. officials. An intense, high energy light beam could conceivably be employed as an anti-ICBM weapon. Government efforts to classify company-supported laser work and the security restrictions applied to government-sponsored work in this field indicate serious military consideration of "death rays."

In communications, General Electric (Ithaca) is studying design requirements and performance of tight-beam space communications systems on a theoretical level. A 1-mw cw laser system would have a range of 61,000 nautical miles, according to GE studies. This is based on a 2-cm diam beam, receiver sensitivity of 10^{-12}w, and signal to noise ratio of 4 to 1 at the receiver. Laser amplifiers designed on paper do not, however, meet the sensitivity requirement, and GE believes that photomultipliers may have to be used at the receiving end of the system.



Energy levels involved in the natural red fluorescence of ruby. Pumping light excites chromium ions to higher energy bands as shown for 5600 A (green) and 4100 A (blue) light. Ions then pass from both bands to R levels via radiationless transitions, and return to ground level by emitting 6929 A and 6943 A red light. By brute force optical pumping of the ruby with a 10 megawatt mercury lamp, Dr. Maiman claims to have inverted the normal chromium ion population between the R and ground levels thereby inducing stimulated rather than natural fluorescence of the ruby.

low as the level into which the chromium ions drop is not densely populated. Bell Laboratories and Technical Research Group, Syosset, N. Y., are among those attempting to develop a laser utilizing this principle.

Hughes Laser Requires Intense Pumping

Dr. Maiman, however, obtained laser action by employing the "main" fluorescence line of ruby, where chromium ions radiate 6929 A and 6943 A red light by dropping from a higher energy state directly to the ground energy level. This is considerably more difficult, as the ground level must first be depopulated by highly intense optical pumping. The present Hughes device is limited to pulsed operation at about 60 sec. intervals primarily because of the intense heat generated by the discharge lamp used for pumping. During the one msec/operating interval, however, output is 10 kw.

Present operation is at room temperature and coherence is rather poor; operation at liquid nitrogen temperatures should improve coherence by a factor of about 25, and a further improvement of several orders of magnitude will be obtained by mounting the ruby in an interferometer resonator of appropriate design.

Ruby Iraser Believed Possible

Another approach to the use of ruby is being developed by Dr. Gunter Wessel at the General Electric Electronics Laboratory in Syracuse. Dr. Wessel hopes to generate infrared radiation through chromium ion transitions from the $2\bar{A}$ to the $2\bar{E}$ energy levels. These are the levels from which energy transitions to the ground level generate red light in the Hughes laser. Dr. Wessel calculates that energy transition between these levels will emit far infrared radiation. Operation at liquid helium temperatures is required.

(continued on page 18)

CIRCLE 16 ON READER-SERVICE CARD

NEWS

Gas devices, while of inherently lower power than solids, are reportedly close to development by a number of research groups.

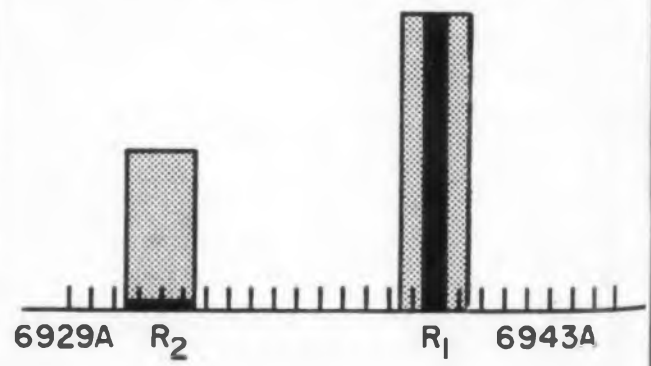
Cesium vapor experiments are in progress at Columbia University, ITT Laboratories, TRG, Martin-Denver, Laboratory for Electronics, Boston, and American Optical Co. Pumping is by a helium lamp, whose spectrum contains a 3888 A line capable of exciting cesium atoms to a higher energy level. The decay of these atoms to a lower level emits 7-micron infrared radiation. A similar scheme using potassium vapor excited by a mer-

"If he has what he thinks he has, he most certainly has a laser,"

. . . is the comment of a pioneer in maser development to Dr. Maiman's claim of a successful laser. All workers in the field agree that Dr. Maiman has performed a remarkable experiment —one that many of them had not even considered possible, but there is some controversy as to whether the success of this experiment warrants the announcement of an operating device.

Through the development of an extremely high-intensity light source (10 megawatts), Dr. Maiman was able to invert the chromium ion population in ruby between the ground and metastable R levels. As a result, he has reduced the time of fluorescence from its natural exponential decay curve to a sharp pulse. Also, the natural fluorescence, instead of being distributed within two bands, is concentrated into one comparatively narrow band covering only 1 A.

Scientists object that the band width must be further narrowed by several orders of magnitude before the Hughes device can be considered as a truly coherent light source. This involves the de-



High intensity optical pumping of ruby results in concentrated fluorescence at 6943 A (black bars). Dotted areas show natural fluorescence spectrum of ruby.

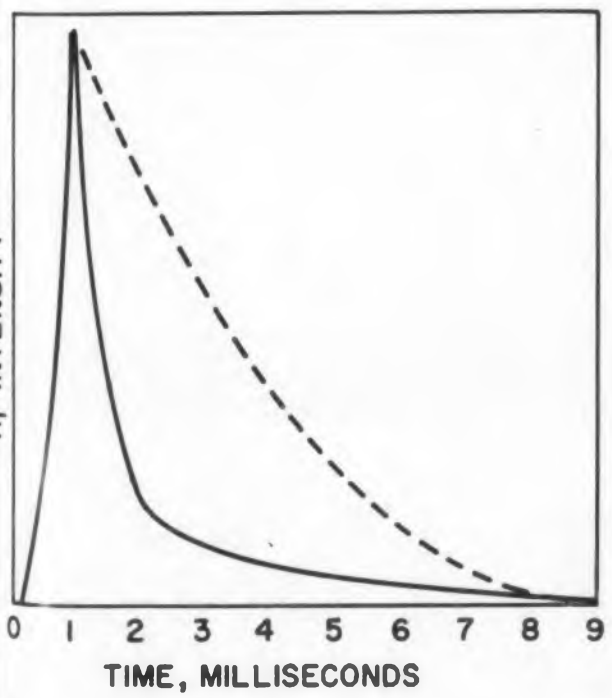
cury arc and emitting 3-micron radiation is also in development at Columbia. Both methods suffer from the corrosive effect of the alkali gases upon their containers.

Gas irasers can also be pumped by self discharge which is more efficient than external pumping. A gaseous mixture is employed. One gas provides the discharge path and the other operates as the iraser. Examples include a krypton-mercury device at TRG and a helium-neon unit at Bell Laboratories. In the Bell iraser, collisions between the helium and neon atoms provide the mechanism by which the neon atoms are excited to a suitable state.

At the American Optical Co., Southbridge,

sign of a suitable interferometer cavity which will reject non-coherent modes of oscillation. Dr. Maiman is now working on this problem and is confident of early success. Others point out however, that the interferometer mirrors must be plane and parallel to less than a wave length of light and that optical inhomogenieties in the ruby present another difficult probiem.

In one method to be tried at Hughes, the ruby will be immersed in a liquid of high refractive index. This will reduce internal reflections in the ruby which propagate some of the non-coherent modes and cool the laser so as to permit continuous operation and minimize thermally-induced distortion of the interferometer mirrors. Dr. Maiman also suggests that other approaches to obtaining coherent operation are being studied, but is reluctant to describe them at this time.



Natural fluorescence time in ruby is reduced from exponential decay curve to sharp peak.

Hughes laser shown without housing consists of ruby cylinder surrounded by high intensity mercury discharge lamp. Interferometer necessary for operation can be achieved by mirroring ends of the cylinder or by mirroring the end plates of the laser housing.

Mass., Dr. Elias Snitzer is studying gas irasers consisting of extremely thin optical waveguides. A hollow, 4-micron thin glass filament coated with several microns of higher index of refraction glass is used. This may prove to be a more efficient mode selector than the larger cylinders used elsewhere. Self discharge pumped and externally pumped types are both in development. Solid filaments are also a possibility. Ruby crystals of the required fineness cannot be grown, but other materials may prove useable.

Two Approaches to a Semiconductor Iraser

Semiconductors are also in the running for iraser materials. At the Lincoln Laboratories, Lexington, Mass., Dr. Benjamin Lax is experimenting with thin germanium sheet sandwiches, separated by dielectric layers which combine to form an interferometer. Electrons in the germanium are pumped by a mercury arc from a deep valence band to the normal conducting band. Electrons drop from an intermediate energy level into the deep valence band emitting infrared radiation in the process. The device requires cryogenic temperatures and an extremely intense magnetic field. Germanium sheets 1 cm square and 10 microns thick would be stacked in a 10-layer sandwich.

At ITT laboratories, an iraser employing silicon-indium antimonide junctions is reportedly in advanced development. The device does not employ optical pumping and will operate cw at relatively low power. ■ ■

School Audio-Visual Methods Under Study by SMPTE

Plans for a conference devoted to the evaluation and suitability of audio-visual equipment and devices for educational needs are under way.

A $24,000 contract, awarded to the Society of Motion Picture and Television Engineers by the U. S. Office of Education, will also cover the formulation of engineering principles that will serve as guideposts in the development of audio-visual devices for use in education.

The two-year study contract, granted under the National Defense Education Act of 1958, will allow for the latest advances in engineering techniques to be made available immediately to both the designers and the users of educational communications media and equipment.

The group will include educators thoroughly familiar with the problems of methods, materials, media, curricula, building facilities, teacher training, and administration. Engineers having the required competency and engineering background to make evaluations and significant recommendations will also participate. They will cover such areas as motion pictures, TV, filmstrips, slides and transparencies, recordings, teaching devices and machines, graphics, and textbook publishing.

The study will be conducted under the direction of John Flory of Eastman Kodak Co. of Rochester, N. Y.

Rocket-Relay Transmission System Being Developed by Air Force

Project Tattle-Tale, an Air Force program to develop an emergency long-range communications system based on rocket-relayed transmissions, is proceeding with limited success at Wright Air Development Div., Dayton, Ohio, and at Eglin AFB, Fla.

In its initial form, the system makes use of an Aerobee-300 rocket to carry aloft a transmitter and a tape deck that contains a prerecorded message. The 100-w transmitter, which operates in one of the regular Air Force uhf telemetry bands, transmits the message over a line-of-sight path for the duration of the rocket's flight, about 800 sec, according to the Air Research and Development Command.

Eventually, the ARDC designers hope to install a receiver in the rocket so that true relay operation would be possible.

Experimental shoots have established that the rocket-borne equipment has to be modified to withstand higher-than-expected temperatures. The equipment is also being redesigned to resist the high-g stresses of the 800-sec flights. So far the system has not been made to work.

WASHINGTON REPORT

Ephraim Kahn

ELECTRONICS RELIABILITY requires "radical improvements" for military adequacy, reports a joint industry-military study group that has been working on improving reliability checks. The advisers suggest that development of electronic parts specifications be centralized, that new levels of parts failure rates be set, and that all specifications be brought up to design demand for current uses. Reliability should be monitored during production, though tests would be made by the manufacturers themselves "under the surveillance of the appropriate government inspection service." In order to minimize the test load in establishing failure rates, the number of types and styles of standard reliable parts would be reduced "to a considerably greater degree than is currently true of military standards."

PAYOFFS FROM BASIC RESEARCH for the Air Force have been handsome, states Brig. Gen. B. G. Holzman, chief of its Research Division. Indications are that practical applications will be many; Gen. Holzman thinks that "there is no conceivable discovery of natural law that would not be of interest to the Air Force." Work is going on, for example, on a new concept in computers which may lead "not only to really practical computers but also to such distinctly Air Force purposes as new, automatic guidance and control systems for missiles and spacecraft." The Air Force will support research projects which hold promise of a payoff. "In many cases the decision as to whether a given project is basic or applied research is an arbitrary one," says Gen. Holzman, observing that it is best policy "not to worry about a line which is so indistinct."

COMPETING BIDS BY AFFILIATES will be allowed on government contracts in certain circumstances. The General Accounting Office has dropped its long-standing ban on such submissions, which in the past has been carried to the extreme of denying an award to a low bidder simply because another bid was made by a related firm. Taking into account the proliferation of affiliated companies, the Accounting Office observes that each may well be answering a separate invitation, and that the two may well be unaware of each others participation. From now on, contracting officers are supposed to turn down such bids automatically only if there is reason to think, "it was resorted to for the purpose of circumventing the requirements of a statute . . .; where an unfair advantage may be gained in cases of an award through the drawing of lots; or in any other instance where multiple bidding is prejudicial either to the United States or to other bidders."

OCEANOGRAPHIC RESEARCH should be stepped up four-fold, states the House Committee on Science and Astronautics. Taking issue with the Navy's performance in this field, the group asserted that "the Navy, until recently, has not pursued a broad program in oceanography, despite its relevance to the Navy's antisubmarine mission, and this has been true even though the Navy now is the largest single supporter of such research. To remove the disparity between the current level of effort and the needs for national security, federal management of an oceanographic program is necessary. This should include identification of goals, budgeting of funds for a balanced research program embracing both military and peaceful studies; and carrying out the program "by both in-house and contract research."

BESETTING PROBLEMS IN R&D for the military deal with needless "layers of decision making" and the large number of reviews given to each project and proposal, according to Dr. Herbert F. York, Director of Defense Research and Engineering. His comments, made after a private 3-day meeting of the Defense Department's R&D managers, indicated that "a climate for progress" was created, though the problems themselves were not solved.

DESIGN STANDARDS and requirements levels for the weapons checkout systems that may be in use as much as 15 years in the future are being studied under Air Research and Development Command contracts. By and large, the studies will cover the electronic (and other) devices which tell whether an aircraft or missile is ready to fly, with all components functioning. One objective of the studies will be to come up with design data that can be used to help standardize and integrate systems components in the interests of efficiency and economy.

PATENT POLICIES of the Treasury Department have been sharply scored by the Senate Subcommittee on Patents, Trademarks and Copyrights. The group's chairman, retiring Sen. Joseph C. O'Mahoney (D., Wyo.), says its inquiries clearly illustrate "the need for legislative standards to cover all research and development expenditures." As the Subcommittee sees it, "when an agency's patent policy is not controlled by legislative standards it may even expend government tax monies for research and development without retaining proprietary rights for the government. Such contractual action grants to the favored contractor all inventions developed as a result of the contract. This gives him a legal monopoly controlling use of the inventions in the commercial market and a claim against the government if they are used for governmental purposes."

NAVAL AVIONICS FACILITY at Indianapolis should be retained as an active unit, according to an advisory group of businessmen who checked seven Navy weapons plants. It urged that three be dropped or consolidated. The Avionics Facility drew approval as the Navy's only wholly-owned plant for high-precision avionic equipment. In addition, its foreseeable workload will enable it to be operated on an economic basis.

NEWS

Solderless Connectors Specified In Many Devices at Huntsville

Solderless connection methods, including crimp-type, poke-home, tapered, and other compression connectors are being specified in an increasingly larger share of ground-support and airborne equipment being designed at the Marshall Space Flight Center, Huntsville, Ala.

Relay sockets and pygmy connectors employed in Saturn ground-support equipment are almost entirely wired in with crimp-type connectors. Huntsville engineers are meanwhile stepping up a recently instituted test program to extend the use of solderless connectors to a larger share of the NASA ground and flight equipment being designed at the space center.

The technical groups headed by Dr. Wernher von Braun were accustomed to working with the soldered connections primarily used in German industry. Since being introduced to solderless connectors they have subjected them to a rigorous series of tests including vibration, pull-out humidity and corrosion, as well as cost analyses and time studies. Results have been favorable and specifications are being drafted to foster the trend away from soldered connectors. The Guidance and Control Laboratory, the Systems Support Electrical Laboratory, and the Fabrication Laboratory are among the Huntsville groups involved.

CHANGES IN PRICES AND AVAILABILITY

TUNNEL DIODES have been drastically reduced in price by General Electric Semiconductor Div. of Syracuse, N.Y. Typical examples are as follows: gallium arsenide type 1N3118, previously priced at $85 each, has been reduced to $6; type 1N3120 has been decreased from $55 to $4.50.

MESA SWITCHING TRANSISTOR, type 2N1300, has been reduced 36 per cent in price by RCA's Semiconductor Products Div. of Somerville, N.J. The cut will drop the unit price of the 2N1300 from $2.75 to $1.76 in quantities of 100-999 and from $2.50 to $1.60 each, for lot purchases of 1,000 or more units.

TRANSISTORS have been reduced in price ranging from 13 per cent to 48 per cent by Philco Corp.'s Landsdale Div. of Landsdale, Pa. Price reductions chiefly affect silicon transistors, 16 types in all, and include a drop in price of the 2N1663 SADT from $12.90 to $8.50 in lots of 1,000.

NEWS BRIEFS . . .

HYPERPURE SILICON for electronic semiconductors will be manufactured by a new process at the E. I. du Pont de Nemour & Co.'s new facility in Newport, Del. The new process is based on the thermal decomposition of silane, a silicon hydride. Du Pont has exclusive rights to make the material in the U.S., Canada and the British Commonwealth. It has the right to sell in all world markets.

FIRST ALL-TRANSISTORIZED electronic data-processing center, a Radio Corporation of America project, is being used in Washington to serve both Government and business.

RECEIVING ANTENNA, 1,000 ft long, 500 ft wide, 250 ft high, was described to a German technical audience in Munich by its inventor, Boynton G. Hagaman of the Developmental Engineering Corp. of Washington, D.C. The Tapered Aperture Horn Antenna, reportedly the world's largest receiving antenna, is currently under service test at La Plata, Md. Evaluation is scheduled to be completed this month.

TV PLAYS IMPORTANT ROLE in medical education and research, a survey by the Council on Medical TV confirms. The Council looked into TV's use in 85 medical schools in the country. Nineteen schools are now employing TV for laboratory instruction and research and 15 plan installations within two years.

ENGINEERING SERVICES and operation analysis in support of a $2-billion Post Office modernization program will be undertaken by Aerolab Development Co. of Pasadena, Calif., under an initial $500,000 contract. Many other companies are participating in the nation-wide project.

UNDERGROUND LAUNCHING SYSTEM for Atlas ICBM will be designed and developed by American Machine and Foundry Co. of New York under a $3,800,000 contract from the Convair Div. of General Dynamics Corp.

INERTIAL GUIDANCE SYSTEM, including ground operating equipment, will be designed and developed by AC Spark Plug of Milwaukee, Wis., under a $84-million Air Force contract.

CERTIFICATE OF APPRECIATION for Patriotic Civilian Service has been presented to the City of Huntsville, Ala. The certificate honors the 70,000 residents for their support of Army activities and personnel from 1941 through 1960.

CIRCLE 850 THRU 865 ON READER-SERVICE CARD

NEWS

WESCON 1960: The Big Show Takes on a New Look

New Los Angeles Sports Arena to Welcome Engineers; Tech. Sessions Geared to Workshop Meetings

LOS ANGELES, the fastest-growing electronic area in the U.S., is again host city for WESCON—which this year has a "Soaring Sixties" theme. Hopefully, the industry (and the convention) will soar like the many missiles produced in the area.

With a brand-new showplace for its exhibits and pioneering treatment of its technical sessions and by-product activities, WESCON's increase in quality is expected to keep pace with its increase in quantity.

More than 200 authors and panelists are scheduled to speak to an audience of about 35,000 engineers. One site, Los Angeles' Memorial Sports Arena, just past its first birthday, will house 987 exhibit booths and 44 carefully planned technical sessions. At some previous WESCONs, the two activities were housed separately.

Headquarters hotel, the Ambassador, will serve as nucleus for other activities like the Distributor-Rep Conference, the All-Industry Cocktail Party, and other WESCON-related activities.

Technical Soup to Nuts

The technical program runs the gamut of the electronic art, including such heretofore fringe sessions as "What are the Communication Values of the Technical Symposium?" (Session 6), "Stereo-Multiplex Broadcasting" (Session 12), "Analysis of Man-Machine Systems" (Session 14), "Working with Engineers" (Session 19), and a special women's session called "Engineering: The Woman's Role."

Chairman Richard G. Leitner and his Technical Program Committee have tried to balance the proportion of theoretical, practical, management and marketing papers. The committee established session formats only after it had received and evaluated all technical papers. In this way sessions were matched to the quality and kind of material received. Session formats include panel discussions, debates, tutorial papers, workshop sessions and paper-plus-panel sessions. Although most sessions will be made up of contributed papers, seven sessions will be conducted by invited authors and panelists. These sessions are: "Stereo-Multiplexing Methods," "Information Theory and Modulation Methods," "Microminiaturization," "Air Traffic Control" (two sessions), "Seeking a Logical Bio-Instrumentation System," and a session on space sciences.

In session 3, new solutions are promised to some old problems in communications: Machi and Hoffman of System Development Corp. in Lodi, N.J., will describe the effect of link elimination in data-transmission systems; Sandia Corp.'s Paul Lux and the University of Washington's Swarm and McNelis will talk about the optimum antenna pattern for a signal-burst communication system, and Elie Baghdady from MIT's Research Laboratory of Electronics will present a linear-cancellation technique for supressing impulse noise.

In the session on microminiaturization, Session 25, Motorola and Fairchild Semi-conductor Corp. will present first-time papers on their microelectronics techniques. Motorola's J. R. Black will talk about the "Design and Fabrication of a Microelectronic IF Amplifier;" and Kattner, Last and Nall, from Fairchild Semiconductor, will speak on Fairchild's new "Solid-State Micrologic Elements." Fairchild's element will be shown at the company's booth.

Pacific Semiconductor's T. C. Hall will report on PSI's successful surface passivation of microcomponents, the promising technique that enables the company to get along without sealing semiconductor microcomponents in a glass or metal container.

In the same session, J. Alegreti of Merck, Sharp & Dohme will discuss a new concept in microcircuitry—"Laminar Junction Structures." Rheem Semiconductor's G. P. Walker will present "Semiconductor Packaging for High Component Density Applications."

"What has happened since the Pioneer V beep opened the IRE Show in New York?" (Session 29) will be a symposium on the Pioneer V experiments. Speakers C. Y. Fan, P. Meyer and J. A. Simpson from the University of Chicago will reveal preliminary results from the space probe Pioneer V, which made history by communicating from 23 million miles in space. Measurements of the geomagnetic and interplanetary magnetic fields by the space probe will be reported by Space Technology Labs' Coleman, Judge, Smith, and Sonett. Radiation measurements made by Pioneer V will be listed and described by the University of Minnesota's Arnoldy, Hoffman and Winckler; and J. D. McGuire, D. D. Morrison and L. Wong of STL will show how an astronomical unit is determined from the least square foot to the orbit of Pioneer V.

A promising session is the preplanned "Seeking a Logical Bio-Instrumentation System" panel discussion (Session 31). Four panelists will discuss:

"The Anesthetized Individual in a Normal Environment," J. B. Dillon, M.D., University of Calif.; "The Unhealthy, Conscious Individual in a Normal Environment," T. Freedman, M.D., North American Aviation; and "The Healthy, Conscious Individual in an Abnormal Environment," P. Meehan, M.D., University of Southern Calif. An apparent non-sequitur in the session is "Computers and Programming in a Bio-Instrumentation System" by Paul Tiffany of System Development Corp.

Workshops Keyed to Technical Sessions

Workshop sessions will be an unusual feature of WESCON this year. Keyed to four technical sessions, the 3-hour afternoon workshops will review the subjects that were discussed by the morning speakers. According to Technical Program Chairman Richard G. Leitner, inputs for the workship discussions, which will be open to the audience, will be largely from written questions received during the morning sessions. The moderators will pick the most controversial questions for review.

Panelists in the workshop will not be the speakers during the technical session, but will be encouraged to attend the paper presentations during the morning.

The workshops and presiding moderators are "Management of Man-Machine Systems," R. L. Clark, Department of Defense; "Analysis of Man-Machine Systems," Lt. Col. Anthony Debbons, Rome Air Development Div.; "Synthesis and Design of Man-Machine Systems," D. T. McRuer, Systems Technology, Inc.; "Operation and Training of Man-Machine Systems," J. Lyman, UCLA.

Some controversies are anticipated during the sessions. One may be the working relationship between engineers and psychologists. Who should work for whom? Should the psychologist be a consultant or should a company building man-machine systems maintain an elaborate staff of psychologists in the organization? The issue of the systems management approach versus complete in-house capability may arise during the workshop on Management of Man-Machine Systems.

Panelists from the Department of Defense, Stromberg-Carlson Co., Radio Corp. of America, Space Technology Labs and Sylvania Electric Products, will discuss whether it is better to have a prime contractor and team members who are legally subcontractors but have participated in the proposal writing, or to maintain a complete in-house capability and subcontract out discreet portions of a system. Team bidding advocates insist that a better job can be done having a systems manager who knows the field and can form a team of small specialists. In-house proponents maintain that better control of the project is pos-

NEWS

sible when the responsibility rests principally within one organization.

The Analysis, Design and Operation sessions will include several psychologists as well as engineers. Forrest Bethel of Stromberg-Carlson points out that the whole man-machine series has a strong "human factors" slant. The area of discussion mainly concerns how man can best get along with machines . . . or how machines can best be designed to get along with man.

No WESCON Recruiting . . . Quite

Recruiting on Show grounds this year will be minimal, according to Show Manager Don Larson. "Of course, there is no way to prevent individuals from talking to each other, but no organized recruiting will go on in the exhibit areas, headquarters hotel or technical sessions."

Response to the famed "gentlemen's agreement" letter sent to major electronic firms by WESCON Chairman Walter E. Peterson was "very favorable," says Mr. Larson. Hundreds of replies were received, unanimously supporting the WESCON no-recruiting policy. ". . . recruiting of engineering personnel has always been discouraged at WESCON," the letter read in part. "We feel it is to the benefit of all attending the trade show and convention to rule out such distracting influences in a high level technical meeting. . . . We wish to call upon your company to join in a 'gentlemen's agreement' to rule out recruiting at WESCON functions."

But plans for the California Southland Career Center are progressing full blast. To be located in the Shrine Auditorium a few miles from the

(text continued on page 30)

Condensed Schedule—Wescon Technical Program

*(Note: Sessions 1&2 are from 10:00—12:30

August 23-26	Room A	Room B	Room C	Room D	Room E
Tuesday 10:30 – 12:30 am	1 Reliability	2 Pulse-Handling Techniques	3 Communications	4 Management of Man-Machine Systems	5 Semiconductor Devices & Tubes
Tuesday 2:00 – 5:00 pm	6 Communication Values of the Technical Symp.	7 Varactors & Tunnel Diode Applications	8 Instrumentation	9 Circuit Theory	10 Semiconductor Devices
Wednesday 10:30 – 12:30 am	11 Computer—General	12 Stereo Multiplex Broadcasting	13 Microwave Theory & Techniques I	14 Analysis of Man-Machine Systems	15 Microwave Tubes
Wednesday 2:00 – 5:00 pm	16 Computer Circuits & Devices	17 Magnetic Data Recording	18 Microwave Theory & Techniques II	19 Working With Engineers	20 Vehicular Communications I
Thursday 10:30 – 12:30 pm	21 Component & Systems Reliability	22 Air Traffic Control I	23 Antennas I	24 Synthesis & Design of Man-Machine Systems	25 Microminiaturization
Thursday 2:00 – 5:00 pm	26 Government & Industry	27 Air Traffic Control II	28 Antennas II	29 Pioneer V Experiments	30 Microminiaturization
Friday 10:30 – 12:30	31 Seeking a Logical Bio-Instrumentation System	32 Military Electronics	33 Information Theory & Modulation Methods	34 Operation & Training of Man-Machine Sys.	35 Vehicular Communications II
Friday 2:00 – 5:00 pm	36 Continuation of Session 31	37 Coding Methods & Telemetry	38 Continuation of Session 33	39 Effects of Nuclear Radiation on Electronic Equipment	40 Vehicular Communications III

Technical Papers—Subject Index

AM sessions begin at 10:30; pm sessions at 2:00. *Note: Sessions 1 and 2 begin at 10:00.

Air Traffic Control

Operational Considerations in ATC Design (22) Thur am—Room B
Pilot Looks at ATC (22) Thur am—Room B
ATC From Aircraft Owners' Viewpoint (22) Thur am—Room B
Airlines & Air Traffic Control (22) Thur am—Room B
Central Data Processing of ATC Systems (27) Thur pm—Room B
Data-Processing Requirements of ATC Systems (27) Thur pm—Room B
Need for Automatic ATC (27) Thur pm—Room B
Future Trends in ATC (27) Thur pm—Room B

Antennas

Optimum Antenna Pattern-Signal Burst System (3) Tues am—Room C
Tower and Guy Effects on Side Mounted Vertical Antennas (20) Wed pm—Room E
Broad-Band 160-Mc Colinear Array (20) Wed pm—Room E
Vehicular Center-Fed Whip Antenna (20) Wed pm—Room E
Continuous Bistatic-Echo Area Range (28) Thur pm—Room C
Region Boresight Methods (28) Thur pm—Room C
Zone-Plate Focusing Element (28) Thur pm—Room C
Beacon Antennas for Project Mercury (28) Thur pm—Room C
Cavity-Fed Slot Antennas (28) Thur pm—Room C
"Coke-Bottle" Antenna (23) Thur am—Room C
Circular-Array Frequency Scan (23) Thur am—Room C
Low-Sidelobe Interferometer Antenna Patterns (23) Thur am—Room C
Design Techniques—Spiral Antenna (23) Thur am—Room C
Phase Distribution of Spiral Antennas (23) Thur am—Room C

Automation & Sound Control Systems

Automation in ATC (27) Thur pm—Room B
Need for Automatic ATC (27) Thur pm—Room B

(continued on page 30)

NEWS

Sports Arena, the Career Center will hopefully be visited by 3,000 engineers looking for a change, says William Douglass, president of Career Publications, Inc.

"When an industry needs engineers it *has* to recruit," he pointed out. "Even with the best intentions a company that must fulfill a contract may resort to technical seminars which are little more than recruiting devices to tell the company's story to invited engineers.

Most engineers recruited during the Show, according to Mr. Douglass, will be from the West. "To recruit engineers locally cuts costs. This year scientists and mathematicians as well as engineers will be in demand." ■ ■

Broadcasting

FM Stereophonic Radio Transmission (12) Wed am—Room B
FM Stereophonic Broadcast Systems (12) Wed am—Room B

Circuit Theory

Feedback Systems—Gain and Time Constant Variations (9) Tues pm—Room D
Sensitivity of Linear Systems (9) Tues pm—Room D
Sampled-Data Technique for Network Transfer Functions (9) Tues pm—Room D
Delay Distortion Correction for Networks and Filters (9) Tues pm—Room D

Communications

Link Elimination in Data Systems (3) Tues am—Room C
Optimum Antenna Pattern Signal Burst System (3) Tues am—Room C
Suppressing Impulse Noise (3) Tues am—Room C
Vehicular Center-Fed Whip Antenna (20) Wed pm—Room E
Broad-Band 160-mc Colinear Array (20) Wed pm—Room E
Tower and Guy Effects on Vertical Antennas (20) Wed pm—Room E
Foamflex Coaxial Cable (20) Wed pm—Room E
Electronic Ancestor Worship (32) Fri am—Room B
National and Global Systems (32) Fri am—Room B
Computer Techniques-Ground Support (32) Fri am—Room B

Performance Compatibility and Standards (35) Fri am—Room E
Modular Construction (35) Fri am—Room E
Paging in the VHF Band (35) Fri am—Room E
Control Console and Related Facilities (35) Fri am—Room E
Fail-Safe Binary Communication (37) Fri pm—Room B
Multichannel Telephone Service (40) Fri pm—Room E
Address Communication Systems (40) Fri pm—Room E
Pushbutton Dial Radiotelephone (40) Fri pm—Room E
Three-Channel SSB Multiplexed FM Radio (40) Fri pm—Room E
Guarded Tone Signalling (40) Fri pm—Room E

Computers

Microsecond Clock Synchronization (8) Tues pm—Room C
Digital Control in Space (11) Wed am—Room A
Polymorphic Data Processing (11) Wed am—Room A
Adaptive Character Reader (11) Wed am—Room A
Random Access File (16) Wed pm—Room A
Visual Display Encoding (14) Wed pm—Room D
Magnetic Core Logic (16) Wed pm—Room A
Adaptive Switching Circuits (16) Wed pm—Room A
25-Mc-Clock Rate Circuits (16) Wed pm—Room A
Logic For a 16-Mc Clock Rate (16) Wed pm—Room A
ATC Data Processing (27) Thur pm—Room B
ATC Data Processing Requirements (27) Thur pm—Room B
Optimized Data Systems (37) Fri pm—Room B

Instrumentation

Microsecond Clock Synchronization (8) Tues pm—Room C
Compensating Networks (8) Tues pm—Room C
Servo Response Plotter (8) Tues pm—Room C
Determining Instantaneous Speed Error Data (8) Tues pm—Room C
Extending Recording System Bandwidth Wed pm—Room B
CM-100 Recorder—Mechanical Design (17) Wed pm—Room B
CM-100 Recorder—Electrical Design and Performance (17) Wed pm—Room B

Magnetic Data Recording

Extending Recording System Bandwidth (17) Wed pm— Room B
Wideband Magnetic Recording (17) Wed pm—Room B

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Merit, Excellence, Designs Shown

WESCON's second Industrial Design Awards program, which has nothing to do with the value of the electronic circuitry or techniques within a package, will exhibit 22 award-winning entries. Five awards of excellence and 17 awards of merit will be announced. Award-winning products this year listed alphabetically:

- **Ampex FR600 Magnetic Tape Recorder/Reproducer; Designers: Frank T. Walsh and F. Arden Farey, Ampex Data Products Co., Redwood City, Calif.**
- **Ampex TM-1 Digital Tape Handler, designers: Frant T. Walsh and F. Arden Farey**
- **Amphenol Micromodule Connector, designer: Connector Div., Amphenol-Borg Electronics Corp., Chicago, Ill.**
- **Beckman Laboratories Potentiometric Recorder, designers: Tor Petterson and Melvin Best, Beckman Instruments, Fullerton, Calif.**
- **Beckman Model 210 High-Speed Data-Processing System, designer: Zierhut/Vedder/Shimano Associates, Los Angeles.**
- **Bendix G-20 Data Processing System, designers: Emerson/Johnson/Mackay**
- **Corning NF Fusion Sealed Resistor, designer: Corning Electronic Components Div., Corning Glass Works, Bradford, Pa.**
- **Decker Corp., group of four measuring instruments: Model 905 Delta Unit Controller, Model 410 True Differential Voltmeter, Model 904 Delta Unit, Model 306 Differential Pressure Meter. Chosen as group because of design resemblance. Designer: E. Rolin Nichols, Decker Corp., Bala Cynwyd, Pa.**
- **DeMornay-Bonardi Precision Standing Wave Detector, designer: Richard E. DeMornay, DeMornay-Bonardi, Pasadena, Calif.**
- **Eitel-McCullough X7626 Power Triode**
- **Eitel-McCullough Model X778 Traveling Wave Tube**
- **Electro-Instruments Model 300 X-Y Plotter, designer: Robert D. Mason, IDI**
- **General Electric Model GE312 Digital Control Computer, designer: Henry H. Bluhm**
- **Hewlett-Packard Variable Attenuator, designers: Carl Clement, Allen Inhelder, Phil Hand, Lawrence LaBarre, Ed Phillips**
- **Huggins Traveling Wave Tube**
- **Librascope RPC 4000 Electronic Computer System, designers: George H. Kress Associates, ASID, Los Angeles.**
- **Librascope X-Y Plotter Model 210, designer: Zierhut/Vedder/Shimano Associates, Los Angeles.**
- **P. R. Mallory Voltage Reference Battery.**
- **Mincom Div. Minnesota Mining & Mfg. CM-100 Video Band Recorder/Reproducer**
- **Ramo-Wooldridge Standard Cabinet, designer: Joseph Police, Thompson-Ramo-Wooldridge**
- **Southwest Industrial Electronics Model N-2 Signal Generator.**
- **Voltron Products Precision Electronic Motor, designer: Tor Petterson, ASID**

Sensitive Reproducing Head (17)
Wed pm—Room B
CM-100 Recorder—Mechanical Design (17)
Wed pm—Room B

CM-100 Recorder—Electrical Design and Performance (17) Wed pm—Room B
FM and Carrier Erase Techniques Wed pm—Room B

Management

Communications Values of Technical Symposium (6) Tues pm—Room A
Marketing (19) Wed pm—Room D
Patent Law (19) Wed pm—Room D
Accounting and Finance (19) Wed pm—Room D

Man-Machine Systems

Management Appraisal of Human Engineering (4) Tues am—Room D
Human Factors in Management Control (4) Tues am—Room D
Human Pilot Dynamics (14) Wed am—Room D
Air Defense Center Decisions (14) Wed am—Room D
Linear Dynamics of Human Systems (14) Wed am—Room D
Systems Analysis Methodology (14) Wed am—Room D
Visual Display Encoding (14) Wed am—Room D
Systems Design Requirements (24) Thur am—Room D
Human Factors Laboratory (24) Thur am—Room D
Detection Threshold (24) Thur am—Room D
Color Display Unit (24) Thur am—Room D
Teaching Systems (24) Thur am—Room D
Unit Repair (34) Fri am—Room D
Human Factors in ADP Systems Performance Fri am—Room D
Maintenance Functions (34) Fri am—Room D
Human Factors in Systems Operations and Training (34) Fri am—Room D
Human Interactions in Systems (34) Fri am—Room D

Microwave Theory and Techniques

Periodic Structures—Equivalent Circuits (13) Wed am—Room C
X-Band Circulator (13) Wed am—Room C
Broadband Filters (13) Wed am—Room C
Waveguide Attenuation (13) Wed am—Room C
Broadband Rotary Joint (13) Wed am—Room C
Parametric Diode Equivalent Circuit (5) Tues am—Room E
Multiple Reflectors in Semiconductors (10) Tues pm—Room E
Masers for Systems Applications (18) Wed pm—Room C
Parametric Amplifiers Noise Figure (18) Wed pm—Room C
TEM Diode Switching (18) Wed pm—Room C

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Tunnel Diode Oscillators (18) Wed pm—Room C
S-Band Parametric Amplifier Wed pm—Room C

Microwave Tubes

Low Noise TWT Amplifiers (15) Wed am—Room E
High Convergence Electron Guns (15) Wed am—Room E
Slow Space-Change Waves (15) Wed am—Room E
ARC Discharge (15) Wed am—Room E
Backward-Wave Oscillators (15) Wed am—Room E
Ku-Band Klystron Amplifiers (15) Wed am—Room E

Military Electronics

Electronic Ancestor Worship (32) Fri am—Room B
National and Global Systems (32) Fri am—Room B
Ground Support Computer Techniques (32) Fri am—Room B

Pulse-Handling Techniques

Enhancement Filters (2) Tues am—Room B
Pulsed RF Storage (2) Tues am—Room B
Video Processing and Distribution (2) Tues am—Room B
Solid-State Video Processor (2) Tues am—Room B

Reliability

Electronic Equipment Maintenance (1) Tues am—Room A
Models for System Design Engineers (1) Tues am—Room A
Precision Film Potentiometers (1) Tues am—Room A
Product Quality (1) Tues am—Room A
Wiring Failure-Rate Data for Component Part Derating (21) Thur am—Room A

Semiconductor Devices

Thermionic Converters (5) Tues am—Room E
High Power at 1 Kmc (5) Tues am—Room E
Parametric Diode Equivalent Circuit (5) Tues am—Room E
Power Transistor Reliability (5) Tues am—Room E
Electrostatic Storage Memory Element (10) Tues pm—Room E
Multiple Microwave Reflections (10) Tues pm—Room E
PN-PN Switches (10) Tues pm—Room E
Transistor Scaling Theory (10) Tues pm—Room E
Tunnel-Diode Adder-Subtracter (10) Tues pm—Room E

Space Electronics

Telemetry

Tunnel Diodes & Varactors

Distributor-Reps Meet All Day

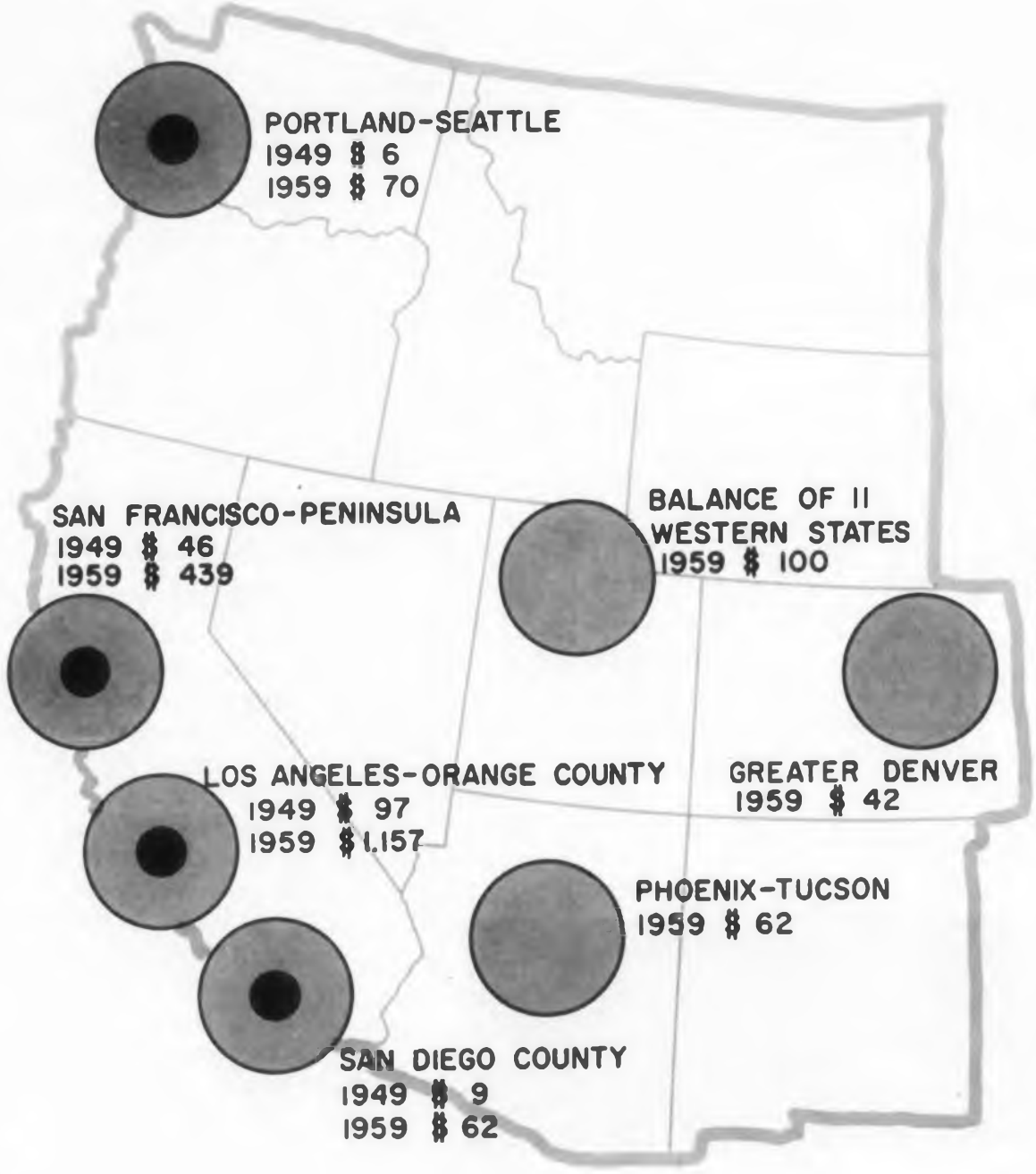
Facilities for an expected 600 participants in the Sixth Annual Distributor-Representative Conference will be set up in the Ambassador Hotel. Chairman W. Bert Knight predicts that many distributors, factory sales managers and sales representatives from throughout the West will spend all day Monday, Aug. 22, exchanging views at the Ambassador Hotel. Even before the event Mr. Knight is anticipating a greater program in future years. "The popularity of the program is responsible for the suggestion that it be made a two-day affair in future years with its own program of speakers. We will ask for a vote on this proposal at this year's conference," Mr. Knight says.

Hughes modern installation contrasts with old Cal Tech

Electronics in the West: The 1960 Look

Little Boom Shot Up to Big Boom But Still Suffers Growth Pains

CONCENTRATED in five principal areas—Portland-Seattle, San Francisco-Oakland, Los Angeles-Orange County, San Diego, and Phoenix-Tucson—the western electronics industry this year will reach a total of $2 billion sales. To those accustomed to the relative density of medium-sized and large companies in the Midwest and East, this figure may be misleading. There are more firms than might be supposed—about 800. Nu-



Ten-year growth figures from 1949 to 1959 compiled by the Western Electronic Manufacturers Association last year show the explosive growth of the western electronics industry. In 1949 there were a total of 85 electronics firms in the 11 western states; in 1959 there were 770. Employment in 1949 was 11,000; in 1959, 146,000. Sales were multiplied a dozen times from $158 million in 1949 to $1.932 billion in 1959. The breakdown is shown in the table.

Ten-Year Growth

(Statistics from Western

1949

City	No. of Firms	Employees	Sales
Seattle-Portland	5	400	$ 6 million
San Francisco-Peninsula	34	3,300	$46 million
Los Angeles	43	6,700	$97 million
San Diego County	3	600	$ 9 million
Phoenix-Tucson	—	—	—
Greater Denver	—	—	—
Balance of 11 western states	—	—	—
Total	85	11,000	$158 million

merically, most of the western electronic companies are small firms employing fewer than 100 people.

In Los Angeles, with 485 firms, some 80 per cent have fewer than 100 employes, according to the Los Angeles Chamber of Commerce. About 63,000 workers are employed by 20 per cent of Los Angeles firms—including, of course, Hughes Aircraft Co., with 32,168 employes of its own in electronics. Hughes accounts for $385 million of the Los Angeles-Orange County estimated total gross of $1.7 billion sales in 1960.

Western electronics has a predominance of systems, building blocks, and study and test equipment. It is not fundamentally a components area, according to sources at the Western Electronics Manufacturers Association. This is in some sense a result of the proximity of large aircraft companies such as Lockheed, Hughes Aircraft, Douglas, Boeing, and Convair; and to the location, in Los Angeles, of the Air Force Ballistic Missile Div. Research and development programs proliferate partially because of the small size of the majority of western electronics firms and the encouragement provided by Stanford University, the California Institute of Technology, and the University of California at Berkeley. It is easier for a

of Western Electronics

Electronic Manufacturers Assn.)

1959

No. of Firms	Employees	Sales
35	6,000	$70 million
144	35,000	$439 million
461	84,000	$1,157,000,000
31	4,000	$62 million
21	5,000	$62 million
18	3,100	$42 million
60	9,000	$100 million
770	146,000	$1,832,000,000

small company to go into an R&D program than to engage in mass production of hardware.

Despite the industry's still strong ties with the aircraft industry, much activity is taking place in third- and fourth-generation spin-offs. Companies like Thompson-Ramo-Wooldridge—then Ramo-Wooldridge—which were started by a group of engineers from a large aircraft firm, are now generating spin-offs of their own and, in some cases, the spin-offs have given birth to companies in turn. In the Portland-Seattle area where Boeing Airplane Co. encouraged the creation of a number of small electronics companies, these companies have so grown as to encourage several spin-offs of their own during 1959 and early 1960.

The development and perfection of the "team bid" concept in the West is largely due to the fierce competition given large companies by the numerous small ones. Pushed strongly by James D. McLean, then of Hoffman Electronics Corp., team bidding is now common and successful, and has the blessing of the Small Business Administration.

'Soaring '60s' Getting off the Ground

While western electronics sales have increased from 1959, industry sources indicate that the increase has not been up to expectations. Hardware and test equipment manufacturers have complained that first-quarter business was not as good as was hoped for. Research and development groups grumble that the Western area has not kept pace with areas like Boston, New York, and New Jersey, in study-program contracts. At the moment, however, industry spokesmen are looking for an increase in military and industrial contract negotiation. One manufacturer feels the disappointment in rate of growth has purely political origins. According to another manufacturer, the Skybolt program and revitalization of the B-70 program will help.

Electronic Exurbanites

As with much of the nation, electronics is moving outward from the large cities into suburban areas. Except for Convair Electronics, almost all of San Diego's electronics is concentrated several miles out of town on Kearny Mesa. In Los Angeles the recent exodus of TRW, Litton Industries, and Packard-Bell Electronics point up the movement from the center of town to the countryside some 40 miles away. Most of San Francisco electronics is concentrated on the Peninsula —a lovely, resort-like finger of land which stretches 45 miles south to join the mainland at San Jose.

Partial List of Western SBIC's

AGRI-Supply Finance
P. O. Box 198
Lathrop, Calif.

Continental Capital Corp.
120 Montgomery Street
San Francisco 4, Calif.

Equity Capital Corp.
485 Ramona Street
Palo Alto, Calif.

Northern California SBIC
345 California Avenue
Palo Alto, Calif.

Small Business Enterprises
300 Montgomery Street
San Francisco 4, Calif.

Western SBIC
1005 A Street
San Rafael, Calif.

Capital for Small Business, Inc.
1314 Westwood Boulevard
Los Angeles 24, Calif.

Electronics Capital Corp.
1400 Fifth Avenue
San Diego 1, Calif.

First California SBIC
215 West Sixth Street
Los Angeles 14, Calif.

South East SBIC
3350 Tweedy Boulevard
Southgate, Calif.

Columbia SBIC
2035 SW 58th Avenue
Portland 1, Oregon

The prime reason for the development of electronics in the suburbs, industry sources say, is to attract engineers to good living conditions, to take advantage of cheaper land, and reduce the cost of semi-skilled labor. But labor costs, even in the suburbs, are on the rise. Several firms on the San Francisco Peninsula are looking outside the area for expansion, due to increasing labor costs. One company has indicated they get twice the productivity in their Salt Lake City plant than in their California facility.

More Money Available

Ever since the Small Business Investment Act was passed by Congress in 1958, Longterm equity financing has been more readily available to small electronics companies. The Act provided tax incentives for establishing small-business investment companies geared to provide new firms with funds for working capital, growth and eventual expansion or modernization.

With such a large numerical percentage of small firms in the West, it might be expected that small business investment companies would flourish—and so they have. There are a round dozen major SBIC's between Portland to San Diego. Of these the largest is Electronic Capital Corp. with offices in San Diego and Los Angeles, which specializes entirely in the electronics industry. The company is staffed by successful former electronics executives and engineers and says its prime

objective is to provide continuing financial strength to its client companies during "fair and foul weather."

While most SBIC's are mainly interested in already-established companies with promising products or services, chances are good that an engineer with a good idea and sound technical background can obtain capital to start a new business.

At ECC, President Charles Salik says the corporation tries to find out from the engineer just how good his idea is. Is the product soundly designed? Is there a market for it? And, most important, is there a good chance that the market can be expanded? The next step is to investigate the applicant. ECC wants to know something about the engineer's technical background and his record in business, "In particular," Vice President Richard Silberman says, "we want people who have some experience in business, who have made some mistakes, so to speak, and consequently have learned their lesson." ECC requires a projection from the engineer or firm as to what the contemplated organization, sales and marketing operations will be, who the management people will be, and how much money the engineer thinks he needs. If this checks with what ECC thinks is reasonable and proper, after analysis negotiations begin.

One of the brightest examples of the rising interest in electronics investment is Electro-Logic Corp. in Venice, Calif. Two working engineers obtained financing early this year on the strength of their technical and sales abilities and several solid product ideas. Result: a new digital volt-

The Space Technology Laboratories shown here has been leased to Aerospace Corp., demonstrating the interplay of Western electronics. The building is in Los Angeles.

meter currently stirring interest in the industry and a digital transponder system with an extremely high market potential for use in telemetering.

In the Los Angeles basin alone new capital investment estimated for 1960 amounts to $28,070,000—spent for the construction of six new plant buildings and the expansion of 46 others.

The western population increase that has made boom towns of Phoenix and Tuscon and boosted Los Angeles to No. 3 City in the nation, barely trailing Chicago in population, has included large numbers of engineers and scientists. Universal fair weather in the "Southland" (as Southern Californians call their country) and the Southwest, the equable climes of Northern California and the gorgeous, though damp, scenery of Portland and Seattle are largely responsible. Companies needing high-level personnel for research and development operations that do not require extensive marketing and logistic accommodations are likely to set up shop in a spot which offers a pleasant environment. Once established in the West, these engineers and scientists are not likely to return East. "It would have to be a darn good offer to make me go back to Detroit," one contented engineer said recently.

About 20 per cent of the 35,000 engineers looked for at WESCON will be Easterners. Some, having lived through a week of Los Angeles sunshine and casual atmosphere, will stay.

WEMA Is a Prime Mover

Spokesman for the western electronics industry is the Western Electronics Manufacturers' Association. A non-profit organization comprising more than 100 electronics firms, WEMA compiles statistics, co-sponsors WESCON and supports a scholarship program to cultivate more students in the engineering and scientific fields. Last year WEMA made scholarship awards to 17 western universities. According to S. H. Bellue, President of WEMA, chairman of its Los Angeles Council and vice president of marketing at Osborn Electronics Corp., WEMA was founded in 1943 with the objective of encouraging the recognition and development of the electronics industry in the western states.

"Consumer electronics, the older and smallest segment of the industry, accounted for $1.6 billion last year, reflecting a 21 per cent gain in sales over 1958. We forecast about a 5 per cent gain in this part of our industry for this year. Industrial electronics," Mr. Bellue continued, "a sleeping giant—has begun to stir during the past year. In 1959, industrial electronics sales were estimated to be $1.65 billion. It is entirely possible that in the first year of 'The Soaring '60s' industrial sales may be increased another 14 per cent to $2.31 billion." ■ ■

Exotic design at left is representative the exotic circuits that may be pos using the epitaxial-growth process position of vaporized silicon so that it c tinues the single crystal structure of seed crystal. This is an example of sili deposition on a crystal oriented along 100 plane.

At right is a matrix of four resis transistor-logic gates deposited in 11 lay on a glass substrate by IBM for the Sig Corps. This group is part of a 9-cir matrix.

Services Spelling Out Micromin Plans

AF, Signal Corps Programs Jelling; Current Plans and Problems Outlined

AS THE FOCUS on electronics moves West for the industry's number two show of the year, much attention will be directed toward microminiaturization as hardware begins to make an appearance.

Comments of troubled components manufacturers at New York's IRE Show in March showed the many doubts that existed about the proper approach to the coming micromin era (*ED*, April 13, p 16). Since the military is the primary potential user of micromin, parts producers have looked to statements from the services to clarify the future.

In convention statements, and during interviews with ELECTRONIC DESIGN, some military leaders have spelled out as fully as they can at this juncture the direction of their intentions.

Col. Leon J. D. Rouge, components research director, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J., summed up a view that appears to be prevalent:

"As any improved circuitry technique demonstrates reliability equivalent to other techniques," he commented, "we will replace the old circuits with the new ones."

Lt. Col. Jeremy K. Schloss, chief of Wright Air Development Div.'s Electronics Technology Laboratory, backed up this view by indicating that various Air Force agencies are currently investigating micromodules, and if they are found reliable enough they will be used in Air Force equipment.

A second vital requirement was stressed in a recent speech by Vice Adm. Rawson Bennett, Chief of Naval Research, when he explained that if a choice had to be made between two transceivers, one of wrist-watch size and 1-oz weight, and the other of billfold size and weighing 5 oz —the Navy would buy the smaller one only if it cost less.

A timetable for development of various microminiaturization concepts has been one of foggy issues in the program. Although solid circuits are now off-the-shelf items at Texas Instruments, Inc., and Westinghouse Electric Corp. has built operating functional blocks, the Air Force still considers the molecular electronics program to be in an "applied research" status, Colonel Schloss said.

He explained that current efforts can be considered a form study aimed at developing techniques for combining functional blocks. Westinghouse plans to produce blocks suitable for making a radio receiver by mid-1962, and Texas Instruments is building a small computer using blocks measuring 4 x 4 x 1 in.

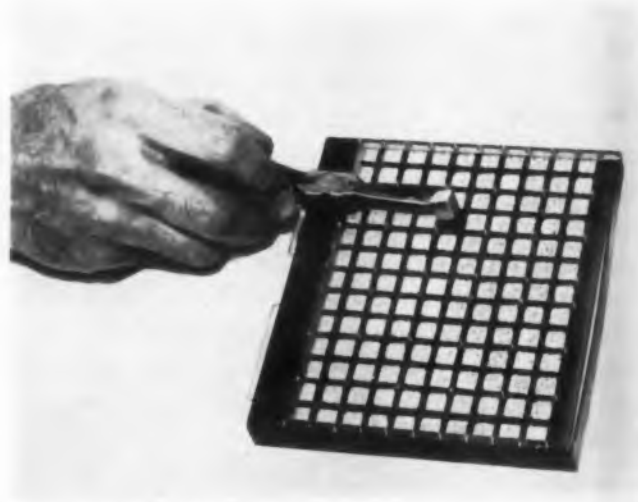
Actual form will depend on requirements for particular equipment, Colonel Schloss commented. For example, if radiation will be a severe problem, encapsulation may be specified. This is necessary because unshielded semiconductor material could serve as a target for fast neutrons.

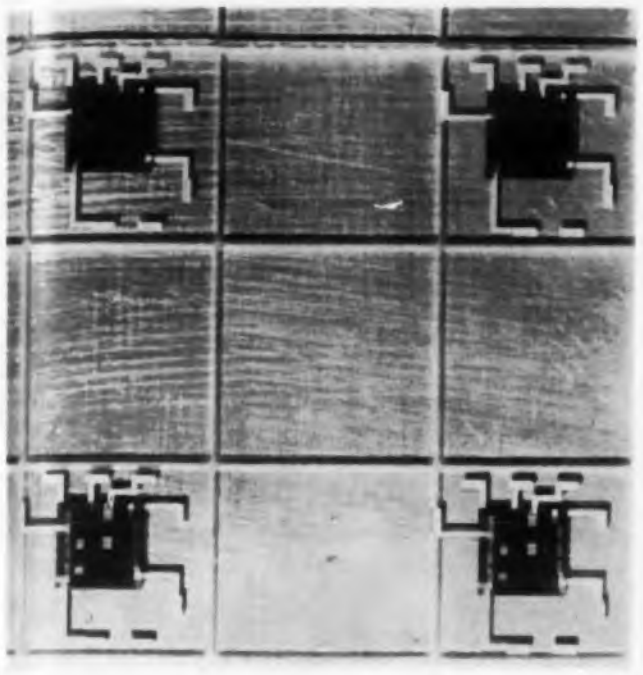
Heat dissipation is a problem receiving much attention now. Several approaches are being investigated including making use of the peltier effect.

New Problems With Functional Circuits

New design problems will arise with functional circuits, Colonel Schloss said. Interstage transformation effects must be considered, and very low impedance levels may be required to avoid impedance matching problems.

The next two to five years will be spent in proving feasibility of the molecular electronics concept for usable equipment, according to Colonel Schloss. About $2.4 million has been spent specifically on development of functional electronic blocks, he said, although developments





in many other projects are also making contributions to this program.

The Army Signal Corps micromodule program, which has advanced to the prototype equipment stage, has a more detailed timetable. A front line combat radio, either for use in helmets or in the pocket, will be ready in prototype form by early fall of 1961, with final models scheduled for the

Technician removes micromodule flip-flop from the navigation computer used with the RCA micromodularized inertial-guidance system, upper and lower left. Pencil at lower left points out some of the preamplifier micromodules, which have been mounted on the inner gimbal of the guidance system to cut down on the number of slip-rings required. Size of encapsulated modules is illustrated above. This spoonful is equivalent to six transistor commercial receiver.

NEWS

end of next year. Deliveries are set for 1962. A final prototype of a micromodule field computer is also scheduled for 1962.

Radio Corp. of America, prime contractor to the Signal Corps on this program, has already built an operating inertial guidance system using micromodules (*ED*, July 6, p 18). RCA is now working on a micromodulized digital differential analyzer to use with the guidance system.

Colonel Rouge feels that enough automation equipment will be installed by 1965 to make micromodules competitive pricewise with conventional components of comparable quality. Some sources at RCA are estimating a much more optimistic cross-over point of 1962.

First MICRAM Equipment Delivered

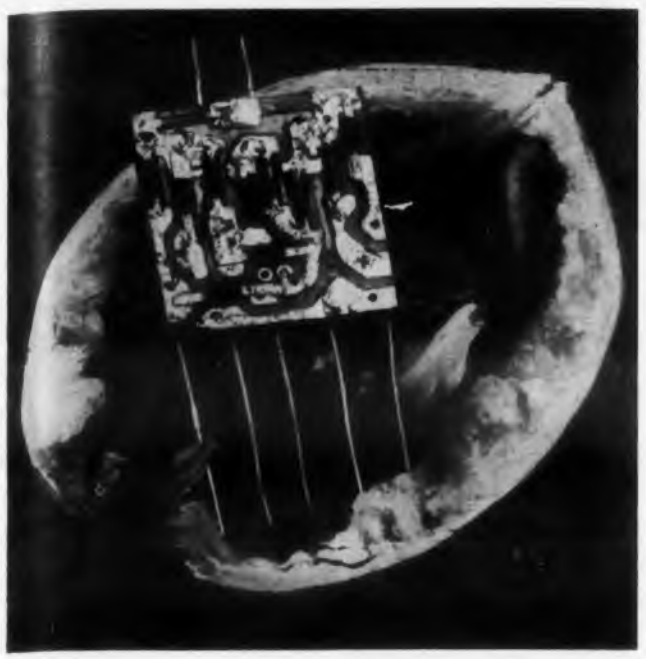
Progress is also being made by seven firms which are cooperating under a program known as MICRAM, for Microminiature Individual Component Reliable Assembled Modules. (*ED*, March 16, p 8.)

The first equipment produced under this program has just been delivered to the Army by Cleveland Metal Specialties Co., the coordinating firm in the program. Infrared devices and an electronic timing and fusing system are being produced using conventional microcomponents mounted on wafers.

Wafer size is not being standardized for this program according to Al Gross, chief engineer

What Happens To Designers In The Molecular Era

There will be a shift in design requirements rather than a replacement of circuit-design engineers when the functional block comes into use some years from now, according to Col. Leon J. D. Rouge, components research director, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J. Currently, Colonel Rouge pointed out, there are three basic types of designers—for components, circuits, and equipment. As technology moves into the functional block era, he predicted, there will be a progression to designers for functional networks, equipment, and systems. This amounts to one step up the ladder for each type, and will require just as many designers as are available now.



Flip-flop in a nutshell was shown at the recent National Convention on Military Electronics in Washington along with several other circuits produced under the MICRAM program. Cooperating firms are Cleveland Metal Specialties Co.; Aerovox Corp.; Formica Corp.; Pacific Semiconductors, Inc.; Raytheon Co.; Sylvania Electric Products, Inc.; and Wilrite Products, Inc.

for the Cleveland company. Although it has been suggested that MICRAM wafers be standardized at 1/3-in., to conform with the micromodule wafer size, Mr. Gross told ELECTRONIC DESIGN that present plans are to vary sizes to meet particular applications.

Greater Flexibility and Packing Density

This will permit much greater flexibility, and also allow much greater packing densities than can be accomplished with micromodules. Currently, Mr. Gross said, MICRAM wafers are being assembled with tweezers, soldering irons, and binocular microscopes. Automation of some of the procedures is possible, but this is not yet a prime requirement since only small lots are being produced.

Another technique which has great promise is the thin film deposition of circuit layers. Recent developments in the epitaxial vapor growth of semiconductors could permit complete circuits to be deposited in the form of a layered thin film. (*ED*, July 6, p 4.)

The current practice in the Army Signal Corps program limits each wafer to one manufacturing process. If the thin-film-deposition techniques demonstrate reliability, however, they might be used where small size is very vital.

IBM has developed automation equipment for alternate layer deposition on a circuit substrate using masks in sequence under vacuum. ■ ■

Post Office Installing Electronic Handlers

First Fully Automated Facility at Providence, Electronically Controlled Equipment Throughout

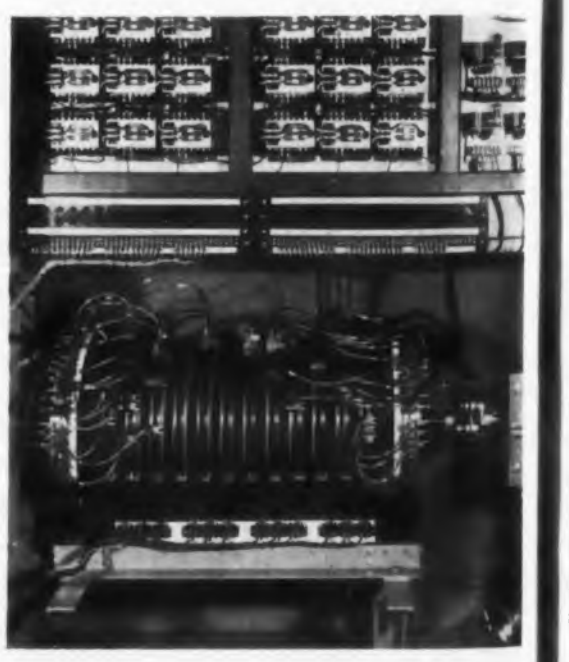
ELECTRO-MECHANICAL mail-handling equipment is now being installed at Providence, R.I., for the fall opening of Project Turnkey, the world's first fully automated post office. The electronically controlled equipment going into the automatic mail system includes:

- Facer-canceller
- Mail sorter
- Package sorter

The facer-canceller examines each letter through a system of photocells to determine the position of the stamp. A series of belts then turns the letter into either of two positions for canceling. The machine recognizes metered and unstamped mail and deflects it out of the canceling line. Colored stamps on colored envelopes do not confuse the machine; nor do picture postcards. Capacity is approximately 24,000 letters per hour. Six cancelling machines, manufactured by Standard Elektrik Lorenz of Germany, an International Telephone and Telegraph associate, will be installed.

The letter sorter is operated by six workers, each of whom punches a destination code into the machine as the letter moves past his work station. The code is stored in mechanical "combs" which travel along an endless belt. A separate comb is coded for each letter and travels on the belt in synchronism with the letter, which is meanwhile deposited into a box moving past a series of bins. When the comb reaches a position correspond-

Rube Goldberg appearance of facer-canceller belies its 24,000-letter-per-hour capacity. System of photocells controls belt drives moving letters through the machine to cancelling heads in foreground. Metered and unstamped mail is deflected into tray which is shown at the right of machine.



Magnetic drum memory of package sorter. Destination of packages traveling on pallets is written on drum by operators. When package is above its destination bin, command is given for the pallet to tip the package into the bin.

Electromechanical memory of letter sorter. Each "comb" is punched according to destination of a particular letter and travels along endless belt. Letter travels in a box on another belt in synchronism with the memory belt. Teeth on combs signal the box to open and to deposit letter into its proper destination bin. Two of the six encoding mechanisms controlled by the operators are visible at the bottom of the photo.

ing to the position of the box above its destination bin, the box is automatically opened and the letter falls into its proper bin.

The machine can sort up to 18,000 letters per hour in this manner into 300 destination bins. The Bell Telephone Manufacturing Co. of Belgium, another ITT associate, is providing 11 letter sorters for the Providence installation.

The package sorter, built by the J. B. Webb Conveyor Engineering Co. of Detroit, employs a magnetic storage drum as its memory. Packages are placed on tiltable pallets and destination coded by a keyboard operator. This code is stored on the drum and causes the pallet to dump the package when it passes above the correct destination bin. The machine can sort up to 14,400 parcels per hour to 32 destinations. Two package sorters will be installed initially, with two more to be added later.

In addition to these machines, a control center equipped with indicators, controls, and a communications system will direct traffic flow on the work floor. Automatic conveyors and chutes will be controlled from the center to move the mail from one machine to the next. ■ ■

WHY PERMANENT MAGNETS ARE PERMANENT!

Study of Remanence by Indiana Steel indicates 100% stability can be achieved

Truly permanent permanent magnets are now possible, according to scientists of Indiana Steel Products Division, Indiana General Corporation. Proof of 100% stability of remanence was gained during a special research project conducted by Indiana and supported by funds of the United States Air Force.*

Natural Stability

Materials having a high coercive force displayed the greatest natural stability. For example, a sample of non-oriented barium ferrite (INDOX I) with an H_{ci} of 4,000 oersteds was measured for natural stability over a period of more than 5,000 hours. Relative remanence was 100% ±0.1%. An oriented sample of the same material (INDOX V) with an H_{ci} of 2,030 oersteds measured 99.5% ±0.1%. The material having the lowest coercive force—ALNICO III — also exhibited the least natural stability, 97.04% ±0.05%.

A second important factor affecting natural stability was length-to-diameter ratio (L/D). It was found that rods of ALNICO V, having a greater L/D ratio, proved more stable. For example, rods with a ratio of 8.7:1 showed *no* detectable loss in remanence during a year. Rods with an L/D of 2.1:1 logged only 97.6% for the same period.

Where change in remanence was perceptible, it was found that it decreases linearly with the logarithm of time (see figure 2). This relation is expected to hold for all permanent magnets when they are undisturbed at room temperature and made of a material which does not change with time.

Test Conditions

During the study, sample magnets were kept in a special room where they were relatively free from such external demagnetizing influence as temperature variations, stray magnetic fields, short circuiting by iron contact and excessive movement or handling. Temperature was held virtually constant at 24° ±2.5°C.

The sensitive measuring apparatus was also located in the test room. Developed in 1948 by Dr. Rudolph Tenzer of Indiana Steel, this equipment permits measurements to an over-all tolerance of better than 1 in 10,000.

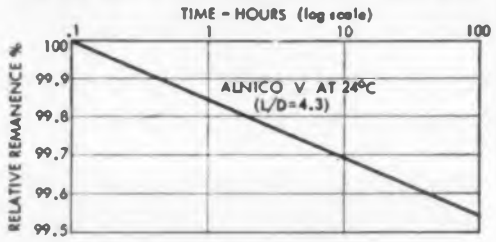
*Contract AF33 (616) — 3385 monitored by the Aero. Res. Lab., WADC.

FIGURE 1. Summary of Experimental Results

Material	L/D	Remanence Bd kilogauss	Stability Relative Remanence at 24° C 5 log cycles (10,000 hr) after magnetization	Measuring Accuracy
INDOX I	0.9	1.4	100.0%	± .1%
INDOX V	0.8	2.5	99.6	± .1
ALNICO III	3.5	4.5	98.10	± .04
	2.2	3.2	97.04	± .05
ALNICO VII	3.5	4.9	99.32	± .04
	2.2	3.9	98.96	± .06
ALNICO V	8.0+	12.3	99.95	± .01
(long)	5.8	11.9	99.81	± .02
(medium)	4.3	10.4	99.23	± .02
(short)	3.5	8.2	98.84	± .04
	2.9	6.7	98.50	± .05
	2.1	4.1	97.6*	± .07

*Extrapolated 1 to 2 log cycles beyond last measurement

FIGURE 2. Remanence decreases with time



Artificial Stabilization

Critical space-age applications often require that a magnet be completely stabilized. Many methods for achieving this were surveyed. For critical applications, methods based on repetitive processes were found superior to those based on any sudden, one-time action. Two of these proved successful, both involving artificial reduction of remanence.

1. **Temperature Knockdown.** ALNICO V magnets were repeatedly exposed to temperatures above and below the temperature of magnetization. Several cycles improved magnetic stability, while remanence was reduced somewhat as a result. Low temperature exposures, to −65° C, produced the greatest improvement in stability, as well as the greatest reduction in remanence.
2. **Knockdown by Applied AC Field.** ALNICO V magnets were subjected to a cycling diminishing field, which also caused a reduction in remanence. Depending upon the material and its use, magnets were knocked down a predetermined amount between 5 and 15% to achieve complete stability. Variations in remanence were less than ± 0.03%, which is the limit of measuring accuracy for this size sample.

Conclusions

This study indicates that permanent magnets *can* be completely stabilized. A magnet, however, that is perfectly stable under these conditions can still be affected by larger temperature variations, stray magnetic fields, vibrations or many other factors. In the case of selected magnets, stability *can* be guaranteed for a flux change no greater than 0.01% per year.

For complete information on the practical aspects of "Stability," ask for a copy of *Applied Magnetics*, First Quarter, 1959. Write Dept. M-8.

NEWS

Air Force To Test Eighteen Automatic Tutoring Machines

Eighteen automatic teaching machines, designed to increase speed and accuracy of learning, will be tested by the U.S. Air Force for training personnel in basic electronics.

Western Design, a division of U.S. Industries Inc. of New York City, has received an Air Force contract to produce the machines, known as the AutoTutor. The contract calls for both machines and training material to be service-trained at Keesler Air Force Base.

The AutoTutor is basically an automatic, random-access film projector. It presents either microfilmed or motion picture material to the student, examines him on each point presented, and requires him to demonstrate understanding before it will pass on the next point. At the same time, the AutoTutor keeps a detailed record of his progress.

The machine's functional specifications are:

- Selects and projects any one of 10,000 stored images when the number of the desired image is entered into the selector keyboard.
- Standard 35 mm motion picture film is used.
- The image is presented on a back projection screen with an image area of 8.2 in. x 11.2 in.
- Search speed is 24 images per second.
- The sequence of images viewed and the time spent viewing each are recorded numerically on tape.
- The search control unit is bi-directional; it searches forward or backward from any given position without resetting.

In addition to increasing the precision of the educational process, the AutoTutor speeds training by permitting each student to progress at his own maximum speed.

Ehricke Sees Manned Probes To Mars and Venus in Decade

Manned, nuclear-powered space ships may be blasting off for Mars and Venus within the next 10 or 11 years, Krafft Ehricke, rocket pioneer and program director for Convair Astronautics, has predicted.

At the Semi-Annual Meeting and Aviation Conference of the American Society of Mechanical Engineers, Mr. Ehricke said the scientific payload of instruments, probes and other equipment should be about 57,000 lbs for the flight to Mars and about 320,000 lbs for Venus.

The crew for Mars would take radiation coun-

ter., meteor-search radar and instrumented satellites to go into various orbits from the main ship, he said. Both recoverable and non-recoverable landing probes would be made to sample soil, air temperature, humidity, and sound.

He described the manned radar reconnaissance satellite for Venus as being able to eject a smaller satellite carrying part of the crew from the spaceship's regular orbit into the outer fringes of Venus' atmosphere.

For more detailed reconnaissance, several smaller instrumented satellites, atmospheric entry probes and a power plant and radar equipment for high-altitude reconnaissance would be ejected from the main vehicle.

Projection System Is Called Aid to Intelligence Briefings

A projection system, said to combine real-time display with large-screen performance, has been developed for use during military intelligence briefings. Called the Light Valve projection system, the device gives high brightness to TV images and other data projected on large screens, according to developer, General Electric Co.

In Light Valve projection, a special control layer modulates the light from a high intensity Xenon lamp. The optical characteristics of the control layer are changed by a beam from an electron gun which is controlled by the input signal.

The system is self-contained except for power supplies. A typical cabinet measures 63-1/4 x 41-1/4 x 25 in.

In addition to military uses, the company says the system opens new projection possibilities in the medical, educational, and commercial fields.

Computers Used To Simulate Blast Furnace Operations

Electronic computers are being used to simulate the operation of blast furnaces in studies aimed at increasing productive capacity at low cost.

Comparison of the computer predictions with former methods has shown computer predictions to be more reliable.

New steelmaking methods and rising costs have made it imperative that the production of iron and ferro-alloys be increased with as little investment as possible.

The results of the computer studies point to production increases of as much as 25 to 30 per cent in blast furnaces as well as other important gains in thermal efficiency and control.

CIRCLE 42 ON READER-SERVICE CARD

NEWS

Highly Reliable Resistors

METAL-FILM resistors with a reliability objective of 0.004 per cent per 1,000 hr at 25 C and at 0.5 rated load—reportedly an order of magnitude better than that of the best commercial resistors—will soon be available to designers.

The resistors are graded at 1/8 w at 125 C and are said to meet MIL-R-10509C. Key to their reliability, according to the manufacturer—International Resistance Co., Philadelphia—is the careful testing each resistor undergoes.

Tests are said to be made of: film adhesion to ceramic, temperature coefficient of film, solderability of the resistors' gold-plated terminals, pull qualities of leads, resistance from lead to edge of termination, absence of chips, and quality of the glass-to-glass hermetic seal.

A gas-leak test, in which the units are filled with helium, is also made, as well as a short overload test, during which the resistors are subjected to a 2.5-v overload. The resistors are also checked for resistance after two weeks under rated load.

Each resistor has a code number and its own individual IBM card. The card records the complete history of the resistor and is used to analyze the resistor's characteristics. Purchasers receive a card with each resistor.

The resistors, called "XLT" by their manufacturer, were developed for the Minuteman ICBM program under a contract from North American Aviation Co.

According to IRC, the XLT reliability ratings are supported by tests of 4,000 hr each on 65,000 units. In describing the reliability of the XLT resistors, the company defines failure statistically. That is, defects are not related to the specification but to the deviation from the statistical distribution established by the various tests. In this system, defects can be caused by departures from homogeneity in favorable as well as in unfavorable directions.

Tests made and tolerances required are:

- *Resistance*—Within 1 per cent of normal resistance.
- *Temperature cycling*—Change in resistance not to exceed ±0.2 per cent plus 0.05 ohm.
- *Low temperature operation*—Change in resistance not to exceed ±0.2 per cent plus 0.05 ohm.
- *Short-time overload*—Change in resistance not to exceed ±0.2 per cent plus 0.05 ohm.
- *Terminal strength*—Resistance will not change in excess of ±0.2 per cent plus 0.05 ohm.
- *Dielectric-withstanding voltage*—Change in resistance not to be greater than ±0.2 per cent plus 0.05 ohm.

Result from Rigid Tests

- *Insulation resistance*—Not less than 10,000 megohms.
- *Effect of soldering*—No change in resistance in excess of ±0.1 per cent plus 0.05 ohm.
- *Moisture resistance*—Change in resistance between initial and final measurements not to exceed ±0.5 per cent plus 0.05 ohm, and insulation resistance to be minimum of 100 megohm.
- *Resistance temperature characteristic*—Not to exceed 25 ppm at each of the required temperatures.
- *Load life*—Change in resistance between initial measurement and any succeeding measurement not in excess of ±0.5 per cent plus 0.05 ohm.
- *Acceleration*—No change in resistance in excess of ±0.2 per cent plus 0.05 ohm.
- *High-frequency vibration*—No change in resistance in excess of ±0.2 per cent plus 0.05 ohm.
- *High-temperature exposure*—Change in resistance not to exceed ±0.2 per cent plus 0.05 ohm.

Electrostatic Glass Shielding Shown At Design Show

Electrostatic glass shielding to prevent electromagnetic interference near computers, in laboratories, or similar uses was displayed by Corning Glass Works, Corning, N.Y., at the 1960 Design Engineering Show in New York.

The shields are borosilicate glass panels coated on one side with a 1/16-millionth-in. transparent metallic film. The coating, which intercepts radio frequency interference, can be grounded by conductive tape, a carbon button, or clamp-on spring. About 70 per cent of visible light is transmitted.

Applications include windows in computers to prevent buildup of spurious charges, shielding for low-level medical measurements, radio and TV studios, and other places where interference is an important problem.

The panels are available on special order in sizes up to 2 x 6 ft.

Minus Sneaks Into Plus Spot

A minus crept in where a plus should have been in the description of the character recognition machine being developed by Baird-Atomic, Inc., in *ED*, July 6, p 14.

The third paragraph on p 14 should have begun with $(P_i + N_i)$ rather than $(P_i - N_i)$.

NEWS

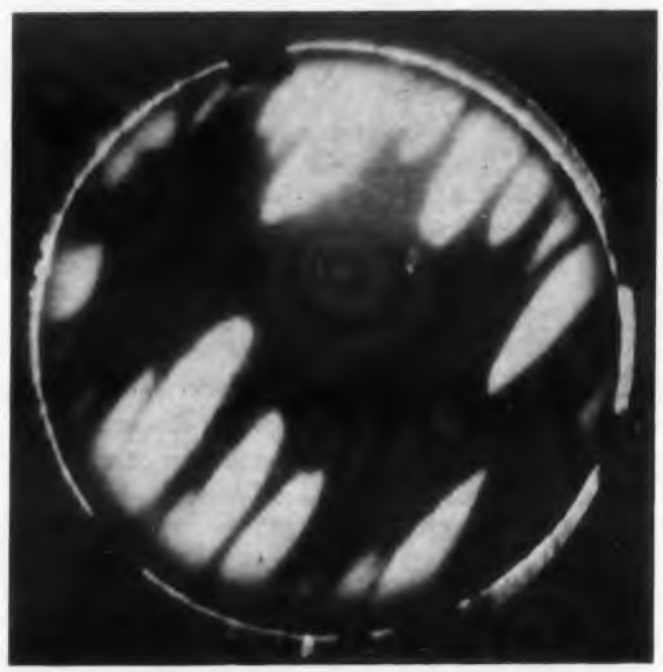
Superconductive Transitions Revealed by New Technique

A NEW TECHNIQUE enabling direct visual observation of metals in transition between the superconductive and normal states has been developed at the General Electric Research Laboratory, Schenectady, N.Y. The shift of metallic domains into and out of superconduction is clearly seen. The high resolution and fast response of this method suggest its application in the design of cryotrons, superconducting gyros, and other low-temperature electronic devices.

A combination of magnetic and optical effects is used. Since metals in their superconductive state are essentially perfect magnetic insulators, the flux distribution within a specimen in a magnetic field corresponds exactly to the arrangement of superconductive domains in the metal. This flux pattern is rendered visible by its effect on the polarizing action of certain kinds of glass (the Faraday effect).

A sample disk of the metal under study is covered with a 0.01-in.-thick sheet of cerium metaphosphate glass which polarizes reflected light according to the intensity of the magnetic field present. Monochromatic, polarized light from a mercury arc is beamed at the glass. The light reflected from the glass, now repolarized in certain areas due to non-superconductive domains in the sample at those areas, is observed or photographed through an analyzer.

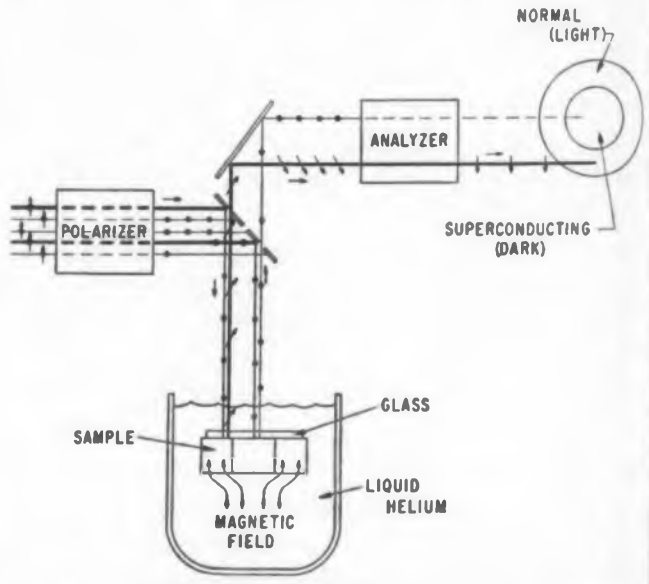
The sample and glass are housed in a vacuum chamber which is immersed in a 1.5 K liquid helium bath. A magnetic field on the order of 250 oersted is applied transversely to the sample by a solenoid. The glass, available from Bausch and Lomb, rotates polarized light approximately 5 deg/100 oersted/mm at 1.5 K. This shift is sufficient to permit ready observation and photography of time-dependent superconductive domain transitions. Conventional methods employ ferromagnetic powder which gathers in non-superconductive regions. This is, however, slow-acting and offers poor resolution in that the powder tends to adhere at small surface imperfections.



Superconductive domains in a thin tantalum sheet appear as dark areas. Magneto-optical technique developed by Dr. Warren DeSorbo at GE Research Laboratory permits direct visual observation of intermediate superconductive state. Normal areas shown in white, are elongated in the direction in which the sheet was rolled.

Movies Showing Method Available

Dr. Warren DeSorbo and W. A. Healy developed the magneti-optical technique from an approach originally used at the Naval Research Laboratory by Dr. Perry Alers. Dr. Alers applied



Polarized light is the key to observation of superconductive and normal areas of a sample. As shown in this schematic diagram of the new method, polarized light is shifted by the glass at areas where the sample is normal, but remains unaffected where the sample is superconductive. Resultant light and dark pattern is observed through an analyzer.

a cerous nitrate glycerol solution to his samples and obtained similar though less effective results. During the last three months Dr. DeSorbo has analyzed several dozen samples of various metals using the new technique. Motion pictures of his findings are available on request. A second film which also describes the laboratory apparatus and technique will be available in about two months.

Computer Diagnosis of Ills Envisioned in 10 to 50 Years

Medical diagnosis of human ills may be performed with the aid of computers in "ten or twenty or fifty years," two physiologists told a session of the Semi-Annual Meeting of the American Society of Mechanical Engineers.

Mechanical simulation of the living human body is already a valuable aid, the session heard. Attendants at the Dallas meeting agreed that medical science would be in a poor state without the contributions of mechanical processes, mathematics and computers.

As an example of simulation of human functions, the session was told of experiments in which arteries had been equated with a rubber tube filled with water. Studies made of these rubber-tube systems yielded information on the behavior of arterial pulses. The simulated systems were adjusted until their pulses matched that of a human.

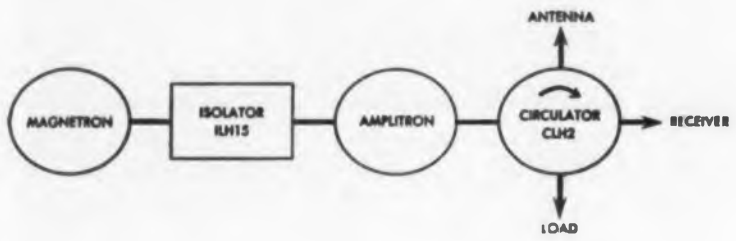
Doctors can now feed data on a patient's arterial system into a computer and, by determining the difference between that data and information for a normal artery, can determine whether the patient's system is normal.

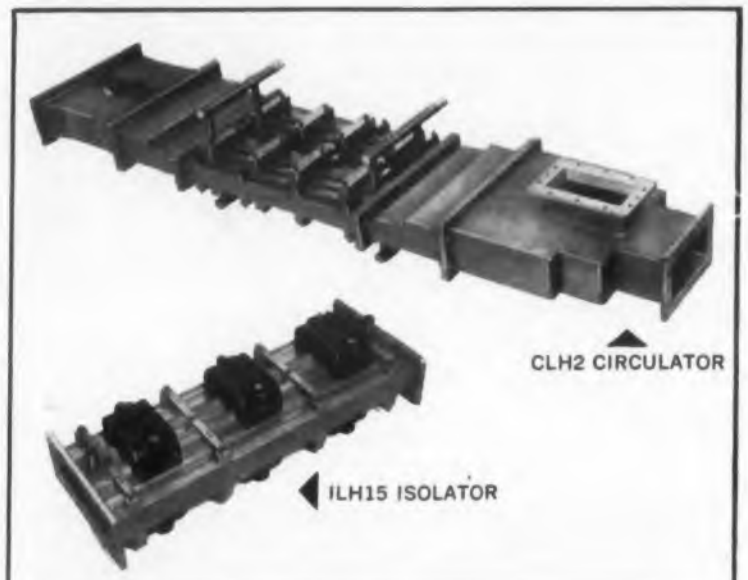
According to R. W. Stacy, associate professor of physiology and biophysics, and N. A. Coulter Jr., assistant professor of physiology and biophysics, both of Ohio State University, the future for simulation of bodily processes by formulas on a computer is bright.

"It is conceivable," the two reported, "that after ten or twenty or fifty years of development . . . a physician can collect his data on a patient whose diagnosis is not obvious . . . then transmit these data to a central medical computing agency. The computer then . . . returns to the physician an analysis stating the most probable diagnosis, the probability function associated with this diagnosis, a second most probable diagnosis with similar information and perhaps even a recommendation for further data collection or for treatment."

The physiologists concluded: "Perhaps at this point we may be permitted to speculate even further. The ultimate step in the process of simulation would be the design of an artificial brain."

FERRITE DEVICES FOR HIGH-POWER RADAR





TYPICAL SPECIFICATIONS

	ILH15 ISOLATOR	CLH2 CIRCULATOR
Frequency range (mc)	1250-1350	1280-1350
Power, average	2.5 KW	5 KW
Power, peak	2 MW	6.5 MW
Isolation, min.	22db	26db
Isolation, max.	24db	32db
Insertion loss, min.	.7db	.65db
Insertion loss, max.	.9db	.8db
VSWR, min.	1.28	1.04
VSWR, max.	1.30	1.12
Weight, lbs.	60	140
Length, in.	22	69⅛
Flanges	½ ht. L-band	mates with UG418/U
Waveguide (liq. cooled)	½ ht. L-band	WR 650

RAYTHEON ISOLATORS AND CIRCULATORS IN IMPROVED L-BAND "FLIGHT TRACKER" SYSTEM THAT BOOSTS OUTPUT TO MORE THAN 5 MEGAWATTS

With an output of more than 5 megawatts at 1,280 to 1,350 mc., the improved FAA "Flight Tracker" radar system has *ten times* the power of its predecessor. In the microwave generator and amplifier circuits, Raytheon isolators and circulators help achieve this power level by providing the required broadband match between magnetron and Amplitron®...and between Amplitron and antenna. The isolator also aids in maintaining frequency stability during the 5 megawatt pulse peaks by acting as a buffer between magnetron and Amplitron.

The L-band ILH15 isolator and CLH2 circulator in the "Flight Tracker" are part of Raytheon's line of L-band devices with ratings from 1.5 to 10 kilowatts average and peak power capabilities as high as 6.5 megawatts.

On Massachusetts' Route 128 in the Waltham Industrial Park, Raytheon has recently opened the most modern facility devoted exclusively to microwave ferrite device and materials development, testing and production. To learn more about the work now underway at these new facilities, or for information on your particular microwave ferrite problem, **please write to the address below.**

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NEWS

Japanese Television Is Seen No Threat to U.S. Market

Tokyo shoppers in the market for a TV receiver must pay $150 for a 14-in. portable and as high as $320 for a 21-in. table model. When shipping charges plus import duty are added to these figures, it becomes obvious that the threat of Japanese TV flooding the U.S. market is relatively unlikely. However, Dr. Milton Goldstein, Dean and Director of Research, cautioned that a price cut-back could take place in the event the Japanese home market becomes saturated and other markets are needed.

Addressing radio and TV design engineers attending the Chicago Spring Conference on Broadcast and TV Receivers, Dr. Goldstein outlined the growth of the seven-year old Japanese TV industry. Over 40 per cent of the Japanese electronic production, or $350 million, was directed toward TV. As an example of the rapid growth still in progress, about 50 TV stations were broadcasting in early 1960, 90 are on the air now and 27 more are scheduled for operation before the end of the year. Surveys indicate that one of every five homes in Japan boasts a TV set. Considering the fact that a 14-in. set costs $150 and the average electronic worker's salary (including fringe benefits, not take-home pay) is $125 to $150, the percentage of TV owners is quite high.

The 14-in. size represents about 80 per cent of the total TV market with the 8-in. "small screen" and 21-in. expensive models finding little interest. Japanese receivers are sold with a one-year labor and parts guarantee compared to 90 days for U.S. merchandise, Dr. Goldstein stated. It is customary, he added, for the repair agency to supply a substitute set for the time during which repair work is needed.

Japanese Electronic Exports To U.S. Rise 350% in Year

Japanese electronic exports to the U.S. climbed to $75.6 million in 1959, according to figures released by the U.S. Dept. of Commerce. This was an increase of 350 per cent over 1958.

Most of this increase was accounted for by radios, of which more than 6 million were imported in 1959, compared with 2.5 million in 1958. The bulk of these radios contained three or more transistors each.

Heavy imports in other types of electronic gear during 1959 included:

Capacitors—8.9 million.

Vacuum tubes—7.9 million.

Loose transistors—2.4 million.

Earphones—2.7 million.

The average prices at which these components were imported were given as: radios, $14.30; capacitors, 6 cents; vacuum tubes, 27 cents; transistors, 66 cents, and earphones, 44 cents.

Electronics is now Japan's second largest export industry. The U.S. is the largest customer for the exports accounting for 56 per cent of Japan's foreign electronic equipment sales.

The rise in exports of Japanese electronic products accomplished record production by the Japanese electronics industry, the Dept. of Commerce reports.

Electronics production in Japan in 1959 was valued at $936 million, according to the department. This compares with $498 million in 1958. The record level is attributed chiefly to the accelerated production of consumer electronics products, which rose to $531 million in 1959, more than the output of all electronic products in 1958.

Japanese Electronics Production, 1959, 1958
(Value in millions of dollars)

	1958	1959
Consumer electronic products	266.2	531.4
Commercial, industrial and military electronic equipment	85.2	110.6
Electron tubes	76.5	141.1
Semiconductor devices	24.5	52.9
Other electronic components	45.6	99.7
	498.0	935.7

Vibration Tester Installed at GE

A new vibration-test facility for the precision testing of flight and fire-control components has been developed at General Electric Light Military Electronics Dept., Johnson City, N.Y. The 15,000 lb force, electronically driven, oscillator-controlled machine, called the C-200, performs sinusoidal vibration testing at temperature ranges of —65 to +200 F and is specially equipped with an oil-film table for difficult testing in the horizontal mode. A technician tests a sight amplifier, the F-104.

ELECTRONIC DESIGN maintains a policy which demands accuracy . . . accuracy on which its 36,000 readers have learned to rely in keeping themselves informed of the very latest electronic developments.

This policy is stated in the explicit sentences found in every issue of *ELECTRONIC DESIGN*.

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Recognizing the power of the printed word to influence, it is *ELECTRONIC DESIGN'S* policy:

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To reserve the right to refuse any advertisement.

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NEWS

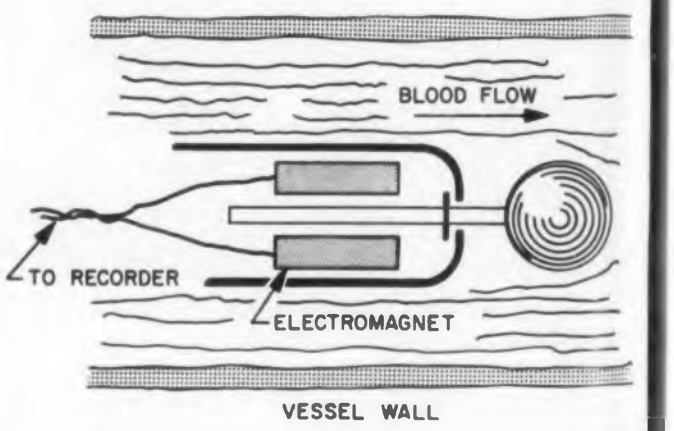
Electromagnet Measures Blo

Instrument Under Development At Franklin Institute Labs

DIRECT measurement of blood flow within the heart is promised by a sub-miniature electromagnetic device now in development at the Franklin Institute, Philadelphia. The instrument consists of a tiny ball restrained by an electromagnet and is inserted directly into a blood vessel at the end of a long, flexible tube. Viscous drag exerted on the ball by the blood stream displaces an iron rod within the magnet thereby providing a readily measurable change in magnet current proportional to flow velocity.

Work to date has resulted in a 6-mm diam unit which has been tested only in conditions simulat-

Blood flow meter components shown here are too large for animal or human use. The 6-mm ball was used in simulated flow experiments. Both the magnet coil and its plastic bobbin are illustrated. The ball is machined of Teflon or other physiologically inert material.



Iron rod through electromagnet is displaced by the viscous drag exerted on the ball in the blood stream. Resulting change in magnet current gives accurate indication of flow velocity.

Blood Flow Within Heart

ing blood flow. A 3-mm device is being assembled for use with experimental animals and will be followed by a 1.6-mm device suitable for human patients. For best results, the meter should not be larger than 1/10th the diameter of the vessel in which it operates.

Accuracies to within 5 per cent are thought to be attainable, but a blood flow meter having even a 20 per cent error would be welcomed as a significant improvement over present methods. Even greater accuracies may be achieved by substituting a differential transformer for the electromagnet. This would maintain a fixed extension of the ball at all flow velocities and minimizing inaccuracies due to differing hydrodynamic conditions at various ball positions.

In use, the flows meter ball undergoes a maximum excursion of ±0.075 in. Signal-to-noise ratio very good. Input to the magnet coil is about 10 vdc on which is superimposed a 1500-cycle signal at about 5 v rms. The alternating current imparts a slight vibration to the ball which prevents the accumulation of fibrous deposits on it during the hour or so that the ball remains in the blood stream.

The flow meter is being developed by John H. Busser, senior staff engineer at the Franklin Institute. The National Institutes of Health are supporting the program. ■ ■

Portable Checkout Receiver To Be Developed for JPL

Jet Propulsion Laboratory has awarded a contract for development of a tiny, all-transistorized portable telemetry checkout receiver to Leach Corp.'s Communications Div. at Compton, Calif.

The device will be an ultra-high frequency phase-lock receiver intended for demodulation of sub-carrier tones and used for calibration and confidence checks of telemetry and command systems in laboratory or field applications. It will be made to be hand-carried up into the gantry.

Specifications call for the unit to be approximately 160 cu in. Powered from a 28-v dc power supply, it is designed for detection of phase-modulated signals at either end of two fixed-carrier frequencies.

Microwave Rectifier Tube Des

High-Vacuum Device Could Be Used In Sky-Station Communications Link

A NEW DEVICE for converting beamed microwave energy to any lower frequency or dc has been operated with 40 per cent efficiency at Raytheon Co.'s Spencer Laboratory, Burlington, Mass.

The microwave rectifier, designated Microfier, is a high-vacuum device which could be used in a sky-station relay link for communications, TV, or other transmission. The stationary sky platform would be powered from the ground by directed, narrow-beam microwave energy.

When the sky-platform idea was first recommended by Raytheon (*ED*, June 10, 1959, p 3) it was suggested that microwave energy could be converted to heat to drive the rotor blades used to keep the platform in the air. If electrical energy was required in the station an inefficient conversion from heat back to dc or a low frequency would probably be required.

The Microfier, however, should be capable of directly converting part of the beamed energy to the required low frequency or dc for electronic equipment at efficiencies in the 70 to 80 per cent range.

The Microfier is a high-vacuum, traveling-wave device, producable using standard vacuum-tube technology. Conversion is accomplished by crossed

Microfier experiment is conducted at Raytheon's Crossed Field Tube Lab by John Jensen, staff engineer. Electromagnets are at left, and a QK625 M-Type backward wave oscillator delivering 200 w of cw at S-band is at right. The converter, with a 2-in. metal band around it, is located between the pole pieces of the electromagnets.

Designed at Raytheon

field interaction of waves and an electron beam.

Using vacuum promises long life and little change in characteristics over long periods, which would be difficult to achieve with ionized-gas filled tubes.

Dc-bias voltages are necessary to operate the Microfier. These can be provided by using some of the converted microwave energy once the tube is in operation, however a small dc power source will be required for starting.

Initial laboratory tests were performed at "hundreds of watts," according to Edward Dench, manager of Raytheon's Crossed Field Tube Laboratory.

"We can foresee levels of tens of kilowatts at least with no difficulties," he said.

Mr. Dench estimated that a Microfier weighing about 20 pounds should be capable of handling power levels of 1 or 2 kw.

Initial Tests at S-Band

The initial Raytheon tests were conducted at S-band using modified rather than specially designed equipment for the experiment according to Dr. John M. Osepchuk, staff engineer, who is in charge of the project.

This laboratory model used about 1/3 of the dc produced for biasing, however with specially designed equipment it should require about 10 per cent of the converted energy to bias the Microfier.

The 40 per cent efficiency was determined by subtracting the dc biasing power from the dc output, and dividing this figure by received power minus a small amount of rf exhaust power which might be used for some application in the sky platform.

Although other applications for the device have not been fully explored, it might find use where it is difficult to install or maintain cables to remote transmitting or relay stations. Beamed microwave energy might be used instead of cables.

Interrogation of sonar buoys is another possible application of the beamed-power technique.

Now that feasibility of the Microfier has been proven, further development is being held up until its use is called for in a specific project, according to Mr. Dench. ■ ■

Optical Tracker Designed For

Circular Scan Locks on Moon Rim Using Motor-Driven Telescope

AN OPTICAL tracking system for terminal guidance of an unmanned moon vehicle has been designed by Aerojet-General Corp., Downey, Calif.

The system is designed to be carried in a 650-lb terminal vehicle about 30-in. in diameter and 52-in. long. The main weight is a retro-rocket, with instrumentation contributing about 150 lb.

The optical tracker locks onto the rim of the moon with a circular scan, modulated to produce a gear-tooth pattern. The output of the optical system is a series of evenly spaced matched pulses over the portion of the circular scan where the moon's rim offers a light-dark contrast. A motor-driven telescope, with its optical axis offset from a stable platform axis, performs the scan.

The system provides automatic measurement of range to the center of the moon, range rate, and angular velocity of the scanning centerline. These measurements, beginning at about 70,000 miles from the moon, increase in accuracy as range decreases.

Several Moon Missions Possible

The present system is capable of several possible moon missions, Robert H. Grube, head of the detection systems analysis section at Aerojet's Avionics Div., told a session of the recent National Specialists Meeting on the Guidance of Aerospace Vehicles in Boston. These include a close approach with subsequent escape to space, circling or orbiting the moon, or making a free-fall or direct impact.

A soft landing would be difficult to achieve without additional instrumentation because the moon's jagged edge introduces important errors with close approaches.

A trajectory which carries the vehicle within 30,000 miles of the moon with a velocity below 7,000 ft/sec is accurate enough for the system.

Instrumentation consists of a tracking telescope, a stable platform, computing circuits, and three servo subsystems. The servos position the telescope, the stable platform, and the vehicle with respect to the stabilized axis.

The platform axis is aligned toward the moon prior to launch, and remains in an inertial mode throughout the launch. Alignment accuracy within

For Guiding Moon Vehicle

a few degrees is all that is required. The vehicle servo subsystem aligns the vehicle longitudinal axis with the stable axis soon after launching, and the vehicle remains in alignment with the platform through the rest of the trip.

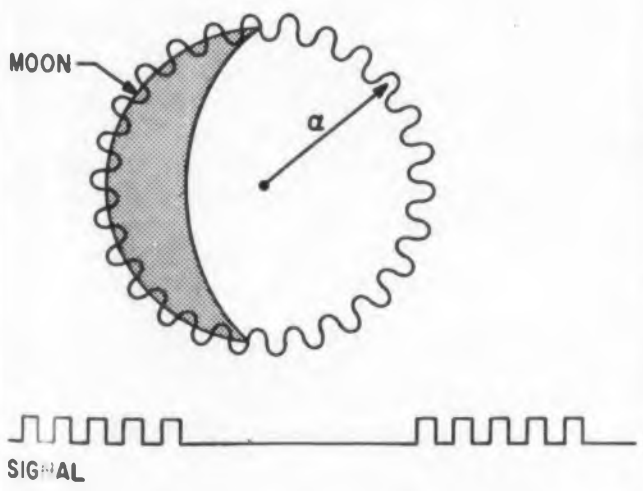
Digital Encoder Reads Moon Angle

The optical tracker in the terminal package consists of a folding parabolic telescope, a photoconductive detector, an oscillating reticle assembly, motors, and gearing for the conical scanning. Amplifiers and logic circuitry, along with a digital encoder for reading the angle across the radius of the lunar disc, are also required.

The distance to the center of the moon is computed by combining this half-angle of the scan with the known radius of the moon. The torque required to orient the scanning axis continuously toward the center of the moon is used to measure $d\theta/dt$, the angular velocity of the scanning axis in space. Radial velocity is obtained by differentiating the range measurement.

Trajectory correction is applied by firing the retro-rocket at the closest point of approach. A small guidance computer is preset to initiate the correction at the proper time.

The signal for firing the rocket might be initiated at this point by either the radial range rate



Circular gear-tooth type scan is used optically to lock onto the sharp discontinuity between the edge of the moon and space beyond. Equal-sized, equally spaced pulses result when system is properly locked on, as shown. Although only part of the scan gives signals with a non-full moon the system interpolates full circle.

or scanning angle rate going to zero, or when the scanning angle rate first indicates a change in sign, Mr. Grube said. Range accuracy is optimum at this point.

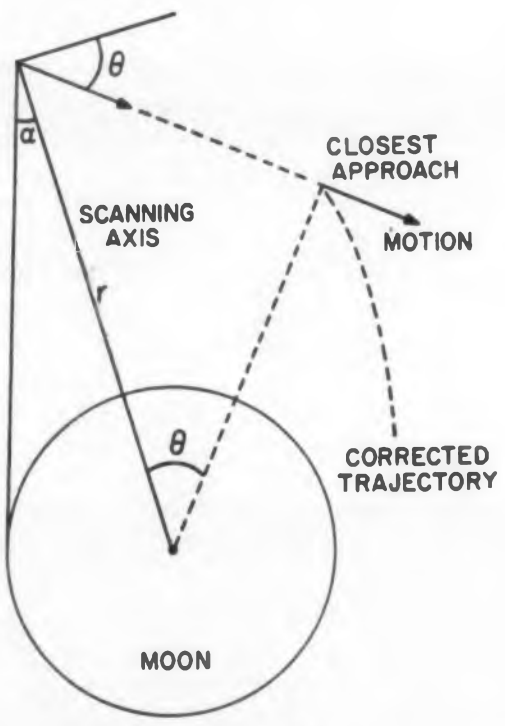
If the rocket impulse brings the horizontal velocity to zero, the vehicle will impact the moon in free-fall. This would give about 14 hours for photography, Mr. Grube estimated.

Since the radial velocity is zero, an impulse to slow the horizontal velocity by a pre-computed amount would result in an elliptical orbit coming as close to the moon as desired.

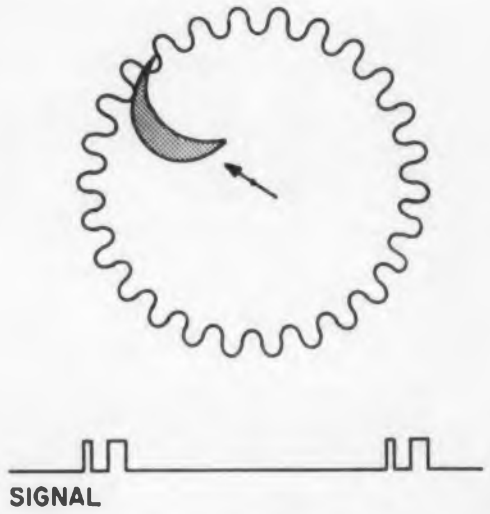
The closest point of approach is not the optimum point for trajectory correction from the fuel economy standpoint, Mr. Grube commented, however it offers the best combination of simple instrumentation, computation and rocket positioning.

Inward Spiral Scan Acquires Moon

Initial acquisition of the moon is accomplished by presetting the scanning angle to a large value, perhaps 10 deg, so that the moon will be inside of the scan during the early phase of the trajectory. The case is set to continuously spiral inward until the moon's rim is acquired. The scan continues to spiral inward until the moon is encircled and the scanning axis is directed at the moon's center.



Retro-rocket applies impulse to give the desired corrected trajectory at the closest point of approach to the moon. The rocket is positioned so that its thrust is opposite to the motion at the correction point. Tracker measurements will indicate $dr/dt = 0$; $d\Theta/dt =$ maximum; and $d\alpha/dt = 0$ at the correction point. Known radius of the moon times cscα results in the r measurement.



In acquisition mode, scan spirals inward until it encircles the moon.

If the scanning radius becomes too large the pulses become too narrow because the telescope is directed at the bright portion of the moon during only a short portion of the scan. Conversely, pulses become too wide when the scanning radius becomes too small. If the scan shifts in X or Y directions, unequal pulse widths result.

Corrections are automatically generated to compensate for these errors.

If the scan is jarred off the moon's rim onto the inner edge of a crescent moon, the logic will cause the scan to spiral to zero. The scan will then be expanded and reacquisition follows.

One of the most difficult conditions is a nearly-full moon. The system might lock on the junction between light and dark areas on the surface. The poor discontinuity between the light and dark areas of the moon's face compared to the sharp discontinuity between the moon's rim and space beyond might be used to correct this possible error, Mr. Grube commented.

Best accuracy can be obtained, he said, with a short wavelength optical system—perhaps an infrared one.

MIT Studies Aim Toward Improved 3-Color TV Stability

Studies of the two-color L and color television scheme in progress at Massachusetts Institute of Technology have confirmed the outstanding picture stability provided by the system, according to an MIT researcher.

Understanding of the reasons for this stability may lead to improvements in stability of the present red-blue-green system. The Land system, developed by Dr. Edwin H. Land, president of Polaroid Corp., Cambridge, Mass., uses only red and white.

NEWS

New Thermoelectric Device

THE CAPABILITY of sudden, unsuspected attack represents the key weapon of a modern submarine; take away the element of surprise and the undersea craft is relatively unarmed. To avoid the ever-increasing submarine-detection systems, noise must be reduced to an absolute minimum, said Lt. Cmdr. Peter G. Beierl, U.S.N., in his keynote speech to more than 125 engineers attending New York Univ.'s course on Thermoelectric Materials and Devices, this spring.

The Navy is seeking thermoelectric power generators and cooling systems for use in nuclear-powered submarines, Commander Beierl explained, as a means for propulsion, food storage over long periods, and air conditioning. Since moving parts are reduced to a minimum (water-circulating pumps, for example, would still be required), quiet operation with inherently improved reliability are to be expected compared to existing equipment. Although space is at a premium inside a submarine, he said, thermoelectric devices could be stacked in small unused areas throughout the interior rather than the large central area now required for conventional generators. Finally, Commander Beierl indicated that the simplified maintenance anticipated could reduce the crew complement as a further saving in space and needed supplies. Efficiencies in the order of 12 per cent would be considered competitive with present power systems in submarines. To bring this goal closer to reality, the Navy is spearheading the quest for improved thermoelectric materials.

Following Commander Beierl's keynote talk, various phases of T-E research were outlined. Since the "figure of merit" of a thermoelectric material is inversely proportional to electrical resistivity and thermal conductivity, scientists are searching for new materials with low values for both quantities. Properties of bismuth telluride, lead telluride, ternary semiconductors, refractory and ionic materials, molten salts and liquids were discussed in terms of thermoelectric possibilities.

In addition, thermionic emission and plasma devices were outlined. The course in Thermoelectric Materials and Devices was presented by the Metallurgical Dept. of the NYU College of Engineering and the Office of Special Services to Business and Industry with Dr. Irving Cadoff course chairman.

USSR T-E Efforts Cited

Soviet advances in thermoelectric power generation and refrigeration were presented by

Sought for Navy Subs

Cmdr. C. G. Spoerer, Bureau of Ships. Russian efforts to apply the Peltier effect for refrigeration began in 1950, headed by Prof. A. F. Ioffe of the Leningrad Physico-Technical Institute of the Academy of Sciences. By 1953, a prototype of a 0.35 cu ft cooling capacity refrigerator was completed. The unit required 25 w to maintain a 4 C chamber temperature from a 27 C ambient; steady-state operation was reached four hours after startup. The figure of merit of the materials was about 1.23 x 10^{-3}/C and the coefficient of performance was 20 per cent with a 40 C temperature difference across the elements.

In 1954, a 1.92-cu-ft unit was developed reportedly using n-type lead telluride-arsenide and p-type tellurium-antimony alloy. In 1956, the first semicommercial refrigeration was built in Leningrad; the capacity was 1.4 cu ft with insulation approximately 4.75 in. thick. The unit was designed to operate from 127-v ac house supply mains with rectification by means of germanium diodes. About 75 w were required during start-up with 55 w necessary after the steady-state temperature was reached. Latest efforts include commercial refrigeration units which have been tested in Soviet TU-104 passenger jet planes.

Soviet Active in Field

The famous Soviet TGK-3 kerosene-fueled thermoelectric generator was mass-produced in 1953. The heat from the kerosene lamp was applied to zinc antimonide and constantan thermoelements and 3-w output was obtained, sufficient to power a radio receiver. The temperature difference was reported to be 30 C. The TGK-3 provided 0.5 amp at 2 v for filament supply and 2 amp at 2 v for a vibrator to produce higher plate potential. By 1956, an improved version (TEGK-2-2) was made with 4-w output; enough couples were included in the plate supply to eliminate the vibrator; plate supply input was 9 ma at 100 v.

By 1958, a 15-w generator (TGU-1) was developed for transceiver applications to establish communication between central agricultural stations and field tractors. Other devices developed included 200-w and 500-w generators using wood or gasoline as fuel. A 40-w solar thermoelectric generator was built in 1956 and a 100-w unit is reported in operation.

Soviet goals for 1961 include the development of thermoelements with efficiency of 15 per cent and service life of 20,000 to 30,000 hrs. ■ ■

NEWS

Independent Inventor's Importance Cited in Statistical Research

The independent researcher has not been lost in the shadows of the giant corporations with their teams of skilled scientists and engineers.

This conclusion was reached by Dr. Daniel Hamberg, professor of economics at the University of Maryland, in the June issue of "Challenge" magazine, a New York University publication.

In his article, Dr. Hamberg pointed out that:

- Of 61 important inventions made since 1900, 33 were the products of independent inventors, six were the products of research conducted in laboratories of small to medium-size firms, and only 11 can be traced unqualifiedly to the laboratories of giant corporations.
- Manufacturing companies employing 5,000 or more persons account for some 70 per cent of R&D carried on in manufacturing industry.
- In contrast, manufacturing firms employing less than 500 people account for only 10 per cent.

Dr. Hamberg made it clear, however, that the statistics contain several important qualifications:

- The figures refer to performance, not to amounts of sources of research financing.
- The data also show that for any size group of firms, there is great variation in R&D expenditures from industry to industry. The bulk of unsubsidized research is concentrated in three or four industries.

Glass Disc Holds Dictionary In Russian-English Translator

A 10-in. glass disc holding coded Russian words, idioms, and phrases paired with English meanings serves as the memory unit in an experimental translator. The data are arranged in 700 concentric tracks in an annulus 0.36 in. wide.

According to the translator's developer, International Business Machines Corp., a Russian dictionary of about 55,000 word stems has been compiled so far. With the word endings also listed, this is said to correspond to about a half million words as they appear in text.

The data on the disc are read by a light source from a cathode-ray tube. As the disc rotates at 1400 rpm, the light beam scans each track searching for a match to the input Russian text. When a proper match is found, the corresponding English meaning is read out.

If at any time the transistor finds a word not in its dictionary, it signals the output printer to print this word in red for later addition to the disc

memory. Proper names and nouns are also printed in red.

Right now, the system is said to be capable of translating at a rate of 1,800 words a minute. The company is currently pursuing research in automatic print reading and is supporting a development program at Baird-Atomic Corp., Cambridge, Mass. By the end of the year, it is expected that high-speed equipment will read printed material and feed it to the system at a rate of 2,400 words a minute.

Also under development is a word analyzer that will improve the translator's grammar, the company says. The analyzer will be designed to scan entire sentences and determine the correct grammatical role of each word. This approach is similar to the process called predictive analysis now being used at the Harvard Computational Laboratories (*ED*, March 30, p 22).

The company's Russian translation program has been carried out mostly under contract to the Air Force's Air Research and Development Command. While the Air Force is mainly interested in Russian technical information, applications of the translator are seen in other areas of science, industry, and government.

Soundproofing Seen as New Use For Rigid Polyurethane Plastic

Rigid forms of Stafoam polyurethane plastic may provide superior soundproofing of terminal and junction boxes, telephone booths, consoles, and cabinets.

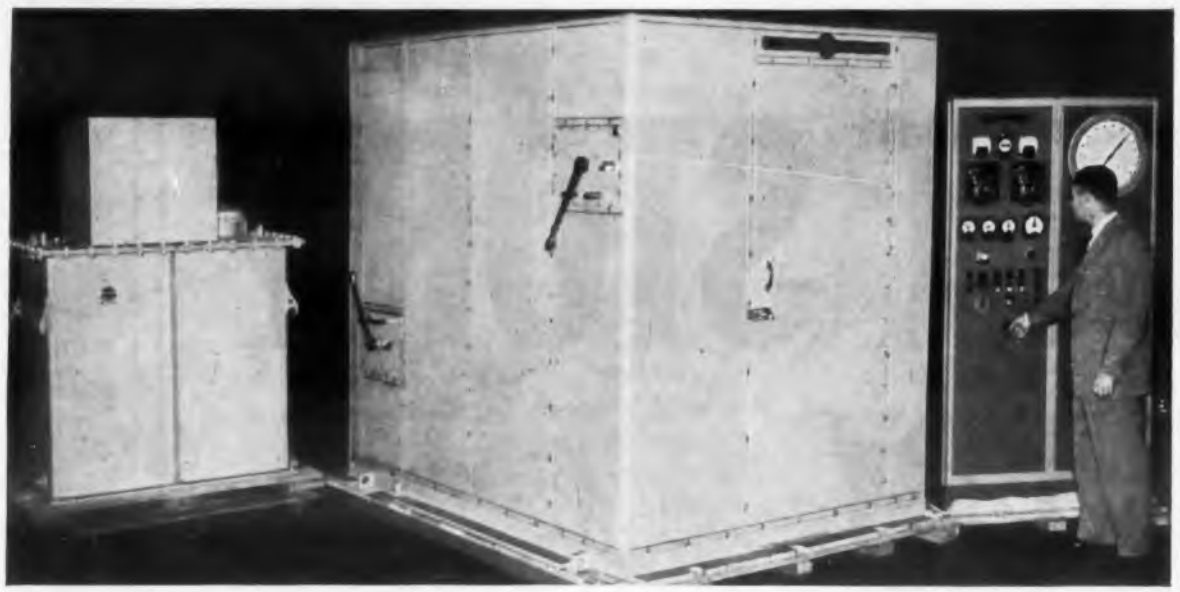
According to reports from Freedlander Research and Development Laboratory, American Latex Products Corp. of Hawthorne, Calif., cast urethanes not only provide exceptional acoustic damping, but the lightweight material can be made strong enough to form the entire protective box cover or cabinet wall. Console cases could be fabricated from urethane with the single material providing structure, thermal insulation, and soundproofing, the company says.

Stafoam urethane can also be sprayed or poured in liquid state on the interior walls of metal or fiber glass cabinets providing both soundproofing and increased structural strength, according to the maker. A chemical reaction causes the material to foam, completely filling all voids and cavities, bonding itself to the shells as it rapidly becomes rigid at room temperatures.

Stafoam urethane is also adaptable for insulating, cushioning, and potting transformers, and other electronic devices, because of ability to be poured through tiny openings, Freedlander reports. Dielectric constants and power factors also lend themselves to electrical applications.

PROJECT '60s: DESIGN NOW FOR THE GREAT YEARS AHEAD ... with GENERAL ELECTRIC electronic components

Most electronics manufacturers face the continuing challenge of staying ahead of obsolescence. These General Electric components, designed specifically for the needs of the '60s, can help solve that problem.

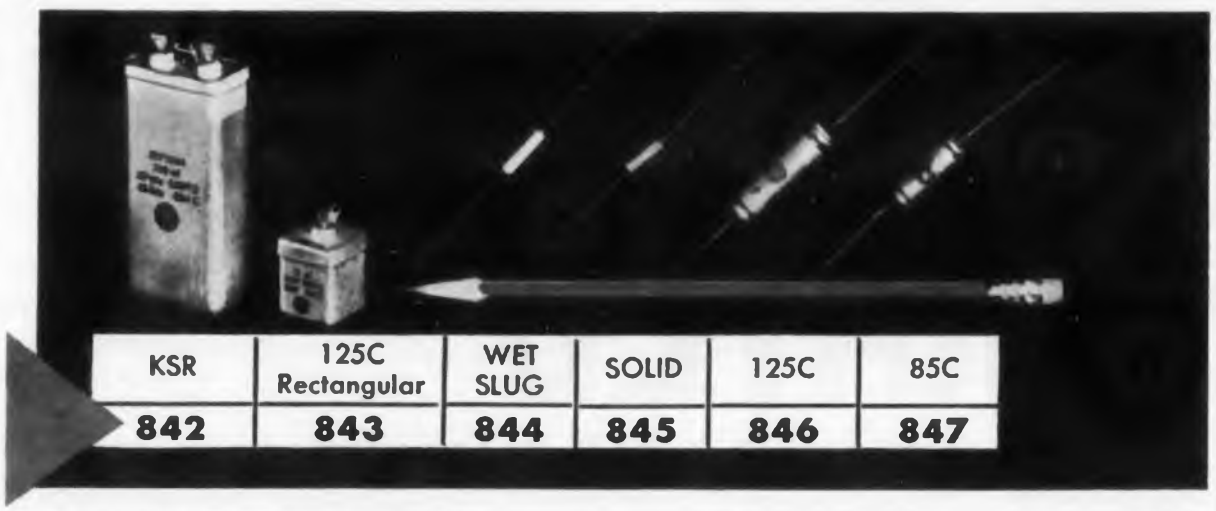


Custom-built d-c power supplies such as this silicon rectifier unit (designed to charge a 7,000,000 joule capacitor bank every 15 minutes) give you efficient power to meet special requirements. G-E power supplies can be designed to meet virtually *any* high-voltage d-c requirement from approximately 10-kv to 1000-kv, d-c, and from milliampere values to 250 amperes. Save time, space, and money by specifying G.E. Our Holyoke, Mass. plant stands ready to supply the units you need.

For more information, circle 840 on reader service card.

AC and DC BIG LOOK Panel Meters are now available in a complete family, including 2½-, 3½-, and 4½-inch designs. BIG LOOK meters give you truly distinctive appearance, excellent readability and extra-long operating life. With the BIG LOOK design, you get up to 28 percent scale increase, large numerals which cannot be obscured by the pointer and elimination of shadows. Self-shielded mechanism on d-c meters eliminates interaction.

Circle 841 on reader service card.



The complete line of General Electric Tantalytic* capacitors fills a wide range of critical electronic applications. Small in size and unsurpassed in reliability, G-E Tantalytics perform within specification requirements even at environmental extremes.

For more information about General Electric Tantalytic capacitors, circle these numbers on the reader service card.

KSR	125C Rectangular	WET SLUG	SOLID	125C	85C
842	843	844	845	846	847

* Registered trademark of General Electric Co.

671-01

GENERAL ELECTRIC

NEW PRODUCTS

NEW Tantalytic Capacitors in ratings to 300 volts

The General Electric Company has announced the availability of a new high-voltage foil capacitor, rated to 300 volts at 85C and 250 volts at 125C, in both polar and non-polar designs. The new units are smaller than any previously available capacitor with similar voltage ratings and also provide size and weight advantages over series arrangements of lower voltage units.

Circle 848 on reader service card.

NEW Radar Transformer

Typical of G.E.'s line of custom-designed high-voltage transformers, this new 1800-lb pulse unit has a specially developed molded epoxy bushing for operation above 250 kv. It incorporates a special series reactor for protection from load transients. The new unit is still another example of the wide range of specially engineered high-voltage transformer products available from General Electric.

For more information on these and other specialty transformers, circle 849 on reader service card.

EDITORIAL

High Hopes for WESCON

Each year, every electronics show or convention is expected to be "bigger and better than ever." Certainly this year's WESCON shows every promise of living up to this customary expectation.

The convention is housed in Los Angeles' new Memorial Sports Arena and a new annex adjacent to the building—both fully air conditioned. New equipment, systems, and components will be displayed in 958 booths. (New items being shown for the first time are reviewed in this issue on p 106 to p 199.) More than 200 authors and panelists will participate in the technical program which includes 44 sessions (see p 28).

Finally, many interesting trips to local electronics plants are scheduled, and the usual popular social events and activities should make WESCON a bang-up affair this year. (More details on p 26.)

We shall be especially interested in observing the operation of the "new approach to the effective interchange of advanced electronic engineering concepts," promised for the technical session.

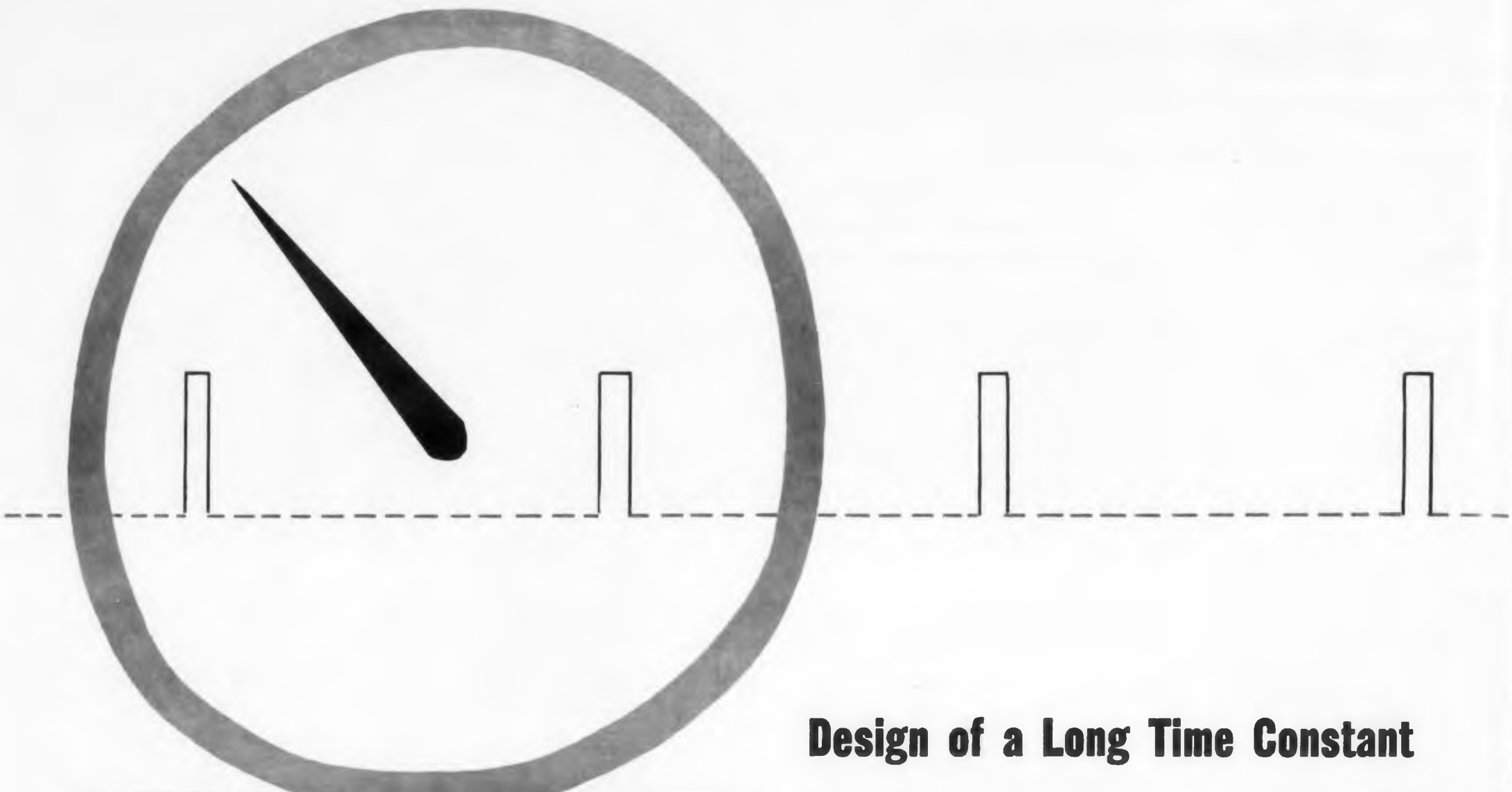
Making preprints available at registration time, arranging special panel-discussion sessions on questions arising out of the day's formal talks, exploring a broader range of subjects such as "The Woman's Role in Engineering" and "Working with Engineers," and attempting to brief speakers on better techniques of oral presentation are highly commendable program-committee efforts to make a WESCON visit really profitable.

We shall be adding our bit to these efforts as well. We shall once again be publishing ELECTRONIC DAILY, covering WESCON activities during the show. We shall be on hand at Booth 2714-5 to say hello and to answer questions about ELECTRONIC DESIGN. We'd like to hear your comments on the magazine; we'd like to get to know you. But especially, we'd like to talk over your articles or ideas for articles.

We have three major specifications for articles in ELECTRONIC DESIGN. First, the article must have solid, interesting information. Second, it must be practical. Third, it must be aimed at design engineers. If you think that your article, outline, or just plain idea for an article meets these specs, please come along and talk to us. We think we can help you enhance your career and make a little money on the side.

See you at WESCON!

Edward E. Grazda



Design of a Long Time Constant Asymmetrical Transistor Multivibrator

Long time constant asymmetrical multivibrators are often inefficient in terms of supplying sufficient current for relays or stepping switches. The design steps, together with a special Equation Derivation section, are presented as an aid in such applications. A typical design example is outlined to illustrate the procedure.

Maury I. Marks*

Electronic Development Section
International Resistance Corp.
Philadelphia, Pa.

AN ASYMMETRICAL transistor multivibrator followed by a driver stage is often used to supply brief intervals of power every few seconds to a relay coil or stepping switch. With proper circuit design, including most efficient load placement, the driver stage can be eliminated with subsequent decrease in overall complexity, number of components and cost.

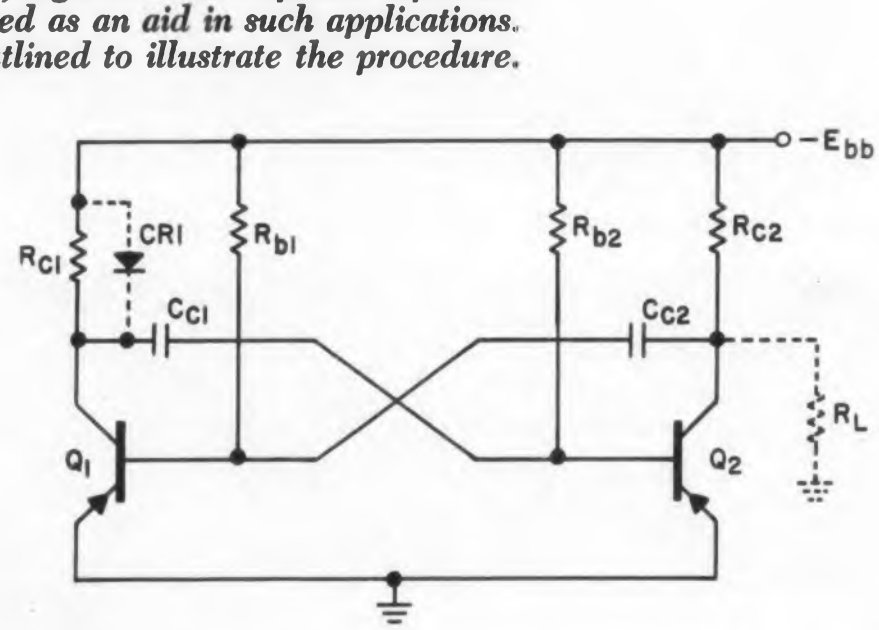


Fig. 1. An asymmetrical free running transistor multivibrator with load (relay coil R_{c1}) in the collector of briefly conducting Q_1. An alternate load position, in series with collector resistor R_{c2}, is wasteful of power.

Large Base Resistor Limits Collector Load

A free-running transistor multivibrator which has a long period, on the order of seconds, must employ very large cross coupling capacitors to achieve long time constants. Because the capacitors are usually the largest in physical size and the heaviest in weight of the circuit elements comprising the multivibrator, they limit the minimum physical size and weight of the circuit. Also, large value electrolytic capacitors have the further dis-

*The work described above was done while the author was employed at American Electronic Laboratories, Philadelphia, Pa.

advantages of changing capacity with age and ambient conditions.

Since the RC product determines the time constants, the circuit designer may be tempted to use very large base resistors and smaller cross-coupling capacitors to attain the desired periods. However, it is the base resistor which determines the collector load of the transistor for saturated operation. Saturated operation is often desirable, since nearly all of the available supply voltage is applied to the load when the transistor is in the conducting state.

If a large value base resistor is used, then the collector load must be correspondingly light. If a heavy load, such as a relay coil, is to be driven from the multivibrator, an extra stage of gain must often be added to the circuit. This extra stage increases the cost, the complexity, the number of components and reduces statistically the reliability of the circuit.

Asymmetrical Multivibrator Characteristics

In many cases, the two time constants of the multivibrator are unequal. That is, one of the two transistors may be in conduction for a period of seconds, and the other for a period of milliseconds. The application of power to the coil of a relay or stepping switch with regularity every few seconds is one very common application of the asymmetrical transistor multivibrator. By employing a very large base resistor and small cross-coupling capacitor to achieve the longer of the two time constants it is possible to drive a heavy load without wasting power.

To see what is meant by wasting power, consider the free running multivibrator of Fig. 1 and its waveforms shown in Fig. 2. If power is to be applied to a load for the shorter period of time t_1, the load can be placed in either of two positions. Since Q_1 is conducting during the time t_1, Fig. 2a, the load could comprise the collector resistor R_{c1} or, since Q_2 is cut off during the time t_1, Fig. 2c, the load could be driven from the collector of Q_2 (shown dotted in Fig. 1). The latter of the two possibilities is wasteful of power since R_{c2} must be made necessarily small to obtain maximum voltage across R_L when Q_2 is cut off. However, Q_2 is conducting most of the time and the small R_{c2} would be draining unnecessary current from the supply when no current would be required at the load.

Design Equations

The operation of a free-running transistor multivibrator such as that shown in Fig. 1 is governed by the time constants R_{b1}, C_{c2}, and $R_{b2}C_{c1}$. Transistor Q_1 will be in conduction for 0.7 $R_{b2}C_{c1}$ sec, and Q_2 will be in conduction for 0.7 $R_{b1}C_{c2}$ sec. To obtain maximum voltage variations at the collectors, the transistors should be saturated when in the "on" or conducting state. Then the collector voltage will vary between E_{bb} and zero volts (actually about 0.3 v).

The base current of either transistor will be essentially E_{bb}/R_b when in saturation, and the collector current E_{bb}/R_c. Also the current gain of the transistor, B, multiplied by the base current must be greater than the collector current for saturated operation; therefore, $\beta \frac{E_{bb}}{R_b} > \frac{E_{bb}}{R_c}$. Rewriting this inequality, $R_c > \frac{R_b}{\beta}$.

Thus R_b limits the collector load R_c.

For example, if the multivibrator switched states every 3.5 sec, the circuit parameters might assume the following values:

$$R_{b1} = R_{b2} = 100 \text{ K}; \; C_{c1} = C_{c2} = 50 \; \mu\text{f}.$$

The collector resistors, for a beta of 50, should then be greater than 2 K. However, when the conduction times of the transistors are unequal, such as shown in Fig. 2, the collector load of the transistor which is in conduction for the shorter period of time can be made independent of its base resistor. In the case shown, t_1 is less than t_2, and R_{c1} is independent of R_{b1}. The following relationships are derived in the Equation Derivation Section:

(1) $t_1 = 0.7 \; R_{b2} \; C_{c1}$

(2) $t_2 = 0.7 \; R_{b1} \; C_{c2}$

(3) $R_{c1} > \frac{R_1 + R_{c2}}{\beta} \left(e^{\frac{t_1}{(R_1 + R_{c2}) C_{c2}}} \right)$

provided $t_1 > 2(R_i + R_{c2})C_{c2}$

R_i is the input resistance of the transistor.

A design example will illustrate the usefulness of Eqs. 1, 2, and 3.

Typical Design Example

A relay is to be energized for a period of 35 msec, every 3.5 sec. The transistors to be used have a beta of 50.

1. First calculate C_{c2}.

$$t_2 = 0.7 \; R_{b1} \; C_{c2}$$

$$C_{c2} = \frac{3.5}{0.7 \; R_{b1}}$$

Since Q_1 is in conduction for the shorter period of time, t_1, its base resistor R_{b1} does not limit R_{c1}.

(Continued on p 72)

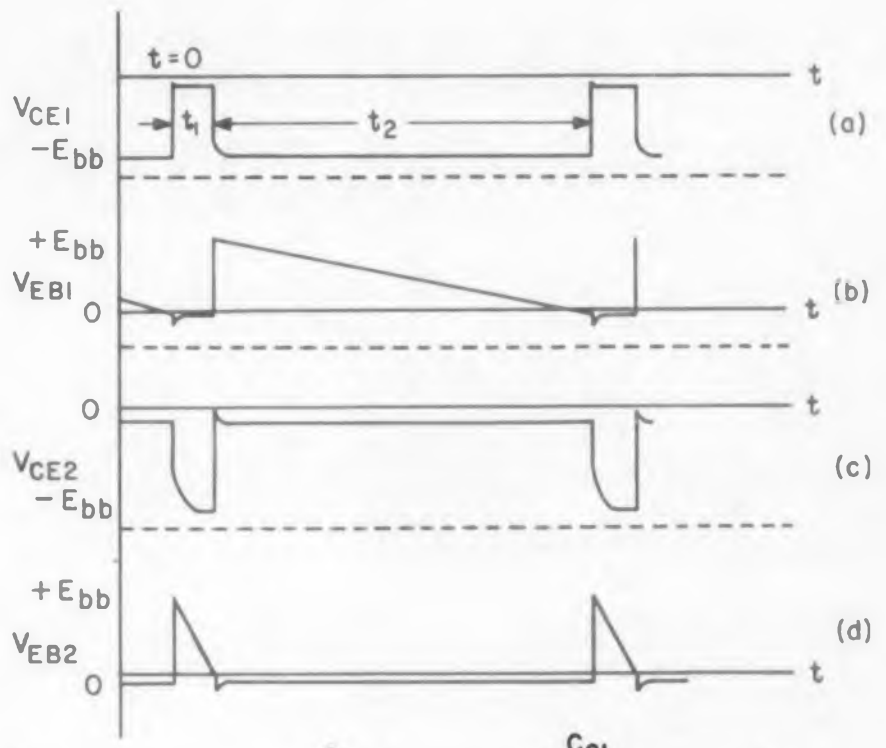
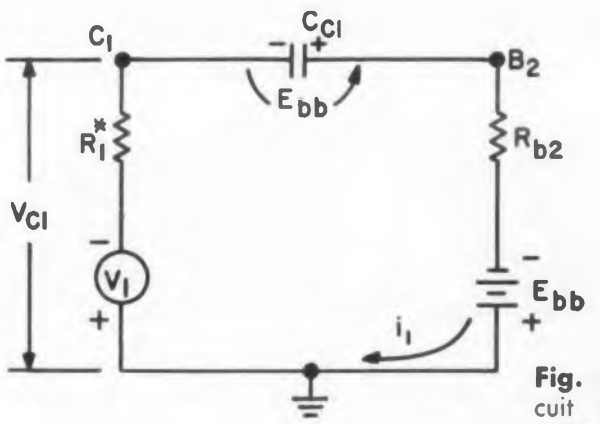
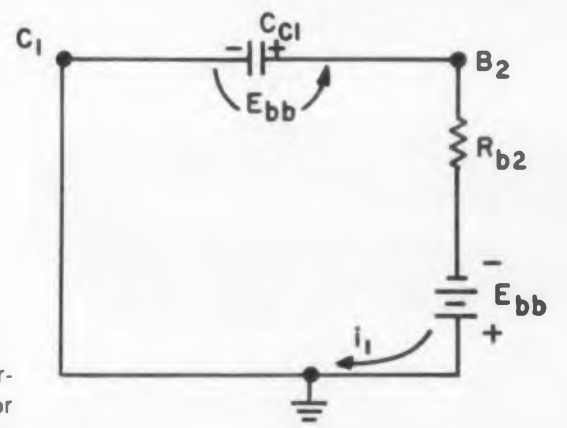


Fig. 2. Waveforms of asymmetrical multivibrator. Transistor Q_1 conducts for a short time, t_1, while Q_2 operates over a substantially longer period, t_2.

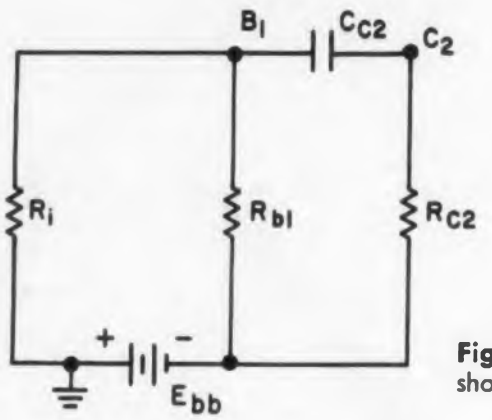


(a)

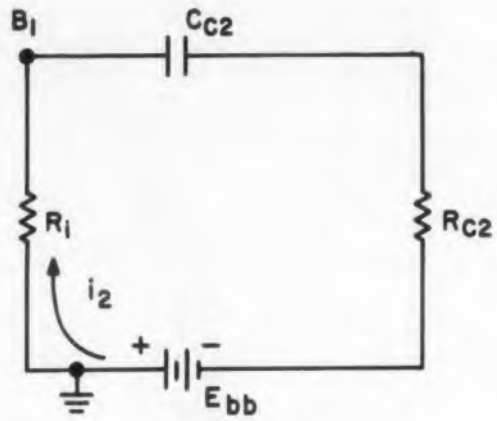


(b)

Fig. 3. Equivalent circuit of the transistor multivibrator with Q_1 just turned "on."



(a)



(b)

Fig. 4. Equivalent circuit showing Q_2 turning "off."

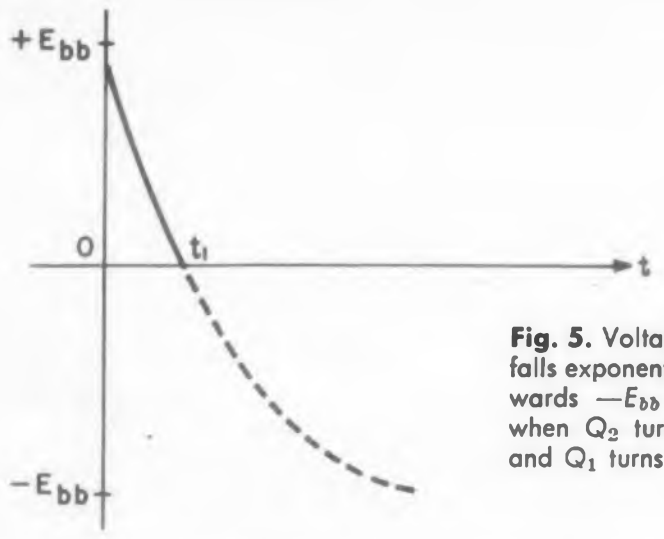


Fig. 5. Voltage V_{EB2} falls exponentially towards $-E_{bb}$ until t_1 when Q_2 turns "on" and Q_1 turns "off."

Therefore, R_{b1} is made as large as feasible. It is important to note that R_{b1} is limited by the back-biased emitter to base resistance of Q_1, and by the leakage resistance of C_{c1}. These two resistances appear in parallel with R_{b1} when Q_1 is "off." $R_{b1} = 1$ meg is a reasonable choice.

$$C_{c2} = \frac{3.5}{0.7 \times 10^6} = 5\ \mu f$$

2. Next calculate R_{c2} from $t_1 > 2\ (R_i + R_{c2})\ C_{c2}$ R_i, the input resistance of the transistor, is a function of the load; however, it usually ranges from 1 K to 2 K. Assume $R_i = 2$ K.

$$35 \times 10^{-3} > 2\ (2 \times 10^3 + R_{c2})\ 5 \times 10^{-6}$$

$$R_{c2} < \frac{7 \times 10^3 - 4 \times 10^3}{2} = 1.5\ \text{K}$$

3. R_{b2} is determined from $R_{b2} < (\beta)(R_{c2})$ (for saturation)

$$R_{b2} < 50 \times 1.5\ \text{K}$$

$$R_{b2} < 75\ \text{K}$$

Let $R_{b2} = 70$ K

4. C_{c1} is determined from Eq. (1)

$$C_{c1} = \frac{t_1}{0.7\ R_{b2}} = \frac{35 \times 10^{-3}}{0.7 \times 70 \times 10^3} = 0.715\ \mu f$$

5. R_{c1} is then calculated

$$R_{c1} > \frac{R_1 + R_{c2}}{\beta}\ e^2$$

$$R_{c1} > \frac{2 \times 10^3 + 1.5 \times 10^3}{50} \times 7.4$$

$$R_{c1} > 518\ \text{ohms.}$$

Thus, the dc resistance of the relay must be greater than 518 ohms. The diode CR_1 shown dotted in Fig. 1 protects the transistor from the back emf of the relay coil when Q_1 goes from conduction to non-conduction. E_{bb} is selected on the basis of the wattage rating of the relay.

$$E_{bb} = \sqrt{W\ R_{c1}}$$

Finally, the maximum collector to base voltage rating of the two transistors must be greater than $2E_{bb}$ (see Fig. 2). ■ ■

Asymmetrical Transistor Multivibrator Equation Derivation

Consider Figs. 1 and 2. Assume Q_1 has just turned "on," and is in saturation, and Q_2 is turning "off." This instant of time will be designated as $t = 0$. Between the collector of Q_1 and ground, a voltage generator V_1 is seen in series with R_1^* (Fig. 3a). This combination represents the theveninized equivalent of the transistor Q_1 in saturation. V_1 represents the collector to emitter drop of Q_1, and R_1^* is the impedance seen looking back from the collector.

1. $R_1^* = \dfrac{R_{c1}R_{o1}}{R_{c1} + R_{o1}}$; R_{o1} is the output impedance of $Q_1 \left(\dfrac{1}{h_{oe}}\right)$

If $R_{o1} \gg R_{c1}$, $R_1^* \approx R_{c1}$

The initial voltage across C_{c1} is E_{bb} with the polarity indicated in Fig. 3a. For, in the previous half cycle, the collector of Q_1 was at $-E_{bb}$ (Q_1 was "off"), and the base of Q_2 was at a very small negative voltage (Q_2 was hard "on"). During the switching time, C_{c1} loses a negligible amount of charge; thus, its voltage before Q_1 turns on is essentially its voltage at $t = 0$.

The following assumptions are now made, which are in most cases quite reasonable:

1. $V_1 \ll E_{bb}$
2. $R_1^* \ll R_{b2}$

Thus, the equivalent circuit of Fig. 3a simplifies to that of Fig. 3b. At $t = 0$, the following conditions exist:

(1) $V_{c1} = 0$
(2) $V_{EB2} = E_{bb}$

At $t = \tau_1$, $V_{EB2} = 0$ (See Fig. 2d).

Therefore, (2) $V_{EB2} = E_{bb}\left(2e^{-\frac{t}{R_{b2}C_{c1}}} - 1\right)$

Fig. 5 shows that V_{EB2} is falling exponentially to $-E_{bb}$; however, at $t = \tau_1$, Q_2 becomes forward biased, regenerative action takes place, Q_2 turns "on," and Q_1 turns "off." Therefore, the equivalent circuits of Fig. 3 are valid only from $t = 0$ to $t = \tau_1$.

Substituting in Eq. 2, $t = \tau$, and $V_{EB2} = 0$.

Eq. 3 is obtained.

3. $0 = E_{bb}\left(2e - \dfrac{t}{R_{b2}C_{c1}} - 1\right)$

4. $t_1 = R_{b2}\ C_{c1} \log_e 2$
5. $t_1 = 0.693\ R_{b2}\ C_{c1}$

Thus a relationship has been established between two

circuit parameters, and the "on" time of Q_1. In a like manner, the "on" time of Q_2 is defined by

(6) $t_2 = 0.693\ R_{b1}\ C_{c2}$

The analysis up to this point is of an introductory nature, and is entirely conventional. The usual design procedure from this point on is as follows:

R_{b2}, C_{c1}, R_{b1}, C_{c2} are selected on the basis of Eqs. 5 and 6. To insure the transistors operating in saturation so that the collector voltage swings will be maximized, the resistors $R_{c1,\ 2}$ are selected from Eq. 7.

(7) $R_{c1,\ 2} > \frac{R_{b1,\ 2}}{B}$ where B is defined as the dc current gain of Q_1 and Q_2 from base to collector.

It will be shown now that R_{c1} is actually independent of R_{b1}, and can be made much less than its value determined from Eq. 7, provided $t_1 < t_2$. Fig. 4 shows the equivalent circuit depicting the turning "off" of Q_2. R_i is defined as the dc input resistance of Q_1. The following conditions prevail:

1. Q_1 has just turned "on"; therefore, its base is at zero volts.

2. Q_2 was just "on," thus its collector, at the instant of switching also is at zero volts.

3. The preceding two conditions show that C_{c2} is not charged. (Actually, C_{c2} is charged to a voltage which is the difference between the steady state collector saturation voltage of Q_2 (about —0.3 v) and the base voltage of Q_1, at which switching occurs (about —0.3 v). With respect to an E_{bb} as low as 5 v, the voltage across C_{c2} can still be considered zero.)

4. R_{b1} is much greater than R_i or R_{c2}.

Thus, before the collector of Q_2 can drop to $-E_{bb}$ (turn "off"), C_{c2} must become charged. It is the charging current of C_{c2} which makes R_{1c} independent of R_{b1} for the time t_1. Neglecting R_{b1}, for the moment, it can be seen from Fig. 4b that

$$(8)\quad i_2 = \frac{E_{bb}}{R_i + R_{c2}} \left(e^{-\frac{t}{(R_i + R_{c2})\ C_{c2}}} \right).$$

The collector current of Q_1 is B_{i2}. If Q_1 is to be in saturation,

$$(9)\quad iB_{i2}\ R_{c1} > E_{bb}$$

Substituting Eq. 8 in 9

$$(10)\quad E_{bb} < \frac{B\ R_{c1}\ E_{bb}}{R_i + R_{c2}} \left(e^{-\frac{t}{(R_i + R_{c2})\ C_{c2}}} \right)$$

This condition must prevail for the time t_1, so solving (10) for R_{c1}

$$(11)\quad R_{c1} > \frac{R_1 + R_{c2}}{B} \left(e^{\frac{t1}{(R_i + R_{c2})\ C_{c2}}} \right)$$

It is important that V_{CE2} approach $-E_{bb}$, therefore the time constant in Eq. 8 $(R_i + R_{c2})C_{c2}$ should be less than t_1. Thus, the last condition is established $t_1 > 2(R_i + R_{c2})C_{c2}$. It is interesting to note that the operation of the multivibrator is independent of E_{bb}.

A Reliability Quiz

B. E. Phillips
The Martin Co.
Baltimore, Md.

B. E. Phillips' "Reliability Quiz" should be fun for lots of engineers—and not so much fun for others. A good reliability engineer should be able to answer his questions in 12 minutes. Can you? Mr. Phillips' responsibility for reliability work on the ground support equipment of Mace, Pershing, and Titan qualify him well for the responsibility for this quiz.

WE TALK and talk about reliability and think we have explained everything to everybody. Then we find a man with a great big gap in knowledge and understanding. Finally, we list things every reliability engineer should know so each one can see what he needs to learn. To make the list more palatable, we twist it around and convert it to the form of a quiz.

The quiz is designed for three purposes and thus is not ideal for any one of them. The purposes are:

1. To measure the knowledge and progress of reliability engineers at Martin-Baltimore.
2. To show engineers who aren't reliability specialists the types of special information they can expect a reliability engineer to bring to their project.
3. To help evaluate an applicant for reliability work.

To use the jargon of educational test specialists, this quiz is not validated nor are the questions "reliable." To validate the quiz would require a large sample of highly competent reliability engineers not readily available. The major purpose is stimulation, rather than measurement.

Some of the questions are of the background type—the answers in themselves are not necessarily nuggets of reliability information but give a pretty firm indication as to whether the respondent has had to deal with similar questions before. Some of the questions have highly debatable answers but still provide interesting responses.

The answers are given at the end of this article. If you disagree violently, please write the author and send a copy to ELECTRONIC DESIGN. Several people helped collect these questions, and we are sure there are many more good ones. If you can think of some, send them in.

THE QUIZ

1. Define reliability.
2. State two numerical measures of reliability.
3. Define series components.
4. Define parallel components.
5. State the formula for reliability when constant failure rate applies.
6. Define "frit."
7. State the two important stresses on resistors.
8. State the two important stresses on capacitors.
9. State an important stress on relays.
10. What per-cent of troubles in operation of early production military equipments has been found to be caused by engineering errors?
11. State two important stresses on semiconductor diodes.
12. What is the approximate numerical value of $e^{-0.001}$?

    What is the approximate numerical value of $e^{-1.0}$?
13. What fraction of devices will operate for a time equal to their mean time between failures?
14. If a device is "qualification tested" so that 1,000 hr of operation without failure result, what can be said about the failure rate of the device?
15. Solve for x: $e^{-x} = 0.05$.

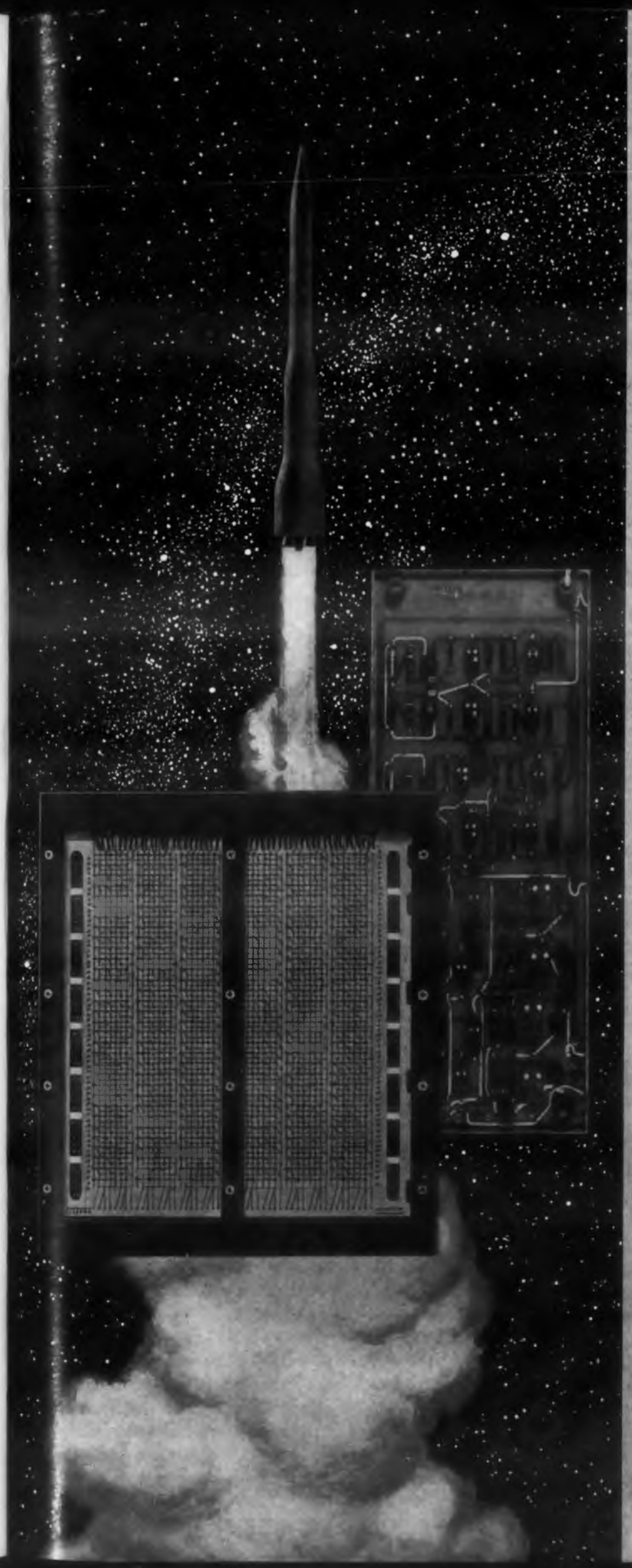
    Solve for x: $e^{-x} = 0.50$.
16. What industrial association is very active in reliability?
17. What professional society is very active in reliability?
18. What business organization is very active in reliability research?
19. Name five individuals known nationally for their reliability activities.
20. Name two government officials with top responsibilities for reliability.
21. Name three phases in the life of a product in which reliability control is important.
22. Which statistical distribution is useful in determining confidence limits for failure rates based on tests for a predetermined number of failures?
23. What is the statistical test which allows the comparison of two failure rates based on tests for a predetermined number of failures?
24. If a reliability prediction, completed before release of drawings to factory, shows too low a reliability level, what is the most immediate engineering action indicated?
25. Rate the following means of attaining reliability in order of decreasing value: Derating of parts, degrading of performance, redundancy, failure reporting, failure analysis, conversion to solid-state, reliability posters, indoctrination lectures, reduction of functions, circuit analysis, reliability predictions.
26. Name three government specifications on reliability.
27. What does the abbreviation AGREE mean?
28. If the MTBF of a system is required to be 100 hr, how much sequential testing may be necessary to demonstrate its reliability with 90 per cent confidence?
29. Which phrase is most closely associated with MTBF? Average life, minimum time to failure, reciprocal of failure rate during period of life when failure rate is constant.
30. Which phrase is most closely associated with life? Average time to failure, time when failure rate becomes too high, time when 50 per cent have failed.
31. State three items of information necessary for a successful reliability program.
32. Name three books that contain substantial information on parts failure rates.
33. Name the three commonly mentioned reliability states in the life of a device.
34. In the following chronological phases of product development, which is the earliest one where reliability effort is valuable? Advanced design, detail functional design, product design, procurement, experimental fabrication, production, customer use.

(Answers on p 76)

A Reliability Quiz *(continued)*

THE ANSWERS

1. Reliability is the probability that a device will perform satisfactorily under specified conditions for a specified time.
2. Reliability can be measured by failure rate, mean time between failures, or probability of survival for a given time.
3. Series components are elements of a system whose individual failure causes system failure.
4. Parallel components are elements of a system so arranged that all the components must fail to cause system failure.
5. The reliability formula is e^{-rt}, where r is failure rate and t is time.
6. "Frit" is a Martin-invented failure rate unit equal to 10^{-9} failures per hour. We offer this as an industry standard term.
7. Resistors are stressed primarily by temperature and power dissipation.
8. Capacitors are stressed by temperature and applied voltage.
9. Relays are stressed by current through the contacts.
10. Various companies have reported that between 30 and 70 per cent of their early factory output of military equipment have been found to have design errors.
11. Semiconductor diodes are stressed by temperature and power dissipation.
12. $e^{-0.001} = 0.999$. $e^{-1.0} = 0.368$.
13. 36.8 per cent of devices will operate to MTBF if their failure rate is independent of time.
14. Failure rate is somewhere between zero and 3-million "frits" (something greater than 333 hours MTBF) at the 95 per cent confidence level, assuming constant failure rate.
15. If $e^{-x} = 0.05$, $x = 3$. If $e^{-x} = 0.5$, $x = 0.69$.
16. Aerospace Industries Association is very active, through its Electronic Reliability Panel.
17. The American Society for Quality Control is very active—also the IRE Professional Group on Reliability and Quality Control.
18. RCA, ARINC Research, Vitro and Battelle Memorial Institute are very active.
19. Leading individuals doing reliability work are C. M. Ryerson (RCA), Frank Gryna (Martin), R. Lusser (formerly of Redstone Arsenal), J. Hershey (Bell Telephone Labs.), R. Briggs (Bendix Systems), H. Voegtlen (RCA) and E. Nucci (DOD). There are many others, of course.
20. Government officials are C. M. Beyer (Office of Guided Missiles), E. J. Nucci (AGREE), G. A. Henderson (Army Ballistic Missile Agency), A. L. Jackson, Jr. (Air Research & Development Command), G. Peratino (BuWeaps), R. C. Littler (Air Material Command) and Maj. W. O. Castleberry (Hq., USAF).
21. We need reliability control in advanced design, detailed engineering, production and customer use.
22. The chi-squared distribution is related to estimated failure rates.
23. Comparison of failure rates should be based on the F-test (variance ratio).
24. This is a good one. A review of the detailed functional block diagram in search of a new concept that will avoid the high-failure rate parts will probably help most, if time permits. If not, additional derating should be considered.
25. We could write a book about this question. In the present industrial situation, the most valuable means of attaining reliability are: (a) failure analysis of early equipment units, (b) detailed circuit analysis, especially of tolerance, (c) reliability predictions when used to influence the design, (d) reducing the functions to a minimum consistent with military values. Of course, we should squeeze all these methods dry for the ultimate in reliability.
26. Reliability specifications are MIL-R-19610, MIL-R-25717, MIL-R-26667, MIL-R-26674, MIL-STD-411, MIL-R-27173 and AFBM Exhibit 58-10.
27. AGREE = Advisory Group on Reliability of Electronic Equipment.
28. This depends also upon the minimum acceptable MTBF, but 1030 hours is a good figure for R&D equipment.
29. Reciprocal of failure rate when failure rate is constant is phrase most closely associated with MTBF.
30. This is a debate question, a matter of semantics. In our opinion, life should be stated only as a function of failure rate; some uses can stand a higher failure rate and thus use equipment longer.
31. A project cannot succeed in achieving desired reliability unless it is stated: (a) What numerical reliability is required. (b) Exactly what the equipment must do. (c) What means of reliability demonstration will be used.
32. Martin-Baltimore. *Electronics and Electrical Reliability Handbook.*
Martin-Baltimore. *Missiles and Electronic Mechanical Reliability Handbook.*
RCA. *Reliability Stress Analysis for Electronic Equipment.*
Bell Telephone Labs. *Instructions and Data for Failure Rate Prediction.*
ARINC. *Improved Techniques for Design Stage Prediction.*
Minneapolis-Honeywell. *Reliability Guide.* (There are other valuable sources which are too numerous to mention).
33. Infant mortality or debugging period, random failure or reliable period and wearout region are reliability states.
34. Reliability effort ideally pays off inversely with the aging of a project; thus work during advanced design gives highest yield. However, in many companies where reliability talent is not available during preliminary design, it is probable that "experimental fabrication" is the earliest phase where a reliability engineer can really help. ■ ■



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY IN

COMPUTER DEVELOPMENT

Space Vehicle Command – An important advance in the control of space vehicles has been accomplished with the development by Lockheed scientists of space-borne, command decoders and sequence programmers. Basically, the programmers store information and, at a predetermined time when the vehicle is out of contact with ground stations, cause commands to be executed by the various subsystems. In this way, versatility of vehicle missions can be markedly expanded.

In addition, when the vehicle comes in range of ground command stations, the programmer can be given new instructions for either future or immediate action. All of the programmer's components are solid state devices. There are no moving parts nor vacuum tubes. The ferrite core memory in which information is stored is a two core-per-bit matrix.

A primary design goal was to reduce power requirements. Although the Lockheed programmer is highly complex and employs over 600 transistors, the average power consumption is only 3.5 watts, less than a Christmas tree light bulb. The development of such complex circuitry that will withstand the shock, vibration and a temperature range from −40°C to +85°C is in itself a significant achievement.

The highly precise timing necessary for the execution of the various programmed assignments is accomplished by means of a crystal oscillator – maintained at an exact temperature by means of a two phase mixture of solid and liquid inert chemical.

Engineers and Scientists: Lockheed's capability in design and development of computers is contributing to the advancement of the state of the art in a number of areas. Work is being carried on in research and development of ultra reliable digital circuitry, ferrite logic systems, and millimicrosecond switching techniques; radically new devices for pattern recognition operations; high speed digital plotters; self-organizing systems; large scale systems for the automatic storage and retrieval of information; microminiature packaging techniques; and systems research and engineering of large scale information handling complexes.

If you are experienced in work related to logic design or computer development, you are invited to inquire into the interesting work being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. H-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM;
the Air Force AGENA Satellite in the DISCOVERER, MIDAS
and SAMOS Programs; Air Force X-7; and Army KINGFISHER.

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Record Antenna Patterns Using Off-The-Shelf Test Equipment

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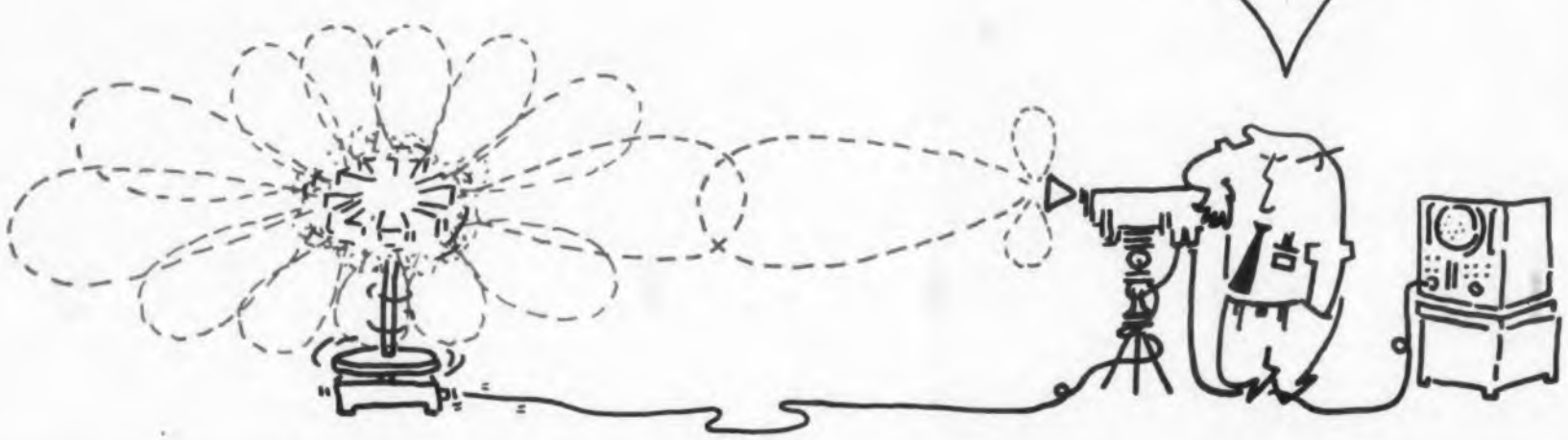
Design Engineer
Douglas Aircraft Co.
El Segundo, Calif

Here is a novel technique for recording antenna-radiation pattern beam-widths without resorting to special test fixtures or elaborate recording devices. The technique employs standard items of test equipment that are available in any microwave laboratory. Only a small, easily constructed control box can be considered custom-built.



IN MANY facilities where numerous half-power beam-width measurements are taken day in and day out, the elaborate recording equipment usually associated with this procedure may be at a premium. An adequate test set-up which employs readily available standard test units can avoid the costly delays that can result.

Using an oscilloscope, scope-camera, standard microwave plumbing and test-equipment, antenna-beam measurements have been obtained in the 1 to 40 kmc range that compare favorably with those obtained using elaborate recording equipment. The technique is usable in both indoor anechoic chambers and in outdoor ranges.

Test Circuit Built From Standard Components

An over-all block of the test set-up is shown in Fig. 1. The test equipment consists of:

- Rf signal generators or klystrons to provide the rf power.
- Transmitting antennas—these may be optimum gain standard horns
- High-gain amplifiers
- Detectors
- Turntable and control wiring
- Associated rf plumbing
- Dual-trace oscilloscope
- System control box

All the above test equipment, with the exception of the system control box, are in common usage in laboratories performing rf and microwave measurements. The control box, Fig. 2, may be easily fabricated and consists simply of a circuit breaker and two toggle switches. One switch is used to control the direction of rotation of the turntable while the other switch is employed to energize the camera system when a photograph of the radiation pattern is desired. The control box should be located adjacent to the oscilloscope within easy access to the operator.

The technique consists in synchronizing the turntable rate of rotation with the horizontal sweep rate of the oscilloscope. A high-gain amplifier and a sensitive detector provide the means of obtaining a visual trace of the radiation pattern on the oscilloscope. A second amplifier and detector permits monitoring the rf power output simultaneously with the radiation pattern cut. The system may be operated quite adequately by one or two operators.

Control limit switches mounted on the periphery of the turntable, determine the azimuthal pattern coverage in degrees obtainable. Photographs presented here represent an azimuthal coverage of 200 deg or 20 deg per cm on the oscilloscope face plate. These control limit switches are also used to provide the circuitry to externally trigger the oscilloscope and camera shutter. The persistence of the oscilloscope affords ready visual radiation pattern characteristics. In addition, the camera may be used to obtain a photograph of the radiation pattern. The rise

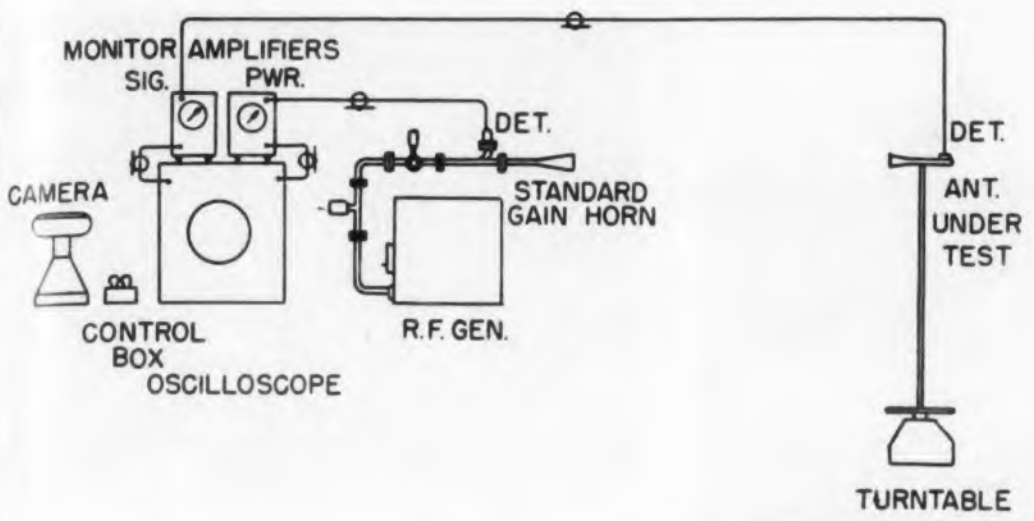


Fig. 1. Antenna beam-width-recorded circuit is built from standard test components.

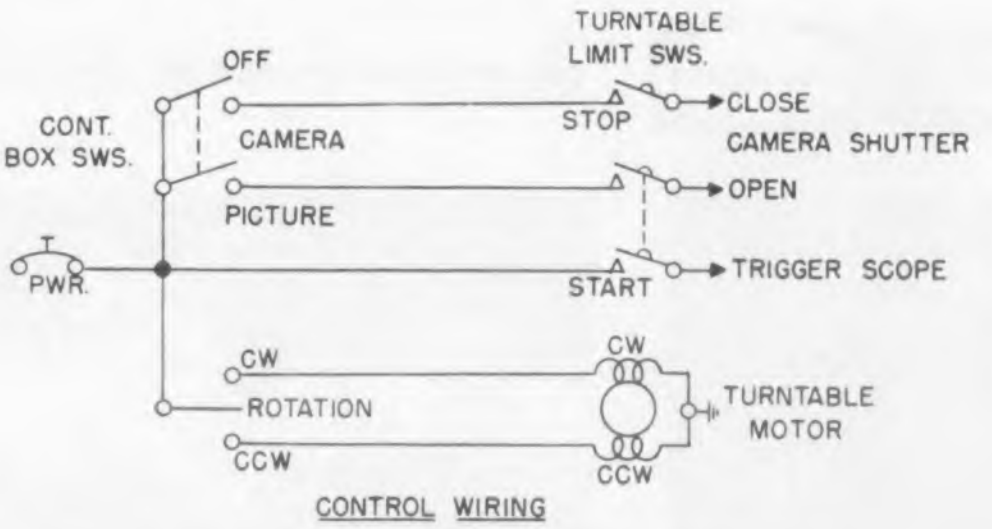


Fig. 2. Control box, only custom-built unit, controls turntable, scope and camera.

time of the oscilloscope provides a more instantaneous indication of the antenna radiation pattern characteristics than would otherwise be provided by a pen-recording device.

A Wide Choice Of Test Units May Be Used

A standard signal generator or klystron may be used as the rf source. Such factors as power output requirements, minimum allowable transmitting test distances, stability and ease of operation should all be considered in the selection of the type of rf source. When possible, standard signal generators should be used, since these devices provide greater stability and ease of operation. Standard signal generators are commercially available in frequency ranges up to about 40 kmc. These generators can deliver an rf output of at least 1 mw into a matched load.

Horn type antennas may be used as the transmitting antennas. Optimum[1] gain standard horns are very good for this application since they afford the following desirable characteristics—a useful value of gain, broadband coverage, accurate calibrations and reasonable size. Such units may be bought commercially or built in the laboratory to existing design data.[2]

Either bolometers or crystals may be used as the detectors of the rf energy. Each has its respective advantages and disadvantages. The bolometer is relatively poor in detection-sensitivity when compared with the crystal detector but displays "square-law" characteristics over a much broader dynamic range. Mounts are available for both in the coaxial or waveguide types—either fixed-tuned or tunable. A single broadband coaxial crystal mount[3] (using tripolar video diodes) may be obtained that covers the entire frequency spectrum of 50 mc-12,000 mc. Higher frequencies will necessitate the use of waveguide types. The microwave plumbing is standard, but should provide for both vertical and horizontal polarization.

Two amplifiers, such as Hewlett-Packard 415B types are used in this recording technique. These units are usually readily available in laboratories performing rf measurements. These units contain an input signal jack for either crystal or bolometer operation. The output jacks are used to provide pattern and rf power-monitor information to the dual-trace oscilloscope. The sensitivity of these devices is about 0.1 mv at a 200-ohm level for full scale deflection. Since the units are "square-law"-calibrated, the detector response may be easily verified to ascertain "square-law" operation. The dynamic output response of these amplifiers, a a particular scale setting, is limited to 10 db. The units are also extremely useful in checking the calibration of the attenuators used in the test set-up.

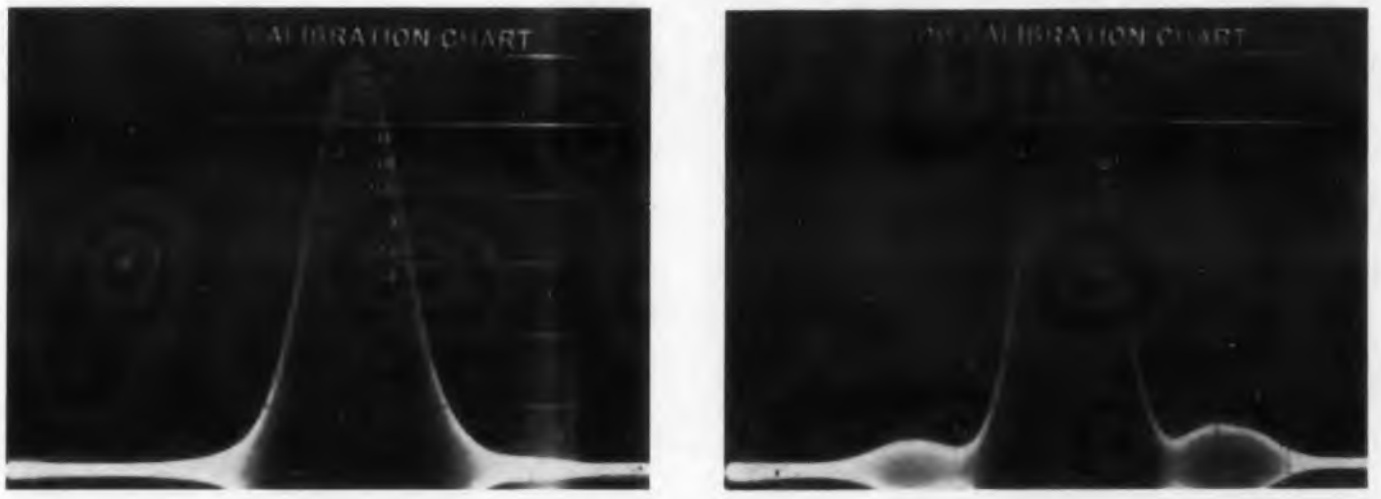
Dual-Trace Scope And Polaroid Provide Permanent Record

A dual-trace oscilloscope and polaroid oscilloscope camera are required. A Tektronix Type 535 oscilloscope with a type 53/54C plug-in unit were used in obtaining the patterns shown. The rise time is about 0.035 μsec and the persistence is such that good visual indication of the radiation pattern is obtained. The face plate was modified in order to inscribe a db scale for convenience in data reduction.

The dual-trace feature is utilized to provide a monitor of the rf power output simultaneously with the radiation pattern cut. It is very essential in performing radiation pattern measurements to know the characteristics of the rf output at the actual time the pattern is cut. Variations in rf power output will result in radiation patterns that are not valid.

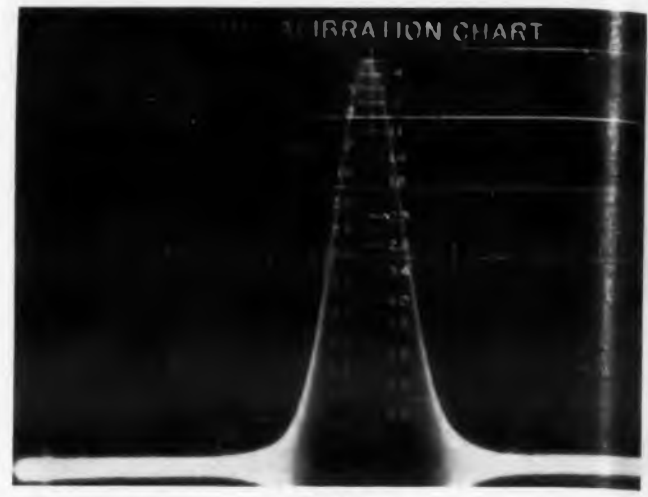
Limitations of The Test Technique

The dynamic recording response of this method, as presented, is limited to about 10 db. This is due primarily to the output response of the amplifiers employed at a particular scale setting. This response is quite adequate, however, when

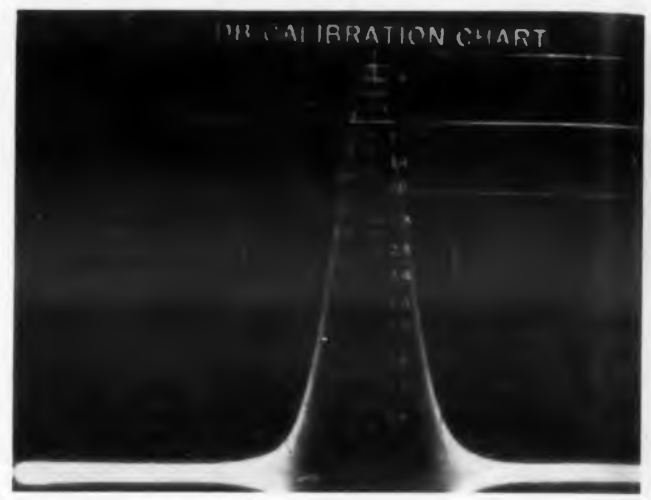


(a) (b)

Fig. 3. Radiation pattern of 23 cm (1300 mc) standard-gain horn. Cut *a* is for a vertically polarized horn. Beamwidth, calculated as 29.4 deg, measures 31 deg. Cut *b* is for a horizontally polarized horn. Beamwidth, calculated as 28.8 deg, measures 21.3 deg.



(a)



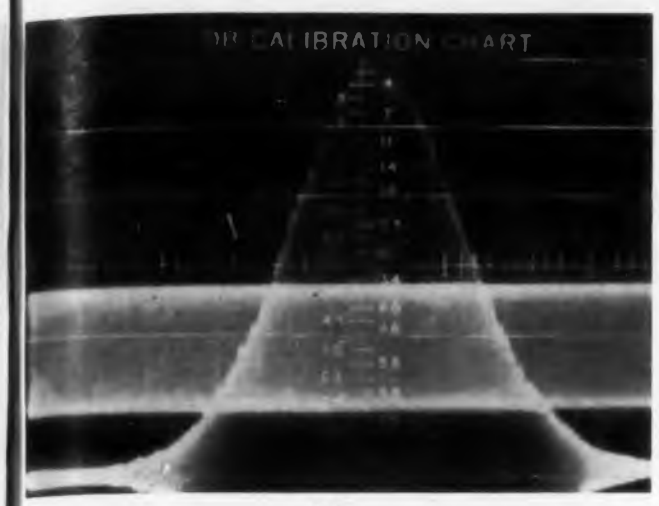
(b)

Fig. 4. Radiation pattern of 6.67 cm (4500 mc) standard-gain horn. Cut *a* is for a vertically polarized horn. Beamwidth, calculated as 22 deg, measures 22 deg. Cut *b* is for a horizontally polarized horn. Beamwidth, calculated as 21.6 deg, measures 21.3 deg.

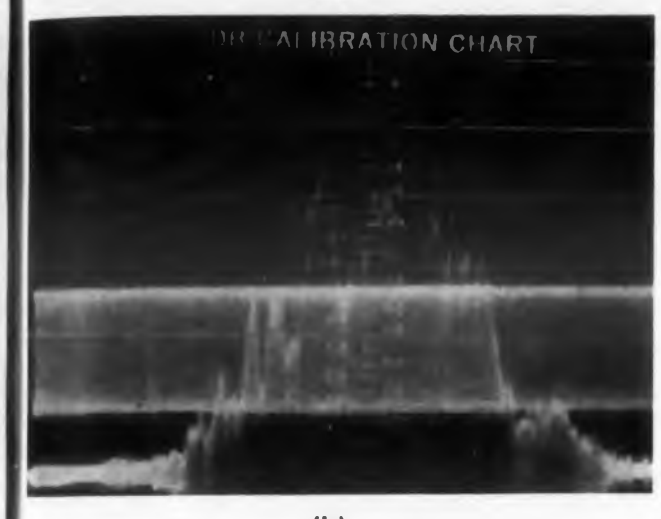
the prime interest is in the half-power beamwidth characteristics of the antenna radiation pattern. A great deal of antenna test work is concerned only with the radiation pattern half-power points. Due to the limited response of this system, it is not usable for the investigation of the side-lobe characteristics of the radiation pattern as a greater dynamic response for this type of investigation would be required. Amplifiers with greater dynamic response would, of course, increase the usefulness of this pattern-recording technique.

Radiation-Pattern Photographs

Photographs of the antenna-radiation pattern may be obtained, if so desired, for record purposes. Typical radiation pattern photographs are shown in Figs. 3, 4 and 5. Figs. 3 and 4 are patterns of a 23-cm and 6.67-cm optimum gain standard horns at their respective design frequencies. Half-power beam-width results obtained with this recording technique compared favorably with the calculated values for these horns. Half-power beamwidth of these horns was also measured with elaborate recording equipment and the values



(a)



(b)

Fig. 5. Radiation pattern of 3800 mc antenna, installed (*a*) and in radome (*b*) showing rf power output monitor superimposed on the same scope trace.

compared within 1 deg to those indicated in the photographs.

Photographs in Fig. 4 show the application of the method in antenna installation and radome evaluation tests. These photographs are included only to illustrate the simultaneous monitoring of the radiation pattern and the rf power output.

This technique is quite versatile. With proper modification, the basic principles involved can be used for a wide range of frequencies and antenna types. ■■

Acknowledgement

Mr. C. R. Peyton suggested the feasibility of this technique and assisted in its development into a usable system.

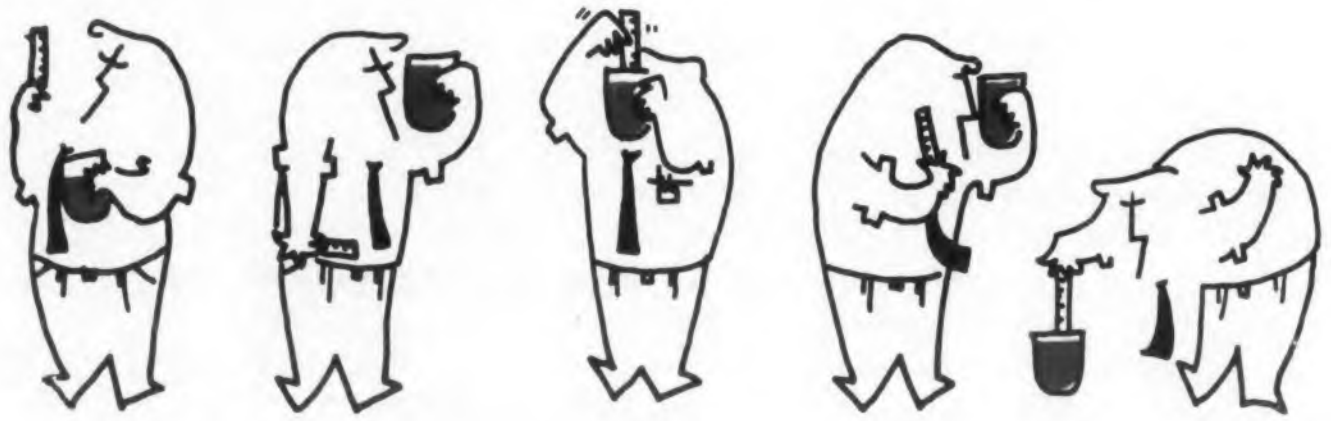
References

1. An optimum horn has aperture dimension chosen to give maximum gain when the slant height is held fixed.
2. "Design and Calibration of Microwave Gain Standards," by W. T. Slayton, NRL report No 4433, Nov. 1954.
3. Such a coaxial mount is designed to transform the coaxial line impedance (usually 50 ohms) to 65 ohms to match characteristic impedance of tripolar crystals.

Probe Design For Capacitive Level Measurements

George Revesz
Robertshaw-Fulton Controls Co.
Eastern Research Center
Philadelphia, Pa.

As with many other aspects of instrumentation, probe design has long been more of an experimental art than a science. By cut-and-try, designers would develop a technique to perform a measurement or control function and everybody would be happy. Then cases would crop up where the technique wouldn't work and the designers would be stumped. To eliminate the guess-work in probe design, George Revesz, technical director of Robertshaw-Fulton's Eastern Research Center, developed the basic approach in this article.



CAPACITIVE probes are extremely useful for measuring levels. But probes can give erroneous measurements if there are changes in dielectric constant, conductivity, temperature, or pressure of the material level is to be measured.

Fortunately, if the frequency of the applied voltage and the probe's insulation thickness are properly chosen, the effects of parameter changes can be minimized and substantially correct measurements will result.

Simplest Level Probe, Bare Rod, Has Marked Disadvantages

In its simplest form, a probe is a metal rod mounted in the vessel whose content is to be measured. The rod must have a seal insulating it electrically from the vessel wall. The capacitance is formed by the rod (the live electrode) and the vessel wall (the grounded electrode).

In at least three important applications, the bare rod has marked disadvantages:

- Materials with a high dielectric constant are hard to measure due to large capacitance values.
- Conductive materials can't be measured at all.
- Corrosive materials are hard to handle, so very expensive metal alloys must be used.

Most Applications Need Insulated Probe

The probe would usually have an insulating sheath around the live electrode. Such a probe, sketched in Fig. 1, can be considered, electrically, as two capacitors:

1. The insulation capacitance C_i which is the capacitance between the rod and the outside of the insulating sleeve.
2. The outer capacitance C_o from the outside of the sheath to the vessel wall.

These two capacitances are in series. When the vessel is empty, the total capacitance C_e is a series connection of C_i and C_o.

$$C_e = \frac{C_i C_o}{C_i + C_o}$$

When the vessel is filled with a material having a dielectric constant K, C_o changes to KC_o and the system capacitance is

$$C_f = \frac{C_i C_o}{C_i + KC_o} K$$

For analysis, the whole electrode can be pictured as a series of little sections of unit length, each being either full or empty, and each with a capacitance of either C_e or C_f. A probe of unit

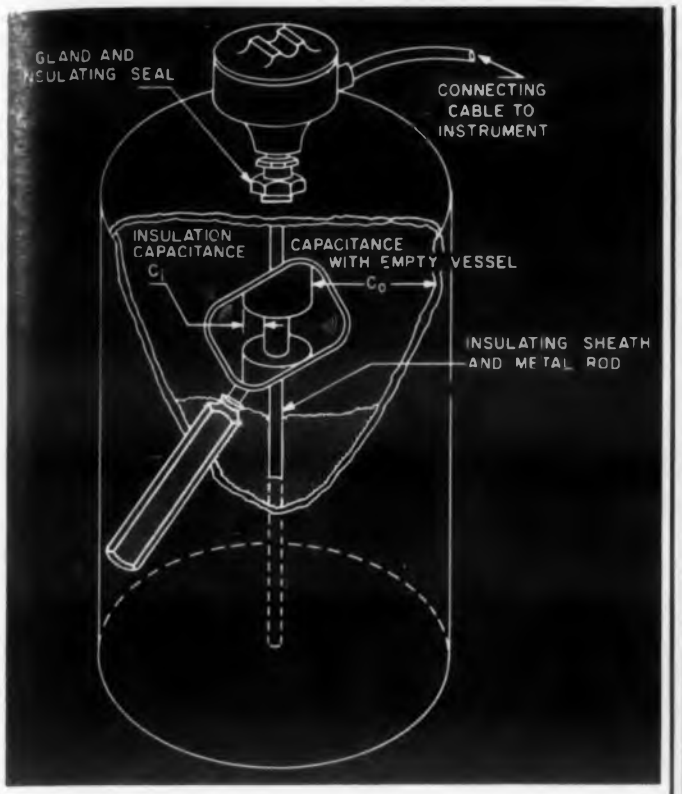


Fig. 1. Typical level-gaging probe has two capacitances in series.

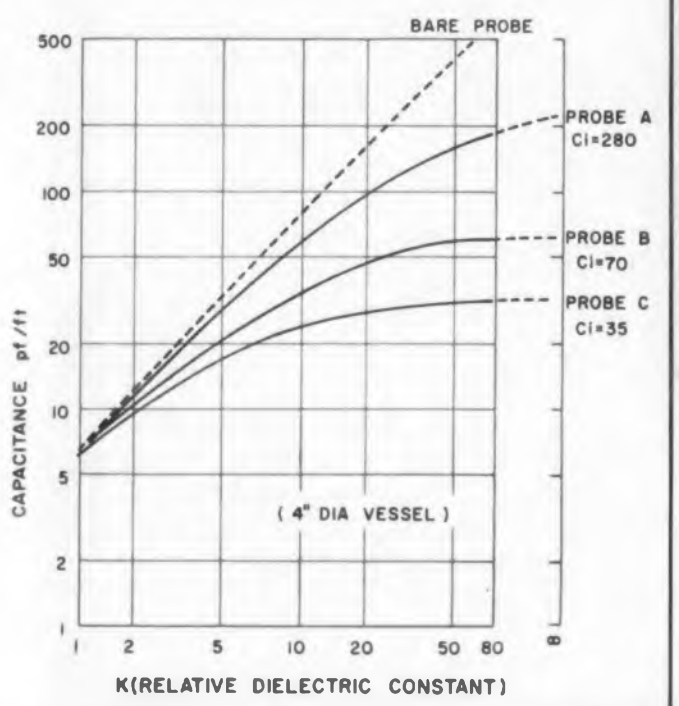


Fig. 2. Capacitance of insulated probes is a nonlinear function of the dielectric constant of the insulating sheath.

length can thus be studied and the data can be multiplied by the length of the probe to obtain the behavior of the whole probe.

Insulated Probe Capacitance Is Nonlinear Function of Dielectric

As indicated in Fig. 2, the capacitance of a particular probe is a function of dielectric constant. For insulated probes, the curves start out looking approximately linear ($C_f = KC_o$), then tail off asymptotically ($C_f = C_i$) at high K values.

(continued on p 84)

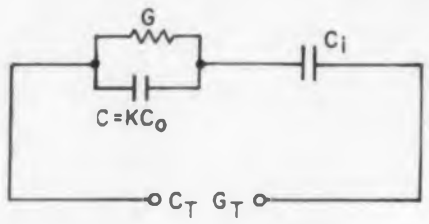


Fig. 3. Equivalent circuit of an entire probe system.

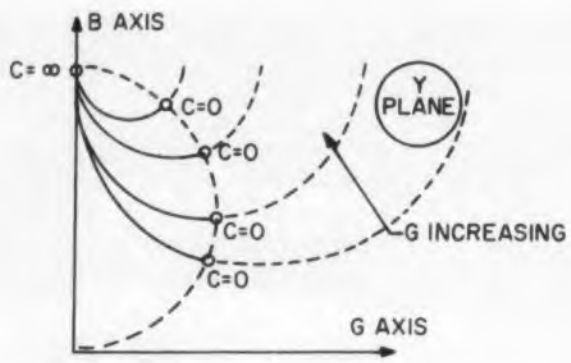


Fig. 5. A construction similar to that of Fig. 4 shows the effect of varying C with different values of G.

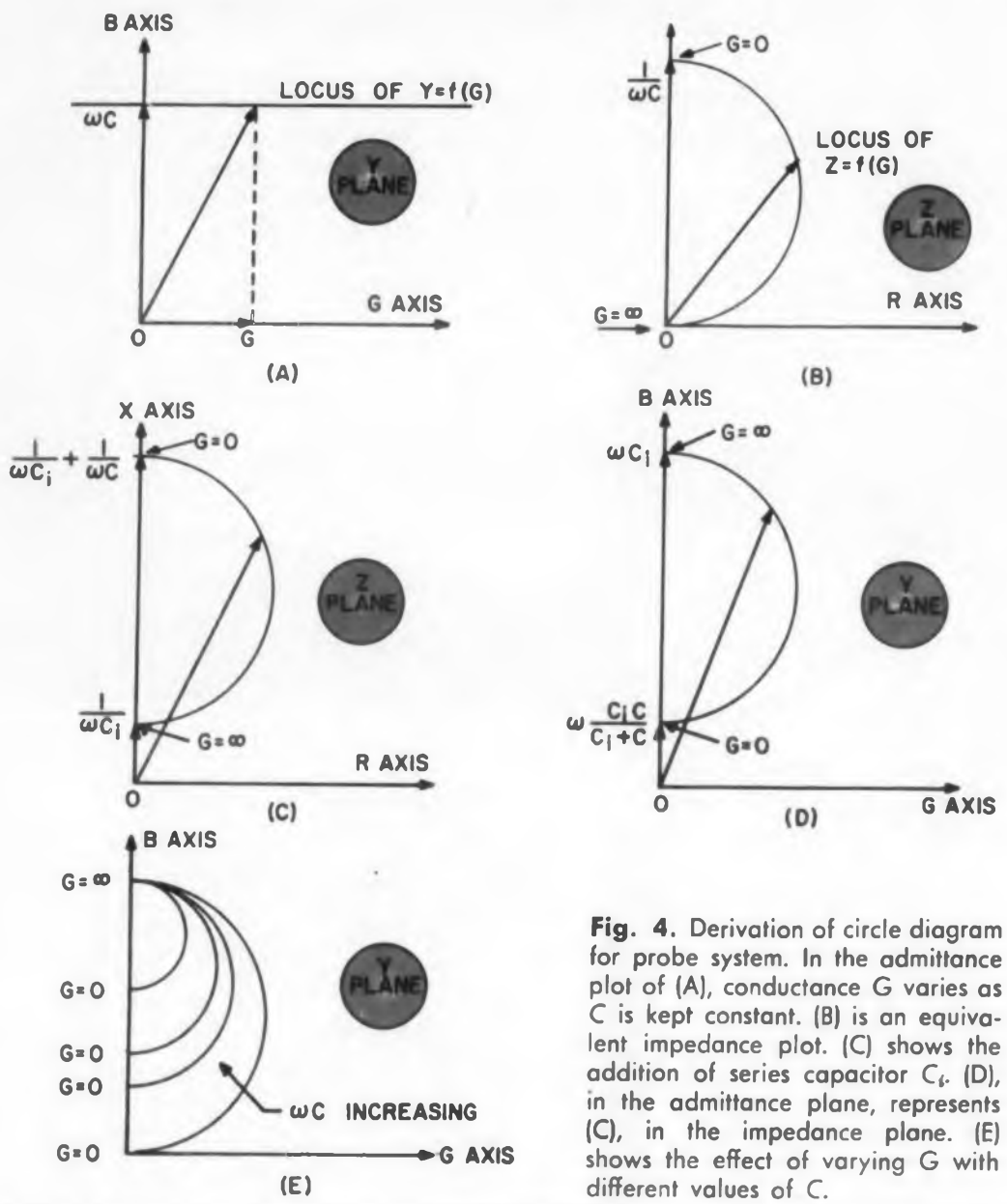


Fig. 4. Derivation of circle diagram for probe system. In the admittance plot of (A), conductance G varies as C is kept constant. (B) is an equivalent impedance plot. (C) shows the addition of series capacitor C_i. (D), in the admittance plane, represents (C), in the impedance plane. (E) shows the effect of varying G with different values of C.

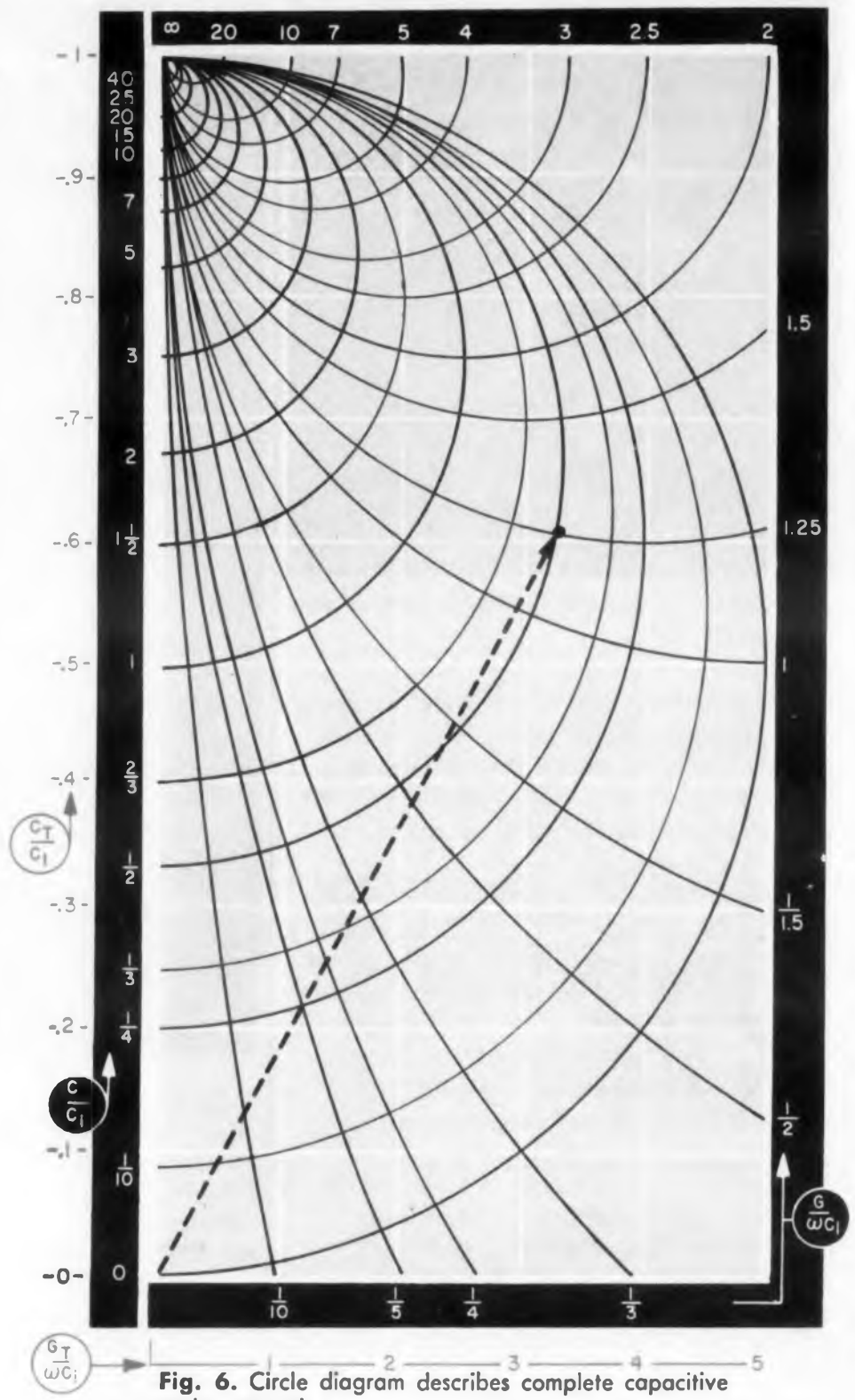


Fig. 6. Circle diagram describes complete capacitive probe network.

For $K = 1$, the capacitance equals the unit-length capacitance with the vessel empty (C_e). The capacitance change per unit length is the difference $C_f - C_e$ where C_f depends on the dielectric constant of the material measured.

Conductive Leakage Affects Capacitance Reading

This is true only where there is no leakage in the material to be measured. When there is conductance in the material to be measured, the probe system can be represented by Fig. 3. It comprises the insulation capacitance C_i in series with the parallel combination of conductance G and capacitance KC_o.

The total capacitance C_T and conductance G_T both vary as C and G vary. To understand how the variations take place, one can first consider a situation with a fixed C and a variable G. Fig. 4A shows how the admittance varies as a function of conductance while C is kept constant. As G varies from zero to infinity, the admittance vector moves along a horizontal line.

To add the effect of C_i to this vector sum of G and C it is best to move from the admittance plane to the impedance plane of Fig. 4B where the vector moves along a semicircle as G varies. The impedance of C_i is easily added to this vector as shown in Fig. 4C.

Shifting back to the admittance plane yields

Fig. 4D as the probe's equivalent circuit (Fig. 3), with C constant. This is useful since the probe instrumentation measures capacity. Finally, varying C gives the family of semicircles shown in Fig. 4E.

Circle Diagram Describes Probe Network

A similar approach can yield the analogous family of semicircles of Fig. 5 for mixed G and variable C. Superimposing these two sets of semicircles gives the system of circular coordinates of Fig. 6 which completely describes the entire probe network.

Fig. 6 has been normalized so both C and G components are divided by the value of insulation capacitance C_i. Use of this circle diagram is best explained by a typical example:

The following data pertain to a particular probe: $C_i = 100$ pf, $C = 50$ pf, $R = 2.5$ K, $G = 1/R = 10^{-4}$ mhos, $f = 500$ kc. From these data one can compute C/C_i and $G/\omega C_i$.

$$C/C_i = 1/2$$

$$G/\omega C_i = \frac{10^{-4}}{2\pi \times 5\,(10^5) \times 100\,(10)^{-12}} = 1.25$$

The intersection of the semicircles for these two quantities on Fig. 6 represents the end point of their vector sum. This vector represents the magnitude of the total admittance.

On this circle diagram, a curve can be plotted to describe the effect of a varying third parameter such as temperature which can influence both the dielectric constant and conductivity of the medium whose level is to be measured. To plot such a curve, it is necessary first to plot separate curves showing the variations in K and G as a function of the third parameter.

If the empty capacitance C_o is known (this is a function of geometrical arrangement of probe and vessel wall), the vessel-full capacitance per unit length KC_o can be computed.

For a specific instrument frequency and specific insulation capacitance (determined by the geometry and the insulation-sheath material), one can take points for KC_o and G from the separately plotted temperature curves and enter them on the circle diagram.

By plotting several such temperature curves on the circle diagram for different instrument frequencies and different insulation capacitances, one can determine which combination of frequency and insulation capacitance yields least change in the instrument's capacity readings over a range of temperatures. ■ ■

Designing Low-Noise Transistor Circuits

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Papers on noise are usually fairly complex and loaded with mathematical equations and derivations. A brief description of noise sources and their origin, considerations in circuit design and a typical design example involving a low-noise application is presented as a practical guide to the design engineer.

APART from the obvious advantages of freedom from the hum and microphony of vacuum tubes, it has now been shown that good transistors have better noise performance than tubes in fairly low-impedance applications.[1] Although tubes remain much better at high source impedance levels, the point at which it becomes equally advantageous from a noise point of view to use a tube or a transistor is roughly a source impedance of 10 K, depending on the properties of the specific devices in question.

Types and Origin of Noise

The amplitude spectrum of transistor noise is generally as shown in Fig. 1. At low frequencies, the noise is predominantly "flicker noise," or, as it varies approximately inversely with frequency, "1/f noise." It has a slope of 3 db/octave. It is generally considered that it has two components: surface noise and leakage noise. Surface noise is caused by fluctuations of energy levels at junction surfaces which modulate the junction resistances and is strongly current dependent, whereas leakage noise is caused by leakage current across the junctions. Obviously, leakage noise will be strongly bias voltage dependent, but at low biases (less than 10 v), it is small, and at very low biases (less than 3 v), it is negligible for good transistors.

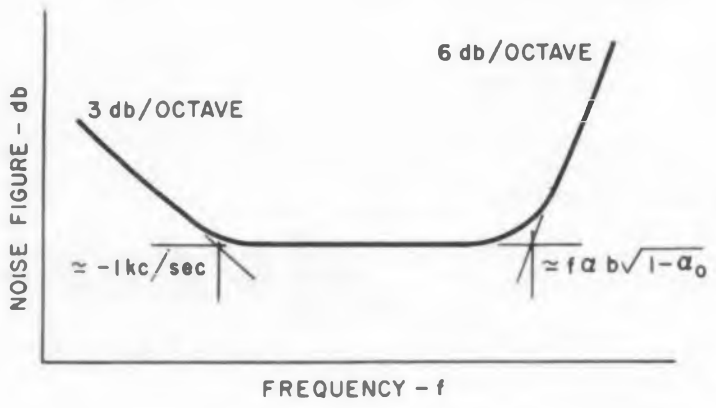

Fig. 1. Noise spectrum for a typical transistor. At low frequencies, "flicker noise" varies inversely with frequency at a slope of 3 db/octave. At higher frequencies, the noise figure increases at about 6 db/octave.

Above about 1 kc, shot noise predominates. It is generally accepted that this noise is the combination of the thermal noise generated by the ohmic resistances in the device and the noise caused by the discrete character of the currents across the junctions. While flicker noise can be considerably reduced by proper surface treatment by the device manufacturer, relatively little improvement can be made in the magnitude of the shot noise.

At higher frequencies, the noise figure of transistors increases at about 6 db/octave at frequencies higher than approximately $f_{\alpha b}\sqrt{1-\alpha_0}$ where $f\alpha_b$ is the α cut-off frequency and α_o is the low frequency current multiplication factor. This dependence is due to the appearance of α in the equivalent noise resistance formula.

Considerations in Circuit Design

(1) It is obviously essential to use a low noise transistor. In the past silicon transistors have not had the excellent noise characteristics exhibited by many germanium devices. However, recent advances in technology have permitted the production of silicon devices with noise performance very nearly equal to that of the best germanium devices available and with vastly superior temperature, frequency and voltage characteristics.

Since there are now on the market many transistors with a noise figure of less than 10 db, the selection of these is then more a matter of desirability of other characteristics, particularly high frequency response, as described in (4) below.

(2) Flicker noise is large compared to other noise at low frequencies. Therefore, it follows that the minimum low-frequency response needed should be designed into the equipment, and if it is possible to cut off below 500 cps, then that should be done.

(3) Noise figures are strongly dependent on emitter current and source resistance. For most transistors useful as small signal amplifiers, the noise figure is minimum at some emitter current less than approximately 0.5 ma, but starts going up again at approximately 0.1 ma. Hence, 0.3-ma emitter current is suitable in most cases. For most transistors, the noise figure is more or less independent of source resistance for resistances in the range 500-1500 ohms. Therefore, it is important to use some device for impedance transformation if the source impedance is not of the order of roughly 1000 ohms. For this purpose a transformer is particularly well-suited since it is possi

ble to obtain the highly desirable added advantage of stabilizing the transistor operating point, irrespective of the I_{co} variations. This is a particularly important consideration for germanium transistors.

(4) As mentioned previously, the noise figure of a transistor starts rising at $f \simeq \frac{f_{\alpha b}}{\sqrt{\beta_0}}$, where β_0 is the low-frequency current gain. For example, if a 3-mc low-noise pulse amplifier is desired, it becomes important to use a transistor with an alpha cut-off of at least $3 \times \sqrt{50}$ mc, or 21 mc, assuming a β_0 of 50. Unfortunately, the low current condition which insures low-noise operation conflicts with the high frequency requirement, since gain-bandwidth product, being inversely proportional to current, is much lower at low currents than the normally quoted figure.

For example, from the type 2N1613 data sheet, it is seen that the gain-bandwidth product (f_t) is typically 90 mc at $I_E = 20$ ma ($V_{CE} = 15$ v), while at 1 ma it is only 12 mc. Since the frequency dependence of β can be expressed as

$$\beta = \frac{\beta_0}{1 + jf/f_\beta}$$

where f_β is the beta cut-off frequency, f_β can be expressed in terms of the f_t by setting $\beta = 1$ at $f = f_t$. This yields

$$f\beta = f_t/\beta_0$$

Now, using a value of $f_t = 12$ mc and $\beta_0 = 50$, the f_β then becomes 240 kc. Therefore, using even this high frequency transistor in a common-emitter stage at $I_E = 1$ ma will permit a bandwidth of only 240 kc to be obtained, while at $I_E = 0.3$ ma it will be even less. Thus it becomes very important for most low-noise applications to use the highest frequency transistor available.

Step-by-Step Design Procedure

(1) Determine the required frequency response of the amplifier. From the transistor's data sheet, determine the optimum operating point for lowest noise. Calculate f_β at that point ($f_\beta = f_t/\beta_0$) and ensure that f_β is higher than the required passband of the amplifier. If not, improve f_t by using a faster transistor, increasing the emitter current, or providing emitter degeneration.

(2) Determine the source impedance. If it is not in the range 500-1500 ohms, use a suitable transformer for coupling, if possible.

(3) Design the bias network to give required operating point and stability.

(4) Determine the lowest frequency necessary and design the circuit to give that frequency response and no lower.

Circuit Design Example

Suppose it is necessary to amplify short bursts of a sinusoidal signal, as would be encountered

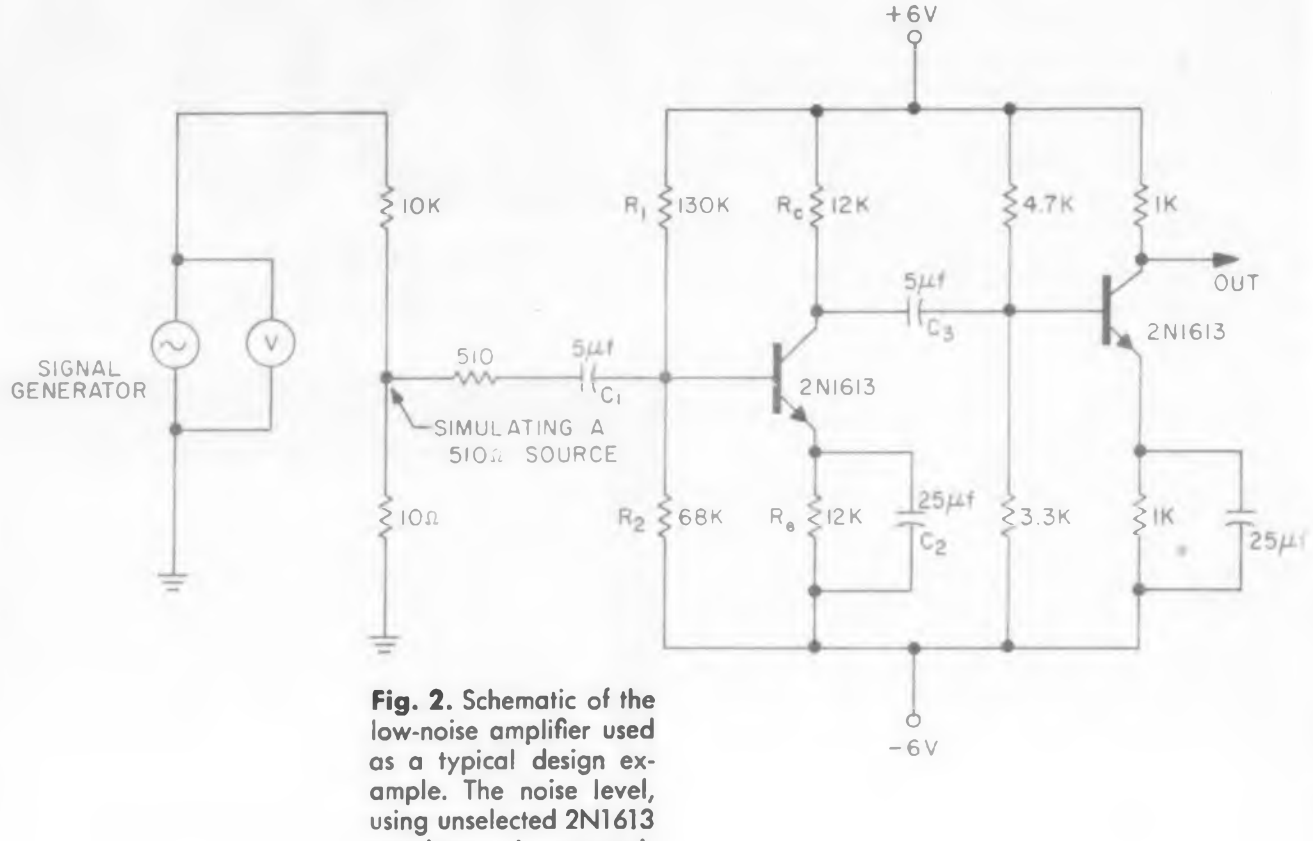

Fig. 2. Schematic of the low-noise amplifier used as a typical design example. The noise level, using unselected 2N1613 transistors, is approximately 18 μv p-p.

in the readback from a thin magnetic head in a character recognition system. Assume further that the required passband of the amplifier was calculated from Fourier analysis to be 200 cps to 150 kc, and that the input signal was about 200 μv from a 500-ohm source.

(1) First, select a low-noise transistor. The 2N1613, for example, has a typical noise figure of 7 db. From the 2N1613 data sheet, best noise performance occurs at $I_C = 0.3$ ma, and is fairly independent of V_{CE}. Thus, select $V_{CE} = 5$ v, $I_E (\simeq I_C) = 0.3$ ma, and ± 6 v supplies. From the curve of 20 mc h_{fe} vs I_C, the gain-bandwidth product f_t is estimated to be (0.4 x 20) mc = 8 mc at that point. Using 50 as a typical

$$\beta_0, f_\beta = \frac{f_t}{\beta_0} = 160 \text{ kc.}$$

This meets the 150-kc requirement of the system.

(2) $R_{source} = 500$ ohms, and therefore no impedance transformation will be needed.

(3) Design the bias network. Assuming the transistor is symmetrical with respect to the power supplies and $V_{CE} = 5$ v, $V_C = 2.5$ v and $V_E = -2.5$ v. Therefore

$$R_C = \frac{(6 - 2.5)}{0.3} = 12 \text{ K and}$$

$$R_E = \frac{[-2.5 - (-6)]}{0.3} = 12 \text{ K.}$$

Assuming a bleeder current of 10 I_b,

$$R_1 + R_2 = \frac{12}{10\, I_b} = \frac{12}{10\, (I_C/\beta_0)} = 200 \text{ K.}$$

Similarly, assuming a 0.6 v V_{BE} drop, $V_B = -2.5 + 0.6 = -1.9$ v. Therefore, $R_1/R_2 = \frac{6 - (-1.9)}{-1.9 - (-6)} = 1.93$, and $R_1 = 131.7$ K, $R_2 = 68.3$ K. Use $R_1 = 130$ K. $R_2 = 68$ K.

(4) The low-frequency response of a common-emitter circuit is determined primarily by the emitter capacitor, since its reactance is reflected back to the input as βX_{C_E}.

Hence $f_1 = \frac{\beta_0}{2\pi\, R\, C_E} = 200$ cps, where $R = R_{source} + h_{ie}$ ($1 \sim 1.5$ K). This gives $C_E = 25$ μf. C_1 must furnish a small reactance compared to βX_{C_E}. Putting $X_{C_1} = (0.1) X_{C_2}$, then $C_1 = 5$ μf. The second stage is conventional.

Experimental Results

Experimental results of this amplifier (Fig. 2) with unselected 2N1613's (using batteries for the power supplies) yielded a noise level referred to the input of about 18 μv peak-to-peak, a frequency response from 130 cps to 200 kc and a voltage gain of about 335. ■ ■

References

1. Noise In Junction Transistors, Vander Ziel, *P. I. R. E.* June 1958.

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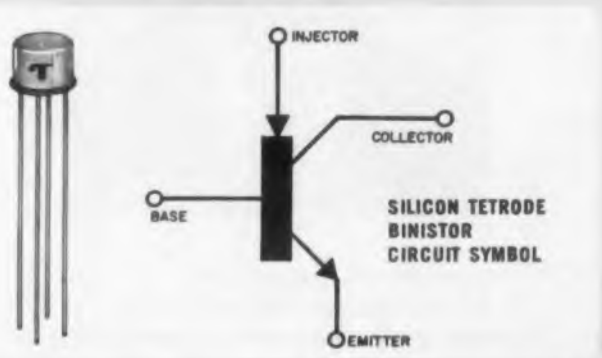

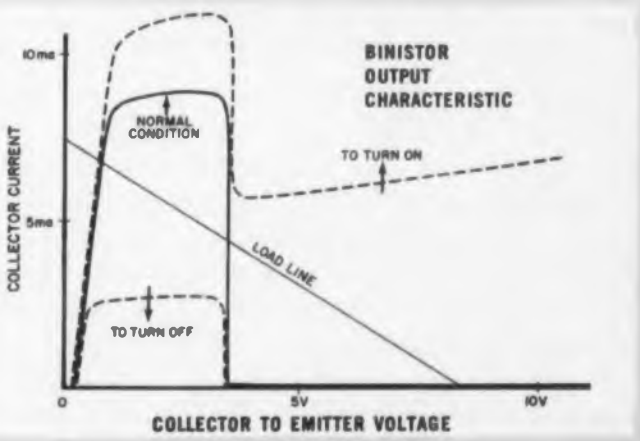

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Natural Interference In Space Systems

RFI

James F. Lee
Branch Leader
Radiation and Propagation Branch
Melpar, Inc.
Watertown, Mass.

Jim Lee's current work at Melpar includes the responsibility of predicting natural interference sources and their detrimental effects. His recommendations for reduction of RFI is expected to drastically cut errors in space systems designs.

SINCE earth-orbiting satellite systems are to operate under unprecedented environmental conditions and at extreme ranges, certain interference effects which have hitherto been considered relatively unimportant must now be taken into account, preferably during the early stages of system design and development. Careful consideration must be given to radio noise of cosmic origin, the principal source of natural interference to be expected in such systems.

Broadly speaking, cosmic radio emissions may be divided into two categories: (a) those which are internal to our solar system and (b) those which are external to the solar system. Fig. 1 contains a detailed breakdown of sources of such radiation which have been detected to date.

Calculation of Cosmic Noise Power

Cosmic noise generally does not emanate from point sources as assumed in conventional inverse square power calculations, but arises in sources which subtend a finite solid angle (measured in steradians or square degrees) at the earth. An important concept useful in the computation of interference levels under these conditions is that of brightness temperature.

An extended radiating source is regarded as a black body radiator with a certain absolute temperature (measured in deg K) and which emits in accordance with Planck's radiation law. A given cosmic noise source is thus assigned an equivalent black body temperature which, in most cases, depends on the particular frequency being considered. Since at radio frequencies, the Rayleigh-Jeans law is a valid approximation to Planck's law, it may be used to connect source brightness to equivalent black body temperature. The average brightness of a source, B_{av}, as observed on earth is, for practical purposes, thereby given as:

$$B_{av} = \frac{2\,K\,T_{av}}{\lambda^2} \text{ (w } m^{-2} \text{ cps}^{-1} \text{ rad}^{-2}) \qquad (1)$$

where K = Boltzmann's constant (1.38 x 10^{-23} joules/K)

T_{av} = average equivalent black body temperature of source, deg K

λ = wavelength

The resulting unit of brightness is, in effect, power flux density per unit bandwidth per unit solid angle subtended by the source. For convenience, the unit "jansky" (abbreviated jan) is adopted, which is equivalent to 1 w per square meter per cycle, and the unit of source brightness is given in jan rad^{-2}. This source brightness now can be used to compute the noise power which is received by a system.

Antenna Power Calculation

Since, in general, cosmic radio emission is randomly polarized, a 3-db loss is included in calculation of the noise power levels resulting therefrom. Thus the power received by an antenna pointed at a cosmic source is given by:

$$P = \tfrac{1}{2} A_e\, B_{av}\, \omega_r \text{ (w cps}^{-1}) \qquad (2)$$

where P = received power per unit bandwidth

A_e = effective aperture of the receiving antenna

ω_r = source extent (rad^2)

Substituting (1) in (2), the received power in terms of the equivalent source temperature is

$$P = \frac{K\,T_{av}\,A_e\,\omega_r}{\lambda^2} \text{ (w cps}^{-1}) \qquad (3)$$

The gain of an antenna is related to its effective aperture and beam area by the relations:

$$G = \frac{4}{\beta_r} = \frac{4\pi\,A_e}{\lambda^2} \qquad (4)$$

where G = antenna gain over isotropic radiator

β_r = beam area of the antenna (rad^2)

From this

$$\beta_r = \frac{\lambda^2}{A_e} \qquad (5)$$

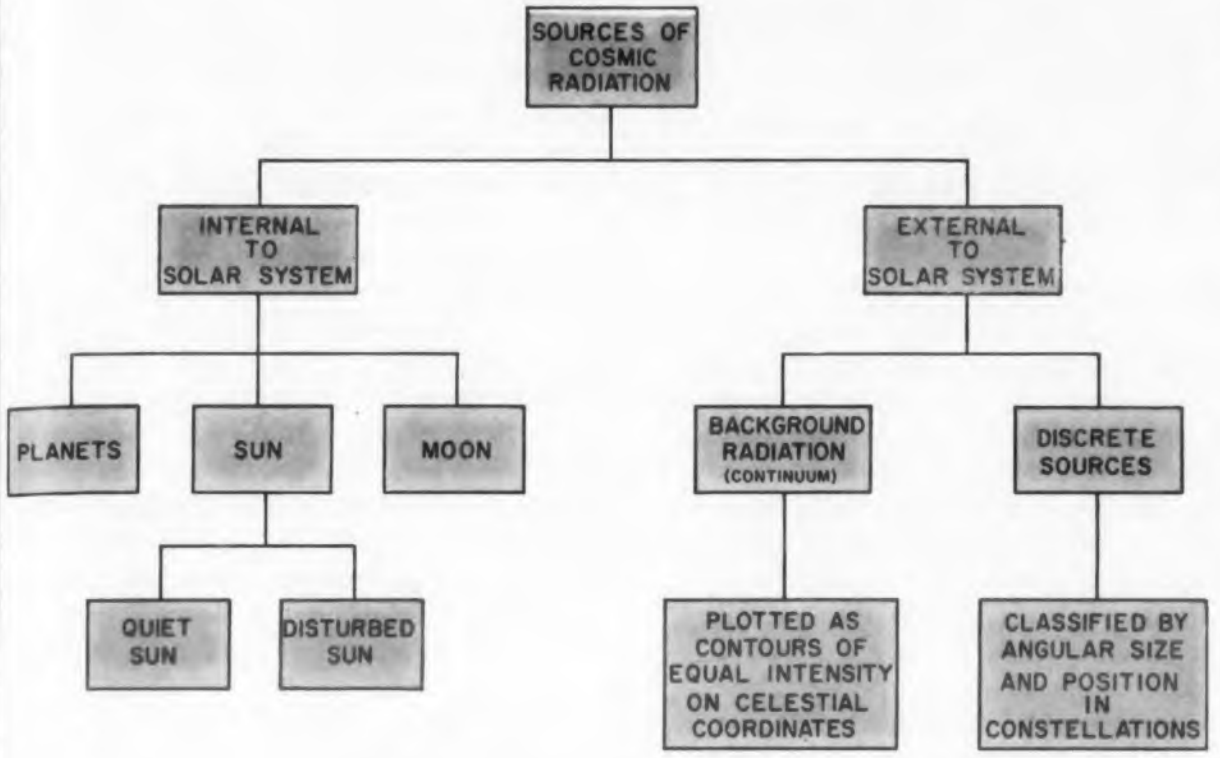

Fig. 1. Sources of cosmic radio emission—internal and external to our solar system.

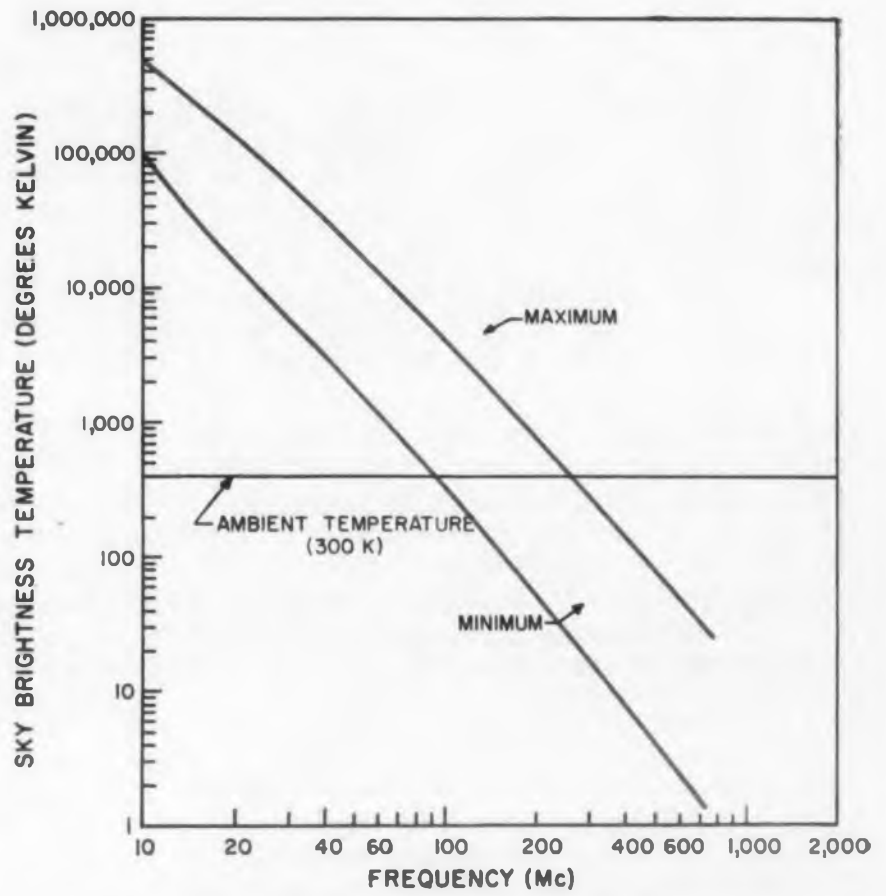

Fig. 2. Maximum and minimum levels for observed cosmic background radiation or continuum; equivalent black body temperature plotted vs frequency.

which, substituted into (3), gives

$$P = \frac{K\, T_{av}\, \omega_r}{\beta_r} \text{ (w cps}^{-1}\text{)} \qquad (6)$$

The term $T_{av}\,\omega_r/\beta_r$, involving the equivalent black body temperature of the radio source may be regarded as an equivalent antenna temperature T_A.

$$T_A = T_{av}\,\frac{\omega_r}{\beta_r} \qquad (7)$$

where ω_r and β_r may be either in units of rad^2 or degree^2. It follows that the equivalent antenna temperature due to a cosmic noise source is lower than the associated equivalent black body temperature of the source whenever the beam angular area of the antenna is greater than the source angular area. When the beam angular area is less than the source area, however, the angular extent of the source is effectively reduced to that of the antenna beam; so that $T_A = T_{av}$, and (6) reduces to:

$$P = K\, T_{av} \text{ (w cps}^{-1}\text{)} \qquad (8)$$

For cases where the antenna beam is small and the effective source temperature is constant over the beam area, the equivalent antenna temperature is taken equal to the effective temperature of the source. With low gain wide-beam antennas (such as a dipole), however, the effective antenna temperature would be obtained by computing an average effective temperature over the source extent and multiplying this by the ratio ω_r/β_r. Received cosmic noise power thus is expressed in terms of effective antenna temperature.

Once the physical aperture of the antenna and operating frequency are specified, the received power is expressed explicitly as

$$P = \frac{K\, T_{av} z A_p \omega}{3283\, \lambda^2} \text{ (w cps}^{-1}\text{)} \qquad (9)$$

where A_p = physical aperture of antenna
z = dimensionless efficiency factor
ω = source extent in deg^2 (1 rad^2 = 3283 deg^2)

To obtain the total interfering noise level, this power per unit bandwidth is increased by a factor dependent upon the bandwidth of the receiving system. For most practical cases this is done by simply multiplying by the bandwidth in cycles, although for higher accuracies a step-by-step summation of the power over the particular frequency interval involved can be carried out.

Cosmic Radiation External to Solar System

All characteristics—spectral, temporal, and spatial—must be considered in assessing the degree of cosmic interference in a system. Cosmic radio emission consists essentially of a randomly polarized, continuous radiation having the characteristics of random noise and extending over the radio spectrum from a wavelength of approximately 1 cm to at least 300 m, and with a restricted line emission from atomic hydrogen in inter-stellar space at 21 cm. The spectral characteristics of cosmic background radiations generally appear predominantly non-thermal, with resulting equivalent black body temperatures which increase with wavelength. The maximum and minimum levels for observed cosmic background radiation or continuum, are shown in Fig. 2[1] wherein equivalent black body temperature is plotted versus frequency. This radiation is distributed continuously across the sky with maximum intensities occurring in the galactic plane (which is related visually with the bright band of the Milky Way), and with minimum intensities occurring in the direction of the galactic poles.

In addition to this background continuum, extremely "bright" spots have been observed in the sky; these subtending relatively small angular areas. To date these discrete sources have been attributed only to colliding galaxies and supernovae (exploding stars), although it has been suggested by some radio astronomers that individual stars radiate energy in the same manner as the sun. (Present radio telescopes do not have sufficient resolving power to confirm this hypothesis because of the extremely small angles subtended

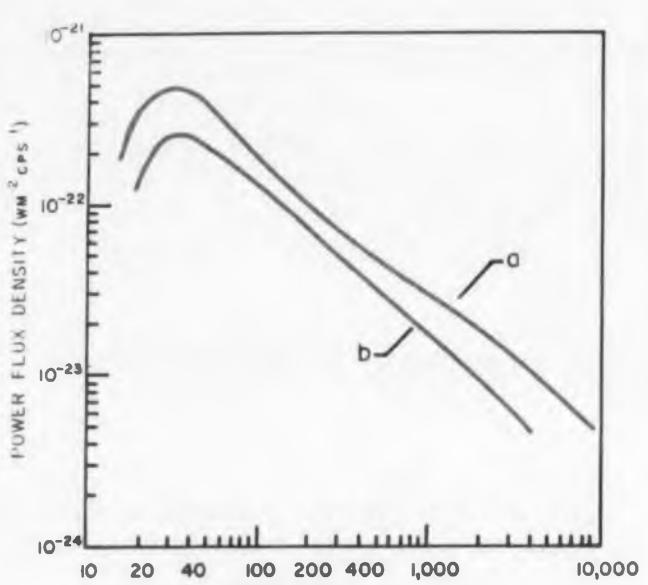

Fig. 3. Power spectra associated with the two most intense discrete sources detected to date (*a*) Cassiopeia A and (*b*) Cygnus A.

by even the nearest stars, but suggestions have been tentatively formulated for establishing an antenna capable of the required resolution.)

The frequency spectra of these discrete sources are predominantly like the continuum, and non-thermal in character. Fig. 3[1] shows the power spectra associated with the two most intense discrete sources which have been detected to date. These spectra typify the frequency dependence of most discrete sources.

In regards to spatial distribution, the positions of cosmic radio sources in the sky will appear to move with time because of terrestrial rotation. These movements may be plotted in the same manner as that used by astronomers for visible stars, and radio maps giving contours of equal brightness temperature for the background continuum have been plotted for different frequencies. In addition to this, tabulations of the sizes and positions of discrete sources are also available if required for computation purposes.[2]

Cosmic Radiation Internal to Solar System

The sun is the most important single source of radio emission within our solar system. At wavelengths shorter than 1 cm, its radiation is characteristically thermal as well as randomly polarized, that is, it follows the emission characteristics of a Planckian black body radiator (at 6000 K) while at wavelengths greater than 1 cm, non-thermal radiation components are present.

Under disturbed solar conditions the spectral curve of this emission tends to have a negative slope resulting in an increase of equivalent black body temperature with wavelength. "Noise storms" associated with sunspots and solar flares occur mainly in the 1-cm to 10-m wavelengths regions and are characterized by bursts of greatly enhanced radiation. The complex dynamic spectral characteristics of these noise storms are beyond the scope of the present discussion. Fig. 4[3] however, indicates the solar power spectra observed on earth, together with curves of the emission from a black body radiator at various temperatures. The maximum variation of intensity levels between quiet and disturbed solar conditions are also shown and it is seen that equivalent black body temperatures may lie within the range of 10^4 to 10^{10} K in the rf band.

The visible disc of the sun subtends an angle of approximately 0.5 deg when viewed from the earth but the angular size of the "radio" sun tends to be somewhat larger than this value and increases with the wavelength observed. This arises from the fact that radiation is generated in the solar atmosphere as well as from the photosphere (visible disc).

At 3,000 mc this "radio" diameter is approximately 0.75 deg, although the equivalent temperature varies considerably over the source area and shows a marked increase at the limb or edge of the visible disc. Antenna half power beam widths subtending angles less than 0.5 deg will effectively have an equivalent antenna temperature equal to the equivalent black body temperature of the sun at the specified wavelength if the antenna is pointed directly at the source. Interference power levels under these circumstances may be considerable, especially in a wide-band system.

The curves in Fig. 5 indicate the relative levels of interfering noise power across the rf band due to cosmic background radiation, solar radiation, and the radiation from Cassiopeia A, the most

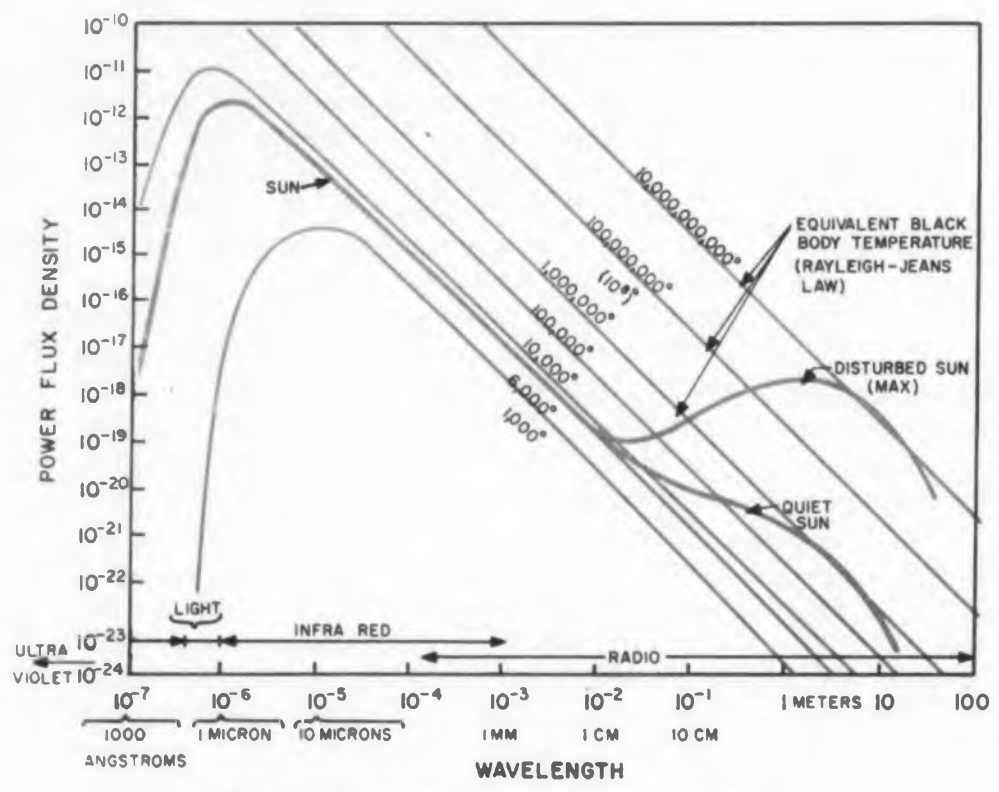

Fig. 4. Solar power spectra observed on earth.

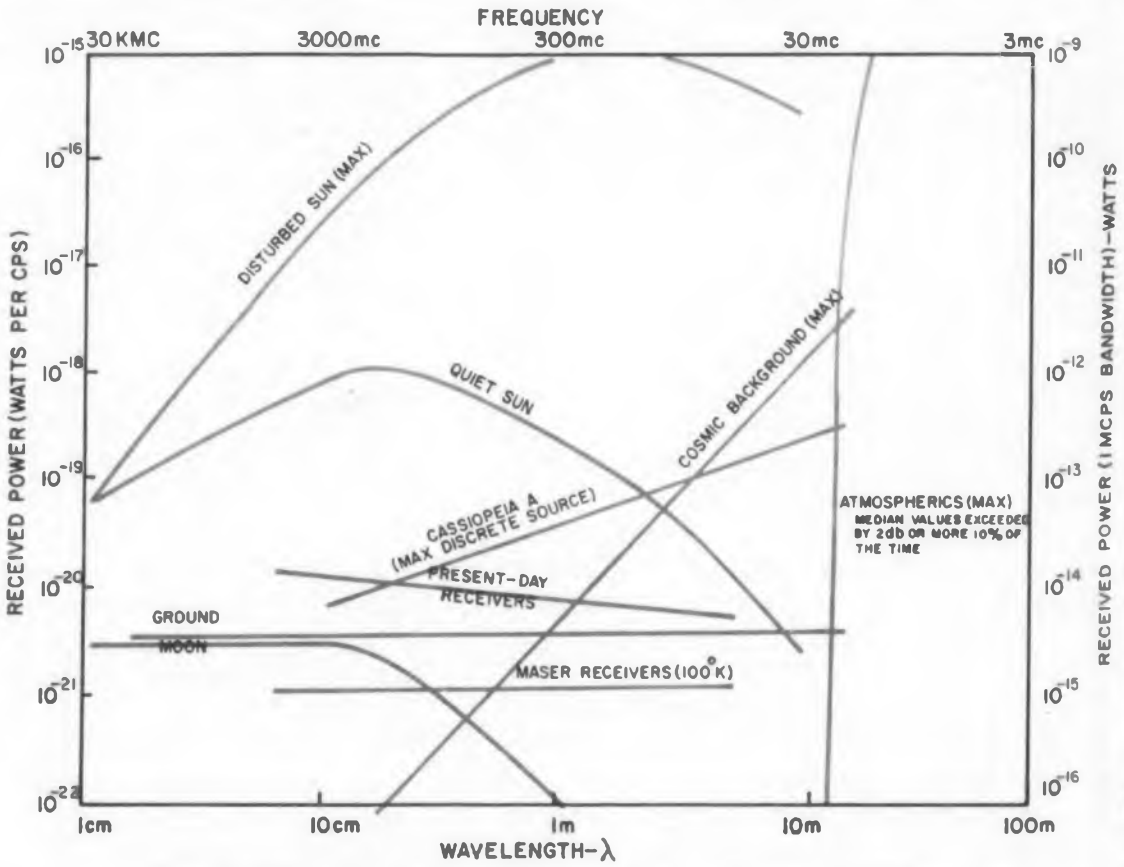

Fig. 5. Relative levels of interference noise power across the rf band due to radiation encountered in space.

intense discrete source yet observed outside the solar system. Specifically, this date represents noise power per unit bandwidth received by a 100-ft diam parabolic antenna for radio frequencies between 15 mc and 30,000 mc. For comparative purposes the internal noise power generated by present day receivers and masers as well as the power levels of terrestrial atmospherics produced by lightning discharges and thermal radiation from the ground, are also shown. Data may be applied directly to the analysis of space communication systems.

Space Probes Aid RFI Work

It might be of interest to conjecture upon the portions of the electromagnetic spectrum which cannot be observed on earth because of ionospheric cut-off and atmospheric molecular absorption effects, and which may constitute strong interference bands in space-to-space communication systems. For instance, in the rf band lower than 10 mc, where ionospheric cut-off prohibits extra terrestrial observation, extrapolation of the cosmic background radiation curves in Fig. 2 yields equivalent black body temperatures of the order of 10^7 K. In like manner, the negative slope of the disturbed solar radiation in this portion of the spectrum if extrapolated would yield equivalent temperatures as high as 10^{12} K. Does this level of radiation actually exist in the regions above the earth's ionosphere?

Experiments with high altitude rockets are now investigating this, as well as the ultraviolet region of the spectrum which until recently had been restricted to wavelengths greater than about 2850 A by reason of ozone and oxygen absorption. Data on the radiation levels in the millimeter-wavelength range which are to a great extent shielded by molecular absorption in the atmosphere are also being obtained. No doubt gaps in our knowledge of the electromagnetic environment beyond the earth's atmosphere and in our knowledge of cosmic radio noise as it relates to the operability of future space communications systems will be filled in as appropriate instrumentation in satellites and other space vehicles becomes available. ■ ■

Acknowledgment

Aspects of the work described herein were sponsored by the U.S. Air Force, Air Research and Development Command, Rome Air Development Center, Mr. Benjamin Lindeman, Technical Monitor.

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2. Cosmic Noise Survey, D. H. Menzel, Harvard Observatory, Cambridge, Mass.
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Simple Equations for Rapid Design of Pi-Network

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Monterey, Calif.

IMPEDANCE-transforming pi-networks can be quickly designed with the aid of only three simple equations. Referring to the circuit shown in Fig. 1, these equations are:

$$Q_1^2 + 1 = \frac{R_1}{R_2}(Q_2^2 + 1) \qquad (1)$$

$$C_1 = \frac{Q_1}{\omega R_1} \text{ and } C_2 = \frac{Q_2}{\omega R_2} \qquad (2)$$

$$L = \frac{R_2 (Q_1 + Q_2)}{\omega (Q_2^2 + 1)} \qquad (3)$$

where $Q = \omega C_1 R_1$ and
$Q_2 = \omega C_2 R_2$

The Q factors relate the energy stored in the capacitors to the shunt load resistance. In designing the network a suitable value of Q_1 or Q_2 is first assumed and the value of the other Q is calculated from Eq. 1. C_1, C_2 and L are then computed.

To illustrate the design procedure, let us consider the problem of a 400-ohm load to be driven by a class C tuned power amplifier at a freqency of 3 mc. The tuned power amplifier requires a load of 2060 ohms. The matching network then has R_1 equal to 2060 ohms and R_2 equal to 400 ohms. Since the input to the network consists of current pulses, a suitable value of Q_1 should first be chosen. Note that the higher the Q, the larger the capacitor, but the better will be the harmonic suppression.

The tabular compilation was made for two assumed values of Q_1. The sum of $Q_1 + Q_2$ gives a comparison value for the Q of a simple tuned circuit load for which a Q of 10 to 15 is suitable.

Sample Calculations for Two Assumed Values of Q.

Q_1	$Q_2^2 + 1$	Q_2	$Q_1 + Q_2$	C_1 μμf	C_2	L μh
8	12.6	3.56	11.56	206	472	19.5
10	19.6	4.31	14.31	258	573	15.5

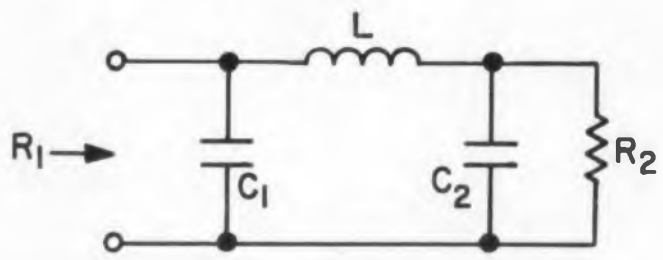


Fig. 1. This pi-network can be easily designed using the equations given in the text.

Variation of Input Resistance

The input resistance of the pi-network will vary considerably with only a slight increase in the load capacitance.

Suppose in the network of the example where Q_1 was chosen equal to 8, C_2 increases by 5 per cent. With the same values for L and R_2 we can find the new values of R_1 and C_1. Since Q_2 is also increased by 5 per cent:

$$Q_1 = \frac{\omega L (Q_2^2 + 1)}{R_2} - Q_2 = 10.0$$

Eq. 1 yields $R_1 = 2700$ ohms. This is a 30 per cent increase of R_1.
Eq. 2 yields $C_1 = 197$ μμf which is about a 5 per cent decrease.

Laboratory Component Adjustment

After the design components have been assembled and the load connected, the desired value of R_1 can be obtained by connecting the

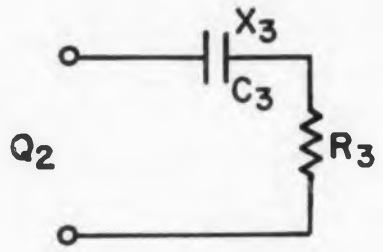


Fig. 2. The parallel R_2C_2 combination of Fig. 1 can be replaced by the series R_3C_3.

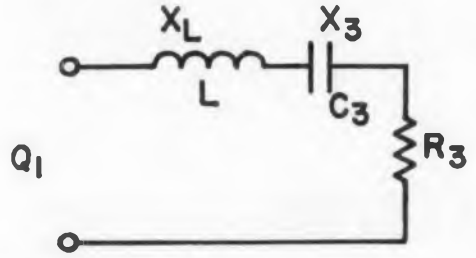


Fig. 3. The value of inductor L, placed in series with R_3C_3, is calculated from Eq. 3.

etwork in series with a resistor of R_1 ohms. This ombination is then connected to an oscillator set t the matching frequency. A vtvm across the inut of the network is maximized by tuning C_1. Adjustment of C_2 will make the input voltage to he net one-half of the oscillator voltage. This akes the input resistance equal to that of the eries resistor.

Derivation of Design Equations

Eqs. 1-3 were derived by following the steps below:

A. Convert the C_2 R_2 parallel circuit of Fig. 1 to its equivalent series circuit, C_3 R_3, then:

$$R_3 = \frac{R_2}{Q_2^2 + 1}$$

$$X_3 = Q_2 R_3 \qquad \text{(Fig. 2)}.$$

B. Connect L to this series circuit.

$$Q_1 = \frac{X_L + X_3}{R_3}$$

Therefore:

$$X_L = Q_1 R_3 - X_3 = R_3 (Q_1 + Q_2)$$

$$L = \frac{R_2 (Q_1 + Q_2)}{\omega (Q_2^2 + 1)} \qquad (3)$$

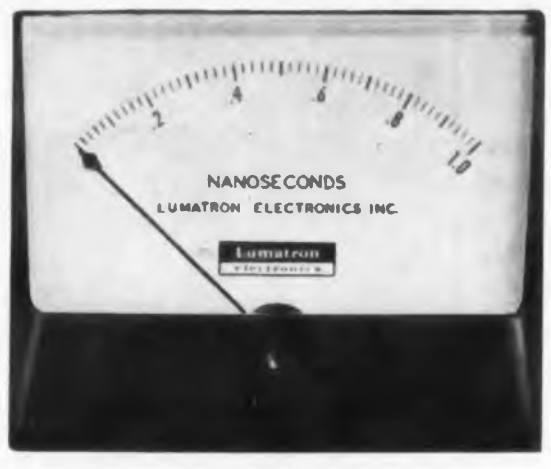
C. Convert the series resistance R_3 of Fig. 3 to the equivalent shunt resistance R_1.

$$R_1 = R_3 (Q_1^2 + 1) = R_2 \frac{(Q_1^2 + 1)}{(Q_2^2 + 1)} \quad \blacksquare\blacksquare \quad (1)$$

References

QST March & April 1957.
CQ May 1950, Sept. 1950, May 1951.

Direct-Reading Switching-Time Tester Samples Nanosecond Waveforms



A NEW INSTRUMENT measure switching times as short as half a nanosecond. Five times faster and te times more accurate than earlier instru ments that did part of its job, this teste measures rise, fall, turn-on, turn-off, an storage times, one at a time or in an sequence.

Particularly useful for measuring th important time parameters of semicon ductors and high-speed computer ele ments, Lumatron's model 400 Automati Switching Time Parameter Tester pro vides a response equivalent to a bandpa of almost 1000 mc. It provides accurac to within 0.2 nsec or 3 per cent (whic ever provides the wider tolerance) i measuring time from 0.5 to 1000 nsec.

CIRCLE 789 THRU 799 ON READER-SERVICE CARD

Manufactured by Lumatron Electronics, Inc. of 116 County Court House Road, New Hyde Park, L.I., N.Y., the "400" requires no lengthy calibration and set-up procedures in changing test programs, devices to be tested, or signal amplitudes. It requires no calculations—no squinting at scope screens.

Test results appear, in about a second, on a meter, precisely calibrated in nanoseconds. Readings can be programed into a discriminator for go-no-go testing; they can be digitized for printout; they can be presented directly on a digital voltmeter; and waveforms can be monitored on a high-speed oscilloscope.

Sampling Percentage Levels Yields Better Performance

Two key factors account for the 400's versatility, speed, and accuracy. One is its use of sampling techniques; the other is its measurement between percentage levels rather than voltage levels.

With the sampling technique, instead of viewing each signal waveform in its entirety, the 400 samples 0.3-nsec slices of successive cycles of the signal. These slices can be advanced along the waveform by as little as 1 psec. The samples represent instantaneous amplitudes which, if stretched and displayed as successive dots on a crt, would recreate the original waveform, but much more slowly.

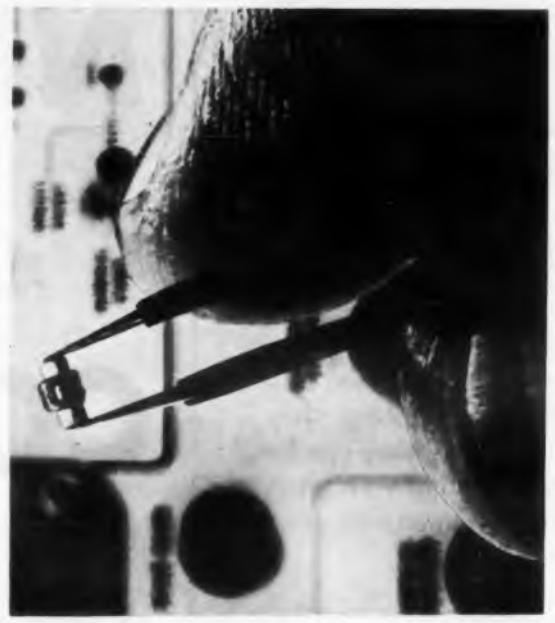
By reading the time between percentage levels rather than between voltage levels, the tester's accuracy becomes independent of the output amplitude of a device. This output amplitude may not be constant and, in fact, it may not even be known.

In a test of, say, storage time, the 400 determines the time between 90 per cent of the amplitude of the lagging edge of a self-generated test pulse and 90 per cent of the lagging edge of the output of a device under test. It generates a voltage corresponding to the time difference between these levels.

The 400, available on a 60- to 90-day delivery, costs about $6900. A model 420, which covers the range of 1 to 1000 nsec with an accuracy of 0.4 nsec or 3 per cent, costs about $4900.

For more information on these automatic switching time testers, turn to the Reader-Service Card and circle **250.**

See this product at WESCON, **Booth 2414.**

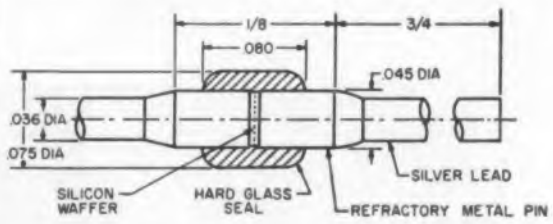


Unpainted unit glows with red-heat as 10-amp current is sent through it.

Silicon Diode Withstands 10 Times Power Overloads, Tolerates Red-Hot Operation

RED-HOT is the word for the miniature glass-enclosed silicon diode about to be marketed by the Unitrode Transistor Products Corp. (214 Calvary St., Waltham, Mass.) That is, it can glow with red heat and still operate satisfactorily while sustaining power overloads of up to 10 times rating. And once the overload is removed, the diode's characteristics—both electrical and mechanical—will be the same as those it had before the overload was applied.

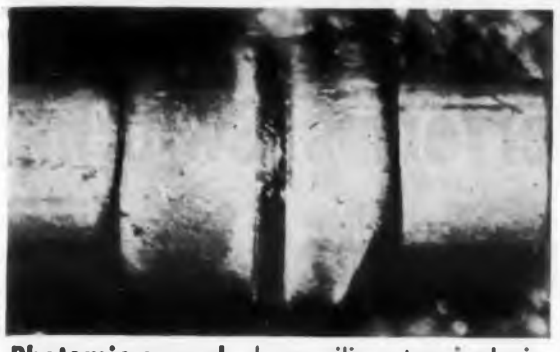
Under rated load, the diode can operate in ambients from —195 to +300 C. It can withstand peak inverse voltages of up to 10,000 v. The unitized or "Unitrode" construction also makes the diode unusually resistant to mechanical shock, vibration, and acceleration.



Tight, high-dielectric constant hardglass seal surrounds silicon wafer and refractory metal terminal pins. With the same diameter as the wafer, the pins rapidly conduct heat from the silicon to the silver leads.

The construction of the diode is shown in the figure. Leads, terminal pins, and the diffused silicon wafer are bonded together into a single assembly. The glass bead completely covers the portion of the diode sensitive to environment. The glass is in intimate contact with the silicon and the pins, leaving no void in which gas, air, or other contaminants would accumulate. Since the hard-glass ambient can not contaminate the silicon surface, the surface is permanently stabilized. The electrical characteristics of the diode are fixed and independent of environmental changes.

A high power dissipation safety factor is provided by the two terminal pins which are fused to both sides of the silicon wafer. The metal pins have the same diameter as the wafer and therefore conduct heat away from the silicon and into the silver leads at a rapid rate. This is in



Photomicrograph shows silicon-terminal pin "sandwich" and connecting silver leads.

contrast to conventional diodes, where the "whisker" spring is bonded to a small area of one side of the wafer.

All materials, including the silicon and the bonds between materials, stand up well at +500 C, compared with the 150-200 C top temperature of other diodes.

Since the glass and the terminal pin metal have been carefully matched to the same thermal coefficient of expansion as the silicon, fabrication of the diode produces an unstressed structure. Because this common coefficient is low, no ill effects are experienced in a wide range of temperature cycling, thermal shock, or other heat and cold testing. No special precautions are necessary for either iron or dip-soldering assembly procedures.

The high peak inverse voltage of the diode is a result of its complete glass sealing. This seal isolates the terminal pins from each other and fills all the space surrounding the silicon. With its high dielectric constant, the glass prevents arcing between pins which could occur when gaseous contaminants are present.

The glass-ambient diode is supplied in standard MIL and JEDEC types, such as the IN649 series, the IN540 rectifier series and the IN459A low-leakage diode series. These include piv's from 50 to 720 v, leakage currents from 0.025 to 10 μa, and forward currents from 10 to 750 ma. Higher voltage and special types are also supplied to customer specifications. Prices are competitive with standard diode types. Delivery is within 30 days.

The diode can be seen at WESCON at the Unitrode Transistor Products Corp. booth.

For further information on this silicon diode circle Reader-Service 252.

Silicon Tetrode

Performs Switching And Memory Functions

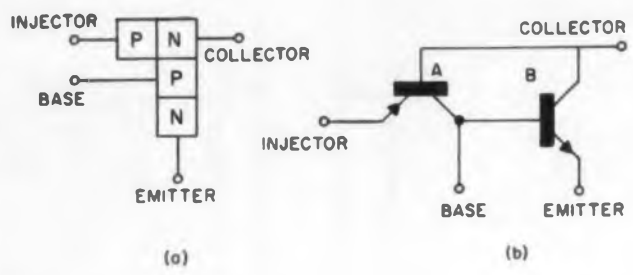


Fig. 1. (a) Physically the silicon binistor resembles a four-layer switch. (b) Equivalent circuit for the binistor.

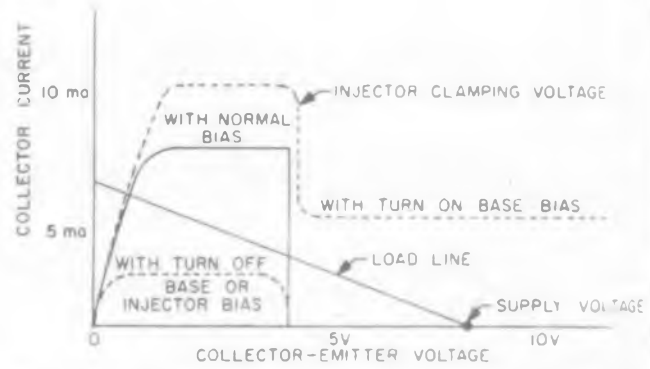


Fig. 2. Binistor E-I characteristics with varying input bias conditions.

Condensed Binistor Specifications

Typical Turn-off Current Gain	50 @ 15 ma Collector Current
Operating Collector Current Range	50 μa to 15 ma
I_J critical	0.5 ma @ 5 ma Collector Current
Operating Temperature Range without Temperature Compensation	—65° C to 150° C

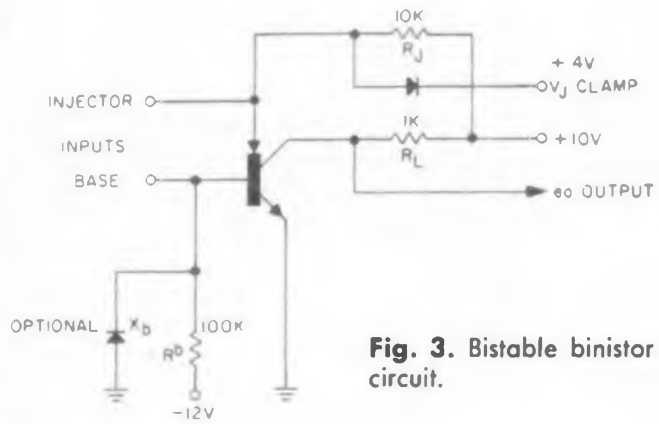


Fig. 3. Bistable binistor circuit.

SWITCHING and storage circuits can now make use of the binistor—a new semiconductor device with many of the properties of a flip-flop. And while the typical flip-flop requires at least 13 components, the equivalent binistor stage requires only 4.

A bistable, negative resistance device, the binistor is manufactured by the Transistron Electronic Corp. (168-182 Albion St., Wakefield, Mass.) It depends largely on an external voltage supply for its negative resistance characteristic. Consequently it is very stable and uniform in manufacture. Input and output voltage swings are comparable in level with typical transistor and diode circuits. Further, it can realize high current and voltage gains and can operate from —80 C to +200 C.

The first binistors to be made available will be of silicon, npn tetrode construction. In structure it resembles a four-layer switch, Fig. 1a. The output current is taken from an intermediate layer. The upper junction serves only as a "latch" to hold the device on when it is in the conducting stage. The main npn transistor A is designed for a high alpha and the pnp transistor B is designed to have an emitter breakdown voltage at least as high as the collector breakdown voltage of transistor A. Equivalent circuit is shown in Fig. 1b.

Essentially the operation of the binistor involves the gating of base current to the main transistor through the latching transistor. This gating in turn depends primarily on the collector voltage and the injector clamping supply voltage. If the collector is cut off, it will remain cut off, and if saturated it will remain saturated. An E-I output characteristic is shown in Fig. 2. The binistor's specifications are condensed in the table.

In addition to its application as a bistable device, Fig. 3, the binistor has been designed into several other simpler circuits. It has been used in a ring counter and in a coincident current memory with non-destructive readout. Further investigation is required to establish applications for the binistor as a small-signal negative resistance device.

Where applicable, prices will be competitive with germanium and silicon transistors. Quantities are available through Transitron's distributors.

For further information on this binistor turn to the Reader-Service Card and circle **253.**

Ultra-High Regulation Featured In All-Transistor Supply

LOAD regulation of less than 0.0005 per cent plus 25 μv can be obtained from a new transistorized dc power supply. Continuously variable, the 0-36 v, 1-amp supply operates from standard voltage sources of 115± 10 v or 220± 10 v with line frequencies of from 50 to 1000 c.

Designed by Krohn-Hite Corp. (580 Massachusetts Ave., Cambridge 39, Mass.) power supply model UHR-T361 has a line voltage stability of less than 0.0002 per cent plus 10 μv, for a ±10 per cent line voltage change, a hum and noise level of less than 50 μv rms, and a ±0.01 per cent or ±1 mv (whichever is greater) output voltage drift for an 8-hr period.

Temperature coefficient of the supply is 0.01 per cent per deg C, or 7 mv per deg C (whichever is greater). This is the same value found in other commercially available units. However, its effect may be to detract somewhat from the remarkably high line and load regulation otherwise obtainable.

The supply differs from conventional units in that it uses two interlocked regulators— a main regulator and a pre-regulator. The main regulator is a series type with a high-gain (94 to 114 db) amplifier. With this high gain, the internal impedance at dc and low frequencies is less than 250 μohm.

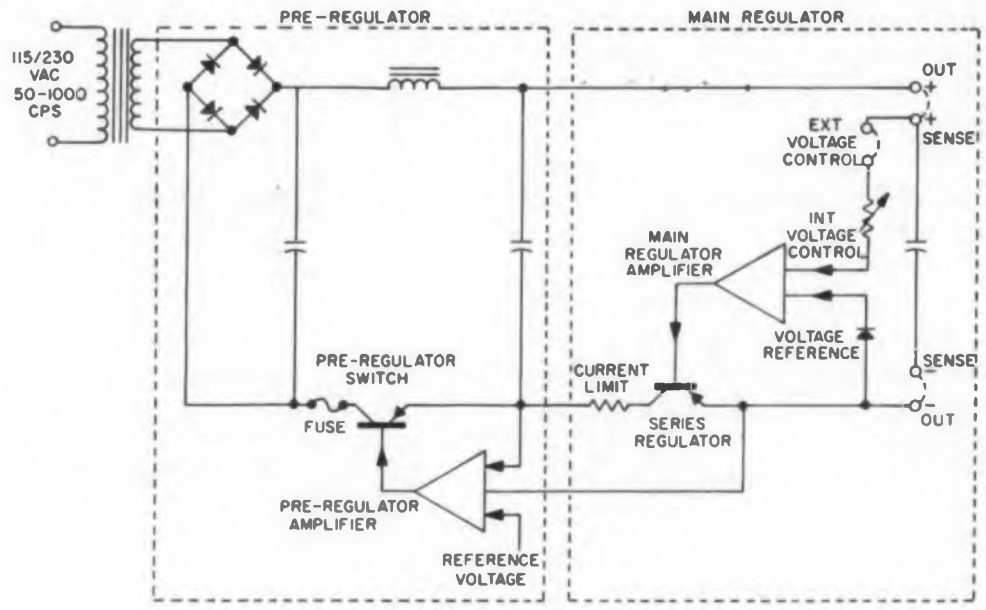
The pre-regulator acts as a very efficient transistor switch which maintains the voltage across the series regulator constant, independent of line voltage or load changes.

Stabilization of the main regulator allows the output voltage to recover to within 10 μv of its pre-set level within 25 μsec after the application or removal of a large load.

Because the efficiency of both regulators is high, convection cooling is adequate up to an ambient temperature of 60 C. If this temperature level is exceeded an automatic sensing device shuts the supply off.

No derating is required at maximum voltage and current output. Full rated current can be drawn with 100 per cent duty cycle at any output voltage, and at any line voltage within the specified range.

Output voltage of the Model UHR-T-361 is continuously adjustable by a precision ten-turn potentiometer, coupled to a three-digit, ten-turn counting dial. This dial registers from 0 to 36 v and is



SIMPLIFIED SCHEMATIC DIAGRAM

Power supply circuit uses two interlocked regulators to achieve its 0.0005 per cent load regulation.

Bench-model supply has digital voltage dial, accurate to 50 mv. The dial is also featured on rack-mounted units.

settable to 50 mv. The potentiometer resolution is 1.6 mv. Model variations also have continuously adjustable voltage control by a precision single-turn potentiometer, or with four decade-rotary selector switches.

Short circuit and overload protection is provided by a current-limiting circuit which automatically restores the output voltage when the load fault is removed. Current limits can be set at 50, 100, 200, 500 and 1,000 ma. Under short circuit or overload conditions, the output current will not exceed the selected limit current by more than 10 per cent.

The supply has provisions for both remote voltage control and remote sensing. For remote sensing, separate SENSE terminals are available to permit full regulation of the output voltage at a remote load. Rated power can be delivered to a load 100 ft away with a static output voltage change of less than 500 μv between no load and full load. The ripple is less than 250 μv rms.

Available in both rack mounted and bench models, the power supply is priced at about $750 with delivery scheduled for the fourth quarter of 1960. Other models in the power supply line—UHR-T363 (0-36 v, 0 to 3 amp); UHR-T365 (0-36 v, 0 to 5 amp); and UHR-T3610 (0-36 v, 0 to 10 amp)—will be ready for delivery in 1961, when prices will be announced. The supplies will be on display at WESCON, **Booth 713.**

For further information turn to the Reader-Service Card and circle **254.**

Most Products at WESCON To Be Displayed for First Time

LIKE A PERSIAN bazaar, this year's WESCON show will thrive on customer curiosity.

The lure for the customers will be displays by hundreds of equipment manufacturers of everything from computers to cable connectors. The companies' top salesmen and engineers will explain and demonstrate the equipment to as many touring engineers as well listen.

Most of the products will be displayed for the first time. According to the company responses to an ELECTRONIC DESIGN questionnaire, the products may not be revolutionary, but many will feature clever, and even ingenious, innovations on existing devices.

Data Equipment

Tape recorders, many using transistors, are being designed more frequently in modular form. Several types will be shown by Ampex Corp., and by Minnesota Mining and Manufacturing Co.

The bandwidth of the Ampex model is 300 to 250,000 cps at a tape speed of 60 ips. The Minnesota company's model has a bandwidth of 50 to 120,000 cps at a low tape speed. At a tape speed of 120 ips, this unit is said to have an upper frequency limit of 1 mc. Both models can record on seven wide-band tracks. Miniature recorders, to be shown by Pacific Electro-Magnetics Co., also are multi-channel, and have 100 kc bandwidths.

A high-speed printer, also in modular form, will be displayed by Beckman Instruments, Inc. The unit prints 12-digit numbers in either black or red, and accepts data from Eput meters or digital voltmeters.

A data transmitter to be shown by Gates Radio Co. is reported to have uniform frequency response from dc to 50 kc. The unit's carrier-frequency range is 130 to 150 mc, with 50 w output.

Packard Bell will display its first general purpose computer. The low-cost, small-size unit—$30,000 and 110 lb—can be operate at 41,666 instructions per second. Its capacity is 1,808 words, but can be extended to 15,888 words at additional cost.

Servo System Components

A dc voltage proportional to the phase difference between an input and a reference signal is obtained from a demodulator and phase detector to be shown by Varo Manufacturing Co. The device has uniform (within 3 db) response between 700 and 1500 cps.

American Electronics Inc. will show motor tachometers of greater precision than that available in its previous models. The units have a 2.75 v output per 1000 rpm $\pm$ 0.25 per cent from 60 to 80 C.

An angular oscillating table for frequency-response testing of gyros, accelerometers and guidance systems will be displayed by Micro Gee Products, Inc. The table is designed to be electrodynamically driven by an audio oscillator. Operation only at 60 cps can be obtained by driving the unit from a Variac connected to the power lines. Rate information is fed to an oscilloscope or a recorder for presentation. The table's upper frequency limit is 100 cps.

At least two companies will display servo-motor speed-reducer and gear heads. They are Bowmar Instrument Corp. and Dynamic Gear Co. The Dynamic model offers 190 ratios from 7:1 to 595:1. The Bowmar model offers ratios from 10:1 to 2,025:1, and is 1/2 in. in diameter by 3/4 in. long. Dynamic said its gear ratios were accurate to within 0.5 per cent.

And last, but hardly least, there will be displays of servo-motors. One unit, from Kearfott, weighs 3 oz and has minimum stall torques ranging from 1.8 to 20 oz-in. Gearheads for the unit come in 28 ratios from 7.62:1 to 1254:1.

Microwave Equipment

Vswr measurement instruments will be displayed by Polytechnic Research and Development Co. and FXR, Inc. The Polytechnic model is an electronic amplifier with four regular scales and one expanded scale. It is for use with slotted sections. The FXR model uses the incident and reflected power technique to make measurements. It measures microwave energy directly.

FXR also will display precision attenuators with a range from 0.3 to 30 db. The attenuation value "fixed" into each unit is the customer's choice. The attenuation is dependent of the ambient temperature, according to the company. Other devices to be shown by FXR are: interchangeable slotted sections, ferrite isolators, and direct-reading coaxial frequency meters with a range from 3.95 to 11 kmc.

Additional microwave equipment will be exhibited by these firms: Frequency Standards Corp., an absorbtion-type wavemeter for use as a marker cavity; Sylvania Electric, a microwave diode for K-band applications; Emerson & Cunning, a bistatic microwave reflector; Huggins Laboratories and Microwave Electronics Corp., travelling wave tubes.

Semiconductors and Tubes

Semiconductor firms will bring out their latest versions of silicon devices. Pacific Semiconductor, Inc. and International Rectifier Corp. both will show silicon rectifiers. IRC has several models—two replace mercury vapor tube types 8008 and 872A; a third, in the form of stacked modules, can be used to give 750 amp output; a fourth can handle surges up to 1000 amps. The Pacific devices are rated at 12,000 through 30,000 v.

Transitron Electronic Corp. will display 18 types of diffused mesa silicon transistors. They include small signal, intermediate power and high power units. Motorola Semiconductor Products Inc. will show industrial power transistors. These units are rated for continuous operation at junction temperatures of 100 C; power dissipation is 90 w. Raytheon will show silicon transistors for high temperature applications.

Despite an apparent preponderance of silicon devices, there will be a representative showing of non-silicon diodes. Raytheon will exhibit its types 1N275 and 1N277 for airborne and missile equipment. Delco Division of GM will show its line of tunnel diodes.

Evidence that tubes still are around will come from Raytheon, Westinghouse, and RCA. Raytheon and RCA will show power tubes that can deliver 40 kw at 1215 mc and 400 kw at 30 mc, respectively. RCA will also have a triode of pencil-tube design for use as a tunable oscillator. Westinghouse will display a combination low-mu triode and sharp-cutoff pentode for use in industrial power supplies.

Power Supplies

Electronics companies are continuing their competition for the market in transistorized, well-

regulated, low-ripple power supplies.

One innovation comes from Power Designs Inc., which will display a unit that can be used as a constant-voltage or a constant-current source. Its range is 1 to 40 v at 0 to 500 ma. Regulation in either mode of operation is reported to be better than 0.05 per cent. The ripple is said to be less than 500 μv, when used as a voltage source, and 25 μamp, when used as a current source.

Six companies report their low-voltage power supplies have ripples of 2 mv rms maximum and regulations not greater than 10 mv from no load to full load. They are: Invar Electronics Corp.; Perkin Engineering Corp.; Kearfott; Mid-Eastern Electronics; Power Designs Inc.; and North Electric Co.

Test Instruments

Voltmeters, ohmmeters, ammeters, oscilloscopes and signal generators for a multitude of applications and in a multitude of sizes continue to be poured onto the market.

The voltmeters all promise accuracy within 1 per cent, and a possible headache for the designer who must choose from the many types available.

The signal generators displayed will give pulses, and sinusoidal uhf and microwave frequencies. A diode recovery test unit made by Lumatron Electronics consists essentially of a pulse generator with pulse heights variable between 0 and 100 v, and pulse width variable from 5 to 50 nsec. A pulse generator to be exhibited by Electro-Pulse, Inc., has a repetition rate variable between 100 cps and 10 mc, with a 12 v open-circuit output.

Most of the oscilloscopes displayed will be of the general purpose type with upper frequency limit around 500 kc or 15 mc.

Oscilloscopes with upper frequency limits around 1 to 2 kmc also will be exhibited. Tektronix, Inc. will show a 1-kmc model that uses an accelerating potential of 24 kv. The viewing area is 2 by 6 cm.

Lumatron Electronics, Inc., will exhibit a trigger-rate converter that reportedly permits viewing of 60-mc sine waves on 30-mc oscilloscopes.

Noise measurement equipment will be displayed by Quan-Tech Laboratories. One unit measures resistor noise voltage at 1000 cps; another measures transistor noise at 100, 1000, and 10,000 cps simultaneously.

In addition to these products, grouped arbitrarily according to their obvious, and sometimes overlapping, applications, there are many that fail to fall neatly into these categories.

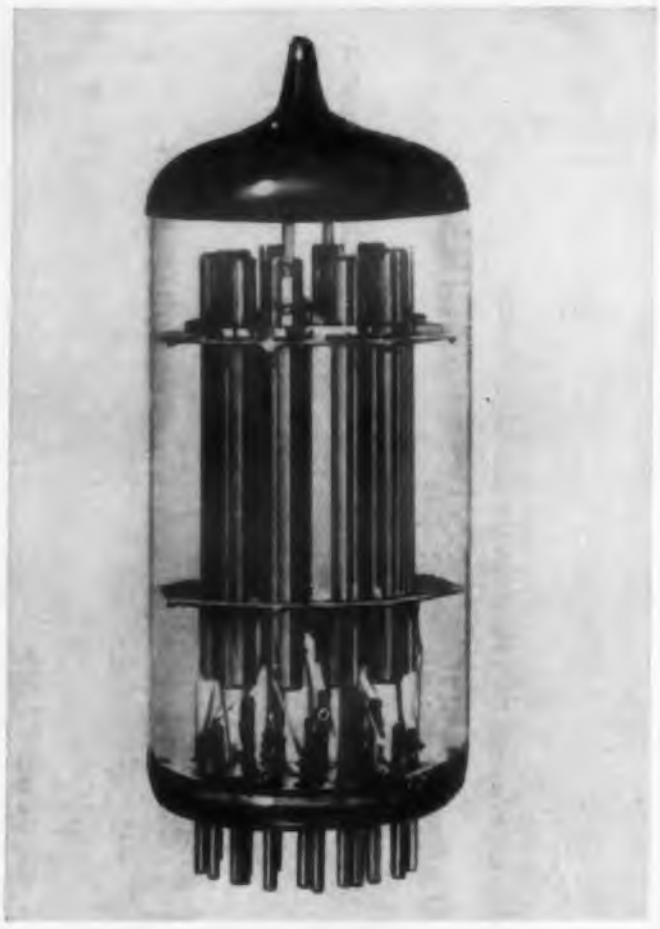
These include portable TV cameras, environmental test chambers, antennas, radar transponders, and a prodigious assortment of hardware from insulators to coil winders.

If you can spare the shoe leather, however, you'll see them all. ■ ■

NEW PRODUCTS

Over 200 products on display at this year's WESCON are described in the following columns

Includes items generally specified by engineers designing electronic original equipment. Use the Reader's Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



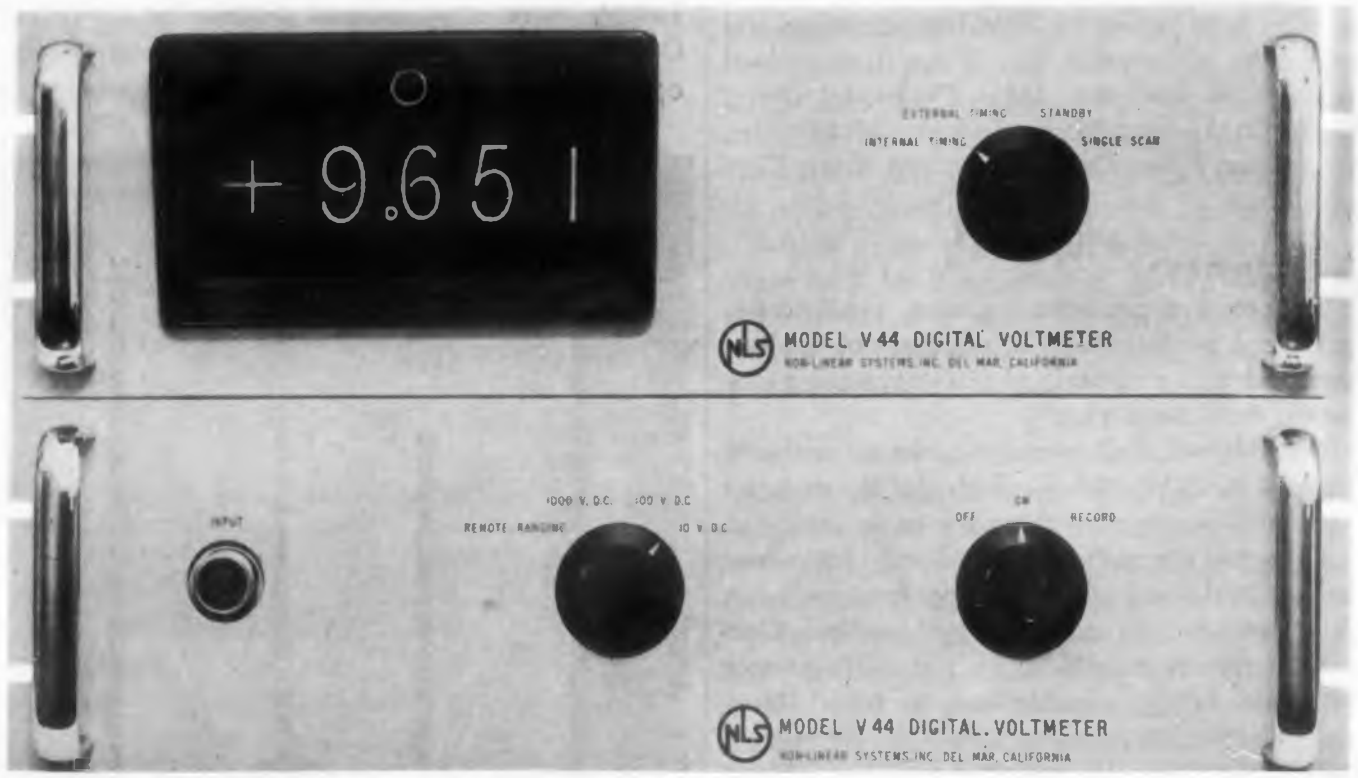
Switching Tube Has Four Electrodes Per Position — 567

Type BX-1000 multiposition electronic switching tube has a four-electrode structure per position. The fourth electrode, called the shield grid, makes possible three new functional characteristics: constant switching input requirements are unaffected by output level; for constant switching grid input requirements, the target operates over a wide range of output voltages; it allows for the operation of non-linear devices having non-linear characteristics in terms of time. Weighing 1.5 oz, the tube occupies 3 cu in.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.

Price & Availability: *$24.50 in single quantities; deliveries have started.*

Booth 2136-2137.



Digital Voltmeter Offers Print Connection — 569

Model 484 industrial digital voltmeter offers printer connection and automatic control. Designed for applications requiring ±0.01% accuracy, it is a four digit unit. The meter measures dc voltages from ±0.001 and ±999.9. Using one of the firm's preamplifiers extends the range to ±99.99 and ±999.9 mv, full scale. Using one of the firm's ac-to-dc converters, the unit measures ac voltages from 0.001 to 999.9 v, 30 cps to 10 kc. When operated with plug-in accessories, the meter can form the nucleus of automatic data logging systems for a wide range of applications.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

Price & Availability: *Price is $2,150 complete; production models available within 90 days.*

Booth 2815-2816.

Speed Reducers And Gearheads Designed With Whole-Number Ratios — 568

Designed with whole-number ratios, these Buord size 11 frame speed reducers and gearheads eliminate the need to make extensive calculations. They have postless type construction and offer ratios that are accurate to within 0.5%. The units come in over 190 stock ratios, from 7:1 to 5950:1. Mounting on standard Buord MK 14 servomotors, the units are designed for either opposite or direct rotation. They are lubricated for life, operate in temperatures from —55 to +100 C, and measure 1.42 in. over-all. Output torque is 75 oz-in.

Dynamic Gear Co., Inc., Dept. ED, Dixon Ave., Amityville, N.Y.

Price & Availability: *Stock units are available in two weeks maximum; reducers and gearheads from stock are priced from $88 to $78, respectively.*

Booth 438.

Electro-Optical Relay Has No Moving Parts **570**

Having no moving parts, this electro-optical relay is designed to replace a substantial portion of relays, potentiometers and commutators in their existing applications. Called a Raysistor, the unit has a conductance on-off ratio of 1,000,000:1 and is capable of speeds up to 100 operations per sec. It includes a light source in the control end which, when excited, actuates a photo-conductor in the signal end, allowing either ac or dc information to pass.

Raytheon Co., Industrial Components Div., Dept. ED, Newton 58, Mass.
Booth 2017-2018.

Microwave Attenuators Cover 2.6 to 90 Kmc Range **571**

The Series 175 attenuators cover frequency ranges from 2.6 to 90 kmc. Attenuation range for each model is from 0.3 to 30 db. A unit's fixed attenuation is accurately calibrated and then permanently locked at the value required. This value is maintained regardless of ambient temperature or humidity.

FXR, Inc., Dept. ED, 25-26 50th St., Woodside 77, N.Y.
Booth 2325-2326.

CIRCLE 93 ON READER-SERVICE CARD

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 3

RAYTHEON 1,000,000-WATT MAGNETRON LOGS OVER 13,000 HOURS IN MOBILE RADAR

This is the first reported history of a Raytheon QK-358 magnetron substantiated with an exhibit. Still, there are numerous other cases in which these exceptional Raytheon tubes have been clocked in excess of 10,000 hours, radiating at peak power.

The case in point concerns the application of a QK-358 magnetron in an AN/FPS-8 radar, for which the General Electric Company is the prime contractor. When the tube was replaced after 13,000 hours of service for "preventative maintenance" reasons, it was returned to Raytheon where the tube was found to be operating within specifications. Findings showed it to be highly stable and still capable of radiating more than one megawatt of power.

A large measure of the reliable operation and outstanding life of the QK-358 was achieved through special attention given to its unique characteristics in the overall design of the radar transmitter.

For your information, the QK-358 is a mechanically tunable pulsed-type oscillator with an integral magnet and is designed for coupling to a standard 3" x 6" waveguide. Typical operating characteristics include:

Frequency Range	"L" Band
Peak Power Output	1.3 Mw
Average Power Output	1,630 W

AN/FPS-8 high-power search system by General Electric, used primarily in aircraft control and early-warning operation. The complete mobile version (AN/MPS-11A) shown here, can be airlifted or carried on nine trucks and two trailers.

Life testing of Raytheon tubes, such as the QK-358 magnetron, for six weeks or more serves as a quality check of their performance characteristics as recorded and plotted against time.

Excellence in Electronics

RAYTHEON

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Co., Waltham 54, Mass. In Canada: E. Waterloo, Ontario. In Europe: Zurich, Switzerland.

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

NEW PRODUCTS AT WESCON

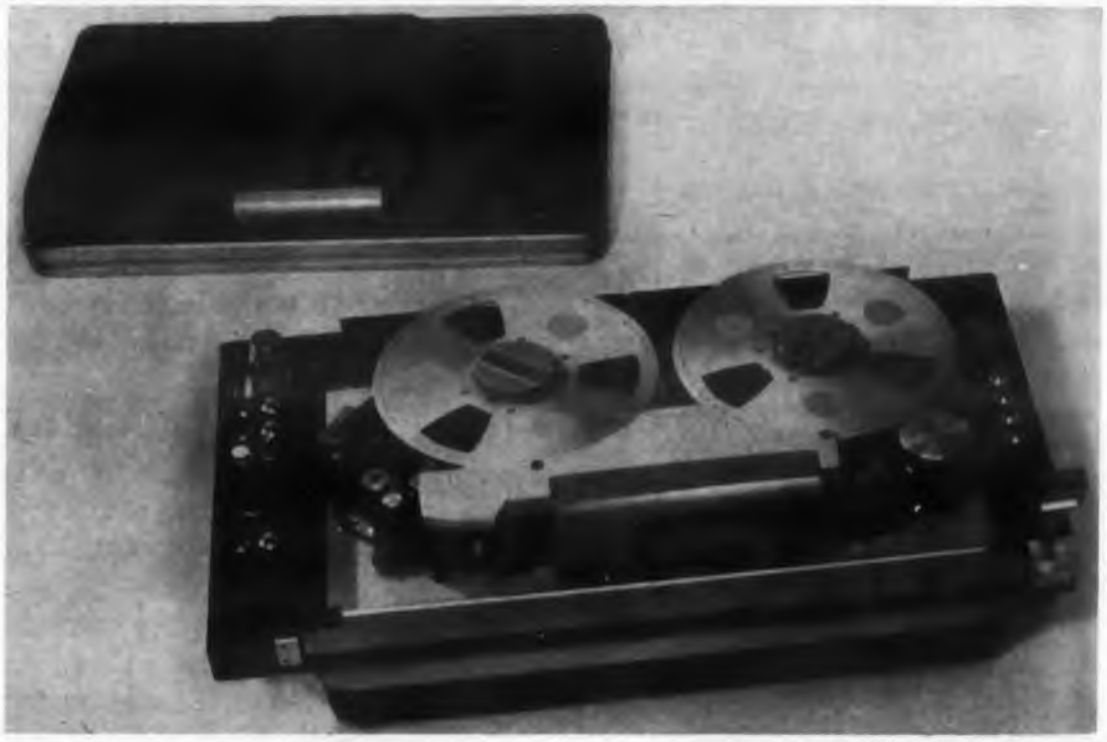
Latch-In Relay Requires 2-1/16 x 1-1/2 In. Panel Space

572

Requiring 2-1/16 x 2-1/2 in. of panel space, the Class 11LHS relay consists of two complete, miniature type relays mounted together. Armatures of the two relays are mechanically interlocked so that energizing one armature latches it in and releases the other armature. Coils and contact mechanisms of each relay are complete and entirely independent of the other relay, except for the latch-in levers. Operating voltages or currents, and contact arrangements of the two relays can be entirely different. The unit is available hermetically sealed or with removable covers for dc continuous or intermittent duty with up to four Form C contacts per relay.

Magnecraft Electric Co., Dept. ED, 335D W. Grand Ave., Chicago 51, Ill.

Booth 955.



Airborne Recorder Handles From 10 Cps to 4 Mc

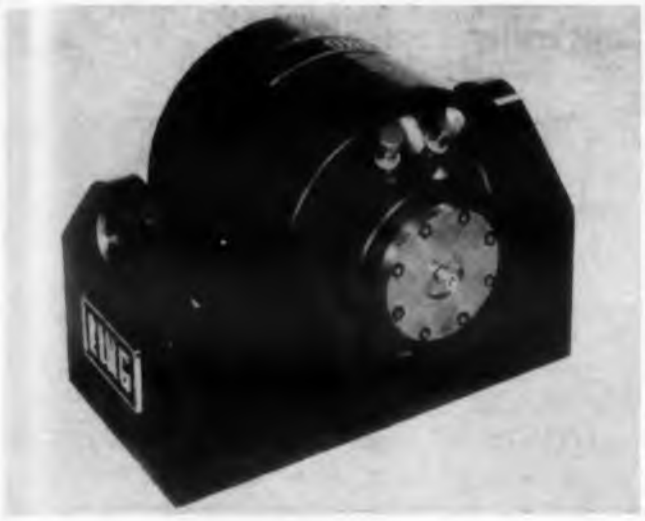
573

Designed for military and scientific applications, model AR-300 airborne recorder, shown, handles two channels of information over the frequency range of 10 cps to 4 mc. Amplitude response is flat within 3 db over this frequency range. Solid state components and etched circuitry are used throughout the system. It displaces 3.5 cu ft and weighs less than 150 lb, including tape. A ground unit, model FR-700, is a complete recording and reproducing system and has the same electronic characteristics as the AR-300. Both units record two channels of auxiliary information with a frequency response from 200 cps to 15 kc.

Ampex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood City, Calif.

Availability: By December, 1960.

Booth 2004-2006.



Vibration Testing Shaker Rated At 25 Lb — 574

Model LPM25 Permag vibration testing shaker is rated at 25 lb. It can serve as a vibration testing system for small components and also as a back-to-back accelerometer calibration unit. The unit is linear through the entire vibration range, 5 to 10,000 cps. A phenolic diaphragm protects the shaker from foreign particles that are commonly present in testing environments.

Ling Electronics, Dept. ED, 1515 S. Manchester Ave., Anaheim, Calif.

Price & Availability: Net price is $995; available from stock by August 15.

Booth 2501.

Ferrite Isolators Rated At 10 W Avg — 575

Rated at 10 w avg power and up to 2 kw peak power, the Series 157 broadband waveguide and coaxial ferrite isolators have frequency ranges from 3.95 to 26.5 kmc. They are said to provide maximum isolation and minimum insertion loss when used to reduce the vswr presented by a load or antenna or when eliminating anomalies caused by long line effects in oscillator outputs. The isolators are intended, primarily, for bench test setups. Lengths vary from 4.5 to 8.75 in.

FXR, Inc., Dept. ED, 25-26 50th St., Woodside 77, N.Y.

Price & Availability: Deliveries from 30 to 45 days; prices per unit vary from $220 to $450.

Booth 2325-2326.

NEW PRODUCTS AT WESCON

Radar Transponders 503

For missile tracking systems

Type SST-101 transponder is a general purpose crystal-video unit intended for tracking intermediate range missiles, drones and piloted aircraft. The unit has solid state circuitry and withstands extreme environments. Signal variations of —35 to 0 dbm result in a beacon delay of only 12 nsec. The unit measures 7 x 4-1/2 x 2-5/8 in. and weighs 4 lb, 1 oz. The Type SST-102 transponder is a superheterodyne unit for long range missile tracking applications. It uses a solid state modulator switch, a ferrite circulator and mesa transistors. It is designed for use with chain radars and has a delay stability of less than 0.05 μsec over an 80 db dynamic range. The unit measures 8 x 9.3 x 3.1 in.

Motorola Inc., Military Electronics Div., Dept. ED, 8201 E. McDowell Road, Phoenix, Ariz.
Booth 2021-2022.

Direct Writing Oscillographs 502

Response is dc to 100 cps

Two instruments, Models 299 and 301 direct writing oscillographs, are single-channel units in 21 lb brief-case type packages. Both units have a frequency response from dc to 100 cps within 3 db and a maximum sensitivity of 10 mv per chart division. Model 299 writer has a direct-coupled amplifier intended for dc input signals. Model 301 writer contains an oscillator, a high gain carrier amplifier, and a phase-sensitive demodulator for ac recording of transducer output levels.

Sanborn Co., Industrial Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.
Booth 608-609.

Continuity Tester 583

For production or lab use

The Circuitester is for production line or lab wiring continuity checks. It is a transistorized buzzer that provides an audible tone when path resistance is less than 0.5 ohms. Path resistance changes between 0.5 and 15 ohms change the pitch of the buzzer substantially; above 15 ohms there is no tone. The device tests for direct wire paths and is not sensitive to paths through inductances or capacitors.

Invar Electronics Corp., Dept. ED, 323 W. Washington Blvd., Pasadena, Calif.
Booth 2322.

Rate Gyros 549

Subminiature, fluid-filled

The Series A2016 fluid-filled rate gyros measure less than 1 in. in diameter and 2.45 in. long. Units are available either with a simple viscous-shear type damper, providing a relatively constant damping ratio, or with a mechanism compensating for fluid viscosity within 20% from —55 to +85 C, without heaters. The gyros are available in two- or three-axis rate sensing packages. Most parts are interchangeable.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.
Booth 626-627.

Pressure Transducers 521

Have expanded scale outputs

The Series P2-1253 pressure transducers are applicable where interest lies primarily in the upper end of a pressure transducer's range, that is from 475 to 550 psi. Full 0 to 5 v dc output is concentrated in this portion of the range, rather than being dissipated in areas of no interest. Units have high output with no amplification needed. Accuracy is better than 0.15%.

Wiancko Engineering Co., Dept. ED, 255 N. Halstead St., Pasadena, Calif.

Price & Availability: Units, made to order, can be delivered in 6 weeks at $725, less quantity discounts.

Booth 420-421.

Cable Jacketing 548

For cables of decreasing diameter

This tapered Zippertubing provides a tight-fitting cable jacket for cables where branch-outs create decreasing diameters. Wires can be pulled through perforations in the tapered tubing to permit attachments to termination points. One man can apply the tubing without special tools.

The Zippertubing Co., 752 S. San Pedro St., Los Angeles 14, Calif.

Booth 2320.

Germanium Transistors 551

For audio and switching applications

Types 2N524 through 2N527 transistors are pnp germanium units designed for audio and moderate-frequency switching applications. Collector-to-base voltage is —45 v max; collector-to-emitter voltage, —30 v max; emitter-to-base voltage, —15 v max; collector current, 500 ma max; power dissipation, 225 mw max. Typical current gain at an I_e of 20 ma is from 35 for the 2N524 through 91 for the 2N527, with other transistors having intermediate values. The base lead is connected to the metal case. Package has a JEDEC-TO-5 type outline.

Sylvania Electric Products, Inc., Semiconductor Div., Dept. ED, 730 Third Ave., New York 17, N.Y.

Booth 2058-2059.

NEW PRODUCTS AT WESCON

Solenoid 584

Life is 20,000,000 cycles

No. 32 solenoid, designed primarily for use in computers and data processing, lifts up to 8 oz intermittent or 6 oz continuous duty and has a life of 20,000,000 cycles. It operates on 6 to 110 v dc with 3 w continuous or 6 w intermittent duty. Enclosure is steel shell; terminals are plug-in or lead types; mounting is 4-28 threaded bushing. The size is 0.5 in. in diameter and 3.5 in. long.

Guardian Electric Mfg. Co., Dept. ED, 1550 W. Carroll Ave., Chicago 7, Ill.
Booth 840-841.

Silicon Power Transistors 552

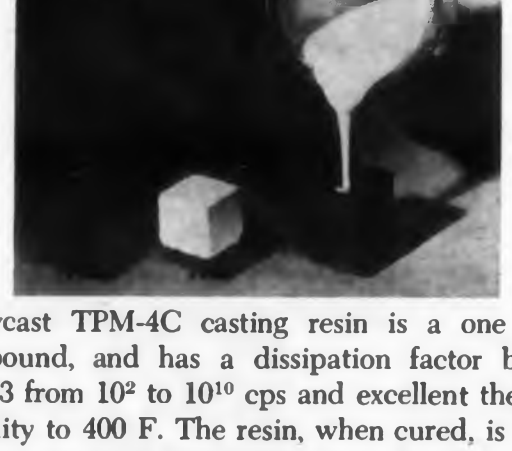
Dissipate 15 w

Types 2N1067, 2N1068, 2N1483, 2N1484, 2N1485 and 2N1486 power transistors are diffused-junction, npn silicon types rated at 15 w power dissipation. Temperature range is −65 to +175 C. These units have high beta and low saturation resistance. They are hermetically sealed in welded metal cases. Packages conform to the JEDEC-TO-8 outline.

Silicon Transistor Corp., Dept. ED, 150 Glen Cove Road, Carle Place, L.I., N.Y.
Availability: Delivery is immediate.
Booth 744.

One Part Casting Resin 515

Has low-loss, high-temperature properties



Stycast TPM-4C casting resin is a one part compound, and has a dissipation factor below 0.0003 from 10^2 to 10^{10} cps and excellent thermal stability to 400 F. The resin, when cured, is rigid and can be used for structural applications.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.
***Price & Availability:** The resin is available from stock. A 2-lb sample kit is $9.00.*
Booth 120-121.

Regulated Power Modules 558

Have five-year life expectancy

The Series RPM regulated power modules have a five-year life expectancy and are designed for a maximum operating temperature of 65 C in continuous use. Regulation is 0.05%. Ripple is 1 mv, rms, max. Units are designed to meet MIL-E-16400-B specifications.

ACDC Electronics, Inc., Dept. ED, 2979 N. Ontario St., Burbank, Calif.

Price & Availability: Units, priced from $215, are available in 3 to 4 weeks.

Booth 2230.

Knobs 561

Meet MIL specs

Series 500 knobs, designed to MS-91528 specifications for military applications, are available in six types. Rounds, skirted rounds, dial-skirted rounds, plain and skirted pointers and crank types are included. Six different sizes are provided in either MIL spec matte black or in mirror finish. Knobs are molded of Tenite No. 2, with ribbed contstruction in large diameter models. Each has two hardened set screws. Either 1/4 in. MIL spec or 1/8 in. diameter shaft holes are available.

Lerco Electronics, Inc., Dept. ED, 501 S. Varney St., Burbank, Calif.

Availability: Knobs for immediate delivery are available.

Booth 2504.

Magnetic Amplifiers 566

For servo motor applications

Series MAT magnetic amplifiers are designed for servo motor applications in transistorized circuits. Power outputs up to 18 w at 115 v, 400 cps, are available. Units are hermetically sealed and meet MIL specs.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.

Booth 430.

CIRCLE 60 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Tape Recorder 577

For instrumentation or laboratory use

Model CP-100 seven- or 14-channel recording and reproducing system is a reel-to-reel machine for instrumentation or general laboratory applications. It accommodates 0.5- or 1-in. tape on 10.5-in. reels and provides tape speeds of 1-7/8, 3-3/4, 7-1/2, 15, 30, and 60 ips. Cumulative flutter is below 0.6% peak-to-peak at 60 ips, tape speed deviations are ±0.25% max, and start time is less than 3 sec. Frequency response from dc to 200 kc is available. The unit can be operated in its mobile case or mounted in a 19-in. rack. It can be used at altitudes to 10,000 ft.

Ampex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood City, Calif.

Booth 2004-2005.

Magnetic Modulators 582

Range is 60 cps to 10 kc

The F5A magnetic modulators have a standard frequency range of 60 cps to 10 kc but can operate as high as 100 kc with low-impedance units. The dual-channel type F5A113 has a signal winding resistance of about 700 ohms. Single-channel type FSA114 is also offered. Originally intended for use as a circuit element in conjunction with amplifiers in servo systems, the units can also be used with thermocouples, strain gages, computing devices, and telemetering equipment.

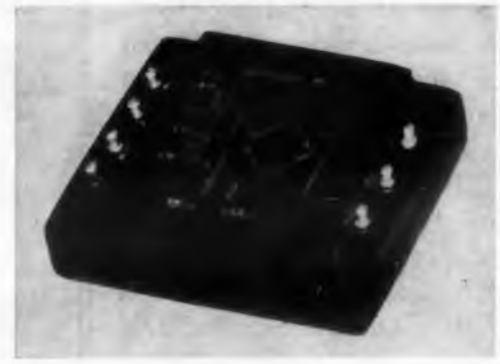
Motorola, Inc., Aviation Electronics, Inc., Dept. ED, 3302 Airport Ave., Santa Monica, Calif.

Price & Availability: *Delivery is from stock. Dual channel units are priced at $81.67 and single channel units are priced at $45.83.*

Booth 2021-2022.

Demodulator-Phase Detector 556

For missile and aircraft applications



The Model 1806 demodulator-phase detector is designed for guidance applications in missiles and aircraft. The unit provides a dc voltage proportional to the amplitude difference between the signal input and reference input. Frequency response is 700 to 15,000 cps. The device is encapsuled in epoxy resin.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

Booth 2332.

Nylon Cable Clamps 518

Can be opened, closed, readjusted

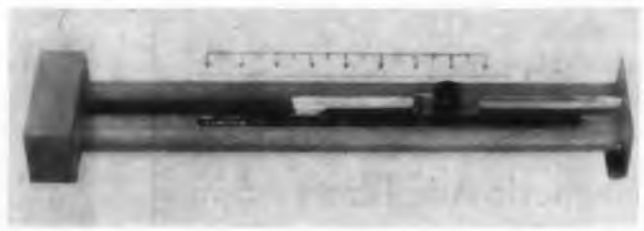
Lok-Strap nylon cable clamps and ties have miniature quick-release tabs that hold the clamp securely around the wire, but which release quickly to allow adjustment of wires. Wire harnesses from 1/8 to 2 in. can be accommodated.

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

Booth 346.

VHF Phaser 576

Has relative phase adjustment of 65 deg at 100 mc



Model 2260 vhf phaser provides a relative phase adjustment of 65 deg at 100 mc to 270 deg at 400 mc with no change in the physical length of the phaser. Input and output terminals are type N, 50-ohm coaxial. The impedance match is maintained over the entire range of adjustment and frequency.

Meridian Metalcraft, Inc., Dept. ED, 8739 S. Millergrove Dr., Whittier, Calif.

Price & Availability: *$225 ea in small quantities; from stock.*

Booth 2519.

Variable Linear Reactor 391

Range is 10 to 5,120 ohms

This variable linear reactor has an impedance range of 10 to 5,120 ohms. The unit has eight coils, each with a maximum rating of 90 v at 2.5 amp. The max volt-ampere rating is 7500 va. Inductance of the unit increases linearly with the applied voltage without saturation or wave distortion. The reactor measures about 6 x 5-1/2 x 27 in. and weighs 35 lb. Applications are in development and test laboratories, power supply systems and as a ballast for fluorescent or mercury vapor lamps.

Sylvania Electric Products, Inc., Sylvania Lighting Products Div., Dept. VLR, Dept. ED, Ipswich, Mass.

Availability: Units are immediately available.

Booth 2009-2010.

Zener Diodes 429

Power rating is 10 w

These Zener diodes are rated at 10 w. Types 1N1603 through 1N1609 diodes have breakdown voltages from 8.2 to 27 v, in test currents from 250 ma to 70 ma dc, and in Zener impedances from 0.25 to 4.5 ohms. Types 1N2498 through 1N2500 diodes have breakdown voltages from 10 to 12 v at a test current of 500 ma and a dynamic impedance of 2 ohms. Types 1N1816 through 1N1836 diodes are rated at 13 to 91 v at 500 to 50 ma, and Zener impedances from 2 to 35 ohms. Types 1N2008 through 1N2012 diodes are rated at 100 to 150 v at 50 ma, and Zener impedances from 40 to 82 ohms. Types 1N2043 through 1N2049 Zener units are rated from 6.2 to 27 v breakdown, at 1 amp to 150 ma dc test currents and Zener impedances of 0.8 to 8 ohms.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles, Calif.

Booth 946.

CIRCLE 116 ON READER-SERVICE CARD ➤

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Each of the authorized Cannon Distributors listed below, and many more, have a complete selection of the most popular Cannon Plugs—*plus*, he gives you prompt service and immediate delivery...*at factory prices!*
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CIRCLE 63 ON READER-SERVICE CARD

NEW FROM CANNON

KQ/KR MINIATURE PLUG A new miniature plug designed to meet the severe requirements of today's and future missiles and aircraft. Also adaptable for general purpose applications, these new plugs fill an important industry need. The KQ/KR features a single receptacle which will accept either of two quick coupling devices—a push-pull or a bayonet-lock mating device—and is fully tested for high-altitude performance. Integral construction features crimp-type, probe-proof contacts; monobloc insert-grommet assembly; polarization by multiple keyways.

CIRCLE 64 ON READER-SERVICE CARD

CRIMPEE COAXIAL PLUGS A completely solderless RF coaxial plug using a simplified crimping method for high-speed assembly. Fits many applications, such as mobile communications equipment, ham radio sets, and television master antenna distribution systems. This new CRIMPEE mates with the standard UHF Series of RF receptacles, and is available for five coaxial cables; RG-8/U, 9/U, 11/U, 58/U, and 59/U. An inexpensive crimping tool is provided for quick and easy assembly of the plug to its cable.

CIRCLE 65 ON READER-SERVICE CARD

CANNON/TUCHEL PLUGS Micro-miniature plugs incorporating a completely new operating principle. Electrical contact is made by pushing the pin into a claw-like socket. Contact reliability is increased by means of several springs of diminishing diameter and overlapping each other. This new Cannon/Tuchel construction insures a greater mechanical grip of interlocking parts, provides automatic cleaning of contacts, and increases electrical effectiveness even in the smallest space. These micro-miniature plugs are designed especially for aircraft, portable instrumentation, and other miniature electronic equipment.

CIRCLE 66 ON READER-SERVICE CARD

CANNON morpho* PLUGS

A NEW DEVELOPMENT FOR INDUSTRIAL AND MANY MILITARY APPLICATIONS

The unique hermaphrodite-modular design of Cannon's new MORPHO lightweight plugs provides unusual flexibility and versatility! Especially intended to meet commercial applications such as computers, business machines, and communication equipment inexpensively and with complete reliability—these unusual plugs are equally well suited for many military requirements. The MORPHO line features hermaphrodite crimp type contacts and hermaphrodite modular insulators which fit both plug and receptacle. Currently available in 12, 24, and 36 contacts...allows numerous alternate insert positions.

Write for Catalog MH-1 today for the complete story of MORPHO ...another reason why you should consult the world's most experienced plug manufacturer for all your plug requirements.

* tradename pat pend

CANNON PLUGS

CANNON ELECTRIC COMPANY • 3208 Humboldt St., Los Angeles 31, Calif.

CIRCLE 67 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Conductive Cement 513

Cures at room temperature

Eccobond solder 70 C cement is a two-component, epoxide-based, room-temperature curing conductive adhesive. Volume resistivity is less than 0.1 ohm-cm. The cement has a coarse texture, and is intended for metal-to-metal surface joints rather than delicate electronic wiring. It is suitable for heat conducting and rf shielding joints.

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

Price & Availability: *The cement, available from stock, is $5.00 per lb.*

Booth 120-121.

Triode-Pentode Regulator Tube 520

For industrial power supplies

The Type WL-7734 regulator tube is a low-mu triode and sharp cut-off pentode intended for industrial power supplies. The triode acts as a series regulator under control of the pentode which is used as a dc amplifier. Sections have separate cathodes, each with a heater-cathode rating of —300 v. With a 50-v plate potential and zero bias, the triode will conduct 70 ma with a plate dissipation of 70 w max. The pentode has a plate resistance of over 7 meg with 100 v plate voltage, 50 v screen voltage and bias adjusted for 100 μa of plate current.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

Price & Availability: *Consumer retail price is $5.45. Sample quantities are available immediately.*

Booth 2342.

Capacitors 546

For silicon controlled rectifier applications

These capacitors are designed for use in commutating circuits where a silicon controlled rectifier is exposed to a dc voltage. The units have low, series inductance and resistance. They are available in stud-mounting tubular types with high heat dissipation, and in rectangular paper dielectric units. Stud mounted units are available from 1 to 4 μf at 140 v peak, and operate to frequencies of 10 kc. Rectangular units are available to 60 μf and 200 v dc.

General Electric Co., Capacitor Dept., Dept. ED, Hudson Falls, N.Y.

Availability: *Tubular units are available only in prototype quantities; rectangular capacitors can be shipped in production quantities.*

Booth 2122-2123.

Transistorized Power Supply 559

For laboratory applications

Model MTRO36-15 power supply is a transistorized dc unit intended for general laboratory use requiring precision regulation. Output is 0 to 36 v at 15 amp, regulated to within 10 mv. Ripple is 2 mv, rms, max. The device contains a magnetic amplifier and a transistorized regulator. It measures 19 x 17 x 7 in., and is constructed for rack mounting.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

***Price & Availability:** Units will be available from stock by September 1, 1960; price is $1,045.*

Booth 760-761.

Induction Motor 562

Delivers 12.4 hp

The Model F-25-2 induction motor is capable of delivering 12.4 hp at 11,600 rpm. The unit measures 5-1/2 in. diameter and 9-3/16 in. long, and weighs 17.72 lb. The device is a three-phase motor, fully enclosed and explosion-proof and protected from thermal overload. It is designed for airborne or ground based axial vane blower applications. Input power is 200 v, 400 cps, 3 phase. MIL specs are met.

Kearfott Div., General Precision Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Booth 626-627.

Power-Line Isolation Transformers 564

Input-output capacitance less than 0.1 pf

The HIT-Series power transformers isolate input and output for critical circuit. Capacity coupling between primary and secondary circuits is less than 0.1 pf. Input and output are 115 v, 60 cps. Power ratings up to 600 w are available. MIL specs are met.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.

Booth 430.

CIRCLE 75 ON READER-SERVICE CARD➤

NEW PRODUCTS AT WESCON

Miniature Band Pass Filters 563

For printed circuits

The Series MNF and MWF band pass filters are miniature devices covering frequencies from 400 through 70,000 cps with 7.5% and 15% bandwidths, respectively. The filters are designed for printed-circuit applications in transistorized circuits. Filters come in two sizes: 1-3/16 in. sq x 1/2 in. weighing 1 oz; and 23/32 in. sq x 1/2 in. weighing 1/3 oz. Input and output impedence is 10 K. Units are hermetically sealed and meet MIL specs.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.
Booth 430.

Magnetically Shielded Tape Container 560

Holds single 10 in. reel

These tape containers will hold one 10-in. reel of magnetic tape. The container is costructed of a Netic alloy that will protect the tape from extraneous magnetic fields, even if accidently placed on a tape degausser. A label on the container identifies its contents. Containers can be padlocked. They are non-shock sensitive, non-retentive, and do not require periodic annealing to retain shielding effectiveness.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.
Booth 2629.

Power Transformers 565

For transistorized circuits

Types H-141 through H-147 power supply transformers are designed to power transistorized circuits from 115 v ac input. Outputs are from 10 to 21.5 v at up to 20 amp. Both full-wave and half-wave models are available. Units are hermetically sealed and meet MIL specs.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.
Booth 430.

Wirewound Potentiometers 462

Diameter is 7/8 in.

The 2100 Series Micropot, wirewound potentiometers have a 7/8 in. diam and are available in 10-turn and 3-turn models. Resistances to 100 K are offered. The assemblies can withstand over 1 million revolutions without exceeding tolerances. Servo or bushing mountings are available. Zero-based or independent linearity is offered. Units will withstand 1000 v rms between shaft and terminals. MIL specs for environment are met.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.

Booth 848-849.

Readout Driver Modules 475

Triggered by 3 v at 300 μa

Types TR-40 and TR-57 driver modules are designed to operate the miniature Nixie and the standard and super Nixie indicator tubes, respectively. The driver circuits employ 10 npn transistors in breakdown condition, with current limited by the indicator tube. Signals of 3 v at 300 μa are sufficient to trigger the circuits. The modules are designed for panel mounting and for operating temperatures of −30 to +55 C.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.

Price & Availability: Modules without indicator tube are priced from $25 to $30 depending on quantity. Units are available from stock.

Booth 2136-2137.

NEW PRODUCTS AT WESCON

Magnetic Core Circuits 471

Frequency range is 0 to 250 kc

These magnetic-core circuits, including shift registers, pulse gates and core drivers, operate from 0 to 250 kc and are physically and electrically compatible with the T-Series transistor circuits. One core in these circuits will produce the flip-flop action of two transistors. The units are packaged in T-Series containers measuring 7/8 in. in diameter and 2-3/16 in. long, and fit miniature tube sockets.

Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

Price & Availability: *The units, made to order, can be delivered in 30 days and are priced at $15.*

Booth 1017.

Analog Tape Recorder 476

Range is 300 to 250,000 cps

The Model FR-600 tape recorder has a frequency range of 300 to 250,000 cps and a 60-in.-per-sec tape speed. Seven tracks of wideband information plus one track for voice are provided on the 1-in. tape. Reels, with 14-in. diam, provide 24 min of recording time. At the end of a reel, a second transport is automatically activated. The instrument utilizes solid-state, modular design. Precise phase response with amplitude response flat ±3 db over full bandwidth is provided for fm/fm telemetry recording.

Ampex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood, Calif.

Booth 2004-2005-2006.

RF Power Density Meter 474

Range is 200 to 10,000 mc

Model NF-157 rf power density meter directly reads power densities from 0.1 to 2000 mw over a continuous frequency range of 200 to 10,000 mc. The unit uses small batteries as a power source and any of three constant-gain probes. Power is measured by a thermistor element in a temperature-compensated dc bridge. The unit weighs 10 lb. Suggested applications include personnel safety indication in strong rf fields, near-field intensity measurement and detection of hot spots and leakage near antennas.

Empire Devices Products Corp., Dept. ED, Amsterdam, N.Y.

Price & Availability: Units, priced at $1,975, can be delivered in 30 days.

Booth 2819-2820.

Data Transmitter 479

Frequency response is dc to 50 kc

The Model CS-1976 data transmitter provides uniform frequency response from dc to over 50,000 cycles. Carrier frequency range is 130 to 150 mc. Power output is 50 w. The unit is designed for rack mounting.

Gates Radio Co., Dept. ED, Quincy, Ill.

Price & Availability: The transmitter, priced at $1875, can be delivered in 120 days. Units will be available from stock in 1961.

Booth 1069.

NEW PRODUCTS
AT WESCON

Preformed Solder 428

For automated assembly

These Solderforms consist of solder and flux shaped into washers, discs, coils or any other configuration desired. They are suited for automated assembly of transistors, diodes and other electronic devices.

Kester Solder Co., Dept. ED, 4201 Wrightwood Ave., Chicago 39, Ill.
Booth 320.

Glass-Ceramic Cement 426

Thermal expansion matches glass

Pyroceram cement No. 89 is designed to seal glasses and other materials with thermal expansions between 80 and 92 x 10^{-7} cm per cm per deg C. Electrical properties are similar to those of Pyroceram cement No. 95. The cement fires at about 450 C, and the resulting seal is serviceable up to about 425 C. The cement also seals metals and ceramics. The cement is a finely powdered glass applied in a low viscosity vehicle. Upon firing, it partially crystallizes, resulting in a vacuum tight, devitrified seal.

Corning Glass Works, Industrial Bulb Sales Dept., Dept. ED, Corning, N.Y.
Price & Availability: *A 1-lb kit is $12.50; 5 lb are $58.*
Booth 853-854.

Oscilloscope 427

Range is to 30 mc

Model 170A oscilloscope is a rugged, militarized 30-mc instrument with a 5-in. crt. The device has a beam finder and dual plug-in system. An attachable unit, Model 166D sweep delay generator, delays the main sweep to permit detailed examination of a complex signal or pulse train.

Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.
Booth 651-652-653-654.

IF Transformer 361

For use with a balanced mixer

Type 1502 if transformer, for use with DB-665 balanced mixers, is designed to match the push-pull output of a balanced mixer to the single-ended input of an if amplifier. The unit permits the amplifier to be located remotely. Output is matched to a 50-ohm coaxial transmission line.

DeMornay-Bonardi, Dept. ED, 780 Arroyo Parkway, Pasadena, Calif.

Price & Availability: *$138 to $154; from stock.*

Booth 2214-2215.

Subcarrier Oscillator 364

Linearity is 0.1% of bandwidth

Model 10087 subcarrier oscillator has a linearity of 0.1% of bandwidth. Frequency and sensitivity stability are within 0.3% over the temperature range of 0 to 85 C and 0.6% over the temperature range of —18 to +100 C. Made to IRIG standards, the unit is available for channels 8 through 18 and A through E. Configuration, size, and weight, are similar to model 10077.

Hoover Electronics Co., Dept. ED, 110 W. Timonium Road, Timonium, Md.

Booth 2822.

DC Power Supply 418

For laboratory, circuit development work

The Model P60-1 power supply provides continuously adjustable outputs of 0 to 6, 0 to 30 and 0 to 60 v dc at 1 amp. The supply, designed for laboratory and circuit development work, is unregulated. A three-scale voltmeter is located on the front panel. Ripple is 0.5%. Several units can be stacked on top of one another.

Consolidated Avionics Corp., Dept. ED, 800 Shames Drive, Westbury, N. Y.

Price & Availability: *Units, available from stock, are $95.00.*

Booth 2255.

◀ CIRCLE 912 ON CAREER INQUIRY FORM, PAGE 233

NEW PRODUCTS
AT WESCON

Coil Winding Machine 417

Handles coils from 0.065 in. ID

Model S Toroyd coil winding machine will handle a full range of wire sizes. It will wind coils measuring from 0.065 in. ID to 5.25 in. OD at 1600 rpm. The machine does both random and precision winding. Set-up and change-over time is rapid. The instrument will operate in conjunction with Model 1C-601 inductance comparator to wind precise inductances.

Electrical Specialty Co., Dept. ED, 2820 E. 12th St., Los Angeles 23, Calif.

Availability: *Delivery is 4 to 6 weeks.*

Booth 308.

Vacuum Gage 431

Range is 10 to 200 mm Hg

Model SP-3 vacuum gage gives direct-reading pressure measurements over a range of 10 to 200 mm Hg. The instrument is unaffected by atmospheric changes. A noble-metal thermopile and nickel-plated tube assure freedom from outgassing, system contamination, corrosion and rust. Applications include impregnation and vacuum drying. Models capable of monitoring up to five positions are available.

Hastings-Raydist Inc., Dept. ED, Hampton, Va.

Booth 705.

Rack-Mounting Oscilloscope 434

Range is dc to 450 kc

The Model RM503 oscilloscope is a rack-mounting version of the Model 503 unit. Sensitivity of the instrument is 1 mv per cm; range is dc to 450 kc in 14 calibrated steps. The unit measures 7 x 19 x 16-1/2 in.

Tektronix, Inc., Dept. ED, P.O. Box 500, Beaverton, Ore.

Price: *Model RM503 oscilloscope is $640.*

Booth 817-818.

◄ CIRCLE 105 ON READER-SERVICE CARD

Hermaphroditic Connectors 436

Have snap-in contacts

The MH Series connectors have hermaphrodite contacts and insulators that fit both plugs and receptacles. Contacts are snap-in, crimp type. The plugs are designed for commercial applications such as business machines, computers and communications equipment.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

Booth 2836-2837.

Resistance Measuring System 379

For precision production testing

Model 242 resistance measuring system consists of a Model 240-R Kelvin ratio bridge, an RS-925 decade resistance standard and a Model 800-R generator-detector, all housed in a 29.5 x 19.5 x 15.1 in. metal cabinet. Direct resistance can be measured to within 0.01%, and like resistors can be compared to 1 ppm. Model 241 resistance comparison system is similar, but without the resistance decade standard.

Electro Scientific Industries, Inc., Dept. ED, 7524 S. W. Macadam Ave., Portland 19, Ore.

Price & Availability: *Prices are: Model 242, $3400, Model 241, $2300, both fob Portland. Availability is 60 days.*

Booth 649-650.

High-Vacuum Diode 437

For rectifier and surge limiter uses

Type 8020W high-vacuum diode tube has rectifier or surge-limiting industrial applications. It has a graphite anode for cool operation, a non-frangible filament, a large circumference, kovar-top, cap seal and dual getter traps.

United Electronics Co., Dept. ED, Newark, N.J.

Price & Availability: *The tube is priced at $28.50, available from stock.*

Booth 2501-2502.

CIRCLE 106 ON READER-SERVICE CARD ➤

Expert Night Pilot. In certain smaller types of bats, their amazingly precise echolocation enables perfect navigation and hunting of insects. Although the natural sonar system of bats is the smallest known, ounce for ounce and watt for watt it is billions of times more efficient than any sonar equipment that has ever been made by man.

Tiny Control Center. Synchronous at 24,000 r.p.m. in less than five seconds — using overvoltage techniques — this 2 oz., subminiature floated rate gyro assures stable, precise flight control of missiles, special weapons and space vehicles. MPB bearings on critical main shaft help assure accuracy under 150 G's of shock and 30 G's vibration to 2000 cps on any axis.

Man With Miracles. Friction, inertia, and today's ever-shrinking component space provide an exciting challenge to MPB Sales Engineer, Gene Burrichter. Working closely with engineers and scientists he constantly helps solve miniaturization problems throughout industry. MPB Sales Engineers are ready to give you similar assistance.

Miracles in Miniaturization

ACTUAL SIZE OF THE MPB BEARINGS IN SUBMINIATURE GYRO SHOWN ABOVE

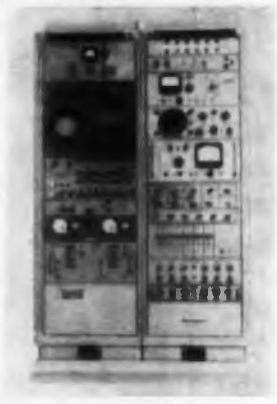
In modern miniaturization many components have become so small they can hardly be seen. Yet they keep on doing as much work — or more — and getting closer to their designers' objectives. To engineers with new projects in this rapidly widening field, MPB's unequalled research facilities offer opportunities for highly effective teamwork. For details, and for a catalog on MPB bearings, the world's largest line, write to **Miniature Precision Bearings, Inc.,** 908 Precision Park, Keene, N. H.

MPB *Helps you perform miracles in miniaturization*

CIRCLE 107 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Vibration Control System 521



Works with any amplifier-shaker

Model 1011 random vibration control system applies and controls random vibration. It is compatible with any power amplifier and electrodynamic shaker combination. Test specifications can be matched closely in minutes. Continuous monitoring of shaker output performance indicates any change during tests. A mix of two signals may be varied while test is in progress. The output may be tape recorded.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

Price & Availability: *Units are priced at $18,750 and are available from stock.*

Booth 842-843.

Wet-Anode Tantalum Capacitors 473

For airborne and missile application

These M-type wet-anode tantalum capacitors provide ranges from 1.75 to 330 μf in voltages up to 125 v dc. Units are compact and designed to withstand rugged service with a 2000-hr life at a maximum temperature of 85 C. Capacitors are available in three case sizes.

ITT Components Div., International Telephone and Telegraph Corp., Dept. ED, 815 San Antonio Road, Palo Alto, Calif.

Booth 2044-2045.

DC Power Supply 522

Regulates either current or voltage

The Model 4005 transistorized dc power supply may be operated as a constant-voltage source, a constant-current source, a constant-voltage source with automatic current limiting, or a constant-current source with automatic voltage limiting. The range of 1 to 40 v at 0 to 500 ma is covered. Regulation is better than 0.05%. Ripple is less than 500 μv or 25 μa. The unit measures 5-3/4 x 8-5/8 x 11-3/4 in. Panel adapters are available for rack mounting.

Power Designs, Inc., Dept. ED, 1700 Shames Drive, Westbury, N.Y.

Price: $143.50 fob Westbury.

Booth 2305.

Silver-Zinc Battery 523

Discharges at 250 amp for 1 min

The Model P-3001 Silvercel silver-zinc battery for missile applications has a nominal capacity of 4 amp-hr. It can be discharged continuously at 250 amp at 25 v for 1 min, or pulsed at currents up to 1500 amp. The unit, designed for flight control systems, telemetering and guidance, is automatically activated in 1/2 sec and has a dry shelf life of 5 yr. The battery measures 4 x 6 x 10 in. and weighs 15 lb.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York, N.Y.

Availability: Units can be delivered in 90 days.

Booth 551.

NEW PRODUCTS AT WESCON

Photomultipliers 460

Sensitive to visible light

Types CL-1002 and CL-1003 photomultiplier tubes are 10 stage end-on units sensitive to visible light. The tubes have 2 in. and 3 in. diameters respectively. Plano-concave faceplates and curved-surface photocathodes provide a very short, transit time spread. The tubes are designed to withstand shock and vibration.

CBS Laboratories, Electron Tube Dept., Dept. ED, High Ridge Road, Stamford, Conn.

Price & Availability: *Tubes, available from stock, are priced at $55 for the CL-1002 and $115 for the CL-1003.*

Booth 2523.

Transistor Noise Analyzer 526

Measures at 100, 1000 and 10,000 cps

The Model 310 transistor noise analyzer measures the noise inherent in transistors at three separate frequencies simultaneously: 100, 1000 and 10,000 cps. The low-frequency bandpasses measure 1/f, or fluctuation noise; and the higher frequency bandpass measures "shot" noise. The system automatically corrects for variation in transistor gain. The instrument can be supplied with a 1,000-cycle filter only for MIL checks.

Quan-Tech Laboratories, Dept. ED, Boonton, N.J.

Price & Availability: *Unit with three filters, $1,800; unit with 1,000-cps filter only, $1,450. Delivery is about 10 weeks.*

Booth 1029.

FIXED PRECISION ATTENUATORS
Model 175

- Operation over full waveguide frequency ranges.
- Full range of sizes from 2.6 to 40 KMc.
- Stability dependent only on locked mechanical setting.
- Frequency sensitivity ± 0.3 db to 20 db. ± 0.5 db 20 to 30 db.
- VSWR 1.15 max.
- Factory set values from 0.5 to 30 db.

COAXIAL BROADBAND DIRECTIONAL COUPLERS
Model 616 and 617

- Operation over a two octave freq. range.
- Model 616 — 250 to 1000 Mc.
  617 — 1000 to 4000 Mc.
- Coupling 20 db, frequency sensitivity ± 1.5 db.
- Directivity 20 db min.
- Attached individual calibration curves.

WAVEGUIDE SWITCHES
Model 641

- Operation over full waveguide freq. ranges.
- Full range of sizes from 2.6 to 40.0 KMc.
- Crosstalk 60 db min.
- VSWR 1.10 max.
- Manual or solenoid operation.
- High power capacity.

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Time Code Generator 533

Frequency stability is 3 parts in 10^8

The Model ZA-802 time code generator supplies either a 17-bit binary coded time signal produced each second or a slow rate 13-bit signal produced each 15 sec at a 1 pps rate. Both codes indicate hours, minutes and seconds. Frequency stability of the instrument is three parts in 10^8, or 1 sec per month. An external frequency standard may be substituted for the internal crystal oscillator. A 1 pps signal is available for comparison with WWV time ticks. The unit occupies 7 in. of standard 19-in. rack space. Depth is 17 in. Construction is all solid state.

Electronic Engineering Co. of Calif., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.
Price: *$7,050 fob Santa Ana.*
Booth 2527-2528.

Non-Magnetic Latching Relays 532

Mechanically locks in position

Type A-2A relay is a non-magnetic latching unit that mechanically locks in either the open or closed position, and requires a new command pulse before it can be reactivated. Contacts are plug-in type, assuring contact under extreme conditions and permitting loads up to 20 amp at 26.5 v dc. Energizing current is 0.25 amp at 18 to 32 v dc.

Mitchell Camera Corp., Astromics Div., Dept. ED, 611 W. Harvard St., Glendale, Calif.
Price & Availability: *Units will be in stock by September 1, 1960; price is $48.50 for less than 50 units, $34 for over 50.*
Booth 838A.

NEW PRODUCTS AT WESCON

DC Power Supply 541

Rated up to 10 amp

This power supply can be made for any dc voltage output, up to 3 kw power, at 10 amp. Regulation is within 0.6% for changes of ±10% line voltage, 0 to full load current, 0 to 50 C. Noise and ripple is 0.3%. Response time is 25 msec with 50% change in load. Unit has overload protection. It measures 19 x 8-3/4 x 20 in., is designed for rack frame, or drawer mounting, and weighs 150 lb.

North Electric Co., Electronetics Div., Dept. ED, Galion, Ohio.

Price & Availability: *Units are made to consumer requirements, can be delivered in 60 to 90 days, and are about $630.*

Booth 2612-2613.

Electronic Timer and Counter 456

Operates to 10 mc

The Model 7370 universal timer is a 10-mc instrument capable of performing as a high-speed counter, as an events-per-unit-time or as a time interval meter. Time intervals from 0.3 μsec to 10 million sec, 116 days, can be measured. The output is displayed on a seven-place readout panel; binary-coded output is provided for digital recording equipment. Used in conjunction with a computing transfer oscillator, the instrument will measure frequencies to 21,000 mc.

Berkeley Div., Beckman Instruments, Inc., Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

Price: *The instrument is priced at $1975.*

Booth 2514-2515.

PROGRAM 2020

NEW RAYTHEON STANDARD VOLTAGE REGULATOR MODELS INCLUDE COMPONENT STYLE UNITS WITH EXTERNAL CAPACITORS FOR CONVENIENT UPRIGHT OR HORIZONTAL INSTALLATION ON ELECTRONIC EQUIPMENT CHASSIS • APPARATUS STYLE UNITS FOR USE WHERE A COMPLETELY SELF-CONTAINED INSTALLATION IS DESIRED • OPEN STYLE UNITS (WITHOUT END BELLS) • CORD AND RECEPTICAL PLATE FOR LINE APPLICATIONS... REGULATOR SELECTION GUIDE LETS YOU CHOOSE FROM 2,020 DIFFERENT UNITS.

Now, Raytheon provides 2,020 standard magnetic voltage regulator models for AC loads and DC power supply applications with easier selection, faster delivery, lower cost.

It's the easiest, most economical way yet devised to assure you of exactly the voltage regulator you need.

Raytheon's Regulator Selection Guide provides a simple, reliable means of selecting input and output voltages, volt-ampere rating and type of mounting. By using the Guide included in the new Raytheon voltage regulator catalog you can quickly determine size, weight and other pertinent data to aid you in selecting the unit that best suits your requirements. Your selection is made from *2,020 standard voltage regulator models*, all available for prompt delivery.

In addition to their use in countless AC applications, these new regulators provide many significant advantages for the DC power supply designer. Using the Selection Guide, he can readily select the appropriate regulator model directly on the basis of DC output voltage and power requirements.

An extremely wide range of AC voltage ratings is available from 2.3 to 1,055 volts and up to 10,000 volt amperes. Regulation on all models is ± 1% for line voltage variations of ± 15%.

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FOR EXTREME PRECISION IN MINUTE PACKAGE . . . single-turn potentiometers are available that provide maximum reliability and precision in units from 25% to 40% smaller than competitive models . . . the world's smallest ten-turn pot is also available in this line.

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Series 341 multi-turn high precision potentiometers

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DAYSTROM, INCORPORATED
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MINIATURE WIRE-WOUND GANGABLE POTS (Model 319) solve many complex phasing, reliability, space and linearity problems. Each ganged section is ⅞" x ¼" high and is ganged without clamping rings for exceptional stability. By means of an exterior access opening, each wiper is independently adjustable through 360°. Maximum reliability is ensured by a rugged plastic body, even step linearity, fine resolution, low noise characteristics and long life over a range of 100 ohms to 200K.

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NEW PRODUCTS AT WESCON

Miniature Tape Recorder 537

For wideband multi-channel recording

Wideband multi-channel recording under rugged environmental conditions is the primary application for the Model PMR-300 tape recorder. The unit measures 10 x 6 x 4-1/2 in., weighs 4-3/4 lb and requires less than 18 w from a 24-v dc source. Recording bandwidth is 100 kc at 30 ips, and lower speeds with proportionately reduced bandwidth are available. Modular electronic circuits for up to seven channels on 1/2-in. tape are available.

Pacific Electro Magnetics Co., Dept. ED, 942 Commercial St., Palo Alto, Calif.

Price & Availability: *Units are made to order, and can be delivered in 90 days. Prices vary from $3,000 to $7,000 depending on the number of channels.*

Booth 414.

Klystron Tube Mounts 472

For testing and operation

These klystron tube mounts are designed to simplify klystron mounting for tests and operation. Free access to tuning adjustments, forced air cooling and AN type connectors are provided. The mounts are constructed of cast aluminum, and connecting cables for power supplies are available.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, L.I., N.Y.

Price: Mounts for Varian, Sperry, Raytheon and EMI klystrons are $60, $85, $100 and $125 respectively.

Booth 822-823.

NEW PRODUCTS AT WESCON

Silicon Rectifers 536

Handle 45 to 150 amp, and surges of 1000 amp

These Quad-Sealed silicon rectifiers are rated from 45 to 150 amp at 50 to 600 v over a temperature range of —20 to +130 C. They can withstand surge currents of 1000 amp peak. They are recommended for industrial power and battery charging applications. Stud mounted, flat base and reverse polarity types are available.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Price & Availability: *In quantities of 1 to 99, $6.53 to $45.60 each. Delivery is from stock.*

Booth 284.

Digital Modules 470

Transistor and magnetic-core types

These solid-state transistorized modules are rated at medium speeds of 200 kc and high speeds of 3 mc; the magnetic types are rated at medium speeds of 50 kc and high speeds of 100 kc. Transistorized NOR logic modules and high-temperature modules are also available. All modules have 15-pin connectors.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

Price & Availability: *Prices range from $30 to $200 per unit. Modules can be delivered in 15 to 60 days.*

Booth 2264.

Slip Ring Brush Assembly 579

With low noise level

This slip ring brush assembly is manufactured on modular tooling which permits any number of rings from 1 to 32 to be furnished without tooling costs or time delay. The silver graphite brush rides in a rectangular groove on the coin silver ring resulting in reduced noise levels.

Costello & Co., Fabricast, Inc., Dept. ED, 2740 S. La Cienega Blvd., Los Angeles 34, Calif.
Availability: *Delivery time is 10 to 20 days.*
Booth 408.

Portable Oscilloscope 581

Has high writing speed

Model S42 high-writing-speed oscilloscope uses a 4-in. cathode ray tube. Operating at 3.7 kv, it provides a brightness so that a 1-μsec, single-shot pulse can be seen and photographed. Balanced low-drift amplifiers have a bandwidth of dc to 6 mc up to 100 mv per cm. Gain is 10 mv per mc. Features of the S31 that are retained include time and voltage calibration with built-in square-wave calibrator and automatic sync and selective triggering. Maximum speed is 0.1 μsec per mc. The unit weighs 18 lb.

The Scopes Co., Inc., Dept. ED, P. O. Box 56, Monsey, N.Y.
Price: $465.
Booth 2210.

NEW PRODUCTS AT WESCON

Dual-Synchro Position Indicator 539

Accuracy is ±0.03 deg

Series IU dual synchro position indicators are designed for accurate, non-ambiguous indication of linear or angular position of transmitter units. The indicators can be read accurately within ±0.03 deg from a 5-1/4 in. panel mounting. A separate synchro receiver is geared to each pair of concentric dial pointers. Model IU-3 indicator can be reset to zero with respect to an arbitrary reference point; Model IU-6 indicator monitors mechanisms with fixed reference points.

Scientific-Atlanta, Inc., Dept. ED, Atlanta, Ga.
Booth 539-540.

RF Power Triode 540

Delivers 400 w continuous output

The Type ML-7482 tube is a general purpose, vapor-cooled triode that can deliver a 400 kw continuous output as a class C amplifier or oscillator at 30 mc. It can also deliver 2.5 megawatts as a pulsed rf amplifier and can switch 14 megawatts in a pulse modulator at a relatively long pulse duration. The grid and cathode are ruggedly mounted, coaxially, and have low-inductance, high-conductivity rf terminals.

Machlett Laboratories, Inc., Dept. ED, 1063 Hope St., Springdale, Conn.
Booth 2020.

DC Power Supply 545

Delivers 50 amp at 36 v dc

The Model HC 36-50 transistorized power supply is rated at 0 to 36 v from 0 to 50 amp dc, and has a line regulation of 0.05% and a load regulation better than 0.1% for 0 to full load changes. Ripple is less than 2 mv. Input power is 208 v, 60 cps, 3-phase, four-wire wye. The bias supply, amplifier and overload circuitry are contained in separate plug-in modules. Dimensions are 17.5 x 20 x 19 in. for rack mounting.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commercial St., Springfield, N.J.
Price & Availability: *$2995 fob Springfield; delivery is 90 days.*
Booth 2312.

Cable Connectors 553

Have up to 104 contacts

Series 2500 connectors are available in 14, 26, 34, 50, 75 and 104 contact sizes with removable contacts for No. 14 to 24 AWG wire. Contacts are supplied separately and are wired independently, permitting mounting of connector plug and socket units before wiring is completed. Crimp termination eliminates soldering. Contacts can be removed and replaced quickly without disturbing the connector body. Molding material is glass filled Plaskon Alkyd (MIL-M-14F, type MAI-60) or glass filled Diallyl Phthalate (MIL-M-19833, type GDI-30).

Continental Connector Corp., Dept. ED, 34-63 56th St., Woodside 77, N.Y.
Booth 855.

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Yes! Schweber can sell any model of BOURNS TRIMPOT® at factory prices. Sizeable quantities are available for immediate shipment from stock from Schweber's warehouse.

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See our new products at WESCON—Booths 2250, 2251

NUMBER 6—APPLICATION SERIES

Bourns Trimpot® Instead of a Fixed Resistor?

Yes, these units meet the same Mil-Specs that fixed resistors meet and give you the added advantage of adjustability! Because of their design and construction, Trimpot potentiometers are virtually unaffected by the most severe shock and environmental conditions—a fact proven repeatedly in major missile and space programs.

Trimpot units offer several kinds of savings. They minimize the need to maintain stocks of close-tolerance resistors—you can adjust to compensate for the variances of fixed components. Production labor costs are cut, too, for Trimpot units eliminate trial-and-error matching of fixed units to the system. Savings also carry over to maintenance because the technician can adjust equipment quickly in the field—no time and dollars spent to replace components.

Before you specify fixed units, investigate all the advantages offered by Trimpot potentiometers. Over 20 basic models (wire-wound and carbon)—in four terminal types and three mounting styles—are available on short notice from stocking distributors or factory. Get the facts . . . write for the new Trimpot brochure and list of distributors.

Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

CIRCLE 119 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Portable Temperature Chambers 542

Temperatures maintained within ±0.2 F

The Series 1060 portable temperature chambers maintain temperatures within ±0.2 F from −100 to +500 F. Control is accomplished by a meter-relay and copper-constantin thermocouple. Cooling is by liquid and solid CO_2, and heating is by 650-w electric elements. A centrifugal blower assures temperature uniformity throughout the chamber. A rack mounted model, two bench models with test volumes of 10 x 7 x 7 in., and a wide-drawer model with a test volume of 16 x 7 x 7 in. are available.

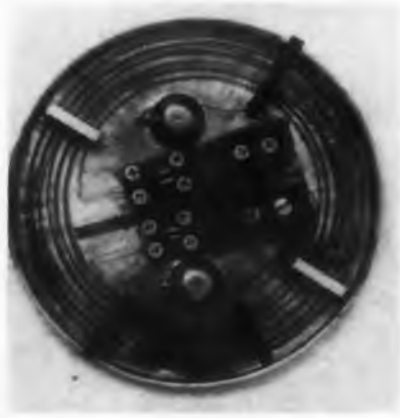
Delta Design, Inc., Dept. ED, 7460 Girard Ave., La Jolla, Calif.

Price & Availability: *Units are available from stock and are priced from $585 to $720.*

Booth 2621.

Wire Sonic Delay Lines 465

Delay is 2 μsec to 20 msec



These wire sonic delay lines use piezoelectric transducers for the inputs and fixed outputs and magnetostrictive transducers for the adjustable outputs. Available delays are 2 μsec to 20 msec, with ±0.1 μsec tolerance. Maximum operating frequency is 1.25 mc. Piezoelectric drives have a power loss of 10 to 15 db; magnetostrictive types have losses of 20 to 25 db. Output amplitude is stable, generally within 10% for changes in input frequency, repetition rate or temperature.

General Electric Co., Heavy Military Electronics Dept., Defense Industries Sales, Dept. ED, Court St. Plant, Syracuse, N.Y.

Booth 2716.

Quadrature Rejection Circuit 544

Operates at 400 cps

The Model D4821-01 quadrature rejection circuit eliminates input signal components which are 90 deg out of phase with a reference signal. It is designed for signals of 400 ±60 cps at 0.005 to 6 v. Minimum rejection ratio varies from 35:1 to 50:1, depending on signal voltage. The in-phase signal component appears as a square-wave output of magnitude proportional to load and input signal. The device operates from synchro, preamplifier or other signal sources into servo amplifiers. The unit, transistorized, weighs 4 oz and meets Mil specs.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Booth 626-627.

DC Power Supply 458

For transistorized equipment

Model ZA-720 DC Power Supply, shown, provides a dual 12-v, 5-amp output. Model ZA-721 is a transistorized, 12-v, 1-amp dc power supply that plugs into a standard 14-pin miniature socket. A 33-v ac tap is included with this model. For both models, voltage regulation is 0.1%, and ripple is less than 0.001 v rms. The units are intended as a power source for equipment using T-Series digital plug-in circuits, N-Series decade counters and R-Series indicators. Model ZA-720 measures 5-1/4 x 19 x 16 in., and Model ZA-721 measures 3-3/4 x 4-3/4 x 2-3/16 in.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif.

Price & Availability: *Model ZA-720 is $995, and ZA-721 is $215. Both are available from stock.*

Booth 1017.

Bearing Analyzer 439

Checks balls, rollers up to 10 in. OD

Model BA-20 bearing analyzer checks balls or rollers and all raceways in a 1/2 min. The machine locates the position and sizes of flaws, and indicates unserviceable bearings both visually and audibly. Relative torque, surface finish and lubricant contaminants are indicated. The instrument inspects all bearings up to 10 in. OD. It occupies 18 in. sq of bench space.

Bearing Inspection, Inc., Dept. ED, 3311 E. Gage Ave., Huntington Park, Calif.

Price & Availability: *The machine, priced at $4,600, can be delivered in 90 days.*

Booth 105.

High-Voltage Rectifier 438

Inverse voltages to 30 kv

Type 705WA rectifying tube is rated for 100 ma dc at inverse voltages up to 30 kv. The device operates at an ambient temperature of 125 C. Lead wires are made of heavy-duty tungsten.

United Electronics Co., Dept. ED, Newark, N.J.

Price & Availability: *The rectifier, available from stock, is priced at $30.*

Booth 2501-2502.

Bearing Washer 440

Washes sizes up to 7 in. OD

Model MC-4-1 bearing washer will wash all anti-friction bearings from small instrument sizes to 7 in. OD types. Solvent and air under pressure is used in a cleaning action not requiring removal of shields or seals. The machine will wash from 60 to 200 bearings an hour. The washer is self-contained and occupies a bench space of 18 by 30 in.

Bearing Inspection, Inc., Dept. ED, 3311 E. Gage Ave., Huntington Park, Calif.

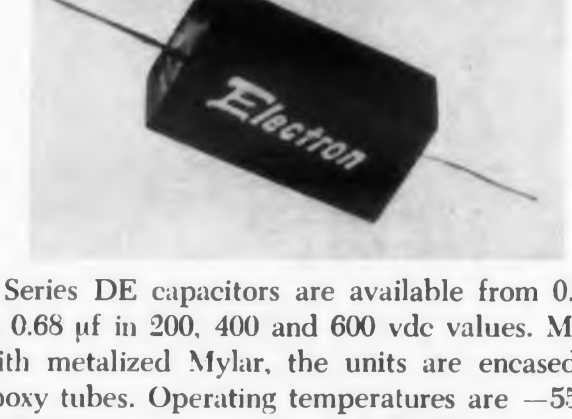
Price & Availability: *The washer is priced at $2500 and can be delivered in 90 days.*

Booth 105.

NEW PRODUCTS AT WESCON

Metalized Mylar Capacitors 457

Capacitances of 0.001 to 0.68 μf



Series DE capacitors are available from 0.001 to 0.68 μf in 200, 400 and 600 vdc values. Made with metalized Mylar, the units are encased in epoxy tubes. Operating temperatures are −55 to +85 C; insulation resistance is 10,000 meg; dissipation factor is less than 1% at 25 C. The 0.001 to 0.033 μf units measure 0.57 x 0.29 x 0.17 in.

Electron Products, Dept. ED, 430 N. Halstead St., Pasadena, Calif.

Booth 621.

Differential DC VTVM 455

Ranges from 0.3 to 100 v dc

Model 410 differential dc vtvm is capable of 1% accuracy with full scale ranges of ±0.3 to ±100 v dc in six steps. Input impedance is 20 meg (single) 40 meg (differential). The unit measures 8 x 7-3/4 x 6 in.

The Decker Corp., Dept. ED, 45 Monument Road, Bala-Cynwyd, Pa.

Price & Availability: *Units, available from stock, are priced at $375 each in small quantities.*

Booth 2315-2316.

Traveling Wave Tube 528

For broad-band, low-noise preamplification

The Type M2101-B traveling wave tube is a broad band, periodically-focused low-noise device designed for preamplification applications in the 8 to 11 kmc range. It provides a minimum of [illegible] mw rf power, has a low-level gain of 25 db and a nominal noise figure of 13 db. The tube is of metal-ceramic ruggedized construction, ppm focused, and is temperature compensated.

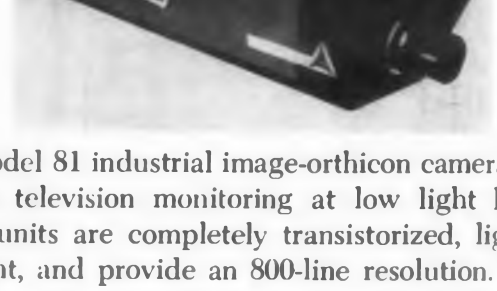
Microwave Electronics Corp., Dept. ED, 4061 Transport St., Palo Alto, Calif.

Price & Availability: *Price is $3,000; delivery in 30 days.*

Booth 2154.

Portable Television Camera 531

For low light-level industrial application



Model 81 industrial image-orthicon camera provides television monitoring at low light levels. The units are completely transistorized, light in weight, and provide an 800-line resolution. They measure 5 x 5 x 20 in. and weigh 15 lb. The camera is operated remotely from a control unit, also of transistorized, modular construction.

Thompson Ramo Wooldridge, Inc., Dage Television Div., Dept. ED, 10th St., Michigan City, Ind.

Booth 2166.

Sweep Oscillator 477

Provides frequencies of 1 to 2 kmc

The Model 628A sweep oscillator provides cw and swept rf frequencies from 1 to 2 kmc. The device has independent, direct-reading frequency, sweep-rate and sweep-range controls. The oscillator can be used with an oscilloscope or on mechanical recorders.

Hewlett-Packard Co., Dept. ED, 1051 Page Mill Road, Palo Alto, Calif.

Booth 651-652-653-654.

AC Timing Motor 441

Length is 7/8 in.

The Series 42100 ac timing motors are 5-oz devices that have a running torque of 30 oz-in. The units are 7/8 in. long; rotor speed is 300 rpm. Output speeds are from 300 rpm to 1/6 rph. Voltage ratings range from 6 to 230 v at 20 ma max. Direction of rotation is electrically controlled. Temperature rise is 40 C max, and power input is 2.5 w max. Both steel and brass gears are available.

A. W. Haydon Co., Dept. ED, 232 N. Elm St., Waterbury, Conn.
Price: The units are priced from $1.50 to $5.70, depending on quantity.
Booth 457-458.

Tantalum Capacitors 433

Rated at 0.33 to 0.82 and 2.2 ot 5.6 μf

The Series TSP1 tantalum capacitors range in value from 0.82 to 0.33 μf at 50 v dc and 85 C. Their case size is 1/8 in. in diameter and 1/4 in. long. The units weigh about 1/2 gm. The Series TSP2 capacitors range in value from 2.2 to 5.6 μf at 50 v and 85 C. Their diameter is 0.172 in. and length is 0.438 in. They weigh about 1.2 gm.

U. S. Semiconductor Products, Dept. ED, 3540 W. Osborn Road, Phoenix, Ariz.
Booth 2239-2240.

Distributor Module 435

Operates at 100 kc

Model D-9000 distributor module uses a Type BX-1000 Beam-X switch with 10 output positions. The module provides nine of these outputs for useful work, while the tenth cascades additional modules in a distributor system. Operating voltage of the unit is 60 to 300 v; input pulses to 100 kc are accepted. Output currents of 2.5 ma are provided.

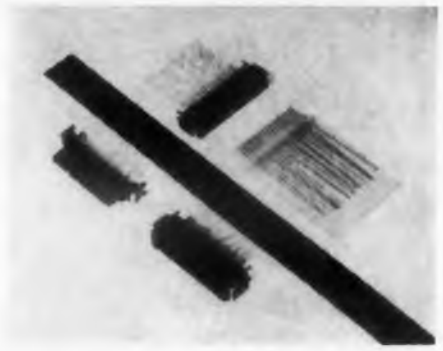
Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226 Plainfield, N.J.
Booth 2136-2137.

CIRCLE 123 ON READER-SERVICE CARD ➤

NEW PRODUCTS AT WESCON

Miniature Connectors 464

For printed and modular circuits



The Micro-Min series of circuit connectors, shown, has 38 double-side contacts and is intended for flat-form packaging of such units as printed-circuits. Connector length is 1-5/16 in. and contacts are on 0.05-in. centers. Micro-Mod connectors, designed for "stick" or modular packaged circuits, consist of a receptacle and polarized plug 0.38 in. sq. They have 12 contacts on 0.075-in. centers.

Amphenol-Borg Corp., Amphenol Connector Div., Dept. ED, 1830 S. 54th Ave., Chicago 50, Ill.

Booth 848-849.

Microwave Modulator 468

Covers 5,400 to 35,000 mc

Model 10002 microwave modulator will accommodate any of 76 magnetrons, covering 5,400 to 35,000 mc with peak outputs from 20 to 500 kw. The modulator includes a high-voltage power supply variable from 0 to 8 kv at 200 ma, a pulse generator with an output of 37 kv at 40 amp that is variable from 180 to 300 pulses per sec, meters, and viewing connectors.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, L.I., N.Y.

Price: The unit is priced at $9375.

Booth 822-823.

Function Generator 359

Analog type

This analog function generator is an electromechanical analog computer designed for arbitrary function generation on one variable expressed as a function of one or more variables. The functions are programed on a plug-board arrangement which stores 441 discrete voltage values. Over-all system accuracy is better than 1% and frequency response is more than 5 cps over full scale. Maximum resolution is 0.02%.

Link Div. of General Precision, Dept. ED, Binghamton, N.Y.

Price & Availability: $6,900 ea; 90 to 120 days for delivery.

Booth 641-642.

Velocity Multiplier 408

One linear, one non-linear output

Model VM-1019 velocity multiplier for missile applications provides a potentiometer shaft position as a function of a dc signal input. The unit has two modes of operation the first provides an output on each of two potentiometers as a linear function of an input signal of 0 to 2.33 v dc; the second mode provides a similar but non-linear function of a 0 to 5.86 v dc signal. Accuracy is ±2%. Power requirements are: 115 v, 400 cps, 6.3 v, 400 cps, 200 v dc unregulated, and 200 v dc regulated for a feedback circuit at 10 ma max.

American Electronics, Inc., Instrument Div., Dept. ED, 9503 W. Jefferson Blvd., Culver City, Calif

Availability: Units, made to order, can be delivered in 60 days.

Booth 2349.

CIRCLE 130 ON READER-SERVICE CARD

NEW PRODUCTS

AT WESCON

Backward Wave Oscillators 360

Eight types offered

Types L-3291 through L-3298 backward wave oscillators are lighter and smaller than types L-3141 through L-3148. The five tubes with the highest frequencies have identical magnets, making them interchangeable with only one change in rf output. The other three tubes are also identical, but are slightly larger.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif.
Booth 2104.

Teflon Terminal 363

Has 0.03-in. diam through-hole

Type RFT-SM-40-SL feed-through Teflon terminal has a through hole 0.03-in. in diameter. A slotted terminal top facilitates bringing the lead through the terminal for wrap-around connection. The device can be used in header applications and is particularly suitable for potentiometer requirements.

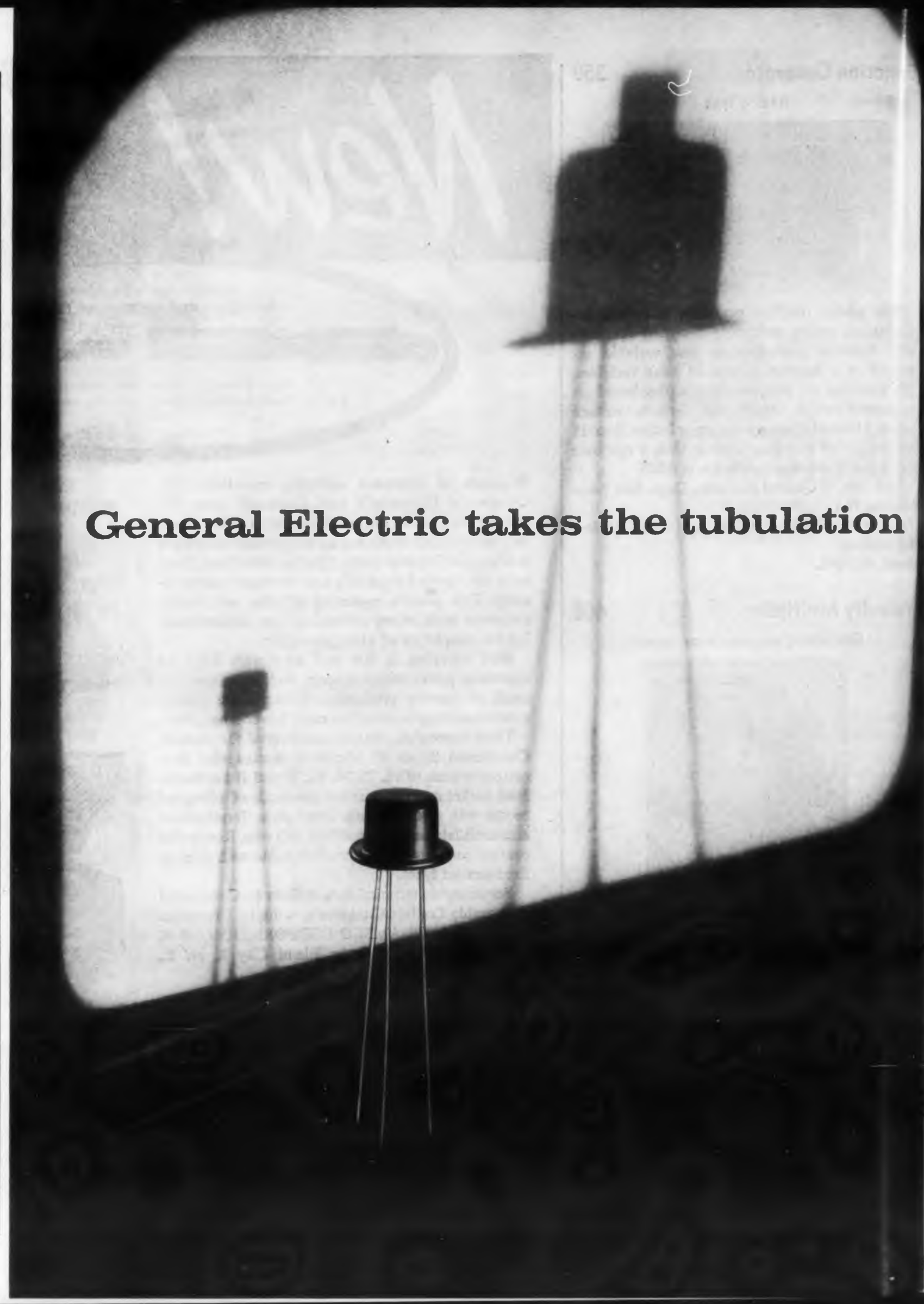
Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N.Y.
Booth 954.

Silicon Rectifiers 387

Rated at 12,000 to 30,000 v

Types 1N3052 through 1N3061 silicon rectifiers are rated at 12,000 through 30,000 v. Of the wire-in, coaxial lead design, the units are 1/2 in. in diameter and from 4 to 8 in. long. No voltage derating is required up to 175 C. Uses are in radar modulators and power supplies.

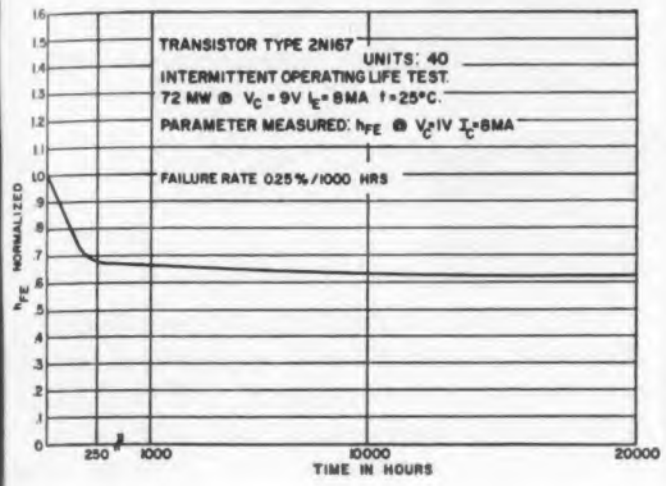
Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.
***Availability:** Immediately, in production quantities.*
Booth 2812-2813.

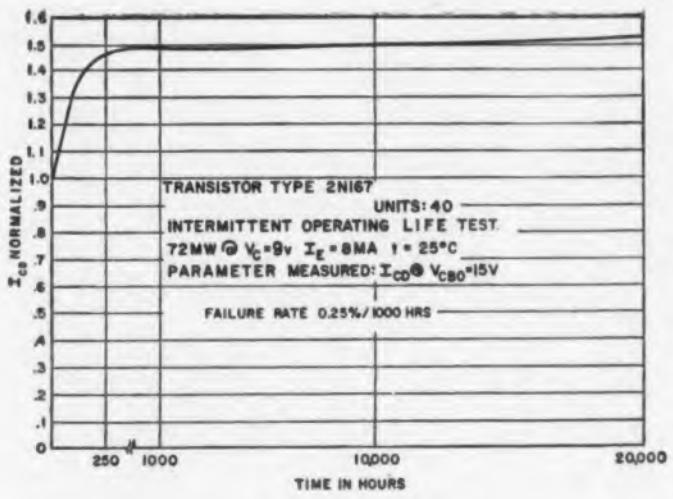


General Electric takes the tubulation

General Electric transistors hold the record in rate-grown reliability

General Electric has manufactured millions of rate-grown transistors in the past seven years. As a result of this experience, G.E.'s parameters are exceptionally stable and a vast amount of reliability data has been accumulated, some of which is shown here. These curves cover 29 lots of General Electric 2N167, tested to MIL-T-19500/11.





The rate-grown process produces a small, clean junction which exhibits almost no drift or deterioration at high voltages and offers the user low I_{CO} and I_{EO}. Two new types, the 2N1510 and 2N1217, will be useful for low-level switch and neon indicator applications. Both the 2N1217 and 2N167 operate at extremely low current and leakage levels, making them ideal for starvation circuits of 2 ma or less.

...off rate-grown NPN transistors!

Remove the tubulation (pinch-off) from rate-grown transistors without sacrificing reliability? General Electric has done just that and even improved reliability with stabilized beta and collector cutoff current. Prices have been reduced on some types up to 20%.

Removal of the tubulation was made possible by adding a sieve or getter. Improved beta and collector cutoff current results from a 125-hour 85°C bake, which also improves the paint's resistance to solvents and chipping. Pellet, pellet mount and processing are identical to the previous process before encapsulation. Then a sieve is added rather than evacuation and subsequent pinch-off. The sieve is the same used and proved for years on G.E.'s PNP low-frequency 2N525 and PNP high-frequency 2N396 lines.

The high-reliability 2N78A and 2N167A have guaranteed 71°C I_{CO} and tight AQL's. The 2N78A also features a 20 volt BV_{CEO} rating compared with the 2N78's 15 volts. The 2N167A, in addition to 71°C I_{CO}, has a lower I_{EO}. For more information, see your G-E Semiconductor Sales Representative or Authorized Distributor. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

ADVANTAGES TO YOU: 40% lower height • Reduced prices • Stabilized I_{CO} and h_{FE}. All units baked 125 hours at 85°C • Greater resistance of paint to solvents, chipping, and salt spray • Improved low-temperature performance and reliability.

Type No.	Maximum Ratings				Electrical Parameters					
	$P_c$mw @ 25°C	BV_{CE} BV_{CB}	I_C ma	T_J°C	MIN h_{FE}	@ I_C ma	MIN f_{α}mc	MIN G_{α}db	MAX I_{CO} (μa)	@ V_{CB}
2N78	65	15	20	85	45	1	5	27	3	15
2N78A	65	20	20	85	45	1	5	29	3	15
2N78A (Cert)	65	20	20	85	45	1	5	29	3	15
2N167	65	30	75	85	17	8	5	—	1.5	15
2N167A	65	30	75	85	17	8	5	—	1.5	15
USAF2N167A (per MIL-S-19500/11)	65	30	75	85	17	8	5	—	1.5	15
2N169A	65	15	20	85	34	1	—	27	5	15
2N1198	65	25	75	85	17	8	5	—	1.5	15
2N1217	65	20	20	85	40	2	5	—	1.5	15
2N1510	75	75	20	85	8	1	—	—	5	75

IN STOCK FOR FAST DELIVERY FROM YOUR AUTHORIZED GENERAL ELECTRIC DISTRIBUTOR

GENERAL ELECTRIC

AC Current Probe 377

For vtvm or oscilloscope readings

Model 456A ac current probe converts ac current functions to voltage functions for direct reading on a vtvm or oscilloscope. The probe clamps onto the current-carrying wire, taking measurements without direct connection to the test circuit. The instrument's bandwidth of 20 cps to 15 mc permits oscilloscope viewing of current waveforms; unity conversion of 1 mv to 1 ma permits direct current reading on voltmeters. The unit weighs 3 lb.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palto Alto, Calif.

Price & Availability: *The unit is priced at $190.00; availability is 14 weeks.*

Booth 653-654.

Printed Circuit Connectors 390

Have bifurcated contacts

Series 5011 Varicon printed circuit connectors, with bifurcated contacts, accept Series 53 taper pins. The insulator body is a glass-filled diallyl phthalate. The units have integrally molded board guides and a single row of contacts on 0.2 in. centers.

Elco Corp., Dept. ED, M St. below Erie Ave., Philadelphia 24, Pa.

Booth 724-725.

Handles 386

Come in four lengths

These panel handles are offered in the following sizes: type 1260, 2 x 1-5/16 in.; type 1261, 3 x 1-5/16 in.; type 1262, 4 x 1-1/2 in.; and type 1263, 6 x 1-3/4 in. Made of brass per ASTM B-121, alloy 4, they have black oxide or 0.0005-in. nickel plate finish.

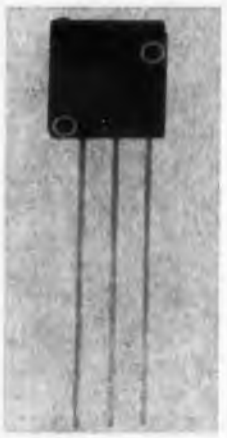
Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Booth 747.

◀ CIRCLE 132 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Trimmer Potentiometers 358



Temperature range is —55 to +150 C

Series 316 Squaretrim trimmer potentiometers, designed for printed circuit applications, operate over the temperature range of —55 to +150 C. A circular resistance element eliminates the effects of differential thermal expansion. These miniature units stand 2,000 cps vibration and shock of 30 g. Standard models are offered in resistance values of 10 ohms to 100 K.

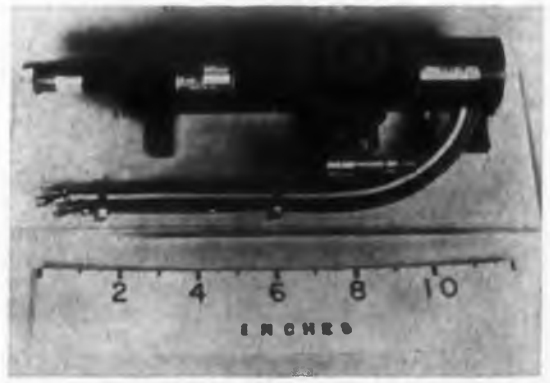
Daystrom, Inc., Pacific Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Price & Availability: *$6.10 ea for standard units in quantities of one to nine. Standard units are delivered from stock; others, in 30 days.*

Booth 1039-1040.

Traveling Wave Tubes 356

Cover 7,000 to 11,000 mc



Suited to operate in series as an amplifier chain, types L-3266 and L-3236 PPM-focused traveling wave tubes cover 7,000 to 11,000 mc. Minimum saturated cw power is 20 mw for the L-3266 and 2 w for the L-3236. Each tube provides a small signal gain in excess of 33 db. Applications are in ECM repeaters, radar-target enhancement systems, frequency diversity radar transmitters, and equipments requiring general-purpose microwave amplifiers. Both tubes weigh less than 4 lb and measure about 1 ft long.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif.

Booth 2104.

Latching Relay 352

Coaxial type

Type RC5 latching vacuum relay is for 50-ohm, 1-5/8-in. coaxial lines. It provides a means of remotely or manually switching for communications, and radar transmitters. The device has a frequency range of 0 to 100 mc with a vswr of 1.02 max at 30 mc and 1.05 max at 60 mc. Power rating is 25 kw cw avg at 30 mc into a matched load. The relay has greater than 60 db isolation at 30 mc. Relay actuation is available for 24- or 115-v dc solenoids. Two spdt microswitches are available at auxiliary contacts for remote indication.

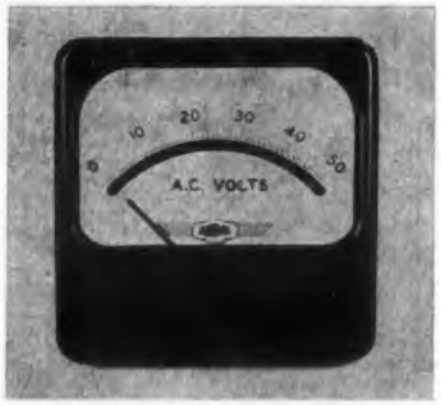
Jennings Radio Manufacturing Corp., Dept. ED, P.O. Box 1278, San Jose 8, Calif.

Price & Availability: $518 ea in quantities of one to 10. Delivery time is 30 to 45 days.

Booth 2520-2521.

Precision Voltmeters and Ammeters 407

Are accurate to 1%



These meters, with anti-parallax mirror scales, are accurate to 1%. Parts are machine turned, with spring-mounted jewel bearings. Meter ranges are from 50 μa to 500 amp dc, 100 μa to 20 amp ac, 10 mv to 750 v dc, 8 to 500 v ac. Ac meters are rectifier type. Meters measure from 2-1/2 to 6-3/4 in. sq.

Airpax Electronics Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

Price & Availability: Priced from $29.75 to $54.40, the meters can be delivered in 7 days.

Booth 711-712.

NEW PRODUCTS AT WESCON

Tape Equipment 370

Search and control system

The ZA-821 tape search and control system employs a 24-bit, binary-coded-decimal time code detection technique. The system rapidly searches the desired tape area, switches the transport (which may be at a remote location) to playback speed, and provides contact closures for operation of auxiliary equipment during preset intervals. Recycling of the selected playback area is automatic. Solid-state circuitry is used throughout. The unit occupies 15-3/4 in. on a 19 in. rack. Maximum depth including connectors is 18 in.

Electronic Engineering Co., Dept. ED, 1601 Chestnut Ave., Santa Ana, Calif.

Price & Availability: *Price is $11,400 fob Santa Ana; delivery is 90 days.*

Booth 2527-2528.

DC Charging Reactors 400

For pulse modulator applications

These dc charging reactors are used in pulse modulators for klystrons in linear accelerators and high power radar. They may be epoxy resin encapsulated or oil insulated, depending on the requirements. The unit shown operates at 8 amp dc average current from a dc source voltage of 15 kv. Its peak current rating is 20 amp. Inductance rating is 0.5 h and pulse repetition rate is 800 pps.

Electro Engineering Works, Dept. ED, 401 Preda St., San Leandro, Calif.

Availability: *Made on order.*

Booth 601.

Oscilloscope Preamplifier 388

Gain is 40 db

Model SPR-100 oscilloscope preamplifier has a gain of 40 db. Response is flat from 500 kc to 250 mc. The unit provides a 60-cps square wave response. Its vswr is less than 1.08.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa.
Booth 426-427.

Air Data Computing System 389

Supplies flight data for fighter systems

The central air data computing system designed for the F-104G supplies flight data intelligence to systems including the auto-pilot, in-range computer, fire control computer, position and homing indication, and internal navigator. The system consists of a transducer package and total temperature sensor. Information from these units is fed to a computer package which supplies Mach, altitude, pressure, air speed and angle of attack information.

The Garrett Corp., AiResearch Manufacturing Co., Dept. ED, 9851-9951 Sepulveda Blvd., Los Angeles 45, Calif.
Booth 2056-2057.

Stand-Off Terminals 385

Double-turreted

These double-turreted, Teflon stand-off terminals are 0.148 in. in diameter and fit into a 0.136 ±0.002-in. hole, accommodating panel thicknesses of 1/16 to 1/4 in. The following heights are offered: type 4025, 1/4 in.; type 4026, about 9/32 in.; type 4027, about 5/16 in.; and type 4028, 11/32 in. They are finished in silver plate or electro-tin plate and are constructed of brass.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.
Booth 747.

CIRCLE 137 ON READER-SERVICE CARD ➤

NEW PRODUCTS AT WESCON

Tapered Transitions 355

Frequency range is 3.95 to 140 kmc

Offered in any of 60 combinations of input and output sizes, the DB-108 line of tapered transitions covers the frequency range of 3.95 to 140 kmc. Energy can be transfered from one size of waveguide to a waveguide of another size using only one transition. Standard UG-n/U cover flanges are supplied with the units. All units are plated with nickel over silver over copper.

DeMornay-Bonardi, Dept. ED, 780 Arroyo Parkway, Pasadena, Calif.

Price & Availability: $50 to $270 ea; delivery in two weeks to 30 days.

Booth 2214-2215.

Resistivity Bridge 453

For ultra-pure water

Model RD-336 "Solu-Bridge" checks the resistivity of hot, ultra-pure water used in washing of semiconductor materials. Range of the instrument is 1 to 18 meg per cm specific resistance, and a manual temperature compensator calibrated for 70 to 100 C is included.

Industrial Instruments, Inc., Dept. ED, 89 Commerce Road, Cedar Grove, N.J.

Booth 2314.

Attenuator 394

Range is dc to 500 mc

Model AV-50, laboratory rf attenuator has a range of dc to 500 mc. Attenuation is 0 to 62.5 db in 0.5-db steps. Vswr is 1.15 at 250 mc and 1.4 at 500 mc.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa.

Booth 426-427.

Hi-G TIME DELAY RELAYS

1, 2 OR 4 POLE DC TYPES

The Time Delay Relays shown here are all standard units. Most units are custom manufactured utilizing faultless Time Delay circuitry combined with relays, custom adjusted in our own plant to meet stringent requirements.

TYPE	CONTACT ARRANGEMENT	CONTACT RATING	MAXIMUM CURRENT DRAIN @ 25°C
1107	1PDT	2A, 32 V DC Resistive	100 MA.
1108	2PDT	2A, 32 V DC Resistive	150
1109	4PDT	2A, 32 V DC Resistive	200
1110	4PDT	5A, 32 V DC Resistive 3A, 115 V AC Resistive	300

ELECTRICAL CHARACTERISTICS

INPUT VOLTAGE: 18-31 VDC

TIME DELAY: 50 milliseconds - 180 sec., on "make" only.

TIME DELAY TOLERANCE: 10% Standard over Temperature range, closer tolerances available.

RECYCLE TIME: 20 milliseconds maximum. The recycle time is the time required to attain 95% of normal time delay when power is interrupted after timing cycle is completed.

RECOVERY TIME: .1 sec. Max. 50 MS to 90 Sec.
.5 sec. Max. 91 Sec. to 180 Sec.
The recovery time is the time required to attain 90% of normal time delay when power is interrupted during timing cycle.

RESET TIME: 10 Milliseconds Max. The reset time is the time required for the contacts to return to normal position when power is removed.

ENVIRONMENTAL CHARACTERISTICS

TEMPERATURE: —55° to +85° C

VIBRATION: 20 G to 2000 CPS

SHOCK: 50 G 11 ± 1 millisecond duration

INSULATION RESISTANCE: 1000 Megohms @ 500 VDC

SEALING: 80,000 ft.

LIFE: 100,000 operations minimum

DIELECTRIC STRENGTH: 1000 VRMS, 60 cps. @ sea level

NOTE: **The Time Delay Relays described in this advertisement are standard units. Special units are available at other voltages, time delays, tolerances, and other environmental characteristics. Delay times may be obtained on break only (with or without power) and other special timing requirements. Mounting configuration variations are available. Please consult factory regarding these requirements.**

SEE US AT THE WESCON SHOW BOOTH 666

BALANCED Hi-G ROTARY

HI-G, INC.

BRADLEY FIELD | TEL: NA 3-2481 • TWX: 562
WINDSOR LOCKS, CONNECTICUT

CIRCLE 139 ON READER-SERVICE CARD

Power Triode 367

Rated at 60 kw

The type D-1008, a ceramic-metal power triode designed to withstand environmental extremes, is a water-cooled tube with a heavy-wall copper anode and mesh-type cathode. The tube is rated at 60 kw, full-power input to 50 mc and reduced input to 110 mc, with maximum anode dissipation of 20 kw. Applications include use as a class C amplifier, or as an oscillator in dielectric and induction heating service. The tube can switch 220 amp at 18 kv as a hard-tube radar modulator.

ITT Components Div., Electron Tube Div., Dept. ED, P.O. Box 412, Clifton, N.J.
Price & Availability: *The D-1008 is available for immediate shipment and priced at $380.*
Booth 2044-2045.

Multiplier Phototube 372

For ultra-violet and visible light

The type 7664 photomultiplier has 10 stages and is sensitive to visible and ultra-violet light to 1800 A. An adjustable focusing electrode controls photo-electron efficiency. Average sensitivity is 60 μa, with a minimum of 50 μa for white light. The window has a 1-1/2 in. min diameter. Average cathode sensitivity at max response, and 210 v between cathode and other electrodes, is 0.056 per μa per μw. Average current amplification at 150 v per stage is 2 million.

Allen B. Du Mont Laboratories, Inc., Electronic Tube Sales Dept., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.
Price & Availability: *The type 7664 is priced at $250 each and is available for immediate delivery.*
Booth 1023-1024.

NEW PRODUCTS AT WESCON

Trigger Rate Converter 399

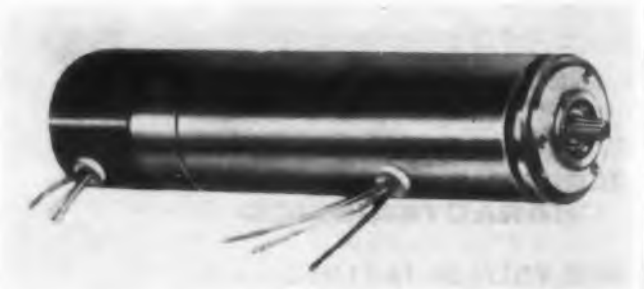
Provides rates to 300 mc

Model 602 trigger rate converter permits triggering rates to 300 mc and higher with conventional and sampling oscilloscopes. The device makes it possible to view sine waves up to 60 mc on 30-mc oscilloscopes. Pulses generated have risetimes in millimicroseconds and a 50-kc repetition rate. The pulses are synchronous with the input signal.

Lumatron Electronics, Inc., 116 County Court House Road, New Hyde Park, L.I., N.Y.
Price & Availability: *$440; from stock.*
Booth 2414.

Tachometer 402

Motor-integrating type



This motor-integrating tachometer, size 10, has a diameter of 0.937 in., a rotor moment of inertia of 3 gm-cm² and an acceleration at stall of 9,500 radians per sec². The scale factor is 2.5 v per 1,000 rpm and the linearity from 0 to 3,600 rpm is ±0.12%. Temperature range is −55 to +125 C. The device is suitable for use in analog computers and velocity regulation systems.

Bendix Corp., Eclipse-Pioneer Div., Dept. ED, Teterboro, N.J.
Booth 1050-1051.

Power Transistors 451

Meet military specifications

Thirty-four additional industrial power transistors have been issued under the Meg-A-Life certified reliability program. The units are designed for continuous operation at junction temperatures of 100 C, and are housed in TO-3 packages. Power dissipation is 90 w and thermal resistance

is 0.8 C per w. Each production lot of these transistors undergoes mechanical, electrical, environmental and life testing according to MIL-S-19500B specifications.

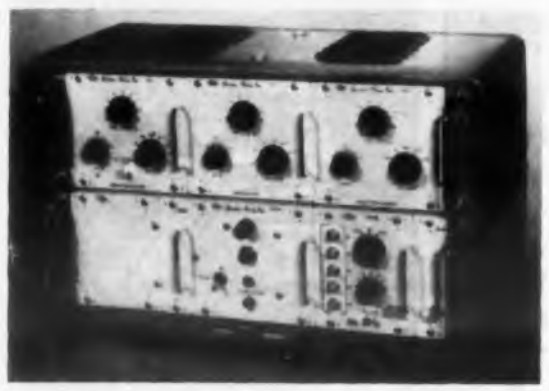
Motorola Semiconductor Products, Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Price & Availability: *Units in quantities of 100 and over are priced from $1.80 to $9.00. They are available from stock.*

Booth 2021-2022.

Pulse Generator 351

Repetition rate is 10 mc to 100 cps



Model 4550A 10-mc pulse generator has a repetition rate that is variable from 10 mc to 100 cps, a variable delay of 0.02 to 1,000 μsec, a variable duration of 0.05 to 1,000 μsec, and a rise time of less than 10 nsec. The output amplitude is 12 v open circuit, 8 v into a 180-ohm load.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Price & Availability: *$1,695 ea; 60-day delivery.*

Booth 412-413.

Chart Recorders 404

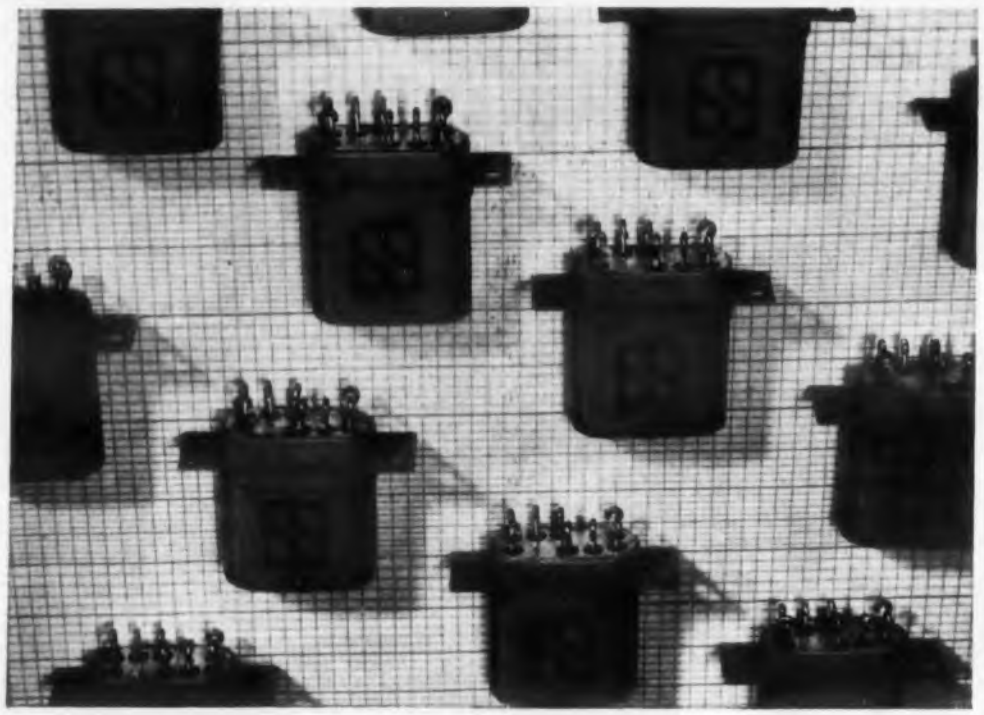
Single and dual-channel models

These single and dual-channel galvanometric chart-recorders have flush-mounting design for panel installation. They have swing-out chart carriages and a slide-out chassis. A zero adjustment provides for zero settings over the entire scale as well as zero suppression above and below scale.

Texas Instruments, Inc., Dept. ED, 3609 Buffalo Speedway, Houston 6, Tex.

Price & Availability: *$495 for the single units, $92[illegible] for the dual type; 60-day delivery.*

Booth 735-736.



This is the new Union Crystal Case Relay

The UNION 2-PDT General Purpose Crystal Case Relay is designed to consistently meet the requirements of MS 24250, Mil-R-25018, Mil-R-5757C. Use it where minimum size and *optimum reliability* are esssential—in control systems, computers, airborne and guided missile electronic equipment.

To provide vibration immunity, we have incorporated a unique feature in this relay's armature suspension system. A torsion wire is anchored to the armature and backstrap. It acts as a biasing spring; supports the armature and eliminates end play. The relay uses the rotary principle of operation, found in the entire line of extremely reliable Union Switch & Signal miniature relays.

The 2-pole, double throw, bifurcated contact structure increases reliability and efficiency in dry circuit applications. UNION Crystal Case Relays are designed for continuous operations in the —65°C to +125°C range.

Union Switch & Signal's manufacturing capabilities and experience make it possible to provide these quality relays in quantity. Manufacturing techniques make it possible to provide the ultimate in reliability.

The new UNION Crystal Case Relay is available with the 0.2″ grid-spaced header or "S" type header, with solder lugs, plug-in terminals, or 3-inch leads, and for various operating voltages.

Contact Union Switch & Signal for additional information about this new Crystal Case Relay. Write for bulletin 1064.

Vibration: 20 G—2,000 cps
Shock: 50 G
Temperature Rating: —65°C to +125°C
Contact Rating: Dry circuit to 2 amp., 28-volt DC resistive load.

See the new UNION General Purpose Crystal Case Relay at the WESCON Show, Memorial Sports Arena, Los Angeles, California, August 23-26, 1960, Booth 2828-2829.

"Pioneers in Push-Button Science"

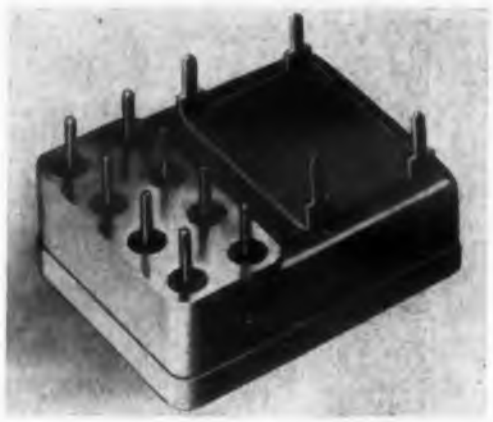
UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

CIRCLE 141 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

DPDT Relay 405

For printed circuit use



Style 6A dpdt relay is similar to the firm's style 6 relay but is smaller. Installed height is about 0.44 in. Terminals and mounting tabs conform with the 0.2-in. grid pattern. The unit operates at coil powers lower than those required for larger current-sensitive relays in the same class. It switches load currents of 2 amp resistive and higher at 26.5 v dc or 115 v ac. It stands 50 g shock and 20 g vibration at 2,000 cps.

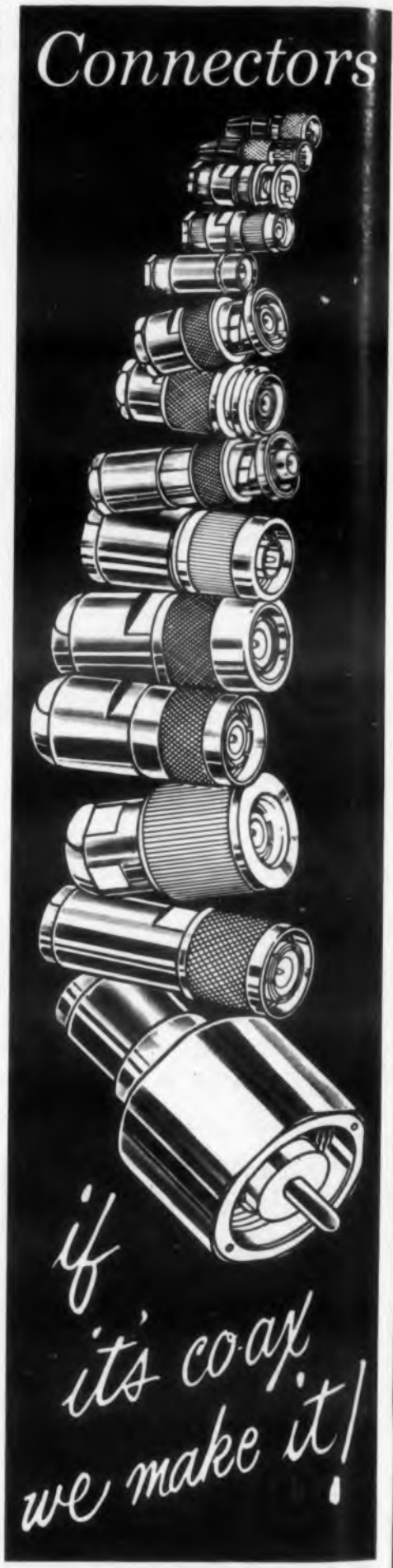
Price Electric Corp., Dept. ED, Frederick, Md.
Price & Availability: *$9.45 ea in quantities of 100 to 499; 30- to 45-day delivery.*
Booth 459.

Motor Tachometer 409

Unit is temperature-compensated

Model 15A23D-O1C motor tachometer is a precision temperature-compensated, non-frequency sensitive instrument. Output is 2.75 v per 1,000 rpm ±0.25% from 0 to 70 C, with adjustability to ±0.01% from 60 to 80 C. Linearity to 3,600 rpm is within ±0.07%. The unit is designed for missiles, computer packages, electronic systems and airborne or ground support control units. Environmental Mil specs are met.

American Electronics, Inc., Instrument Div., Dept. ED, 9503 W. Jefferson Blvd., Culver City, Calif.
Availability: *Delivery is 60 days.*
Booth 2349.



Technical Brochures are available upon request.

Automatic
METAL PRODUCTS CORP.
323 BERRY ST., B'KLYN 11, N.Y.
Telephone: EVergreen 8-6057

CIRCLE 142 ON READER-SERVICE CARD

Copper Clad Laminates 383

Thickness is 1/200 in.

A number of thin, copper clad laminates are available in lengths up to 100 ft. Among them are 1- or 2-oz copper bonded to 0.005-in. Kel-f, 0.005-in. Teflon-FEP, 0.007-in. Teflon-glass cloth, 0.005-in. linear polyethylene and 0.006-in. Mylar. Copper clad vinyl, Mylar vinyl and glass-reinforced silicone rubber will be available in the future.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.
Booth 804-805.

Subcarrier Oscillator 365

Input impedance is 50,000 ohms

Model 10081 subcarrier oscillator provides a full frequency deviation ouput for only 20 mv input and has an input impedance of 50,000 ohms. Linearity is within 1% of bandwidth and frequency stability is within 2.5% over the temperature range of 0 to 85 C. All the functions of a low-level dc balanced input amplifier as well as those of a subcarrier oscillator are contained in the unit.

Hoover Electronics Co., Dept. ED, 110 W. Timonium Road, Timonium, Md.
Booth 2822.

C-Band Attenuator 382

Attenuation exceeds 25 db

Model TFA-1 is a C-band, electrically variable attenuator. Attenuation range exceeds 25 db from 4900 to 5800 mc. The insertion loss is less than 1 db, and temperature range is —55 to +125 C. It can handle 3 w average and 3 kw peak power. The unit has a 1.12-in. diam and 3.18-in. length. Weight is 6 oz. Applications include fast AGC circuits, remote level control systems, and use as a modulator or fast-acting switch.

The Bendix Corp., Electron Tube Products, Red Bank Div., Dept. ED, Eatontown, N.J.
Booth 1046-1047.

CIRCLE 143 ON READER-SERVICE CARD ➤

Westinghouse

SILICON POWER RECTIFIERS AND TRANSISTORS

NOW IN STOCK

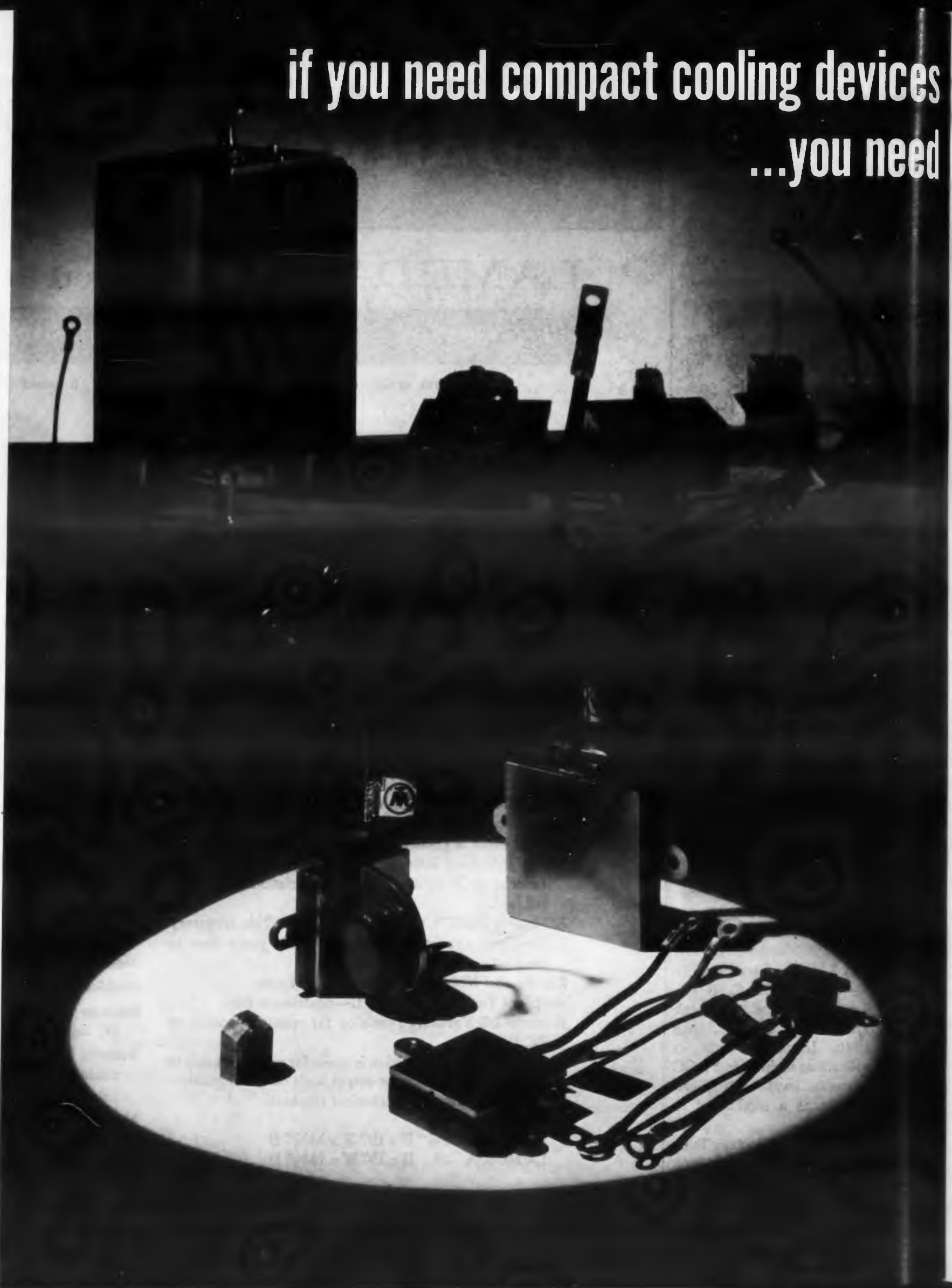
YOU CAN OBTAIN UP TO 1000 PIECES OF MOST TYPES AT FACTORY PRICES FROM

Schweber

ELECTRONICS

60 HERRICKS ROAD,
MINEOLA, L. I., N. Y.
PIONEER 6-6520.
TWX G-CY-NY-580U

CIRCLE 129 ON READER-SERVICE CARD



WESTINGHOUSE THERMOELECTRIC COOLERS

NOW AVAILABLE AT REDUCED PRICES

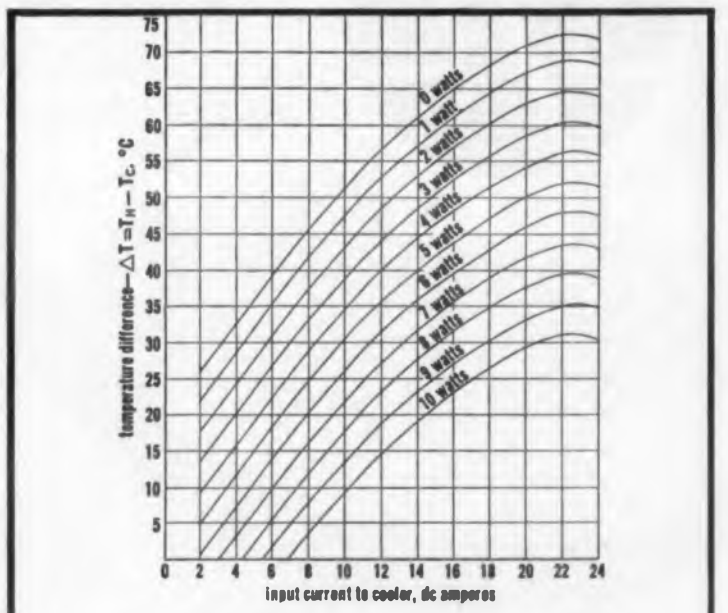
Now you can have the space and weight savings of Westinghouse "Component-Matched" thermoelectric coolers—with new cost savings, too. Prices are reduced on standard units, up to 50%!

Exclusive Westinghouse "Component-Matched" configurations! With no moving parts, Westinghouse Thermoelectric coolers provide dependable, compact, lightweight cooling where it is necessary to reduce component temperature below ambient. These unique "Component-Matched" coolers feature exterior cooling surfaces or inner-cooled chambers with tailor-made dimensions to fit specific requirements. As a result of new production facilities, a wide range of configurations can be offered to electronic equipment designers.

Only Westinghouse guarantees minimum ΔT ratings! Recent Westinghouse improvements in thermoelectric materials and assembly techniques have made it possible to guarantee minimum ΔT ratings for each cooling unit. Thus, a designer can select the unit he needs knowing in advance what the temperature drop will be from the hot to the cold side of the cooler.

Immediate military and industrial applications include: Photocells, photomultiplier tubes / Germanium transistors / Infrared detectors / Mechanical and electrical instruments / Laboratory and portable medical equipment / Controlling temperatures of solids, liquids and gases.

Westinghouse engineers who developed these new thermoelectric coolers will be glad to provide engineering assistance in your applications. For full information, contact your local Westinghouse representative, or write: Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Pennsylvania. SC-1000



Typical ΔT°C versus input current—Types WX814-H, WX816-H

"Buy and Try"—from Westinghouse distributors —standard WX814 and WX816 Coolers for immediate delivery at new reduced prices.

EASTERN

CAMERADIO	Pittsburgh, Pa./EX 1-4000
CRAMER ELECTRONICS, INC.	Boston, Mass./CO 7-4700
ELECTRONIC SUPPLY	Melbourne, Florida/PA 3-1441
GENERAL RADIO SUPPLY CO., INC.	Camden, N.J./WO 4-8560
KANN-ELLERT ELECTRONICS, INC.	Baltimore, Md./TU 9-4242
MILGRAY ELECTRONICS	New York, N.Y./RE 2-4400
RADIO & ELECTRONIC PARTS CORP.	Cleveland, Ohio/UT 1-6060
SCHWEBER ELECTRONICS	Long Island, N.Y./PI 6-6520

MIDWESTERN

ELECTRONIC COMPONENTS FOR INDUSTRY CO.	St. Louis, Mo./WO 2-9917
INTER-STATE RADIO & SUPPLY CO.	Denver 4, Colo./TA 5-8257
LENERT CO.	Houston, Texas/CA 4-2663
RADIO DISTRIBUTING CO.	Indianapolis, Ind./ME 5-8311
SEMICONDUCTOR SPECIALISTS, INC.	Chicago, Ill./NA 2-8860
UNITED RADIO, INC.	Cincinnati, Ohio/MA 1-6530

WESTERN

ELMAR ELECTRONICS	Oakland, Calif./TE 4-3311
HAMILTON ELECTRO SALES	Los Angeles, Calif./BR 2-8453
NEWARK ELECTRONICS CO.	Inglewood, Calif./OR 4-8440

YOU CAN BE SURE...IF IT'S

Westinghouse

Westinghouse

SILICON POWER RECTIFIERS AND TRANSISTORS

NOW IN STOCK

YOU CAN OBTAIN UP TO 1000 PIECES OF MOST TYPES AT FACTORY PRICES FROM

Schweber ELECTRONICS

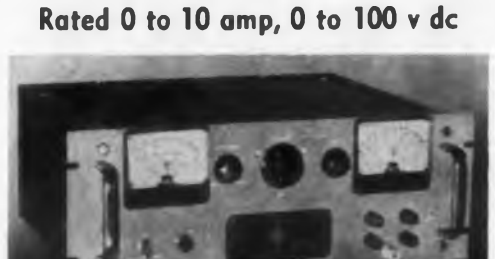
60 HERRICKS ROAD,
MINEOLA, L. I., N.Y.
PIONEER 6-6520.
TWX G-CY-NY-580U

CIRCLE 129 ON READER-SERVICE CARD
CIRCLE 144 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Regulated Power Supply 369

Rated 0 to 10 amp, 0 to 100 v dc



Model ST100-10 transistor power supply is rated at 0 to 100 v dc, 0 to 10 amp continuous duty; the output is continuously variable over the entire range. Vernier control provides about 1 v variation for full rotation. Line regulation is 0.005% for changes between 100 and 135 v ac, and load regulation is 0.01% for changes from 0 to full load. The unit has continuously variable automatic overload protection, programming from a distant point over a narrow voltage range and plug-in sub-assemblies.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price & Availability: *Price fob Springfield is $1595; delivery is 30 days.*

Booth 2312.

Rack-Mounted Oscilloscope 454

Bandwidth is 500 kc

Model 401BR is a rack-mounted version of Model 401B general purpose oscilloscope. Bandwidth of the scope is 500 kc at 3 db down. Sensitivity is 10 mv per cm with identical X and Y amplifiers.

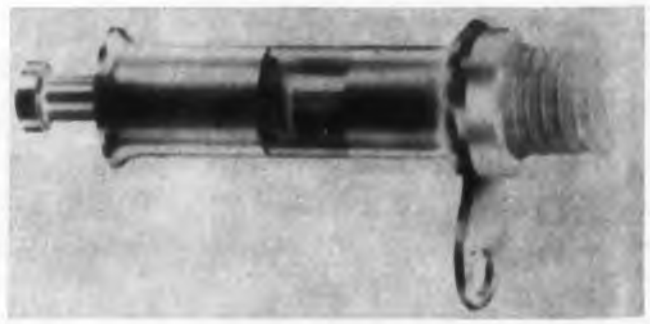
Allen B. Du Mont Laboratories, Inc., Dept. ED, Clifton, N.J.

Price & Availability: *Price is $430. Units are available from stock.*

Booth 1023-1024.

Trimmer Capacitors 398

For ungrounded operation



The Turret Sealcap series of trimmer capacitors offers low capacitance to ground for applications requiring ungrounded operation. Capacitance

ranges vary from 0.6 to 30 pf. Sealed interior construction protects against atmospheric effects. Tuning resolution is excellent. With glass dielectric, there is no derating at 125 C; with quartz, no derating at 150 C.

JFD Electronics Corp., Dept. ED, 601 16th Ave., Brooklyn 4, N.Y.

Price & Availability: *$3.15 to $6.75 ea in production quantities. Delivery time is one week.*

Booth 667.

Scanner 353

Scans up to 100 inputs

Model 701 electronic scanner scans up to 100 inputs, using a true differential, isolated, and guarded input. The measured value is the voltage between the two input terminals independent of the common mode voltage. The unit is internally organized in groups of 10 channels with a maximum of 10 groups. Maximum operating rate is 500 channels per sec.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

Booth 2810-2811.

Marker Generator 396

Is crystal controlled

Model CM-10 crystal-controlled marker generator is similar to model CM-6, but is a 10-crystal unit and is rack mounted. Frequency range is 2 to 100 mc. In the higher frequencies, up to the 20th harmonic will be visible, and in the lower frequencies, up to the 10th harmonic will be visible. The outputs of the individual oscillators can be mixed with the output of each completely controlled from maximum output to no output.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa.

Booth 426-427.

NEW PRODUCTS AT WESCON

Oscillating Table 393

Angular type

Model 61A angular oscillating table is for frequency-response testing of gyros, accelerometers, and guidance systems. A rate pickoff provides instantaneous rate information for presentation on an oscilloscope or recorder. Input may be from any audio amplifier, dc power amplifier, or shaker amplifier over the range of 0 to 100 cps.

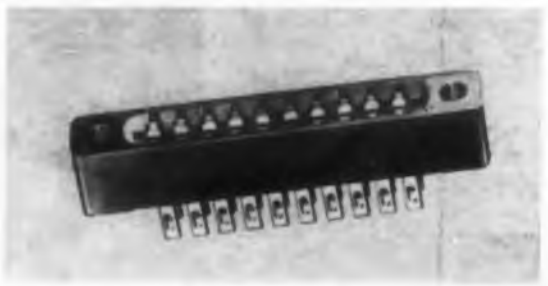
Micro Gee Products, Inc., Dept. ED, Box 1005, 6319 W. Slauson Ave., Culver City, Calif.

Price & Availability: *$4,950 ea; from stock.*

Booth 2624.

Printed Circuit Connectors 411

Provides 20 connections



Series 600 printed circuit connectors accept 1/32-in. printed circuit board or tape cable. A double row of 10 contacts with solder lug terminals provides 20 connections for board and circuit wiring on a connector length of 1-7/8 in. Voltage ratings are 650 v rms at sea level, 200 v rms at 70,000 ft. Current rating is 3 amp.

Continental Connector Corp., Dept. ED, Woodside 77, L.I., N.Y.

Availability: *Delivery is about 30 days.*

Booth 855-856.

Digital Computer 442

Operates at over 40,000 instructions per sec

Type PB-250 general purpose digital computer operates at up to 41,666 instructions per sec. The unit has a capacity of 1,808 words, which can be adapted for 15,888 words; it has a magneto-

new, low-cost micro-microammeter

Model 414 offers high performance over 17 ranges for just $280.00!

● The Keithley 414 Micro-micro-ammeter is today's lowest-cost instrument for low current measurements in production tests, monitoring installations and experiments in the range of 10^{-2} to 10^{-11} ampere. The 414 can be used as the amplifier element in systems, such as reactor controls, thickness gauges, ionization gauge control in high-vacuum equipment. Contact meter models are available for go, no-go production tests, alarm and control systems.

SPECIFICATIONS

Ranges: 17 ranges in 1x and 3x steps, from 10 ma to 0.1 mμa f.s.

Accuracy: Within ±3% of f.s. to 10 mμa; ±4% on lower ranges.

Input Voltage Drop: Below 5 mv all ranges with full-scale signals.

Response Time: Below 0.5 sec. all ranges, for any input capacitance to 5000 $\mu\mu$f.

Zero Drift: Below 2% of f.s. per day.

Recorder Output: 5 volts with a 1 ma capability.

Price: Model 414 . . . . . $280.00

For full details, write:

KEITHLEY INSTRUMENTS

12415 EUCLID AVENUE
CLEVELAND 6, OHIO

CIRCLE 148 ON READER-SERVICE CARD

strictive delay line type memory system. The instrument is designed for 46 different commands. It measures 30 x 19 x 24 in., and will mount in a standard relay rack. Word length is 26 bits plus sign.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

Price & Availability: *The unit is priced at $30,000, and can be delivered in 180 days.*

Booth 2264.

Traveling-Wave Tubes 368

Amplifiers for test instruments

This series of traveling-wave tubes is designed for test instrument application in the X-band. Type M2201-A is a direct electrical and mechanical replacement for use in the HP494A amplifier unit and operates from 7.0 to 12.4 kmc. The M2201-B is a replacement for use in the Alfred Electronics Model 504 amplifier unit and operates from 8.0 to 12.4 kmc. The tubes use metal-ceramic construction, low-temperature oxide cathodes and ceramic rod-supported helices, providing long life, low spurious modulation and high stability.

Microwave Electronics Corp., Dept. ED, 4061 Transport St., Palo Alto, Calif.

Price & Availability: *Tubes, priced at $850, can be delivered in 2 weeks.*

Booth 2154.

Tape Programer 401

Programs 10 lines at a time

Model 213 tape programer is able to program tape at one setting for an entire 10-line, eight-hole set of frames, instead of the usual one line at a time. It also alters or adds frames while duplicating tapes. It can punch tape frame by frame as well as line by line.

California Technical Industries, Dept. ED, 1421 Old County Road, Belmont, Calif.

Availability: *Immediate.*

Booth 2631-2632.

5-POUND PROGRAMMER *delivers better than* 5-PARTS-PER-MILLION TIMING ACCURACY *in missile applications*

MODEL DS-500 PROGRAMMER
5" DIA. x 7"

Only 5 inches in diameter and 5 pounds 2 ounces in weight, the DS-500 Programmer delivers a typical timing accuracy of better than five parts per million. Over a total 15 minute program, it has a measured timing error of only .0045 seconds. This miniature tape programmer offers simultaneous, 6-channel, timing functions . . . incorporates amplifiers and control circuitry for remote operation control . . . provides contact closure at extremely precise intervals over the full program period after actuation of the "start time" signal. The programmer meets rugged environmental specifications: vibration —20 g at 5 to 2000 cps; acceleration—30 g; shock—50 g operation, 100 g survival; temperature range —from —25°C to +85°C; altitude —250,000 feet.

For complete information, write for Data File ED-1256-1.

Del Mar ENGINEERING LABORATORIES

INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIF.

CIRCLE 149 ON READER-SERVICE CARD

NEW 2½-POUND COMMAND RECEIVER

SCREENS OUT NOISE ...PULLS IN SIGNAL

for targets, drones & missiles

MODEL R-400A UHF RECEIVER
260 MC—400 MC
6.8" L. x 3.5" W. x 3.1" H.

Operating under conditions of highly congested air space and a crowded radio spectrum, this tough, 44-ounce UHF remote receiver maintains excellent selectivity . . . eliminates spurious short time noise signals through an integrating time delay system. A crystal-controlled receiver, the R-400A operates on a very narrow channel with a stability greater than ±.01% of the input frequency over a temperature range of —65°F to +160°F. It offers unlimited application in remote control of targets, drones and missiles where single channel remote control is desired. Selectivity (RF-IF) is: 6 db down, 60 kc ± 10 kc; 60 db down, 170 kc ± 20 kc. Sensitivity is better than 2 microvolts. Meets requirements of MIL-T-9790A.

For complete information, write for Data File ED-1257-1

Del Mar ENGINEERING LABORATORIES

INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIF.

CIRCLE 150 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Frequency Converter 354

Sensitivity is 1 mv

Model FC-1 transistorized frequency converter is for use with the firm's FM-6 or FM-7 vhf frequency meters. With these units, it measures and generates frequencies from 10 kc to 1,000 mc. It can be used with other meters. Resettability is ±10 cps; sensitivity is 1 mv. Accuracy is 0.0001% ±20 cps from 10 kc to 20 mc and 0.0001% from 20 mc to 1,000 mc.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.
Price & Availability: *$425 ea; 30-day delivery.*
Booth 801-802.

Miniature Gearheads 410

Diameter is 1/2 in.

This size 5 gearhead and speed reducer unit weighs only a few grams; it measures 3/4-in. long and is 1/2-in. in diameter. It can have step-up or step-down ratios from 10:1 to 2,025:1. It is designed for satellite applications.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind.
Booth 765.

Insulating Tubing 444

Made of rolled glass-silicone

Grade 11556 rolled glass-silicone tubing has a dissipation factor of 0.0015 and arc resistance of 240 sec at temperatures up to 500 F. The tubing, with high tensile strength and impact resistance, is suitable for coil forms, lead insulation and other

fabricated parts. The tubing is available in wall thicknesses from 0.031 to 0.5 in., ID from 0.187 to 6 in., OD from 0.25 to 7 in., and 36 in. lengths.

General Electric Co., Laminated Products Dept., Dept. ED, Coshocton, Ohio.

Price & Availability: *Price is $6.50 to $10.75 per pound depending on thickness and quantity. Delivery is about 14 days.*

Booth 211-B.

DC Power Supplies 373

Supply 5 to 50 v at 225 to 750 ma

The 20-Series Power Supplies (24 models) have an external potentiometer for output voltage adjustment, a removable cover, and either solder terminal or octal plug input and output connectors. Input is 105 to 125 v ac, 60 or 400 cps. Output is from 5 to 50 v dc, 225 to 750 ma, depending on the model. Regulation is within 20 mv. Units, weighing 3.25 lb measure 2-3/4 x 3-3/4 x 5 in. They are protected against overloads and shorts.

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

Price: *$115.00, fob Pasadena.*

Booth 1011.

Antenna Multiplexer 376

Greater than 60-db separation

Model MT-395 antenna multiplexer consists of three highly selective band-pass filters and a combining network for isolating transmitters and receivers with low rf loss. General specifications are: frequency range, 225 to 300 mc; isolation, greater than 60 db with 10 mc separation; insertion loss, 0.7 db max; vswr, 1.5:1 max; passband ±750 kc min.

Rantec Corp., Dept. ED, Calabasas, Calif.

Availability: *Delivery is about 60 days.*

Booth 2207.

NEW PRODUCTS AT WESCON

Silicon Rectifiers 412

To replace mercury vapor tubes

Types ST-9 and ST-10 silicon plug-in rectifiers directly replace types 8008 and 872A mercury vapor rectifier tubes respectively. The units are rated at 10,000 piv and 1,250 ma dc output. Temperature range is from −65 to +75 C. The rectifiers are hermetically sealed. The ST-9 measures 8.03 in. x 2.13 in. diameter; the ST-10 measures 8.18 in. x 2.31 in. diameter.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.
Booth 2517-2518.

Photoelectric Cells 366

In many shapes and sizes

Type 5 self-generating selenium photoelectric cells can be fabricated into various spherical or cylindrical shapes, or into flexible strips which can be twisted into a variety of spiral designs. Sizes range as small as 1/16 in. sq, suitable for reading punched data cards. Convex or concave spherical shapes tend to be omnidirectional or unidirectional without the aid of a lens. Curved and spiral shapes set on a rotating base would be suitable for on-off power functions. Cells have high, stable output and resist mechanical damage.

Daystrom, Inc., Weston Instruments Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.
Booth 1037-1038.

Voltage Comparator 395

Provides dc and rf voltage reference traces

Models VC-12 voltage comparator provides simultaneous dc and rf voltage reference traces on the sweep frequency display. The unit is made up of three sections. A switch contains two spdt, coaxial, mercury relays having a vswr of less than 1.1 from dc to 250 mc. An rf section has a calibrated 1-mc signal that may be varied from 120 μv to 12 v rms. A dc section has positive and negative outputs of 120 μv to 12 v.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa. **Booth 426-427.**

Clamp Assemblers 443

For rod, tube and pipe structures

These clamp assemblers form rigid joints between rods, tubes and pipes, which can be used to mount switches and instrumentation equipment. An angle clamp to serve as a base or mount is available. Joints may be fixed in 10-deg increments of rotation from 0 to 360 deg. Snap-on clamps and insulated cable clamps are available.

Rotocon Div., Unistrut Products Co., Dept. ED, 933 W. Washington Blvd., Chicago 7, Ill.

Price: *Clamps are priced from $0.66 to $0.86 each.*

Booth 321.

Twin Power Triodes 449

For series-regulated power supplies

Types CK6336A and CK6528 twin power triodes are high current tubes intended primarily for series-regulated power supplies. They are claimed to be extremely rugged, with low internal drops and excellent control sensitivity. The tubes are enclosed in hard glass.

Raytheon Co., Industrial Components Div., Dept. ED, Newton 58, Mass.

Price & Availability: *Currently available from stock, the CK6336A is $19.00 and the CK6528 is $21.55 in single units.*

Booth 2017-2018.

NEW PRODUCTS AT WESCON

Servomotor 403

Size 8

Designated model 8 SM 461, this size 8 servomotor is 0.84-in. long and weighs 1.1 oz. The unit is for 115-v sources. It has a rotor inertia of 0.18 gm-cm² and a stall torque of about 0.22 oz-in., providing acceleration at stall of 86,500 radians per sec². Ambient temperature range is —55 to +130 C; maximum operating temperature is 200 C.

Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Road, Fullerton, Calif.
Booth 2514-2515.

Solderless Terminals 446

Permits rapid component connection

Springclip terminals are designed to be inserted into 3/32-in. holes in insulated boards. A spring arrangement will clamp up to six component wires to the terminal. The wires can be connected and disconnected rapidly without soldering. Contact resistance is less than 0.002 ohms. The terminals are designed for breadboard experimental circuits.

Vector Electronic Co., Inc., Dept. ED, 1100 Flower St., Glendale 1, Calif.
Price & Availability: *Terminals are available from stock, priced at 5 to 12 cents each depending on quantity.*
Booth 942-943.

DC Power Supplies 374

For laboratory use

Models 62-150 and 62-151 Power Supplies are transistorized, laboratory dc units. Model 62-150

has an output of 0.5 to 100 v at 0 to 1 amp; line regulation is 50 mv at 100 v output; load regulation is 25 mv at 100 v output; ripple is less than 1 mv rms. Model 62-151 has an output of 3 to 100 v at 0 to 3 amp; line regulation is 50 mv at 100 v output; load regulation is 75 mv at 100 v output; ripple is less than 2 mv rms.

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

Price & Availability: *The Model 62-150 sells for $810, and the 62-151 for $925, both fob Pasadena. Both models are available from stock.*

Booth 1011.

Engraved Drum Dials and Verniers 452

Diameters are 1.5 to 3 in.

These precision engraved drum dials and verniers are available in diameters of 1-1/2, 2, 2-1/2 and 3 in. They are black adonized with white filled engraving. Vernier readings are accurate within 6 sec. Mil specs are met.

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

Price & Availability: *Prices are from $45.00 to $75.00, less 5% in quantities of 101 to 200, less 10% for 201 to 500. Availability is from stock.*

Booth 311.

Mesa Transistors 392

Come in 18 types

These diffused mesa transistors come in 18 types, including small signal, medium power, intermediate power, and high power units. The six high-power diffused mesa silicon units have advanced electrical and mechanical characteristics. The four intermediate power diffused mesa transistors are packaged in a 7/16-in. stud-mounted hex package. The small signal units are for low-level, high-voltage switching and amplification: they come in the TO-18 packages. The medium power units have the collector lead isolated from the case.

Transitron Electric Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

Booth 2638-2639.

NEW PRODUCTS AT WESCON

Thyratron 397

Peak power is 33 megawatts

Type KU-74 ceramic-metal, hydrogen thyratron is rated at 33 megawatts peak power and is capable of operation at an average anode current of 4 amp at an rms value of 90 amp. The tube is for long-pulse, high-power radars. Internal heat sinks maintain proper operating temperatures of the grid and reservoir. No artificial cooling is necessary under ordinary ambient conditions.

ITT Components Div., Dept. ED, Box 412, Clifton, N.J.

Availability: For immediate shipment.

Booth 2044-2054.

Semiconductor Switches 447

Voltage ratings to 200 v

The Transwitch series pnpn switching devices are available in voltage ratings up to 200 v. The higher voltage units of these bistable silicon devices are suitable for digital indicating tube applications. The series includes the types TSW-30, TSW-60, TSW-100 and TSW-200 in the TO-5 package, and the types TSW-31, TSW-61, TSW-101 and TSW-201 in the TO-13 package.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

Booth 2638-2639.

DC Power Supply 375

For computer applications

The Model RP-10 power supply is a completely transistorized, regulated, 8-amp unit designed for computer applications. Measuring 5-1/4

n. high by 19 in. wide and 11-1/2 in. deep and veighing 38 lb, it will power 320 LE-10 logical lement T-PACs operating continuously at 1 mc. nput voltage is 117 v ±10%, 60 cps, single phase t 280 w max. Output is —13 to —19 v. It is a ack-mounted unit.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Price: Approximately $648.

Booth 561-562.

Navigation Aid Test Equipment 450

Provides rf circuitry for bench testing

Type 235-A navigation aid test set provides he rf circuitry required for bench testing and alibrating air traffic control transponders and irborne distance measuring equipment-Tacan avigation systems. The set contains a crystal-con-rolled rf generator with ranges of 960 to 1049 mc nd 1130 to 1219 mc at —10 to —100 dbm, a eak pulse power comparator indicating from 23 o 33 dbm from 960 to 1215 mc, and a wavemeter ccurate to ±0.5 mc from 1070 to 1110 mc. The nit is designed to be used with Collins Radio's odel 578X1 or 578D-1 bench test set.

Boonton Radio Corp., Dept. ED, Boonton, N.J.

vailability: Sets will be available from stock in ebruary, 1961.

ooth 751-752.

ilicon Rectifier Stack 413

Modular assemblies rated at 750 amp

The standard building block of these rectifier acks is the 2-1-2-D doubler module with an tegral paralleling reactor and four 70-amp sili-on junction rectifiers mounted on copper cooling ns. Two of these modules may be mounted to rm a single-phase bridge (shown) rated at 550 mp. Three stacked modules will provide a 750-mp dc output. The piv rating is 50 to 600 v.

International Rectifier Corp., Dept. ED, 1521 Grand Ave., El Segundo, Calif.

ooth 2517-2518.

CIRCLE 166 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Miniature DC Relays 406

Sensitivity is 25 and 40 mw

Type JSH relays are spdt and dpdt units with sensitivities of 25 and 40 mw respectively. Non-inductive contact rating is 2 amp at 29 v dc or 1 amp at 115 v ac. The relays can withstand vibration of 15 g from 55 to 2000 cps, 0.09 in. double amplitude from 5 to 55 cps, and shock of 50 g without contact chatter. The units weigh 1.1 oz.

Allied Control Co., Inc., Dept. ED, 2 East End Ave., New York 21, N.Y.
Booth 535.

Coil Winder 448

Operates at 5,000 rpm

Model 315-AM bobbin-solenoid-repeater-resister coil winder operates at 5,000 rpm. The traverse rod and wire guide mechanism are rear-mounted. Consistent cam tracking and quick change-over is provided. The OD coil clearance is 5 in. max; coil length is 3 in. max.

Geo. Stevens Manufacturing Co., Inc., Dept. ED, Pulaski Road at Peterson, Chicago 46, Ill.
Price & Availability: *Immediately available, the winders are priced at $700 fob Chicago.*
Booth 109.

Punched Tape Programer 371

Time base, 8-channel

The Model TP-860 8-channel, time base punched-tape programer uses standard teletype punched tape. It has separate motors for forward

drive and automatic rewind. Twenty minutes of precision time-base programing at 1 in. per sec are provided. Output is an 8-channel switch closure with common return. The self-contained unit, measuring 5 x 8 x 6 in., stores reels for 100 ft of tape.

Anaheim Electronics Div., Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price & Availability: *Price is $875 fob Santa Ana, with 6 week delivery.*

Booth 2527-2528.

UHF Power Tubes 501

For missiles and aircraft

Types 7650 and 7651 tubes are small, forced-air cooled, uhf beam power types with coaxial electrode construction. Belonging to the Cermolox series of tubes, they have maximum plate dissipation of 600 w, and can be operated at full ratings through 1215 mc. The tubes can be adapted for either coaxial cylinder or parallel line circuits. Type 7651 is designed for pulse operation, and can deliver nearly 40 kw at 1215 mc. The 7650 unit has a plate voltage of 2500 v max and plate input of 1250 w when used continuously as an rf power amplifier and oscillator in class C telegraphy service.

Radio Corp. of America, Electron Tube Div., Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

Booth 1054-1055.

Noise Source 357

Provides 18.5 ±0.5 db

Warranted for 2,000 hr min life, type L-2017 noise source provides an excess noise ratio of 18.5 ±0.5 db over the frequency range of 8,790 to 9,190 mc. Similar tubes are available for other frequencies. The tubes are particularly useful in providing continuous radar system performance monitoring because the excess noise ratio is unaffected by changes in ambient temperature or operating current over a wide range of values.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif.

Booth 2104.

NEW PRODUCTS AT WESCON

Electronic Housings 524

Use modular packaging

These housings, suitable for electronic circuits, are made in a modular style. The units are designed to provide ease of wiring and installation of equipment, mobility and loading capacity. Rounded corners and proportioned lines are intended to beautify the instrumentation.

Wyco Metal Products, Stantron Div., Dept. ED, 6914 Beck Ave., North Hollywood, Calif.

Availability: Delivery is 30 days.

Booth 523-524.

Chassis Slides 445

Easily pivot and disconnect

QDP Series chassis slides have thin ball-bearing slide mechanisms that pivot 90 deg up and down for chassis servicing. The pivoting section readily disconnects. The slides, constructed of extruded aluminum, meet MIL specs.

Jonathon Manufacturing Co., Dept. ED, 720 E. Walnut St., Fullerton, Calif.

Price & Availability: Slides are $40 and up in large quantities; delivery is 4 weeks.

Booth 319.

Cooling System 478

For 250-w airborne tubes

The Model E/HT-100, Type 100, cooling system provides a OS-45 coolant heat sink for a

250-w airborne electron tube. The unit weighs 3.9 lb and requires 95 va under continuous operation. The system provides for coolant expansion, visual coolant inspection, over-pressure and overheat protection. MIL-E-5400 specifications for Class II equipment are met.

Eastern Industries, Inc., Dept. ED, Box 4372, Hamden 14, Conn.
Booth 2054-2055.

Traveling Wave Tube 529

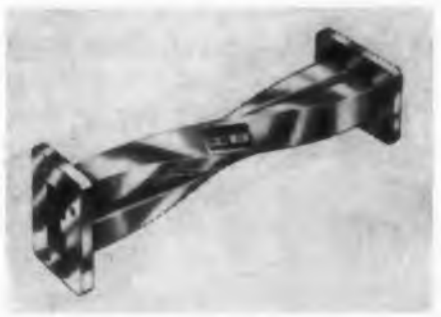
Noise figure is 7 db min

The Type HA-70 traveling wave tube has a noise figure of 7 db max, a 25-db min gain, a 1 mw saturation power output min, and a frequency range of 2,300 to 3,400 mc. It is focused in a 750 gauss solenoid and has a back attenuation of 70 db min. The tube is 22.4 in. long and has a 1-in. diameter. It is warranted for 1,000 hours.

Huggins Laboratories, Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.
Booth 820-821.

Rigid Waveguide Components 469

Operate in 4.75 to 11 kmc band



This line of microwave measuring equipment and components operates with the Type D9 double-ridged waveguide in the 4.75 to 11 kmc band. The waveguide cross section and flanges meet the proposed standards of the Electronic Industries Association. The line of equipment includes adapters, tunable detectors, variable attenuators, directional couplers, impedance meters, slide screw tuners, sliding terminals, high-power terminals, 90-deg axial twists (shown), and waveguide tubings.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, L.I., N.Y.
Booth 822-823.

IMPULSE

A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE DIV. OF ALCOA, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

DEEP PROBLEMS OF THE BRINY DEEP. While outer space and missiles continue to grab the headlines, the Navy has sounded a big blast and challenge to the electronics system designer. Urgently needed are solutions to a seemingly endless series of problems encountered in the area of Anti-Sub Warfare. There are indications that ASW represents such a pressing need that it may soon reach the proportions of the ICBM program. Of the total of nearly $2 billion earmarked for ASW, some $25 million will go into electronic equipment, most of it sonar devices. The problem basically breaks down into four major areas: surveillance, localization, classification, and killing. One expert singles out the first as the most perplexing of all, but the Navy is ready for full-steam-ahead on all phases. Good starting point for interested parties is BuShips Form 550.5. So, anchors aweigh! Because ASW is a deep problem and the Navy needs you to cope with it.

INFORMATION SQUEEZE. Do you have time to read all the technical journals and periodicals that bear on your work? Equally important, have you a reliable system for classifying, filing, and retrieving articles you want? No simple problem this, it is being investigated jointly by the Special Libraries Association and the American Library Association. Of course, individuals in many firms also have come up with suggestions. One we saw did a very good job of breaking down the entire electrical field into manageable divisions. Another more complex approach is being tried by the chemical people. They are working with a large computer firm on a system that arranges titles by a method called "Key Word in Context." The computer does the work of evaluating titles of articles and then classifying according to "key words." Printout provides groupings of key words and a detailed bibliography.

DUTCH TREAT. Revival of interest in microwave cooking may be given a boost by an electronic oven developed in Holland. This one is designed to cook prefrozen meals at a rate that could run to 150 an hour. Meals come in one end at minus 25°C and come out at serving temperature of plus 80°C. A total microwave capacity of 10 KW is provided by five magnetron elements. Equalization and isolation zones between each unit prevent the magnetrons from affecting one another. Actual heating time for a meal is one minute, but a total of eight minutes in the oven is needed, the remainder being spent in the equalization and isolation zones.

LAND OF THE NEVER-SETTING SUN. A solar battery with 648 silicon cells is being used to power the warning light on top of at least one Japanese lighthouse. It's been in operation since November and has been so satisfactory that plans call for building six more. The flashes can be seen for nine miles.

CABLEMAN'S CORNER. The subject of cable testing is an important one. This is the phase of production that determines whether or not the cable you are purchasing is in accordance with your standards and requirements. In the field of electronics and automation, cables are required to suit various stringent electrical, mechanical, and/or chemical environments. Many years of study and testing have gone into the design of test equipment to be used for these critical tests. It is not enough to know that a cable has been tested in a manner that is "essentially" the same as the required standard. Slight variations in equipment design or methods of tests can mean the difference between conformance and non-conformance. Make sure the test data you receive gives a true picture of the performance of your cable. When you need cable, call on a cable specialist. Phone Rome 3000, or write: Rome Cable Division of Alcoa, Dept. 1180, Rome, New York.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request. (21)

NEW PRODUCTS AT WESCON

UHF Isolators 538

Strip transmission line type

This series of uhf strip transmission line isolators are designed for operation from below 300 to above 1000 mc. Models D44J7 and D44P1-5 isolators are designed for J- and P-band operations, respectively, over 10% bandwidths. They have isolations of 10 and 20 db and insertion losses of 1 and 1.2 db for the 400 to 450 and 870 to 990 mc bands, respectively. The isolators measure 1.5 x 3 x 7-37/64 in. and weighs 2-1/2 lb. These units are intended for low power applications up to 10 w cw. Units for higher power applications or wider bandwidths and at other frequencies can be produced.

Sperry Microwave Electronics Co., Dept. ED, Clearwater, Fla.
Booth 2148-2149.

Precision Miniature Floated Gyro 489

Angular momentum is 300,000 gm-cm² per sec

The Zero-One floated gyros are high precision miniature instruments. They have a trimmed drift rate of less than 0.01 deg per hr, an angular momentum of 300,000 g-cm² per sec, and a mass unbalance of less than 0.4 deg per hr per g. The gyro case is 1.8 in. in diameter, and the unit weighs about 1/2 lb.

Reeves Instrument Corp., Dept. ED, Garden City, N.Y.
Booth 919-920.

Audio Volume Level Indicator 491

Range is −40 to +20 db

The Type TR-942-C volume level indicator is a transistorized version of the Series 924 indica-

tors. The device measures the level of signals in the power range of −40 to +20 db on 600 ohm audio transmission lines. Frequency response is ±0.1 db from 50 to 10,000 cps and ±0.25 db from 20 to 20,000 cps. The unit operates from −25 to +65 C, and is not affected by line voltage changes of over 10%.

The Daven Co., Dept. ED, Livingston, N.J.
Booth 444.

S-Band Circulator 494

Typical unit measures 3/4 x 2-1/2 x 7 in.

This S-band circulator has a typical size of 3/4 x 2-1/2 x 7 in. and weighs less than 2 lb. Characteristics are: 20 db isolation, less than 0.5 db insertion loss, and input vswr less than 1.2 over a 2 mc bandwidth. The circulators can be adapted for use with parametric amplifiers as input-output couplers, or in low-power applications of up to 1 w, avg.

Hughes Aircraft Co., Components Div., Dept. ED, Bldg. 20, Florence Ave. and Teale St., Culver City, Calif.
Booth 846-847.

Bowl-Magnet 463

For voltage-tunable magnetrons

This bowl-magnet, designed for voltage-tunable magnetrons, is a compact, light-weight unit that the firm can apply on a custom basis to any of its S-, L- or X-band vtm's. For example, the Type Z-5337 vtm, with a range of 2,900 to 3,100 mc, weighs 1.5 lb, has a diameter of about 3 in. and has a height of less than 1 in.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady 5, N.Y.
Booth 517-518.

NEW PRODUCTS AT WESCON

Decade Counter Module 461

Resolves pulses at 110 kc

The Model DC-111 miniature, decade-counter modules combine a type BX-1000 Beam-X switch with transistors to resolve pulses at 110 kc. The units, designed as plug-in modules for use in computers, electronic counters, machine control, automation and test equipment, can be cascaded and driven by a 12-v signal. Total power consumption is 2 w. Outputs will operate remote Nixie indicators and printers.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.
Booth 2136-2137.

Power Supply 498

Outputs are −25 and +25 v

Model D3907-01 dc power supply has outputs of +25 and −25 v, both maintained to better than ±0.01%. Input power requirements are: 115 v ±6%, 400 cps ±2%, 3-phase, 5 w, max; 28 v dc ±2%, 40 ma max; and 28 v dc unregulated, 7.5 w. The unit weighs 8 lb and measures 8.823 x 7.025 x 4.472 in. Temperature range is −55 C to +71 C.

Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.
Booth 626-627.

Resistor Noise Test Set 527

Has resistance range of 100 ohms to 22 meg

Model 315 Resistor noise test set measures the increase in noise generated in a resistor by a dc voltage applied across it. It will test resistors from 100 ohms to 22 meg at voltages from 3 to 300 v.

Noise voltages from 0.6 to 1,000 μv at 1,000 cps are measured. Readings are in microvolt per volt in a decade of frequency.

Quan-Tech Laboratories, Dept. ED, Boonton, N.J.

Price & Availability: *Units, priced at $1,550, can be delivered in 6 to 8 weeks.*

Booth 1029.

Miniature Connectors 466

Accommodates either ball- or bayonet-lock plugs

The KQ/KR Series connectors consist of Type KRO receptacle, Type KQ ball-lock plug, shown, and Type KR bayonet-lock plug. These crimp-type, miniature plugs have removable snap-in contacts. The receptacle will accommodate either the ball-lock or the bayonet-lock plugs. Plugs with 3 to 55 contacts and ratings from 1250 to 2400 v are available. The series has been tested to 100,000 ft and at 257 F.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

Booth 2836-2837.

Semiconductor Mounts 525

For modular circuits

These modular Tri-Plate semiconductor mounts are suitable for breadboarding in strip transmission line circuits. The holders are available for cartridge, double ended, pill or pigtailed glass packages.

Sanders Associates, Inc., Dept. ED, 95 Canal St., Nashua, N.H.

Booth 929-930.

NEW PRODUCTS AT WESCON

High-Speed Printer 459

Accepts 1-2-2-4 or 1-2-4-8 binary code

The Model 1453 high-speed printer accepts either 1-2-2-4 or 1-2-4-8 binary coded information. The unit will print 12-digit numbers in either black or red, and is designed to fit into a half-rack of a standard 19-in. relay rack. The instrument is designed to accept information from digital voltmeters and similar equipment.

Berkeley Div., Beckman Instruments, Inc., Dept. ED, 2200 Wright Ave., Richmond, Calif.
Price & Availability: *Units will be available from stock in September, 1960, at $995 each.*
Booth 2514-2515.

Tantalum Capacitors 500

Rated at 6 to 100 wvdc

Series TSW hermetically sealed, wet-electrolyte, sintered-anode tantalum capacitors are available in ratings from 6 to 100 wvdc and capacitances from 270 to 4.7 μf at 85 C. Supplied with or without an insulating sleeve, the bare tube case measures 0.188 in. in diameter, 0.525 in. in length for model TSW1; and 0.282 in. in diameter, 0.720 in. in length for model TSW2.

U.S. Semiconductor Products, Dept. ED, 3540 W. Osborn Road, Phoenix, Ariz.
Booth 2239-2240.

Silver-Zinc Primary Battery 467

Has two sections of 20 cells

The Model P-3000 primary battery has two sections: one section provides 24 to 26.8 amp continuous drainage with 33.2-amp pulses every

60 sec at 28 v ±0.7 v for 3.5 min; the other supplies a continuous current of 38.5 to 65 amp with a peak pulse of 145 amp at 27.5 to 26 v for 3.5 min. Each section consists of 20 cells of 3 amp-hr capacity. The unit has a curved shape and is designed for missile applications; it weighs 22 lb, measures 5 x 6 x 15 in.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York, N.Y.
Availability: Units can be delivered in 90 days.
Booth 551.

Temperature Detector and Control — 488

Detects variations of 0.1 C

The Series 8000 thermistor temperature control consists of a magnetic amplifier relay, a built-in dc power supply, and two legs of a bridge circuit designed to monitor and control small variations in temperature. When coupled to a thermistor and reference resistor, the bridge can detect temperature variations as small as 0.1 C. Model 8001 will handle 1 amp loads, while Model 8002 will switch up to 5 amp.

Sigma Instruments, Inc., Dept. ED, 185 Pearl St., South Braintree 85, Mass.
Booth 749-750.

Volume Resistivity Jig — 496

Measures 5 x 10″ meg per cm³

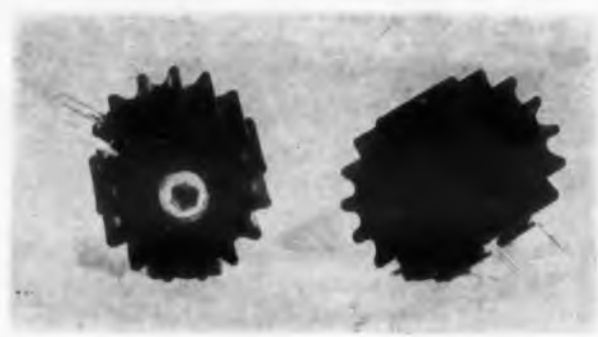
Volume resistivity readings up to 5 x 10″ meg per cm³ can be determined accurately within 10 sec by using this volume resistivity jig with the firm's Megatrometer. The same equipment and technique is applicable to tape, film, and insulating materials. Accuracy of the Megatrometer is 3% in the upper half scale up to 5,000 million meg. Repeatability is better than 0.2%.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.
Price & Availability: Volume resistivity jig is $85 and Megatrometer is $865. fob Springfield.
Booth 2312.

NEW PRODUCTS AT WESCON

Transistor Heat Radiator 535

For printed-circuit mounting



The Model 3AL-685 radiator, designed to prevent thermal runaway, has an 8-32 tapped-stud hole for mounting all transistors having TO-31 and TO-26 packages. Radiators, designed for mounting on printed circuit boards, have two mounting pins 0.3 in. apart. They are 1/2 in. long with 1/2 in. in diameters. Units have 15 cooling fins for a total of about 4 sq in. of radiating surface.

The Birtcher Corp., Industrial Div., Dept. ED, 4371 Valley Blvd., Los Angeles 32, Calif.
Booth 565.

Geared Servo Motor 499

Size 8 unit

Model M-327-001 geared, servo motor is a size 8 unit. Centered-shaft gearheads are available in 28 ratios ranging from 7.62:1 to 1254:1; eccentric-shaft gearheads are provided in ratios ranging from 7.62:1 to 903:1. It operates in ambient temperatures of —54 to +105 C. Minimum stall torque is from 1.8 to 20 oz-in. Inertia reference is 0.005 g-cm². No load speed is from 4.7 to 773 rpm, min. The unit weighs about 3 oz.

Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.
Booth 626-627.

Tape Programer 534

For aircraft and missile applications

The Type TP-813 tape programer is designed to withstand severe operating conditions encountered in missile, aircraft and ordnance equip-

ment. It is mechanically and electrically interchangeable with similar units. It has a capacity of 75 ft of 35 mm Mylar tape for a 20 min program at 0.748 in. per sec. Contacts are rated at 0.4 amp. The instrument provides 13 independent timing channels. Programs can be changed quickly. Accuracies are on the order of 1 ppm.

Electronic Engineering Co., Anaheim Electronics Div., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price: *$990 fob Santa Ana for one to three units.*
Booth 2527-2528.

High Speed Ferrite Switch 493

Switching time is less than 0.2 μsec

This high-speed ferrite switch is capable of on-off or spdt switching in less than 0.2 μsec. Utilizing Faraday rotation, the switch operates over a 10% bandwidth at X-band without programing the drive current. Characteristics include under 0.7 db "on" insertion loss, 30 db "off" insertion loss or cross channel separation, and power capability of 200 w avg. Typical applications include pulse modulation of cw sources, tr tube replacement in high repetition rate radar systems, and diplexing of two sources into a common waveguide.

Hughes Aircraft Co., Components Div., Dept. ED, Bldg. 20, Florence Ave. and Teale St., Culver City, Calif.
Booth 846-847.

Electron Tube 495

Tunable oscillator triode

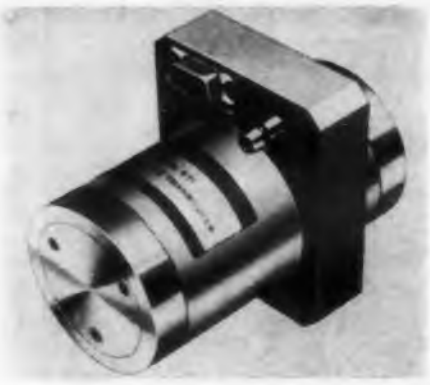
Type 7533 electron tube is a tunable oscillator triode of pencil-tube design. It operates at altitudes of nearly 19 miles without pressurization, and at temperatures ranging from +67 to —67 F. The unit measures about 2.5 in. long and weighs 4/5 oz. Two screws projecting from the side are used to tune the triode to any frequency between 1660 and 1700 mc. The tube is for use in battery-operated radio transmitters of weather balloons.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.
Booth 1054-1055.

NEW PRODUCTS AT WESCON

Altitude Control Transducer 543

Intended for expendable applications



The Model 571 altitude control transducer is economically designed for use in expendable target drones or tactical missile and aircraft applications. The unit employs a trapped-air-pressure design to provide an accurate altitude error signal. It operates to 80,000 ft with a dynamic error band of ±2%. Functional range is ±0.5 psi. The unit has a 2-1/4 in. diam and is 4-1/4 in. long.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.
Booth 2250-2251.

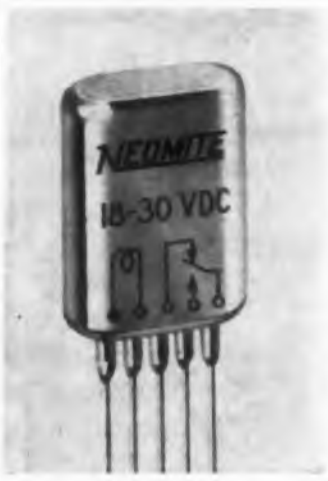
Microwave Diode 497

For K-band applications

Type 1N26C K-band mixer microwave diode meets all military environmental tests. The overall noise figure is 9.5 db max. The unit has a maximum vswr of 1.5, a maximum conversion loss of 7.5 db, and a maximum noise ratio of 1.5.

Sylvania Electric Products Inc., Semiconductor Products Div., Dept. ED, Woburn, Mass.
Booth 2058-2059.

Miniature Relays 530



Encased in transistor can

Series NM Neomite relays are packaged in a transistor can measuring 0.53 x 0.392 x 0.196 in. The units have coil resistances from 50 to 2,000 ohms, and require voltages from 4 to 30 v at 7

4 ma. Contacts are rated at 0.25 amp at 28 dc Form C relays have spdt contacts. Units are ermetically sealed and weigh 0.09 oz.

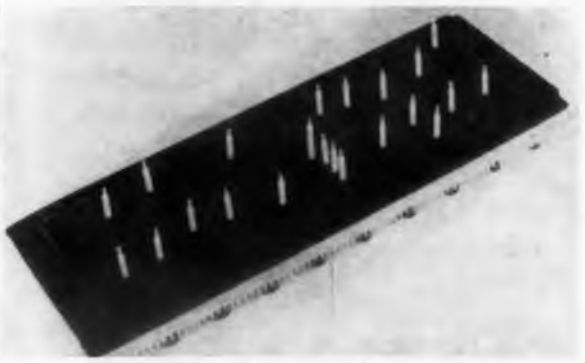
Elgin National Watch Co., Electronics Div., ept. ED, 2435 N. Naomi St., Burbank, Calif.

rice & Availability: Relays are available as distributor stock items at $24.00 each.

ooth **701.**

Computer Programing Pinboards 492

Uses diode pins to form matrix



These programing pinboards consists of two ontact strips, one vertical and the other horizonal, drilled and aligned to accept diode pins. emplates placed over the pinboard can indicate roper pin placement, or multiple plug-in conectors can be wired to permit rapid interchange f pre-programed assemblies.

Beckman Instruments, Inc., Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

Booth **2514-2515.**

Trimmer Potentiometers 490

Dual units are internally ganged

The Series 309 Squaretrim potentiometer line rovides two independent elements internally anged into one 3/4-in. sq package allowing simultaneous adjustment of two circuits. The units re available in standard resistances from 50 hms to 50 K. Humidity-proof versions are available in either the standard screw or Allen-head djustment screw styles.

Daystrom, Inc., Pacific Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Booth **1039-1040.**

NEW PRODUCTS

Microvoltmeter 633

Sensitivity is 1 mv

Model MV-28A high-frequency, linear-scale microvoltmeter has a sensitivity of 1 mv full scale and a minimum voltage reading ability of 300 μv. Accuracy is 5% from dc to 200 mc and 10% from 30 kc to 700 mc. The unit uses a chopper dc polarized amplifier. The carrier-amplifier has eight stages.

Millivac Instruments, Div. of Cohu Electronics, Inc., Dept. ED, Box 997, Schenectady, N.Y.

Price & Availability: *$495 ea; from stock.*

DC Power Supply 669

For transistorized devices

Designed to furnish power for transistorized electronic devices, model 1804-0900 power supply operates from an input of 115 v ac ±10%, 400 cps, single-phase and furnishes an output of 28 v dc at 1.5 amp max. Temperature range of the unit is —55 to +71 C. It weighs about 1.5 lb and measures 3-5/16 x 3-7/8 x 4-1/4 in. Five similar units are also available; four provide 28 v and one, having a regulation of 0.02% provides 9.2 ±4 v.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N.Y.

DC Power Supply 737

Outputs are 400 and 285 v

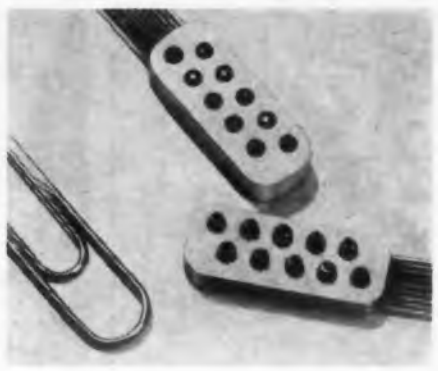
Model V-400 power supply fits into a rack space 5.25 in. high. Made up of models V-401 and V-402, shown, the unit provides outputs of

400 v at 3 amp and 285 v at 3 amp. Model V-401 is a silicon master power supply; model V-402 is a regulator that holds the voltage and current outputs to precise values. No vacuum tubes are used.

Foto-Video Electronics, Inc., Dept. ED, 36 Commerce Road, Cedar Grove, N.J.

Connector 554

Miniature



Type 138 miniature connectors are molded of high-temperature setting-epoxy, polyurethanes, silicone rubbers, and other materials. They are for use with the firm's stranded wire harnesses. All materials used have good dielectric characteristics and withstand a wide range of environmental extremes. A number of sizes are offered, with and without self-locking design.

Cicoil Corp., Dept. ED, 13833 Saticoy St., Van Nuys, Calif.

Availability: *Delivery time is 30 days.*

Power Supply 620

Regulation is 0.25%

This dc-dc power supply has a regulation of 0.25% for combined line, load, and temperature changes. Output is 5 v dc, adjustable to ±5%. Current output is rated at 100 mc; the unit can maintain regulation at up to 200 ma. Maximum ripple is less than 0.1% rms and temperature range is −55 to +100 C. The input is 28 v dc.

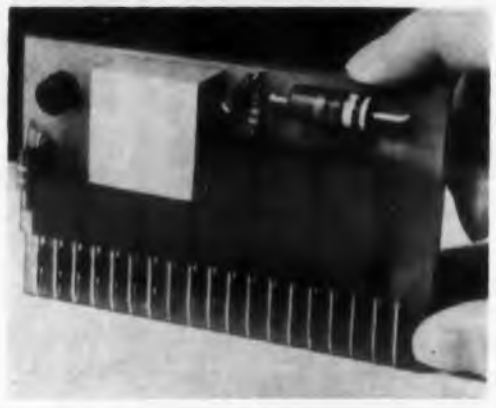
Networks Electronic Corp., Dept. ED, 14806 Oxnard, Van Nuys, Calif.

Price & Availability: *$640 ea; 25-day delivery.*

NEW PRODUCTS

Magnetic Shift Registers 506

Use one core per bit



These magnetic shift registers, offered in 5-, 9-, and 10-bit modules, use only one core per bit. Each module contains its own shift drive, wide-width gate, and hold-gate circuitry. Model 9TDWW150/U, shown, is a 9-bit unit with a maximum frequency of 150 kc and an input-output pulse of 6 v. Typical applications are in short term storage.

Magnetics Research Co., Dept. ED, 255 Grove St., White Plains, N.Y.

Silicon Transistor 673

Current gain is 4 at 6 mc

Model 2N1660 silicon transistor has a current gain of a minimum of 4 at 6 mc and of 45 at 1 amp dc. Power output is 85 w and operating temperature range is —65 to +200 C. Applications for this npn, diffused silicon power unit include power oscillators, power amplifiers, regulated power supplies and computer core drivers.

Raytheon Co., Dept. ED, Waltham 54, Mass.

Availability: From stock for immediate delivery.

Magnetic Tape Transport 647

Stores 324,000 bits

Model 2966 magnetic tape incremental transport can store up to 324,000 bits of information on a continuous belt of 60-in. tape. The unit is designed for a 4-in. tape providing 54 recording

tracks. The tape can be used in increments of 0.01 in. on signal command or at a steady speed of 10 in. per sec. The unit is adaptable as a component in magnetic tape recording and programming for manufacturing control applications.

Designers for Industry, Dept. ED, 4241 Fulton Parkway, Cleveland 9, Ohio.

Availability: 30-day delivery.

Mercury Switch 555

Has 0.5-in. length, 0.162-in. diameter

Type HG22010 mercury switch measures 0.5 in. in length and 0.162 in. in diameter. Its rating is 0.1 amp. Initially developed as a reversing switch for a portable electric device motor clutch, the unit is suited for use as a miniature on-off switch, and other applications requiring slight force or having a low load or light weight. Switching action is spst; differential angle is 15 deg. The ac load or the dc load at 115 and 230 v is 0.1 amp.

Gordos Corp., Dept. ED, 250 Glenwood Ave., Bloomfield, N.J.

Magnetic Storage Device 643

Stores 100,000 bits

Type BD-100 rotating magnetic disc storage device has a 7.5-in. disc diameter, stores 100,000 bits of information on 32 tracks, and operates over the temperature range of 30 to 150 F. The disc is made of magnetic mylar material. The device requires no warm-up and stands severe shock and vibration. It can be used horizontally or vertically.

Laboratory for Electronics, Inc., Dept. ED, 1079 Commonwealth Ave., Boston 15, Mass.

Price & Availability: $2800 and up; 90-day delivery.

NEW PRODUCTS

X-Band Pulse Power Calibrator 646

For use from 8500 to 9600 mc

Model PCX-9 X-band pulse power calibrator covers the range of 8500 to 9600 mc. It measures the power of pulsed rf signals above the level of 0.5 mw within an accuracy of ±0.5 db. A reference level is established each time the equipment is used. Some applications of the unit are: calibration of signal generators; measurement of radar power output, cable attenuation, and directional couplers and attenuators.

General Communication Co., Dept. ED, 667 Beacon St., Boston 15, Mass.

Availability: *The product can be delivered in six to eight months.*

Mica Capacitors 670

For operation at 125 C

Type 210M series of stacked-foil Fabmika capacitors has an epoxy casting process to provide resistance to humidity, moisture, shock and vibration. Standard units range from 300 to 6000 v in capacitance ratings of 0.01 to 1 μf. They can be used at temperatures up to 125 C in airborne electronic equipment, pulse-forming networks, corrosive atmospheres, and in high-voltage applications in high-powered transmitters and similar devices.

Sprague Electric Co., Dept. ED, North Adams, Mass.

Power Supplies 616

Are convection-cooled

The LA series power supplies, having outputs of 5 and 10 amp at 0 to 34 v dc, are convection-

cooled and use solid-state components throughout. Line and load regulation is better than 0.15% or 20 mv for input variations of 100 to 130 v ac and from no load to full load. All models provide for remote sensing. The 5-amp model weighs 55 lb and measures 3-1/2 x 14-3/8 in. and the 10-amp model weighs 100 lb and is 7 in. high.

Lambda Electronics Corp., Dept. ED, 11-11 131st St., College Point, N.Y.

Price: *The 5-amp unit is priced at $395 without meters and $425 with. The 10-amp unit is priced at $510 without meters and $540 with.*

Vaneaxial Air-Mover 739

Will not stall

The non-stall blade of this air-mover, Model BC 1607V-1, eliminates the dip in the pressure-flow curve. The unit has a 3-in. over-all diameter and is 2-5/16 in. long. It weighs 15 oz and is designed for 115 v, 400 cps, although units with other power requirements are available. The air-mover, suitable for cooling compact components in missiles, submarines and aircraft, meets MIL specs for environment and performance.

IMC Magnetics Corp., Dept. ED, 570 Main St., Westbury, N.Y.

Availability: *Units can be delivered in eight weeks.*

Lamp for Readout Devices 694

Operates at 4 v, 1.8 amp

Operating at 4 v at 1.8 amp and rated at 2200 K, this lamp is designed to scan punch cards and tapes. It was engineered for use with an input device for instantaneous computation of aircraft position for an air-traffic control system. The spring-tensioned, straight-wire filament offers the single, straight, light source. The filament can be made to withstand repeated 30-g shocks at a 90-deg angle. The lamp can be equipped with a non-reflective, black shield or background.

Chicago Miniature Lamp Works, Dept. ED, 1500 N. Ogden Ave., Chicago 10, Ill.

Price & Availability: *Price is $12 ea; delivery time is 10 days.*

NEW PRODUCTS

Data-Amplifier Converter 638

Gain stability is ±1%

This data-amplifier converter has a high input impedance for use in airborne instrumentation applications requiring the amplification and conversion of millivolt-level ac data signals. Gain stability is ±1% over the temperature range of −55 to +100 C. Silicon transistors are used. Applications are in strain-gage data systems, servo-amplifier systems, and synchro position transmitter systems.

The Mira Corp., Dept. ED, 2656 N. Pasadena Ave., Los Angeles 31, Calif.

Price & Availability: *$766.92 ea; 30-day delivery.*

Sine Wave Oscillator 731

Distortion is less than 0.1%

Model 401-B oscillator, a source of audio and ultrasonic sine waves, operates with a distortion of less than 0.1% at full output of 20 v, open-circuit. Frequency range is 9 cps to 120 kc, covered in four decade bands. Accuracy is ±2%. Output amplitude is controlled by a five-position decade attenuator plus a continuous control; any voltage above 100 mv can be selected. Output amplitude is independent of frequency within ±0.5 db. The unit measures 8 x 6 x 10.5 in. and weighs 12 lb.

Waveforms, Inc., Dept. ED, 33 Sixth Ave., New York 14, N.Y.

Price: *$160.*

Microwave Switch Attenuator 738

For high power levels

This attenuator is designed to be switched on and off without turning off the transmitter. It can attenuate fixed values from tenths of a decibel to over 20 db. With switch de-activated, power loss is less than 0.6 db. This pressurizable unit is available for most frequency ranges and waveguide sizes.

Bogart Manufacturing Corp., Dept. ED, 315 Seigel St., Brooklyn 6. N.Y.

Availability: *Unit can be delivered within 90 days.*

Diodes 734

Stand 40 kv piv

Series XD-2 diodes include 7131/XD-2 air-cooled type and 7132/XD-2 water-cooled type for rectifier, charging, and shunt-diode service. As rectifiers, they stand a piv of 40 kv at an average anode current of 3 amp. As clippers, they are capable of peak anode currents of 150 amp. These external anode tubes have a thoriated, tungsten filament and have rated dissipation capabilities of 3 and 5 kw for air and water-cooled types, respectively. Uses include high-voltage power supplies.

Central Electronic Manufacturers, 2 Richwood Place, Denville, N.J.

Price & Availability: *Delivery is from stock. Price is $230 per unit, $172.50 when bought in quantity.*

NEW PRODUCTS AT WESCON

General Purpose Oscilloscope 422

Rated at 15 mc

Model 160B oscilloscope is a 15-mc general purpose unit built to Mil standards. The device has 24 calibrated sweep rates from 0.1 μsec to 5 sec per cm. It will accept the Model 166C display scanner, a plug-in unit which provides a permanent recording of a crt trace. With the Model 162A dual-trace amplifier plug-in, maximum sensitivity is 20 mv per cm. The amplifier features differential input and 1-mc electronic chopping.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.
Booth 651-652-653-654.

Power Resistors 415

Rated 2.5 to 210 w

These wirewound resistors are rated from 2.5 to 210 w in a wide range of resistance values. They meet MIL-R-26C specifications in G, V or Y characteristics. Stack mounting, tab terminal and axial lead types are available. The resistors are of vitreous enamel construction.

Ward Leonard Electric Co., Dept. ED, Mt. Vernon, N. Y.
Availability: *Resistors are available from stock.*
Booth 813.

Soldering Tip 430

Will not stick in iron

The Durotherm soldering tip is guaranteed not to stick in any of the manufacturer's soldering irons. Solder will not drip from the tip onto components or work, nor will it creep into the iron to cause damage.

Hexacon Electric Co., Dept. ED, 161 W. Clay Ave., Roselle Park, N.J.
Availability: *Tips are available from stock.*
Booth 118.

Miniature Fastener 414

Quarter-turn and pawl types

The receptacle for this miniature quarter-turn fastener measures 0.812 x 0.375 in. and is 0.012 in. thick. It is applicable where space-weight reductions are important. Another quarter-turn fastener is shock and vibration resistant. Its mounting assembly is an aluminum plate to which is bonded a 1/2-in. thick neoprene rubber boss. The No. 48 adjustable pawl fastener requires a 9/16-in. diam. hole to mount the shaft, plus a 0.082-in. hole to receive a stop pin. The pawl position can be adjusted to accommodate frame thickness variations of 1/4 in.

Southco Div., South Chester Corp., Dept. ED, Lester, Pa.
Booth 326.

Precision Gears 423

28 different varieties

These Precision 2- and 3-spur gears are available in stainless steel, passivated, and aluminum, anodized. Precision 3 gears come in the following pitches: 48, 64, 72, 96, 120, and 200, all in 20-deg pressure angles. There are over 28 different varieties of Precision 2 and 3 gears.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L.I., N.Y.
Price & Availability: *Available from stock.*
Booth 311.

Environmental Test Chamber 425

For temperature coefficient calibration

This temperature coefficient calibration chamber is designed to test and calibrate thermistors and capacitors. The instrument is stable within ±0.005 C, and can be adapted for stabilities of ±0.001 C. Temperature range is from —75 to +250 C. Instruments for recording chamber operations are available.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.
Booth 1027.

◀ CIRCLE 213 ON READER-SERVICE CARD

NEW PRODUCTS

Oscilloscope 724

Sensitivity is 50 mv per cm per channel

Type 516 dual-trace oscilloscope for the dc to 15 mc range. Basic sensitivity is 50 mv per cm for each channel with four operating modes possible. Sweep range is adjustable from 0.04 μsec to over 6 sec per division. Viewing area is 6 x 10 cm. The instrument is suited for bench work. Its dimensions are 13-1/2 x 9-3/4 x 21-1/2 in.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Price & Availability: *$1,000; immediately available.*

Warning System 723

For airborne or ground support equipment

This multi-channel, illuminated annunciator warning system is designed for airborne and ground-support equipment. It consists of a bank of light boxes, each containing two separately energized nomenclature strips to indicate the emergency status of any piece of equipment. Each strip is lighted by two lamps. The unit measures 3.5 x 2.35 x 3.6 in. and weighs 1.5 lb.

Radar Relay, Inc., Dept. ED, 2322 Michigan Ave., Santa Monica, Calif.

Wheatstone Bridge 668

Stands environmental extremes

Series 301 Wheatstone Bridge is designed for outdoor use in environmental extremes. Housed in a waterproof aluminum case with a removable cover and carrying strap, the instrument measures about 6 x 7 x 9 in. and weighs less than 9 lb, including batteries. It performs every routine bridge and loop test, including Wheatstone re-

sistance tests, capacitance tests, and Varley, Murray, Hillearn, and Fither loop tests. Accuracy is of ±0.1% ±0.01 ohms.

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

Cathode-Ray Tube 626

Has 5.25-in. diam

Model K1931 5.25-in. cathode-ray tube is for high-frequency operation for general purpose oscilloscopes and other instruments. The tube has linear post-acceleration for use in low-frequency instruments. It operates at screen voltages of 5,000 v with deflection factors of 25 to 35 v per in. for both sets of deflection plates.

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

Price & Availability: *$50 ea with P1 or P2 phosphors and $56.50 with P7 or P11 phosphors. Delivery is in eight weeks for sample quantities.*

Direct-Reading Attenuators 622

Cover 3.95 to 40 kmc

Type 101 broadband, direct-reading attenuators come in nine models covering the frequency range of 3.95 to 40 kmc. Attenuation range is 60 db and maximum vswr is 1.15. The units are rotary-vane type. The value of attenuation is determined by the angular position of a resistive film with respect to the wavegiude.

PRD Electronics, Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N.Y.

Price & Availability: *The units will be available toward the end of 1960 at prices ranging from $265 to $490 ea.*

NEW PRODUCTS

Oscillograph 725

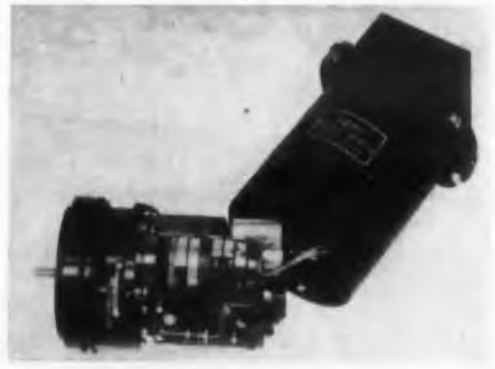
Frequency response is to 125 cps

Model 297 two-channel, direct-writing oscillograph recorder is designed for applications in large instrumentation set-ups for monitoring and as a bench-top instrument for field work. Performance features include: frequency response to 125 cps, within 3 db at 10 mm peak-to-peak amplitude; gain stability of better than 1% in spite of 20 C and 20-v power line variations; and maximum non-linearity of 0.2 mm. Chart speeds are 1, 5, 20, and 100 mm per sec. Over-all dimensions of the unit are 10.5 x 16 x 19 in.

The Sanborn Co., Dept. ED, Industrial Div., 175 Wyman St., Waltham 54, Mass.

Servo Repeater 732

Measures 2-5/16 in. in diameter



This 26-v, synchro, servo repeater measures 2-5/16 in. in diameter and 4-7/8 in. in length. The entire assembly includes gear train, motor-tach, control transformer, transistorized amplifier, and power supply. Backlash is zero between the synchro control transformer and output shaft. Static accuracy is 0.25 deg max at a 7-min synchro input, constant velocity is 500 deg per sec per deg, and slew velocity is 30 rpm. Input requirements are 115 v at 400 cps, 7 va. A size 8 synchro transmitter is required. The repeater meets MIL-E-5272B.

Orbit Instrument Corp., Dept. ED, 131 Eileen Way, Syosset, L.I., N.Y.

***Availability:** Units are made on order and can be delivered in 60 days.*

Counter-Timer 726

Interval is 10^{-6} to 10 sec

Model 361-R counter timer has a time interval of 10^{-6} to 10 sec; it operates over a period of 10^{-6} to 10^{7} sec. It totals random events over any of eight time intervals from 10^{-6} to 10 sec. Frequency is 0 to 10^{6} pps or 1 to 10^{6} pps. The crystal-controlled clock has an absolute stability of ± 0.3 ppm per week. The count-down chain provides 1-mc crystal frequency sine waves and square waves of 100 kc, 10 kc, 1 kc, 100 cps, 10 cps, 1 cps, and 0.1 cps.

Transistor Specialties, Inc., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.

Silicon Power Transistors 672

Four types offered

Types 2N389 and 2N424 silicon power transistors require only 1.5 v to drive a 1.5-amp collector-current level. They have a higher frequency response than comparable units. Type 2N1470 has a low collector leakage current, low saturation voltage and an alpha cut-off of 1 mc. Type 2N1657 is identical to the 2N1470 but is in the square-power transistor shell.

Raytheon Co., Dept. ED, Waltham 54, Mass.
Availability: From stock for immediate delivery.

Power Supplies 728

Are 1.25 to 1.5 in. wide

These transistor-regulated power supplies are 1.25 to 1.5 in. wide, depending on power output. Depth and length are both 4 in. Designated the 7400 series, the units are rated at 5 to 60 v dc at 200 ma. No load to full load regulation is 0.05% and line change regulation is $\pm 10\%$. Ripple is less than 2 mv.

Systems Research Corp., Dept. ED, Box 251, Northridge, Calif.

DESIGN DECISIONS

Featuring the clever and unusual in packaging, appearance design, and circuitry in electronic equipment.

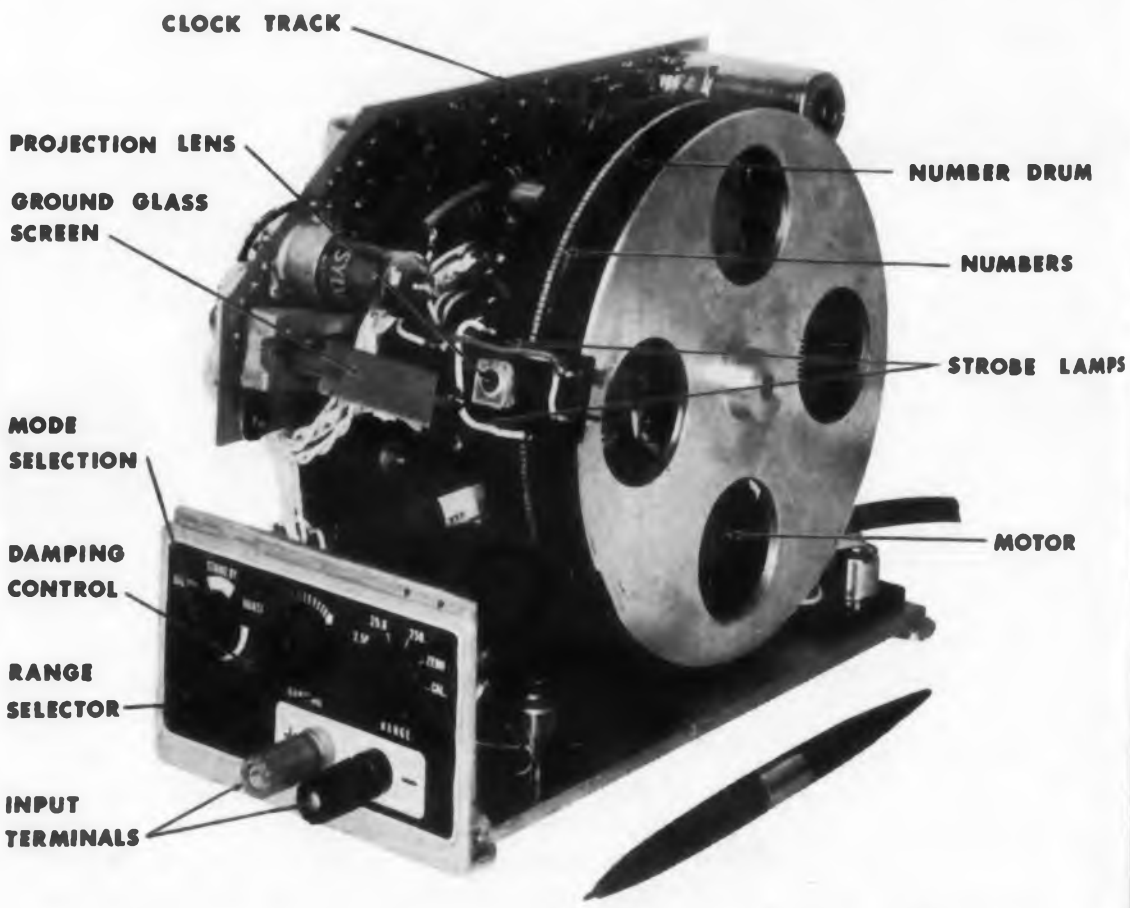
Strobed, Rotating Number Drum Cuts Cost of Digital Voltmeter

A STROBOSCOPIC readout is the key to the low price ($295) of Electro-Logic Corp.'s model V-1 digital voltmeter. The DVM uses a rotating potentiometer (on the same shaft with a number drum) to generate a sawtooth sweep.

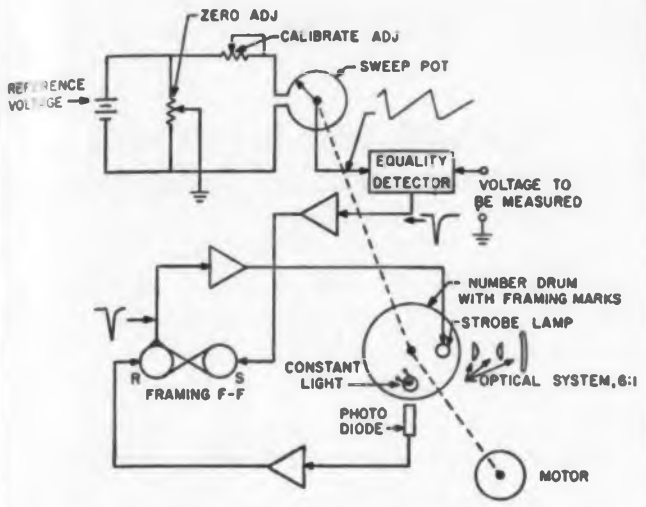
With the usual ramp voltage technique, George Giel, vice president of Electro-Logic points out, there are two time sources—clock and sweep . . . and feedback is necessary to tie them together. But with the drum and potentiometer on the same shaft, and both keyed to the strobe lamp, the drum speed (a nominal 1500 rpm) need not be closely regulated, so an 85-cent motor can be used.

On the surface of the drum, there are small rectangular holes corresponding to each of 250 numbers. A light inside the drum shines through these holes, enabling a photodiode to send a series of clock pulses to a flip-flop.

The pulses have no effect on the flip-flop until the nearest hole following equality of sawtooth voltage and unknown is illuminated. Then the flip-flop



Strobe lamps illuminate voltage reading on rotating drum in low-cost digital voltmeter.



When input and sweep voltages are equal, photodiode triggers flip-flop which flashes strobe lamps which illuminate voltage reading which is optically enlarged.

is reset. The amplified reset pulse fires the strobe lamps which illuminate a number on the drum surface. The number is optically enlarged and projected on a ground-glass screen.

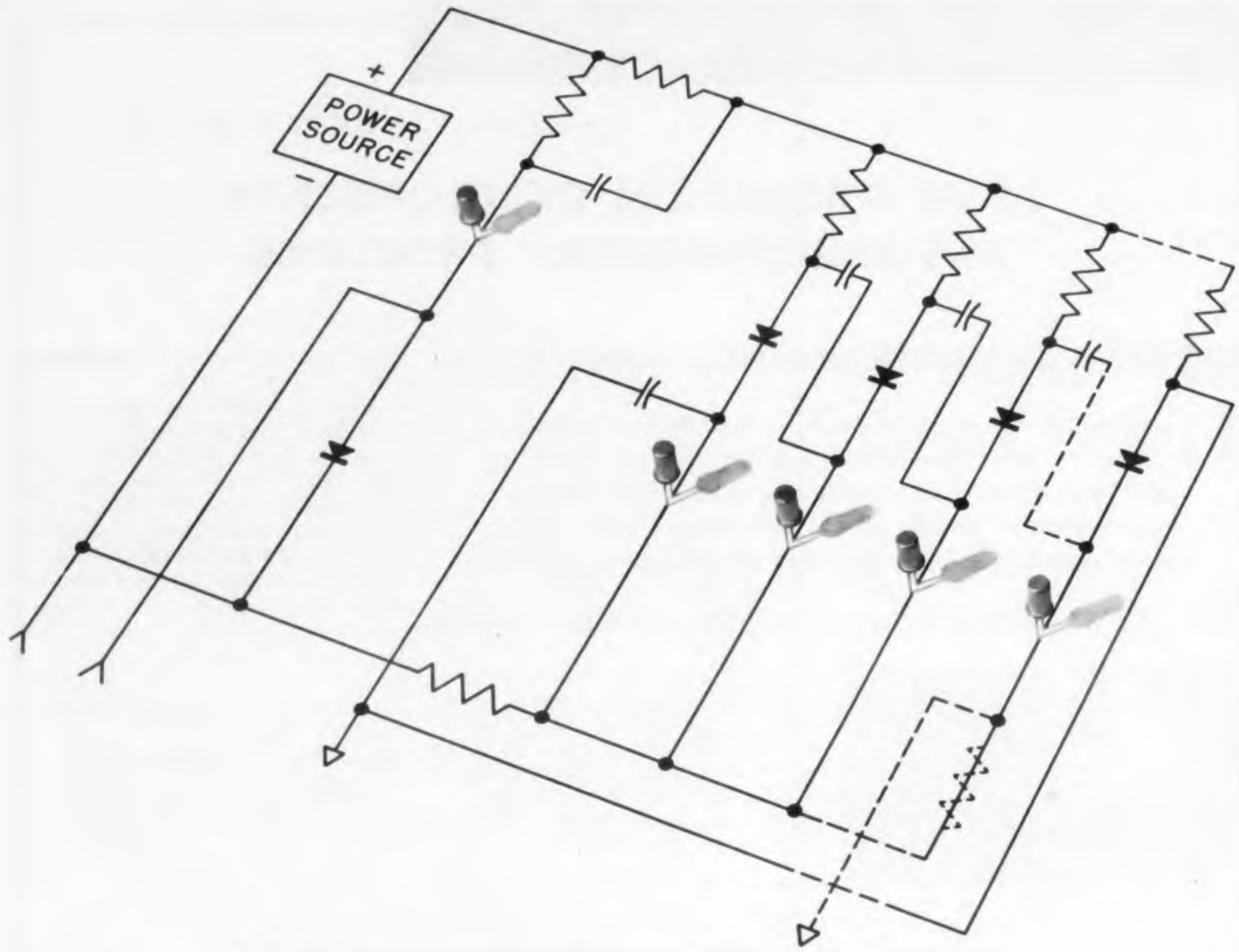
To change from digital to "quasi-digital" presentation, where numbers roll smoothly across the screen, an operator can disconnect the flip-flop with a front-panel control. The strobe lamps then flash as soon as the sweep equals the unknown. This permits interpolation between numbers and lets the operator observe a voltage trend. "It's equivalent," notes Electro-Logic's president, Vincent Van Praag, "to a 70-in. analog scale."

There are only 11 transistors in the 0.5-per-cent accurate DVM, all of them of commerical quality. Transistorized pulse circuitry uses heavy feedback to maintain proper stability. The only close tolerances required are in the concentricity and positioning of the bore for the potentiometer shaft.

The sweep potentiometers are conductive-plastic units, manufactured by Markite Products Corp. in New York City and New England Instrument Co. in Woonsocket, R.I. Life tests of 250 million revolutions confirm the manufacturers' life specifications.

Covered by a patent, the circuit principle in the stroboscopic DVM is applicable to many other devices. Some of these are in the works. ELECTRONIC DESIGN will report on them when they are available to the market.

Availability of this DVM as well as its technical specifications have already been disclosed in the March 30th issue of ELECTRONIC DESIGN.



*SHOCKLEY 4-LAYER DIODES *used in typical multiple-stage ring counter circuit.*

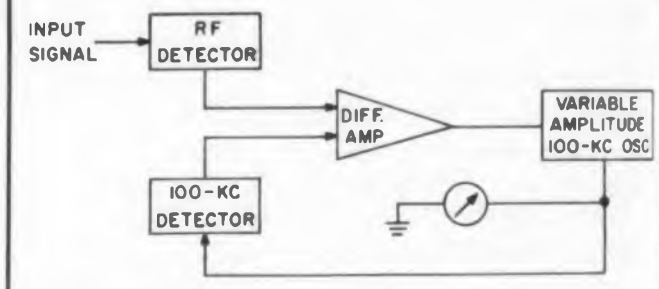
DESIGN DECISIONS

Feedback-Stabilized Probe Uses Replaceable Diode Cartridge

A pair of balanced diodes in a replaceable cartridge provides rf probes with an unusual degree of temperature independence. The diode cartridge fits into any of a number of rf probes for Hewlett-Packard's model 411A RF millivoltmeter.

Probes include a pen type, useful from 5 kc to 50 mc; a vhf type, useful from 500 kc to 250 mc; a type N "Tee" for 10 kc to 1 kmc; a BNC and a TNC, both useful from 500 kc to 1 kmc; a type N 50-ohm termination for 10 kc to 1 kmc; and a 100:1 capacity divider probe for 10 kc to 1 kmc.

The cartridge uses feedback stabilization to help provide a linear scale readout. One of the diodes in the cartridge rectifies the incoming rf. The other diode rectifies the output of a variable-amplitude, 100-kc oscillator. The output of each diode goes to a differential dc chopper amplifier which amplifies the difference between their dc

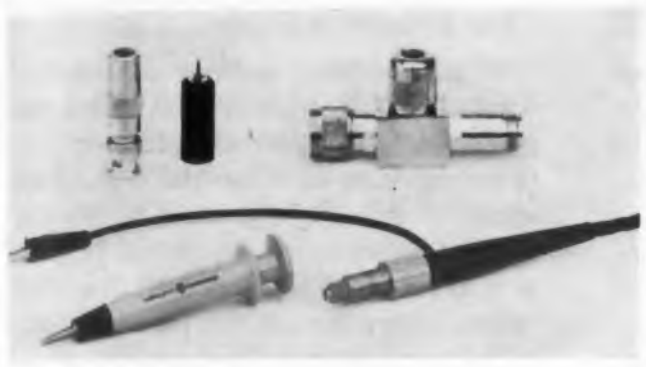


Linear readout results from nonlinear detection of incoming rf and 100-kc signal.

Easily replaced diode cartridge obviates time-consuming selection of matching diodes.

levels and controls the amplitude of the 100-kc oscillator. The meter on the 411A measures the amplitude of the 100-kc signal.

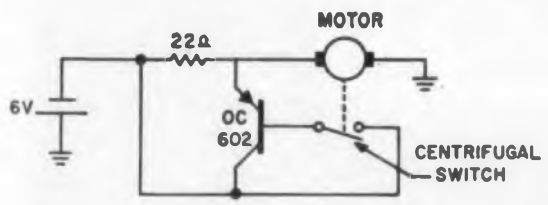
Since the oscillator's feedback through the 100-kc detector is nonlinear, just as is the output of the rf detector, the scale readout is linear. Since both diodes in the probe are at the same temperature, the instrument is unusually free from the effects of varying temperature.



Part of the selection of probes for the 411A RF millivoltmeter.

Centrifugally Switched Transistor Controls Motor Speed

A power transistor helps maintain constant motor speed in the Niki tape recorder made by the German firm Grundig. In this battery-operated recorder, a 6-v battery powers the motor through a 22-ohm dropping resistor.



Transistor, controlled by centrifugal switch on tape-recorder motor, helps maintain constant motor speed.

The collector-to-emitter resistance of an OC602 power transistor shunts the 22-ohm resistor. The base of the transistor is shorted to the collector by a centrifugal switch on the motor.

The centrifugal switch is not used to short the 22-ohm resistor directly because the high currents through the switch would reduce its life substantially.

Ir. A. V. J. Martin, Paris, France.

NEW LITERATURE

Tapes and Adhesives 261

This manual provides comprehensive information on the physical characteristics and typical applications of a full line of industrial tapes, bulk adhesives, coatings, and other pressure-sensitive products. Products are cross-indexed by Armed Forces specification data, tape type, tape function and industrial application. Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39, Ill.

Reference Folder 262

Prepared to be used either as a wall chart or as a desktop reference, this folder contains three tables of information: a temperature table showing conversion from Centigrade to Fahrenheit, or vice versa, from 0 to 3000 deg; a table of decimal equivalents of fractions in increments of 1/64 in., and a table giving the mechanical and electrical properties of high alumina and steatite ceramics. Centralab, Electronics Div. of Glove-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Parts Catalog

This 1960 edition of the Green Sheet contains a listing of various electronic equipment available from the company. Among the items listed are transmitting, receiving and special purpose tubes, X-band microwave equipment, test equipment, motors and rheostats, and transformers. *Send $0.25 to Barry Electronics Corp., Dept. ED, 512 Broadway, New York 12, N.Y.*

Filter Reference Guide

Printed in three sections of loose-leaf sheets, this reference guide covers the performance characteristics of filters, magnetic amplifiers and toroidal coils. Each group of sheets is organized by type of product. Separate data sheets are jacketed in a cover, which doubles as its own filing jacket, with a die-cut tab providing easy visibility when in a filing cabinet. *Write on company letterhead to Components Corp., Dept. ED, 2857 N. Halsted St., Chicago 14, Ill.*

Plastic Products Catalog 263

Plastic products of Teflon, Raylon and Kel-F are described in this 36-page catalog. It contains mechanical and electrical properties plus performance curves. Illustrated are basic shapes, custom-machined parts, thin wall tubing, O and back-up rings, bearings and coatings. Raybestos-Manhattan, Inc., Plastic Products Div., Manheim, Pa.

Refrigeration Systems 264

A variety of miniature refrigeration systems for cooling electronic devices to temperatures ranging from 3.5 K to 200 K is described in this illustrated brochure, four pages. Included are data on closed and open systems for infrared detectors, masers, irasers, parametric amplifiers, and other cryogenic applications. Air Products, Inc., Allentown, Pa.

Synchros 265

Catalog No. 4000, a 16-page, two color brochure, contains definitions of synchro parameters, dimensional drawings, circuit diagrams, and physical, electrical and mechanical characteristics of the company's basic line of size 8, 10, 11 and 15 synchros for military, industrial and scientific applications. John Oster Manufacturing Co., Avionic Div., 1 Main St., Racine, Wis.

Plastics Catalog 266

This 64-page catalog lists plastic products in sheet, tube, rod, film and roll form. The plastics covered are plexiglas, vinyl, acetate, phenolic, nylon, teflon, kel-f, polyethylene, polystyrene, rexolite, delrin, and fluorglas accessories. Commercial Plastics & Supply Corp., 630 Broadway, New York 12, N.Y.

Silicone Materials 267

This 12-page engineering guide contains technical data and processing information on silicones. It details the important electrical and mechanical properties of the silicones most useful in electronics. Also included are typical applications in various areas of use. Dow Corning Corp., Midland, Mich.

NEW LITERATURE

Knobs and Handles 268

Specifications, dimension drawings and illustrations of 49 stock designs of molded plastic knobs and handles appear in this eight-page catalog. Groups include ball knobs, oval and tapered knobs, tapered handles, push-pull and lid knobs, knurled and fluted handwheels and knobs, thumb screws and terminal nuts, pointer and instrument knobs, and others. Dimco-Gray Co., 207 E. Sixth St., Dayton 2, Ohio.

Digitalizing Radar Data 269

A description of a system for the digitalizing of radar position data is given in this technical paper on "Precision Data Recording System for Instrumentation Radars." Electronic Engineering Co., Sales Dept., 1601 E. Chestnut Ave., Santa Ana, Calif.

Ultrasonic Filter Cleaner 270

This 38-page technical report describes a hyperintense proximal scanning ultrasonic system which uses cavitation to clean filter elements and other equipment. Sections include data on components, operation, installation, input requirements and cleaning limitations. Aircraft Porous Media, Inc., 30 Sea Cliff Ave., Glen Cove, N.Y.

Amplifiers 271

Series USA-4 and K2 operational amplifiers are described in this short-form data sheet, one page. The data sheet contains brief technical data, photographs of the units and price information. George A. Philbrick Researches, Inc., 127 Clarendon St., Boston 16, Mass.

Crystals and Oscillators 272

This 20-page catalog includes specifications for crystals from 400 cycles to 140 mc. Oscillators from 60 cycles and up are shown in detail. Ovens with a stability of 0.003 C are also covered. Monitor Products Co., 815 Fremont, S. Pasadena, Calif.

Technical Data Catalog

This 1960 technical data catalog is a pocket size edition. It covers the following fields: Power Transmission Machinery; AC Motors and Generators; Electrical Transmissions; AC and DC Electricity; Transformers, Relays and Meters; 5 Place Trig and Log tables; Conversion Tables and others. *Send $1.25 to Lefax Publishers, Dept. ED, Philadelphia 7, Pa.*

Antenna Instruments 273

Listed in this 1960 short form catalog is information on various antennas and associated equipment, such as: antenna pattern recorders; antenna positioners; a Fourier computer; remote tuned signal sources; synchro transmitters; model range towers, and wide range receiving systems. Scientific-Atlanta, Inc., 2162 Piedmont Road, N.E., Atlanta 9, Ga.

Semiconductor Exchangers 274

Semiconductor heat exchangers, series 5000, for medium pressure forced air cooling systems using transistors, Zener diodes and rectifiers, are described in this four-page bulletin, No. 260. A complete description on the material, construction, finish, mounting, and ducting and baffling of the heat sinks is included. Line drawings, illustrations and characteristic curves also appear. Wakefield Engineering, Inc., 7 Broadway, Wakefield, Mass.

Printed Circuit Resistors 275

This one-page data sheet contains data on miniature and printed circuit encapsulated precision wire wound resistors. Specifications include temperature coefficient, wire terminals and tolerances. A table gives physical dimensions and ratings. Dmeter Manufacturing Co., Inc., 68 N. Broadway, Yonkers, N.Y.

Silicon Transistors 276

Bulletin 11-109, one page, offers technical data for types 2N389 and 2N424 high-power silicon transistors. Specifications and illustrations are included. Silicon Transistor Corp., Carle Place, Long Island, N. Y.

NEW LITERATURE

Relays 277

This 12-page booklet discusses the complete line of relays for various applications. Relays described include: general purpose, machine tool, mechanically held, pneumatic time-delay and synchronous motor-driven timing. The illustrated booklet, No. GEA-7021, contains wiring diagrams, dimension drawings and tables. General Electric Co., Schenectady 5, N.Y.

Vacuum Gages 278

Heated thermopile vacuum gages are described in this six-page booklet. The illustrated booklet covers pressure ranges for single meter types, twin meter types, battery-operated types, and controllers. Chart and scale ranges of two types of recorders are included. The booklet also describes various accessories. Hastings-Raydist, Inc., Hampton, Va.

Stunt Box Control Device 279

The Teletype 28 stunt box is described in this 20-page, four-color brochure. It is intended to provide users and potential users of Teletype model 28 equipment with data of how model 28 page printers and automatic send-receive sets can be used to maximum capabilities. The illustrated brochure describes functions and function mechanisms. Teletype Corp., Dept. SP-9, 4100 Fullerton Ave., Chicago 39, Ill.

Cold Cathode Tube Manual

The complete line of cold cathode counting tubes is described in this 36-page manual. Included in the manual are specifications, applications, and numerous circuit diagrams and design criteria on all counting tubes, trigger tubes, register and voltage reference tubes offered by the company. *Send $1 to Baird-Atomic, Inc., Dekatron Handbook Section, Dept. ED, 33 University Road, Cambridge, Mass.*

Precision Ball Bearings 280

Type HDR precision radial ball bearings are described in catalog No. 60, eight pages. Data covered include: tolerances, internal clearances, materials, shaft

and housing fits, lubrication, dynamic load ratings, dynamic thrust and combined load ratings and static load ratings. Ball bearings in four standard series of bearing envelopes are described. Split Ballbearing, Lebanon, N.H.

Capacitors 281

This two-color, four-page brochure is intended to aid in the selection of Vitramon capacitors. It contains illustrations and details of axial and axial-radial series and the ceramic microminiature capacitors. Their availability is listed by part number, capacity, dimensions, etc. Schweber Electronics, 60 Herricks Road, Mineola, Long Island, N.Y.

Printed Circuit Drafting Aids 282

Included in this six-page table are all of the pre-cut shapes and sizes of pressure sensitive drafting aids required to make paste-up printed circuit drawings. Illustrations are provided in chart form for cross reference between corresponding donut pad, teardrop pad and twin pad sizes. Actual size illustrations of the shapes and hole diameters for each are included. By-Buk Co., 4314 W. Pico Blvd., Los Angeles 19, Calif.

Miniature Lamps 283

This pocket-size booklet lists all of the known standard miniature lamps now available, almost 400 of them, and the sources of supply from which they may be obtained. Specifications are given as well as complete lamp nomenclature with drawings of various lamp styles and descriptions of lamp parts. Chicago Miniature Lamp Works, 1500 N. Ogden Ave., Chicago 10, Ill.

Printed Circuits 284

This four-page folder, No. 1159, discusses the use of printed circuits. The types of insulating materials and the current capacity in relation to width of copper conductive pattern are described. The booklet also lists the choice of metals available for the conductive pattern as well as the types of plating recommended to achieve results. Whitney Blake Co., Printed Circuit Div., New Haven, Conn.

IDEAS FOR DESIGN

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

Solid-State Relay Varies Operational Amplifier Gain

THE GAIN of an operational amplifier can be rapidly changed by electronically switching different resistors into the feedback loop. Switching is accomplished by using the high forward conductance and high reverse resistance characteristics of silicon diodes. Gain changes can be achieved with dissipations of less than 600-μw. This compares with the 200-mw a high sensitivity, electromechanical relay would require.

Fig. 1 shows an operational amplifier with negative feedback applied through R_{fb1}. The passive electronic relay is contained in the dotted rec-

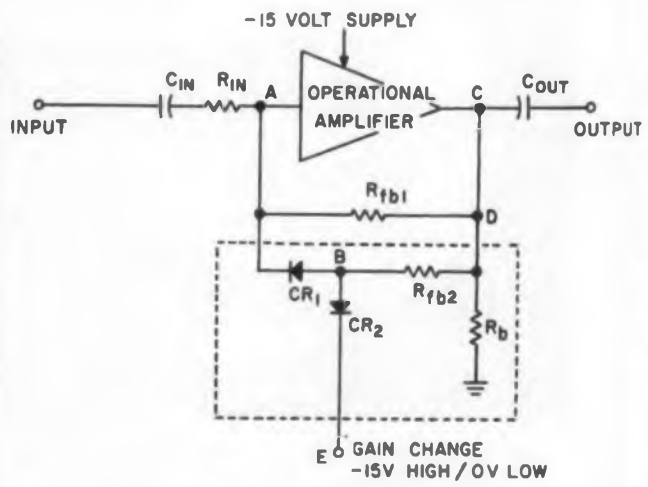


Fig. 1. Operational amplifier gain can be varied by using silicon diodes to switch paralleling feedback resistors in or out.

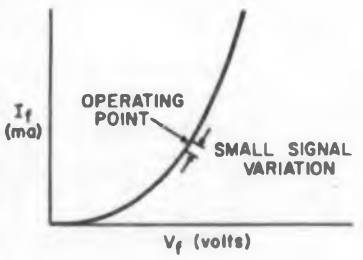


Fig. 2. Small signal operation of diodes keeps their forward resistance almost constant in the operating range.

tangle. The closed loop gain (CLG) of the circuit is given by:

$$CLG = \frac{R_{fb}}{R_{in}}$$

where R_{fb} is the effective value of the feedback resistances.

By varying the bias voltage applied at E, the silicon diodes will switch in, or switch out, resistors paralleling R_{fb1}. Thus, the overall amplifier gain can be changed in step with the voltage at E.

To understand the circuit operation, let us assume that the voltage at A is −6 v. For high stage gain point E is set at −12 v. These voltages forward bias CR_2 via R_{fb2} and R_{b1}, and reverse bias CR_1. Since the back resistance of these diodes is much greater than R_{fb1} and R_{fb2}, loop BD is effectively open. Gain of the operational amplifier is:

$$CLG = \frac{R_{fb1}}{R_{in}}$$

For low gain, point E is set at 0 v. This forward biases CR_1 via R_b and R_{fb2}, and reverse biases CR_2. The gain of the amplifier is now:

$$CLG = \frac{\dfrac{R_{fb1}\,(R_{fb2} + R_{cR_1})}{R_{fb1} + R_{fb2} + R_{cR_1}}}{R_{in}}$$

Where R_{cR1} is the diode forward resistance.

Gain-Change Transient Can Be Held Small

The speed of gain change is limited by (1) the diode frequency response and (2) the closed loop amplifier frequency response. With a fast switching diode, the amplifier will be the limiting factor on the speed. However, proper design can make the gain change transient extremely short.

Placing the diodes at the small-signal input of the amplifier minimizes the effect of their nonlinear resistance characteristics. This is illustrated by the silicon diode's forward characteristic shown in Fig. 2. Under small signal conditions the variation in slope around the operating point is negligible. This also allows greater freedom in the choice of biasing voltages at A and E. Experiment has shown that the −12 v at E could be as high as −8 v, and the 0 v state could be as low as −3 v with very slight difference in gain from the 12 v/0 v levels.

Note that resistor R_b is much smaller than R_{fb} or R_{fb2}. It only serves as a dc biasing path for the two diodes.

Possible application of the gain switching principle are numerous. Basically, it can be used to electronically change or modulate stage gain as a function of time or some other variable. A suitably programmed voltage can change the gain at speeds up to 5mc.

George Shaheen, Senior Development Engineer, Bendix-Pacific Div., Bendix Aviation Corp., North Hollywood, Calif.

IDEAS FOR DESIGN

Cut-Off Diode Triggers Fast Output Pulses

Computer control systems often require fast trigger pulses of fixed duration and amplitude generated at a time coincident with the leading or trailing edge of a control pulse. These pulses should not be too dependent on the input signal rise time and should load the input as little as possible.

A capacitor-resistor differentiator is often used for this purpose, but if the trigger duration is to be less than 0.1 μsec, the pulse source may be overloaded and the trigger output amplitude will depend on the rise time of the input pulse.

The circuit of Fig. 1 generates a negative trigger pulse when the input pulse goes negative. The duration of the trigger pulse is dependent upon the resistor input network and the delay and rise time of T_1. With the parameters shown, the output pulse duration is only 0.05 μsec.

The operation of this circuit is as follows: When the input to the trigger circuit is zero volt, trans-

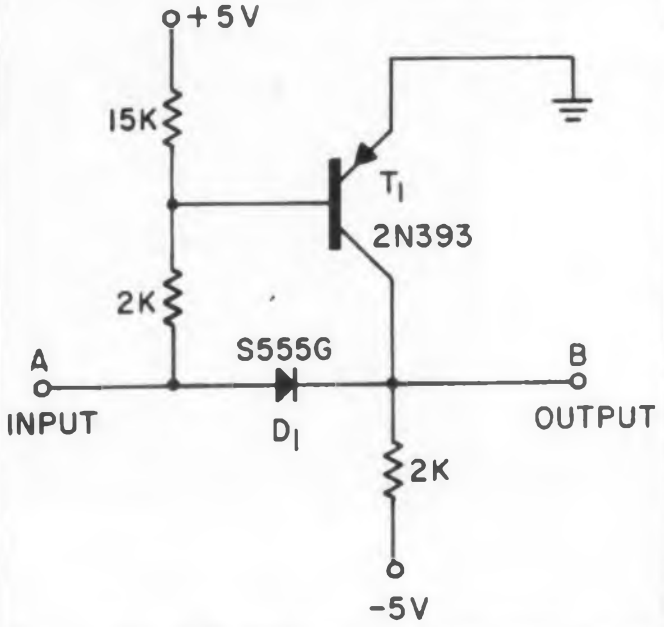


Fig. 1. Fast (0.05 μsec) pulses are generated in this transistor-trigger circuit by cutting off the diode with a negative input pulse.

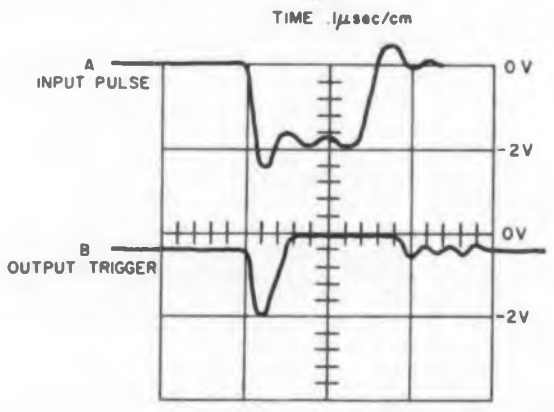


Fig. 2. Sketches taken from an oscilloscope show the 0.2-μsec input pulse (a) and the resultant 0.05-μsec output pulse (b).

sistor T_1 will be biased off, and diode D_1 will pull the output B up to −0.4 v which is the drop across the diode. When input A goes negative, the 2 K resistor tied to −5 v will pull point B negative several volts, since T_1 has previously been cut off. With A negative, transistor T_1 will soon start conducting and pull B up to −0.1 v, which is the drop across the conducting transistor.

Other transistors and diodes could be used, but the 2N393 micro alloy transistor and the S555G diode were used because of their speed and low voltage drops.

The characteristics of this circuit are shown in Fig. 2. The trigger duration is 0.05 μsec, and the amplitude is 2 v.

This circuit is also useful for determining the speed of a combination of input network and transistor. The width of the output pulse is the effective turn-on time of this combination.

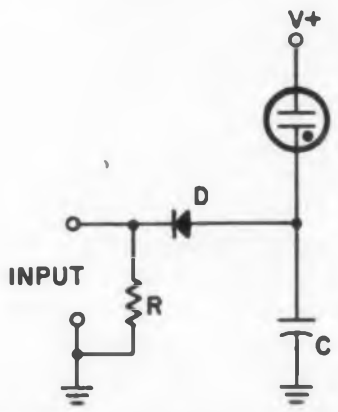
Forrest Salter, Argonne National Laboratory, Applied Mathematics Div., Argonne, Ill.

Holding Capacitors Fires Neon on Short Pulses

By adding a voltage-holding capacitor, neon tube indicators can be used in situations where pulse durations are shorter than the tubes' turn-on time. The capacitor is connected as shown in the figure.

When a fast negative pulse appears, the capacitor C will charge through the diode, D. With the termination of the pulse, the negative voltage is blocked by D and remains on C. If the pulse amplitude is large enough, the tube will fire. After firing, tube current will flow through D and the resistor R.

This idea supports the use of the neon tube indicators as explained by A. Hemel in his Idea for Design "Neon Lamp Matrix Stores Information Visually" (ED, April 27, p 123).



Capacitor C holds the fast input pulse voltage amplitude until the neon tube can fire.

David S. J. Smith, Project Engineer, Stromberg-Carlson Co., Rochester, N.Y.

BOOKS

Control Systems Engineering

William W. Seifert and Carl W. Steeg, Jr., Editors, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y., 964 pp, $15.00.

With over 950 pages, this volume can well live up to its authors' claim of providing "relatively complete coverage" of the mathematical aspects of modern control-systems engineering as applied in the study of complex, large-scale automatic control systems. It was written to serve as a text for the advanced student, or as a reference book for research workers in industrial and governmental laboratories.

The first two chapters introduce the general subject of control-systems engineering and show the important role played by models, both physical and mathematical. The remaining 15 chapters are devoted to a systematic development of the theoretical techniques used in the analysis and synthesis of control systems.

The chapters which provide the necessary background for more advanced topics on control systems are directed toward the control engineer rather than the mathematician. Coverage is included on modern control system theory from the trial-and-error procedures which are commonly used in the design of linear systems to the application of game theory in the synthesis of complex systems. The final six chapters in the book contain a large percentage of new material.

Said to be broader in scope than other books in the field, this volume draws on

the specialized talents of 11 different contributors, all of whom are former members of the Dynamic Analysis and Control Laboratory at Massachusetts Institute of Technology.

Photoconductivity of Solids

Richard H. Bube, John Wiley & Sons, Inc., 440 Fourth Ave., Nek York 16, N.Y., 461 pp, $14.75.

A unified picture and interpretation of photoconductivity phenomena in solids is presented with examples drawn from many different kinds of materials. In addition, the text describes the correlation between photoconductivity and other related phenomena in insulators and semiconductors.

Emphasis throughout is placed on presenting a physical description in order to obtain a qualitative understanding of photoconductivity, rather than on detailed mathematical analyses. Basic concepts of photoconductivity are discussed on a level for both the graduate student and the research worker. However, the text provides more detailed treatment of the current theoretical understanding of the mechanisms of photoconductivity. The chemical preparation and properties of photoconductors are also treated.

An extensive bibliography and a summary of most of the photoconducting materials which have been investigated are included.

Basics of Induction Heating—I and II

Chester A. Tudbury, John F. Rider Publisher, Inc., New York, 132 pp (Vol. I), 133 pp (Vol II), $3.90 ea.

The fundamental principles underlying the induction heating art are presented using the "pictured text" approach.

This approach makes the volumes easily understandable to any reader who is at all familiar with the basic laws of electricity.

Also discussed are the electrical and thermal aspects of induction heating, the mechanical problems associated with fixturing and the applications of induction heating equipment.

BOOKS

Transistor Circuit Analysis and Design

Franklin C. Fitchen, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N.J., 356 pp, $9.00.

The scope and content of this textbook is designed for a one-semester transistor circuits course for electrical engineering students at the junior or senior level. However, it is felt by the author that the practicing engineer, encountering transistors for the first time, will find the analysis and design examples helpful as background for the solution of his specific problems.

It is assumed that the reader has had an introduction to vacuum-tube electronics and has a working knowledge of the fundamentals of both ac and dc circuit theory. The book is introductory and requires no prior knowledge of transistors or of semiconductor physics. The three most important of the many transistor equivalent circuits—the current-generator equivalent tee, the hybrid equivalent, and the hybrid-pi equivalent—are discussed as well as semiconductor physics, characteristic curves, biasing, and circuit gains.

Introduction to Atomic Energy

William G. Atkinson, John F. Rider Publisher, Inc., 116 W. 14 St., New York, N.Y., 68 pp, $1.35.

This little volume is designed as a primer for those who have a desire to learn the fundamentals of atomic energy without consulting engineering texts on the subject. It starts with the discussion of the atom, its components, and the necessary physics and chemistry required for understanding the nuclear force, the fundamentals of radioactivity, the various particles, and other components of nuclear radiation. Then nuclear reactions, with special emphasis placed on the fission reaction, are discussed. A number of different types of reactors, as well as the materials that enter into nuclear reactors, are explained. A later chapter explores reactor design problems. The last chapter provides a specification listing of all existing reactors.

Advances in Cryogenic Engineering, Vol. 5

K. D. Timmerhaus, Editor, Plenum Press, Inc. Proceedings of the 1959 Cryogenic Engineering Conference, 227 W. 17 St., New York, N.Y., 584 pp, $13.50.

Cryogenics—the science dealing with the behavior of materials at temperatures close to absolute zero—has become a practical tool for industry, particularly in the fields of aircraft, electronics, metals, atomic energy, rockets and missiles. The physical properties of materials at very low temperatures differ so vastly from those usually encountered that the engineer cannot rely upon ordinary experience, and so an entirely new and thriving industry has developed.

In order to improve the exchange of information among organizations active in cryogenic engineering, the National Bureau of Standards—Atomic Energy Commission Cryogenic Engineering Laboratory in Boulder, Colo., sponsored the first Cryogenic Engineering Conference in 1954.

The Proceedings of that and all conferences held to date were published to enable scientists to become familiar with research achievements and the development of new techniques.

This latest volume collects the papers presented at the Fifth National Cryogenic Engineering Conference held at the University of California in Berkeley, Sept. 2-4, 1959.

Section headings in the book include applications and techniques, with a paper discussing cryogenic engineering advances in the space age, missile technology, heat transfer, liquefaction and refrigeration, and fluid phenomena.

1960 Radio Diagrams and Servicing Information

M. N. Beitman, Supreme Publications, 1760 Balsam Road, Highland Park, Ill., 192 pp, $2.50

Collected in this service manual are the schematic diagrams and repair information for the new 1960, and older radios. Included is alignment data replacement parts lists, values of voltage and stage gain, and location of trimmers. Material is given for portables, clock radios, record changers, fm, and automobile sets.

RUSSIAN TRANSLATIONS

J. George Adashko

Series-Connected Transistors Increase Voltage Switched To Load

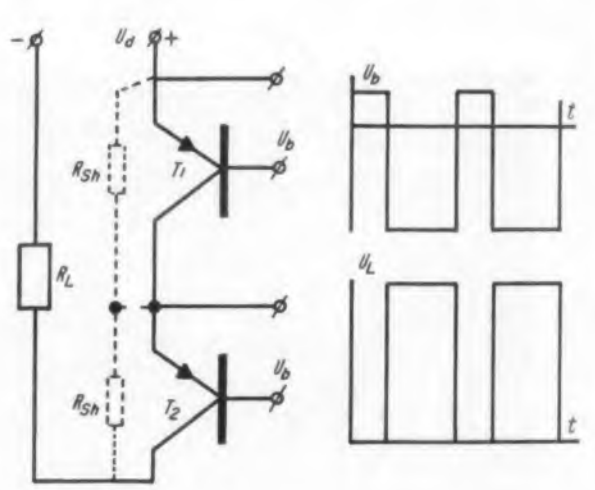
USE OF the junction transistor in switching applications can be greatly expanded by connecting two, or more, of the transistors in series. Such an arrangement by-passes the present limitation caused by the transistor's relatively small maximum collector voltage.

To illustrate the design of series-transistor circuits, we will consider a pulse-width modulation system operating into a resistive load. In Fig. 1a two series-connected transistors, T_1 and T_2, are connected to a load resistor R_1 and to a dc source. The average load voltage can be controlled by varying the duration of the positive and negative pulses at the transistor bases.

In discussing the operation of the circuit three conditions must be considered—the transistors are (1) conducting (2) switching and (3) cutoff.

Conducting Transistors Have Essentially Constant Voltage Drops

The voltage drops across the conducting transistors are small and change little with collector



(a) (b)

Fig. 1. Voltages higher than the individual transistor's rating can be switched by connecting two transistors in series.

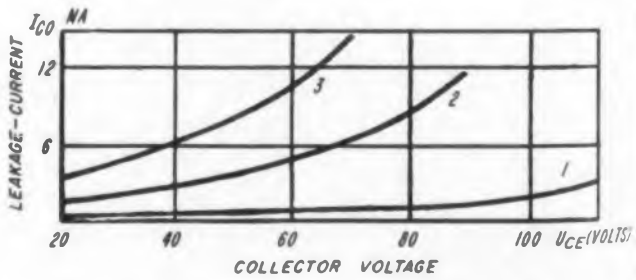


Fig. 2. Since the leakage current-collector voltage relationship varies between units, the source voltage will not divide equally when the transistors are cut off.

current and ambient temperature. Almost all of the power supply voltage appears across the load.

Rapid Switching Required Because of Unlike Characteristics

During switching the operating points of the transistors may not always move "synchronously" along the load lines. This is due to differences in the transistor characteristic, and can lead to an uneven distribution of the potentials across the transistor terminals. For this reason, the switching time should be reduced to a minimum. Switching pulses with sufficiently steep fronts should be simultaneously applied to the transistor bases. These steep fronts can be obtained, for example, from magnetic amplifier circuits having rectangular-hysteresis loop core material.

In designing the circuit, Fig. 1a, it is necessary to know the maximum power dissipated by the transistors. This will help determine the dimensions of any heat-radiating shield, or heat sink. Two powers must be considered: the power dissipated under saturation conditions and the power dissipated during switching.

The first power can be determined from the static characteristics of the transistor. However, calculating the switching power is more difficult. This power is determined from the theoretical or empirical value of the on and off time intervals, t_0 and t_2.

It can be shown that the maximum value of the switching power is approximately $0.15\,P_L(t_0 + t_2)f$, where P_L is the maximum load power, and f is the switching frequency.

Leakage Currents Cause Cut-off Transistors to Divide Source Voltage Unequally

When the transistors are cut-off and there are no shunting resistances, leakage current flows through the series circuit T_1 — T_2 — R_L. The source voltage is applied almost entirely to the transistors. It divides across them in proportion to the resistance corresponding to the particular leakage current. For reliable operation this voltage should divide equally between the transistors within the variations of the load and of the ambient temperature. In this connection, it is necessary to analyze the variation of the leakage current of a cut-off transistor, I_{CO}, under different operating conditions.

For example, let us assume that T_1 has characteristic *1*, Fig. 2, and T_2 has characteristic *3*. Then if the source voltage is 120 v, a simple graphical construction will show that the voltage across T_1 is 108 v and the voltage on T_2 is 12 v. The voltage across T_1 greatly exceeds the maximum collector voltage rating of commonly available transistors (usually 60 to 80 v). This situation can be remedied by using shunting resistances as shown in Fig. 1a. If R_{sh} equals 2.5 K the voltages across the two transistors become, again under the worst combination of transistor characteristics, 68 and 52 v. With better matched transistors the shunting resistance can be increased to 5 or 10 K and excessive heat rise will be prevented even under difficult temperature conditions.

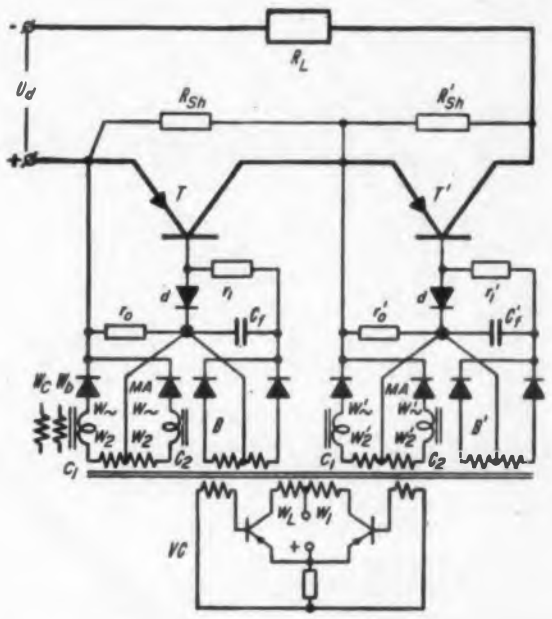


Fig. 3. Control circuit for series-connected transistors has square-wave base pulses supplied by magnetic amplifiers. Shunting resistors R_{sh}, R'_{sh} equalize transistor voltage for cut-off condition.

Complete Control Circuit Uses Series Transistors Fired by Output From Magnetic Amplifier

Fig. 3 shows a complete control circuit, with series transistors, proposed by the author. The voltage converter *VC* serves as the supply to the magnetic amplifier *MA* and generates a rectangular voltage output. The blocking potential in the base circuits of the series connected transistors T and T_1 is produced by isolated supply sources (rectifiers B, B' on the secondary side of the voltage converter) and by means of diodes d, d'. The magnetic amplifier serves to switch the power transistors. Its distinguishing feature is that each of its cores has two ac windings w and w', which are connected to individual secondary windings w_2 and w_2' of the voltage converter. Thus, the parallel electric circuits of the magnetic amplifier are independent, permitting individual control of the power transistors. Since the magnetic circuit is common, simultaneous switching is insured. By varying the saturation angle of the magnetic amplifier from π to 0, the duty cycle of the signal can be changed from 0 to 1, thus changing the average load voltage.

Translated from Series Connection of Switching Transistors, O. A. Kossov. News, Academy of Science of the USSR—Power and Automation #1 *Jan.-Feb. 1960 pp 169-172.*

GERMAN ABSTRACTS

E. Brenner

One-Mc Parametric A

MOST PUBLISHED data dealing with parametric amplifiers are concerned with circuits whose pump frequency is of the order of tens of megacycles or higher. The circuit of Fig. 1 uses a pump frequency of 1 mc. The signal frequency is 100 kc and the nonlinear reactance is a Zener diode, biased in the reverse direction, with the capacitance-voltage characteristic shown in Fig. 2.

The circuit operates as a linear amplifier for small signals, Fig. 3. The voltage gain-bandwidth product is constant, Fig. 4. The experimental results are in general agreement with published data cited in the American literature. However, because of the lower pump frequency used, the pump voltages had to exceed the diode bias to obtain substantial power gain. As a result, the capacitance was driven into the conducting state. The attending losses are not accounted for in the conventional calculations. At higher pump frequencies lower pump voltages suffice, since the negative conductance presented to the signal circuit is proportional to frequency.

Abstracted from an article by R. Elsner, L. Pungs, and K. H. Steiner, Frequenz, *Vol. 14, No. 2, Feb. 1960, pp 59-67.*

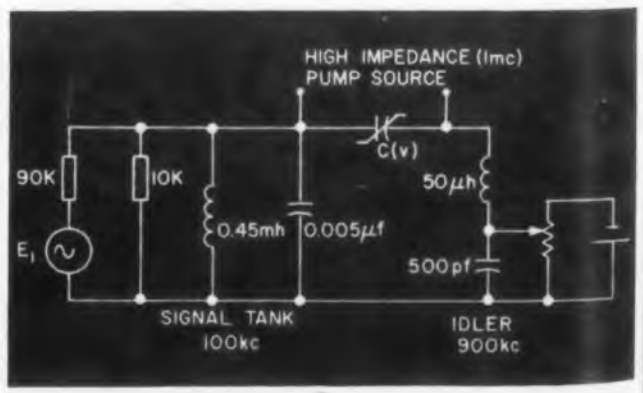


Fig. 1. One-mc parametric amplifier uses the nonlinear reactance of a Zener diode.

Amplifier

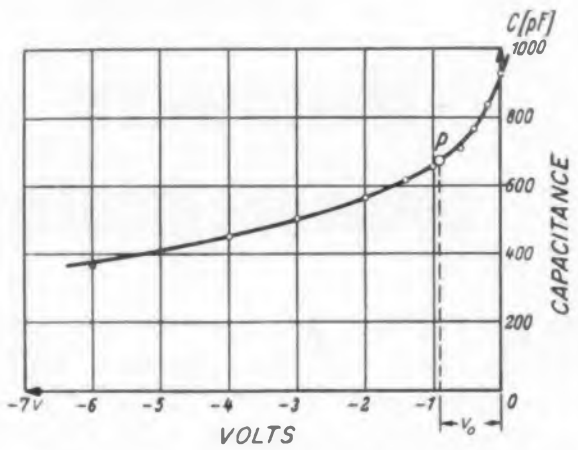


Fig. 2. Zener diode capacitance-voltage characteristic.

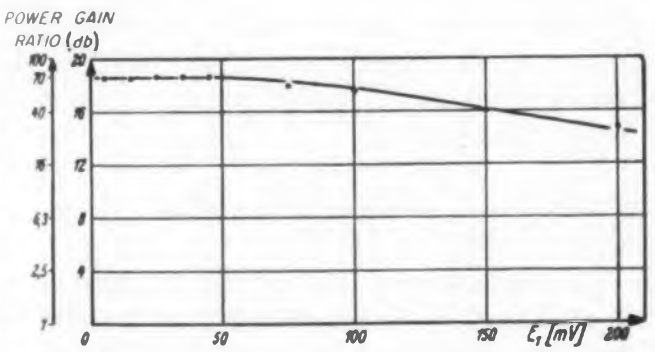


Fig. 3. Power gain as a function of input voltage.

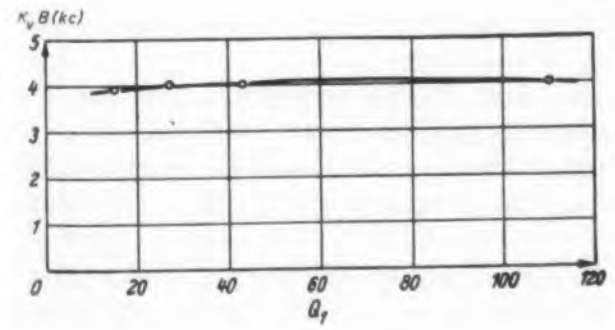


Fig. 4. Gain bandwidth product as a function of signal tank Q.

ELECTRONIC DESIGN
DIGEST
of recent papers and literature

Signal Flowgraphs Simplify Microwave Measurements

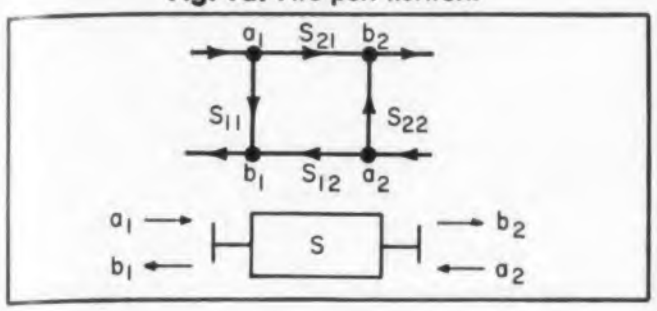
MICROWAVE measurement techniques can be simply analyzed by using signal flowgraphs to describe the networks in the measuring system. The flowgraphs of the individual networks are then combined to represent the entire system. Reviewed here are the methods for setting up flowgraphs of microwave networks and the rules for their solution. An example of the method is then given for a system which measures the reflection coefficient of a load with a directional-couple reflectometer.

Simple Signal Flowgraphs Represent One and Two-Port Networks.

The signal flowgraph is used to represent a set of equations. In the flowgraph the variables are replaced by points and the interrelations are replaced by directed lines. These combine to give a direct picture of signal flow. Fig. 1 shows some simple flowgraphs used as building blocks for more complicated networks.

In Fig. 1a the general two-port network is shown as specified by its scattering matrix coefficients. Here a_1 and a_2 are the complex-entering-wave amplitudes, while b_1 and b_2 are the outgoing-wave amplitudes at ports *1* and *2* of the network. These are represented in the flowgraph as points or "nodes." The "nodes" are related to one another by directed lines (signal flow) marked with appropriate coefficients. These are the scat-

Fig. 1a. Two-port network



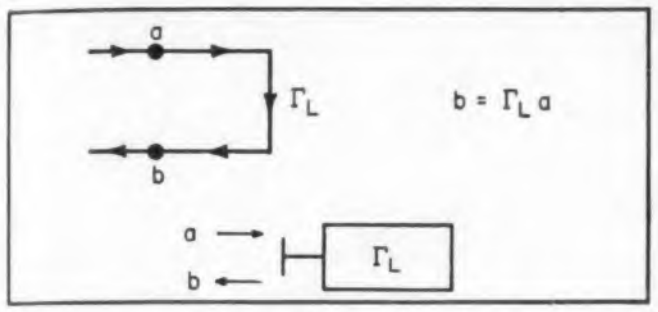


Fig. 1b. Load

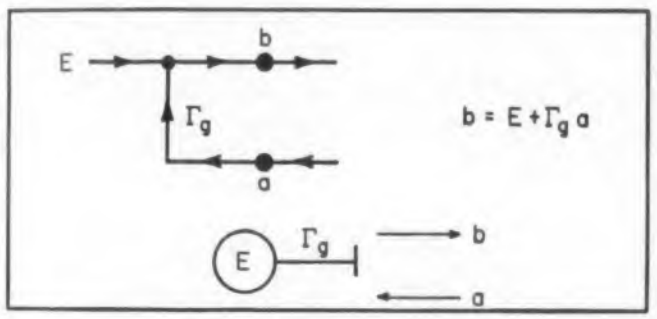


Fig. 1c. Generator

tering coefficients S_{11}, S_{12}, S_{21}, S_{22}. Their meaning is derived from the equations:

$$b_1 = S_{11}\, a_1 + S_{12}\, a_2 \qquad (1)$$
$$b_2 = S_{21}\, a_1 + S_{22}\, a_2$$

Here S_{11} is the reflection coefficient, b_1/a_1, at port *1* when port *2* is terminated in a matched load ($a_2 = 0$). S_{22} is the reflection coefficient b_2/a_2 at port *2* when port *1* is matched ($a_1 = 0$). S_{21} is the transmission coefficient b_2/a_1 from port *1* to port *2* when port *2* is matched ($a_2 = 0$). In all reciprocal networks $S_{12} = S_{21}$. The value of each node in the flowgraph is the sum of all signals entering it, each signal being the value of the node from which it comes multiplied by its path coefficient. The independent variables a_1 and a_2 in the equations represented by the flowgraph are characterized by signal flow which is directed into the graph.

Fig. 1b depicts a termination or load whose reflection coefficient is Γ_L.

Fig. 1c shows a mismatched generator. Here E

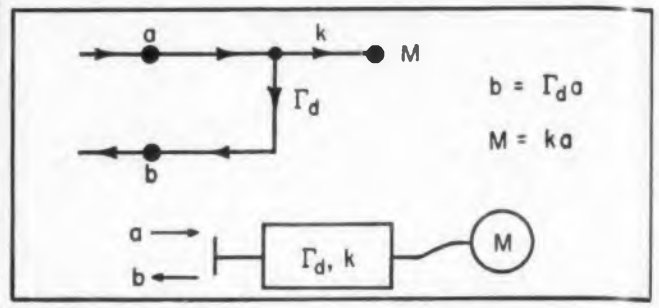


Fig. 1d. Video detector

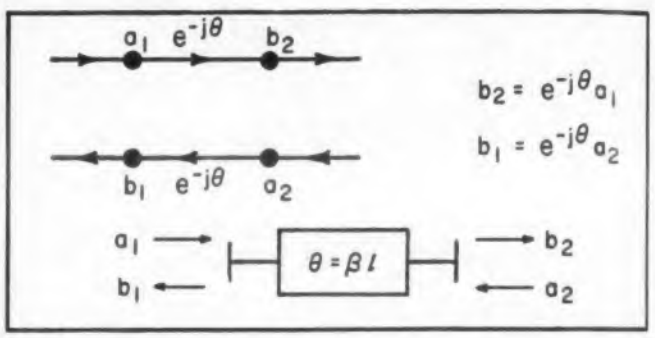


Fig. 1e. Lossless-line length

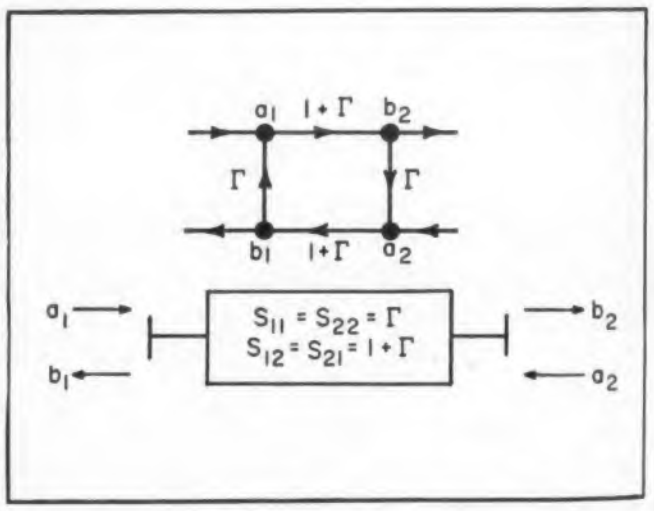


Fig. 1f. Shunt admittance

is the wave amplitude at the port when the generator sees a matched load ($a = 0$), and Γ_g is the reflection coefficient looking into the port when E is zero.

Fig. 1d shows a video detector (such as a crystal or a barretter mount). Γ_d is the detector reflection coefficient at the port, and k is a scalar conversion efficiency relating the incoming-wave amplitude to a meter reading M. It is assumed that this meter is calibrated to take account of the de-

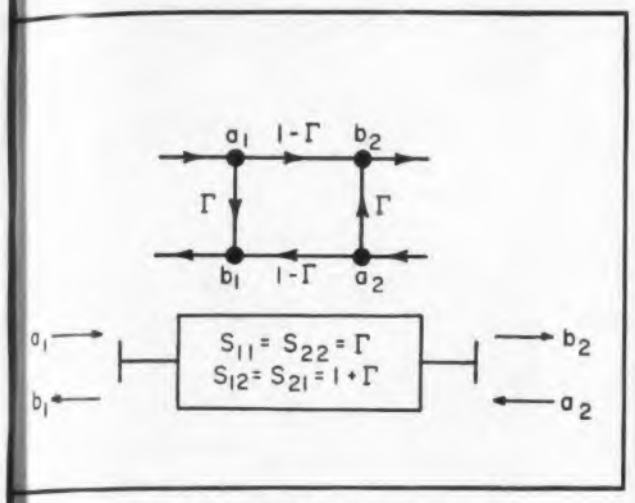


Fig. 1g. Series impedance

tor law, so that k is independent of signal level. is also assumed that Γ_d is independent of signal vel. (Both these conditions are satisfied very arly with detectors used in reflectometer sys- ms in their proper operating range.)

Fig. 1e represents a length of lossless transmis- n line.

Fig. 1f is a shunt discontinuity, such as a junc- n between two lines, or a probe which can be nsidered as a shunt admittance. The coefficient $= S_{22} = \Gamma$ is the reflection coefficient which uld be measured if the discontinuity were fol- ved by a matched load. The coefficient $S_{12} = = 1 + \Gamma$ follows from the fact that the net ve amplitudes on either side of the discon- uity must be equal. The coefficient Γ is related the normalized shunt admittance Y by

$$\Gamma = -\frac{Y}{Y+2} \tag{2}$$

g. 1g is a lumped series impedance. Here the efficient Γ is related to the normalized series pedance Z by

$$\Gamma = \frac{Z}{Z+2} \tag{3}$$

scaded Flowgraphs Form ore Complicated Networks

When networks are cascaded, it is only neces- y to cascade the flowgraphs, since the outgoing ve from one network is the incoming wave to next. This is shown in Fig. 2 where a network place between a generator and a load. The tem now has only one independent variable,

DIGEST

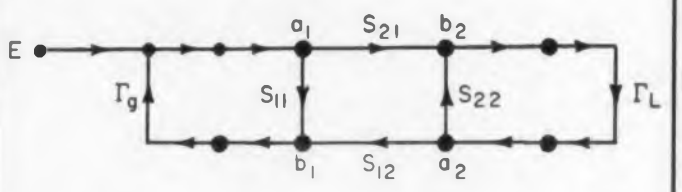


Fig. 2. When a network is placed between a load and a generator, the flowgraphs are cascaded.

the generator amplitude E. The flowgraph contains paths and loops.

A "path" is a series of directed lines followed in sequence and in the same direction so that no node is touched more than once. The value of the path is the product of all coefficients encountered en route. In the figure there is one path from E to b_2. It has a value S_{21}. There are two paths from E to b_1, namely S_{11} and $S_{21}\Gamma_L S_{12}$.

A first-order "loop" is a series of directed lines coming to a closure when followed in sequence and in the same direction with no node passed more than once. The value of the loop is the product of all coefficients encountered en route. A second-order loop is the product of any two first-order loops which do not touch at any point. A third-order loop is the product of any three first-order loops which do not touch, and so on. In Fig. 2 there are three first-order loops, namely, $\Gamma_g S_{12}$, $S_{22}\Gamma_L$ and $\Gamma_g S_{21}\Gamma_L S_{12}$ and there is one second-order loop $\Gamma_g S_{11} S_{22}\Gamma_L$.

A flowgraph is "solved" by applying the "nontouching rule" which written symbolically is:

$$T = \frac{\left\{\begin{array}{r} P_1(1-\Sigma L(1)^{(1)}+\Sigma L(2)^{(1)}-\Sigma L(3)^{(1)}+\ldots) \\ +P_2(1-\Sigma L(1)^{(2)}+\Sigma L(2)^{(2)}\ldots) \\ +P_3(1-\ldots) \end{array}\right\}}{1-\Sigma L(1)+\Sigma L(2)-\Sigma L(3)+\ldots} \qquad (4)$$

Where $\Sigma L(1)$ is the sum of all first-order loops, $\Sigma L(2)$ is the sum of all second-order loops, and so on. $\Sigma L(1)^{(1)}$ is the sum of all first-order loops which do not touch path P_1 at any point, and so on.

P_1, P_2, P_3, etc., are the values of all the various paths which can be followed from the independent-variable node to the node whose value is desired. Thus, each path is multiplied by the factor (in brackets) which involves all the loops of all orders which that path does not touch. T is a general symbol representing the ratio between the dependent variable of interest and the independent variable. This process is repeated for each independent variable of the system, and the results are summed.

As examples of the application of the rule, the transmission, b_2/E, and the reflection coefficient, b_1/a_1, are written as follows:

$$\frac{b_2}{E} = \frac{S_{21}}{1-\Gamma_g S_{11} - S_{22}\Gamma_L - \Gamma_g S_{21}\Gamma_L S_{12} + \Gamma_g S_{11} S_{22}\Gamma_L} \quad (5)$$

$$\frac{b_1}{a_1} = \frac{S_{11}(1 - S_{22}\Gamma_L) + S_{21}\Gamma_L S_{12}}{1 - S_{22}\Gamma_L} \quad (6)$$

Note that the generator flowgraph is unnecessary when solving for b_1/a_1, and the loops associated with it are deleted when writing this solution. Also second- and higher-order loops can quite often be neglected while writing down the solution, if one has orders of magnitude for the various coefficients in mind.

Flowgraph for Three-Port Network

The flowgraph of the general three-port network with the third port terminated by a detector is shown in Fig. 3a. The equations described by the flowgraph are:

$$\begin{aligned} b_1 &= S_{11}a_1 + S_{12}a_2 + S_{13}a_3 \\ b_2 &= S_{21}a_1 + S_{22}a_2 + S_{23}a_3 \\ b_3 &= S_{31}a_1 + S_{32}a_2 + S_{33}a_3 \\ a_3 &= b_3\Gamma_d \\ M &= kb_3 \end{aligned} \quad (7)$$

(note also the $S_{12} = S_{21}$, $S_{13} = S_{23} = S_{32}$ for reciprocal networks).

Since only two rf ports are available with this combination, the flowgraph can be simplified con-

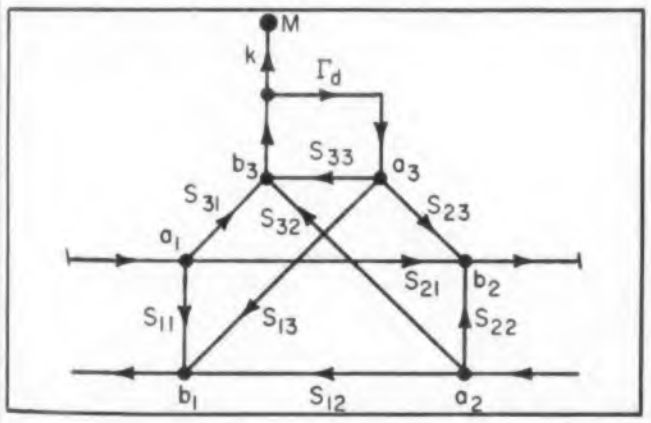


Fig. 3a. Three-port network terminated by a detector.

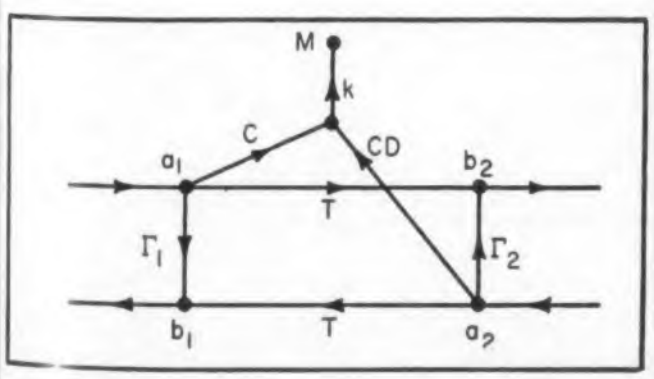


Fig. 3b. With only two available rf ports, network flowgraph can be simplified.

siderably. Fig. 3b shows this simplification. The symbols for the coefficients are chosen with a directional coupler-detector combination in mind. The directional coupler is assumed to have a built-in termination in one end of its secondary arm, and the other end of the secondary arm is the third port which is terminated by a video detector. The relationships involved are:

$$
\begin{aligned}
b_1 &= \Gamma_1 a_1 + T a_2 \\
b_2 &= \Gamma_2 a_2 + T a_1 \\
M &= k\,(C a_1 + CD a_2) \\
\Gamma_1 &= S_{11} + \frac{S_{13}^2 \Gamma_d}{1 - S_{33}\Gamma_d} \\
\Gamma_2 &= S_{22} + \frac{S_{23}^2 \Gamma_d}{1 - S_{33}\Gamma_d} \\
T &= S_{21} + \frac{S_{13} S_{23} \Gamma_d}{1 - S_{33}\Gamma_d} \\
C &= \frac{S_{31}}{1 - S_{33}\Gamma_d} \\
D &= \frac{S_{32}}{S_{31}}
\end{aligned}
\tag{8}
$$

These relationships are written directly through application of the non-touching loop rule, Eq. 4. Note that the path a_1 to M is the main coupling direction involving an effective coupling coefficient C, and the path a_2 to M is the residual coupling direction involving the coupling factor and effective directivity coefficient D. For a directional coupler, the coupling factor as usually defined is 20 log $|(1/S_{31})|$, while the directivity is 20 log $|(S_{31}/S_{32})|$.

Applying Flowgraphs to Measure Reflection Coefficient

A reflectometer system for measuring the reflection coefficient of a load is shown in Fig. 4. In this arrangement a single directional-detector is used with two slide-screw tuners, one at each end of the coupler. These tuners are for cancelling residual signals, which can cause a measurement error. They consist of a probe of adjustable penetration projecting into the line through a slot along which the probe position can be varied.

In the flowgraph of the system the generator tuner reflection is lumped together with the generator reflection as Γ_g', and the load tuner is represented as a general two-port network with coefficients Γ_{t1}, Γ_{t2}, and T_t. It can be shown that Γ_g' can be made equal to any arbitrary value by proper adjustment of the generator tuner (although E varies with the adjustment), and Γ_{t1} can be made any arbitrary value by proper adjustment of the load tuner.

The solution for the meter reading M is

$$
M = \left| CkE' \frac{(D + T\Gamma_{t1}) + \Gamma_L (TT_t^2 - T\Gamma_{t1}\Gamma_{t2} - D\Gamma_{t2})}{\left\{ \begin{array}{l} (1 - \Gamma_g'\Gamma_2 - \Gamma_g'\Gamma_{t1} T^2 - \Gamma_1\Gamma_{t1}) \\ \quad - \Gamma_L\,(\Gamma_g' T^2 T_t^2 + \Gamma_1 T_t^2 \\ \quad\quad + \Gamma_{t2} - \Gamma_g' T^2\, T_{t1}\Gamma_{t2}) \end{array} \right\}} \right| \tag{9}
$$

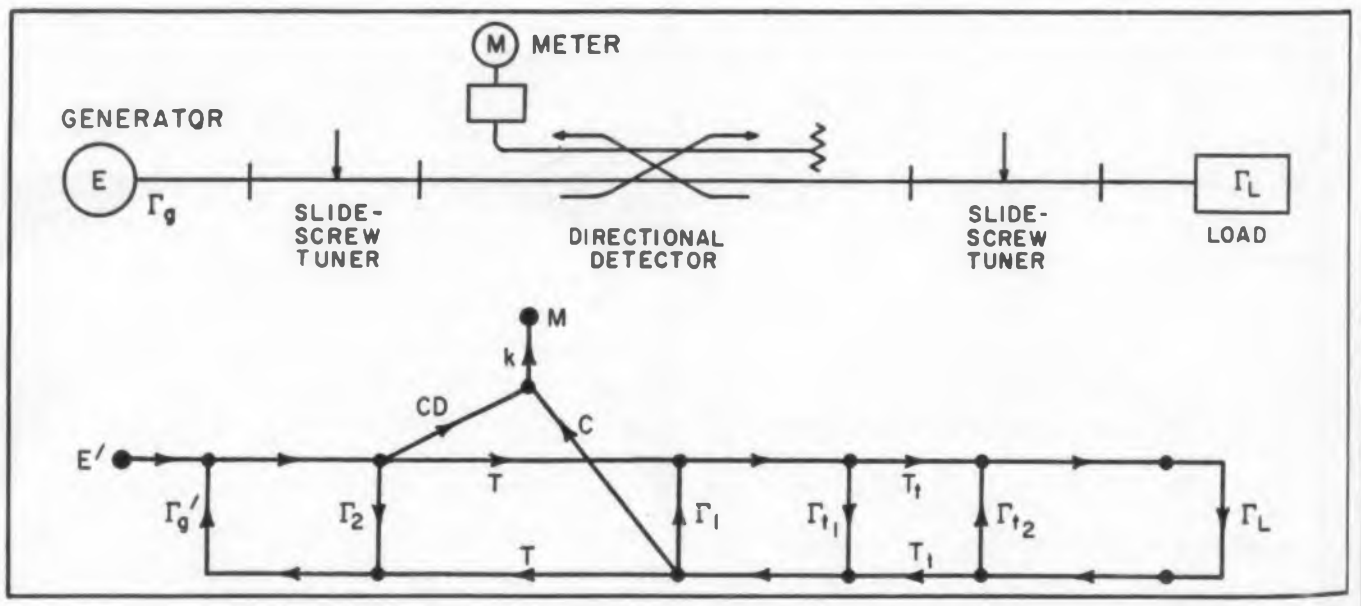


Fig. 4. Equivalent flowgraph of a single-coupler reflectometer used to measure load-reflection coefficient.

This assumes that connector or flange joint reflections are lumped within the tuner networks, and that the coupler coefficients Γ_1, Γ_2, D are small compared to unity. All third- and higher-order loops are negligible, and second-order loops involving Γ_1 or Γ_2 are also negligible. These approximations are quite valid for practical systems and simplify the algebra considerably. Since the meter reading M is not directly proportional to Γ_L, the reflectometer system as it stands cannot give an accurate result.

Procedure

The procedure for achieving the accurate relationship is as follows:

(1) Adjust the load tuner.

Terminate the system with a low-reflection phaseable load. The Γ_L term in the denominator is then negligible by comparison with the constant term, whereas the Γ_L term in the numerator is comparable to the constant term. As the load is moved, the meter reading will vary. By adjusting Γ_{t1} so that no variation occurs, the constant term in the numerator can be brought to zero. This means $\Gamma_{t1} = -(D/T)$.

(2) Adjust the generator tuner.

The system is now terminated with a phaseable short circuit. As this is moved, the meter reading varies as a result of the beating between the Γ_L term and the constant term in the denominator. By proper adjustment of Γ_g' the Γ_L term can be made zero. That is,

$$\Gamma_g' = \frac{\Gamma_1 T_t^2 + \Gamma_{t2}}{T^2 \Gamma_{t1}\Gamma_{t2} - T^2 T_t^2} \qquad (10)$$

With this adjustment no variation in M occurs as the short is moved.

(3) The meter reading is now directly proportional to Γ_L. That is, $M = K\Gamma_L$. The meter reading is adjusted to the reference value of unity by adjustment of a gain control. If now an unknown load is connected to the system the meter will accurately measure the magnitude of its reflection coefficient. In a practical case it may be necessary to apply corrections to the meter readings to take account of small deviations of the detector law from the meter law.

Material taken from Analysis of Microwave Measurement Techniques by Means of Signal Flowgraphs, *J. K. Hunton, Hewlett-Packard Co. The complete article appeared in Hewlett-Packard Application Note 38*—Microwave Measurements for Calibration Measurements.

REPORT BRIEFS

VLF Antennas

The problems involved in applying helical top-loading techniques to large, high-power antennas for the vhf range were studied. Electrical design and performance parameters are calculated for a 15-kc antenna and a 1/10 scale model. *Low- And Very-Low-Frequency Antenna Data, ITT Labs., Nutley, N.J., Oct., 1957, 76 pp, Microfilm $4.50, Photocopy $12.30. Order PB 137694 from Library of Congress, Washington 25, D.C.*

Transistor Logic

Discusses the design of a logic module employing junction transistors. This package is designed as a standard module for logical operation in a digital computer, and employs "NOR" logic in place of the usual "AND," "OR," and "NOT" functions. In addition, the principle of threshold operation for the "NOR" circuit is introduced; this characteristic increases the versatility of the logical operation. The worst-case design philosophy was employed in the design technique. The circuit analysis of this module includes the various input and output loading conditions. A small-signal equivalent circuit for saturation operation is also presented. *Investigation of High-Frequency Transistor Logic Circuit for Digital Application, Thomas Wong, Naval Ordnance Test Station, China Lake, Calif., 1 Aug. 1959, pp 104, Microfilm $5.70, Photocopy $16.80. Order PB 145166 from Library of Congress, Washington 25, D.C.*

Thermionic Emission

Surveys the various materials which may have low electron affinities. More promising materials include MgO, carbides, nitrides, the halides of the alkali and alkaline earths, and ionic compounds of the rare earths. "Hot electron" emission has been obtained under dc operation from silicon diodes after a cesium surface treatment. *Thermionic Emission Studies, G. A. Morton, A. H. Sommer et al., David Sarnoff Research Center, Princeton, N.J., Oct.-Dec. 1958, 22 pp, Microfilm $2.70, Photocopy $4.80. Order PB 145236 from Library of Congress, Washington 25, D.C.*

Broad-Band Transistor Amplifiers

Analysis, comparison, and design of broad-banded, low-pass transistor amplifiers are discussed in this report. The configurations by which broad-banding can be achieved, are common-emitter stages with resistive, series-peaked, or shunt-peaked interstages, and common-emitter stages with a parallel RC network in the emitter

lead. *Shunt-Peaked Transistor Amplifiers, R. S. Pepper and D. O. Pederson, Electronics Research Laboratory, University of Calif., Berkeley, Calif., April 1959, 27 pp, Microfilm $2.70, Photocopy $4.80. Order PB 145696 from Library of Congress, Washington 25, D.C.*

Transistor Equivalent Circuits

Through the use of simpler transistor equivalent circuits a great deal of modern network technology can be easily applied to the study and design of transistor circuitry. In this report, certain of these simple equivalent circuits are investigated and/or clarified. In particular, two topics are given most attention: the problem of excess phase and the incorporation of the depletion layer capacitance to obtain a dominant pole response. *A Note on Simplified Transistor Equivalent Circuits, D. O. Pederson, Electronics Research Laboratory, University of Calif., Berkeley, Calif., Feb. 1959, 16 pp, Microfilm $2.40, Photocopy $3.30. Order PB 145496 from Library of Congress, Washington 25, D.C.*

Junction Transistor Standards

Sets forth measurements and circuits required for the specification and evaluation of junction transistors. The report covers the basic measurements required on most transistors, and specific techniques and circuits for vhf and uhf devices. A sample outline of a portion of a transistor specification is given to demonstrate the acceptance electrical tests. *Junction Transistor Measurements and Practical Standards, Bernard Reich, Army Signal Research and Development Laboratory, Fort Monmouth, N.J., Feb. 16, 1959, 24 pp, $0.75. Order PB 161469 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D.C.*

Printed Circuit Switch

Full details of a printed circuit switch design are shown and examples of various forms of application demonstrated. The switch can be used where printed wiring boards are employed for mounting and interconnecting the component's electrical parts. Included are concentric shaft and multiple decking arrangements. A kit form of the switch is suitable for general experimental use in the laboratory, and the applicability to mass production and automatic assembly methods is stressed. *A Versatile Printed Circuit Switch for Application in the Laboratory and in Production, W. H. Hoffmann, Jr., Army Signal Research and Development Laboratory, Fort Monmouth, N.J., Aug. 1958, 31 pp, $1.00. Order PB 161458 from OTS, Washington 25, D.C.*

YOUR CAREER

NEWS AND NOTES

Most companies rely on the engineer to decide for himself what information he can use on subsequent jobs with other concerns. However, the engineer and his new employer often have been sued for using information gathered at the previous job.

This was the conclusion of a study by the Engineers Joint Council of "Employer Practices and Expectations Concerning the Safeguarding of Proprietary Rights."

The study was based on a survey of 206 companies that employ engineers. The responses indicated that wide use is made of agreements that protect the current employer.

Nearly half the companies said they make contracts with engineering employees to restrict their use of "company-acquired" knowledge either during or after the period of employment.

More than half the companies said their "trade secrets" are defined for engineering employees at some time during the employment period.

However, 68 per cent of the concerns said they did not review with the employee, at the time of his leaving the firm, the information that is considered restricted, or a definition of restricted information for his future guidance.

° ° °

The Martin Co. in Baltimore will send a man to Johns Hopkins University every year to perpetuate the name of the nation's first space program—Project Vanguard.

Under the terms of the Project Vanguard Annual Graduate Fellowship, the recipient must be a candidate for a bachelor's or master's candidate in engineering or the physical sciences. He may be a citizen of any of the 61 nations that participated in the International Geophysical Year from July, 1957 to December, 1958.

Of the $5,000 included in the fellowship, $3,000 will be given to the Fellow and $1,200 will be applied to his tuition. The remaining $800 will go to the university for administrative purposes.

The Martin Company was the prime contractor for the rockets used in Project Vanguard, under which three artificial satellites were placed in orbit around the earth.

° ° °

The president of the American Rocket Society has called on engineering professional societies to stimulate creativity.

H. S. Seifert, at the recent ARS meeting in Los Angeles, made the following suggestions to the societies:

- Attract young researchers into society activities by establishing, for example, mixed panels of junior and senior engineers.
- Arrange summaries of the "state of the art" to alleviate confusion on the part of young researchers in new, broad fields.
- Program "free-forum" sessions where any member can make a 15-minute presentation of his work without review or necessity for publication in any but abstract form.
- Support youth programs and adequate secondary teacher training to encourage young persons to enter technical fields and receive proper education.
- Encourage philosophical papers that deal with the future to direct young persons to promising research goals.
- Arrange informal meetings between engineers and scientists in different fields.

° ° °

Companies should give more consideration to increasing the individual engineer's productive rate, according to Lynn C. Holmes, director of engineering operations for Stromberg-Carlson, Rochester, N.Y.

Many companies, he said, try to increase their engineering output by using more engineers or by increasing the time spent on a project. He suggested, however, that greater output could also be obtained if the "rate factor" were increased.

Companies could improve their engineers' productive rate, he said, by providing more training, better supervisors, adequate wage incentives, and a good working environment.

Two factors that determine the engineer's rate were beyond the company's control, Mr. Holmes said. They were the man's inherent ability and his "individual drive."

Mr. Holmes made his remarks in a talk on "More Output From Fewer Engineers" at a conference on "Utilization of Engineering Manpower" at Garden City, N.Y.

° ° °

Engineering education today is being pulled simultaneously in opposite but necessary directions, according to Robert F. Goheen, president of Princeton University.

The need to replace the "traditional approach" of emphasizing specialized training with "an engineering education that emphasizes ideas, generalizations, concepts, and principles" exists, he said, alongside the need to broaden engineers' humanistic education.

The latter, however, "must be acquired with little or no diminution in the competence of the engineer to handle technical facts and scientific data," Dr. Goheen told the recent graduates of the Newark College of Engineering, Newark, N.J.

He said the engineering profession may eventually require four years of liberal-arts education as a preface to professional training.

° ° °

Design engineers these days often "don't know" what they have done until they speak to a public-relations man.

For the benefit of those engineers who haven't had time to think about it, they were involved in the following phases of industrial development (according to the "Engineer's Lexicon" of the Auburn Manufacturing Co., Middletown, Conn.):

STRICT QUALITY CONTROL IS NOW BEING EXERCISED—We fired the girl who was dropping hairpins in the gunk.

MODERN PRODUCTION EQUIPMENT HAS BEEN INSTALLED—The old machine fell apart and we had to buy a new one.

A CONTINUING EXPANSION PROGRAM—Last year we installed a new sink in the washroom and the year before the president put up a shelf in his closet.

HIGH ACCURACY—The joints meet.

FIELD TESTED—The lab was too crowded.

EXTENSIVE DEVELOPMENT WORK LED TO THIS NEW ADHESIVE—While working on another project, this stuff spilled on the floor and we still haven't been able to clean it off.

ADVANCED DESIGN—The advertising copy writer couldn't understand it.

EXCITING NEW PRODUCT—This sold miserably for the past 11 years so we have added some chrome and repackaged it.

AFTER PAINSTAKING ENGINEERING WORK—We really goofed around on this for about three years and finally hired a competitor's engineer to get the secret.

MORE THAN SATISFIES NAVAL REQUIREMENTS—The Swiss Navy, that is.

The complete course in deciphering the PR man is available from Auburn free of charge.

PAGES
MISSING
ARE NOT
AVAILABLE